Interreg North-West Europe
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DODILog

# Deliverable D2.1.1

## Prioritisation Analysis of Quality Preservation Needs for Operators in the Cereals and Potatoes Sectors

Work Package 2
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# Glossary of Abbreviations

The table below explains the abbreviations and acronyms used throughout this deliverable.

| Abbreviation | Meaning |
|---|---|
| **AI** | Artificial Intelligence. |
| **CAPEX** | Capital Expenditure. |
| **CIPC** | Chlorpropham. A chemical sprout suppressant formerly used on most stored potatoes in the EU; its approval was not renewed by the European Commission in 2019, and use was phased out by October 2020 (see Section 2.2.2). |
| **DMN** | 1,4-Dimethylnaphthalene. One of the alternative sprout-suppression treatments adopted following the CIPC withdrawal. |
| **DODILOG** | Develop Opportunities to Digitalise & Innovate in the Agri-Food value chain's Logistics — the Interreg North-West Europe project under which this deliverable is produced. |
| **ERP** | Enterprise Resource Planning. |
| **EU** | European Union. |
| **IoT** | Internet of Things. |
| **IWT** | Inland Waterway Transport. |
| **MRL** | Maximum Residue Level — the legal limit for pesticide residue permitted on or in food products. |
| **NWE** | North-West Europe — the Interreg cooperation programme area covering parts of Belgium, France, Germany, Ireland, Luxembourg, the Netherlands and the United Kingdom. |
| **PESTLE** | Political, Economic, Social, Technological, Legal, Environmental — the macro-environmental analysis framework used in Part 2. |
| **ROI** | Return on Investment. |
| **SME** | Small and Medium-sized Enterprise. |
| **SWOT** | Strengths, Weaknesses, Opportunities, Threats — the analysis framework used in Part 2. |
| **WP2** | Work Package 2 — the DODILOG work package covering needs assessment and stakeholder mapping, of which this deliverable is an output. |

# Executive Summary

This deliverable (D2.1.1) presents the findings of the prioritisation analysis conducted under Work Package 2 of the DODILOG project. It covers two agro-food sectors in North-West Europe (NWE): cereals and potatoes. The analysis integrates three complementary components: a stakeholder consultation mapping the profiles and quality preservation needs of operators across the value chains; SWOT and PESTLE analyses identifying the key strengths, weaknesses, opportunities and threats for quality preservation in each sector; and a prioritisation matrix indicating where DODILOG should focus its development efforts first.

The stakeholder consultation reached about 150 actors across Belgium, France, the Netherlands and Germany, representing the full breadth of both value chains, from producers and cooperatives to processors, transport operators, port authorities and research institutes. Eighteen organisations completed the online questionnaire on post-harvest practices and quality monitoring tools. Across both sectors, cost and practical applicability emerged as the dominant barriers to technology adoption, while temperature and humidity monitoring are already widely deployed.

The SWOT and PESTLE analyses confirm that the cereals sector benefits from mature, well-organised supply chains with significant multi-modal infrastructure, but suffers from data fragmentation, reactive rather than preventive quality monitoring and unreliable insect detection. In the potato sector, the challenges are structurally more complex, reflecting the crop's higher biological sensitivity and a supply chain that extends from breeding and seed supply through to processing intake. The transition away from CIPC as a sprout suppressant emerges as a critical and time-sensitive challenge.

The prioritisation matrix applies a risk score based on probability of occurrence, economic impact and detectability to rank intervention areas. For cereals, inland silo storage and port storage and handling are the top priority zones for DODILOG, with detection system gaps as the key enabling bottleneck. For potatoes, long-term storage, post-CIPC sprout control, and harvest damage and bruising are the highest-priority areas, followed by soil health and climate-related risks.

A cross-sector conclusion drawn from both analyses is that data integration and feedback loops, from field to storage to processing, represent the greatest untapped value lever in both chains. DODILOG's development work should therefore prioritise continuous monitoring tools, AI-based risk models and decision-support systems that can be deployed at the most critical nodes identified in this analysis.

# Part 1 – Stakeholder Consultation: Profile and Needs of Interviewed Actors

## 1.1 Methodology

The stakeholder consultation carried out under WP2 aimed to map the quality preservation needs, current practices and technology readiness of operators across the cereals and potato supply chains in North-West Europe. The consultation was designed as a two-stage process: a broad outreach phase targeting a wide range of value chain actors to fill in an online questionnaire, and an interview phase targeting the most relevant actors to gain in-depth knowledge.

In total, about 150 organisations were identified and contacted across Belgium, France, the Netherlands and Germany, covering the full spectrum of roles in both value chains. Of these, 18 organisations completed the online questionnaire - a response rate of 12%. A subset of respondents also expressed interest in participating in in-depth interviews, which will feed into subsequent deliverables.

The questionnaire gathered information on: the respondent's place in the value chain; volumes of potatoes and/or cereals handled per year; types of quality losses experienced; existing monitoring tools and technologies deployed; openness to integrating new technologies; and barriers to adoption. Responses were collected in French, Dutch and German, reflecting the multilingual reality of the NWE partnership.

## 1.2 Profile of Actors Consulted

### 1.2.1 Breadth of the stakeholder base

The stakeholder mapping comprises over 150 organisations, categorised by sector (cereals only, potatoes only, or both), role in the value chain, and country of operation. The following typologies of actors are included:

- Producers and growers (individual farms and producer groups)
- Seed producers and breeders (particularly in the potato sector)
- Agricultural cooperatives
- Storage and silo operators
- Transport operators (road, rail, inland waterways, maritime)
- Port authorities and terminal operators
- Processors (flour mills, starch plants, frozen fries and crisp manufacturers)
- Retailers and traders
- Sectoral associations and interprofessional bodies
- Research institutes and universities

- Quality control and certification bodies
- Regional public authorities and government agencies
- Innovation and technology providers

This diversity reflects the multi-actor complexity of both supply chains and ensures that DODILOG's needs assessment captures perspectives from all stages of the value chain, including actors whose needs may not be immediately visible from a primary production or processing standpoint.

Figure 1 gives an overview of the types of actors that have so far responded to the survey. The category 'Other' includes lobbying unions, providers of infrastructure and the whole chain.

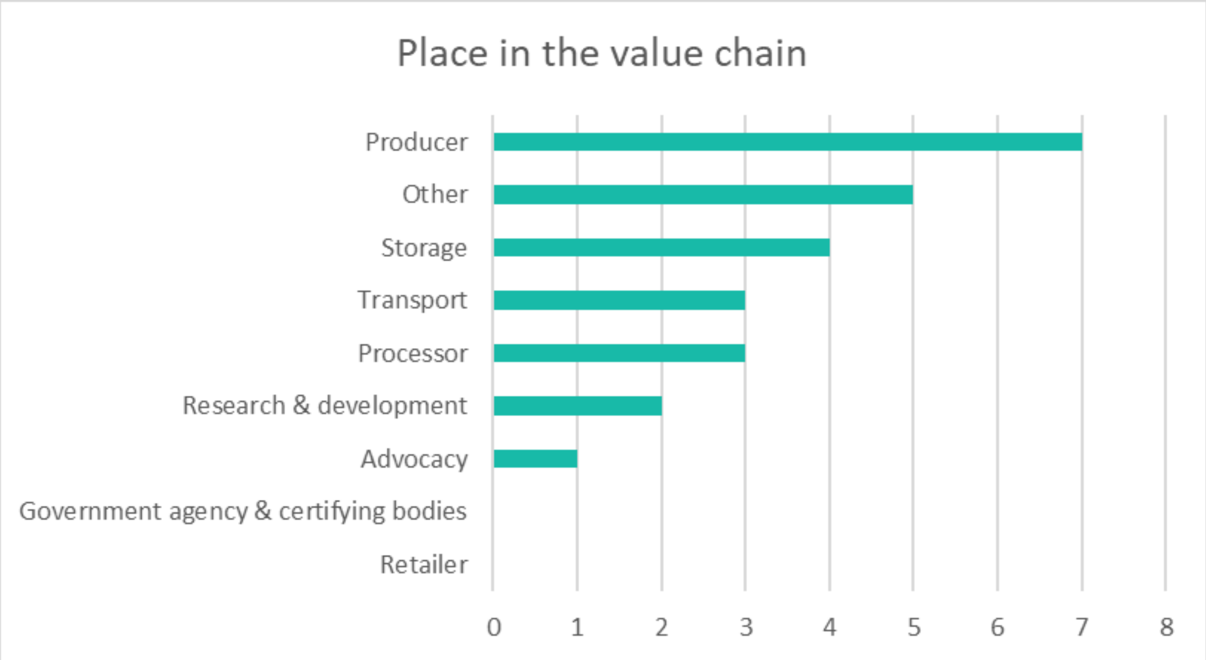



Figure 1: Companies' place in the value chain.

### 1.2.2 Geographic coverage

The stakeholder base covers all four NWE partner countries as well as European-level associations and institutions. Belgium is particularly well represented in the potatoes sector, given the concentration of processing capacity (notably frozen fries) in Wallonia and Flanders. France contributes a significant number of actors across both sectors, particularly cooperatives and producers. The Netherlands is a major hub for seed potato trade and large-scale potato processing, as well as for grain trading and port logistics (Rotterdam). Germany brings port infrastructure and grain logistics actors based in the Bremen/Bremerhaven corridor, as well as potato sector associations and retailers.

Several EU-wide associations and quality control networks are also included, providing a European policy and market intelligence dimension to the analysis.

Figure 2 gives an overview of replies per country we have so far received.

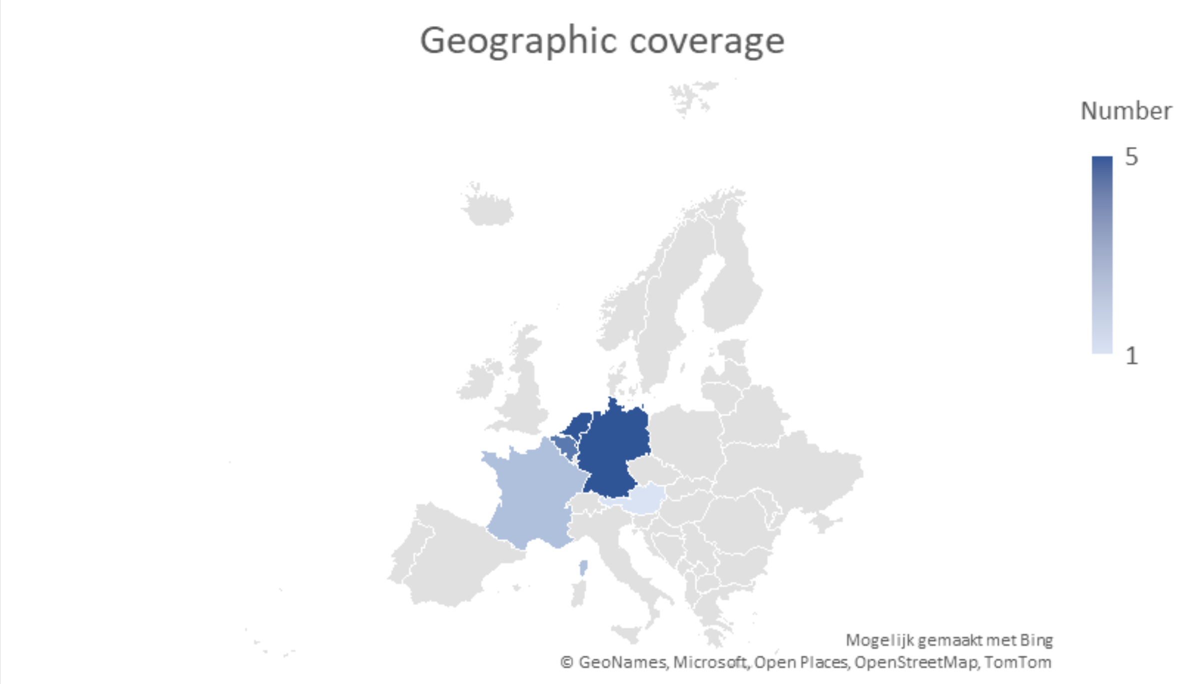



Figure 2: Geographic coverage

### 1.2.3 Profile of questionnaire respondents

The 18 organisations that completed the questionnaire represent a broad cross-section of the two sectors. The table below presents their profiles.

| Organisation | Role | Sector | Country | Volumes handled |
|---|---|---|---|---|
| Respondent 1 | Storage/Transport | Cereals | Germany | 3,500,000 t |
| Respondent 2 | Transport | Cereals | Germany | 20,000 – 50,000 t |
| Respondent 3 | Infrastructure provider | Cereals | Germany | ~4,000,000 t |
| Respondent 4 | Advocacy | Both | Germany | N/A |
| Respondent 5 | Input supply/Storage | Cereals | Austria | 3,000,000 t |
| Respondent 6 | Interprofessional body | Potatoes | Belgium | N/A |
| Respondent 7 | Producer/Storage/ Processor | Potatoes | Belgium | 60,000 t |
| Respondent 8 | Research & Development | Potatoes | Belgium | 30 t |

| | | | | |
|---|---|---|---|---|
| Respondent 9 | Lobbying union | Potatoes | France | 7,000,000 t |
| Respondent 10 | Producer | Potatoes | France | 4,000 t |
| Respondent 11 | Seed producer | Potatoes | Netherlands | 580,500 t |
| Respondent 12 | Processor/Storage | Potatoes | Netherlands | 2,000,000 t |
| Respondent 13 | Trader/Storage | Cereals | Netherlands | 18,000,000 t |
| Respondent 14 | Producer/Trader | Potatoes | Netherlands | 1,000,000 t |
| Respondent 15 | Producer/Processor | Potatoes | Netherlands | 200,000 t |
| Respondent 16 | Research & Development | Potatoes | Canada | ~163 t |

Notes:

- For some companies we received two replies. As they are bigger players with multiple activities within the value chain of one or both crops, both replies are useful. However, in the table above we bundled the replies per company.
- Respondent 16 (Canada) responded to the questionnaire as an R&D actor with active interest in DODILOG's technology development; while outside the NWE geographic scope, their response provides useful comparative data on storage monitoring for potatoes.

### 1.2.4 Sectoral and size distribution

Of the 18 respondents, 6 are active primarily in cereals, 11 in potatoes, and 1 in both sectors. In terms of scale, the respondent base covers a wide range: from the largest grain traders handling 18 million tonnes of cereals annually, through mid-sized cooperatives and seed producers handling hundreds of thousands of tonnes, down to small individual producers handling a few thousand tonnes. This diversity is important, as technology needs and adoption capacity vary significantly with scale.

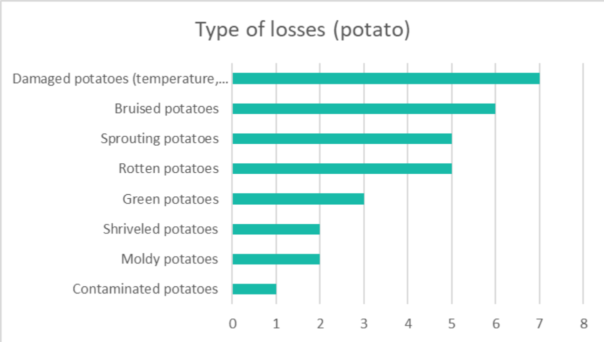
In the potato sector, actors span the full value chain: from seed producers and growers through to major processors (handling 2 million tonnes per year) and interprofessional bodies.

In the cereals sector, respondents are concentrated in the storage, transport and trading segments, reflecting the structure of the cereals supply chain where post-farm value is concentrated at silo and port level.

## 1.3 Key Needs and Quality Preservation Challenges

### 1.3.1 Types of quality losses encountered

Respondents were asked to identify the types of quality losses they encounter. The results, presented by sector (potatoes - 11, cereals - 6, both - 1), are as follows:



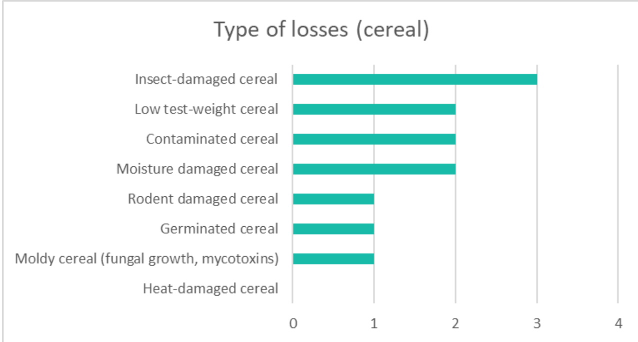




Figure 3 & 4: Type of losses in the cereal and potato sector.

In the cereals sector, insect-damaged grain is the most frequently cited quality issue, reflecting the endemic risk of insect infestation in silo storage during warm seasons. Moisture damage and contamination are also widely reported. Notably, one respondent from the transport sector indicated they do not encounter quality losses in their activities.

In the potato sector, the range of quality loss types is more spread out, reflecting the complexity of the crop. Sprouting is the dominant concern for long-term storage, followed by bruising and mechanical damage (which often generate losses that are only visible later in the chain), and rotten potatoes (linked to storage diseases and harvest conditions). The variety of loss types reported underscores the importance of a multi-parameter approach to quality monitoring.

### 1.3.2 Existing quality monitoring tools and practices

When asked about the monitoring tools currently in use, respondents reported the following technologies: see Figure 5.

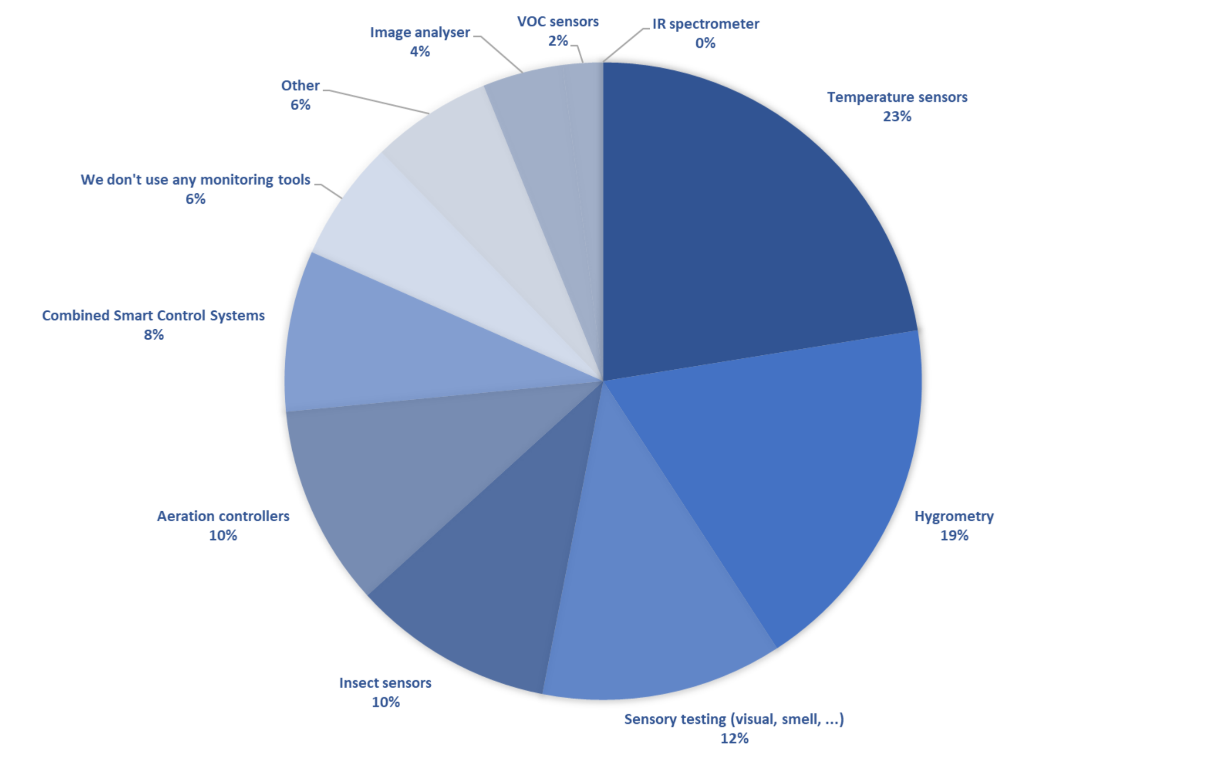



Figure 5: Used tools for quality or early risk monitoring.

Temperature monitoring is nearly universal among storage and processing actors, and hygrometry is widely used in potato storage. However, several respondents, notably smaller producers and advocacy bodies, reported using no monitoring tools at all beyond manual sensory inspection. This reveals a significant gap between the most technologically advanced actors (large processors and grain traders) and smaller operators who still rely predominantly on manual, experience-based quality management.

One major potato processor noted that they are active in innovation but declined to share details, highlighting the competitive sensitivity of monitoring technology in the sector. This is an important dynamic for DODILOG to navigate in the dissemination of project outputs.

### 1.3.3 Technological needs and innovation interest

Respondents were asked to identify technological improvements that could help address the quality problems they encounter. Key themes emerging from the responses include:

- Early detection of sprouting: several potato sector respondents specifically identified the need for tools that can detect incipient sprouting before it becomes visible.
- More advanced insect detection: particularly for cereal storage operators, who currently rely on manual sieving (unreliable at low infestation levels).
- Better storage data integration: linkage of field-level and intake data with storage monitoring to enable proactive rather than reactive management.
- $CO_2$ monitoring and aeration control: for potato storage, the relationship between $CO_2$ concentrations, temperatures and frying quality was specifically flagged as a data gap.

- Predictive and decision-support tools: respondents in both sectors expressed interest in AI-based tools that could help anticipate risk events (pest emergence, moisture spike, disease spread) in advance.

Overall, 13 out of 18 respondents stated that they are open to integrating new technologies, and 5 responded ‘maybe’. No respondent indicated outright opposition. This is a strongly positive signal for DODILOG’s technology development work, suggesting a receptive operator community. However, adoption willingness is conditional on addressing the barriers described below.

### 1.3.4 Barriers to technology adoption

The barriers cited most frequently by respondents are, see Figure 6:

- Practical applicability (cited by 13 out of 18 respondents): the most frequently cited barrier. This indicates that technologies aren’t always adapted to or are difficult to adapt to operational realities of the sector.
- Cost (cited by 12 respondents): the upfront investment cost of sensors, platforms and integration is a major barrier, particularly for small and medium-sized operators.
- Compatibility with current processes (cited by 9 respondents): integration with existing ERP, traceability or storage control systems is often seen as technically difficult or costly.
- Lack of trust (cited by 4 respondents): scepticism regarding reliability, false positive rates and data security.
- Lack of information (cited by 3 respondents) and lack of training (2 respondents): operators often lack the expertise to interpret sensor data or manage digital platforms effectively.
- Knowledge gaps (cited by 1 respondent).

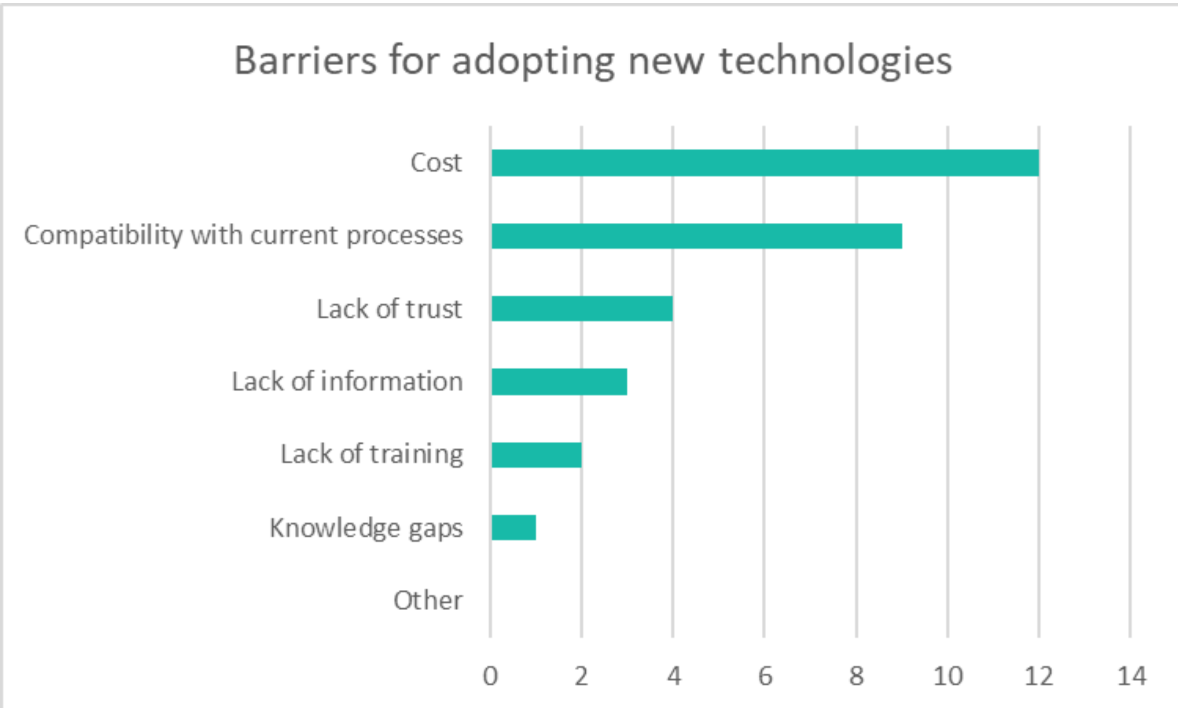



Figure 6: Barriers for adopting new technologies.

These findings have important implications for DODILOG's design philosophy. Technologies developed or promoted by the project must be practical, cost-accessible and compatible with existing workflows if they are to achieve adoption at scale. Training and dissemination are important and integral components of the implementation pathway.

### 1.3.5 Unavoidable losses

The respondents were asked to indicate which secondary process(es) they use to valorise their unavoidable losses (see Figure 7). So far, none of the respondents dispose of their losses without valorisation. Most crops that cannot be valorised in the agrofood value chain, end up in the animal feed value chain (8). Composting is the second most common practice.

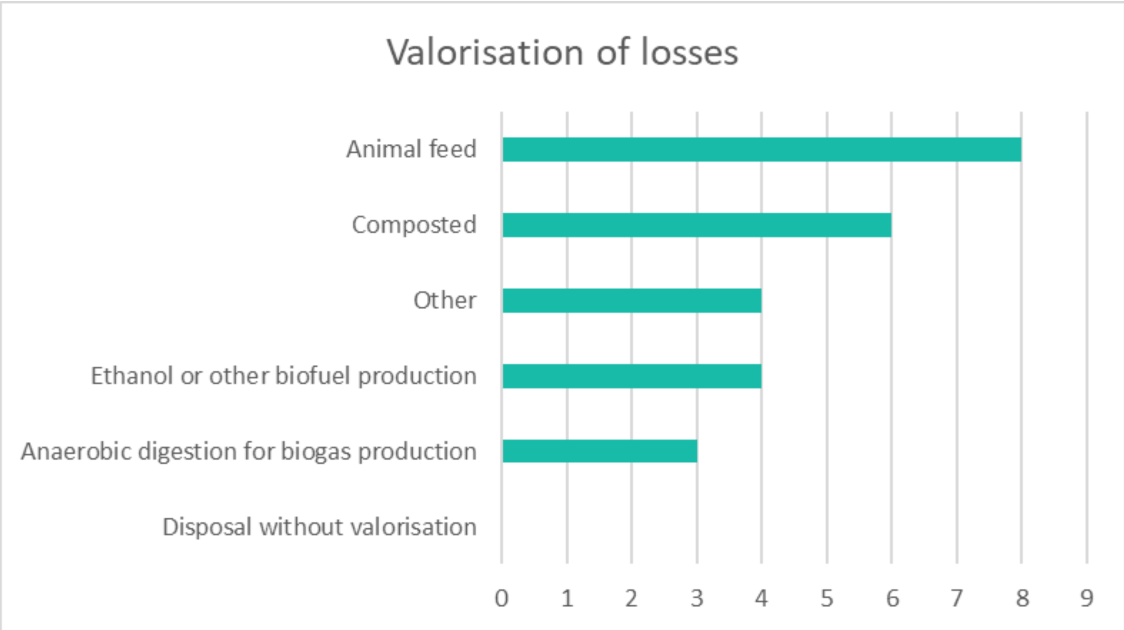



Figure 7: Valorisation of losses.

This information will feed the data for the DODILog's business model (WP1).

## 1.4 Summary and Implications

Key takeaways from the stakeholder consultation

1. Both sectors show strong openness to new monitoring technologies, but cost and practical applicability are the primary barriers to adoption.

2. Data fragmentation across the chain is a cross-cutting challenge: actors at each stage have partial information, and there are few feedback loops from downstream (processing, retail) back to upstream (storage, farm).

3. In the cereal sector, storage and port operations are the highest-value nodes for quality intervention.

4. In the potato sector, the full chain from field preparation to processing intake must be considered as an integrated quality system.

5. The post-CIPC transition represents an urgent and sector-wide technical challenge requiring immediate support.

# Part 2 – SWOT and PESTLE Analysis: Results by Sector

## 2.1 Cereal Sector

### 2.1.1 SWOT Analysis

The SWOT analysis for the cereals sector was developed on the basis of stakeholder interviews, the online questionnaire results and desk research. It covers the full supply chain from farm harvest to export, with a focus on NWE conditions.

| STRENGTHS<br>Internal / Positive | WEAKNESSES<br>Internal / Negative |
|---|---|
| • Structured and mature supply chains with established logistics actors (cooperatives, ports, transport operators)<br>• Multi-modal transport capabilities (road, rail, inland waterways)<br>• Advanced silo infrastructure with large storage capacities<br>• Existing standardised quality control procedures (sampling, sieving, traceability)<br>• Strong institutional ecosystem linking research institutes, cooperatives and logistics actors | • Fragmented data: no harmonised indicators on quality losses or costs<br>• Limited continuous quality monitoring (sampling-based rather than real-time)<br>• Inefficient insect detection (manual sieving, unreliable at low infestations)<br>• Complex multi-step logistics increase risk of quality loss<br>• High dependency on operator experience and silo management practices<br>• Return trips often empty, increasing costs and emissions |
| **OPPORTUNITIES**<br>External / Positive | **THREATS**<br>External / Negative |
| • IoT sensors for real-time monitoring (temperature, humidity, $CO_2$, insects)<br>• AI-based prioritisation tools for critical nodes and early intervention<br>• Improved detection technologies (optical, acoustic, multi-parameter)<br>• Modal shift to rail and inland waterways reducing handling steps<br>• NWE-level harmonisation of standards and cross-border data frameworks<br>• Alignment with EU Green Deal and Farm to Fork food loss reduction targets | • Climate variability: higher humidity, pest proliferation, storage instability<br>• Stricter regulatory limits on pesticides and storage treatments<br>• Market competition (e.g. Black Sea region) pressures cost reduction<br>• Ageing infrastructure: silo bottlenecks, low river levels disrupting IWT<br>• High cost of quality failure (unloading a contaminated barge: >€30,000)<br>• Resistance to change and scepticism towards new detection technologies |

### 2.1.2 PESTLE Analysis

The PESTLE analysis maps the macro-environmental factors shaping quality preservation in the cereals supply chain, identifying the political, economic, social, technological, legal and environmental drivers and constraints that DODILOG must account for.

| Factor | Key points | Implications for quality preservation in DODILOG |
|---|---|---|
| Political | • Strong EU policies: Green Deal, Farm to Fork, food waste reduction targets<br>• Cross-border cooperation programmes: Interreg, Horizon Europe | • Public support for sustainable logistics and modal shift |
| Economic | • High logistics costs across the supply chain (storage ~€6.4-15/t)<br>• Increasing pressure on margins → need to reduce losses | • High cost of non-quality: rejected batches, reprocessing, contract penalties<br>• Investment barriers: high CAPEX for modern silos/sensors, uncertain ROI |
| Social | • Growing consumer awareness of food waste and sustainability<br>• Skills gap in digital and logistics expertise; reliance on experienced operators | • Stakeholder complexity: farmers, cooperatives, transporters, ports have diverging objectives<br>• Resistance to technological change in traditional sectors |
| Technological | • Emerging technologies: IoT sensors (temperature, humidity, $CO_2$), AI predictive models<br>• Current limitations: lack of interoperability, fragmented IT systems | • Detection technology challenge: need high sensitivity with low false positives<br>• Opportunity for integrated digital platforms |
| Legal | • Strict EU and national food safety regulations: contamination thresholds, traceability<br>• Increased restrictions on pesticides and fumigation methods | • Liability risks: cross-contamination in shared storage facilities |
| Environmental | • Climate change: increased pest risks, moisture variability<br>• Pressure to reduce $CO_2$ emissions and energy consumption (ventilation, drying) | • Push towards modal shift and optimised logistics flows<br>• Environmental footprint becoming a key performance indicator |

### 2.1.3 Value Chain Risk Mapping

A step-by-step mapping of quality risks and intervention levers along the cereals supply chain identifies the following key stages and associated challenges:

Farm (harvest and on-farm storage)

- Risks: high moisture at harvest, initial contamination (insects, fungi), poor on-farm temperature control.
- Levers: harvest timing optimisation, on-farm drying, early quality screening at intake.

Collection (primary transport and silo reception)

- Risks: mixing of heterogeneous batches, lack of systematic quality control at intake, transport delays causing deterioration.
- Levers: better batch segmentation, digital traceability from farm to first silo, smart routing to nearest appropriate storage facility.

Inland storage (silo networks and platforms)

- Risks: insect development during storage, moisture and temperature variation, poor stock rotation (storage costs range from approximately €6.4 to €15 per tonne, reflecting the economic significance of this stage).
- Levers: continuous monitoring (IoT sensors), ventilation optimisation, predictive risk models.

Transport (road, rail and inland waterways)

- Risks: temperature fluctuations during transit, long transit times without monitoring, limited visibility during intermodal transfers.
- Levers: modal shift to rail and barge (more stable conditions and fewer handling steps), real-time tracking, reduced transshipment.

Port storage and handling

- Risks: large volumes amplify the impact of any quality error; cross-contamination risks in shared facilities; late detection of insect infestation or contamination. The cost of unloading a contaminated barge can exceed €30,000.
- Levers: advanced detection systems at intake and during storage, strict entry controls, batch isolation strategies.

Export and processing

- Risks: final batch rejection, contract penalties, reputational loss for exporters.
- Levers: end-to-end certification and traceability systems, shared quality data standards with receiving parties.

### 2.1.4 Summary and Recommendations

> **Central recommendation from the cereals value chain analysis**
>
> The cereals supply chain delivers its strongest quality outcomes when collection, inland storage, transport and port handling are managed as one connected monitoring system rather than as separate handling steps. The greatest value from DODILOG lies in upgrading insect and contamination detection at inland silos and port facilities — the two highest-priority nodes identified in the prioritisation matrix — and in connecting batch-level data from farm intake through to export, so that quality issues are identified and acted on before large volumes are affected.

## 2.2 Potato Sector

### 2.2.1 SWOT Analysis

The potato supply chain is structurally more complex than the cereals chain, reflecting the crop's greater biological sensitivity and the diversity of end markets (fresh, fries, crisps, starch, seed). The SWOT analysis below captures this complexity, drawing on stakeholder inputs from Belgium, France, the Netherlands and Germany.

| STRENGTHS<br>Internal / Positive | WEAKNESSES<br>Internal / Negative |
|---|---|
| • Highly productive potato region with favourable soils and high yields.<br>• Integrated and specialised value chains (breeders, seed producers, growers, processors).<br>• Major processing and export hub for frozen products, fresh and seed potatoes.<br>• Strong technical expertise in agronomy, storage and variety management.<br>• Advanced large-scale storage facilities and specialised handling know-how.<br>• Innovation ecosystem: precision agriculture, decision-support tools, alternative sprout-control. | • Higher environmental footprint than cereals (soil movement, refrigeration, irrigation).<br>• Dependence on restricted crop protection products.<br>• Storage quality highly sensitive to temperature, humidity, sprouting and bruising.<br>• Fragmented quality data across the chain.<br>• High fixed and variable production and storage costs.<br>• Price volatility exposes growers to significant risk.<br>• Uneven storage infrastructure across regions. |
| **OPPORTUNITIES**<br>External / Positive | **THREATS**<br>External / Negative |
| • Digital quality monitoring (temperature, humidity, $CO_2$, sprouting risk, bruising sensors).<br>• AI-based prioritisation and predictive risk models for stores, routes and batches.<br>• Alternative sprout-control solutions (mint oil, orange oil, ethylene, DMN, refrigeration).<br>• Precision agriculture and decision-support systems for inputs and blight management.<br>• Breeding innovation for resistance to disease, drought, heat stress and bruising.<br>• Cross-border harmonisation through Interreg cooperation.<br>• Growing consumer demand for sustainable, lower-residue supply chains. | • Climate change: drought, heatwaves, rainfall and warmer storage seasons.<br>• Higher pest and disease pressure (late blight, nematodes, storage rots).<br>• Regulatory restrictions on pesticides and storage treatments (post-CIPC transition).<br>• Energy cost volatility affecting refrigeration, ventilation and processing.<br>• Land competition and rising rents in Belgium, Netherlands and northern France.<br>• Market imbalance and overproduction risk from rapid area expansion.<br>• Quality failure costs: rejected batches, reprocessing, contract penalties. |

### 2.2.2 PESTLE Analysis

The PESTLE analysis for the potato sector reflects the sector's specific regulatory, climatic and social pressures, in particular the ongoing regulatory transition away from CIPC. CIPC (chlorpropham) is a chemical sprout suppressant that was, until recently, used on the large majority of potatoes stored in the EU. Following the European Commission's 2019 decision not to renew its approval, on environmental and residue-compliance grounds, its use was withdrawn across Member States, with national use-up periods ending by October 2020. The consequence for the sector is significant: storage operators have had to replace a single, well-understood treatment with a combination of newer and less-proven methods (e.g. essential oils, ethylene, DMN, refrigeration), which represents a defining challenge for the entire storage sub-sector.

| Factor | Key points | Implications for quality preservation in DODILOG |
|---|---|---|
| Political | • Strong alignment with EU and Interreg priorities: climate adaptation, circular economy, food loss.<br>• Cross-border cooperation needed for transnational potato flows and processing. | • Public pressure for sustainable farming: reduced pesticides, climate resilience.<br>• Strategic importance of potatoes for food security in NEW. |
| Economic | • High-value but high-cost crop: seed, land, crop protection, irrigation, storage.<br>• The processing industry drives demand: frozen fries, crisps (Belgium, Netherlands, France, Germany).<br>• Cost of non-quality: bruising, sprouting, rot, sugar accumulation cause downgrading/rejection. | • Price volatility creates significant grower risk.<br>• Investment barriers for modern storage, sensors and alternative sprout-control systems. |
| Social | • Growing consumer concern about sustainability, lower pesticide use and traceability.<br>• Skills gap in digital storage management and data interpretation.<br>• Complex stakeholder responsibilities across farmers, processors, retailers and logistics. | • Resistance to change: traditional practices, cost concerns, fear of false alarms.<br>• Public perception challenges around intensive production (pesticides, water, soil). |
| Technologica l | • Emerging storage technologies: IoT, automated ventilation, $CO_2$ monitoring, sprout-risk prediction. | • Data integration gap across farms, stores, processors and logistics operators. |

| | | |
|---|---|---|
| | • Precision crop management: remote sensing, variable-rate tools, late blight decision-support.<br>• Post-CIPC technical transition: oils, ethylene, DMN, refrigeration combinations. | • Opportunity for digital twins and integrated risk dashboards. |
| Legal | • Strict food safety, residue (MRL) and phytosanitary standards.<br>• Withdrawal/restriction of active substances forces rapid adaptation.<br>• CIPC residue legacy: ongoing compliance and monitoring challenges. | • Disputed liability across the chain when quality problems emerge.<br>• Strict seed and fresh potato trade certification systems. |
| Environmental | • Climate change affects both field phase (drought, heat) and storage phase (warmer seasons).<br>• Soil health pressure: compaction, erosion, nematodes from intensive production.<br>• Water use pressure: increasing irrigation needs, possible scarcity. | • Energy and carbon footprint: storage, refrigeration, processing.<br>• Food loss reduction as both an environmental lever and policy priority. |

### 2.2.3 Value Chain Risk Mapping

The potato supply chain is mapped across eight stages, each with specific quality risks and intervention levers:

Stage 1: Breeding, variety selection and seed supply

Risks include the limited availability of varieties combining yield, processing quality, blight resistance and storage stability. Seed-borne diseases and phytosanitary barriers can compromise quality from the very start of the chain. Key levers include variety selection aligned to end use, stronger cross-border seed traceability and closer collaboration between breeders and processors on future quality requirements.

Stage 2: Farm planning, rotation and soil preparation

Short rotations increase nematode and disease pressure; heavy machinery causes soil compaction and reduces tuber quality. Longer rotations (ideally 4 to 5 years), soil health monitoring, traffic-lane management and cover crop strategies are the primary levers.

Stage 3: Crop growth – fertilisation, irrigation and crop protection

Increasing restrictions on crop protection products reduce the available toolbox for managing late blight, nematodes, Colorado beetle and aphids. Decision-support systems for blight, irrigation scheduling, and variable-rate nutrient application are key levers for maintaining quality while reducing input pressure.

Stage 4: Haulm destruction and harvest timing

The phase-out of key desiccant chemicals creates operational challenges. Poor haulm destruction increases contamination and reduces skin set. Harvest timing decisions that balance skin set, dry matter content, market destination and weather conditions are critical quality determinants.

Stage 5: Harvest handling and primary transport

Bruising and mechanical damage at harvest create hidden quality losses that only manifest later in storage or at processing intake. Batch-level traceability from field to store, monitoring of drop heights and conveyor speeds, and segmentation by variety and intended use are key levers.

Stage 6: Curing and intake into storage

Inadequate curing increases rot risk. Stores historically treated with CIPC may create residue compliance issues. Systematic intake quality checks (dry matter, damage, rots, soil tare, size, defects) and digital intake records linked to field data are critical at this stage.

Stage 7: Long-term storage

This is the highest-priority stage in the potato chain. Sprouting, weight loss, rots, sugar accumulation and loss of processing quality are the dominant risks. Warmer winters and the post-CIPC transition amplify these risks. Continuous monitoring of temperature, humidity, $CO_2$, ventilation and sprouting risk, combined with automated alerts and variety-specific storage protocols, are the essential levers. Energy optimization for ventilation and refrigeration adds a sustainability dimension.

Stage 8: Secondary transport, processing intake and final use

Temperature fluctuations during transport affect frying colour and reducing sugar levels. Processing rejection due to acrylamide risk, bruising or rots generates contract penalties and waste. Quality-based routing (fresh, fries, crisps, starch, feed or secondary valorisation) and data feedback loops from processors back to storage operators and growers are key to closing the quality loop.

> Central recommendation from the potato value chain analysis
>
> The potato supply chain must be treated as a field-to-store-to-processing quality system, not as separate farm, storage and logistics operations. The greatest value from DODILOG lies in building the data bridges between these stages: enabling actors to share information and act earlier in the quality degradation process.

# Part 3 – Prioritisation Matrix

## 3.1 Methodology

The prioritisation matrix ranks the key quality risk areas in each sector using a risk scoring model derived from three dimensions:

- Probability of occurrence (1 to 5): how frequently the quality risk arises in practice, based on operator feedback and the SWOT analysis.
- Impact of quality loss (1 to 5): the economic, operational, contractual and reputational consequences when the risk materialises.
- Detectability (1 to 5, inverted): how difficult it is to detect the quality issue early — a score of 5 indicates low detectability (high risk contribution).

The risk score is calculated as: Probability × Impact × Detectability. Areas with the highest scores are classified as HIGH PRIORITY (act immediately), intermediate scores as MEDIUM PRIORITY (optimise), and lower scores as LOWER PRIORITY (monitor). These categories correspond to the three zones of the prioritisation matrix: the red zone (high probability, high impact), the orange zone (medium risk requiring optimisation) and the green zone (lower immediate priority).

## 3.2 Cereals Sector: Priority Areas

The following table presents the prioritisation scoring for the cereals supply chain. The scoring reflects both the quantitative model and the qualitative inputs from stakeholder consultations.

| Risk / Issue | Probability (1-5) | Impact (1-5) | Detectability (1-5) | Priority Zone |
|---|---|---|---|---|
| Inland silo storage | 5 | 5 | 4 | HIGH |
| Port storage and handling | 4 | 5 | 5 | HIGH |
| Detection systems (insect/contamination) | 4 | 4 | 5 | HIGH |
| Primary transport (road/rail/IWT) | 3 | 4 | 3 | MEDIUM |
| Collection (farm to first silo) | 3 | 3 | 3 | MEDIUM |
| On-farm storage | 2 | 3 | 2 | LOWER |
| Final delivery/export | 2 | 2 | 2 | LOWER |

The results confirm that inland silo storage and port storage and handling are the top-priority areas for DODILOG intervention in the cereals sector. Both combine high frequency of quality risk occurrence with high economic impact and significant detection gaps. A contamination event identified only at the port stage, after blending of batches from multiple origins, is particularly costly and difficult to remediate, as illustrated by the reported cost of over €30,000 for unloading a contaminated barge.

Detection systems for insects and contamination rank equally as a high priority, as the current standard (manual sieving) is acknowledged by operators to be unreliable at low infestation levels and not deployed systematically at all stages. This creates a systemic blind spot in the cereal quality chain. DODILOG's work on optical, acoustic and IoT-based detection technologies directly addresses this gap.

Primary transport and collection are classified as medium-priority areas, not because the risks are insignificant, but because the primary intervention opportunities lie at the storage and handling nodes. Improving traceability and monitoring continuity across these stages would, however, amplify the value of interventions at the storage level.

## 3.3 Potato Sector: Priority Areas

The potato sector presents a more complex prioritisation landscape, reflecting the greater number of stages in the supply chain and the diversity of risks. The following table presents the prioritisation results.

| Risk / Issue | Probability (1-5) | Impact (1-5) | Detectability (1-5) | Priority Zone |
|---|---|---|---|---|
| Long-term storage (sprouting, rots, sugars) | 5 | 5 | 4 | HIGH |
| Post-CIPC sprout control transition | 5 | 4 | 5 | HIGH |
| Harvest damage and bruising | 5 | 4 | 4 | HIGH |
| Soil health and rotation | 4 | 4 | 4 | HIGH |
| Climate and water risk | 4 | 4 | 4 | HIGH |
| Curing and storage intake | 3 | 4 | 4 | MEDIUM |
| Crop protection failures (blight, nematodes) | 4 | 3 | 4 | MEDIUM |
| Batch traceability across the chain | 3 | 4 | 4 | MEDIUM |
| Transport conditions (temperature) | 3 | 3 | 3 | MEDIUM |

| | | | | |
|---|---|---|---|---|
| Processing intake rejection | 3 | 3 | 3 | MEDIUM |
| Retail stage quality monitoring | 2 | 2 | 2 | LOWER |
| Mature logistics flows | 2 | 2 | 2 | LOWER |

Long-term storage stands as the single highest-priority area in the potato chain, combining maximum probability of quality risk occurrence with maximum economic impact. The transition away from CIPC, which has been the dominant sprout suppressor for decades, significantly amplifies the risk at this stage, as storage operators are navigating a forced adaptation of their management protocols with unproven alternatives. The post-CIPC sprout control challenge is therefore treated as an equally high-priority issue, distinct from but intimately linked to the broader long-term storage challenge.

Harvest damage and bruising rank as the third high-priority area. The key characteristic of this risk is that it generates hidden losses: bruising inflicted at harvest or primary transport may not be visible until storage or processing intake, making it highly relevant from a detectability standpoint. DODILOG's work on early detection tools and batch traceability is directly applicable here.

Soil health and rotation, and climate and water risk, are classified as high-priority issues despite lower scores, because they represent structural, long-term threats to the quality and yield base of the sector. They are included in the high-priority zone because their impact is cumulative, irreversible and increasingly pressing under climate change conditions.

Medium-priority areas; curing and storage intake, crop protection management, batch traceability, transport conditions and processing intake rejection, are all important and should be addressed as DODILOG's tools are deployed, but they either require lower initial investment or represent downstream consequences of addressing the higher-priority nodes.

## 3.4 Cross-sector Synthesis and DODILOG Implications

Across both sectors, the prioritisation analysis points to a set of consistent conclusions that should shape DODILOG's development and implementation strategy:

### Storage is the highest-priority intervention node in both sectors

Inland silo storage in cereals and long-term potato storage represent the nodes where quality risk probability, economic impact and detection gaps are simultaneously highest. Continuous, real-time monitoring tools, covering temperature, humidity, $CO_2$, insect activity and sprouting risk, deployed at these nodes will generate the greatest return in terms of quality preservation.

### Detection gaps are a systemic vulnerability

In both chains, a major driver of quality loss is not the risk itself but the inability to detect it early enough to intervene. Manual, sample-based detection methods, whether for insect infestation in grain or sprouting in potato stores, are too slow, too infrequent and too dependent on human expertise. DODILOG's development of automated, continuous detection systems directly addresses this vulnerability.

### Data integration across the supply chain is the missing enabler

Neither sector currently benefits from effective data sharing between stages. Harvest and farm data do not flow to storage operators. Storage data does not inform transport decisions. Processing intake results rarely give feedback to growers or storage managers. Building the data bridges between these stages, through digital traceability, shared platforms and feedback loops, would multiply the value of any monitoring or detection technology deployed at individual nodes.

### Sector-specific urgency in potatoes: the post-CIPC transition

The regulatory withdrawal of CIPC creates a time-sensitive and sector-wide challenge that has no direct parallel in the cereals sector. DODILOG should consider positioning its potato storage work within this transition context, offering alternative sprout-control decision-support tools as a flagship application.

> **Summary: Priority areas for DODILOG by sector**
>
> CEREALS → Act first on: (1) Inland silo monitoring and insect detection; (2) Port storage detection and contamination management; (3) Traceability across collection and transport.
>
> POTATOES → Act first on: (1) Continuous storage monitoring and predictive alerts; (2) Post-CIPC sprout-control decision support; (3) Bruising and harvest-damage detection; (4) Soil, climate and water risk mapping.
>
> CROSS-SECTOR → Invest in: (1) Data integration platforms and feedback loops; (2) AI-based risk prioritisation tools; (3) Training and knowledge transfer to SMEs and smaller operators.

# 4. Conclusions and Next Steps

Deliverable D2.1.1 provides the analytical foundation for DODILOG by establishing a clear, evidence-based picture of where quality preservation risks are concentrated in the cereals and potato supply chains of NWE, and where technological and organisational interventions would generate the greatest value.

The stakeholder consultation confirmed a high level of engagement from operators across both sectors, with strong openness to new technologies tempered by practical concerns about cost, compatibility and reliability. These findings should directly inform the design criteria for the tools and methodologies developed under WP3 and beyond.

The SWOT and PESTLE analyses reveal that external forces, in particular climate change, regulatory tightening and the post-CIPC transition in potatoes, are actively increasing quality preservation risk across both chains, while the tools currently available to operators remain largely static and reactive. DODILOG's value proposition is precisely to close this widening gap.

The prioritisation matrices provide a ranked agenda for DODILOG's technology development: storage monitoring and automated detection are the first priorities; data integration and traceability are the systemic enablers; and SME-accessible, cost-effective solutions are the necessary condition for scaled adoption.

This deliverable will be updated as additional interview data is collected and as the project's pilot activities generate new empirical evidence on quality risk patterns. It serves as a living reference document for the project's needs assessment work throughout WP2.

# Annex - list of references

- Survey Data: "Post-harvest practices and early risk detection" (Internal DODILog Survey, June 2026).
- Stakeholder List: "WP2 stakeholders - List.xlsx" (June 2026).
- Interview Report: Crepon, K. (2025). Interview reports: Expectation of silo managers to detect insects in grain. ARVALIS