



# Circular Bio-Based Business models to create high-value Bio-based products in integrated value chains



Funded by  
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Funded by the European Union, under Grant Agreement N° 101135323. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or REA. Neither the European Union nor the granting authority can be held responsible for them.

| WOOD                                                                              | VINEYARDS                                                                         | CEREALS                                                                             | APPLE                                                                                    | POTATOES                                                                            | WETLANDS                                                                                             |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
|  |  |  |       |  |                   |
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# Forestry residue for essential oils and hydrosol extraction model

Transforms woody biomass into essential oils and hydrosol, unlocking higher value from district heating system feedstock. In synergy with a power plant volatile aromatic compounds are captured, creating biobased ingredients for cosmetics, cleaning and wellness sectors. Reduces waste and diversifies revenue streams.

**Products & Inputs**  
Main products: essential oils and hydrosol (aromatic water).  
Input: woody biomass (e.g. spruce wood chips, pruning residues).

**Process**  
Woody biomass undergoes distillation to extract essential oils and hydrosol via passing steam through shredded biomass, condensation and mechanical separation. Residual biomass remains suitable for combustion.

**Market**  
Targets B2B industrial buyers in cosmetics, cleaning and wellness sectors. Focuses on bulk sales of raw essential oils and hydrosol for further use.

**Costs & Revenues**  
Main costs: labour, overhead, electricity, heat, water, raw materials, and maintenance. Revenue: sales of essential oils and hydrosol.

**What makes this business model circular biobased?**  
Upcycles woody biomass into biobased ingredients, capturing value from volatile compounds otherwise lost. Increases resource efficiency. Internally recycles water.

**What makes this business model fair?**  
Fairness is ensured through joint problem-solving, normative contracting with multi-year agreements, and collaborative communication. Emphasizes transparency, information sharing, and cultural adaptation, strengthening trust and long-term commitment.



|               | Value proposition                                                                                                                                   | Value creation                                                                                                                                                          | Value delivery                                                                                                                      | Value capture                                                                                                                                                  |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Economic      | <ul style="list-style-type: none"><li>Essential oils and hydrosol for cosmetics, cleaning and wellness</li></ul>                                    | <ul style="list-style-type: none"><li>Transporting biomass</li><li>Extracting compounds by steam distillation</li><li>Synergies with local biomass plant</li></ul>      | <ul style="list-style-type: none"><li>Long-term bulk contracts with industrial clients</li><li>Direct and fast delivery</li></ul>   | <ul style="list-style-type: none"><li>Sales of essential oils</li><li>Sales of hydrosol</li></ul>                                                              |
| Environmental | <ul style="list-style-type: none"><li>Upcycled circular forestry residue valorisation</li></ul>                                                     | <ul style="list-style-type: none"><li>Locally sourced forest biomass</li><li>Residue biomass is used for energy, water is largely used internally</li></ul>             | <ul style="list-style-type: none"><li>Minimal and non-toxic waste/residues</li><li>Water recycled</li></ul>                         | <ul style="list-style-type: none"><li>Converting low-value residues from forestry into heat and useful co-products</li><li>Resource efficiency</li></ul>       |
| Social        | <ul style="list-style-type: none"><li>Circular and resource-efficient regional economy</li><li>Recognition of biomass below low-value use</li></ul> | <ul style="list-style-type: none"><li>Regional resource efficiency and responsible production</li><li>Local employment and upskilling</li></ul>                         | <ul style="list-style-type: none"><li>Low societal risk of pollution, health and environmental problems</li></ul>                   | <ul style="list-style-type: none"><li>Rural attractiveness</li><li>Stronger forestry supply chains</li><li>Circular economy and industrial symbiosis</li></ul> |
| Fairness      | <ul style="list-style-type: none"><li>Processor-led</li><li>Collaborative, transparent and respectful partnership</li></ul>                         | <ul style="list-style-type: none"><li>Relational, normative contracting, informal monitoring</li><li>Joint problem solving</li><li>Adequate contract duration</li></ul> | <ul style="list-style-type: none"><li>Collaborative communication</li><li>Information sharing</li><li>Cultural adaptation</li></ul> | <ul style="list-style-type: none"><li>Trust, transparency and commitment in regional collaboration</li></ul>                                                   |

# Industrial biocarbon from forestry model



Transforms low-value sawdust into biocarbon, syngas and pyrolysis oil. A centralized biorefinery converts forestry byproducts into fossil-free carbon for industries like metallurgy, exploiting synergies from industrial symbiosis. Reduces CO<sub>2</sub> emissions, waste, and reliance on fossil resources.

### Products & Inputs

Main product: biocarbon; byproducts: syngas and pyrolysis oil.  
Input: sawdust from local sawmills and foresters.

### Process

Sawdust is dried on-site and converted via pyrolysis into biocarbon, syngas, and pyrolysis oil. The dry material is split equally into biocarbon and a mix of pyrolysis oil and syngas.

### Market

Targets metallurgical industries seeking fossil-free carbon alternatives.  
Secondary customers: district heating companies for pyrolysis oil and gas.

### Costs & Revenues

Main costs: raw material, energy for drying, labour, and transport.  
Revenue: biocarbon and pyrolysis oil/gas sales for heat generation.

### What makes this business model circular biobased?

Upcycles forestry residues. Biobased carbon replaces fossil coal and is partly embedded in the steel. Improves resource efficiency and supports climate action.

### What makes this business model fair?

Fairness is ensured through adaptive pricing for sawdust providing fair benefits for foresters. Strengthens regional industrial linkages, creates rural jobs, and fosters a sustainable bioeconomy.

|               | Value proposition                                                                                                                                                                                | Value creation                                                                                                                                                                       | Value delivery                                                                                                                                                                     | Value capture                                                                                                                                                             |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Economic      | <ul style="list-style-type: none"><li>High-quality biocarbon for steel industry</li><li>Lower reliance on carbon credits</li></ul>                                                               | <ul style="list-style-type: none"><li>Large scale</li><li>Energy exchange with CHP plant in industrial symbiosis</li></ul>                                                           | <ul style="list-style-type: none"><li>Direct shipments to customers</li></ul>                                                                                                      | <ul style="list-style-type: none"><li>Sales of biocarbon</li><li>Sales of pyrolysis oil and syngas</li></ul>                                                              |
| Environmental | <ul style="list-style-type: none"><li>Fossil-free end product</li><li>Biocarbon replaces fossil coal in steel production</li><li>Additional energy and material value from co-products</li></ul> | <ul style="list-style-type: none"><li>Local sawdust sourcing</li><li>Drying, densification and pyrolysis</li><li>Internal use of waste heat and syngas</li></ul>                     | <ul style="list-style-type: none"><li>Biocarbon use in metallurgical industry</li><li>Co-products used for district heating</li><li>Return and reuse of containers</li></ul>       | <ul style="list-style-type: none"><li>Reduced fossil coal consumption</li><li>Syngas and waste heat offset energy use</li><li>Valorisation of forestry residues</li></ul> |
| Social        | <ul style="list-style-type: none"><li>Circular and resource-efficient regional economy</li><li>Stable, skilled and safe jobs</li><li>Healthier environment</li></ul>                             | <ul style="list-style-type: none"><li>Local employment and upskilling</li><li>Above-minimum wages and long-term contracts</li><li>Responsible procurement from suppliers</li></ul>   | <ul style="list-style-type: none"><li>Community engagement and outreach</li><li>Awareness raising on green transition</li></ul>                                                    | <ul style="list-style-type: none"><li>Stronger forestry supply chains</li><li>Local jobs and skills development</li><li>Circular economy</li></ul>                        |
| Fairness      | <ul style="list-style-type: none"><li>Processor-led</li><li>Fair pricing and stable partnerships</li></ul>                                                                                       | <ul style="list-style-type: none"><li>Long-term cost-plus contracts with sawdust suppliers</li><li>Producer representation on board</li><li>Information-sharing mechanisms</li></ul> | <ul style="list-style-type: none"><li>Structured dialogue with foresters' associations</li><li>Long-term partnerships</li><li>Transparent communication and consultation</li></ul> | <ul style="list-style-type: none"><li>Predictable revenues</li><li>Trust and transparency</li><li>Local legitimacy and stakeholder support</li></ul>                      |

# Cereal residue valorisation model

Transforms low-value cereal residues into high-quality pet bedding pellets. An agricultural cooperative upcycles straw and corn stalks into standardized, absorbent pellets, ensuring sustainable biomass use. Strengthens regional value chains, and supports circular agriculture.

### Products & Inputs

Main product: pet bedding pellets.  
Input: straw and corn stalks from local arable farms.

### Process

Cereal residues are cleaned, crushed, and pelletized into absorbent pellets. The process includes pretreatment, conversion, and downstream packaging into small-format bags. No drying or heat is required.

### Market

Targets distributors, wholesalers, and pet industry partners via stable B2B contracts. Focuses on reliability, quality, and standardized packaging for the small-pet bedding market. Secondary markets include livestock farms and biomass operators.

### Costs & Revenues

Main costs: labour, raw materials, electricity, logistics, and overhead.  
Revenue: pet bedding pellet sales.

### What makes this business model circular biobased?

Upcycles agricultural residues into biobased products. Maximizes resource efficiency and supports sustainable biomass use.

### What makes this business model fair?

Fairness is ensured through cooperative governance, profit-sharing, and collaborative decision-making. Emphasizes transparency, joint problem-solving, and open communication, strengthening regional cooperation and trust.



|               | Value proposition                                                                                                               | Value creation                                                                                                                                                | Value delivery                                                                                                                                          | Value capture                                                                                                           |
|---------------|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Economic      | <ul style="list-style-type: none"><li>Absorbent pellets for pet bedding</li></ul>                                               | <ul style="list-style-type: none"><li>Transport, storage and pretreatment of biomass, conversion into pellets</li><li>Cooperative infrastructure</li></ul>    | <ul style="list-style-type: none"><li>Long-term partnerships with buyers</li><li>Reliability and product consistency</li></ul>                          | <ul style="list-style-type: none"><li>Sales of pellets</li><li>Profit sharing between cooperative members</li></ul>     |
| Environmental | <ul style="list-style-type: none"><li>Upcycling residual material into a functional material at a 95% conversion rate</li></ul> | <ul style="list-style-type: none"><li>Biomass from close-by farmers</li><li>Electricity from local grid</li><li>Efficient centralized pelletisation</li></ul> | <ul style="list-style-type: none"><li>High absorbency and biodegradability reduce use and increase recycling</li></ul>                                  | <ul style="list-style-type: none"><li>Improved resource efficiency: reduced reliance on virgin wood resources</li></ul> |
| Social        | <ul style="list-style-type: none"><li>Strengthening of the cooperative model and the collective action</li></ul>                | <ul style="list-style-type: none"><li>Job creation</li></ul>                                                                                                  | <ul style="list-style-type: none"><li>Improved regional circularity</li></ul>                                                                           | <ul style="list-style-type: none"><li>Cooperative network reinforcement and rural income diversification</li></ul>      |
| Fairness      | <ul style="list-style-type: none"><li>Farmer-led</li><li>Fair value distribution</li><li>Inclusive decision making</li></ul>    | <ul style="list-style-type: none"><li>Cooperative model with profit- and risk-sharing</li><li>Joint problem solving and planning</li></ul>                    | <ul style="list-style-type: none"><li>Information sharing</li><li>Collaborative communication, contact channel and supply chain socialisation</li></ul> | <ul style="list-style-type: none"><li>Trust-based collaboration, commitment</li></ul>                                   |

# Milling residue functional food/nutraceuticals model

Transforms low-value wheat bran into high-value soluble fibre complexes, glucose syrup, and residual fibre. A biorefinery upcycles milling byproducts into functional food ingredients, reducing waste and enhancing resource efficiency.

**Products & Inputs**  
Main product: semi-processed soluble fibre complex (prebiotic property); co-products: glucose syrup, residual fibre. Input: wheat bran from milling.

**Process**  
Wheat bran undergoes enzymatic destarching, alkaline extraction, and purification to separate soluble fibre, glucose syrup, and residual fibre. The process includes liquefaction, saccharification, pressing, neutralization, concentration, and spray-drying.

**Market**  
Targets food manufacturers for soluble fibre and glucose syrup with nutraceutical and health-food sectors as long-term focus. Animal feed industry and farmers utilize residual fibre.

**Costs & Revenues**  
Main costs: labour, overhead, electricity, heat, water, materials, maintenance, and quality assurance. Revenue: sales of soluble fibre, glucose syrup, and residual fibre.

**What makes this business model circular biobased?**  
Upcycles wheat milling byproducts into food ingredients, replacing low-value disposal. Maximizes resource efficiency, supports circular agriculture, and reduces waste.

**What makes this business model fair?**  
Fairness is ensured through cultural adaptation, supply chain socialization, and collaborative communication. Emphasizes risk-sharing, co-investment, and joint problem-solving, strengthening trust and regional cooperation.



|               | Value proposition                                                                                                                    | Value creation                                                                                                                                                                                       | Value delivery                                                                                                                           | Value capture                                                                                                                           |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Economic      | <ul style="list-style-type: none"><li>Soluble fibre complex with prebiotic property and glucose syrup</li></ul>                      | <ul style="list-style-type: none"><li>Alkaline extraction of compounds</li></ul>                                                                                                                     | <ul style="list-style-type: none"><li>Long-term collaborative partnerships with buyers of fibre, direct sales of glucose syrup</li></ul> | <ul style="list-style-type: none"><li>Sales of extracted soluble fibre with prebiotic property</li><li>Sales of glucose syrup</li></ul> |
| Environmental | <ul style="list-style-type: none"><li>Upgrading a side stream into a higher value product</li></ul>                                  | <ul style="list-style-type: none"><li>Low impact regional residues and energy utilization</li></ul>                                                                                                  | <ul style="list-style-type: none"><li>Biodegradability of products, no toxicity</li></ul>                                                | <ul style="list-style-type: none"><li>Improved resource efficiency</li></ul>                                                            |
| Social        | <ul style="list-style-type: none"><li>Circular and resource-efficient regional economy</li></ul>                                     | <ul style="list-style-type: none"><li>Local employment and upskilling</li></ul>                                                                                                                      | <ul style="list-style-type: none"><li>Boosting regional innovation in food manufacturing</li><li>Boosting healthy diets</li></ul>        | <ul style="list-style-type: none"><li>Rural income diversification</li></ul>                                                            |
| Fairness      | <ul style="list-style-type: none"><li>Processor-led</li><li>Fair pricing</li><li>Inclusive and transparent decision-making</li></ul> | <ul style="list-style-type: none"><li>Relational contract</li><li>Explicit contract with pricing criteria, informal monitoring of farmers growing conditions</li><li>Joint problem solving</li></ul> | <ul style="list-style-type: none"><li>Collaborative communication and transparency, procedural explanations, quality criteria</li></ul>  | <ul style="list-style-type: none"><li>Improved farm income and rural economy</li><li>Procedural fairness</li></ul>                      |

# Small-scale cooperative potato residue valorisation model

Transforms potato residues into high-value hydroxymethylfurfural (HMF), pulp, and biochar. A small-scale, farmer-cooperative biorefinery upcycles starchy biomass from local potato processing into biobased platform chemicals and materials. Supports rural circularity, reduces waste, and pilots innovative valorisation pathways.

**Products & Inputs**  
Main product: HMF; co-products: pulp and biochar.  
Input: potato residues from local farms and on-farm processing.

**Process**  
Potato residues undergo acid hydrolysis and dehydration to produce HMF. Residues are further converted into pulp and biochar. The process is powered by on-site biogas.

**Market**  
Targets early adopters (pilot users) for HMF and local agricultural markets for pulp and biochar.

**Costs & Revenues**  
Main costs: labour, overhead, heat, raw materials, and waste treatment.  
Revenue: HMF sales mostly, with modest contributions from pulp and biochar.

**What makes this business model circular bio-based?**  
Upcycles potato residues into biobased chemicals, replacing fossil-based alternatives. Maximizes biomass utilization and supports rural circular economies.

**What makes this business model fair?**  
Fairness is ensured through co-ownership, risk-sharing, and joint problem-solving among cooperative farmers. Emphasizes transparency, informal monitoring, and collaborative communication, strengthening trust and regional cooperation.



|               | Value proposition                                                                                                                                                                                                      | Value creation                                                                                                                                                                                                                      | Value delivery                                                                                                                                   | Value capture                                                                                                                                                                          |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Economic      | <ul style="list-style-type: none"><li>High value bio-based HMF</li><li>Pulp for feed</li><li>Biochar for soil amendment</li></ul>                                                                                      | <ul style="list-style-type: none"><li>Storage of biomass, extracting compounds via modular on-site units of cooperatively owned biorefineries</li></ul>                                                                             | <ul style="list-style-type: none"><li>Direct contracts for niche clients</li><li>Collaborative product development</li></ul>                     | <ul style="list-style-type: none"><li>Revenues from sales of HMF, pulp and biochar on niche markets</li></ul>                                                                          |
| Environmental | <ul style="list-style-type: none"><li>Upcycling of agricultural residues</li><li>Non-food competing biomass valorisation</li><li>Low-waste, sustainable resource use</li><li>Maintaining short supply chains</li></ul> | <ul style="list-style-type: none"><li>On-site biorefinery units with minimal transport and local logistics</li><li>Recovery of ethanol/reuse</li><li>Remaining waste streams are potential issue</li></ul>                          | <ul style="list-style-type: none"><li>Low transport emissions</li><li>Replaces fossil-based chemicals</li></ul>                                  | <ul style="list-style-type: none"><li>Reduced climate emissions</li></ul>                                                                                                              |
| Social        | <ul style="list-style-type: none"><li>Strengthening regional circular economies</li></ul>                                                                                                                              | <ul style="list-style-type: none"><li>Local employment and upskilling</li></ul>                                                                                                                                                     | <ul style="list-style-type: none"><li>Promotion of rural entrepreneurship</li><li>Inclusion of smaller producers in innovation systems</li></ul> | <ul style="list-style-type: none"><li>Strengthening links between agro and industry</li><li>Enhanced community engagement and local pride</li><li>Local economic development</li></ul> |
| Fairness      | <ul style="list-style-type: none"><li>Farmer-led</li><li>Creating an additional income stream for member farmers of the cooperative</li></ul>                                                                          | <ul style="list-style-type: none"><li>Patronage-based cooperative with risk- and profit-sharing</li><li>Members agree on explicit rules to govern the cooperative</li><li>Joint quality support for participating farmers</li></ul> | <ul style="list-style-type: none"><li>Joint problem solving and open communication within the cooperative</li></ul>                              | <ul style="list-style-type: none"><li>Profit sharing in cooperative</li></ul>                                                                                                          |

# Centralised industrial potato residue valorisation model

Transforms potato residues into high-value hydroxymethylfurfural (HMF), pulp, and biochar at industrial scale. A large-scale biorefinery integrated in a potato processing facility, upcycling starchy biomass into biobased platform chemicals and materials.

**Products & Inputs**  
Main product: Hydroxymethylfurfural (HMF); co-products: pulp and biochar. Input: residues from potato processing.

**Process**  
Potato residues undergo acid hydrolysis and dehydration to produce HMF. Solid residues are further converted into pulp and biochar. The process operates continuously.

**Market**  
Targets industrial buyers (chemical manufacturers, materials producers) for HMF and agricultural markets for pulp and biochar as feed and soil amendments.

**Costs & Revenues**  
Main costs: labour, overhead, heat, raw materials, and waste treatment. Revenue: HMF sales mostly, with significant contributions from pulp and biochar.

**What makes this business model circular bio-based?**  
Upcycles potato residues into biobased chemicals, replacing fossil-based alternatives. Maximizes biomass utilization and supports industrial circular economies.

**What makes this business model fair?**  
Fairness is ensured through explicit contracting and fair procedures, potential profit and risk-sharing with farmers, and joint planning. Emphasizes transparency and collaborative communication, strengthening trust and long-term commitment.



|               | Value proposition                                                                                                                                                | Value creation                                                                                                                                                                                                                       | Value delivery                                                                                                                                                   | Value capture                                                                                                                                                                                          |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Economic      | <ul style="list-style-type: none"><li>Bulk market HMF for chemicals</li><li>Pulp for feed</li><li>Biochar for soil amendment</li></ul>                           | <ul style="list-style-type: none"><li>Potential for industrial symbiosis</li></ul>                                                                                                                                                   | <ul style="list-style-type: none"><li>Long term contracts with B2B customers</li><li>Specific product specs and partnerships</li></ul>                           | <ul style="list-style-type: none"><li>Sales to chemical industry, feed industry and agricultural inputs</li></ul>                                                                                      |
| Environmental | <ul style="list-style-type: none"><li>Upcycling potato residues for fossil substitution</li><li>Carbon sequestration and soil improvement from biochar</li></ul> | <ul style="list-style-type: none"><li>Use of inhouse residues without transport</li><li>Synergy with biomass power plant if possible</li><li>Recovery of ethanol/reuse</li><li>Remaining waste streams are potential issue</li></ul> | <ul style="list-style-type: none"><li>Low transport emissions</li><li>Replaces fossil-based chemicals</li><li>Carbon sequestration in biochar</li></ul>          | <ul style="list-style-type: none"><li>Reduced climate emissions</li></ul>                                                                                                                              |
| Social        | <ul style="list-style-type: none"><li>Strengthening regional rural economy</li></ul>                                                                             | <ul style="list-style-type: none"><li>Job creation</li><li>Attention to safe working conditions (chemicals and processes)</li></ul>                                                                                                  | <ul style="list-style-type: none"><li>Strengthens regional bio-based agro-innovation system</li><li>Industrial customers increasing bio-based business</li></ul> | <ul style="list-style-type: none"><li>Strengthening links between agro and bio-based industry</li><li>Regional economic development</li><li>Lower exposure of workers to hazardous chemicals</li></ul> |
| Fairness      | <ul style="list-style-type: none"><li>Processor-led</li><li>Fair prices for farmers, and fair-trading practices</li><li>Collaborative partnerships</li></ul>     | <ul style="list-style-type: none"><li>Relational contracts with suppliers</li><li>Explicit contracts, informal monitoring</li><li>Joint problem solving and planning</li></ul>                                                       | <ul style="list-style-type: none"><li>Contact channels and collaborative communication</li></ul>                                                                 | <ul style="list-style-type: none"><li>Fair pricing and profit-sharing with farmers (if possible)</li><li>Trust and commitment</li></ul>                                                                |

# On-farm biorefinery for apple residues model

**Transforms apple pomace, a byproduct of juice production, into high-value hydroxymethylfurfural (HMF), hydrochar, and pulp. A small-scale cooperative biorefinery upcycles residues into biobased chemicals and materials, diversifying revenue while maintaining existing juice production.**

**Products & Inputs**  
Main product: (HMF); co-products: hydrochar and pulp.  
Input: apple pomace from juice production.

**Process**  
Apple pomace undergoes acid hydrolysis and dehydration to produce HMF. Solid residues are converted into hydrochar, while fibrous residues become pulp. The process operates continuously, powered by on-site renewable energy (biogas).

**Market**  
Targets industrial chemical buyers from niche high-value market for HMF, and stable regional markets with agricultural users for hydrochar, and feed/fibre producers for pulp.

**Costs & Revenues**  
Main costs: labour, overhead, heat, raw materials, maintenance, and waste treatment. Revenue: HMF sales mostly, with smaller contributions from hydrochar and pulp.

**What makes this business model circular bio-based?**  
Upcycles apple pomace into biobased chemicals and materials, replacing fossil-based alternatives. Maximizes resource efficiency, supports circular agriculture, and reduces waste.

**What makes this business model fair?**  
Fairness is ensured through profit-sharing, adaptive pricing, and co-investment within the cooperative. Emphasizes transparency and collaborative communication, strengthening trust and fostering regional cooperation.



|               | Value proposition                                                                                                                                                      | Value creation                                                                                                                                                                                                                                                                         | Value delivery                                                                                                                                                                          | Value capture                                                                                                                                             |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Economic      | <ul style="list-style-type: none"><li>• HMF from apple pomace for specialty chemicals companies</li><li>• Pulp for feed</li><li>• Biochar for soil amendment</li></ul> | <ul style="list-style-type: none"><li>• On-farm pomace handling with minimal transport costs</li><li>• Acid hydrolysis and HMF production, biochar and fibrous pulp</li><li>• Quality and waste management</li></ul>                                                                   | <ul style="list-style-type: none"><li>• Direct B2B contracts for small volumes</li><li>• Niche partnerships</li><li>• Collaboration with research</li></ul>                             | <ul style="list-style-type: none"><li>• Sales of HMF to niche markets</li><li>• Sales of biochar to agriculture</li><li>• Sales of pulp to feed</li></ul> |
| Environmental | <ul style="list-style-type: none"><li>• Upcycling residues into multiple cascaded products</li><li>• Carbon sequestration and soil improvement from biochar</li></ul>  | <ul style="list-style-type: none"><li>• On-site sourcing minimal transport emissions</li><li>• Residues transformed to biochar and pulp</li><li>• Use of biogas plant for heat and electricity</li><li>• Ethanol reuse</li><li>• Remaining waste streams are potential issue</li></ul> | <ul style="list-style-type: none"><li>• Carbon sequestration in agriculture</li></ul>                                                                                                   | <ul style="list-style-type: none"><li>• Replaces fossil inputs</li><li>• Lower emissions</li><li>• Soil amendment</li><li>• Low land use</li></ul>        |
| Social        | <ul style="list-style-type: none"><li>• Strengthening local economy</li><li>• Support for rural innovation and SME participation in bio-based economy</li></ul>        | <ul style="list-style-type: none"><li>• Creating skilled jobs</li><li>• Attention to safe working conditions (chemicals and processes)</li></ul>                                                                                                                                       | <ul style="list-style-type: none"><li>• Inclusion of smaller producers in innovation systems</li><li>• Local customers increasing bio-based business</li><li>• Local identity</li></ul> | <ul style="list-style-type: none"><li>• Strengthening links between agro and bio-based industry</li><li>• Local economic development</li></ul>            |
| Fairness      | <ul style="list-style-type: none"><li>• Farmer-led</li><li>• Fair profit-sharing for farmers</li><li>• Farmers' control and authority over decision-making</li></ul>   | <ul style="list-style-type: none"><li>• Farmer cooperative</li><li>• Explicit contracts to reduce uncertainties and align responsibilities</li><li>• Joint problem solving</li></ul>                                                                                                   | <ul style="list-style-type: none"><li>• Dedicated communication channels</li><li>• Information sharing and transparency</li></ul>                                                       | <ul style="list-style-type: none"><li>• Profit sharing in cooperative</li><li>• Trust and commitment</li></ul>                                            |

# Regional supply of 70% purity polyphenol from grape pomace for supplements valorisation model

Transforms low-value grape pomace into 70% purity polyphenols for the food supplements and cosmetics industry. Polyphenols are plant compounds that have antioxidant and anti-inflammatory properties. Collaboration between regional distilleries and wineries enables shared infrastructure, biorefineries built on existing facilities and upcycling winery residues into high-value bio-based products. Reduces waste and strengthens the local wine value chain.

**Products & Inputs**  
Main product: polyphenol-rich extracts; byproduct: leftover pomace.  
Input: grape pomace from regional wineries.

**Process**  
Grape pomace undergoes hydroalcoholic extraction to obtain polyphenols. The process includes maceration, pressing, purification, and concentration. Leftover pomace is sold to biogas facilities.

**Market**  
Targets regional ingredient producers (e.g., supplement manufacturers) via long-term B2B partnerships. Focuses on stable demand, adaptive pricing, and high-capacity utilization.

**Costs & Revenues**  
Main costs: raw materials, electricity, heat, water, maintenance, and marketing. Revenue: polyphenol extract sales and pomace sales to biogas facilities.

**What makes this business model circular bio-based?**  
Upcycles winery residues into high-value bio-based products, replacing low-value disposal. Maximizes resource efficiency and supports a sustainable regional bioeconomy.

**What makes this business model fair?**  
Fairness is ensured through long-term contracts, adaptive pricing, and profit-sharing with wineries. Strengthens regional cooperation, creates shared value, emphasizes transparency and joint planning.



|               | Value proposition                                                                                                                                          | Value creation                                                                                                                                                                    | Value delivery                                                                                                                          | Value capture                                                                                                                               |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Economic      | <ul style="list-style-type: none"><li>70% purity polyphenols with natural antioxidants from grape pomace for regional food supplements producers</li></ul> | <ul style="list-style-type: none"><li>Sourcing pomace and storage</li><li>Hydroalcoholic compound extraction</li><li>Waste management</li><li>Leftover pomace to biogas</li></ul> | <ul style="list-style-type: none"><li>Long-term contracts with B2B customers and strategic partnerships</li></ul>                       | <ul style="list-style-type: none"><li>Regional sales of polyphenols to food supplements, cosmetics and other bio-based industries</li></ul> |
| Environmental | <ul style="list-style-type: none"><li>Upcycling grape pomace</li><li>Functional quality non-toxic, biodegradable, and natural antioxidants</li></ul>       | <ul style="list-style-type: none"><li>Ethanol and resin reusable and recycled</li><li>Leftover pomace to biogas</li></ul>                                                         | <ul style="list-style-type: none"><li>Biodegradability</li><li>Non-toxicity</li><li>Local customers low transport emissions</li></ul>   | <ul style="list-style-type: none"><li>Lower environmental footprint</li></ul>                                                               |
| Social        | <ul style="list-style-type: none"><li>Strengthening local circular economy</li></ul>                                                                       | <ul style="list-style-type: none"><li>Skilled job creation</li></ul>                                                                                                              | <ul style="list-style-type: none"><li>Local cultural identity</li></ul>                                                                 | <ul style="list-style-type: none"><li>Local economic development</li></ul>                                                                  |
| Fairness      | <ul style="list-style-type: none"><li>Processor-led</li><li>Fair pricing</li><li>Transparency</li></ul>                                                    | <ul style="list-style-type: none"><li>Relational long-term contract</li><li>Joint planning, information sharing on harvest, volumes etc</li></ul>                                 | <ul style="list-style-type: none"><li>Responsiveness from wineries to demand from biorefinery</li><li>Trust based partnership</li></ul> | <ul style="list-style-type: none"><li>Trust and commitment</li></ul>                                                                        |

# High purity cosmetic-grade polyphenol extraction cooperative from grape pomace model

Transforms low-value grape pomace into high-purity, cosmetic-grade polyphenol. Polyphenols are plant compounds that have antioxidant and anti-inflammatory properties. An on-farm biorefinery upcycles regional residues into biobased cosmetic ingredients. Strengthens the circular economy, reduces waste, and enhances regional value retention.

**Products & Inputs**  
Main product: 85% purity cosmetic-grade polyphenol extracts; byproduct: leftover pomace. Input: grape pomace from wineries.

**Process**  
Grape pomace undergoes hydroalcoholic extraction to produce high-purity polyphenols. The process includes maceration, pressing, purification, and concentration.

**Market**  
Targets national and European biobased cosmetic companies via long-term B2B partnerships. Focuses on stable demand, joint product development, and regulatory compliance. Potential for regional and EU-wide cosmetic ingredient supply chains.

**Costs & Revenues**  
Main costs: labour, raw materials, overhead, electricity, heat, water, maintenance, and marketing. Revenue: polyphenol extract sales, and leftover pomace sales to biogas facilities.

**What makes this business model circular bio-based?**  
Upcycles winery residues into high-value cosmetic ingredients, replacing fossil-based alternatives, maximizes resource efficiency.

**What makes this business model fair?**  
Fairness is ensured through cooperative governance, profit-sharing, and joint decision-making among wineries. Emphasizes transparency, information sharing, and joint resource creation, strengthening regional collaboration and commitment.



|               | Value proposition                                                                                                                                       | Value creation                                                                                                                                                                                                                                 | Value delivery                                                                                                                            | Value capture                                                                                                  |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Economic      | <ul style="list-style-type: none"> <li>High-purity cosmetics grade polyphenols from grape pomace</li> </ul>                                             | <ul style="list-style-type: none"> <li>Sourcing and transport</li> <li>Hydroalcoholic compound extraction</li> <li>Leftover pomace to biogas</li> </ul>                                                                                        | <ul style="list-style-type: none"> <li>Long-term B2B partnership with customers</li> </ul>                                                | <ul style="list-style-type: none"> <li>Sales of polyphenols to regional/national cosmetic companies</li> </ul> |
| Environmental | <ul style="list-style-type: none"> <li>Upcycling grape pomace</li> <li>Functional quality non-toxic, biodegradable, and natural antioxidants</li> </ul> | <ul style="list-style-type: none"> <li>Ethanol and resin reusable and recycled</li> <li>Leftover residue to biogas</li> </ul>                                                                                                                  | <ul style="list-style-type: none"> <li>Biodegradability</li> <li>Non-toxicity</li> <li>Local customers low transport emissions</li> </ul> | <ul style="list-style-type: none"> <li>Lower environmental footprint</li> </ul>                                |
| Social        | <ul style="list-style-type: none"> <li>Strengthening local circular economy</li> </ul>                                                                  | <ul style="list-style-type: none"> <li>Skilled job creation</li> </ul>                                                                                                                                                                         | <ul style="list-style-type: none"> <li>Local cultural identity</li> </ul>                                                                 | <ul style="list-style-type: none"> <li>Local economic development</li> </ul>                                   |
| Fairness      | <ul style="list-style-type: none"> <li>Farmer-led</li> <li>Fair value distribution</li> <li>Inclusive decision-making</li> <li>Transparency</li> </ul>  | <ul style="list-style-type: none"> <li>Patronage-based cooperative with profit sharing</li> <li>Joint decision making</li> <li>Explicit contracting on rules, roles and entry/exit</li> <li>Joint planning, joint resource creation</li> </ul> | <ul style="list-style-type: none"> <li>Information sharing</li> <li>Supply chain socialisation</li> </ul>                                 | <ul style="list-style-type: none"> <li>Strong partnership, trust, transparency, commitment</li> </ul>          |

# Wetland biomass biorefinery model

**Transforms low-value wetland hay into hydroxymethylfurfural (HMF), furfural, lignin, and hydrochar. A farmer cooperative biorefinery, powered by combined heat and power plant partnerships, turns agricultural residue into fossil-free chemicals and materials. Supports wetland restoration, cuts waste, and reduces pollution.**

**Products & Inputs**  
Main products: HMF and furfural; byproducts: lignin and hydrochar. Input: low-value wetland hay.

**Process**  
Biomass hydrolysis breaks down cellulose and hemicellulose into sugars for furfural and HMF. Lignin is separated, and HMF is purified.

**Market**  
Targets premium niche markets initially, scaling to bulk buyers. Local farmers use hydrochar for soil enhancement; construction material producers use other outputs. Future markets: bio-based binders, agrochemicals.

**Costs & Revenues**  
Main costs: heat, raw materials, labor, and equipment. Revenue: chemical and byproduct sales. Early-stage support may be needed.

**What makes this business model circular bio-based?**  
Upcycles wetland biomass into high-value chemicals, replaces fossil resources, maximizes resource efficiency, and supports climate action and biodiversity.

**What makes this business model fair?**  
Fairness is ensured through collaborative communication, quality support, and contact channels, which boost equity for wetland farmers and biorefineries. The model also creates rural jobs and supports nature conservation goals.

|               | Value proposition                                                                                                                                                                                                 | Value creation                                                                                                                                                                      | Value delivery                                                                                                                                                                          | Value capture                                                                                                                                                                                                         |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Economic      | <ul style="list-style-type: none"><li>• Upcycle wetland hay into HMF, furfural, lignin and hydrochar</li><li>• Additional income for wetland farmers</li><li>• Fossil-free chemical feedstocks</li></ul>          | <ul style="list-style-type: none"><li>• Sourcing wetland hay from nearby farmers</li><li>• Operating full-scale biorefinery</li><li>• Market development in three markets</li></ul> | <ul style="list-style-type: none"><li>• Co-development with early adopters of HMF</li><li>• Long-term contracts</li><li>• B2B sales through gatekeepers and industrial buyers</li></ul> | <ul style="list-style-type: none"><li>• Sale of HMF, furfural, lignin and hydrochar</li><li>• Sale of residual heat</li><li>• Bioeconomy subsidies</li></ul>                                                          |
| Environmental | <ul style="list-style-type: none"><li>• Additional incentive for peatland rewetting</li><li>• HMF and furfural replace fossil-based chemicals</li><li>• Sustainable soil amendment from hydrochar</li></ul>       | <ul style="list-style-type: none"><li>• Wetland biomass sourcing</li><li>• Biomass pretreatment and chemical synthesis</li><li>• Energy from CHP or biomass heat plant</li></ul>    | <ul style="list-style-type: none"><li>• HMF used in polymers and resins</li><li>• Lignin used in construction materials</li><li>• Hydrochar used in nearby agriculture</li></ul>        | <ul style="list-style-type: none"><li>• Reduced CO<sub>2</sub> emissions</li><li>• Biodiversity restoration</li><li>• Valorisation of low-quality wetland hay</li><li>• Reduced fossil-based ingredient use</li></ul> |
| Social        | <ul style="list-style-type: none"><li>• Income diversification for wetland farmers</li><li>• Future-oriented perspective for rural communities</li><li>• Contribution to climate and biodiversity goals</li></ul> | <ul style="list-style-type: none"><li>• Skilled rural employment</li><li>• Training and safe working environment</li><li>• Strengthening farmer associations</li></ul>              | <ul style="list-style-type: none"><li>• Community engagement and demonstrations</li><li>• Regional sourcing and traceability</li><li>• Communication on bioeconomy transition</li></ul> | <ul style="list-style-type: none"><li>• More resilient rural communities</li><li>• Skills development</li><li>• Livable rural areas</li><li>• Climate-resilient land-use model</li></ul>                              |
| Fairness      | <ul style="list-style-type: none"><li>• Farmer-led</li><li>• Fair value distribution</li><li>• Inclusive decision-making</li></ul>                                                                                | <ul style="list-style-type: none"><li>• Cooperative ownership</li><li>• Profit-sharing based on biomass supplied</li><li>• Long-term supplier contracts</li></ul>                   | <ul style="list-style-type: none"><li>• Joint planning with farmer associations</li><li>• Long-term cooperation</li><li>• Transparent agreements</li></ul>                              | <ul style="list-style-type: none"><li>• More stable farm income</li><li>• Additional revenue from biomass sales</li><li>• Reduced dependence on a single income source</li><li>• Fair value distribution</li></ul>    |

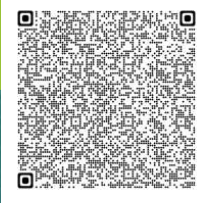
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Funded by  
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