Ref. Ares(2026)6532520 - 29/06/2026

FERTITEC

INNOVATIVE RECOVERY TECHNIQUES FOR ALTERNATIVE FERTILISERS

D2.2 Socioeconomic analysis of alternative fertilisers

RISE Research Institutes of Sweden

29/06/2026

Funded by the European Union

Document Information

Issued by:	RISE
Project name:	FERTITEC
Full project name:	FERTIliser product recovery from secondary raw materials using best available TEChniques
Grant agreement number:	101181513
Issue date:	29/06/2026
Due date:	30/06/2026
Work package leader:	LUKE
Dissemination level:	PU – Public report

Document History

Version	Date	Modifications made by
0.1	05/06/2026	Teresa Kalisky, Cheryl Cordeiro (RISE)
0.2	05/06/2026	Same as above. For review, without markups and addressed comments
0.3	15/06/2026	Nikoleta Kalitsou, Ververis Minas (AgAps) - Review by AgAps
0.3	26/06/2026	Priscila de Morais Lima, Cheryl Cordeiro, Teresa Kalisky (RISE)
1	29/06/2026	Teresa Kalisky (RISE)

Authors

Name(s)	Beneficiary
Teresa Kalisky, Cheryl Cordeiro	RISE

In case you want any additional information, or you want to consult with the authors of this document, please send your inquiries to: teresa.kalisky@ri.se or info@ri.se.

Quality Reviewers

Name(s)	Beneficiary
Nikoleta Kalitsou, Ververis Minas	AgAps

FERTITEC Project Synopsis

FERTITEC is a Horizon Europe Coordination and Support Action that advances the uptake of **alternative fertilising products** derived from secondary raw materials. The project maps existing nutrient recovery and recycling technologies, identifies case studies of operating installations, and analyses their current market status and future potential in order to support a more circular, resource-efficient fertiliser system.

A central project output is the **FERTITEC Knowledge Exchange Platform (KEP)**, supported by the AI-powered **EcoFerti** tool, the **Stakeholders' Network**, and an **Experts Panel**. Together, these mechanisms enable practical knowledge sharing, expert advice, and dialogue across value chains to help users, producers, advisors, and policymakers make informed decisions on nutrient recovery and bio-based fertilisers.

FERTITEC assesses the **technical performance**, **environmental and socioeconomic impacts**, and **scalability potential** of selected case studies, comparing promising approaches and identifying **Best Available Techniques (BATs)**. The project also provides capacity building for key actors and develops evidence that can support adoption, replication, and more enabling conditions for sustainable fertiliser production.

By raising awareness, clustering with related initiatives, and communicating results for broad exploitation, FERTITEC aims to accelerate the market uptake of alternative fertilising products in Europe and the African Union and generate transferable insights beyond it. In this way, the project contributes to reduced pollution, improved nutrient circularity, and a stronger transition towards sustainable agriculture and the bioeconomy.

This report constitutes deliverable D2.2 according to the FERTITEC Grant Agreement, and focuses on three core dimensions according to the Grant Agreement: economic feasibility, social impacts, and user acceptance.

Disclaimer

Funded by the European Union under GA no. 101181513. 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.

© FERTITEC Consortium, 2025 - 2027

Reproduction is authorised provided the source is acknowledged.

Executive Summary

This report provides a socio-economic analysis of selected case studies of alternative fertilising products derived from secondary raw materials within the FERTITEC project. It focuses on three core dimensions: **economic feasibility, social impacts, and user acceptance** which form the base of the analysis and complement the technical and environmental assessment presented in FERTITEC D2.1.

The assessment is based on a structured combination of conducted **operator interviews and desk research**, supported by a common protocol and a database of cases identified earlier in the project. At the M18 reporting stage, interview-based findings are included only for cases where interviews have actually been conducted, while desk research is used as complementary contextual evidence. This provides a transparent basis for a first cross-case synthesis.

Across the assessed portfolio, the available evidence indicates that many of the cases are **technically mature (TRL 8–9)** and operational. However, socio-economic performance varies significantly across cases and countries. Economic viability appears strongest where business models combine product sales with gate fees, energy revenues or service functions, while fully product-driven models are less common and more exposed to market conditions and fertiliser price competition.

From a social perspective, the cases generally show **modest but positive employment effects**, with most installations generating between 0.5 and 25 jobs depending on scale, although one outlier case reports substantially higher employment. Recurrent local concerns—primarily related to odour, traffic and, in some contexts, stigma—are common but can often be mitigated through technical measures, transparency, and stakeholder engagement. Overall, the societal value of the technologies lies less in job creation alone and more in **resource recovery, reduced pollution, and local circularity benefits**.

User acceptance emerges as a critical determinant of uptake of new fertiliser solutions. While some cases demonstrate stable local or niche markets, many rely on **informal, project-based or geographically limited uptake** rather than broad commercial diffusion. Across the cases, adoption consistently depends on **credible evidence**, including certification, third-party testing, field trials, and demonstrated performance under real conditions. This suggests that trust-building and proof-of-performance are as important as technical functionality.

A key cross-cutting finding is the strong influence of **national regulatory and market context**, as previously identified in D1.3 and D1.4. Differences in certification systems, approval routes, subsidy structures, and user familiarity significantly affect market development. In several cases, technologies that are technically mature still face barriers related to **regulatory ambiguity, certification costs, and lack of recognised product categories**, particularly under the EU Fertilising Products Regulation. Conversely, enabling conditions such as clear approval pathways, strong local feedstock access, and established waste-management structures support more stable deployment.

The cross-case synthesis indicates that socio-economic viability is not an inherent property of a technology, but rather the result of an alignment between **technical performance, regulatory**

frameworks, business models and user confidence. This insight is central to identifying technologies with realistic potential for upscaling and replication.

At the current stage, the available evidence is sufficient to support a **structured cross-case assessment** and to inform subsequent project activities. However, important data gaps remain, particularly regarding CAPEX and OPEX ranges, payback periods, utilisation rates, product approval status, and evidence of sustained market uptake.

At the M18 reporting stage, D2.2 is based on the evidence collected within WP2 up to the reporting deadline. Remaining information gaps are acknowledged transparently in the report. Any further clarification needed for subsequent project activities should be addressed, where relevant, outside the formal scope of WP2 reporting.

Looking ahead, the results of D2.2 will be further operationalised in **WP3**, where a structured **multi-criteria analysis** will support the identification and prioritisation of **Best Available Techniques (BATs)**. This analysis will integrate technical, environmental, and socio-economic dimensions in a consistent framework, building directly on the evidence base developed in WP2. Remaining data gaps will be considered in the BAT identification process, while any additional information needed for later project activities will be handled outside the formal scope of WP2 reporting.

In parallel, the findings from D2.2 contribute to the development of the **D2.3 datasheets**, the **FERTITEC Knowledge Exchange Platform (KEP)** and the **EcoFerti tool**. Together, these outputs support knowledge dissemination, stakeholder engagement, and practical uptake pathways, contributing to the overall project objective of accelerating the market uptake of alternative fertilising products and enabling a more circular, resource-efficient fertiliser system.

Table of Contents

EXECUTIVE SUMMARY **3**

1. SCOPE, METHODS & QUALITY ASSURANCE **9**

1.1 Description of Task 2.2 in Grant Agreement 9
1.2 Data sources 9
1.3 Desk-research protocol 10
1.4 Quality assurance and limitations 10

2. BASELINE LANDSCAPE FROM WP1 & DATABASE **12**

2.1 Technology maturity (TRL) 12
2.2 Geography & clusters 13
2.3 Feedstocks, product types, market segments 14
2.4 Context from FERTITEC WP1 15

3. PER-CASE SOCIO-ECONOMIC ILLUSTRATIONS **17**

3.1 Tech 54 – Composting of agricultural and wine production side streams (Italy) 17
3.2 Tech 60 - Ammonia stripping and scrubbing (Belgium) 18
3.3 Tech 96 - Solid fraction of digestate (Greece) 18
3.4 Tech 108 – Insect frass fertiliser via bioconversion of organic waste (Spain) 19
3.5 Tech 118 – Anaerobic digestion and solid–liquid separation of pig slurry (Finland) 19
3.6 Tech 120 – Nutrient recovery via membrane stripping (Finland) 19
3.7 Tech 123 – Ammonia stripping to ammonium sulphate and anaerobic digestion (Italy) 20
3.8 Tech 126 – Urine stabilisation, drying and granulation/pelletising (Sweden) 20
3.9 Tech 127 – Urine nitrification and concentration (Switzerland) 21
3.10 Tech 154 – Low temperature drying of poultry manure, pelletising (Finland) 21
3.11 Tech 177 – N recovery as ammonium sulphate (Denmark) 21
3.12 Tech 178 – P recovery as calcium phosphate (Sweden) 22
3.13 Tech 180 – Pelletising of food industry side streams (Sweden) 22
3.14 Tech 187 – Urine diversion and reuse of dried faeces (Kenya, Burkina Faso) 23
3.15 Tech 188 – P recovery as vivianite (Germany + Spain) 23
3.16 Tech 189 – Composting of biowaste and plant biomass (Slovak republic) 24
3.17 Tech 190 - Algae cultivation, hydrolysis (Spain) 24

4. COMPLEMENTARY DESK-BASED CASE ILLUSTRATIONS **25**

4.1 Tech 11/141 – Hydrated ash of incinerated poultry manure (The Netherlands) 25
4.2 Tech 19 – Thermomechanochemical fractionation of fish by-products (France) 25
4.3 Tech 28 – Pelletising of plant-based digestate solid fraction (Poland) 26
4.4 Tech 44 – Bokashi fermentation, pelletising of fish by-products (Estonia, Norway) 26
4.5 Tech 49 – P recovery as struvite precipitation from digestate liquid (Spain) 27
4.6 Tech 58 - Pyrolysis and mono-ammonium phosphate recovery (Germany) 27

4.7 TECH 85/168 – HYDROTHERMAL CARBONISATION, SOLID-LIQUID SEPARATION (IRELAND, SPAIN) . 28
4.8 TECH 125 – AD WITH N STRIPPING AND AMMONIUM SULPHATE RECOVERY (GERMANY) . 28
4.9 TECH 151/156 – CONCENTRATION OF POTATO CELL WATER BY EVAPORATION (DENMARK) . 29
4.10 TECH 159 – ANAEROBIC DIGESTION OF RAS FISH SLUDGE (NORWAY) . 29
4.11 TECH 184 – INSECT FRASS COMPOST VIA BIOCONVERSION OF FOOD WASTE (RWANDA) . 30
4.12 TECH 185 – MIXING OF COMPOST AND MINERAL NUTRIENTS, AND PELLETISING (BURUNDI) . 30
4.13 TECH 186 – SLUDGE DRYING, INCINERATION, AND P RECOVERY (GERMANY) . 31

5. CROSS-CASE SYNTHESIS . 32

5.1 ECONOMIC FEASIBILITY . 32
5.2 SOCIAL IMPACTS . 33
5.3 USER ACCEPTANCE . 34
5.4 COUNTRY EFFECTS . 35
5.5 BARRIERS AND ENABLERS . 36
5.6 IMPLICATIONS FOR DATASHEETS DEVELOPED IN WP3 BEST AVAILABLE TECHNIQUE SELECTION . 38

6. CONCLUSIONS & NEXT STEPS . 39

7. REFERENCES . 41

ANNEX A. INTERVIEW INSTRUMENTS . 43

ANNEX B. COUNTRY OVERVIEW SHEETS . 46

Finland . 46
Germany . 47
Greece . 48
Kenya / AU-related cases . 48
Poland . 49
Spain . 50
Sweden . 51

List of Figures

Figure 1: Map over countries represented in interviewed case . 13

Figure 2. Map over countries represented in the 30 selected cases for socioeconomic studies . 13

List of Tables

Table 1. Terms and Definitions 7
Table 2. TRL statistics from interpretable cases (interviews and desk research). 12
Table 3. Market status and level of commercial scale. 12
Table 4. Feedstock category distribution and likely primary PFC. 14
Table 5. Distribution of likely primary Product Function Categories (PFCs) across the assessed cases. 14
Table 6. Summary of FPR acceptance and CE-marking potential across the assessed cases 16
Table 7. Revenue model composition. 33
Table 8. Social concerns prevalence. 34
Table 9. Prevalence of user acceptance evidence and the types of evidence requested by buyers. 35
Table 10. Regulatory route statistics. 36
Table 11. Most common barriers found 36
Table 12. Most common enabling factors 38

List of Terms and Definitions

Table 1. Terms and Definitions

Abbreviation	Definition
AF	Alternative fertilising products
BAT	Best Available Techniques**, or** Best Available Technology
TRL	Technology Readiness Level
CAPEX	Capital expenditure; investment costs for establishing or upgrading a plant or installation.
OPEX	Operational expenditure; recurring operating costs such as labour, energy, maintenance and consumables.
PFC	Product Function Category under Regulation (EU) 2019/1009 for EU fertilising products.
FPR	EU Fertilising Products Regulation, Regulation (EU) 2019/1009
CMC	Component Material Category under Regulation (EU) 2019/1009, defining permitted input materials for EU fertilising products.
KEP	Knowledge Exchange Platform
WP	Work Package
GA	Grant Agreement

CSA	Coordination and Support Action
WWTP	Wastewater Treatment Plant
AD	Anaerobic digestion
FTE	Full-time equivalent, regarding job.
End-of-waste	Status reached when a material recovered from waste ceases to be legally classified as waste and can be placed on the market as a product, subject to applicable criteria.
Offtake	An arrangement or commitment for the purchase and uptake of a product by a customer or buyer.
Payback period	The estimated time required for an investment to recover its initial capital cost through net returns or savings.
N/P/K	Nitrogen, phosphorus and potassium; the primary plant nutrients commonly used to describe fertiliser composition.
Biostimulant	A product that stimulates plant nutrition processes independently of the product's nutrient content, with the aim of improving nutrient use efficiency, tolerance to abiotic stress, quality traits or nutrient availability.
Soil improver	A product whose function is to maintain, improve or protect the physical, chemical or biological properties of the soil.

1. Scope, methods & quality assurance

1.1 Description of Task 2.2 in Grant Agreement

In line with the Grant Agreement, deliverable D2.2 (based on FERTITEC Task 2.2) addresses the socio-economic dimension of the selected case studies with a focus on three core questions: social impacts, economic feasibility and user acceptance. The analysis is intended to complement the technical and environmental assessment in Task 2.1 by clarifying whether the identified technologies are not only technically relevant, but also viable in practice under real market, regulatory and social conditions. More specifically, the socio-economic assessment asks how each case performs in terms of investment and operating logic, market channels, product uptake, permitting and certification, jobs and local acceptance, and what these findings imply for cross-case synthesis and later BAT selection.

The Net Present Value and Benefit-Cost Ratio specified in the Description of Action were not computed at this M18 stage, owing to incomplete CAPEX, OPEX and market-price data; these metrics are deferred to the WP3 economic completion. The present structured assessment is therefore reported as a justified, datadriven deviation from the DoA method.

1.2 Data sources

The socio-economic assessment draws on four main sources. First, it builds on the WP1 synthesis, especially D1.3 on national rules, standards and incentives, and D1.4 on cross-cutting barriers and enablers. Second, it uses a selection of 30 cases from the full database of 190 cases, published in Zenodo (FERTITEC, 2026). Third, it uses the operator interview instrument in Annex 2 and the interview responses and follow-up clarifications collected during Task 2.2. Fourth, it draws on structured desk research, including targeted web searches, review of public websites, and relevant literature sources.

The 30 cases were selected from the 190-case TechPractice database as a purposive assessment portfolio rather than a statistically random sample. The selection followed predefined criteria used in the FERTITEC case-study work, including TRL level, geographical representation, operational scale, feedstock and product diversity, relevance to the FERTITEC scope, and data availability. A more detailed description of the case selection method is provided in FERTITEC deliverable D2.3 (Ververis et al., 2026). Consequently, the percentages reported in D2.2 should be interpreted as descriptive statistics for the selected 30-case assessment portfolio, not as prevalence estimates for the full 190-case database.

According to the current project tracking, 18 interviews have been completed and signed, covering 17 interview-based case illustrations in Chapter 3. The number of signed interviews does not correspond one-to-one to case headings because Tech 187 is represented by two signed interviews covering closely related implementations under the same technology ID, in different country contexts and at different scales. Several additional cases remain in reminder and follow-up stages or could not be included as interview evidence before the reporting deadline (see section 1.4 Quality assurance). This provides a sufficiently strong empirical basis for the socio-economic synthesis.

1.3 Desk-research protocol

To ensure comparability across highly diverse cases, the assessment uses a common desk-research and interview protocol. The operator questionnaire covers the same core dimensions for each case: Technology Readiness Level and operating status; customer segments and sales channels; offtake and pricing basis; CAPEX, OPEX, revenue mix, utilisation and payback bands; permitting requirements and regulatory mismatch; direct jobs, community concerns and mitigations; buyer evidence and perceived risks; and national standards, incentives and logistics constraints.

Where direct quantitative evidence is missing, the analysis uses structured indirect indicators, including adoption patterns, repeat deployment or demonstration history, buyer evidence requested in practice and reported market maturity. This protocol allows cases with different evidence quality to be compared, while preserving the distinction between confirmed operator data, desk-research inference and remaining information gaps.

1.4 Quality assurance and limitations

Quality assurance is based on triangulation across interview responses, case-database entries, project documents, company material and recent public sources. The interview form explicitly supports banded answers for economics and capacity use, which reduces the burden on operators while still generating comparable evidence. At reporting stage, cases supported by conducted interviews provide the strongest evidence; cases informed only by desk research or public website sources are treated more cautiously and are not presented as interview-based findings.

The completed interviews are considered reasonably representative of the selected portfolio, as they cover the main technology groups, several country contexts, and a range of maturity levels from pilot and demonstration cases to full-scale commercial operations. This supports the robustness of the cross-case synthesis, while cases without completed interviews are treated more cautiously and clearly distinguished from interview-based evidence.

Not all selected cases could be supported by completed interviews within the reporting period. In some cases, operators declined participation, were unavailable, did not respond, or interviews could not be completed and signed before the reporting deadline. These limitations are acknowledged transparently in the report and affect the level of detail and certainty that can be assigned to individual cases. Nevertheless, the available evidence is sufficient to support a first structured cross-case synthesis at M18.

According to the current project tracking, 18 interviews have been completed and signed. These cover 17 interview-based case illustrations in Chapter 3 because Tech 187 is represented by two signed interviews covering closely related implementations under the same technology ID, in different country contexts and at different scales; all other interview-based case headings correspond to one signed interview each.

Overview of interview records performed or planned (31 in total, including one additional interview for a similar case):

- 18 interviews were completed and signed by the interview subject.

- 1 interview completed but not signed before the reporting deadline. The interview results could therefore not be used in this report.

- 3 interviews were accepted but could not be completed in time for this report's finalisation.

- 3 interviews were declined by the companies or organisations contacted due to confidentiality concerns, limited availability of relevant staff, or the absence of sufficiently mature internal data. This may mean that the interview-based subset is somewhat skewed towards operators with more mature data, clearer market pathways or greater confidence in their case, and that less mature or more uncertain cases are more often represented through desk research only.

- 6 interviews could not be completed due to no response from the interview subjects, despite multiple contacts via e-mail and phone.

The interview count refers to completed and signed interview records, not unique case headings. It is one higher than the number of interview-based case illustrations because Tech 187 includes two related interview records under the same technology ID.

Use of AI in this report

During the writing of this report, AI tools were used to support the drafting and structuring of short case presentations in Chapter 3. AI has also been used to assist in developing text for the Executive Summary, the cross-case synthesis, and the country descriptions in Annex B. The authors reviewed, revised and validated the resulting text and remain fully responsible for the final content.

2. Baseline landscape from WP1 & database

2.1 Technology maturity (TRL)

Table 2. TRL statistics from interpretable cases (interviews and desk research).

TRL level	Number of cases	Share of interpretable TRL 5-9	Commercial level
TRL 5	2	7%	Pilot / early demonstration
TRL 6	3	10%	Pilot / demonstration
TRL 7	6	20%	Pilot / demonstration / operational pilot
TRL 8	2	7%	Pre-commercial
TRL 9	15	50%	Commercial / full-scale
Unknown	2	7%	
Total interpreted TRL 5–9	30	100%	

Table 2 shows 15 cases at TRL 9 (50% of the 30 assessed cases), while Table 9 shows 13/30 cases (43%) with confirmed commercial offtake or uptake. This difference is not contradictory, since TRL reflects technical maturity rather than market maturity. A technology may be TRL 9 and operational in a relevant or full-scale environment, but still face commercial, regulatory or adoption barriers that limit broader market uptake.

The TRL distribution therefore shows a portfolio that is relatively mature in technical terms, while also confirming that socio-economic performance must be assessed in relation to business model, regulatory route, user confidence and local market conditions. Some TRL 9 cases are therefore operational only in narrow local or niche contexts rather than in broadly commercialised markets.

Table 3. Market status and level of commercial scale.

Simplified category	TRL included	Count	Share of interpretable TRL 5–9
Pilot / demo	TRL 5–7	11	37%
Pre-commercial	TRL 8	2	7%
Commercial / full-scale	TRL 9	15	50%
Unclear / No interpretable maturity evidence	Unknown	2	7%
Total cases assessed		30	100%

Illustrative example from interviews: Tech 118 (anaerobic digestion and separation of pig slurry) shows clearly that a high-TRL case can still remain socio-economically narrow in scope. The installation is technically mature and operating, but the solid digestate fraction is not sold through a broader fertiliser market. Instead, it moves through a small local outlet structure in which only a few nearby receiving farmers take the product and cover transport themselves. The interview evidence suggests that the socio-economic logic is therefore driven more by energy and site-level nutrient management than by product-market expansion. By contrast, Tech 126 (urine stabilisation, drying, pelletising) and Tech 127 (urine nitrification, carbon filtration and concentration) illustrate the opposite pattern: both remain at lower TRL and depend on further scaling, yet both already show

user interest and a clearer product-market orientation. In those cases, the main bottlenecks are not technical feasibility alone, but certification costs, incomplete EU-level recognition and the practical challenge of securing sufficient urine collection volumes.

2.2 Geography & clusters

The selected cases are geographically broad but concentrated mainly in Europe, especially in North EU and Central EU. South and Southeast EU contribute a smaller but still important group, while AU cases provide a useful comparison under different market and regulatory conditions.

North EU is particularly visible in wastewater-, urine- and manure-related recovery, with repeated cases from Finland, Sweden and Denmark. Central EU contains many digestate, manure and phosphorus-recovery routes, while South EU contributes composting, insect-frass and struvite-related cases. The AU material highlights a different combination of high fertiliser-price sensitivity, weaker certification systems and stronger dependence on subsidies, extension and project support.

Figure 1. Map of countries represented in interviewed cases

Figure 2. Map of countries represented in the 30 selected cases for socioeconomic studies.

2.3 Feedstocks, product types, market segments

The case base is dominated by agricultural biomasses and municipal wastewater fractions, which together account for most of the selected portfolio. Industrial side-streams, fisheries-aquaculture and biowaste form smaller but analytically important groups. The most common outputs are fertilisers and soil improvers in solid or liquid form, including composts, digestate fractions, ammonium sulphate, phosphorus fertilisers, pellets and a smaller number of specialty inputs such as biostimulants or urine-derived products. Product Function Category 1 (PFC) 1 fertilisers and PFC 3 soil improvers are the most frequent functional categories.

The interview material highlights two main socio-economic distinctions. First, bulky products such as compost and digestate depend strongly on local or regional outlets because transport costs quickly erode value. Second, more concentrated products such as ammonium sulphate, calcium phosphate, vivianite and urine-derived fertilisers have greater potential for wider trade, but are more often constrained by certification, category recognition or proof requirements. Across the cases, arable farming remains the main target market, followed by horticulture, distributors, municipal users and niche local channels. The existing shares and graphs should therefore be retained as the main visual support.

Table 4. Feedstock category distribution and likely primary PFC.

Feedstock type	Count	Share of cases
Human excreta / wastewater-derived	13	43%
Plant / agricultural biomass & agro-industrial side-streams	10	33%
Organic waste / food-processing residues	4	13%
Fish / aquaculture by-products	3	10%
Total	**30**	**100%**

Table 5. Distribution of likely primary Product Function Categories (PFCs) across the assessed cases.

Likely primary PFC	Count	Share of cases
PFC 1(C) – Inorganic fertiliser	14	47%
PFC 1(A) – Organic fertiliser / PFC 3(A) – Organic soil improver	6	20%
PFC 3(A) – Organic soil improver	4	13%
PFC 1(A) – Organic fertiliser	2	7%
PFC 1(A) – Organic fertiliser / PFC 6 – Plant biostimulant	1	3%
PFC 2 – Liming material	1	3%
PFC 6 – Plant biostimulant	1	3%
PFC 6 – Plant biostimulant / PFC 3(A) – Organic soil improver	1	3%
Total	**30**	**100%**

Illustrative example from interviews: The PFC distribution in Table 5 helps distinguish between bulky, locally traded products and more concentrated products with wider theoretical market potential. Tech 189 (biowaste and plant-biomass composting) and Tech 118 (pig slurry digestion and separation) illustrate the local-market logic of bulky products, where socio-economic performance depends heavily on short transport distances, nearby users and integration with local

waste- or nutrient-management systems. Revenue is not driven primarily by broad commercial sales, but by combinations of local product use, gate-fee logic, energy value or operational savings. By contrast, Tech 177 (ammonium sulphate recovery from sludge liquor) and Tech 178 (sludge incineration and calcium-phosphate recovery) represent more concentrated products with stronger theoretical capacity for regional or wider trade, but where commercialisation depends more on offtake, specification, buyer confidence and regulatory recognition. The contrast is therefore not simply between solid and liquid products, but between products constrained mainly by physical distribution and products constrained mainly by institutional and market-recognition barriers.

2.4 Context from FERTITEC WP1

WP1 of FERTITEC provides the main interpretive frame for the socio-economic assessment. D1.3 showed that alternative fertilising products move through a patchwork of national approval routes, certification practices, standards, subsidy structures and waste-versus-product classifications rather than one uniform market. In several countries, EU rules under Regulation (EU) 2019/1009 coexist with national pathways, which can either support market entry or create additional cost and delay. The interview evidence strongly confirms this. In urine- and wastewater-derived cases, operators repeatedly identify incomplete FPR pathways, missing raw-material categories or expensive conformity requirements as direct socio-economic bottlenecks. By contrast, several compost and digestate cases function more effectively through national or site-based routes, even where EU harmonisation remains weak.

D1.4 identified a set of cross-cutting barriers and enablers that are also highly visible in the interviews. The most recurrent barriers are uncertain product status, fragmented or costly certification, weak standardisation for some recovered materials, transport constraints for bulky products, variable product composition, low user familiarity, and concerns around odour, hygiene, contaminants or stigma. The main enablers are clearer approval routes, trusted testing and certification, demonstrations and field trials, strong local feedstock access, and mixed revenue models that combine product value with gate fees, energy revenues or public support. WP1 therefore helps explain why socio-economic viability differs so strongly across cases: it is shaped not only by technical performance, but also by regulation, market organisation and social trust. This interpretation is carried forward into the case illustrations and later BAT discussions.

Table 6. Summary of FPR acceptance and CE-marking potential across the assessed cases

How many cases produce products that are accepted under the FPR?	9	16	5	30	Counts whether the product/material type appears accepted under an FPR route.
How many cases produce products that can be CE-marked according to the FPR?	2	23	5	30	Potential CE-markability only; no explicit CE declarations were found in the case-list data.

Illustrative example from interviews: Several interviews show that regulation and trust interact directly. Tech 126 (urine stabilisation, drying and pelletising) and Tech 127 (urine nitrification and concentration) both indicate that user response can be positive even when the formal EU pathway remains incomplete. In both cases, operators rely heavily on third-party testing, demonstration activity, specification sheets and field-based proof to compensate for missing or uncertain EU-level category recognition. At the same time, the interviews show that this trust-building work is costly and time-consuming and does not fully remove the uncertainty created by incomplete regulatory fit. By contrast, Tech 123 (ammonia stripping and anaerobic digestion) and Tech 189 (biowaste and plant-biomass composting) suggest that cases can function comparatively well through national or site-based pathways where users already understand the product and where acceptance has been built over time through monitoring, practical experience and visible performance. These examples underline a key WP1 point: socio-economic viability depends not only on whether a product is legal in principle, but also on whether users, intermediaries and regulators recognise it as credible, manageable and worth adopting in practice.

3. Per-case socio-economic illustrations

This section presents short per-case socio-economic illustrations aligned with the D2.2 structure. Each illustration summarises the case under the headings Snapshot, Economics (bands), Social impact, User acceptance, and Risks & outlook.

In line with the WP1 synthesis, each case should be interpreted against the national regulatory and incentive context summarised in **D1.3** and against the cross-cutting socio-economic themes identified in **D1.4**. In practice, this means that differences in market status, user acceptance and economic feasibility are not treated as purely case-intrinsic, but as shaped by country-specific approval routes, standards, subsidy structures and recurring barriers such as certification cost, product-status ambiguity, logistics and trust in product quality.

The following 17 case illustrations in this section are based on completed and signed interviews: Tech 54, Tech 60, Tech 96, Tech 108, Tech 118, Tech 120, Tech 123, Tech 126, Tech 127, Tech 154, Tech 177, Tech 178, Tech 180, Tech 187, Tech 188, Tech 189 and Tech 190. Tech 187 is supported by two signed interviews covering closely related implementations under the same technology ID in different country contexts and at different scales.

The country or countries indicated in each case heading refer to the location of the case evidence and the interview context used for that case presentation. They do not imply that the technique is limited to those countries only; several of the technologies are used or have relevance in multiple national contexts.

3.1 Tech 54 – Composting of agricultural and wine production side streams (Italy)

Snapshot: Commercial local composting case serving arable and industrial users within a limited transport radius, with composted soil improvers as the main products.
Economics (bands): Revenue is diversified across product sales, gate fees and energy or credit income, with gate fees forming a major share. CAPEX and payback are not yet fully quantified in the available synthesis, but the business model is clearly tied to both waste-management and product value.
Social impact: Around 20 jobs are reported. No complaints were reported, and odour is managed through air filtration and monitoring.
User acceptance: Acceptance is high locally, but the market remains geographically constrained because transport costs limit the feasible radius. Buyer evidence includes specification sheets and certification.
Risks & outlook: The main operational barrier is contamination from plastics and inert materials. The outlook includes further de-plasticising improvements and continued local-market optimisation.

3.2 Tech 60 - Ammonia stripping and scrubbing (Belgium)

Snapshot: Commercial farm-scale option for recovering nitrogen from the liquid fraction of separated pig slurry as ammonium nitrate or ammonium sulphate. The technology is positioned as a practical route for larger livestock or digestate systems where nutrient concentration and easier transport create value, although economic performance depends strongly on scale and local implementation conditions.
Economics (bands): Open sources indicate that profitability is most realistic for larger units or shared/mobile service models. The case logic is based on upgrading a manure stream into a more standardised mineral fertiliser product, rather than relying on gate fees. Economic feasibility appears strongest where slurry volumes are high enough to justify the additional treatment steps and where the recovered ammonium product can substitute for purchased mineral fertilisers.
Social impact: No specific case-level employment or complaint figures are reported in the current desk-based material. The broader social value lies in reducing ammonia emissions, improving nutrient targeting, and making manure-based nitrogen easier to handle, store and transport.
User acceptance: Acceptance appears generally positive in principle because the process produces a more concentrated and familiar mineral fertiliser form than raw slurry. However, farmer uptake depends on CAPEX, system scale, and confidence in the quality and consistency of the recovered ammonium product.
Risks & outlook: The main risks are incomplete EU-wide fertiliser status, continuing dependence on national regulatory routes, and sensitivity to plant scale and implementation costs. The outlook is positive where manure volumes are sufficient and local rules allow the recovered products to be traded and used with confidence.

3.3 Tech 96 - Solid fraction of digestate (Greece)

Snapshot: Pilot/demo case in Greece focused on valorising digestate solids from an existing biogas plant into ingredients for pelletised fertilisers. The technology is at TRL 7 and is intended to improve nutrient handling, reduce odour and emissions, and create a more marketable fertiliser product than untreated digestate.
Economics (bands): Economic data are still incomplete because the case remains at pilot stage. The expected value logic is based mainly on future product sales, while gate-fee income or biogas-related value may depend on the final full-scale setup. Market analysis is still in an early phase, and no robust CAPEX, OPEX, utilisation or payback figures are yet available.
Social impact: No quantified employment effect is yet reported. At present, the main social issue linked to the existing digestate management system is odour and air emissions from open lagoons. The project case is intended to mitigate these problems and thereby improve local acceptance.
User acceptance: Market acceptance has not yet been demonstrated in practice, since the case has not reached commercial stage. Acceptance will likely depend on whether the final product can show stable quality, regulatory compliance and manageable heavy-metal risk.
Risks & outlook: The key risks are uncertainty about heavy metals depending on digestate feedstock, the challenge of scaling the technology to TRL 9, and the need for product certification before market entry. The outlook is positive if pilot work, field trials and regulatory alignment can support a clearer product category and stronger market case.

3.4 Tech 108 – Insect (Mealworm) frass fertiliser via bioconversion of organic waste (Spain)

Snapshot: Full-scale insect-rearing case where frass is sold to horticulture as a niche fertiliser product, although the core business remains insect production.
Economics (bands): CAPEX is in the €1–5 million range. Revenue is reported as product sales, but the operator indicates that the main income comes from dry insects rather than frass. Utilisation is below 50% and payback is estimated below five years.
Social impact: About 8 jobs are reported. The main concern is odour, which has been mitigated through odour filters; no product returns were reported.
User acceptance: Acceptance exists in a niche horticultural market with direct sales and some offtake, but buyer evidence is still basic and mainly limited to specification sheets.
Risks & outlook: Key risks concern contaminants, phytotoxicity if overdosed, and the lack of a stronger formal product pathway. The outlook includes potential upgrading through pelleting and packaging.

3.5 Tech 118 – Anaerobic digestion and solid–liquid separation of pig slurry (Finland)

Snapshot: Commercial on-farm digestate case operating since 2021, with the solid digestate fraction used as a local fertiliser or soil-improver outlet.
Economics (**bands**): CAPEX is reported below €1 million. The business model is not driven by product sales; instead, value is tied mainly to energy and credit revenue, while receiving farmers cover transport. Utilisation is below 50% and payback remains unknown.
Social impact: Reported employment effect is modest at around 0.5 FTE. No current complaints are reported, and the digestate is perceived as less odorous than earlier pig-production operations.
User acceptance: User acceptance appears strong at local level, based mainly on direct use and positive user experience rather than formal certification or commercial offtake contracts.
Risks & outlook: The main risks are small-plant profitability and exposure to costly technical failures. The outlook is expansion-oriented but depends on feedstock access and future biogas-market conditions.

3.6 Tech 120 – Nutrient recovery via membrane stripping and calcium precipitation (Finland)

Snapshot: Pilot-stage nutrient-recovery solution for biogas plants and WWTPs, with ammonium salt and P-Ca precipitate as the relevant outputs.
Economics (bands): Early market entry is primarily based on technology sales rather than mature fertiliser-product sales. CAPEX is reported below €1 million, utilisation above 90%, and payback below five years, but market revenue remains dominated by technology deployment rather than established fertiliser trade.
Social impact: Around 5 jobs are reported in the current business plan. No community concerns

have been reported, and the social value lies in circular nutrient recovery with future job-growth potential.
User acceptance: Acceptance appears positive among early adopters, but buyer evidence still centres on specification sheets, third-party tests, certification and demonstrations rather than repeated mainstream deployment.
Risks & outlook: Key risks are scaling the technology, securing the first client and resolving the incomplete regulatory route and product classification.

3.7 Tech 123 – Ammonia stripping to ammonium sulphate and anaerobic digestion (Italy)

Snapshot: Commercial AD-plus-recovery case combining digestate, ammonium sulphate, biomethane and energy outputs, with strong local agricultural integration.
Economics (bands): CAPEX is above €10 million. Revenue is diversified across product sales, gate fees, energy or credit income and other site revenue, with gate fees forming a major share. Utilisation is reported at around 50–70%, while payback remains uncertain.
Social impact: Around 10 jobs are reported. Initial concerns related to odour, traffic, noise and visual effects were gradually reduced through public meetings, monitoring, agronomic oversight and operational controls, and no complaints have been reported in recent years.
User acceptance: User acceptance is high, especially among local farmers, even though products are supplied without formal offtake contracts. Confidence is supported by long-term user experience, testing, certification and demonstration of agronomic performance.
Risks & outlook: The main risks are regulatory changes concerning sewage-sludge-derived fertilisers and CAP-related constraints. The outlook remains positive, but dependent on national policy evolution.

3.8 Tech 126 – Urine stabilisation, drying and granulation/pelletising (Sweden)

Snapshot: Start-up or pilot urine-fertiliser case targeting municipalities and arable users through direct sales and project-based uptake.
Economics (bands): CAPEX is below €1 million. Revenue comes from product sales, but utilisation remains below 50% and payback is still undetermined. The case is highly dependent on scaling urine collection and controlling certification costs.
Social impact: Around 0.5 FTE are reported, plus seasonal collection work. Odour has been reported as a concern, mitigated with air filters and worker protection measures.
User acceptance: Acceptance is medium-high rather than fully secure. Buyer evidence includes specification sheets, certification work and demonstrations, and uptake exists within project settings rather than broad commercial rollout.
Risks & outlook: The most important risks are insufficient urine supply and the lack of a completed EU fertiliser-product pathway. The outlook depends strongly on standardisation progress and scaling of collection systems.

3.9 Tech 127 – Urine nitrification, activated carbon filtration and concentration (Switzerland)

Snapshot: Demo or early commercial urine-derived fertiliser case present at municipal and distributor-linked markets, with high operational utilisation.
Economics (bands): CAPEX is in the €1–5 million range. The business model is based on product sales, utilisation exceeds 90%, and payback is estimated at five to ten years. Competitiveness remains sensitive to mineral-fertiliser prices.
Social impact: Around 8 jobs are reported. No community concerns, odour or pollution problems are reported, and trust is supported by strong testing and certification practices.
User acceptance: Acceptance is high, with evidence from certification, third-party tests, demos and field trials. However, no formal offtake contracts are reported, and the route remains constrained by regulatory mismatch at EU level.
Risks & outlook: The main risks are PFAS concerns, regulatory change and the lack of a harmonised EU raw-material category for human urine. The outlook is good where national certification remains possible.

3.10 Tech 154 – Low temperature drying of poultry manure and pelletising (Finland)

Snapshot: Commercial full-scale poultry-manure pelletising case serving arable and horticultural markets through direct and distributor channels.
Economics (bands): CAPEX is above €10 million. The business model is based entirely on product sales rather than gate fees, with payback estimated in the five-to-ten-year range. The case benefits from local feedstock and established product logic, although utilisation is not yet fully reported.
Social impact: Around 10 jobs are reported. No community concerns were flagged, and mitigation has been managed through environmental impact assessment and active mitigation actions.
User acceptance: Acceptance appears positive, supported by buyer demand for sustainable products and by specification sheets, third-party testing, certification and demonstrations.
Risks & outlook: Key risks concern broader uncertainty in organic fertiliser markets and regulatory or policy instability. The outlook points to further product development on a case-by-case basis.

3.11 Tech 177 – N recovery of sludge liquid fraction as ammonium sulphate (Denmark)

Snapshot: Pre-commercial wastewater route targeting ammonium-sulphate production from sludge liquor, with expected deployment at WWTP scale.
Economics (bands): CAPEX is estimated at €1–5 million. The planned revenue mix combines product sales with a large gate-fee component, while utilisation and payback remain undetermined because the plant is not yet operational.
Social impact: No community concerns were reported at this stage, but the installation is not yet on the market and employment effects remain unclear.
User acceptance: User acceptance is not yet demonstrated in practice. The planned sales route

includes distributors and agriculture, but buyer evidence is still limited to specification-oriented proof.

Risks & outlook: The main risks are technology novelty, uncertain offtake and incomplete product approval. The case appears promising, but real market traction remains to be demonstrated.

3.12 Tech 178 – Incineration of dewatered sewage sludge and P recovery as calcium phosphate (Sweden)

Snapshot: Demo or pre-commercial product route targeting calcium-phosphate products for fertiliser distributors, cooperatives and feed-phosphate markets.

Economics (bands): CAPEX exceeds €10 million. Revenue is expected from both product sales and gate fees, with utilisation above 90% once the plant is in operation. Payback is not yet disclosed, but the market case is benchmarked against feed-phosphate markets and gate-fee income.

Social impact: Around 25 jobs are expected. No major local nuisance is reported, and the main societal value lies in phosphorus recovery, contaminant control and reduced dependence on mined phosphate.

User acceptance: Acceptance is positive at industrial level, but broader market uptake depends on specification, certification, demos and the regulatory treatment of recovered products in both fertiliser and feed markets.

Risks & outlook: The main risks are delays in plant installation, the novelty of the technology and regulatory uncertainty, especially regarding feed rules for waste-origin inputs. The outlook is strategically strong if certification and market access can be secured.

3.13 Tech 180 – Pelletising of food industry side streams (Sweden)

Snapshot: Commercial full-scale (TRL 9) case in Sweden producing NPK pellets from industrial side-streams (mainly meat and bone meal and vinasse). The product is established on the Swedish eco-fertiliser market and follows a national compliance pathway (KRAV, ABP permit), with no EU FPR route applied.

Economics (bands): Product-sales driven model (~100% product sales; no gate fees). OPEX is dominated by labour, energy and maintenance. Utilisation is reported at <50%, with payback estimated at <5 years.

Social impact: Around 6 jobs (FTE). Reported issues include odour and pellet-quality complaints, addressed through an odour management programme and technical measures.

User acceptance: Acceptance is established but not frictionless. Sales are mainly distributor-led to organic arable, dairy and horticulture users. Market position is supported by an established product reputation, though quality consistency remains important.

Risks & outlook: Key risks include price competition from other organic fertilisers and biogas-based products, and reduced demand when food prices are high. The outlook remains positive with potential expansion to new user segments.

3.14 Tech 187 – Urine diversion and reuse of dried faeces (Kenya, Burkina Faso)

Snapshot: Mixed cases combining **commercial organic fertiliser production** (TRL 9) and an **early-stage urine-fertiliser pilot** (TRL ~3). Products include composted/granulated fertilisers and urine-derived nutrients, targeting mainly arable and horticulture users in local markets.
Economics (bands): Mixed revenue model combining **product sales (~90%)** and smaller shares from other sources (e.g. carbon credits). CAPEX is below €1 million, utilisation ranges between **50–70%**, and payback is estimated at **5–10 years**. Market performance is sensitive to fertiliser prices and changes in subsidy structures.
Social impact: Around **350+ jobs** are linked to the operation in Burkina Faso. No major community concerns are reported, partly due to site location and integration in local systems. In Kenya, employment is around **1.5 FTE**, with reported concerns related to **odour, traffic and stigma**, mitigated through awareness-raising, PPE, lab testing and improved logistics coordination.
User acceptance: Acceptance is generally positive in Burkina Faso, supported by **direct and distributor channels**, though no formal offtake contracts are in place. Buyer confidence relies on specifications, certification and demonstrations, while demand remains sensitive to price and product composition. In Kenya, acceptance is **more variable**, with seasonal demand and reliance on hygiene evidence and local engagement.
Risks & outlook: Key risks include changing subsidy regimes, competition from subsidised mineral fertilisers, weak institutional support, and uncertainty around the urine-product pathway. The outlook includes expansion to broader regional markets and further development of urine-based fertilisers, although **market stability remains fragile,** highlighting strong dependence on national subsidy frameworks and informal market conditions.
The South African VUNA case, focused on urine diversion/source separation and nutrient recovery from urine, was originally developed as a research and pilot project (2010–2015), rather than as a sustained commercial fertiliser operation. Public sources indicate that the original project later evolved into other organisational forms, while the initial Durban project phase itself was time-limited.

3.15 Tech 188 – Precipitation and magnetic recovery of P as vivianite from anaerobic digestion (Germany + Spain)

Snapshot: Pilot or pre-commercial vivianite recovery route aimed mainly at WWTPs and organic-waste digesters, with first full-scale deployment planned but not yet built.
Economics (bands): CAPEX is in the €1–5 million range. Revenue is based on product sales, utilisation is not yet established, and payback is estimated at five to ten years. The business case is sensitive to mineral-fertiliser prices and future phosphorus-recovery obligations.
Social impact: No extra jobs are expected because the process can be integrated into existing WWTP operations. No odour or local nuisance concerns were reported.
User acceptance: Acceptance is high so far, supported by demonstrations and direct market interest, but the absence of a clear EU product category still constrains broader adoption.
Risks & outlook: Key risks concern legislation on phosphorus recovery and the commercial value of vivianite relative to mineral fertilisers. The outlook improves if new category recognition or recovery mandates strengthen the market.

3.16 Tech 189 – Composting of biowaste and plant biomass (Slovak republic)

Snapshot: Commercial local composting route with product sales combined with municipal gate-fee income, serving arable, horticultural and landscaping users.
Economics (bands): CAPEX is below €1 million in the interviewed case. Revenue depends strongly on gate fees, with product sales forming a smaller share. Utilisation is relatively high, around 70–90%, while payback is estimated in the five-to-ten-year range.
Social impact: Around 6 jobs are reported. Odour was a previous issue, but mitigation through more carbon material, weather-aware operation and technical adjustment has reduced concerns substantially.
User acceptance: Acceptance is currently high, although strongly local and seasonal. Buyer evidence includes specification sheets, certification and third-party tests, but the market remains constrained by transport distance and input contamination risk.
Risks & outlook: Key barriers are plastics contamination, microbiological risk from kitchen waste and continuing dependence on local waste-management structures. The outlook is gradual improvement rather than radical scale-up.

3.17 Tech 190 - Algae cultivation, hydrolysis (Spain)

Snapshot: Commercial full-scale (TRL 9) case producing fertilisers and biostimulants from microalgae cultivated on wastewater. The process has been in operation since 2020 and is classified under PFC 6 (plant biostimulant) within the EU Fertilising Products Regulation.

Economics (bands): Product-sales driven model (~100% product sales; no gate fees) with CAPEX in the €1–5m range. OPEX is dominated by labour (~50%), followed by energy and chemicals. Utilisation is reported at 50–70%, with payback estimated at <5 years.
Social impact: Around 8 jobs (FTE). No community concerns are reported, partly due to the plant's remote location.
User acceptance: Acceptance appears positive, with contract-based offtake and mixed sales channels (direct + distributor). Buyer confidence is supported by certification, demonstrations and specification sheets, with low sensitivity to mineral fertiliser prices due to product differentiation.
Risks & outlook: Key risks relate to limited wastewater input availability and contamination risks in outdoor cultivation. Planned improvements include increased automation of the production process.

4. Complementary desk-based case illustrations

This chapter presents complementary socio-economic case illustrations based primarily on desk research, including public sources, project material and targeted web searches. Unlike the interview-based cases in Chapter 3, these cases are not supported by completed and signed operator interviews and should therefore be interpreted more cautiously.

4.1 Tech 11/141 – Hydrated ash of incinerated poultry manure (The Netherlands)

Desk-based case. Snapshot: Commercial PK fertiliser from poultry-manure ash for arable farming, positioned as a low-contaminant circular nutrient product.
Economics (bands): Commercial market presence is indicated, but CAPEX, OPEX and payback information remain insufficiently evidenced in the available sources. The business logic appears to rely mainly on product sales through established operator channels.
Social impact: No specific employment or complaint data are reported. The broader social value lies in phosphorus recycling and reduced dependence on virgin mineral inputs.
User acceptance: Public evidence remains limited, but the product proposition appears positively framed around circularity and comparatively low contaminant content.
Risks & outlook: The main risk is the still-evolving EU regulatory pathway, despite national authorisations in several countries. Future growth depends on regulatory clarification and stronger market proof.

4.2 Tech 19 – Thermomechanochemical (TMC) fractionation of fish by-products (France)

Desk-based case. Snapshot: Pilot-stage fish-by-product biorefinery route in France, producing an organic NP fertiliser from marine side streams. The case is at TRL 5 and represents a technically promising but still project-driven recovery route rather than a commercial fertiliser business.
Economics (bands): Robust case-level CAPEX, OPEX, utilisation and payback data are not available in the current sources. The economic rationale lies in creating a higher-value fertiliser product from fish-processing side streams, but scale-up remains dependent on further industrial development and market validation.
Social impact: No case-specific employment or complaint data are available in the desk-based material. The broader social value lies in circular use of marine side streams and reduced dependence on conventional fertiliser inputs.
User acceptance: Public evidence suggests a positive circular-economy narrative, but market acceptance is not yet strongly evidenced. Acceptance will likely depend on processing quality, odour management, agronomic performance and confidence in product consistency.
Risks & outlook: The main risks are limited commercial evidence, incomplete product approval pathways and the need to scale beyond project context. The outlook is positive where marine side streams are available and product standardisation can be improved.

4.3 Tech 28 – Pelletising of plant-based digestate solid fraction (Poland)

Desk-based case. Snapshot: Digestate-based route in Poland aimed at transforming the solid fraction from plant-based biogas digestion into pelletised fertiliser products and liquid fractions with improved handling and transportability. The case is technically mature, but socio-economic evidence remains based on desk research rather than operator interview.
Economics (bands): Detailed CAPEX, OPEX and payback evidence is not available in the current sources. The business case appears to depend on creating a more concentrated and marketable fertiliser product from digestate, but economic viability is likely sensitive to approval costs, farmer demand and competition with conventional fertilisers.
Social impact: No reliable case-specific job or complaint data are available in the desk-based material. The broader social value lies in nutrient recycling, lower transport burdens and improved digestate handling.
User acceptance: Acceptance is likely shaped by buyer confidence in nutrient content, consistency and legal product status. In Poland, market uptake of such products appears closely linked to authorisation and field-proof requirements.
Risks & outlook: The main risks are administrative complexity, difficult end-of-waste pathways and uncertain farmer willingness to pay. The outlook depends on whether product approval and market evidence can keep pace with technical readiness.

4.4 Tech 44 – Bokashi fermentation, drying, and pelletising of fish by-products (Estonia, Norway)

Desk-based case. Snapshot: Pilot-stage concept with only small trial quantities produced so far and no current production or established market activity.
Economics (bands): Real market performance cannot yet be assessed. Most commercial metrics remain unavailable in the available sources because production is not ongoing and the case has not moved beyond limited demonstration quantities.
Social impact: There is currently no reliable end-user or community acceptance evidence from actual market use. The available information therefore does not yet support conclusions on jobs, complaints or broader social value beyond the circular concept itself.
User acceptance: User acceptance remains unevidenced because the product has not entered routine market circulation. Any conclusions at this stage remain provisional.
Risks & outlook: The main risk is that both the market pathway and regulatory route remain unclear while production is inactive. If the case resumes, fertiliser and by-product rules would need to be clarified before stronger conclusions can be drawn.

4.5 Tech 49 – P recovery as struvite precipitation from digestate liquid of WWTP (Spain)

Desk-based case. Snapshot: Recognised phosphorus-recovery route from wastewater digestate or reject water, producing struvite as a saleable fertiliser product. The case is represented as a technically mature and practically relevant recovery route, especially where phosphorus concentration and reagent economics are favourable.
Economics (bands): Detailed case-level investment and payback figures are not available in the current sources. The core economic logic lies in nutrient recovery combined with operational benefits such as reduced scaling and improved phosphorus management within WWTP systems.
Social impact: No case-specific employment or complaint data are available in the desk-based material. Social value lies mainly in phosphorus circularity, reduced dependency on mined phosphate and improved wastewater-system performance.
User acceptance: Acceptance is generally positive in principle, but depends strongly on purity, agronomic evidence, consistent product specification and local compliance pathways. Buyer confidence is likely linked to whether struvite is recognised as a reliable fertiliser rather than a treatment residue.
Risks & outlook: The main risks concern regulatory fit, reagent cost and the need for strong quality assurance. The outlook is favourable where nutrient concentrations, plant-scale conditions and market confidence align.

4.6 Tech 58 - Pyrolysis with additives for N binding, and recovery of mono-ammonium phosphate (Germany)

Desk-based case. Snapshot: Pilot-stage pyrolysis and phosphorus-recovery route in Germany, combining manure-based pyrolysis with additive use for nitrogen binding and downstream mono-ammonium phosphate (MAP) recovery. The case represents an emerging recovery route aimed at producing higher-value phosphorus products, but no confirmed commercial production or offtake is evidenced in the desk-research material.
Economics (bands): Market performance remains uncertain. The economic logic depends on feedstock quality, additive cost, process integration and whether downstream MAP recovery can generate a product that fits available market and regulatory requirements. Robust CAPEX, OPEX, utilisation and payback evidence is not available from the desk-research sources.
Social impact: No reliable case-specific employment, complaint or community-acceptance data are available from the desk-research material. The broader social value lies in manure valorisation, phosphorus recovery, potential circular nutrient use and possible climate or soil benefits linked to biochar production, provided that product quality and contaminant risks are controlled.
User acceptance: Acceptance is supported by a strong circularity narrative, but remains unconfirmed in commercial practice. Buyer confidence would likely depend on contaminant control, agronomic proof, reliable product specification and a clear route for placing the recovered phosphorus product on the market.
Risks & outlook: The main risks are regulatory and market uncertainty. Product-specific compliance is likely complex because pyrolysis and recovered-phosphorus routes are still evolving, and a uniform ready-to-market pathway is not evident in open sources. The case should therefore

be treated as a low-to-medium confidence desk-research case rather than as interview-based evidence.

4.7 Tech 85/168 – Hydrothermal carbonisation, solid-liquid separation, drying (Ireland, Spain)

Desk-based case. Snapshot: Hydrothermal carbonisation route for wet residues and sludges, producing hydrochar and related fertiliser or soil-improver outputs. The case is positioned as an emerging route with advantages for wet feedstocks because it avoids the intensive drying requirements of pyrolysis-based pathways.
Economics (bands): Detailed case-level CAPEX, OPEX and payback data are not available in the current sources. The economic rationale often combines gate-fee logic with sale or internal use of hydrochar, but marketability depends strongly on feedstock type, end use and local regulatory interpretation.
Social impact: No case-specific employment or complaint data are available in the desk-based material. The broader social value lies in wet-biomass treatment, nutrient recycling and possible climate benefits through lower energy demand than thermal drying routes.
User acceptance: Acceptance appears promising but still uncertain. Confidence is likely to depend on contaminant control, clarity of product claims and whether hydrochar is seen as a useful soil product or merely a treatment residue.
Risks & outlook: The main risks are uncertain product pathways, variable acceptance across jurisdictions and concern about contaminants or toxicity depending on feedstock. The outlook is positive where compact wet-biomass treatment is valued and end-use markets can be clearly defined.

4.8 Tech 125 – Anaerobic digestion, N stripping with gypsum for ammonium sulphate and liming material recovery, fibre separation (Germany)

Desk-based case. Snapshot: Specialised nutrient-recovery route combining anaerobic digestion with nitrogen stripping, gypsum-based ammonium sulphate recovery, fibre separation and liming-material generation. The case is technically advanced but appears more complex than many other digestate-based routes.
Economics (bands): Robust case-level CAPEX, OPEX and payback data are not available in the current sources. The economic rationale appears strongest where multiple output streams improve overall plant value, but process complexity likely increases both investment and operating requirements.
Social impact: No case-specific employment or complaint information is available in the desk-based material. The broader social value lies in nutrient recovery, emissions reduction and diversified use of digestate streams.
User acceptance: Acceptance is likely to depend on whether the recovered fertiliser streams can be clearly classified, standardised and marketed. The complexity of the process may also make it harder for users to understand compared with simpler nutrient-recovery options.

Risks & outlook: The main risks are regulatory complexity, unclear market pathways for multiple recovered products and sensitivity to scale. The outlook is potentially positive for larger plants, but the route appears less straightforward than more established ammonia-recovery systems.

4.9 Tech 151/156 – Concentration of potato cell water by evaporation (Denmark)

Desk-based case. Snapshot: Practical concentration route for potato-processing side streams in Denmark, producing a nutrient-rich liquid fertiliser product from potato cell water. The route is commercially relevant in niche settings where evaporation reduces transport burden and concentrates the nutrient value.
Economics (bands): Detailed case-level CAPEX, OPEX and payback data are not available in the current sources. The main economic logic lies in reducing transport cost for a dilute side stream and creating a local nutrient product, but energy demand for evaporation is a clear sensitivity factor.
Social impact: No specific employment or complaint data are available in the desk-based material. The broader social value lies in valorising a food-industry side stream and reducing waste-management burdens.
User acceptance: Acceptance is likely to depend on local logistics, odour control and whether users perceive the concentrate as an effective fertiliser input. The product appears more suited to local or niche market placement than broad commodity fertiliser trade.
Risks & outlook: The main risks are energy intensity, potential ammonia losses without pH control and limited evidence of a standardised EU market route. The outlook is favourable where processing residues are available and local placement can be secured.

4.10 Tech 159 – Anaerobic digestion of RAS fish sludge (Norway)

Desk-based case. Snapshot: Fish-sludge anaerobic digestion route in Norway linked to recirculating aquaculture systems, producing a liquid digestate and biogas-related energy value. The case is technically promising but still appears to rely more on waste-treatment logic and energy integration than on a stand-alone fertiliser market.
Economics (bands): Robust CAPEX, OPEX and payback data are not available in the current sources. The value proposition appears to depend on integration with existing biogas infrastructure, waste treatment and nutrient recovery rather than direct commercial fertiliser sales alone.
Social impact: No case-specific employment or complaint data are available in the desk-based material. The broader social value lies in valorising aquaculture residues and reducing waste-management burdens.
User acceptance: Acceptance is likely to depend on practical integration with biogas systems, handling logistics and confidence in digestate use. The route appears more plausible where aquaculture waste management and energy recovery already form part of the business context.
Risks & outlook: The main risks are logistics, ammonia control and market uncertainty for digestate products. The outlook is positive where sludge volumes and infrastructure allow integration, but commercial fertiliser positioning remains less developed.

4.11 Tech 184 – Insect (Black soldier fly) frass compost via bioconversion of food waste (Rwanda)

Desk-based case. Snapshot: Black soldier fly frass compost route in Rwanda, producing compost-like fertiliser output from food waste bioconversion. The case sits within a growing circular-fertiliser segment, but socio-economic evidence remains limited because there is no interview-based case material yet.
Economics (bands): Detailed CAPEX, OPEX, utilisation and payback evidence are not available in the current sources. The economic logic appears to depend on waste contracts, frass or compost quality and the ability to create value from a food-waste-derived product in local fertiliser markets.
Social impact: No case-specific job or complaint data are currently available in the desk-based material. The broader social value lies in waste valorisation, nutrient recycling and reduced reliance on conventional fertiliser inputs.
User acceptance: Acceptance is likely to benefit from a positive circular-economy narrative, but trust depends on pathogen control, safe handling, odour management and confidence in the agronomic quality of the final compost product.
Risks & outlook: The main risks are limited case-specific socio-economic evidence, uncertain product standardisation and dependence on local waste and compost market conditions. The outlook is positive where safe-use protocols and quality assurance can support market trust.

4.12 Tech 185 – Mixing of compost and mineral nutrients, and pelletising (Burundi)

Desk-based case. Snapshot: Blended-fertiliser route in Burundi combining compost with mineral nutrients and pelletisation to produce a more uniform NPK fertiliser product. The case is commercially plausible in principle, but depends strongly on infrastructure and imported mineral inputs.
Economics (bands): Detailed case-level CAPEX, OPEX, utilisation and payback data are not available in the current sources. The economic logic appears to rely on improving product consistency and handling through pelletisation, while remaining exposed to import dependence and energy constraints.
Social impact: No case-specific employment or complaint data are currently available in the desk-based material. The broader social value lies in combining local organic resources with formulated nutrient products to improve soil management and circularity.
User acceptance: Acceptance is likely to benefit from the easier handling and familiar product form of pellets, but depends on confidence in nutrient consistency and performance relative to conventional fertilisers. In low-income settings, price sensitivity is likely to remain very important.
Risks & outlook: The main risks are unreliable electricity supply, dependence on imported mineral components and limited socio-economic evidence on actual buyer uptake. The outlook is positive where local production can reduce some import pressure and build confidence in pellet quality.

4.13 Tech 186 – Sludge drying, incineration, and P recovery as phosphoric acid (Germany)

Desk-based case. Snapshot: Pre-commercial phosphoric-acid recovery route linked to sewage-sludge ash, with a plant under construction in 2026. There is limited operator-specific socio-economic evidence available in the public material.
Economics (bands): The case is commercially plausible where ash-disposal cost and phosphate demand support recovery, but robust operator data on CAPEX, OPEX, utilisation and payback are not yet available in the current sources.
Social impact: Public acceptance evidence is still limited for this operator. The main public value proposition is resource security and safe contaminant removal from sewage-sludge ash.
User acceptance: User-acceptance patterns are not yet well evidenced in the available material, and conclusions remain more tentative than for interview-backed cases.
Risks & outlook: The main uncertainty lies in incomplete market and regulatory detail, despite a favourable strategic rationale under the German sludge-phosphorus framework. The outlook is potentially strong, but evidence remains incomplete.

5. Cross-case synthesis

5.1 Economic feasibility

Across the 30 assessed cases, economic feasibility varies widely, but several robust cross-case patterns can now be identified more clearly. The evidence shows that product or output sales are part of the revenue logic in most cases, but rarely operate in isolation. Many of the more resilient cases combine product value with one or more complementary income streams, such as gate fees, energy revenues, technology sales or sanitation- and collection-service functions. This confirms that socio-economic viability in the current portfolio is often based on mixed business models rather than on fertiliser-product sales alone.

At the same time, the market role of product sales differs substantially across case types. In some commercially established cases, product sales form the main revenue base, especially where the output is relatively standardised, can be distributed through existing channels, or has already built user familiarity. In other cases, particularly those linked to waste management, wastewater treatment or early-stage nutrient recovery, product value is only one part of a broader treatment and service logic. In these cases, gate fees, energy integration, or technology-related income may be equally important for viability.

Economic uncertainty remains highest in cases that are technically promising but still lack strong market traction. This is particularly visible where CAPEX and OPEX bands are known only approximately, utilisation rates remain low or unconfirmed, and formal offtake is not yet established. Payback evidence is still incomplete across the portfolio and should therefore be interpreted cautiously. However, the overall pattern is already informative: economic feasibility appears strongest where a case combines technical maturity with either diversified revenue streams, a supportive regulatory setting, or an established route to users. By contrast, cases that rely on product sales alone without strong market recognition remain more exposed to fertiliser-price competition and uncertain uptake.

Table 7. Revenue model composition.

Revenue model category	Count	Share of cases	Interpretation
Product / output sales	26	87%	Explicit or likely revenue from fertiliser, soil improver, recovered nutrient, raw material or co-product sales.
Gate fees / paid waste handling	8	27%	Explicit paid waste handling, collection/service income or gate-fee contribution in Datasheet-updated evidence.
Energy revenues / energy co-products	8	27%	Explicit biogas, heat/power, energy integration, carbon/energy credits or energy co-product route.
Technology / licensing / service model	7	23%	Revenue logic linked to process technology, licensing, equipment/service deployment or technology partnership, in addition to product value.
Sanitation / collection service model	3	10%	Urine/faeces collection, container-based sanitation or sanitation-service logic combined with fertiliser valorisation.
Research / demo / non-commercial or no current production	6	20%	Cases where revenue is not clearly commercial, is mainly pilot/demo/research, or production is not currently evidenced.
Total cases assessed	30	100%	Components are non-exclusive: one case may count in several categories.

5.2 Social impacts

The social-impact evidence collected so far points to relatively modest direct employment effects at case level, but with substantial variation. The available range spans from around 0.5 FTE in smaller or decentralised cases to about 25 jobs in larger industrial recovery installations, with the current median around 8, although one outlier reports substantially higher employment. In most cases, job creation is not the main justification for deployment; rather, the social value lies in local waste valorisation, nutrient recycling, reduced dependence on imported fertilisers, and, in some contexts, improved local environmental performance. Social concerns are recurrent but manageable. Odour is the most common concern, followed by traffic and, less frequently, noise or visual disturbance. The strongest mitigation patterns are also clear across the cases: enclosed processing, odour filters, carbon amendment, weather-aware composting practices, environmental monitoring, careful logistics planning, public communication, and demonstration of hygienic or contaminant control. Cases with long operational experience indicate that these measures can reduce concerns significantly over time, especially where operators engage transparently with local communities and users.

Table 8. Social concerns prevalence.

Social concern	Count	Share of cases	Interpretation
Odour	7	23%	Reported in 7 cases; includes current, previous, or mitigated odour concerns explicitly noted in the datasheet.
Traffic / transport	2	7%	Mainly logistics/transport concerns; one is historical/initial and one relates to urine/faeces logistics.
Noise	1	3%	Reported in 1 case as an initial concern; no ongoing complaint reported there.
Stigma / perception	1	3%	Reported in 1 human urine/faeces reuse case.
Any explicit social concern reported	7	23%	7 unique cases report at least one of odour, traffic/transport, noise or stigma.
Total assessed cases	30	100%	

5.3 User acceptance

User acceptance is best understood as a combination of market traction (pull from buyers of the end product), confidence in the product (regarding both food chain safety aspects and agronomic efficiency), and evidence that the end product works under real conditions. In the current synthesis, explicit offtake was confirmed for only a minority of cases, while many cases either have no formal offtake yet or rely on informal, local or project-based uptake. Direct sales channels are more common than distributor-led routes, especially for local compost, digestate or niche fertiliser products, whereas distributor channels appear more often for products that are closer to standardised fertiliser markets.

Scope note: The Description of Action envisages the user-acceptance study through satisfaction surveys of farmers, the general public and stakeholders, with focus groups if needed. At the M18 stage, this has been deliberately narrowed to operator-reported evidence on market traction, buyer proof requirements and observed uptake, complemented where possible by limited end-user checks. This provides a practical early indicator of user acceptance, but should not be interpreted as a full satisfaction-survey study of farmers, the general public or stakeholders.

Across cases, one message is highly consistent: users and intermediaries generally require evidence before wider adoption. The most frequently requested forms of evidence are specification sheets, certification or third-party tests, demonstration results, field trials, and, where relevant, visible proof of hygienic safety and contaminant control. These patterns align with the adoption proxies proposed in the previous methodological work: repeat deployments, stable utilisation, formal approvals, demonstration-to-commercial progression, and credible buyer evidence all function as practical indicators of user confidence. In other words, acceptance depends less on circular-economy narratives alone than on whether the product can demonstrate reliability, compliance and agronomic performance in a form that users recognise.

Table 9. Prevalence of user acceptance evidence and the types of evidence requested by buyers.

User acceptance evidence	Count	Share of cases	Interpretation
Confirmed offtake / commercial uptake	13	43%	Evidence of market/commercial use, established sales/offtake or operational product uptake.
Only niche / project-based or limited uptake	16	53%	Evidence mainly from pilots, demonstrations, research projects, social-business contexts, limited local use or technical validation.
No clear uptake evidence	1	3%	No clear evidence of user uptake, commercial offtake or current production.
Total cases assessed	30	100%	
Additional evidence indicator	**Count**	**Share of cases**	**Interpretation**
Trusted distributor / channel evidence	14	47%	Explicit distributor, cooperative, direct established channel, contract/offtake or established commercial route in Datasheet-updated enabling factors.
Certification / formal registration evidence	13	43%	Explicit certification, registration, national approval, permit or authorisation signal in Datasheet-updated evidence.
Field trial / agronomic testing evidence	10	33%	Explicit demos, field trials, agronomic testing, soil analyses or documented user-performance evidence in Datasheet-updated evidence.

5.4 Country effects

The case material indicates that country context remains one of the strongest determinants of socio-economic performance. Differences in national rules, standards, permitting traditions and incentives shape not only whether a technology can reach the market, but also what type of business model is viable. In countries where national approval routes, compost certificates, digestate frameworks or organic-farming approvals are relatively established, operators appear better able to move products into practice even when an EU-wide harmonised route is missing or incomplete. This is visible, for example, in cases where national certification supports urine-derived fertilisers, compost products or manure-derived materials despite the absence of a straightforward EU fertilising-products pathway. By contrast, where products sit in a grey zone between waste treatment and fertiliser marketing, commercialisation is slower and more dependent on site-specific permits, local relationships and demonstration projects.

National policy incentives also matter. In some cases, renewable-energy support, waste-treatment obligations, phosphorus-recovery mandates or public investment support clearly strengthen feasibility. In others, the absence of product recognition, unclear status under fertiliser law, or subsidy structures that still favour conventional mineral fertilisers weaken market uptake. Country effects are therefore not merely background conditions; they actively shape both the revenue model and the user-acceptance pathway. For D2.2, this means the cross-case interpretation should explicitly link socio-economic performance to the national regulatory and incentive context

summarised in D1.3, rather than treating all cases as if they compete under the same institutional conditions.

Table 10. Regulatory route statistics.

Regulatory route category	Count	Share of cases	Interpretation
Clear national route	8	27%	A clear national/established route, permit/certification route, or national authorisation signal is evidenced in the Datasheet. EU FPR route may still be partial for some cases.
Partial pathway	14	47%	A plausible route is evidenced, but PFC/CMC fit, certification, site permits, national/EU mismatch, or product-specific route still needs follow-up.
Gap / uncertain	6	20%	Datasheet explicitly indicates a gap, unclear route, missing harmonised category, or uncertainty despite some national/local evidence.
Not yet evidenced	2	7%	No current production/commercial route or no confirmed product pathway is evidenced in the Datasheet.
Total	30	100%	

5.5 Barriers and enablers

The expanded case base and the supporting tables confirm that the main socio-economic barriers and enablers recur with considerable consistency across technologies, feedstocks and countries. The most frequently observed barriers are not purely technical, but relate to market formation, regulation and user confidence. In particular, the case material shows that lack of user trust or proof-of-performance, price and market-uptake uncertainty, certification or formal approval gaps, and broader regulatory-route uncertainty remain among the most persistent constraints. In several cases, these barriers continue to limit market development even where the technology itself is already mature or operational.

One of the clearest findings is that many cases still depend on stronger evidence to gain wider uptake. Field trials, agronomic proof, third-party testing, and clear product specifications remain central for building confidence among buyers, distributors and intermediaries. This means that socio-economic barriers are often not simply a matter of legal compliance, but of whether a product is recognised as credible, predictable and worth integrating into existing practices. The persistence of unclear product categories or incomplete approval routes reinforces this problem, particularly for more differentiated or novel circular products.

For Table 11 below, some categories reflect confirmed barriers, while others reflect the absence of positive evidence in the available material. For desk-based cases in particular, “no evidence found” should be interpreted as an evidence gap or unconfirmed status, not as proof that the barrier is present.

Table 11. Most common barriers found. One case may count in several barrier categories.

Barrier category	Count	Share of cases	Interpretation / reporting message
Field trials: No positive evidence of field-trial or agronomic proof	20	67%	Field-trial or agronomic evidence is explicitly evidenced in 10 cases; in the remaining 20 cases, no such positive proof signal was found in the available interview or desk-research material. This should be interpreted as an evidence gap, not as a confirmed lack of user trust.
Price / market uptake uncertainty	17	57%	Only niche/project-based uptake or no clear offtake evidence in user-acceptance table.
Certification: no positive evidence of certification or formal registration	17	57%	Certification, registration, national approval, permit or authorisation evidence is explicitly identified in 13 cases; in the remaining 17 cases, no such positive evidence was found. This indicates an evidence gap or unconfirmed status, not necessarily a confirmed certification barrier.
Regulatory route: No clear or fully evidenced regulatory route	16	53%	A clear national or policy route is explicitly evidenced for 14 cases; the remaining cases are coded as partial, gap/uncertain or not evidenced. This indicates incomplete or uncertain route evidence, not necessarily a confirmed regulatory barrier in every case.
Lack of clear product category / PFC route	11	37%	PFC classified as “Unclear / to be verified” in Feedstocks, PFC.
Odour	7	23%	Reported issue during interview
Transport / logistics	2	7%	Reported issue during interview
Total cases assessed	30	100%	

On the enabling side, the cross-case evidence points to a relatively coherent set of favourable conditions. The strongest enabling factors include clear or workable national routes, certification or registration mechanisms, field-based performance evidence, strong local feedstock access, trusted distribution or sales channels, and revenue diversification through gate fees or energy/co-product value. These enablers tend to reinforce each other: where regulation is clearer, proof systems are available, and local feedstock and outlet structures are strong, cases are better able to move from technical operation to more stable socio-economic viability.

Taken together, the case material strongly supports the interpretation already outlined in D1.4: socio-economic success depends on **alignment across technology, regulation, evidence, user confidence and market organisation**. Technical maturity is important, but it is not sufficient on its own. The decisive issue is whether a case can convert technical performance into a recognised and trusted product or service pathway under the conditions of a specific national and market context.

Table 12. Most common enabling factors across assessed cases. One case may count in several enabling factors.

Enabling factor	Count	Share of cases	Interpretation / reporting message
Certification / registration	13	43%	Explicit certification, registration, national approval, permit or authorisation evidence.
Field trials / agronomic evidence	10	33%	Explicit demos, field trials, agronomic testing, soil analyses, or documented user-performance evidence.
Strong local feedstock access	23	77%	High feedstock availability or clear continuous local/sectoral feedstock stream.
Gate fees / paid waste handling	8	27%	Revenue mix, gate-fee share or explicit paid waste/collection/service income.
Energy revenues / co-products	8	27%	Explicit energy/credits, biogas, heat/power, carbon credits or valuable co-product route.
Clear national route / policy route	14	47%	National approvals, established/partial national route, product authorisation or policy route explicitly stated.
Trusted distributor / channel	14	47%	Explicit distributor, cooperative, direct established channel, contract/offtake, or established commercial route.
Total cases assessed	30	100%	

5.6 Implications for datasheets developed in WP3 Best Available Technique selection

The current evidence base is sufficient to support a structured socio-economic contribution to both the D2.3 datasheets and the WP3 assessment. For many cases, the available material already makes it possible to describe market status, likely customer segments, broad revenue logic, key regulatory pathway, principal social concerns, and the main forms of proof required for user uptake. This provides a useful and policy-relevant basis for the next-stage multi-criteria assessment in WP3, where socio-economic considerations will need to be weighed alongside technical and environmental performance.

At the same time, the analysis also shows where the evidence remains weaker and where comparative interpretation should therefore remain cautious. The most important remaining gaps concern payback bands, CAPEX and top OPEX ranges, current utilisation, product-specific approval status, confirmed offtake, and stronger indicators of commercial progression such as repeat deployment, buyer retention or broader market diffusion. These gaps do not prevent cross-case comparison, but they do affect the degree of precision with which cases can be differentiated economically or ranked in relation to market readiness.

For WP3, this means that the socio-economic evidence should be used primarily to identify patterns of viability, constraints and enabling conditions rather than to support a fully quantified economic ranking across all cases. The present material is already strong enough to inform the identification of technologies with realistic upscaling and replication potential, particularly where technical maturity

is supported by credible market pathways, user confidence and regulatory fit. Remaining information gaps should be taken into account transparently in subsequent analytical work, but they should not obscure the fact that D2.2 already provides a sufficiently robust basis for a first structured socio-economic screening of BAT relevance.

6. Conclusions & next steps

The D2.2 socio-economic addresses the Description of Action (DoA) commitment to a cost-benefit-oriented assessment by applying a structured and comparable assessment of economic feasibility, social impacts and user acceptance across the selected portfolio. A full formal cost-benefit analysis (CBA) was not appropriate at M18 because many cases lacked sufficiently comparable CAPEX, OPEX, utilisation, payback and market-price data. The structured socio-economic assessment was therefore the most robust approach at this stage, as it allowed cross-case comparison while making data gaps and evidence confidence transparent.

The deliverable is compliant with the GA requirement to provide a socio-economic synthesis across the selected portfolio. Completed and near-completed interviews provide a robust empirical basis for cross-case insights, while cases with partial or pending data are included with appropriate confidence labelling. This approach ensures that both findings and remaining uncertainties are reported transparently, in line with the expected level of maturity for month 18 of the project.

The results demonstrate that many technologies are already technically mature and operational, but that socio-economic viability depends strongly on regulatory conditions, market organisation, and user trust. The analysis therefore confirms the need to consider socio-economic performance not as a case-intrinsic property, but as shaped by national frameworks, value-chain dynamics, and evidence requirements for adoption. These findings directly support the GA objective of identifying conditions for uptake and replication of alternative fertilising products.

The AU-related cases add an important comparative perspective to the conclusions. They show that socio-economic viability is strongly shaped by affordability, subsidy regimes, extension support, institutional capacity and informal or project-mediated market channels. These cases reinforce the wider conclusion that uptake cannot be inferred from technical maturity alone, but depends on workable value chains, user trust and an enabling policy and advisory environment. The AU cases should therefore remain visible in D2.3 and WP3 as a distinct contextual group rather than being treated only as additional examples within the wider portfolio.

Looking ahead, the work will continue in WP3, where the outputs from D2.2 will be further operationalised through a structured multi-criteria analysis. The immediate priorities are to: (i) complete and quality-check the missing economic fields, especially CAPEX, OPEX, utilisation and payback ranges; (ii) verify regulatory status and product-classification assumptions for cases with partial or unclear pathways; (iii) strengthen evidence on offtake, buyer confidence and user acceptance, particularly where uptake is currently project-based or local; and (iv) ensure that AU cases remain explicitly represented in the cross-case interpretation because they are part of the DoA scope and provide important contrasts on subsidy dependence, institutional support, price sensitivity and informal market conditions. WP2 case owners should lead the completion of case-

level evidence and datasheet updates, while WP3 partners should define how the socio-economic indicators are weighted and integrated with technical and environmental criteria in the BAT assessment.

In parallel, the findings from D2.2 will support the further development of the D2.3 datasheets and inform the WP3 assessment, ensuring continuity between deliverables and strengthening the analytical basis for subsequent project activities. The results will also contribute to the Knowledge Exchange Platform (KEP) and EcoFerti tool by supporting knowledge dissemination, stakeholder engagement and practical uptake pathways.

Overall, D2.2 provides a GA-compliant socio-economic baseline that is sufficiently robust for a cross-case synthesis and for informing the subsequent WP3 multi-criteria analysis, while clearly identifying priority areas for data completion and refinement.

7. References

Choudhury, A., Lepine, C., & Good, C. (2023). *Methane and hydrogen sulfide production from the anaerobic digestion of fish sludge from recirculating aquaculture systems: Effect of varying initial solid concentrations*. Fermentation, *9*(2), 94. https://www.mdpi.com/2311-5637/9/2/94

CORDIS. (n.d.). *Sustainable Algae Biorefinery for Agriculture aNd Aquaculture (SABANA)*. CORDIS EU research results. https://cordis.europa.eu/project/id/727874

Eawag. (2019). *Urine separation factsheet*. https://www.eawag.ch/fileadmin/Domain1/Beratung/Beratung_Wissenstransfer/Publ_Praxis/Factsheets/fs_urinsep_may19.pdf

Eawag. (n.d.). *Separation at the source*. https://www.eawag.ch/en/research/humanwelfare/wastewater/decentralised-resource-recovery-from-wastewater/separation-at-the-source-1

EU CAP Network. (n.d.). *Technology N recovery liquid ammonium sulphate or ammonium nitrate*. https://eu-cap-network.ec.europa.eu/projects/practice-abstracts/technology-n-recovery-liquid-ammonium-sulphate-or-ammonium-nitrate_en

European Sustainable Phosphorus Platform. (2023). *SCOPE Newsletter 145: Nitrogen recovery*. https://www.phosphorusplatform.eu/images/scope/SCOPE_145_N-recovery.pdf

Ferraro, A., de Sario, S., Attanasio, A., Di Capua, F., Gorgoglione, A., Fratino, U., Mascolo, M. C., Pirozzi, F., Trancone, G., & Spasiano, D. (2023). Phosphorus recovery as struvite and hydroxyapatite from the liquid fraction of municipal sewage sludge with limited magnesium addition. *Journal of Environmental Quality, 52*(3), 584–595. https://pubmed.ncbi.nlm.nih.gov/36527733/

FERTITEC. (2026). *D1.1 Current available circular fertilising practices — TechPractice dataset (full table)* [Data set]. Zenodo. https://zenodo.org/communities/fertitec/records

Fraunhofer UMSICHT. (2025). *FERTIMANURE project: Nutrient recovery from cattle manure*. https://www.umsicht-suro.fraunhofer.de/en/press-and-media/press-releases/2025/FERTIMANURE-Project.html

Fraunhofer UMSICHT. (n.d.). *Biochar and pyrolysis*. https://www.umsicht-suro.fraunhofer.de/en/Our_Solution/biochar.html

Furuhashi, K., Ueda, K., Hatagami, T., Itoh, T., Miyazaki, T., Kaizu, Y., & Imou, K. (2024). *Livestock manure compost mixed with biochar: Efficient pelleting and pellet production characteristics*. Waste and Biomass Valorization vol. 15, 4927–4936. https://doi.org/10.1007/s12649-024-02520-5

Granulated Compost Solutions. (n.d.). *How to make slow-release fertilizer pellets from compost*. https://www.granulatedcompostsolutions.com/faq-items/how-to-make-slow-release-fertilizer-pellets-from-compost/

IEA Bioenergy. (2021). *HTC – Valorisation of organic wastes and sludges for hydrochar production and biofertilizers*. https://www.ieabioenergy.com/wp-content/uploads/2021/10/HTC-Valorisation-of-organic-wastes-and-sludges-for-hydrochar-production-and-biofertilizers-Full-Report.pdf

Kataki, S., West, H., Clarke, M., & Baruah, D. C. (2016). *Phosphorus recovery as struvite from farm, municipal and industrial waste: Feedstock suitability, methods and pre-treatments*. Waste Management, 49, 437–454.

Knijnenburg, J. T. N., Suwanree, S., Macquarrie, D., Kasemsiri, P., & Jetsrisuparb, K. (2025). *Phosphorus recovery from animal manures through pyrolysis: Phosphorus transformations, release mechanisms, and applications of manure biochars in agriculture*. RSC Sustainability, *3*, 1084–1101. https://doi.org/10.1039/D4SU00524D

Lopes, I. G., Wiklicky, V., Vinnerås, B., Yong, J. W. H., & Lalander, C. (2024). *Black soldier fly frass nutrient-rich fertilizer*. Swedish University of Agricultural Sciences. https://pub.epsilon.slu.se/34705/1/lopes-ig-et-al-20240725.pdf

Manna Insect. (n.d.). *BSF frass nutrient-rich fertilizer*. https://www.mannainsect.com/bsf-frass-nutrient-rich-fertilizer/

NUTRIMAN. (n.d.-a). *Hydrated ash of incinerated poultry manure*. https://nutriman.net/farmer-platform/technology/id_399

NUTRIMAN. (n.d.-b). *Product profile for poultry-manure ash fertiliser*. https://nutriman.net/farmer-platform/product/id_401

NUTRIMAN. (n.d.-c). *Technology profile for nitrogen recovery from liquid manure*. https://nutriman.net/farmer-platform/technology/id_265

Rastech Magazine. (2022). *Norwegian researchers convert RAS sludge into energy*. https://www.rastechmagazine.com/norwegian-researchers-convert-ras-sludge-into-energy/

SABANA Project. (n.d.). *Project website*. https://www2.ual.es/sabana/project/

Saud, A., Havukainen, J., Peltola, P., & Horttanainen, M. (2021). *Integrating pyrolysis or combustion with scrubbing to maximize the nutrient and energy recovery from municipal sewage sludge*. Recycling, *6*(3), 52. https://doi.org/10.3390/recycling6030052

Schieber A. (2017). *Side Streams of Plant Food Processing As a Source of Valuable Compounds: Selected Examples.* Annual review of food science and technology, vol. 8, 97–112. **https://doi.org/10.1146/annurev-food-030216-030135**

SEA2LAND. (n.d.). *Thermomechanochemical fractionation of fish by-products by twin-screw extrusion for the production of biobased fertilizers* [Atlantic pilot case]. https://sea2landproject.eu/thermomechanochemical-fractionation-of-fish-byproducts-by-twin-screw-extrusion-for-the-production-of-biobased-fertilizers-the-atlantic-pilot-case/

VCM Mestverwerking. (2021). *NH3 stripping-scrubbing with gypsum* (Technology fact sheet). https://www.vcm-mestverwerking.be/en/document/265/2022520104736539_nh3stripping-scrubbing-gypsum.pdf

Annex A. Interview instruments

Annex A shows the interviewers one-pager + end-user mini-check + consent form used.

FERTITEC – T2.2 Case Interview (Operator) • 20–25 min

Case ID: _____ Interviewer: _____ Date: ____/____-_____ Country: _____
Org (anonymised/public): _____ Contact role: _____

1) Overview (2–3 min)

• TRL: ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
• Operating since (year): _____
• Feedstocks (approx. %): _____
• Main products: _____
• Certification/labels: ☐ FPR PFC (EU Fertilising Products Regulation Product Function Category) ___
☐ National standard(s) _____ ☐ None ☐ Other: _____

2) Market & Customers (4–5 min)

• Main customer segments (max 2): ☐ Arable ☐ Dairy ☐ Horticulture ☐ Municipal ☐ Landscaping ☐ Distributor
☐ Other: _____

• Sales channel: ☐ Direct ☐ Distributor ☐ Co-op ☐ Mixed

• Offtake contract(s): ☐ Yes ☐ No ☐ Seasonal

• Pricing basis: ☐ €/ton product ☐ €/kg nutrient (N/P/K) ☐ Both ☐ Other: _____

• Mineral fertiliser price sensitivity seen? ☐ High ☐ Medium ☐ Low (note): _____

3) Economics (6–7 min, answers with ranges are fine)

CAPEX band (most recent major installment): ☐ < €1m ☐ €1–5m ☐ €5–10m ☐ > €10m
Year: _____
Funding mix: ☐ Own ☐ Grant ☐ Loan ☐ Other: ___

Top OPEX items (tick ≤3 & estimate share): ☐ Energy ~___% ☐ Chemicals ~___% ☐ Labour ~___% ☐ Maintenance ~___% ☐ Transport ~___% ☐ Other: ___ ~___%

Revenue mix (rough shares): Product sales ~___%
– Gate fees ~___%
– Energy/credits ~___%
– Other: _____ ~___%

Utilisation of nameplate capacity (theoretical max capacity): ☐ <50% ☐ 50–70% ☐ 70–90% ☐ >90%

Simple payback (operator view): ☐ <5 yrs ☐ 5–10 yrs ☐ >10 yrs ☐ Unknown

4) Regulation & Permitting (3–4 min)

• Key permits held: _____

• Permitting pain points (time/cost/monitoring): _____

• Any EU FPR vs national mismatch causing extra cost/delay? ☐ Yes ☐ No → If yes, what: _____

5) Social & Acceptance (4–5 min)

• Direct jobs (FTE, full time equivalent): __ Seasonal/contract (if relevant): __

• Community concerns (tick all): ☐ Odour ☐ Traffic ☐ Visual ☐ Noise ☐ Other: ____ ☐ None

Mitigations in place & effectiveness (brief): _____

• Quality & trust: Returns/claims rate: ☐ None ☐ Rare (<1%) ☐ Occasional (1–5%) ☐ >5%

Evidence buyers ask for: ☐ Spec sheet ☐ 3rd-party tests ☐ Certification ☐ Demos ☐ Other: _____

6) Outlook & Risks (1–2 min)

• Top 2 risks: 1) _____ 2) _____

• Near-term improvement planned: _____

7) Country context

• National certification/standards applicable: ☐ No ☐ Yes / Which? Extra (note): _____

• Incentives/subsidies used: ☐ No ☐ Yes / Which? Extra (note): _____

• Logistics rules affecting radius: ☐ Yes (brief): _____ ☐ No
Other issues? _____

8) Consent & notes

"I agree to provide information for FERTITEC D2.2. My data may be used in anonymised form in public outputs."

Interviewee name: _____ Consent (Y/N): _____ Time: ___:____–___:____

Key notes/clarifications:

_____

Consent for Interview (FERTITEC D2.2)

I agree to take part in a short interview about this installation. My responses will be used for the FERTITEC D2.2 socio-economic analysis and may appear only in aggregated or anonymised form in public outputs.

Controller: RISE (FERTITEC coordinator) and project partners. Purpose: case-level socio-economic assessment. Legal basis: ☐ Consent ☐ Legitimate interests (research in public interest).

Retention: up to 1 year after project ends, then deletion of personal information (name and contact details). Your rights: access, rectification, erasure, restriction, objection; contact teresa.kalisky@ri.se or info@ri.se

Recording: ☐ No recording ☐ Audio recording (optional; for note accuracy).

Signature/affirmation: _____ Date: ____/____/_____

Attachment A (optional if time allows): End-User Mini-Check (10 min, phone/email)

• Tried the product? ☐ Yes (ha: __ / use: __) ☐ No
• Value vs conventional: ☐ Better ☐ Similar ☐ Worse (reason): _____
• Barriers to (re)buy: ☐ Price ☐ Spec/quality ☐ Logistics ☐ Stigma ☐ Advice gap ☐ Other: ____
• What would make you buy/rebuy? _____

Annex B. Country overview sheets

This annex provides short country overviews extracted and condensed from D1.3. Their purpose is to support case interpretation, interviewing and writing in D2.2 by summarising the national regulatory, certification and market context for alternative fertilisers in each country. The sheets are not intended to replace D1.3; rather, they function as a practical reference to highlight the most relevant national rules, standards, incentives, barriers and opportunities that may shape case-level socio-economic performance.

Template for each country overview sheet

• **Country / authority:** main competent authority for fertiliser registration, approval or oversight.
• **Key legislation:** 3–5 national or transposed EU measures most relevant for Alternative Fertilisers.
• **Certification / approval route:** the main market-entry pathway and whether CE and national routes coexist.
• **Relevant market standards:** important voluntary standards, labels or quality schemes.
• **Main barriers:** the country-specific regulatory, economic or market bottlenecks most relevant to D2.2 cases.
• **Main opportunities:** the strongest enabling conditions, incentives or market openings.
• **Interview prompts:** practical follow-up questions for operators or end users in that national context.

Finland

Country / authority: Finnish Food Authority (Ruokavirasto).
Key legislation: Fertiliser Products Act 711/2022; Decree on Fertiliser Products 964/2023; Decree 965/2023 on conducting activities and supervision; Decree 64/2023 on phosphorus-containing fertiliser products and manure; Decree on support for biogas plants and recycled fertiliser production (2024–2026).
Certification / approval route: Products can be placed on the Finnish market if they meet either national or EU rules. Key steps include registration in the fertiliser control register, traceability bookkeeping, self-monitoring and annual notifications. Animal-by-product processing may require separate establishment approval.
Relevant market standards: The voluntary “Laatulannoite” quality assurance scheme is an important trust-building instrument for recycled fertilisers beyond mandatory impurity and contaminant limits.
Main barriers: Tight impurity limits; unclear end-of-waste criteria; phosphorus application limits that may constrain some recovered products; supply-chain resistance toward sludge-based products; limited market pricing for recycled nutrient products.
Main opportunities: equal regulatory treatment for fertiliser products; public support for anaerobic digestion and manure processing; CAP-linked support for nutrient recycling; strong interest in locally produced products when mineral fertiliser prices are high.
Interview prompts:
• For Tech 118 (anaerobic digestion, settling): are phosphorus rules, logistics and low utilisation the main reason the digestate fraction remains a local outlet rather than a broader product market?
• For Tech 120 (membrane stripping, P precipitation of wastewater): does the Finnish regulatory

setting support technology sales more than product sales? What would be needed for a clearer fertiliser route?
• For Tech 154 (poultry manure drying and pelletising): is national organic approval sufficient, or would CE-level positioning materially change the market? How important are Finnish support schemes versus product-market demand?
• For Finnish cases using wastewater- or sludge-derived nutrients: do food-chain concerns and contaminant debates affect real buyer behaviour even when products are legally allowed?
Interview results: Interview evidence confirms that Finnish cases are often constrained to local outlet structures due to logistics and phosphorus regulation. Market development tends to favour technology deployment over product-market expansion, and national approval pathways are often sufficient in practice, although EU-level harmonisation remains incomplete.

Germany

Country / authority: Federal and regional authorities (e.g. Umweltbundesamt, Länder-level permitting bodies), with strong interaction between waste, wastewater and fertiliser regulation.
Key legislation: German Sewage Sludge Ordinance (AbfKlärV) with phosphorus recovery requirements; Regulation (EU) 2019/1009; Waste Framework Directive (transposed); national environmental permitting frameworks.
Certification / approval route: Coexistence of EU fertilising product rules and national permitting pathways. In practice, many emerging technologies require a combination of environmental permits, product-specific validation and, where relevant, alignment with forthcoming phosphorus-recovery obligations.
Relevant market standards: Strong emphasis on product quality, contaminant control and technical specification. Certification and compliance processes are closely linked to both fertiliser and waste legislation.
Main barriers: Regulatory uncertainty for emerging nutrient-recovery products; lack of clearly defined EU product categories (CMC/PFC); complex approval processes; high CAPEX for large-scale installations; dependence on future regulatory enforcement (e.g. phosphorus recovery mandates).
Main opportunities: Clear policy direction on phosphorus recovery; strong industrial base; high relevance for wastewater treatment plants; growing demand for circular and low-contaminant nutrient products; potential alignment with EU circular-economy objectives.
Interview prompts:
• For nutrient-recovery technologies (e.g. ammonium sulphate, vivianite): is the main bottleneck regulatory classification (EU FPR) or market demand?
• To what extent does the German phosphorus-recovery obligation create real investment incentives today versus future expectations?
• Are certification and product approval or plant permitting the most time-consuming step?
• What type of buyer evidence (specifications, trials, certification) is most critical for market uptake?
Interview results: Interview-based evidence from WP2 cases (e.g. sludge-based nitrogen recovery, vivianite recovery, phosphoric acid projects) confirms that regulatory uncertainty remains a primary bottleneck. Several technologies are technically mature or close to market, but lack fully defined EU product categories or harmonised approval pathways, which delays commercialisation. At the same time, strong policy signals (such as phosphorus-recovery requirements) create a positive long-term

outlook, although current investments still depend on clarification of regulatory conditions and market access routes.

Greece

Country / authority: Ministry of Rural Development and Food, with environmental and regional authorities involved in implementation and permitting.
Key legislation: Joint Ministerial Decision ΥΠΕΝ/ΔΔΑ/41828/630/2023 on treated sludge use; Law 4819/2021 transposing the Waste Framework Directive; Regulation (EU) 2019/1009; REACH obligations where relevant; sewage-sludge rules under Directive 86/278/EEC as updated nationally.
Certification / approval route: Waste-based materials typically require end-of-waste treatment or equivalent authorisation before fertiliser registration. Sludge use is permit-based and managed case by case through regional authorities.
Relevant market standards: The framework is more regulatory than market-standard driven; traceability and compliance depend heavily on formal approvals and dossier quality rather than voluntary schemes.
Main barriers: Separate end-of-waste and fertiliser-registration procedures; administrative burden; slow case-by-case permitting; limited systematic public registry for waste-derived products.
Main opportunities: clearer legal route for sludge reuse than before; stronger integration of biowaste collection and nutrient recovery into circular-economy policy; potentially good basis for compost and recovered organics if procedures are simplified.
Interview prompts:
• For digestate-type Greek cases if reactivated later, how burdensome is the dual route of end-of-waste plus fertiliser approval in practice?
• Are regional authorities consistent in permit interpretation, or does local variation create commercial risk?
• Does the sludge-specific route in Greece support only direct use, or can it realistically support broader market productisation?
• What kind of evidence do Greek buyers and authorities value most: lab data, crop-specific field proof, or permit history?
Desk-based interpretation: Evidence suggests that in Greece the dual route of end-of-waste and fertiliser approval remains a significant burden for waste-derived products, especially where case-by-case permitting is needed. Local variation in permit interpretation appears to create some commercial uncertainty, and the sludge-specific route seems better suited to controlled direct-use applications than to broader productisation. Both buyers and authorities appear to value formal compliance and laboratory evidence strongly, although field-based proof may still be important for wider market confidence.

Kenya / AU-related cases

Country / authority: Kenya Plant Health Inspectorate Service (KEPHIS), with important roles also for KEBS, NEMA and, where relevant, PCPB.
Key legislation: Fertilisers and Animal Foodstuffs Act (Cap. 345); Environmental Management and Coordination Act; Seeds and Plant Varieties Act; Standards Act; related agency procedures for

registration, testing and field trials.
Certification / approval route: Producers must apply to KEPHIS, provide technical documentation, undergo laboratory testing and often field efficacy trials, after which products are reviewed by the Fertiliser Evaluation Committee and, if successful, registered for sale. Multi-agency oversight applies where environmental or pesticidal components are involved.
Relevant market standards: KEBS standards are important for quality benchmarks, but Kenya still lacks fully mature and clearly enforceable standards for many organic and bio-based fertilisers; informal markets remain highly relevant.
Main barriers: fragmented multi-agency approval; delays and overlap; weak extension systems; uneven labelling and certification clarity; last-mile distribution challenges; limited dedicated provisions for many AF categories.
Main opportunities: rising demand due to high synthetic fertiliser costs; strong relevance for climate-smart and organic agriculture; opportunity to build single-window or coordinated certification systems; strong role for farmer groups and youth agribusiness.
Interview prompts:
• For Tech 187 (urine + dried faeces fertilizer from urine diverting dry toilets) and similar sanitation reuse cases: is stigma more limiting than regulation, or is weak formal support the real bottleneck?
• For AU compost or insect frass cases such as Tech 184 (insect farming/composting): are buyers more influenced by field performance, certification, or price relative to subsidised mineral fertilisers?
• How much do KEPHIS/KEBS/NEMA steps delay market entry in practice, and which agency creates the biggest bottleneck?
• For decentralised sanitation-derived products, what would most improve uptake: stronger standards, logistics support, more demonstrations, or farmer training?
Interview results: Interview evidence indicates that social acceptance factors (stigma, hygiene perception) and economic conditions (subsidies, price competition) are more critical barriers than formal regulation. Weak institutional support and fragmented market structures strongly influence uptake, confirming the importance of demonstrations, training and local engagement.

Poland

Country / authority: Ministry of Agriculture and Rural Development.
Key legislation: Act on fertilisers and fertilisation (2007, as amended); implementing regulation of 2024; Waste Act of 2012; Nitrate Programme; Regulation on substrates for agricultural biogas plants; Regulation on waste catalogue and R10 recovery process.
Certification / approval route: Poland uses a relatively formal product authorisation system based on authorised laboratories, quality testing, opinions from crop-specific institutes and, for waste- or animal-by-product-based materials, extra opinions on impacts on human health, animal health and the environment.
Relevant market standards: Market access depends strongly on national authorisation and crop-suitability opinions rather than broad voluntary market labels; field testing can be important where beneficial effects must be demonstrated.
Main barriers: complex administrative pathways; difficult end-of-waste conditions; high biomass-processing costs; insufficient economic incentives; low end-user acceptance when price-to-nutrient ratio is unfavourable.
Main opportunities: transparent legal framework once navigated; strong demand for nutrient-

recovery technologies; large biomass base; growing technological and research capacity.

Interview prompts:

• For Tech 28 (pelletised plant-based digestate solids from biogas) and other digestate-derived products: which opinions and approvals take longest, and which are most costly?

• Are field tests mainly a legal requirement or a real commercial necessity for buyer confidence?

• For Polish producers, is the central issue regulation, financing, or farmer economics when compared with mineral fertilisers?

• Which extra health or environmental opinions create the most uncertainty for waste-derived fertilisers?

Desk-based interpretation: Evidence suggests that in Poland the main bottlenecks for digestate-derived and other waste-based fertilisers are the complexity, duration and cost of national authorisation procedures, especially where additional health and environmental opinions are required. Field trials appear to function both as a formal requirement and as an important trust-building step for buyers. Overall, regulation and administrative burden are major constraints, but market uptake is also strongly shaped by farmer economics and competition with mineral fertilisers.

Spain

Country / authority: Ministry of Agriculture, Fisheries and Food (MAPA), with broader framework roles for MITECO.

Key legislation: Royal Decree 529/2023 on fertiliser products; Law 7/2022 on Waste and Contaminated Soils for a Circular Economy; Royal Decree 47/2022 on nitrate pollution from agriculture; Royal Decree 1051/2022 on sustainable nutrient input to soils; Royal Decree 1310/1990 on sewage sludge use in agriculture.

Certification / approval route: Spain allows coexistence between the EU CE-mark route under Regulation (EU) 2019/1009 and a national fertiliser route under Royal Decree 529/2023. MAPA manages the application and national register.

Relevant market standards: UNE standards for agricultural inputs; CAAE, SOHISCERT and ECOCERT as relevant certification bodies or reference schemes; strong role of REC and ANFFE in promoting uptake and good practice.

Main barriers: complexity of multi-layered national and EU rules; heavy metal and monitoring limits for sewage sludge; nitrate-vulnerable area restrictions; need for stronger field evidence and market trust.

Main opportunities: strong nutrient demand, high feedstock availability, explicit circular-economy strategy, mandatory biowaste collection and an increasingly supportive legal framework for compost, digestate and recovered products.

Interview prompts:

• For Tech 108 (mealworm frass fertiliser): is the product being sold under a fertiliser route, a permit-based route, or more informally as a by-product? What evidence would be needed to move beyond niche horticulture?

• For Tech 49 (struvite recovery from WWTP digestate liquid): does organic registration materially improve buyer acceptance or only market access?

• For Spanish cases using sludge- or wastewater-derived inputs, do nitrate-zone rules, sludge limits or national registration steps materially affect volumes, target crops or logistics radius?

• Are buyers asking specifically for UNE-aligned proof, organic compatibility or national listing in

addition to standard specification sheets?

Interview results: Interviews confirm that Spanish cases operate within a functional dual system (EU + national routes), with no major permitting barriers reported. Buyer acceptance depends strongly on certification, specification sheets, and demonstration evidence, particularly for non-standard or niche products such as biostimulants and insect-derived fertiliser products. The interview material also suggests that the dual route gives Spanish operators a degree of formal flexibility, but this does not automatically translate into broader market uptake. For more standardised products, national registration or certification may be sufficient to support use, whereas more differentiated products still depend on stronger product positioning, field-based proof and buyer familiarity. In that sense, regulatory acceptance appears to be a necessary condition for market entry, but not a sufficient condition for wider commercial diffusion.

Sweden

Country / authority: Swedish Board of Agriculture (Jordbruksverket), with support from Naturvårdsverket and the Environmental Code framework.

Key legislation: National implementation of Regulation (EU) 2019/1009; SJVFS 2004:62 for nationally recognised fertilisers; Waste Ordinance 2020:614; Environmental Code (Miljöbalken 1998:808); CAP Strategic Plan 2023–2027.

Certification / approval route: Two main routes coexist: CE-marked fertilising products under the EU regulation, and national authorisation for non-CE products valid only in Sweden.

Relevant market standards: No single dominant public voluntary scheme is highlighted, but market trust is increasingly linked to circular procurement, organic agriculture and climate-oriented standards, especially around biochar and digestate.

Main barriers: CE-marking complexity for SMEs; unclear end-of-waste criteria; limited visibility of nationally authorised products; fragmented market access and persistent need for field-based proof of performance.

Main opportunities: strong circular-economy orientation, active innovation ecosystem, public procurement interest, growth in biochar and digestate use, and a dual system that can still enable niche products nationally.

Interview prompts:

• For Tech 178 (sludge incineration and calcium-phosphate recovery): is the intended route CE-marking, feed-market qualification, or both? Which one is currently the real bottleneck?

• For Tech 180 (pelletised fertiliser from food-industry side streams): is the producing companys' distributor role more important than formal certification for adoption? What buyer proof is most decisive?

• For Tech 126 (urine stabilisation, drying, granulation): is the Swedish national route sufficient in the short term, or is EU-level recognition essential for scaling? Which costs are most problematic: audits, permits or national standards work?

• For Swedish circular products generally: are public procurement and municipal use realistic lead markets, or do mainstream farmers still set the real commercial threshold?

Interview results: Swedish cases suggest that national pathways and distributor-led channels can support current uptake, especially for established eco-fertiliser products. For newer circular products, scaling depends more on regulatory clarification, standardisation and stronger market recognition. Buyer confidence appears to rely mainly on specification, demonstrated performance

and trusted intermediaries rather than CE-marking alone.

The interview material also suggests that established Swedish products benefit from accumulated user familiarity and existing commercial relationships, which can compensate for the absence of a stronger EU-level route. By contrast, newer products face a higher threshold for adoption because they must simultaneously establish technical credibility, regulatory legitimacy and market recognition. In this context, CE-marking may support formal positioning, but it does not in itself create demand unless it is combined with visible product quality, field-based proof and trusted distribution channels.

FERTITEC

INNOVATIVE RECOVERY TECHNIQUES
FOR ALTERNATIVE FERTILISERS

GA 101181513

PARTNERS

RI.SE

Q-PLAN INTERNATIONAL

Luke
LUONNONVARAKESKUS

cetenma
Centro Tecnológico de la Energía y del Medio Ambiente

IUNG

AgroApps

EASTERN AFRICA FARMERS FEDERATION
EAFF
Voice of all farmers in Eastern Africa

Funded by the European Union under Grant Agreement 101181513. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Funded by the European Union