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Title: Agri and food waste valorisation co-ops based on flexible multi-feedstocks biorefinery processing technologies for new high added value applications.

Acronym: AgriMax

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Deliverable 8.5	**Proceedings on the stakeholder workshop on AFPW sustainable supply chains**
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Executive summary

Background

Unabated resource use has led to a multitude of environmental concerns in addition to creating problems for many industries in relation to the security and cost volatility of their operational resources. Much of these problems are caused by widespread traditional linear business models that operate on a '*take-make-dispose*' basis. To improve resource efficiency and make the wider economy more sustainable, businesses are being encouraged to transition toward circular business models which focus on the preservation of resources and their efficient use and reuse within and between supply chains. Successfully creating a circular business model (CBM) and realising the potential benefits of such models, however, requires a high degree of supply chain collaboration that goes beyond typical, largely autonomous, buyer-supplier relations.

Bringing together a range of project stakeholders, a workshop was held in Lleida, Spain, on the 28th of September 2017, to collect information required for the development of circular business models to realise the Agrimax supply chain. Typically, a business model provides information on the operations of a business, including for example key business partners, business assets, customer segments, sources of revenue and costs. It can help identifying areas for intervention and options to change a business' value proposition. Within a circular business model, this visualisation and characterisation of business operations and its offerings is extended to explicitly include environmental and social costs and benefits and assess its supply chain and the wider socio-economic-environmental context.

Bringing the wider supply chain and context into the business model equation encourages greater consideration of a business's impacts and opens up opportunities for collaboration, not least in the cascaded, more efficient and innovative use of materials and the consequent benefits derived from resource efficiency and innovation. The potential for new business opportunities which can deliver wider benefits to the environment, society and economy in the form of cost savings, new sources of income, resource conservation, waste and emission reductions and new jobs, which are the product of CBMs, fits the remit and requirements of the proposed Agrimax supply chain.

The degree of collaboration required to develop a CBM, which incorporates high levels of innovation, comes with a variety of challenges. The workshop offered the opportunity to address these challenges proactively, and as such the objectives were to identify:

- Existing business models used for AFPW to be valorised further with Agrimax
- New business models for farmers, food processors, cooperatives, biorefineries and end-users in the future Agrimax supply chain.
- Key constraints and drivers for changing existing supply chains into the new Agrimax circular supply chain: a) Within companies and the supply chain and b) In the wider economic, social and environmental context

Methods

Prior to the workshop a detailed review of literature pertaining to CBM theory and empirical CBM case studies were performed. This review informed the design of the Agrimax workshop and formed the basis for the sharing of key information with the participants ahead of the workshop, to enable their active participation in all workshop activities. Over 70 stakeholders from research, industry, agriculture and government participated in the workshop. During the workshop, participants were split into groups aiming to have representation of the whole supply chain in each group, from the perspective of specific feedstock materials from the olive, potato, tomato, and cereal production and processing.

Initiating proceedings, groups were asked to consider a variety of questions on the types of waste and by-products in their sectors and any current management and issues.

After answering these questions, participants mapped existing business models for agriculture and food processing wastes. Where possible these were models of their own companies. With the insight derived from this exercise, each group worked collaboratively to develop a CBM for either an Italian or Spanish Agrimax cooperative or Agrimax biorefinery.

Based on the CBMs produced by the groups, the existing business models developed individually by participants were analysed to assess what changes would need to be made to these models to allow them to engage in the proposed circular Agrimax supply chain. To conclude the session, participants conducted a demand-based back-casting exercise to identify how value added propositions can be mutually aligned within Agrimax supply chains, and whether any supply chain stakeholders would face barriers or be supported by drivers in offering that value proposition.

The workshop was concluded with a PESTEL analysis (i.e., in respect of Political, Economic, Social, Technical, Environmental and Legal factors) to identify contextual drivers and barriers.

Results

For upstream supply chain actors, canvases and group discussions revealed that *resource security* (including the quality and quantity of input and output materials) was a prominent motive for moving toward a CBM. Quality control, linked to *storage and logistics*, was also considered important. Related to this, the storage of raw materials appeared to be considered the *collective responsibility* of the farmers, food processors and Agrimax cooperative, with the cooperative being suggested to play a key role in coordinating the resource logistics.

For downstream stakeholders, standardisation and certification of potential products received numerous mentions within canvases. This suggestion needs further research; however, discussions inferred that certification would provide product assurance and, potentially, allow a premium to be charged for products. Further analysis of these suggestions also implied that more thought is required on downstream end-user product offerings.

In respect of the holistic nature of CBMs, canvases and table discussion suggested that a balance needs to be struck between economies of scale and economies of scope during the realisation and upscaling of the Agrimax supply chain. Along the whole supply chain, investment in required facilities and R&D, staff training and the use of new resources from traditional waste products were emphasised as areas of importance. To engage in the Agrimax supply chain, several changes to the business models of stakeholders who are currently producing/processing primary produce were duly proposed. The more prominent of these included:

- Development of new manufacturing processes, albeit with an acknowledgment that any investment in new infrastructure must not lead to significant increases in operational costs.
- Due to the perceived complexity of the Agrimax supply chain, a greater coordination of stakeholder activities may be required to manage flow and quality of waste supplies.
- Investment to co-locate the cooperative and biorefinery, the costs of which would need to be balanced with the overall logistics costs.

In respect of the contextual aspect of realising an Agrimax circular supply chain, CBM barriers took a variety of forms. The most commonly identified barriers were legal, in respect of *legislation involved in the use of wastes as products*; social, in the general form of *consumer acceptance of wastes being used in products*; and economic in the form of the *initial investment needed to build the required infrastructure*, i.e. CAPEX. Legislation related to the potential use or reuse of waste products was by far the most heavily cited and voted for barrier, raised by representatives of all crops to be used in the Agrimax supply chain (olives, potato, tomato, cereals).

Of drivers, there were four prominent themes cited, each receiving double or more votes than the remaining contextual drivers. These key drivers were seen to be: social, in respect of increasing

consumer awareness and demand for what are deemed to be environmentally friendly products; environmental, in the form of *waste reduction*; economic, in the form of *creating new markets and customer segments* and, another social driver, *job creation*. Unlike the more selective citation of barriers, notably these drivers were applied to each of the crops and by most groups.

Conclusions and next steps

The stakeholder workshop has provided important insights into the sustainable supply chains that Agrimax seeks to create, identifying critical stakeholder issues such as contextual constraints and drivers that must be addressed in the development of effective circular business models. More work is needed to develop both the CBMs of the Agrimax cooperatives, biorefineries and other supply chain partners. Specifically, further insights need to be gained into the existing business models of the supply chain partners, up- and downstream from the Agrimax cooperative and biorefinery. The work conducted before and during the workshop was innovative in itself and, to an extent, experimental.

The proceedings and results of the workshop add to business model development best practice, both in respect of assessing complete supply chains, and in relation to which supply chain partners are best placed to deliver which part of a given model - including the proportion of costs and benefits associated with those. As a minimum, to enable CBM development within Agrimax, a clearer picture of the end goal and the roles of all supply chain partners needs to be prepared.

Notable questions raised during the day revolved around who would be responsible for the organisation, collection and treatment of waste products, the need to clarify thinking on intended end-users and their needs, in addition to the need for better insight into the waste management needs of potential biorefinery residues. Moreover, existing business models on the valorisation of food waste suggested that certification and standardisation for the future Agrimax supply chain may be a valuable asset to secure access to customer segments.

Many questions and areas of research remain in respect of developing a CBM for the Agrimax supply chain. Moving forward, areas of immediate attention should include:

- Clarification of who will be the customers for Agrimax products.
- Analysing consumer acceptance of waste derived products whilst strengthening consumer awareness and demand for products with environmental and health benefits.
- Assessing the market size for waste derived environmentally friendly products.
- Understanding the potential and level of legislation change required to market new products created from waste and by-products, and working with the regulators to realise the required changes.
- Clarity on benefits to the local economy, including on the type and number of new jobs that will be created with the successful realisation of the Agrimax supply chain.
- Clarification on the level- and source of investment required at project initiation.

The work on CBM development for the Agrimax supply chain will continue within the next tasks in WP8.2. In addition, further case studies of CBMs will be carried out to learn from successful examples and transfer this knowledge to the Agrimax project. Alongside the development of business models, LC will collaborate with Agrimax consortium partners to translate the models into fully fledged business plans to realise the desired project outcomes.

1. Background

This report forms part of Task 8.2 of the Agrimax project: “Set up of the cooperative processing business model”. It also contributes to the delivery of Work Package 8: “Circular Economy strategy and Innovation Impacts”. The objectives of Task 8.2 are to:

- Implement a joint stakeholder platform for operating the cooperative processing plants.
- Define sustainable supply chains and propose suitable business models for the cooperative processing of AFPW.
- Maximise the innovation impacts of the project for contributing to the uptake of the project results for growth and jobs.

Task 8.2 is split into three subtasks:

1. Provision and delivery of a stakeholder workshop (M12).
2. Production of an interim report on feedstock production and current utilisation (M24).
3. Contribute to report on sustainable AFPW cooperative business models, supply chains and consumer perception aspects.

All subtasks are carried out in conjunction with other tasks such as Task 8.1 setting up a stakeholder platform, Task 8.3 on supply chain and consumer perception and Task 8.5 on exploitation planning.

This report covers the preparation, organisation and proceedings of the stakeholder workshop on agricultural and food processing waste (AFPW) sustainable supply chains. The objective of the workshop was to collect the information required to advise the development of circular business models that will underpin the future Agrimax supply chain.

The presented workshop proceedings provide details on:

- Existing business models used for AFPW to be valorised further with Agrimax
- Potential business models for future Agrimax supply chain partners
- Key constraints and drivers for the Agrimax supply chain

Agrimax stakeholder workshop

2. Introduction

2.1 From a linear- to a circular economy

Exploitation of resources has brought economic prosperity and improved well-being for many people around the world (MEA 2005, UNEP 2015, 2016). However, economic challenges are increasingly mounting as a result of the linear *take-make-dispose* model of resource use combined with a growing and increasingly affluent global population (UNEP 2016). With the accelerated exploitation of natural resources and consequent production of wastes and emissions, the environment which we all depend on, is being irreversibly changed (Rockstrom et al. 2009).

Faced with the effects of climate change and economic constraints resulting from resource scarcity and price volatility, governments and businesses alike have started to transition towards more circular, resource efficient and bio-based economic activities that are less dependent on fossil resources (OECD 2009; Laybourn and Morrissey 2009; UNEP 2011; Dobbs et al. 2011; EC 2011a, 2011b; Lee et al. 2012; Accenture and UN Global Compact 2013; Lin et al. 2013; Finster and Hernke 2014; Hoffman et al. 2014; IPCC 2014; Morgan 2014; Rowney 2014). The transition towards a circular economy is necessary, maintaining the utility and value of materials, components and products for as long as possible. The adoption and integration of circular economy practices has direct benefits for companies, such as greater resource security and cost stability, the ability to meet increasingly stringent and sometimes punitive carbon reduction targets, and reduced waste management costs.

2.2 Circular business models

Realising a circular economy requires resource innovation and development of alternative business models. Business models can be described as: *"the rationale of how an organization creates, delivers, and captures value*" (Osterwalder and Pigneur 2010). Osterwalder and Pigneur proposed a business model canvas with nine components, such as key partners, value proposition, cost structure and revenue streams (Figure 1). Effectively, business model *innovation* involves modifying one or more of these components to identify a new way of creating, delivering and/or capturing value.

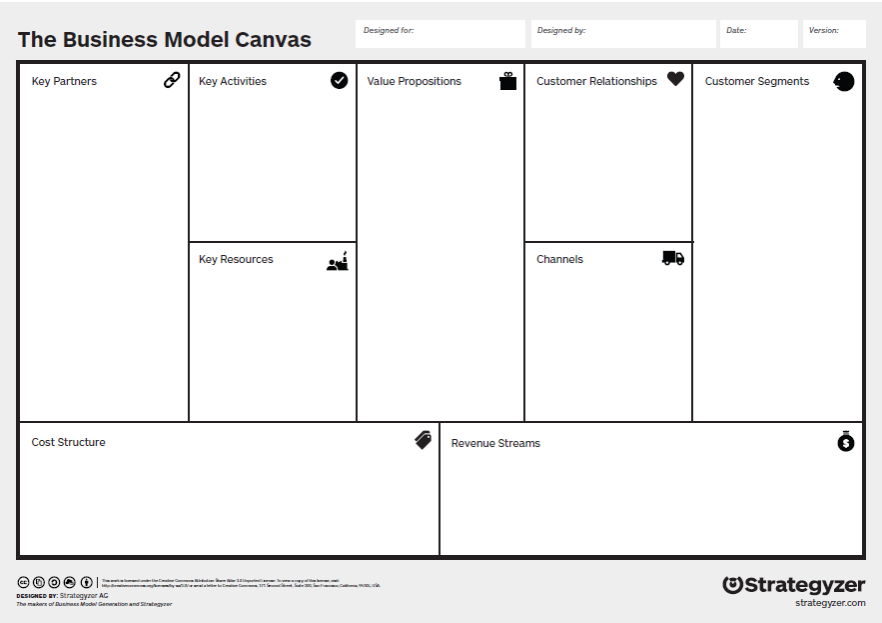

Figure 1: The original business model canvas developed by Osterwalder and Pigneur (2010).

In Circular Business Models (CBMs) additional components, or dimensions, are added to the traditional business model canvas. In this way, elements are integrated into the canvas that help to redefine relations between natural resources, markets and customers (Accenture 2015). CBMs explain how an

organisation adds value to a supply chain with- and within closed material loops (Mentink 2014, Antikainen and Valkokari 2016).

The original business model canvas focuses on one company and their suppliers and other partners. When developing CBMs, however, the focus of the model goes beyond these direct supply chain linkages. For a CBM it is essential to consider the complete supply chain and its wider economic, societal and environmental context (Figure 2).

The exploration and consideration of a wider business context is important because circular supply chains should, it is suggested, be restorative and regenerative by design (Ellen MacArthur Foundation 2017). It is also crucial to understand where in the supply chain which economic, social, technical and environmental values are created and destroyed (Iacovidou et al. 2017), and how mutual benefits for all supply chain partners can be realised.

As such, in developing CBMs, a canvas is required that covers the wider supply chain and context of a given service or product (discussed further in the following sections).

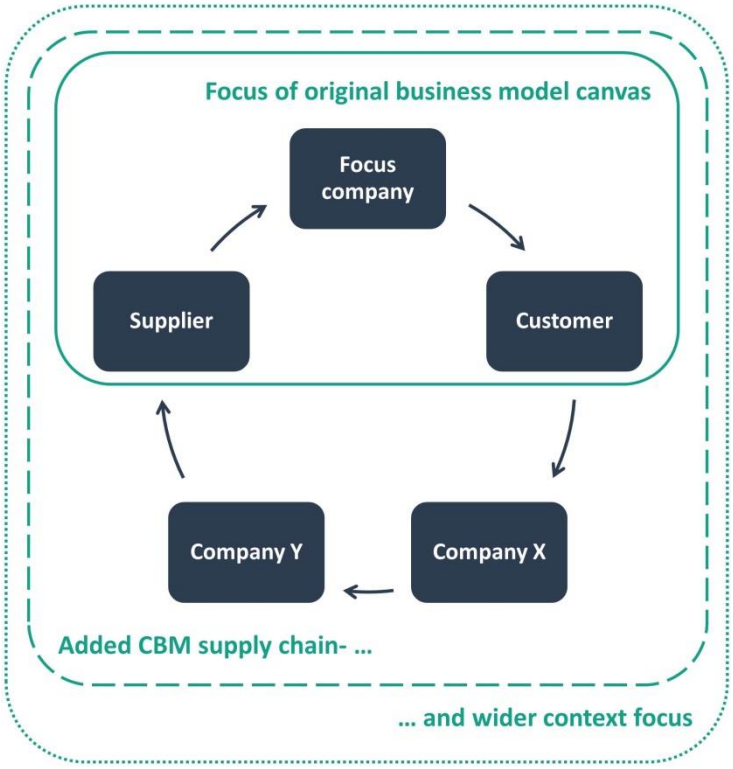

Figure 2: To ensure that a circular business model is sustainable, it is essential to view it in the context of the full supply chain and its wider environmental, social and economic context.

2.3 Drivers and barriers to the adoption of CBMs

Globally, half of company CEOs are looking to adopt CBMs (Accenture and UN Global Compact 2013). There are a variety of drivers and barriers for companies wishing to adopt CBMs. Prominent drivers, creating competitive advantage, include:

- ✓ Cost savings through waste reduction
- ✓ New sales through creation of new products
- ✓ Reduction of risks associated with sourcing primary raw materials
- ✓ Access to and availability of new enabling technologies
- ✓ Differentiation potential to compete on values other than lowest price

- ✓ Business growth opportunities when transitioning from resource- to performance-driven business models

While these drivers are positive and can be compelling, in adopting CBMs there are challenges to overcome as well. For example:

- Availability of financial capital for investment in innovation
- Overcoming mental barriers within companies that can prevent people from being able or willing to understand the business opportunities associated with circular practices (i.e., the cost and time of performing 'change management')
- Coordination within the supply chain to align individual CBMs with each other's needs

Supply chain coordination and collaboration is crucial to successfully realise CBMs. As alluded to above, while 'traditional' business models have a tendency to centre on one company, CBMs broaden the scope to optimise the creation- and prevent destruction of values in the supply chain (Figure 2).

Identification and raised awareness of the economic, environmental, social and technical values in a supply chain can be associated with the repositioning of agreements between companies. This raises questions over who is responsible for new costs and negative impacts, if any, and who gets to take credit- for and ownership of- the additional benefits? Moreover, how can risks be shared in the supply chain and how can partnerships be strengthened to ensure that the whole supply chain benefits from CBM innovations?

In sum, CBMs cannot be developed and realised by one company alone, it has to be a concerted effort of actors along a supply chain. In this way, CBMs can be aligned with each other, increasing the viability of the whole supply chain.

2.4 Workshop purpose, aim and objectives

Given the importance of supply chain collaboration in the development of CBMs, Agrimax has taken a proactive approach, bringing relevant supply chain actors together at an early stage. In this way their interests and envisioned benefits can be identified at an early stage, while facilitating the building of understanding between these actors in order to prevent issues that could otherwise emerge at a later stage and to initiate viable business models for the Agrimax supply chain that will be realised in the near future.

This first subtask of Task 8.2 (introduced in Chapter 1 Background) aims to collect the information required to create and provide advice on the development of CBMs for the future Agrimax supply chain. The proceedings presented here include the inventory and extension of best practice for CBM innovation, in preparation for the stakeholder workshop. The workshop had the objective to collect information on the following subjects:

- Existing business models used for AFPW to be valorised further with Agrimax
- New business models for farmers, food processors, cooperatives, biorefineries and end-users in the future Agrimax supply chain.
- Key constraints and drivers for changing existing supply chains into the new Agrimax circular supply chain:
    - Within companies and the supply chain
    - In the wider economic, social and environmental context

Chapter 3 will briefly introduce the approach taken in preparation of the workshop. Chapter 4 presents results from the CBM innovation best practice review. Chapter 5 and 6 present the workshop design and results. Chapter 7 completes the report with conclusions and recommendations for the development of Agrimax biorefinery and cooperative CBMs.

3. Quick-scan for workshop design and participation

In preparation for the workshop, a quick scan inventorying relevant workshop methods, requirements and constraints was carried out in collaboration with the workshop co-organisers BioVale and FCAC. The scan included the following elements:

Openness
Check how sufficient openness and trust could be created between the organisers and the participants to contribute to developing new business models. While sufficient openness and trust was present from the start, a need was identified for the inclusion of capacity building communications and activities before and during the workshop.

Logistical considerations for participants
The cost and time involved in participants attending the workshop was checked. Peak farming times were avoided as far as possible. The workshop was organised at a location and date that coincided with many of the invited participants already being in the chosen area.

Language
This workshop involved participants from multiple European countries. As such, the native and second language abilities of participant groups, and measures to ensure inclusivity for all relevant actors, was discussed.

Motivation to participate
The basic drivers, barriers, problem perceptions and engagement style of anticipated participants were discussed and the workshop design adapted accordingly.

Identify potential participants
Key participants were identified along the complete future Agrimax supply chain along with agreeing a clear communication strategy for inviting and registering participants.

Review of CBM best practice
CBM types, drivers and barriers, and approaches for CBM innovation were inventoried ahead of the workshop. Best practice was assessed through a review of professional and academic literature.

The above discussion results and agreements were incorporated into the workshop design, the invitation of participants, pre-workshop communications and delivery of the event. Findings of the best practice review are discussed in Chapter 4 with an overview of the workshop design provided in Chapter 5.

4. Circular Business Model best practice

This section includes results from a review of professional and academic literature. Results are shared on:

- Typical CBM types
- CBM barriers and drivers
- CBM innovation approaches

4.1 Circular Business Models

Circular Business Models (CBMs) have been characterised by longevity, renewability, reuse, repair, upgrade, capacity sharing and dematerialisation (Accenture 2014). They strive to eliminate waste and increase resource productivity while, similarly to 'linear' business models, offering a value proposition around quality, price and availability. Key characteristics of CBMs include maximising material- and energy efficiency and the usage of renewable resources. End-of-Life (EoL) options are designed into the supply chain to align the production and selling of products with (prolonged) usage and returning products into following cycles of production and consumption. Resource loops can be closed within one business model or within a system of business models (Mentink 2014, Antikainen and Valkokari 2016). Often this includes a transition from selling products to offering functions, described by the company Philips as a transition from a transaction- to a relationship-based business model (Accenture 2014). Additionally, CBMs increase value by (Accenture 2014, Antikainen and Valkokari 2016):

- Making resources last or be used longer by closing loops
- Enabling the usage of products by multiple clients
- Lengthening of material, component and/or product life cycles
- Linking supply chains through, for example, industrial symbiosis
- Integrating societal and environmental benefits
- Creating benefits for stakeholders beyond the direct supply chain

CBMs have been categorised in a number of ways. Stahel (1994) identified CBMs based on the speed at which resources are used, distinguishing slowing, closing and narrowing loops, including reuse, recycling and using fewer resources per product respectively. Norden (2015) categorised CBMs largely according to the lifecycle of products: product design, service- and function based models, collaborative consumption, reuse, repair, recycling and waste management. This categorisation appears to largely resemble levels of the waste hierarchy. Alternatively, Renswoude et al. (2015) identified six categories based on the pathways via which resources flow through the economy: short cycle, long cycle, pure circles, dematerialised services, and produce on demand. Some controversy, however, exists around the inclusion of down-cycling of resources into lower value applications, with this arguably only extending linear supply chains rather than closing material loops, and thermal recycling i.e. energy recovery as a type of CBM (see e.g. Bocken et al. 2015).

In total, eight archetypes of CBMs were derived from academic and professional literature (Table 1), which can be linked to different stages in the production and consumption cycle. Differences between the archetypes and types of CBMs within them are subtle; however, of the presented CBMs, those based on 'circular supplies' and 'resource recovery' appear to apply most directly to the proposed Agrimax supply chain. Circular supplies CBMs are based on renewable resources including biomass. Resource recovery models focus on energy and resources from by-products and wastes. Given ideas around a potential interactive platform to match AFPW supply and demand, on-demand CBMs may also hold some relevance for Agrimax.

Table 1: Overview of Circular Business Model types (Renswoude et al. 2015, Accenture 2014, Bocken et al. 2015, BSI 2017, WRAP 2017, ZWS 2017)

CBM archetype	Category
Lean manufacturing	Circular supplies Recycling
Resource recovery	Industrial symbiosis Integrated closed-loop recycling Collaborative production Cradle-to-cradle Extending resource value
Remanufacturing and manufacture from secondary materials	Refurbish, remanufacture and recondition Manufacture by secondary material Incentivised return Upcycling
Product life extension	Reuse Encouraged sufficiency Extending product value Repair
Sharing platforms/ Collaborative consumption	Peer-to-peer lending Sharing platforms/ resources
Product as a service/ Product-Service System	Hire and leasing Access and performance Pay per use
On-demand	Produce on order 3D-printing Customer vote on design
Dematerialisation	Physical to virtual Subscription-based rental

4.2 Drivers and barriers

A significant proportion of CEOs are looking to integrate circular practices into their business models (Accenture and UN Global Compact 2013). While CBMs used to be adopted primarily by start-up companies, they are increasingly implemented by multinationals too (Lacy and Rutqvist 2015). The growing interest in CBMs is driven by a number of risk management considerations and business opportunities. Adding to those presented in the introduction, drivers include (Accenture and UN Global Compact 2013, Accenture 2014, 2015, Molander and Jewell 2016, Kraaijenbergen et al. 2016, Linder and Williander 2017):

- Brand protection
- Limit resource availability risks
- Enhanced understanding of customer segments and their demands
- Limit resource accessibility and price volatility
- Cost savings through waste reduction
- Increased innovation capacity through new supply chain relations

In addition to the more business orientated drivers of CBMs, there are contextual drivers. These include growing pressure to limit environmental impacts and sustainability challenges such as population growth and resource availability. Positive contextual drivers, meanwhile, include the creation of new jobs and availability of innovative enabling technologies such as the internet of things and robotics (Accenture 2014, Kraaijenbergen et al. 2016, Molander and Jewell 2016, UNEP 2016, Velenturf and Purnell 2017). Legislation can be a driver, however, the absence of supporting policies and regulations is equally perceived as an important barrier for the uptake of CBMs (Stahel 2010, Kuo et al. 2010, Accenture and UN Global Compact 2013). Similarly, the presence or absence of specific industries can enable or constrain circular practices. For example, the presence of recycling and reprocessing industries can enable the production of high quality streams of recovered materials and, consequently, associated industries producing and relying on the supply of secondary resources.

Finally, the uptake of circular practices can be capital intensive, for example when resources move from expenditures to business assets or when new processing equipment is required; hence capital availability can be an important limitation or driver for CBM realisation.

Barriers operating directly at the business level include (Kraaijenbergen et al. 2016, Linder and Williander 2017):

- Limited number of customer segments interested in circular value proposition
- Operational risks, such as maintaining the supply and quality of materials derived from waste products
- Absence of sufficient technological expertise and/or commercially viable technologies
- Challenges related to return-flow of resources
- Availability of high quality secondary resource flows
- Organisational thinking historically aligned to the linear status-quo

Finally, individual business models need to be aligned within the proposed or desired circular supply chain (Ellen MacArthur Foundation 2012, Accenture 2014, Kraaijenbergen et al. 2016, Linder and Williander 2017). However, practical support to enable such cross-supply chain collaboration has so far remained underexplored in research (Kraaijenbergen et al. 2016).

4.3 CBM innovation

The preceding sections indicated that key processes in the development of CBMs include:

- The internalising of environmental and social, in addition to economic, factors into circular supply chains and business models of the companies involved.
- That collaboration and alignment of CBMs within the supply chain is essential.

Various adaptations of the business model canvas, originally developed by Osterwalder and Pigneur (2010), have been published for the purpose of CBM innovation. While it is feasible to use the original canvas for the development of CBMs, it is not designed for this purpose. Hence, several organisations and researchers have adapted the canvas. The suitability to facilitate and explore the two key processes listed above, during a workshop such as that organised for Agrimax, was reviewed.

CBM canvases

Various canvases have been published and the discussion in this section is not exhaustive. Broadly two types of CBM canvases have been proposed: 1) the “multi-layer” approach and 2) a more integrated model.

In the first type, various elements have been added to the top, side and/or bottom sections of the canvas to reflect a wider and/or circular perspective on the business model canvas (for example, Dewulf 2010, Mentink 2014, Sempels 2014, Bocken et al. 2015, Antikainen and Valkokari 2016). The latter of these authors draw together existing approaches into a new canvas with multiple layers including additional factors that CBMs, converse to linear business models, need to question (Antikainen and Valkokari 2016), i.e.:

- Trends and drivers at the ecosystem level.
- Understanding the value to partners and stakeholders within a business.
- Evaluating the impact of sustainability and circularity, creating values also in environmental and social terms, together with supply chain partners instead of one actor.

To answer these questions, Antikainen and Valkokari (2016) added various layers to the business model canvas (Figure 3). This canvas includes many important elements for CBM innovation, such as the idea that the business model needs to have a positive, sustainable balance between environmental, social and business requirements and benefits within the business ecosystem. However, circularity appears to stay on the outside of the business model as if an “add-on” rather than

becoming fully integrated into the heart of the model such as in the value proposition and cost- and benefit structure. There are models that are more integrated in nature.

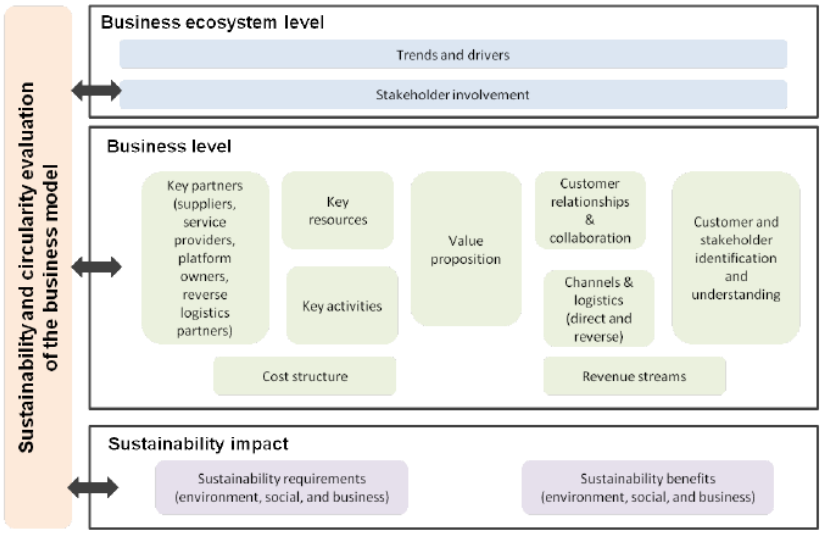

Figure 3: The framework for sustainable circular business model innovation published by Antikainen and Valkokari (2016)

The second model is a more 'integrated' model which adds to the elements of the original canvas (such as, Foxon et al. 2015, Ellen MacArthur Foundation 2016). In contrast to the "multi-layer" model, the canvas developed by the Ellen MacArthur Foundation integrates stakeholder networks and various forms of capital (natural, human and social in addition to finance) in a number of places in the business model canvas. In this way, various supply chain- and contextual challenges are imposed onto companies, including factors that are not necessarily under their control; in respect of risk management this model may be unattractive for a company.

The analyses of the multi-layer and integrated CBMs suggests that a CBM canvas that finds a middle-ground might be preferable. Such canvas should support discussion between supply chain actors on the alignment of their CBMs and facilitate the increasingly internalising of environmental, social and economic factors into the circular supply chain and CBMs of individual companies. The next section proposes a new CBM canvas for this purpose.

New CBM canvas

4Innovation developed a CBM canvas to enable the development of CBMs that cover the necessary wider supply chain and contextual factors as well as facilitating change within the elements of the business model that are under direct control of the company (Figure 4). The canvas strives to enable:

- Integration of technical, social and environmental aspects, in addition to economic values, in the value added proposition.
- In addition to the usual financial incomings and outgoings, inclusion of social and environmental costs and benefits.
- Consideration of costs and benefits beyond the business in question.
- And discussion on where more costs and benefits can be integrated into the business or supply chain, thus striving for a positive influence of the business on the supply chain and wider economic, societal and environmental context.

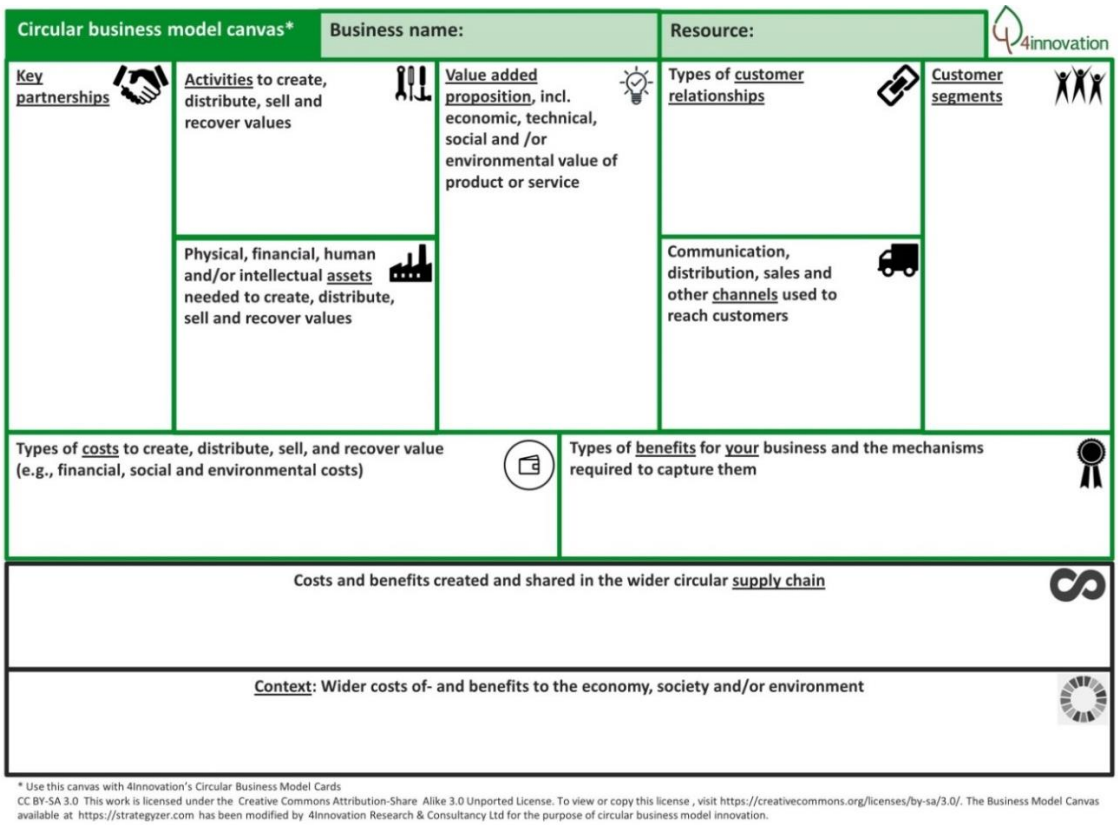

Figure 4: Circular Business Model canvas developed by 4Innovation Research & Consultancy

The proposed CBM canvas (Figure 4) offers the opportunity to discuss the boundaries between what is considered to be within a business, within a supply chain, and part of the business' context. In other words, the canvas distinguishes the intra-, inter-, and contextual levels of the production system and enables discussion around who can control which factors. While clarifying these boundaries, discussion around actors' responsibilities is likely to take place – who is responsible for any additional investments and costs, and who is entitled to which benefits? The canvas can help clarifying who a business should talk to about which matters, as different stakeholders are involved in the management of the company, the supply chain and the wider context.

The CBM canvas consists of 11 categories. Categories are largely self-explanatory, however, they can be briefly summarised as:

Value added proposition, e.g. the economic, technical, social and/or environmental values of product or service: These are the products and services, and their characteristics, which you offer to your customers. What problem are you solving for them? Which needs are being met? For example, consider performance, durability and quality of a product; offering products as a service; reducing waste disposal costs; creating environmental benefits, etc.

Customer segments: Which customers are you striving to reach? Who benefits from the products and services that you offer and which people and organisations are willing to pay? Is there one type of customer or do you serve multiple types of customers? Is it a mass market or more of a niche?

Types of customer relationships: This is the kind of relationship that you establish with each customer segment. For example, it can involve the co-creation of products and services, such as involving end-users in product design; or personal assistance where your team directly helps customers via e.g. email and telephone; or less personal types of relationships such as offering self-service and fully automated services via online systems.

Communication, distribution, sales and other channels used to reach customers: How are you delivering the value added proposition to your customers? Are you using your own shops, delivery

services, etc. or do you need a partner for this? In a circular economy it is also important to consider how products are recovered at their end-of-life, either by you or a further downstream supply chain partner. Which reverse logistics are required and which reuse, recycling or recovery options have you designed into the supply chain? Can the remaining nutrients return to agriculture as fertiliser for a new growth cycle?

Activities to create, distribute, sell and recover values: Consider everything your business does to make and deliver the products and services. For example, as a technology provider you will probably do research and development, train people, and more. In manufacturing you are probably buying resources, design and run a production process, and sell the products. In a circular economy it is also crucial to consider activities to recover values from products when they reach the end of their useful life, are you going to take-back the products, is another company going to take the products to recover materials and/or energy, and so further.

Physical, financial, human and/or intellectual assets needed to create, distribute, sell and recover values: This is as self-explanatory as it sounds. Which buildings, machinery, computers, trucks, knots and bolts do you need to run your business? Don't forget about intangible assets such as intellectual property and brands. People and their knowledge can also be a crucial part of your business assets.

Key partnerships: Here you will find your suppliers and other partners such as government bodies that are funding your R&D, companies helping you sell and distribute products to your end-users, technology providers to design and optimise your manufacturing processes. List partners, motivations to collaborate with them (such as reducing risk, providing a unique resource, or reaching economies of scale), and types of partnerships (such as buyer-supplier relations, joint ventures, etc.).

Types of costs to create, distribute, sell and recover values (e.g., financial, social and environmental costs): Traditionally this is where you would list all types of fixed and variable costs. However, in a sustainable, circular economy we also should consider the social and environmental costs incurred under your control, such as negative impacts on communities, impacts on health, greenhouse gas produced, and impacts on soil fertility.

Types of benefits for your business and the mechanisms required to capture them: Similar to the costs, you should list the types of revenues and mechanisms through which you keep hold of them (for example transaction revenues, licence fees, rent), but also think about the social and environmental benefits for which you can claim responsibility such as jobs created, contributions to social community facilities, air quality improvements, and natural resources saved due to secondary resource use.

Costs and benefits created and shared in the wider circular supply chain: In order to work towards circular supply chains in which the value and utility of resources are kept within the economy for as long as possible, we need to discuss a) what the complete circular supply chain looks like and b) which economic, social, technical and environmental values are created and destroyed at which points in the supply chain, and c) how mutual benefits for all supply chain partners can be realised.

Context: Wider costs of- and benefits to the economy, society and/or environment: Circular supply chains should contribute to a circular economy that is restorative and regenerative for the wider society and environment. In other words, we need to strive for supply chains that make a positive contribution to the context within which they are being realised.

5. Workshop overview

Here the workshop design is briefly discussed and the activities that shaped the results (presented in Chapter 6) are introduced. The workshop was designed to collect information on:

- Existing business models used for AFWP to be valorised within the Agrimax CBM.
- New business models for farmers, food processors, cooperatives, biorefineries and end-users in the future Agrimax supply chain.
- Key constraints and drivers for changing existing supply chains into the new Agrimax circular supply chain:
    - Within companies and the supply chain
    - In the wider economic, social and environmental context

5.1 Workshop set-up

The best practice review emphasised the importance of aligning business models from actors involved in the circular supply chain. Therefore, the workshop was designed to facilitate discussion between actors along the chain. Activities were designed to explore viable combinations of potential business models of partners in the supply chain including farmers, food processors, cooperatives, biorefineries and end-users.

The Agrimax consortium invited actors to represent each step in the supply chain (Figure 5). Participants were then organised into groups based on:

1. Supply chain position/tier,
2. Crop interest (olive, potato, tomato or cereal)
3. Language abilities (English, Spanish/Catalan and/or Italian)

Seventy-two participants from seven European countries attended the workshop. This included representatives from industry (44), academia (11), agriculture (9), government (5) and others (3). Eight groups were formed, two for each crop with one group for English speaking participants and one with bi/tri-lingual facilitators for Spanish and Italian speaking participants. In this way the workshop was made as inclusive as possible within the organisational boundaries. Moreover, participants from across Europe were involved which strengthened the external validity of the results; perspectives on important resources, constraints, opportunities and potential business models from a number of countries and regions were collected, enabling the development of a more robust understanding of relations between business models and value added proposition and the relevant contextual conditions, increasing the transferability of the business model development results.

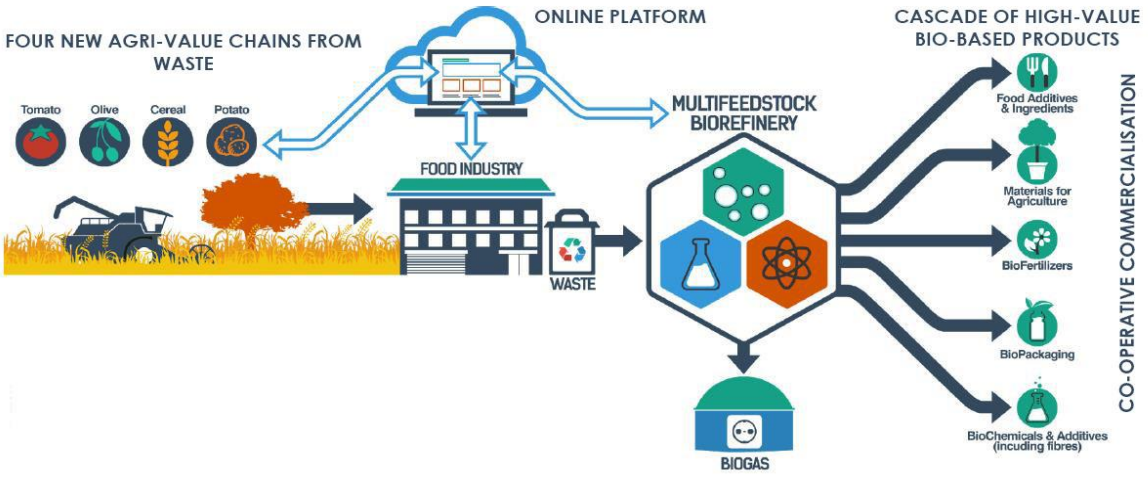

Figure 5: Agrimax supply chain

5.2 Pre workshop communications

Since circular business model innovation was a relatively new subject for most participants, a series of communications was sent ahead of the workshop. These messages:

1. Introduced CBM innovation and the modelling canvas.
2. Explained the categories included on the CBM canvas and presented two case studies on existing CBMs.
3. Discussed some drivers and barriers for CBMs and the importance of collaboration across the supply chain such as initiated by Agrimax. Participants were asked to practice preparing a CBM canvas for their own organisation. Logistical details were shared (programme, joining instructions, timing).
4. Reminder of all of the above and a third CBM case study was shared.

5.3 Programme

The workshop was held over one day. The morning focused on describing existing- and designing new business models for the Agrimax cooperative and biorefinery. In the afternoon alignment within the supply chain and wider contextual drivers and barriers were discussed. Table 2 provides an overview of the programme. Section 5.4 introduces the key activities in further detail.

Table 2: Programme overview

Purpose	Activity
Frame workshop	Welcome & explain purpose of workshop.
Provide background	Introduce Agrimax project
Meet group members	Introductions of participants within their groups with questions to start thinking about AFPW (further details in 5.4.1)
Share necessary knowledge	Introduce business model innovation and CBM canvas
Familiarise with canvas	Prepare business model canvases currently used (preferably for AFPW) (further details in 5.4.2)
	BREAK
Clarify canvas	Question & Answer session
Share necessary knowledge	Introduce details of Agrimax supply chain
Develop CBMs	Prepare CBM for Agrimax cooperative or biorefinery (initial ideas will be provided) (further details in 5.4.3)
	BREAK
Introduce activities	Introduce activities for afternoon
Connect current to future models	Reflect how current business models would need to change to fit to Agrimax coop and biorefinery (further details in 5.4.4)
Identify internal barriers and drivers for change	Discuss linkages between business models & discuss business “internal” barriers and drivers to change supply chain (further details in 5.4.5)
Identify key external barriers and drivers for change	Discuss contextual factors offering opportunities and barriers for Agrimax supply chain & Prioritise contextual drivers and barriers (further details in 5.4.6)
Connect current to future models	Reflect how current business models would need to change to fit into Agrimax supply chain (further details in 5.4.4)
Manage expectations	Present next steps
Thank participants	Thank & close

5.4 Details of key activities

5.4.1 Introductions of participants within their groups with questions to start thinking about AFPW

This was a short introductory activity. Participants introduced themselves with name and affiliation around their tables, and then answered the following questions:

1. What types of agricultural and food processing waste and by-products exist in your sector, and what happens with these wastes and by-products now? Focus on olive, potato, tomato and cereal wastes and by-products.
2. Are there any issues with the ways in which wastes and by-products are managed now?
3. Are there any opportunities to create environmental, social or economic benefits from these wastes and by-products? *[This question was skipped to make up for time used for a welcome by the FCAC president at the start of the workshop]*

Individual answers from participants were noted on cards and collected at the end of the exercise.

5.4.2 Prepare business model canvases currently used (preferably for AFPW)

Following the introduction of the Agrimax project and CBM innovation, participants set to work on mapping existing business models for AFPW. Where possible these were models of their own companies, and participants not running a business themselves were asked to prepare a CBM canvas for a company they had recently collaborated with. In this activity the canvases prepared before the workshop, as recommended in the pre-workshop communications (see 5.2), were further developed.

Participants worked individually on printed A3 size canvases. For further support, multi-language answering cards were provided in English, Spanish and Italian. These cards explained each section of the CBM canvas and provided potential answers by listing concepts commonly used in business models. Participants could turn to the group facilitators for questions and help. Additionally, two facilitators with further expertise on CBMs were in the room to answer more challenging questions. Important questions were captured and answered plenary.

5.4.3 Prepare CBMs for Agrimax cooperative or biorefinery

Each group worked collaboratively to develop a CBM for either an Agrimax:

1. Cooperative in Spain
2. Biorefinery in Spain
3. Cooperative in Italy
4. Biorefinery in Italy

CBM canvases for cooperatives and biorefineries in Spain and Italy were provided. Some examples were included in the canvases to start the discussion in the groups, inviting participants to adapt and build on the canvases provided.

Facilitators guided the group discussions, handling points that emerge organically when filling in the CBM canvas and using the following questions:

- What are the most important activities of the cooperative and biorefinery to create, distribute, sell, capture revenue and recover remaining values at end-of-life from the products described in the value added proposition?
- Can you detail the value added proposition further? What problem are you solving for your customer segments? What environmental, social, economic and technical values are you creating for your customer(s)?
- *[For biorefinery only]* Who are the target customers for the products supplied by the biorefinery? Can you narrow down the suggested customer groups? Which customer (sub)groups have the biggest issues, which the biorefinery can help to solve? Why is this solution better than other solutions that may be available to the envisioned customer groups?
- What are the most important types of cost to deliver the value added proposition? And what kind of benefits do you expect?
- *[For coop only]* Looking at the key partnerships, why should growers and food processors send wastes and by-products to the cooperative, rather than continuing to use/ dispose of these resources in the current way? How can the cooperative make the partnership attractive for growers and food processors?

- *[For coop only]* How can the cooperative ensure that they attract the right kinds of wastes and by-products of the required quality, from the growers and food processors? Are issues with contamination expected? If so, how can these be prevented?
- How could the cooperative and the biorefinery best collaborate, to make sure the biorefinery will have access to the right resources at the right time i.e. to provide supply security to the biorefinery?
- Should the cooperative and biorefinery be one combined entity? Or should they operate separately? What are the up- and downsides of these options?
- What does the supply chain look like after the end-users? Who will buy products and/or services from the end-users? How can the cooperative and biorefinery collaborate with the end-users and their customers, to ensure material flows are closed and valuable nutrients and/or energy are recovered?
- Why is the envisaged usage of wastes and by-products in the Agrimax supply chain more valuable, considering economic, social and environmental factors, than the current applications?

5.4.4 Reflect how current business models would need to change to fit to Agrimax coop and biorefinery

Two moments for reflection upon the participants' existing business models, developed in the morning, were included in the programme. In these activities participants discussed in pairs how their business models would need to change to fit into the Agrimax supply chain, guided by a discussion sheet. Participants were asked to write answers on the discussion sheet and make adaptations to their business models when needed.

The first reflective session was scheduled after the development of the Agrimax cooperative and biorefinery CBMs. Participants answered the following questions:

1. Looking at the business models for the Agrimax cooperative and biorefinery, what are the main changes that you would need to make to your business model to join this supply chain? (*Please change the relevant parts on your canvas when needed.)*
2. Would the way you are handling the wastes and by-products need to change? If yes, in what way? (*Please change the "Activities" on your canvas when needed.)*
3. To join the supply chain, would you need to make any new investments? And would you expect new types of operational costs? (*Please change the "Assets" and "Costs" on your canvas when needed.)*
4. Joining the Agrimax supply chain, would you expect new revenues? And other types of benefits? (*Please change the "Benefits" on your canvas when needed.)*
5. What kind of values do you think the Agrimax cooperative is looking for? What would your value proposition look like, when joining the supply chain? (*Please change the "Value added proposition" on your canvas when needed.)*

The second reflective session was meant to take place after the supply chain- and context analyses (discussed in 5.4.5 and 5.4.6). The following questions were prepared:

1. Looking at the context analysis poster, in what way could the Agrimax supply chain have more positive- than negative impacts on the environment, society and economy? (*Please add to/change the "Context" box on your canvas.)*
2. Staying with the context analysis poster; How can the future Agrimax supply chain partners build partnerships to prevent negative impacts and create additional value for the economy, society and environment? (*Please add to/change the "Supply chain" box on your canvas.)*
3. How would you benefit from these stronger partnerships? (*Please change the "Costs" and "Benefits" on your canvas when needed.)*
4. Considering your previous answers, and looking at the supply chain analysis poster, are there any elements that you would add to- or remove from your value added proposition to strive

for the envisioned benefits for your business, the supply chain and wider context? (*Please change the "Value added proposition" on your canvas when needed.)*

However, at the event we missed this activity as it appeared better for the CBM development process to facilitate a plenary discussion, in which the group facilitators shared the key contextual drivers and barriers identified at their tables (following the context analysis introduced in 5.4.6 below).

5.4.5 Discuss linkages between business models & discuss business "internal" barriers and drivers to change supply chain

In this activity the groups worked through a poster (Figure 6) to discuss how value added propositions can be aligned within the future Agrimax supply chain, and whether any of the actors in the supply chain would face barriers or be supported by drivers in offering that value proposition. The exercise was designed to take a demand-driven perspective, back-casting through the supply chain starting from the value added proposition required for supply to the end-users' customers (please see the arrows on the poster in Figure 6 for clarification).

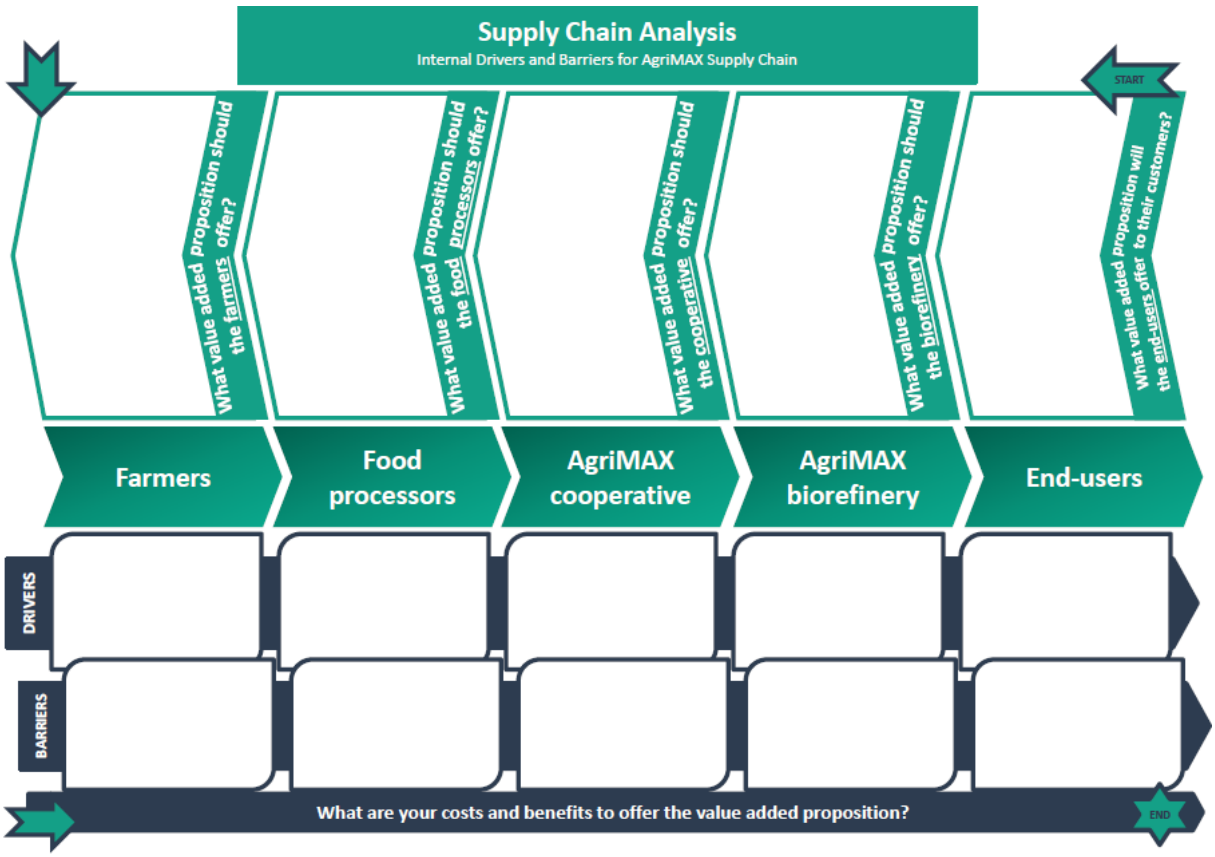

Figure 6: Supply chain analysis poster

5.4.6 Discuss contextual factors offering drivers and barriers for Agrimax supply chain

Constraints and opportunities for realising the Agrimax supply chain were inventoried through a PESTEL analysis, including political, economic, social, technical, legal and environmental factors.

The activity was designed to start with an individual brainstorm writing contextual drivers and barriers on post-its. However, to maintain a positive flow of energy within the group work, most skipped the individual brainstorm. The other groups jumped to the next step, initiating and organising barriers and drivers directly onto the posters (Figure 7), using the following questions posed by the group facilitators:

- What are the social impacts of the future Agrimax supply chain? And benefits?
- What are the current social issues and developments related to the existing supply chain?
- What are the environmental impacts of the future Agrimax supply chain? And benefits?

- What are the current environmental issues and developments related to the existing supply chain?
- What are the economic impacts of the future AgriMAX supply chain? And benefits?
- What are the current economic challenges and opportunities related to the existing supply chain?
- What are the current legal challenges and opportunities related to the existing supply chain?
- What are the current political challenges and opportunities related to the existing supply chain?
- What are the current technical challenges and opportunities related to the existing supply chain?

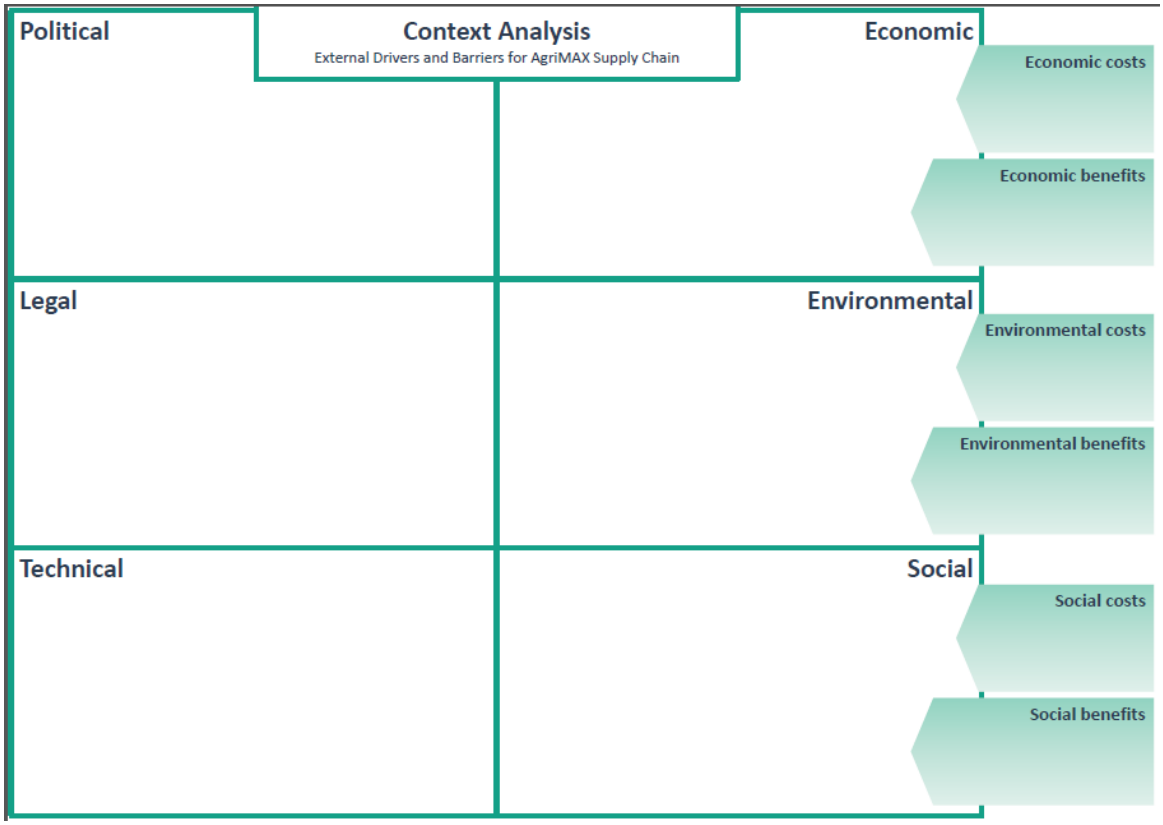

Figure 7: Context analysis poster

Factors were then prioritised with a "sticky dot" ranking exercise, allocating three votes for the most important drivers and three for the most important barriers to each participant. The factors receiving most votes will be considered the key drivers and barriers.

6. Workshop results

6.1 Motivation for new AFPW valorisation

Participants indicated that Agricultural and Food-Processing Wastes (AFPW) and by-products tend to be used predominately as animal feed, compost, biogas and energy (combusted for heat and/or power). Notably, a considerable proportion of the participants reported that they produce very little or no waste; consequently, no issues were reported. Nevertheless, valorisation of wastes and by-products was perceived by many as an opportunity.

However, a number of concerns with AFPW were reported. Pertinent issues included:

- High volumes
- Undesirably high water content (requiring heating or extra processing)
- Waste water treatment
- High transport costs
- Management complexity and high cost of disposal

These issues are likely to serve as drivers to explore innovative solutions to valorise AFPW.

Other issues pertained to the valorisation of AFPW, potentially posing barriers to the implementation of new supply chains such as proposed by Agrimax:

- Costs of storage and limited stability of wastes and by-products
- High cost of technology and processing of AFPW
- Low concentration of valuable compounds
- Changeable regulatory environment
- Availability of material (seasonality, rural location)
- Safety of application and traceability

Opportunities create environmental, social and economic benefits from AFPW include:

- New products and functions, such as biodegradable products for agriculture, biopolymers for packaging, pectin, and polyphenols for food ingredients, antioxidants and nutraceuticals
- Make better use of high nutrient content waste water from food processing, e.g. as fertiliser
- Reduced virgin and raw material use in production and less use of non-biodegradable materials and products
- New economic activity and jobs, with potential for enhanced popularity of jobs in agricultural sector by involvement in novel production chains (other than traditional)

These opportunities constitute potential benefits for the companies involved in a circular supply chain as well as wider benefits for the environment, society and the economy.

6.2 Supply chain overview and business models

CBMs for Agrimax cooperative processing facilities

Figure 8a-8d, below, present the CBMs suggested by the workshop participants. Canvases were produced for:

a. Agrimax cooperative in Spain using olive and potato waste and by-products (8a)
b. Agrimax cooperative in Italy using tomato and cereal waste and by-products (8b)
c. Agrimax biorefinery in Spain using olive and potato waste and by-products (8c)
d. Agrimax biorefinery in Italy using tomato and cereal waste and by-products (8d)

For each position a-d two canvases were produced and merged in Figure 8. The value added propositions were ameliorated with results from the supply chain analysis. The number in brackets indicates how often something was mentioned.

Circular business model canvas: Agrimax cooperative (olive and potato wastes and by-products)

Key partnerships

Cooperatives (farmers) (2);

By-product buyers (1);

Specialist industries (1);

Technology providers (1);

Government (1);

Public (1)

Activities to create, distribute, sell and recover values

Olive pomace oil recovery (1); Local biorefining/ pretreatment such as dewatering of olive pomace, cleaning and separation, and transformation of potato peel (2); R&D on raw materials (1); Commercial plans (1)

Physical, financial, human and/or intellectual assets needed to create, distribute, sell and recover values

Manufacturing facilities (2); Financial investment (2); Skilled personnel and knowledge (2); RRHH (1)

Value added proposition, e.g. economic, technical, social and /or environmental value of product or service

Resource security (4): Raw material supply year round, Raw material quality and quantity; Permanent contracts with raw material suppliers.

Economic benefits (1); Economies of scale (1); New technologies to reduce costs (1)

Products (2): High value products such as food ingredients; Other products such as biogas and animal feed

Local offering (2)

Logistic skills and capabilities (1); Pretreatment to facilitate logistics biorefinery (1)

Image (1); Reputation of entrepreneur (1)

Sustainability (1)

Securing jobs (1)

Regulatory advantages (1)

Knowledge of sector, product and market (1)

Types of customer relationships

B2B (1); Purchase and sale contracts (1); Proximity (1); Co-creation (1); Partnerships in financial capital (1)

Communication, distribution, sales and other channels used to reach customers

Direct contact via e.g. fairs, depending on customer segment (1). Automated element via logistical commercial platform (1)

Customer segments

Food;

Animal feed (2); Agriculture; Fertilisers (1); Bio-insecticide (1); Water for agriculture (1)

Chemical industry (1);

Cosmetic (1).

Types of costs to create, distribute, sell, and recover value (e.g., financial, social and environmental costs)

Financial (facilities investment) (1); Fixed and variable costs (1); Technically qualified staff (1); Cost to assure supply (1)

Types of benefits for *your* business and the mechanisms required to capture them

Revenues from sales (1); Environmental benefits (1); New jobs (1)

Costs and benefits created and shared in the wider circular supply chain

Farmers reduce costs and create new revenue streams from wastes and by-products (1); Increased energy and staff costs in supply chain (1)

Further discussed in Section 6.3.

Context: Wider costs of- and benefits to the economy, society and/or environment

Regulation from government enabling Agrimax supply chain (see context analysis) (1)

Further discussed in Section 6.4.

Figure 8a: CBM suggested by participants for the Agrimax cooperative in Spain.

Circular business model canvas: Agrimax cooperative (tomato and cereal waste and by-products)

Key partnerships

Food processors (1);

Farmers (growing tomatoes and cereals) (1);

Cooperatives with different waste types (1);

Logistics company (2);

Technology provider (2);

Authorities (1)

Activities to create, distribute, sell and recover values

Benchmarking and survey/ research of actual existing feedstocks and selecting optimal material (2); Research whether growers and food processors can provide transport of materials (1); Provide advice on waste handling (1); Market research and benchmarking of products (1); Conversion process (1); Sales (1)

Physical, financial, human and/or intellectual assets needed to create, distribute, sell and recover values

Human resources (personnel) (2); Warehouse (1); Laboratory and plant (2); Databases (1); Finance (1)

Value added proposition, e.g. economic, technical, social and /or environmental value of product or service

Logistical solutions (7): Collect waste from producers for further processing; Simplify management with technological platform

Resource security (3): Sufficient, reliable year round feedstock supply; Consistency over time; Constant quality of waste

Quality control (2): Ensure resource quality by classifying waste type and quality of site of production; Stabilise and storage to provide a steady resource supply

Recover additional products and upgrade raw material for processing into high value applications (2)

Network (2): Create a network between producers and valorisers; End-user contacts

Low price (1)

Types of customer relationships

Sales contracts for material inputs and outputs (1); Co-creation of technology (1); One-to-one, dedicated relations (1)

Communication, distribution, sales and other channels used to reach customers

Direct sales via events such as fairs, media such as magazines and website, social networking and stakeholder platforms (2)

Customer segments

Biorefineries (1);

Agri/ food industry (2);

Chemical industry (1);

Pharmaceutical and cosmetics (1);

Bioenergy producers (1);

Technical developers (1)

Types of costs to create, distribute, sell, and recover value (e.g., financial, social and environmental costs)

Transport (1); Staff (2); Equipment (2); Initial investments (2); Storage costs (1); Stabilisation costs (1); Sales costs (1); Subcontracted analysis (1)

Types of benefits for *your* business and the mechanisms required to capture them

Revenues, profit (1); Share of revenues from sales to end-users (1); Share as coop member for technology use, license fees differentiated for members and non-members (1); Lower waste disposal costs (1)

Costs and benefits created and shared in the wider circular supply chain

Further discussed in Section 6.3.

Context: Wider costs of- and benefits to the economy, society and/or environment

Further discussed in Section 6.4.

Figure8b: CBM suggested by participants for the Agrimax cooperative in Italy.

Circular business model canvas: Agrimax biorefinery (olive and potato waste and by-products)

Key partnerships

End-users (1);

Government (negate/avoid problems using wastes and by-products in high value applications) (1);

Certification bodies (1);

Service providers for manufacturing (1);

Customer associations (1);

Environmental agencies (1)

Activities to create, distribute, sell and recover values

Supply of raw materials (1); Supply of R&D (1); IP protection (1); Buy raw materials (1); Schedule the supply of waste (1); Logistics design (1); Production process/ factory (1); Analyse and create the market (1); Marketing (1)

Physical, financial, human and/or intellectual assets needed to create, distribute, sell and recover values

Transport and logistics assets (1); Network for commercial sourcing of waste (1); Brand (1)

Value added proposition, e.g. economic, technical, social and /or environmental value of product or service

Innovation, knowledge, technology, more efficient processes, and new products (5)

Economic benefits (1); Reduction of productions costs (1); Tax benefits (1)

Sustainable production (1); Economic and environmental improvements in supply chain - from suppliers to end-user waste management (1); Promote circular economy (2); Biocomponents (1)

Local customers (1); Co-design (1)

Regular supply (1)

Connect waste and by-product generation with production of high value applications in the market (1); Diversification (1)

Quality (1); Standardisation (1)

Image (1)

Being an early adopter (1)

Types of customer relationships

Partnership in capital investment (1); Use of specialised distributors (1); Use of technical advisors and consultants (1)

Communication, distribution, sales and other channels used to reach customers

Direct sales and contact with end-users (2); (Distribution of samples of new product (1); Communications via technical documents, social media, fairs etc (1)

Customer segments

Animal feed (1); Fertilisers (1); Bio-insecticide (1); Water and irrigation (1).

Cosmetics and pharmaceutical industries (1).

Pathways to market via customer associations (1) and focus on early adopters and influencers (1).

Types of costs to create, distribute, sell, and recover value (e.g., financial, social and environmental costs)

...

Types of benefits for *your* business and the mechanisms required to capture them

Economic benefits leading to finanical benefits (1); Environmental benefits leading to improved reputation of the company (1); Environmentally friendly products that are less toxic (1); Added value to waste made available to waste producers (1); Licensing fees for processes and products (1)

Costs and benefits created and shared in the wider circular supply chain

Environmental benefit (1); Safety in the use of waste (1); Providing bio-based products that do not compete with food products (1)

Further discussed in Section 6.3.

Context: Wider costs of- and benefits to the economy, society and/or environment

New markets and businesses in the bioeconomy (1)

Further discussed in Section 6.4.

Figure 8c: CBM suggested by participants for the Agrimax biorefinery in Spain.

Circular business model canvas: Agrimax biorefinery (tomato and cereal waste and by-products)

Key partnerships

Cereal and tomato producers (1);

Farmers (1);

Farmers associations (1);

Fertiliser producers (1);

Co-packers (1);

B2B companies (1)

Activities to create, distribute, sell and recover values

Cusomise and design the process (1); Manufacturing (1); Quality control (1); Marketing (1); Packaging (1); Stakeholder engagement (1)

Physical, financial, human and/or intellectual assets needed to create, distribute, sell and recover values

Technology, facilities, pilot plant (2); People and distinct competences (1); Finance, public and private funding (2); Distribution chain (1)

Value added proposition, e.g. economic, technical, social and /or environmental value of product or service

Environmental and economic benefits: Cascading processes which generate less waste (2); Close-cycle (1); More efficient process (1); Technical benefit of disposal (cost + environment) (1); Measurable biodegradable cost (2); Renewability (2);

Less energy (2); Environmental friendly (2); More sustainable (1)

Image (2): Environmental credentials; Brand awareness

Provide R&D (1)

Functional extracts for food ingredients, packaging and fertilisers (1)

Types of customer relationships

Direct relations for buying and selling (2); Prototyping of the finished product to facilitate communications - enabling co-development (1)

Communication, distribution, sales and other channels used to reach customers

Use the cooperatives (1); Closed loop to tomato- and wheat producers (1); Direct contact at trade fairs, open day exhibition, stakeholder forum, sales force (2); Use of media, website (2)

Customer segments

For biofertilisers: Tomato farmers (1), Fertiliser producers (1); Retailers and smaller customers (1).

Varnish producer 1)

B2C companies (1)

Types of costs to create, distribute, sell, and recover value (e.g., financial, social and environmental costs)

Capital and investment costs (2); Production costs (1); Logistics costs (1); Marketing costs (1); Personnel costs (1); Training (1)

Types of benefits for *your* business and the mechanisms required to capture them

Revenue from product sales (2); Waste valorisation (1); Limited number of competitors (1); Commitment of cooperatives (1); Licensing fees/ exclusiveness fees (1)

Costs and benefits created and shared in the wider circular supply chain

Further discussed in Section 6.3.

Context: Wider costs of- and benefits to the economy, society and/or environment

Further discussed in Section 6.4.

Figure 8d: CBM suggested by participants for the Agrimax biorefinery in Italy.

Similarities and differences between the CBMs

Comparing the CBMs for the Agrimax cooperatives in Spain and Italy (Figure 8a and 8b), the models show a high degree of similarity in terms of key partners, the proposed customer segments along a cascade of biomass applications and the direct and close relations with customers involving co-creation and communication (as supported by a platform or network). Both CBMs suggest the need for research on raw materials, while the Italian cooperative would also include waste management advice for its suppliers. The difference in focus widens in the assets and value added proposition statements. The Spanish model includes investment in manufacturing facilities for pre-treatment of AFPW, while the Italian model only invests in warehouses (and presumably leaves the pre-treatment to the biorefinery). This contrast in investment persists into the benefits sections, where both CBMs highlight income from direct sales of products but, in the Italian case, also the exploitation of technology through, for example, license fees. The proposed value added propositions differ considerably. The Spanish CBM focused mainly on security of supply, economic benefits, products and a local offering, while the Italian model prioritised logistical solutions, resource security and quality control.

The comparison of the Agrimax biorefineries shows a less coherent picture. Their position in the supply chain is not clear, with the Italian biorefinery suggesting key partnerships with farmers and the Spanish investing in raw material sourcing networks; the CBMs are overlapping with the Agrimax cooperatives discussed above. It is notable that neither of the biorefineries suggested investment in storage facilities, indicating that this would be a task for the upstream supply chain partners. Turning to the output-side of the model, the biorefineries suggest the need for direct relations, involving close partnerships, for product development in Italy and capital investment in Spain. The customer segments, notably from a business plan perspective, require further definition and market research. Converse to the cooperatives, the biorefineries both suggest technology exploitation through license or exclusiveness fees is an option or consideration. For the Spanish biorefinery, innovation, technology and knowledge form the primary business offering within the value added proposition. Economic and environmental benefits are important components of the value added proposition in both proposed CBMs.

The analysis of the CBMs for the Agrimax cooperative and biorefinery revealed a number of key areas requiring clarification within the project consortium:

- Who has the contact with, and organises collection of wastes and by-products from, the farmers? Is this an activity for the Agrimax cooperative or the Agrimax biorefinery?
- Who can practicably undertake the transport of AFPW? Is this a task for the cooperative? Could or should it be outsourced?
- From what distances can raw materials be collected, whilst maintaining the stability and inherent or residual value of the AFPW? How much material of the right quality is likely to be available within this optimum radius?
- Does the cooperative do any/all pre-treatment, or is the entire biorefining process an activity for the biorefinery alone?
- What is the initial scale of the strived for supply chain? Is it envisioned to start as a new, small-scale specialised offering, possibly for a higher price to the end-user - a diversification of the activities of existing companies - or are economies of scales, with a low price offering, strived for (in the longer term or immediately)?
- Who, specifically, are the end-users and what value added proposition do they really want or need to justify investment?
- If there are any, what will happen with the remaining wastes and by-products and waste water after the biorefining process?

Learning from existing business models for AFPW valorisation

Though not specifically raised as a discussion point during the workshop or identified as a particular area for consideration, several existing, individual CBMs highlighted the role, importance and impact of product certification. Certification was discussed in respect of several aspects of the CBM, including

Key Partnerships, Activities, Costs, Customer Segments and Benefits. Indeed, product certification was seen as something that could be costly but, given the nature of the product (i.e., derived from waste), it was recognised that some form of certification may be required to provide assurances over the safety of the product and/or its provenance and/or its sustainability credentials. Identifying suitable certifying bodies and partners would be required but, if applied for and awarded, would create new assets that open up new customer segments (i.e., health, safety and/or sustainability conscious buyers/consumers) and lead to the consequent benefits of competitive advantage among businesses with similar uncertified offerings and, possibly, create a greater income in premium markets.

6.3 Supply chain analysis

Aligning value added propositions

To realise the Agrimax supply chain, it is crucial to align the business models of all actors in the supply chain. As such, during the workshop, relations between the value added propositions for business models of farmers, food processors, Agrimax cooperative, biorefinery and end-users were discussed.

The results, presented in Figure 9, display a fair level of agreement and coherency, perhaps even the start of a "whole supply chain" CBM. Key common elements that resonate through the supply chain include:

- Turning wastes and by-products into valuable products
- Sustainable, green image throughout supply chain that gains relevance further downstream
- Cost reductions
- High quality of raw materials and products
- Closing loops, preferably locally
- Direct, close relations within supply chain

Additionally, **resource security** is important, especially upstream in the supply of wastes and by-products. Resource security alludes to both sufficient *quantity* and the right quality. *Quality* control, linked to storage and logistics, is considered important. The storage of raw materials appears to be considered the collective responsibility of the farmers, food processors and Agrimax cooperative. The cooperative plays a key role in organising the logistics.

Further downstream, on several occasions standardisation and certification were mentioned. This needs further research, how important is it for the end-users and their customers? Do the benefits outweigh the certification costs?

Finally, this analysis suggests further thought is needed on balancing cost-benefit and low price with highly diverse, and possibly specialist, end-markets. A balance needs to be struck between economies of scale and economies of scope.

Further discussion with supply chain partners is needed to discuss and assess how their existing business models can be aligned with the CBMs for the Agrimax cooperative for AFPW (not to be confused with the current existing cooperatives of farmers taking care of the primary processing of produce) and Agrimax biorefinery. In addition to farmers, food-processors and end-users, the workshop outcomes suggest that technology- and knowledge providers, waste managers, cooperatives (for primary produce), and end-users into greater detail need to be included in this discussion.

Participants' reflections upon connecting CBMs

To join the Agrimax supply chain, participants suggested a number of adaptations to their existing business models. For farmers and food processors these included:

- Improved storage and waste conservation methods, including separation of wastes and quality control

- Add dewatering activities to remove superfluous liquid content

Cooperatives, currently processing primary produce, reported the following changes that may be needed to their business models:

- The joining up of different sources of AFPW to strengthen the offering to the biorefinery
- Greater effort into coordination activities for the more complex Agrimax supply chain
- New manufacturing processes, though investment in new infrastructure must not lead to significant increases in operation costs
- Investment to realise cooperative and biorefinery in close proximity of each other, the costs of which would need to be balanced with the transport costs

Downstream end-users focused on the benefits of certification of products.

Along the whole supply chain and at all tiers, investment in R&D, staff training and the use of new resources were emphasised, along with a holistic approach such as suggested above for the development of whole supply chain business models.

Working on circular business models at the Agrimax stakeholder workshop

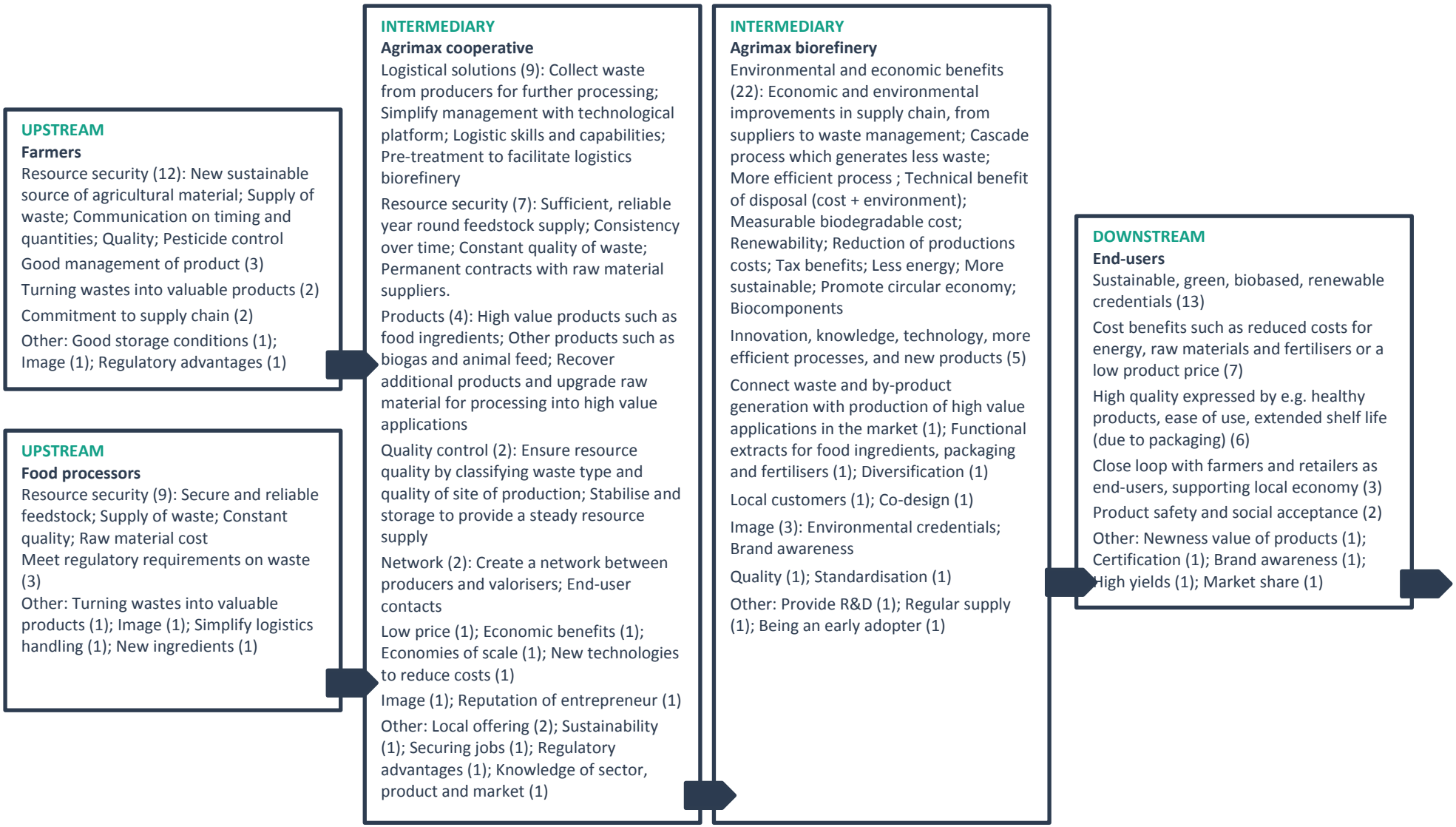

Figure 9: Ranked value added propositions for Agrimax supply chain (in brackets the number of times a factor has been suggested), identified to assess alignment within supply chain. Workshop results suggest that this analysis needs to be extended to include cooperatives processing primary crops, technology- and knowledge providers, waste managers and the end-users in greater detail.

6.4 Contextual drivers and barriers

Figure 10 and 11 present an initial exploration of drivers and barriers collected during the context analysis (activity described in Section 5.4.6). Both the number of factors suggested in each category (Figure 10) and the number of votes given to factors in each category (Figure 11) were calculated. The results suggest that, for realising the Agrimax supply chain, economic factors are most important, while political ones are considered least important. Looking at the combined results of both figures, social and environmental factors are generally considered the most important drivers, political and legal factors are considered the least important of drivers. Conversely, legal matters are consistently considered the most prominent barrier followed by economics. Environmental and political factors were considered as the least constraining factors.

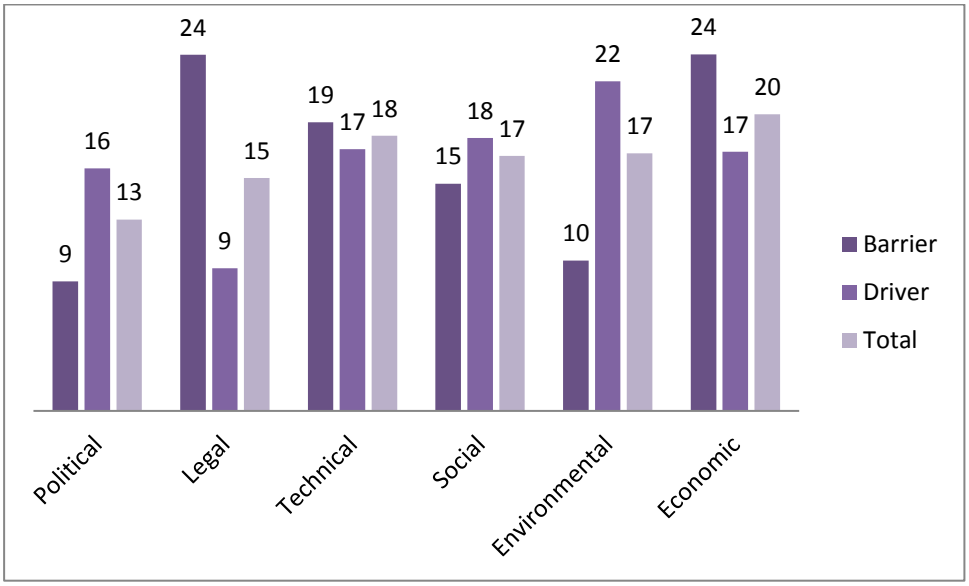

Figure 10: Average percentage of the number of suggested drivers and barriers for each PESTEL category in each group

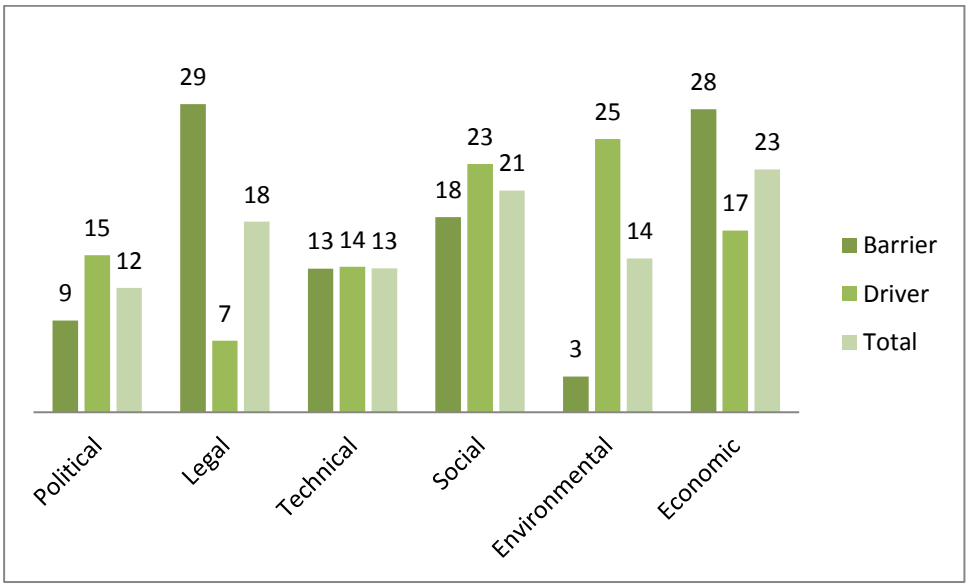

Figure 11: Average percentage of the number of votes for drivers and barriers allocated to each PESTEL category in each group

Contextual barriers took a variety of forms (see Table 3). The most commonly identified barriers were legal, in respect of legislation involved in **the use of wastes as products**; social, in the general form of **consumer acceptance of wastes being used in products**; and economic in the form of the **initial investment needed to build the required infrastructure**, i.e. CAPEX. Legislation related to the potential use or reuse of waste products was by far the most heavily cited and voted for barrier. Moreover, the potential waste reuse legislation was cited as a barrier to realising the Agrimax supply chain by representatives of all key crops (olives, potato, tomato, cereals). These multiple citations and votes contained nuances, ranging from definitions and current restrictions on the use of waste through to the time taken to amend legislation in these areas. Though the social barrier of consumer acceptance of waste based products received three more votes than CAPEX barriers, and was consequently the second most cited barrier to realising the Agrimax supply chain, it was not cited as a barrier by groups covering each of the crops. Conversely, CAPEX investment was seen as a barrier by groups covering all crops and five groups in total (one more than consumer acceptance). The high concern over consumer acceptance of waste based products was, notably, not applied to olives. This could be due to olives' historic and widely known use in a variety of products. Better understanding of why olive AFPW is seen as an acceptable product in a wide array of products could help inform how to tackle this perceived barrier to the use of the other crops.

Of drivers, there were four prominent themes cited, each receiving double or more votes as the remaining contextual drivers. These key drivers were seen to be: social, in respect of increasing **consumer awareness and demand** for what are deemed to be environmentally friendly products; environmental, in the form of **waste reduction**; economic, in the form of **creating new markets and customer segments** and, another social driver, **job creation**. Unlike the more selective citation of barriers, notably these drivers were applied to each of the crops and by most groups. The subthemes of these drivers were also largely complimentary and ranged from awareness of food waste, the impacts of wastes and the development of novel products, through to creation of high value jobs and more jobs in rural areas. The high voting and common reference of the primary drivers for Agrimax suggest some confidence can be placed in their citation. It is notable, however, that some contrast the results of the barriers analysis. For instance, the wide citation of consumer demand for waste based (environmentally friendly) products contrasting with the perceived social concern over the same products being a barrier to the implementation of the Agrimax supply chain. The focus on development of new markets and jobs being a driver to the realisation of the Agrimax supply chain are important going forward as they directly relate to the perceived barrier of CAPEX.

Of the primary drivers and barriers discussed above and detailed in Table 3, complementary and contrasting citations and voting patterns by groups suggest that the overall barriers to the project(s) will be legal obstacles to using waste and up-front investment. In respect of overall drivers, Table 3 and the group voting patterns suggest that the potential creation of new markets, consequent competitive advantage and job creation are the key benefits of the realisation of the Agrimax project.

Table 3: Common factors in context categories with the total number of votes allocated to each factor in brackets.

Category	Barriers	Drivers
Political	Regulatory uncertainty (5) Existing system pushing against environmental agenda (4) Politics unsupportive of valorisation of waste and by-products (4)	New policy and regulation in support of sustainability (7) EU support (5) Incentives (2) Reduce raw material dependency (1) Job creation (0) Local government support (0)
Legal	Adapting regulation for new products from waste and by-products (27) Regulatory challenges in general (10) Permit for biorefinery construction (3) International regulatory variation (2)	Zero land use (4) Low cost raw materials (3) Tax benefits (1) Compliance with environmental regulations (1) Carbon reductions (0) Higher awareness of food waste (0) EU regulation (0) Ability to change regulation (0)
Technical	Sustainability of new technology (6) High costs and investment (5) Lower product performance (3) Technology unavailable (3) Unavailability supporting services such as logistics (2) Resource security (1) Skills to operate new technology (0)	More R&D along supply chain (7) Development of new technologies (6) New business benefits (3) New materials and products (2) Availability of skilled staff (0)
Social	Lack of consumer acceptance (19) Confidence, knowledge and valuation of products in end-markets (3) Local support for building biorefinery (3) Existing agricultural benefits (0)	Consumer awareness and demand for products with environmental and health benefits (17) Job creation (14) Successful example of cooperative processing plant (1)
Environmental	Environmental impacts Agrimax supply chain (3) Waste management of remaining waste after biorefining (2) R&D cost (0) Benefits of existing supply chain (0) Lack of availability waste and by-product (0) More industry (0) Increased regulatory control (0)	Waste reduction (16) Less unrenewable, fossil resources used (10) Reduced carbon emissions (4) Waste regulation (4) Increased sustainability (1) Increasing knowledge (1) Reduced landfill (0)
Economic	CAPEX, high investments needed (16) OPEX in relation to pricing strategy for consumers (11) Economic feasibility (4) Lack of certification (4) Economy in general (2) Immature bioeconomy markets (2) Low profit (1) Knowledge of new processes (0)	New customers and markets with new (bio) products (14) Job creation (4) Waste valorisation (3) Independence of actors within supply chain (2) Public support, incentives (2) Economic benefits in general (0) Sustainability (0)

7. Conclusions and next steps

7.1 Key points from results

Workshop participants identified key issues driving the search for alternative solutions for AFPW, such as the implementation of the Agrimax supply chain. These issues pertained to the costs and complexity of waste management, transport costs, and high volumes of wastes and by-products. Special attention was drawn to the management of waste waters from food processing and, in the future, the Agrimax processes, including dewatering of AFPW. Initial opportunities associated with the Agrimax supply chain include the valorisation of AFPW into new products and functions, while barriers were identified around storage costs and the stability of AFPW, technology costs and other related areas – these and other drivers and barriers were detailed in the context analysis. These were valuable insights that will inform the development of sustainable business models for Agrimax.

More work is needed to develop the CBMs of the Agrimax cooperatives, biorefineries and other supply chain partners, such as farmers, cooperatives, food processors, end-users and waste managers and technology and knowledge providers. Further insights need to be gained into the existing business models of the supply chain partners, up- and downstream from the Agrimax cooperative and biorefinery. Aligning their business models presents a significant body of work that needs to be undertaken as part of the Agrimax project.

The findings from this workshop adds some weight to the best practice of developing business models, both in respect of assessing complete supply chains, and in relation to which supply chain partners are best placed to deliver which part of the model - including the proportion of costs and benefits associated with those. As a minimum, to enable CBM development within Agrimax, a clearer picture of the end goal and the roles of all supply chain partners needs to be prepared. This exercise is about (re)drawing boundaries between future supply chain partners, to decide who will do what.

Indeed, key questions were raised around which actors will organise and/or collect the AFPW from farmers and food processing facilities, who would carry out any pre-treatments on the AFPW, the scale of the envisioned supply chain and development run-in time, clarification around exact end-users and their needs, and the waste management needs of residues after the biorefining process. Notably, existing business models on the valorisation of food waste suggest that certification and standardisation for the future Agrimax supply chain may be a valuable asset to secure access to customer segments.

Along the complete Agrimax supply chain, common elements were repeatedly brought to the fore, such as turning wastes and by-products into valuable products; the creation of a sustainable, green image; operational cost reductions; high quality of raw materials and products; closing loops, preferably locally and direct, close, relations within a/the supply chain. Resource security for the supply of raw materials, including quality control, were considered important by upstream actors, while quality assurance, in the form of certification, were raised by downstream and other actors.

Results on key drivers and barriers were relatively clear. Critical areas of concern and opportunity were suggested and as part of the supply chain realisation efforts can be addressed by the Agrimax consortium during engagement with stakeholders associated with prioritised contextual factors. Areas requiring attention and action are:

- Adapting regulation for new products from waste and by-products.
- Overcoming the lack of consumer acceptance of waste derived products whilst strengthening consumer awareness and demand for products with environmental and health benefits.
- Challenges around high investments required at project initiation.

- Promotion of the implementation of the Agrimax supply chain as an effective means to achieve waste reduction.
- Distinct clarification of who will be the customers and markets for Agrimax products.
- Detail and quantify assertions around the type and number of new jobs that will be created – this is needed to complement the evidence base for Agrimax making a positive difference to local economies.

7.2 Upcoming follow-up activities in WP8

The development of circular business models is evolving as businesses increasingly adopt circular business activities. The nascent nature of CBM research and practice dictates the need for ongoing and reflective research. To further our understanding of how business models can be aligned within the Agrimax supply chain and realise the benefits of circular supply chains, partners will continue to carry out case studies (such as in Appendix A). This will include case studies of farmers, food processors, cooperatives, biorefineries, technology providers, waste managers, and technology- and knowledge providers.

Alongside the development of business models, LC will collaborate with Agrimax consortium partners to translate the models into fully fledged business plans to realise the desired project outcomes. An opportunity exploitation workshop is being prepared and will be held in 2018.

Discussion at the Agrimax stakeholder workshop

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Appendix A: CBM case studies

The delivery of Task 8.2 includes the preparation of 6-10 case studies of circular business models. Ahead of the workshop three cases were shared with the participants. Copies have been included on the next pages:

1. AF Biomass
2. Wilson Biochemical
3. Soldebre

Business Model Case Study 1: Straw

AF Biomass Limited in East Anglia, UK

Introduction

AF Biomass Limited is one of the four subsidiaries of Anglian Farmers Limited (AF), a purchasing cooperative with a diverse set of products and services. Based in the East of England, the cooperative has ca. 3500 shareholders and purchases 10% of the total farming inputs in the UK such as fertilisers, fuel, seeds and animal feed. While most business activities are focused on purchasing products and services for farming *inputs*, AF Biomass Limited is focused on buying straw *outputs* for sales as animal bedding and renewable feedstock for the power generation sector as well as a number of other new and emerging customers. Find out more in this video introducing AF Biomass.

Circular business model canvas

Strong buyer-supplier relationships with farmers supplying straw form the basis of the business model of AF Biomass. Mutual benefits are secured with the help of AF' assets, incl. extensive contact databases, finance, transport, and the AF brand. Attracting straw supplies of varying qualities, AF Biomass has opened- and continues to explore diverse end-markets.

Drivers and barriers

AF Biomass was founded when demand for biorenewables in the energy sector continued to grow. The British government incentivises low-carbon energy, including the use of biomass. However, the use of biomass for energy has been criticised as concerns around food security and land-use change emerged. Finding the middle-ground, AF Biomass has successfully developed a business model (see next page) enabling the use of straw with higher technical value, i.e. of higher quality, for higher value applications whilst also increasing resource efficiency and economic value from lower grade straw by-products.

Horizon 2020 European Union funding for Research & Innovation
Bio-based Industries Consortium
BIO-BASED INDUSTRIES

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Circular business model canvas: AF Biomass Limited, Straw

Key partnerships

Close buyer-supplier relations with arable farmers producing the by-product straw, by offering reliable and convenient service including:

- Secure and regular payments irrespective of harvest/ transport time, offering cash flow security
- Assurance of timely transport before new crop needs planting
- Offer contacts for contractors to bale straw
- Delivery and transport services
- Interest free finance for storage facility

Activities to create, distribute, sell and recover values

Contract arable farmers to source straw, and support them for the baling and storing of straw.

Assess straw quality and match produce to the right end-user.

Transport straw from farmer to end-user.

Explore new end-markets.

Physical, financial, human and/or intellectual assets needed to create, distribute, sell and recover values

Database of suppliers, straw baling contractors, power stations and livestock farmers

Access to finance within business group to support farmers investing in straw storage facilities

Transport and bale handling fleet

Access to digital platform to match supply and demand

AF brand offering security to partners

Value added proposition, e.g. economic, technical, social and /or environmental value of product or service

Mass customisation: Ability to match straw with diverse resource characteristics to the right end-users depending on the quality requirements for their application (energy, animal bedding, etc.) – combining economies of scale with specific customer needs.

Environmental benefit: Certainty that food production and renewable energy are balanced, preventing a supply conflict.

Technical value: Maintaining the highest utility of straw by diversified end-markets.

Types of customer relationships

Combining automated services with personal assistance from specialised staff.

Communication, distribution, sales and other channels used to reach customers

Direct sales through own channels to customers

Customer segments

Multiple diversified customer groups:

1) Renewable energy sector (power stations)

2) Livestock farmers

3) Composting facilities

4) Sewage treatment facilities

Types of costs to create, distribute, sell, and recover value (e.g., financial, social and environmental costs)

Value-driven because of offering customised service, and cost-driven because striving for economies of scale, minimising costs, and maximising automation.

Fixed costs: All usual business costs such as salaries, depreciation assets, etc.; Development of automated online services;

Variable costs: Payments to farmers for straw and building up of stocks; Transport fuel; Fleet maintenance; Innovation budget; Interest on loans for storage facilities; Risk management budget; Tax; Levies to AF.

Types of benefits for *your* business and the mechanisms required to capture them

Mainly the transaction revenues from straw sales.

Additional small amounts of financial income from for example the disposal of assets.

Costs and benefits created and shared in the wider circular supply chain

The straw is used within relatively short supply chains, generally involving three steps – production, trade and usage, before the remaining resources can return to land as soil conditioner. AF Biomass is strengthening the supply chain network by exploring new end-markets such as for linseed straw in the paper industry in Spain and with a new straw pelleting plant in the UK. This diversification should provide greater overall system stability, benefiting all supply chain partners involved.

Context: Wider costs of- and benefits to the economy, society and/or environment

AF Biomass has benefited from the growing renewable energy sector and the increasing demand for straw for power generation facilities. This company is in a position to directly balance demand for straw for higher-value applications, such as livestock farming, with lower-value applications such as energy recovery. When done in such responsible manner, the growing use of biomass for energy can positively contribute to energy security, the low carbon economy and 'green' jobs.

Business Model Case Study 2: Municipal Solid Waste

Wilson Bio-Chemical in Yorkshire, UK

Introduction

This SME develops technology for the waste management sector, converting municipal solid waste (MSW) into products by using steam in large rotating autoclaves. The technology can process mixed waste streams, separating the biodegradable fraction from recyclable resources. The biomass is processed into a fibre product, sold as a renewable energy source for combustion (generating power), gasification (syngas), pyrolysis (hydrogen and methane), and anaerobic digestion (methane and fertiliser) and, in the future, as raw material input for biobutanol-, acetone- and ethanol-production in the chemicals industry. After years of development with a pilot- and demonstration plant, the technology has reached full commercial scale with a plant processing 150,000 tonnes of MSW per annum.

Circular business model canvas

The business model on the next page shows how a company can exploit technology developed through extensive R&D. WBC has developed a truly "multi-dimensional" value proposition, integrating economic, technical, social and environmental values appealing to multiple interdependent customer segments. Both in terms of customer relations and key partnerships, this business model is characterised by strong, dedicated relationships. Supply chain relations are expanding with the exploration of higher value applications of recovered resources, contributing to the regeneration of the wider socio-economic and environmental context.

Drivers and barriers

This business model is driven by environmental and socio-economic challenges, offering a technological solution that can be seen as regenerative – especially in the context of developing countries. The model does depend on continued waste generation which in the long-term may not be sustainable. However, within any reasonable timescale availability of new and already landfilled MSW can be guaranteed. This prevents dissipation- and enables the recovery of multiple types of value as explained in the circular business model on the next page.

Horizon 2020 European Union funding for Research & Innovation
Bio-based Industries Consortium
The AgriMAX project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No. **720719**.

Circular business model canvas: Wilson Bio-Chemical (WBC), Municipal Solid Waste (MSW)

Key partnerships

Joint ventures with technology adopters.

Investors.

Government bodies funding R&D projects.

Academia and research institutes.

Activities to create, distribute, sell and recover values

Technology development; R&D projects; Waste resource testing; Product development.

Secure regulatory permits to use technology and products, such as the end-of-waste application for Biocoal.

Prepare investment opportunities.

Physical, financial, human and/or intellectual assets needed to create, distribute, sell and recover values

Trademarks in Europe and USA.
Intellectual property.
Pilot- and demonstrator plants.
Human resources – know-how and know-how-not-to.
Professional indemnity guarantee protecting the customers' financial capital.

Value added proposition, e.g. economic, technical, social and /or environmental value of product or service

Technology to convert MSW into valuable chemicals; Separate organic fibres from recovered technical materials.

Solve MSW problem with convenient, scalable solution avoiding separation challenges.

Renewable energy supply.

System meets own power and heat requirements, and has low water costs.

Environmental value by reducing and emptying landfills, freeing up land for other purposes, with positive effects on public support.

Social value in taking people off landfills and creating jobs.

Price of waste management competitive compared to incineration.

Types of customer relationships

For each development, technology is transferred by setting up a project team consisting of contract- and project-manager from WBC and customer-engineer "Engineering Procurement Contractor" who carries the commercial risk for the development.

Communication, distribution, sales and other channels used to reach customers

Direct contact - customers and WBC mostly communicate via the telephone for sales and during development. After plant commissioning communication shifts more towards online media.

Customer segments

Interdependent segments, including:

Problem owners:

1. Municipalities providing the waste and sites.
2. National governments of developing countries with large landfill sites creating social and environmental issues.

And solution providers:

3. Private project developers, e.g. waste management companies and landfill operators.

Types of costs to create, distribute, sell, and recover value (e.g., financial, social and environmental costs)

Staff costs and all the usual costs to operate an SME such as office costs, electricity, insurance, etc.

Above average R&D costs.

Social capital: training and knowledge transfer to new employees.

Types of benefits for *your* business and the mechanisms required to capture them

Current: License fee to use the intellectual property, either as annual fee or proportionate to weight MSW processed.

Future: Lease facility after WBC makes capital investment in partnership with investor; possibly in relatively small systems for the shipping sector.

Costs and benefits created and shared in the wider circular supply chain

The supply chain within which WBC's technology will be used starts from waste producers such as households and commercial facilities to the waste management and landfill operators handling the waste using the WBC system, and the downstream reprocessing of recyclables, use of Wilson Fibres and Biocoal or chemicals and manufacturing of new products. Partnerships are increasingly strengthened through R&D into higher value applications, anticipating delivering more economic, technical, environmental and social benefits whilst controlling for negative impacts.

Context: Wider costs of- and benefits to the economy, society and/or environment

The WBC system is marketed in developed and developing countries, offering solutions when wastes are already generated. While waste prevention and reduction should always be prioritised, the reality is that large volumes of mixed waste are produced around the world. Within that context, the WBC system offers a regenerative solution dealing with environmental issues including climate change and pollution caused by waste landfill and incineration as well as growing energy demands. Wastes, especially the biodegradable fraction, are diverted from landfill, reducing greenhouse gas emissions and freeing up land for other purposes whilst producing feedstock for renewable energy, reducing demand for primary materials by offering secondary resources to the market, and creating new knowledge, skills and jobs.

Business Model Case Study 3: Olive kernels

Soldebre in Catalonia, Spain

Introduction

Soldebre is a cooperative that was founded in 1995 by merging three cooperatives active in the agricultural- and food processing sectors of citrus, nuts and olives as well as supplying farmers with fertilisers, crop protection products, fuel and services including credit, insurance and advice. The SME has ca. 1400 members and employs 40 permanent members of staff. In general, the company strives for economies of scale to enable low price value propositions, whilst maintaining product quality. Aiming for growth through consolidating market positions in Catalonia and Europe and expansion into new markets, they are already leading the olive oil market in Catalonia. Owning a mill with multiple processing and packaging lines, 420 tonnes of olives can be processed each day. Harvests vary from 10,000 up to 18,000 tonnes annually, resulting in 1,500-4,000 tonnes of olive oil. About 75% of the harvested weight are wastes and by-products such as leaves, soil, stones and kernels; all of which have recycling and recovery routes in place. The olive kernels are crushed and used within the processing facilities and are also sold to animal farms to generate heat.

Circular business model canvas

Soldebre's business model creates multiple types of value from olive kernels. By using the kernels as biofuel, resource efficiency is increased and carbon benefits are realised, whilst lowering the fuel costs for the olive mill and secure an additional revenue stream from sales of biofuel to animal farms.

Drivers and barriers

The global olive oil market is highly competitive. Additionally, the sector is faced with various environmental challenges. It is important for the long-term resilience of the sector to become more resource efficient and create increasingly circular supply chains, opening new commercially attractive pathways through diversification of business models such as with the creation of value from wastes and by-products as demonstrated here.

Horizon 2020 European Union funding for Research & Innovation

Bio-based Industries Consortium

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Circular business model canvas: Soldebre, Olive kernels

Key partnerships

Growers of olives who are members of the cooperative, with an interest to create as much value from their produce as possible.

Government, providing regulation and incentives in direct collaboration with the olive sector to improve its long-term prospects.

Logistics companies to transport the olive oil.

Activities to create, distribute, sell and recover values

Processing olives into olive oil, package it, and sales to wholesalers, distributors and restaurants.

Processing of wastes and by-products, incl. drying and crushing of kernels used on-site and distributed to animal farms.

Physical, financial, human and/or intellectual assets needed to create, distribute, sell and recover values

Olive mill.

Membership database.

Value added proposition, e.g. economic, technical, social and /or environmental value of product or service

Olive kernels are used at Soldebre's facilities and sold as fuel to generate heat in animal farms. This has a number of benefits for the customer, such as:

Reducing fuel costs with low price alternative.

Environmental benefits through usage of low-carbon fuel.

Types of customer relationships

Customers from animal farms collect the biofuel from the olive mills when they need it. At the mill they get personal assistance to buy the product.

Communication, distribution, sales and other channels used to reach customers

Soldebre sells the biofuel directly through their own channels. Customers bring their own means of transport to collect the biofuel for use at their animal farm.

Customer segments

Internal usage at Soldebre's food processing facilities.

Animal farms.

Types of costs to create, distribute, sell, and recover value (e.g., financial, social and environmental costs)

The cooperative has a cost-driven business model focused on achieving economies of scale; the business model for using olive kernels for energy supports further cost reductions and increases diversification widening the scope of the model.

Additional costs to offer the olive kernels as biofuel are negligible; fixed and variable costs are associated with the production of olive oil and processing of olive pomace oil.

Types of benefits for *your* business and the mechanisms required to capture them

Cost reduction for Soldebre's processing facilities.

Transaction revenues from sales of olive kernels.

Increased resource efficiency and carbon reductions through use of waste product.

Costs and benefits created and shared in the wider circular supply chain

This is a short supply chain from olive growers, to the cooperative and the animal farms using the olive kernels. The realised supply chain offers the opportunity to avoid other types of costs and problems. With the use of olive kernels as a low-carbon biofuel, environmental impacts are reduced such as achieving a reduction in carbon emissions by using less fossil fuels; Moreover, additional revenues are generated for the cooperatives and their members, creating a more steady income for olive growers which strengthens the local economy. The supply chain could possibly be further extended by using the ashes from combustion of the olive kernels in soil conditioners, to feed new growth cycles of olives or other crops.

Context: Wider costs of- and benefits to the economy, society and/or environment

The olive sector has faced environmental challenges in terms of changing weather patterns, plagues and soil degradation. Increasingly strict environmental regulations are driving change and the sector is supported through government lending support and tax reliefs. Moreover, competition outside Catalonia and Europe has increased. Aside from these pressures, demand for sustainable fuels is growing. Cost reduction and diversification of products support the resilience of this sector and the livelihoods of rural communities.

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