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ANIMAL WELFARE INDICATORS AT THE SLAUGHTERHOUSE

Cost-benefit analysis – example of a case study

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Structure

1. Introduction
2. Data analysis and practice change analysis
3. Animal welfare from economic perspective
4. How do technologies affect costs?
5. Example of a case study for an economic assessment

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Introduction

- Livestock farming faces societal pressure from labour, sustainability, and welfare demands.
- Digital tools can improve welfare monitoring and early detection.
- Data do not improve animal welfare – actions do.
- Sensors and AI support faster and more targeted management decisions.
- Industry 4.0 technologies must be adapted to livestock-specific conditions.
- Animal-based indicators reflect the animal's real welfare state.
- Best Practices only work if they are feasible and **economically bearable/viable** on different levels of the production chain (farm, catching, transport, slaughter).

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AI-generated image with OpenAI ChatGPT (DALL·E), 2026

Interpreting Data → Appropriate actions

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Improving animal welfare by implementing Best Practices which are economically viable

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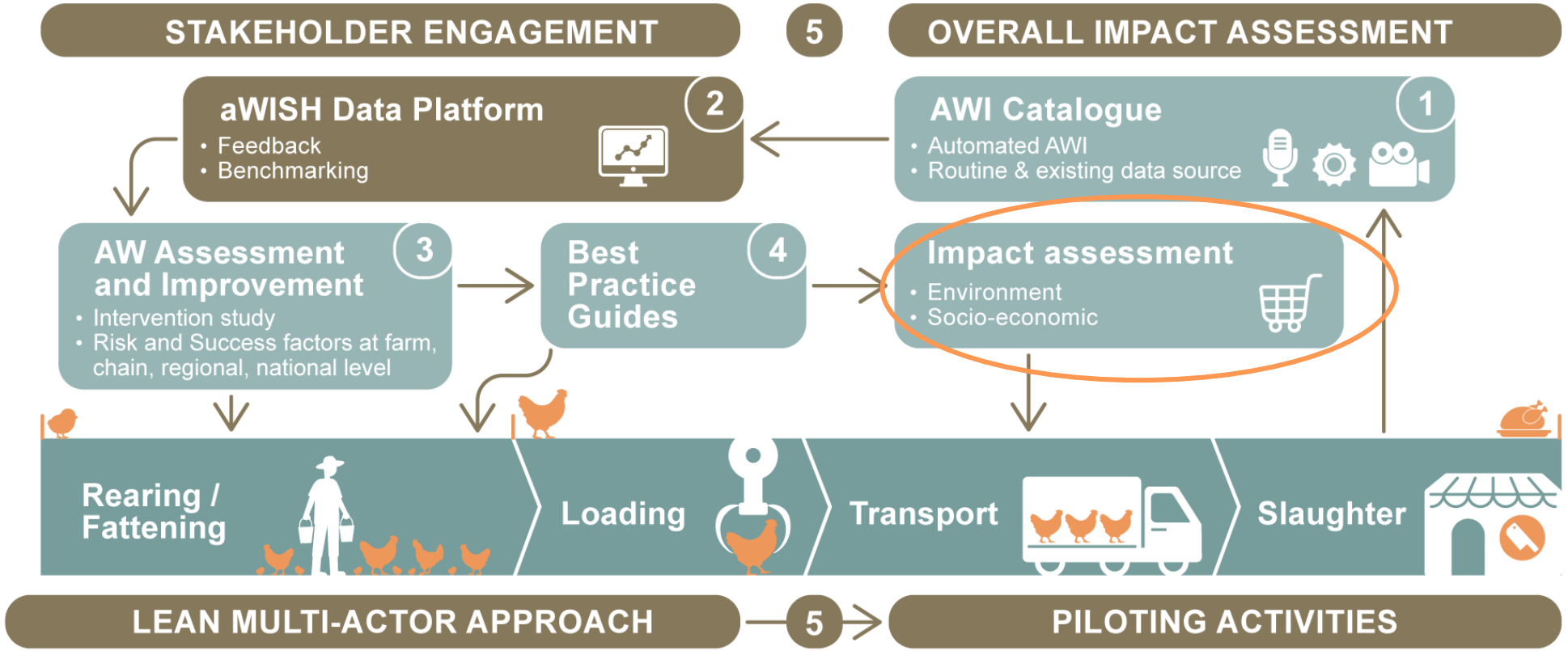

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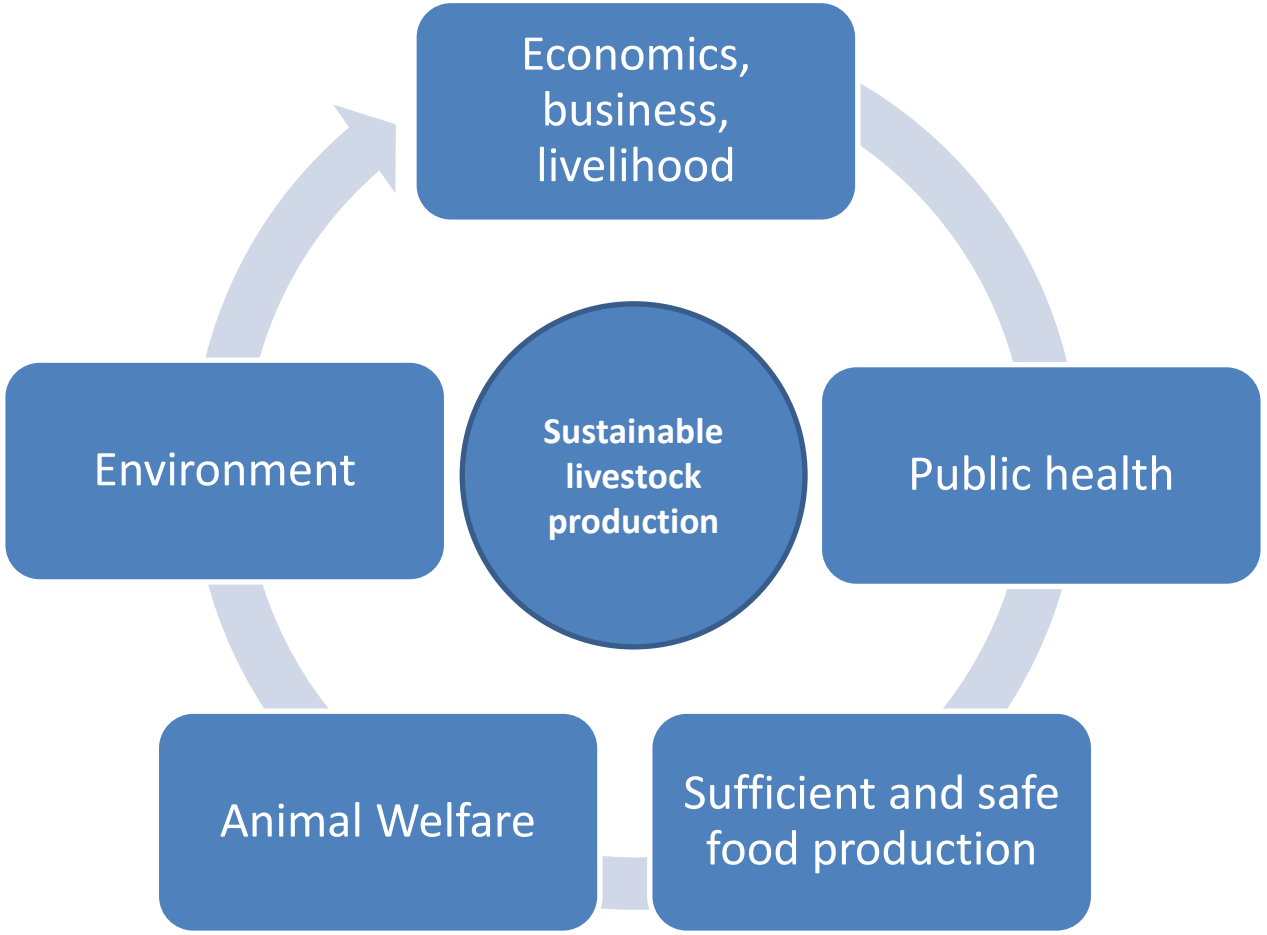
Farm Animal Welfare: Core part of sustainable livestock production



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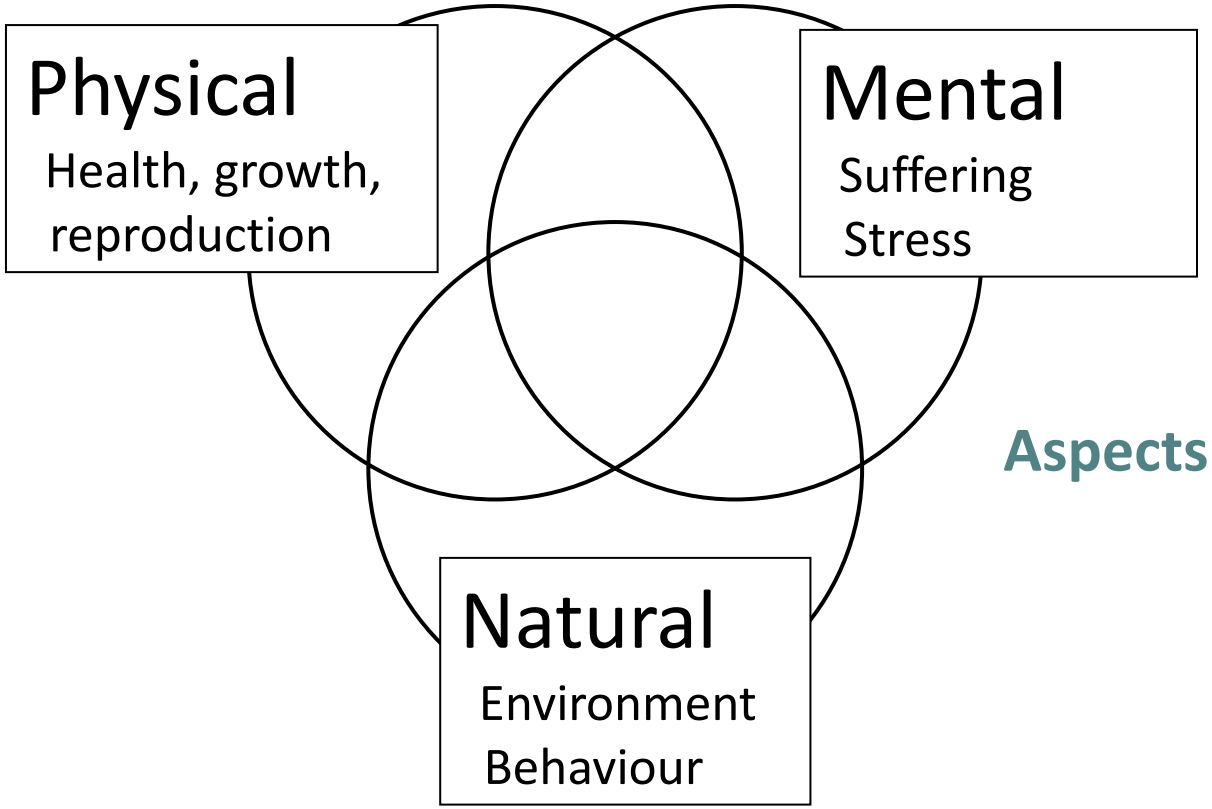

Aspects of animal welfare

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Types of animal welfare indicators

- Resource based indicators
- Management based indicators

Input indicators

- Animal based indicators

Output indicators

- Economic, environmental and social indicators

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Economic indicators

- Costs of production (EUR/100 kg liveweight)
- Profitability (EUR/100 kg liveweight)
- Revenue (EUR/100 kg liveweight)

- Total costs of catching (EUR/100 kg liveweight)
- Profitability of catching operations (EUR/100 kg liveweight)
- Revenue (EUR/100 kg liveweight)

- Transport costs (EUR/100 kg liveweight)
- Revenue (EUR/100 kg liveweight)

- Total slaughter costs (EUR/100 kg liveweight)
- Profitability of slaughtering operations (EUR/100 kg liveweight)
- Revenue (EUR/100 kg liveweight)

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Environmental indicators

Rearing / Fattening

- Electric Energy consumption (kW/hr)
- Gas (GPL or other) consumption (m^3)
- Water consumption (litre)
- Amount of nutrients in water (e.g. phosphate and Nitrates)
- NH_3 emissions (NH_3 /100 kg liveweight)
- CO_2 emissions (kg CO_2 /100 kg liveweight)

Loading

- Fuel consumption (l)
- Energy consumption (kW/hr)

Transport

- CO_2 emissions (tonnes CO_2 / km)

Slaughter

- Water consumption (litre)
- CO_2 emissions (kg CO_2 / kg meat)
- Nutrients in the water (e.g. phosphate and Nitrates)
- Amounts in the pathogens in the water

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Social indicators

- Labour duration (hours)
- Number of injuries to workers (scratches, bruises)
- Working satisfaction
- Hourly wage for workers
- Qualification level for workers

- Labour duration (hours)
- Injuries to workers (scratches, bruises)
- Working satisfaction
- Hourly wage for workers
- Qualification level

- Duration of driving (hours)
- Distance (km)
- Working satisfaction
- Hourly wage for workers
- Qualification level for workers

- Labour duration (hours)
- Working satisfaction
- Injury to workers (scratches, bruises) (per cycle)
- Hourly wage for workers
- Qualification level for workers

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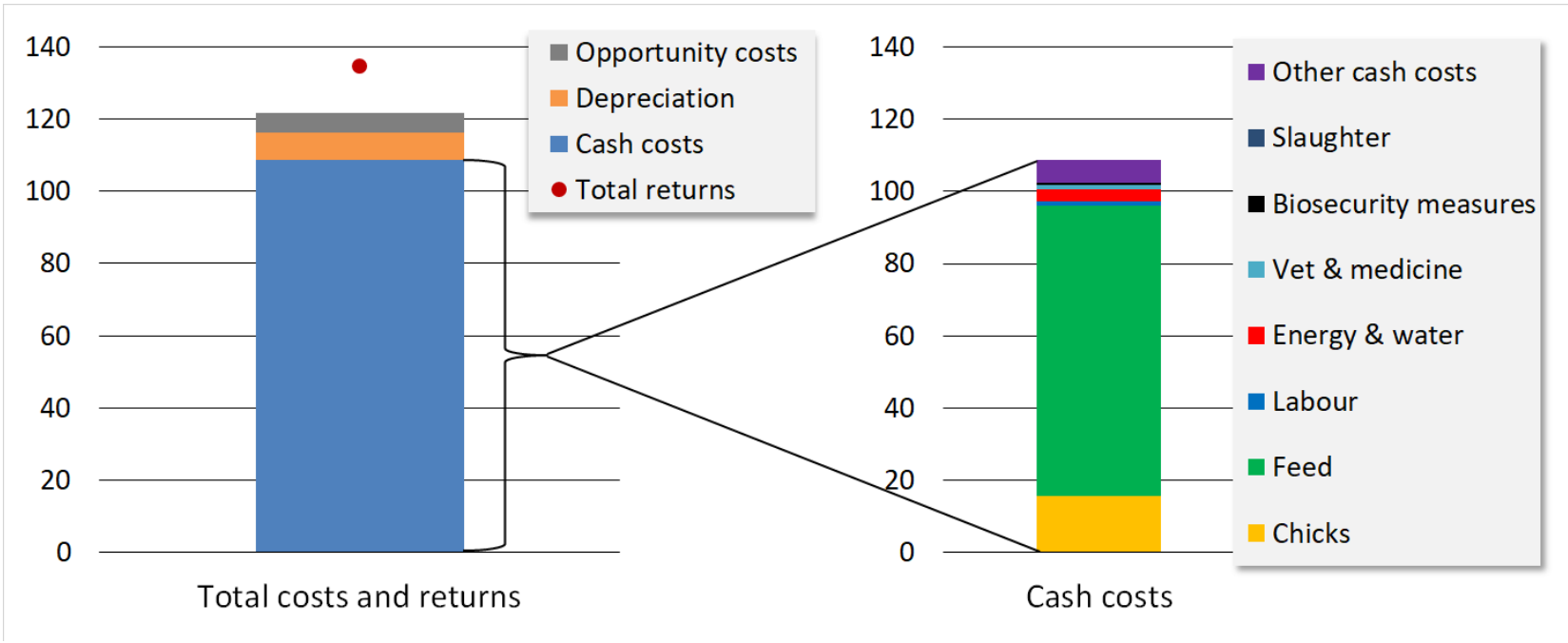
Data Analysis

Physical parameters:

- Nr. cycles/year, Daily weight gain, Mortality rate, Feed Conversion Ratio (FCR)

Production costs and returns (EUR/100 kg LW of produced meat)



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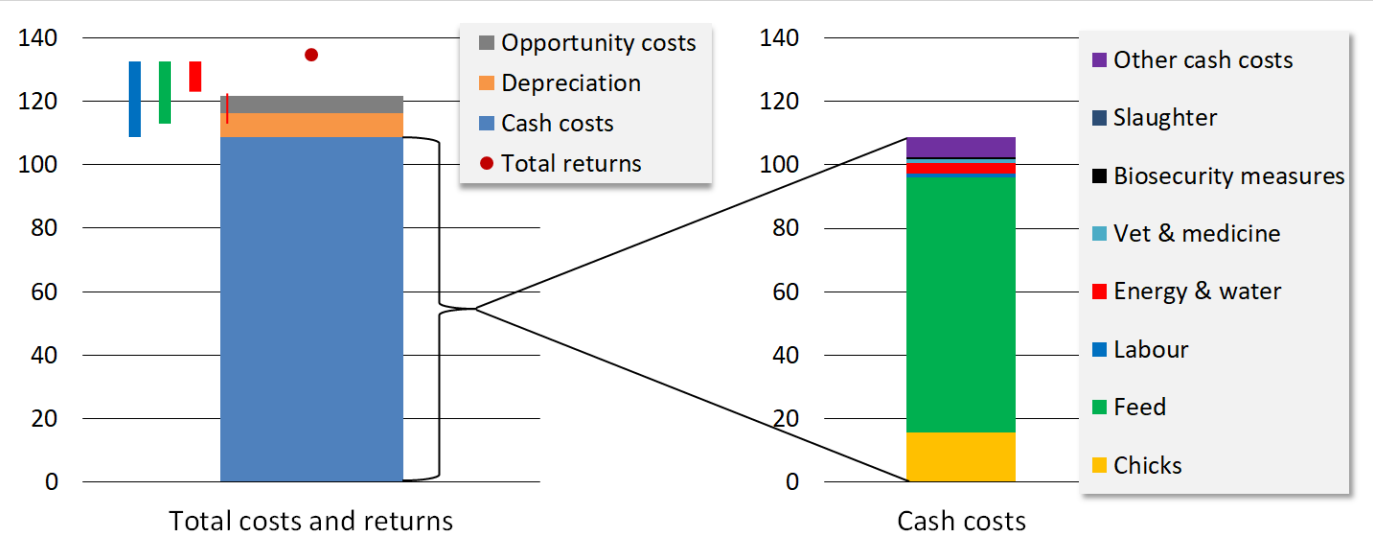
Data Analysis – Calculation of profitability

- Short term profitability = total returns – cash costs.
- Medium term profitability = total returns – cash costs – depreciation costs.
- Long term profitability = total returns – cash costs – depreciation costs – opportunity costs.



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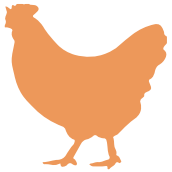
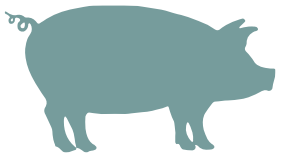
Practice change analysis with the typical farm approach

Baseline: review of the current situation and better understanding of prevailing welfare practices





Practice change: assessment of the socio-economic and environmental impact of animal welfare improvement strategies.

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Practice change analysis

- Analysis of innovative technologies
- Integration of new farm businesses
- Significant changes in management practices

Trial settings

Hard to assess the real farm impacts

- Farm data sets
- **TIPI-CAL: production and accounting model**

Real-world effects (cost structure & returns)
Complex and multifactorial challenges

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TIPI-CAL Model

[Technology Impact and Policy Impact Calculations]

- Production and accounting model
- Whole farm level and enterprise level
- Excel-Spreadsheet
- Basic model and additional modules for cost analysis and data management

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TIPI-CAL Model: Pig entreprise

Sows / piglet production

- Weaner/feeder, production rythm
- Weaning and rearing weights, periods
- Replacement percentage
- Herd growth or reduction
- Differentiation into boars, castrates and females
- 18 variable cost positions per head
- 3 variable cost positions per kg LW
- All values can be expressed per pig, per piglet and per 100 kg live weight (pigless or total)

Pig finishing

- Differentiation in to boars, castrates and females
- 13 variable cost positions per head
- 3 variable cost positions per kg meat
- 3 different feeding periods and feed mixes or individual specification of rations
- All values can be expressed per 100 kg slaughter weight, live weight and per head

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TIPI-CAL Model: Broiler enterprise

- **Performance**: Animal places, feeding periods, days without production, cycles, FCR, etc
- **Mortalities:** coop mortalities, and beyond the farm gate
- **Thining:** up to 3 removal options
- **Returns**: meat, offals, manure and payments
- **13 variable cost:** positions at farm level
- **5 variable cost:** positions at slaughterhouse level
- **11 fixed costs** positions
- All values can be expressed per **cycle or bird or 100 kg of liveweight**

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Agricultural decision making – Minimum, marginal and opportunity cost principle

Digitalisation in animal welfare often shifts cost structures from variable costs to fixed costs:

- This **raises capital intensity**, **lowers variable labour costs per animal**, and **increases the importance of capacity utilisation.**
- As a result, **investment decisions** should be assessed not only by average costs, but also by **marginal and opportunity costs**.

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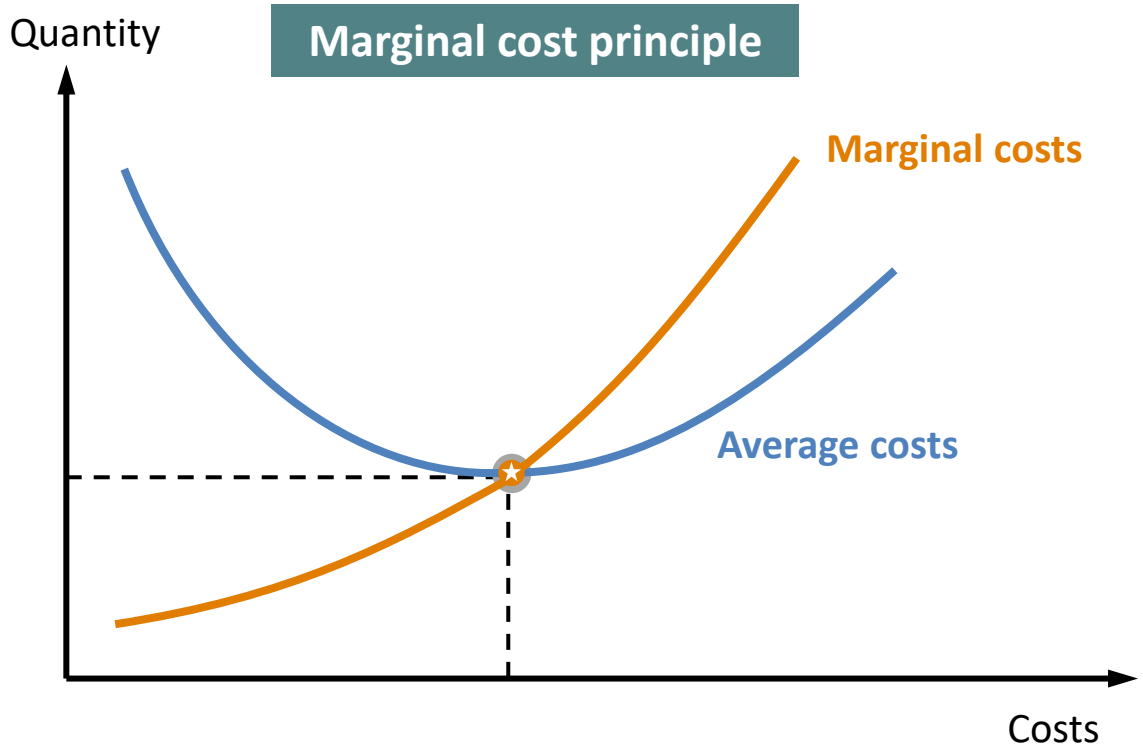
Agricultural decision making – Minimum, marginal and opportunity cost principle

In agricultural decision-making, the **minimum principle** helps identify the least-cost way to achieve a given production or animal-welfare target, the **marginal cost principle** determines whether an additional measure is economically justified, and the **opportunity cost principle** ensures that owned resources such as land, labour, and capital are valued according to their best alternative use.



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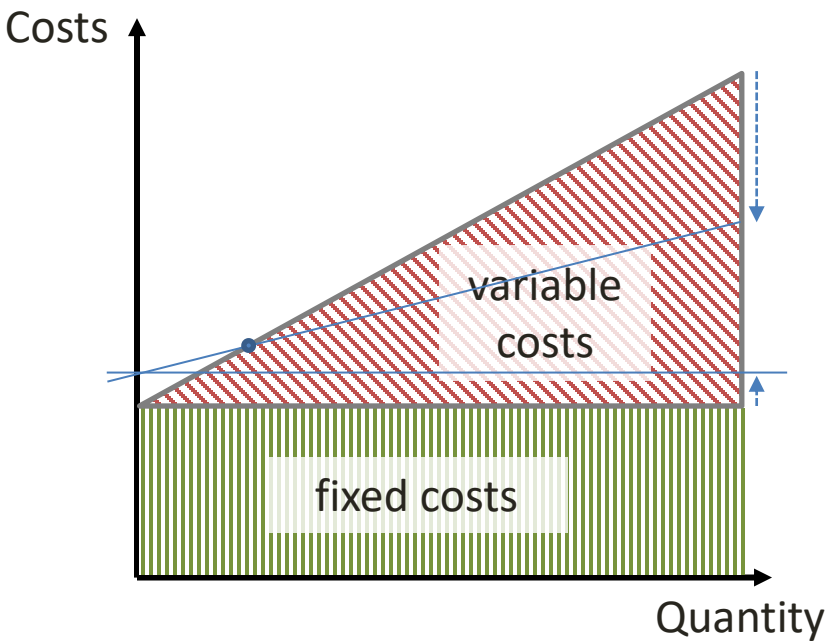
How do technologies affect costs and benefits?

For technology changes, the key point is to **understand how costs shift**.



- **Cost shift** from **variable costs** to **fixed costs**
- Technology may replace recurring inputs such as labour, monitoring, or manual handling with upfront capital, depreciation, and maintenance costs.
- Higher fixed costs only pay off when the technology raises output, improves efficiency, or reduces enough variable cost to spread those fixed costs over more units (**economies of scale**)
- Total cost may fall, stay similar, or even rise if the technology is underused
- A simple **break-even** condition:
  Extra annual benefit ≥ Annualised investment cost + extra operating cost

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How do technologies affect costs and benefits?

- **Cost shifts** from **variable costs** to **fixed costs:**
- Also relevant for contribution margin analysis, because fixed costs must be covered by the contribution margin and therefore affect the technology's profitability.

- **Contribution margin (CM) = Revenue - Variable costs**

- Unit contribution margin = Unit price - Variable unit costs

- Profit = Contribution margin - Fixed costs

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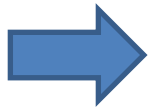
Economies of scale

Definition: Economies of scale occur when increasing output leads to lower average costs per unit.

- For example: a larger pig or poultry farm can often use precision technology more efficiently because the investment costs are spread across more kilograms of produced meat.

Amortisation is determined by the expected service life or replacement cycle of the technology.

Short cycles: the investment is recovered faster, so the amortisation period is shorter, but annual costs are higher.
Long cycles: the investment is spread over more years, so annual amortisation is lower, but the payback takes longer.



The shorter the production cycle, the faster the investment can pay for itself, provided it generates sufficient cost savings or additional revenue per cycle

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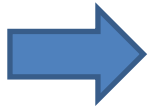
Animal welfare as a cost factor

- Animal welfare is a cost factor. Higher welfare standards usually increase fixed and/or variable costs through housing, labour, monitoring, and management, so these costs must be covered by the farm's contribution margin or passed on in the product price.



Animal welfare improves production standards, but it also adds cost and therefore affects profitability.

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Return on Investment

Return on Investment measures the financial gain from an investment relative to its cost.
It is usually shown as a percentage.

ROI = profit generated per unit of investment cost:

*((Profit-costs)/costs) *100*

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Key factors to consider before investing:

- The appropriate planning horizon for the investment and financing period (Investment lifetime)
- Which technology?
- Production cycle
- Contributing factors: Liquidity, own capital, ROI and market conditions, such as interest rates and output prices.
- It´s marginal and opportunity costs.

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Who pays for the extra costs?

- Higher production costs are often passed through on the consumer.
- Animal welfare cannot be achieved on zero costs.

Set up of a **Business model** to assess business potential and to create value added.

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How to assess business potential? A business model contains:

1. Start with a vision: What do you want to do and why?
2. Test, validate & improve business model's assumptions
   - What is the target market and customers? Why they are your customers?
   - Does a market opportunity exist?
   - How do you reach your customers? Which delivery/sales channels you will use?
   - How the product is priced? ➔ Different pricing models exist.
3. Specify your value proposition: a short message that focuses on your product and why it is worth buying ➔ What customer's problem does it solve? How your product is better than the competitors´product?
4. Select the most suitable delivery channels
5. Determine revenues, which should exceed the costs of a product or service delivered to the customer.

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Example of a case study

Smart farming in action: Evaluating AI weight sensors for assessing the overall welfare status in pig production

The WD camera installed on a commercial pig farm

Banhazi et al. (2024)

- Weight-Detect (WD) from PLF Agritech, Brisbane, Australia, was introduced on a commercial pig farm in Spain in early 2024 as part of the EU-funded aWISH project to;
  - evaluate the applicability of the technology
  - use this information to assess the overall welfare status of the pigs

Banhazi et al. (2024)

The data processing and communication unit of the WD system before deployment

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Example of a case study:

Objectives

- To estimate the **cost saving potential** of using **weight sensor technology**

References

- BANHAZI, T. M., DUNN, M. & BANHAZI, A. 2022b. Weight-Detect™: on-farm evaluation of the precision of image analysis-based weight prediction system. In: BANHAZI, T. M., HALAS, V. & MAROTO-MOLINA, F. (eds.) Practical Precision Livestock Farming: Hands-on experiences with PLF technologies in commercial and R&D settings. Amsterdam, The Netherlands Wageningen Academic Publishers.
- T. BANHAZI, M. DUNN, A. BANHAZI, J. REIXACH, A. R. PEREZ, P. LLONCH, J. MASELYNE (2024) Weight-Detect instrument predicted the onset of respiratory infection a week before clinical signs appeared ISAH conference proceedings, Thailand, 16-20 September, 2024.

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Example of a case study:

Data and Methods

- Hybrid data collection – in-person & remote
- The study is based on data collected at the Spanish Pig Pilot.
- The case study data which had been completely anonymised by only reporting realistic % changes in relation to “industry averages” to maintain strict privacy for commercially sensitive information.
- Changes in costs, returns and profitability per production unit has been compared to the „reference“ situation.

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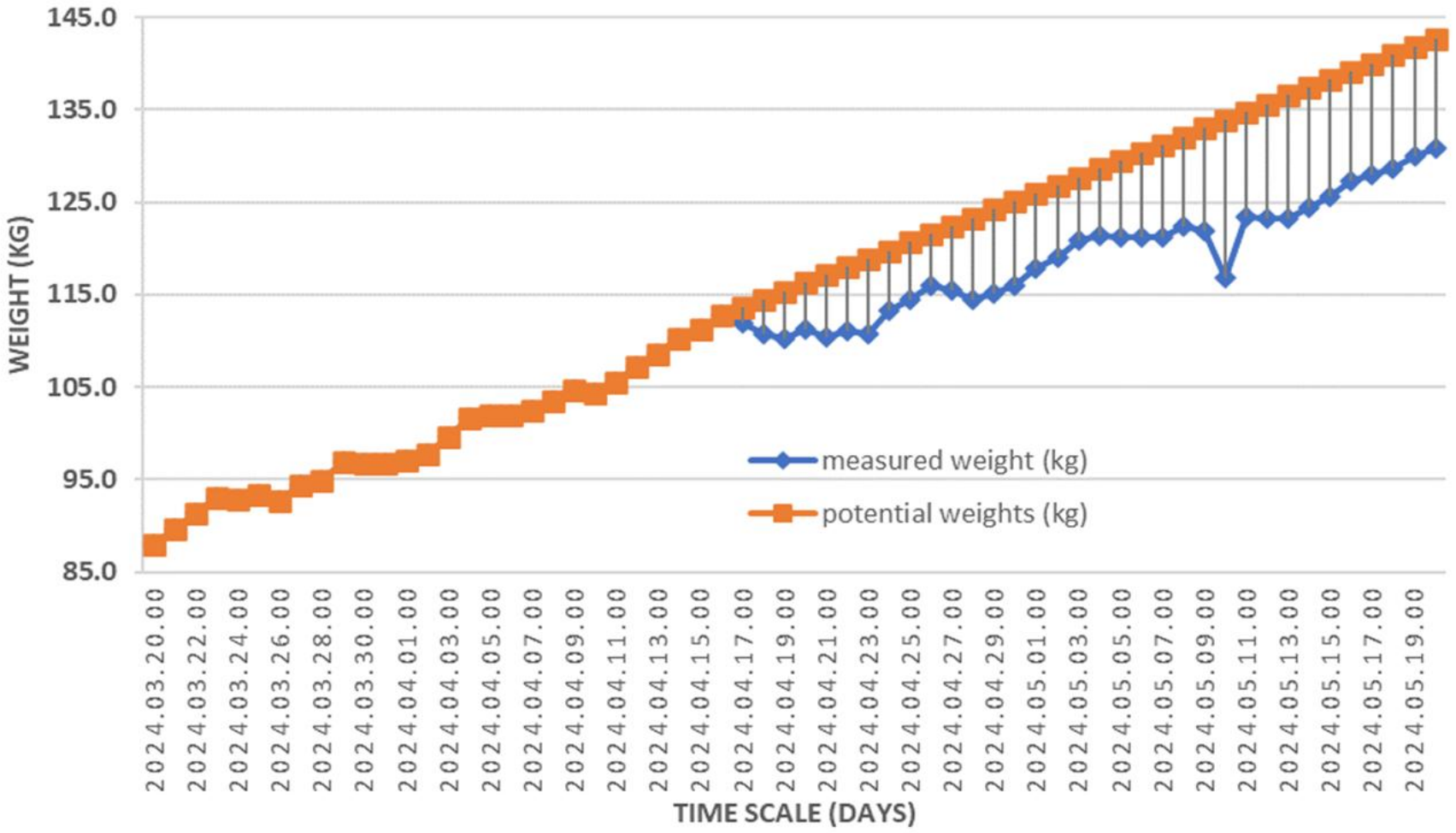
Example of a case study:



If the disease could be avoided and the pigs maintained their initial ADG (approx. 880 g/d), they would have reached the target slaughter weight of 130 kg approx. 14 days sooner resulting in considerable cost savings, that has been calculated as part of this case study.

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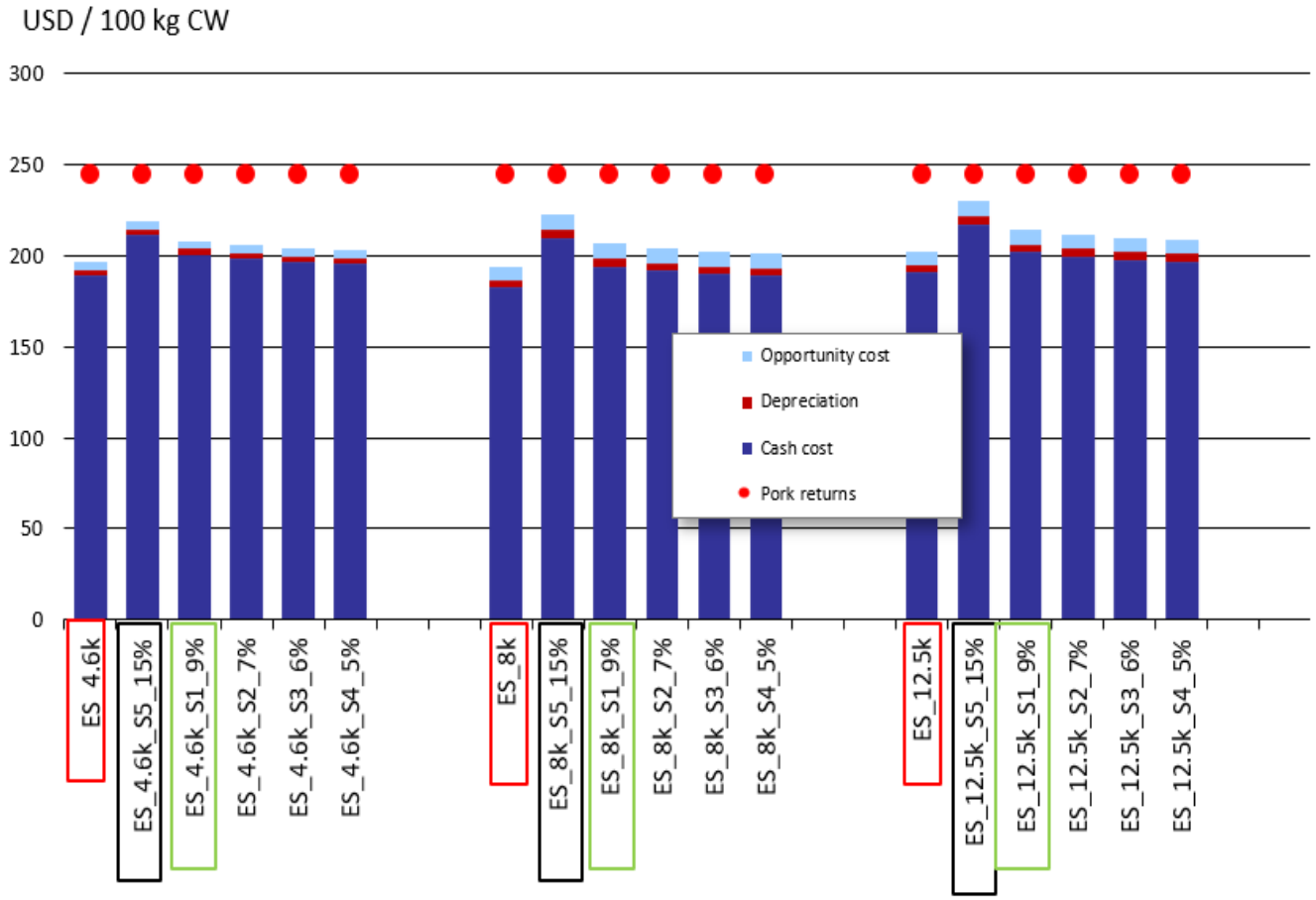
Example of a case study:

Comparison of profits:



- Although returns exceed total costs in all scenarios, the margins vary depending on the promptness of the disease detection. Even small margins per pig can have a significant effect on the herd as a whole.

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Take home messages

- Best Practices only work and will be accepted and adopted if they are feasible and economically viable on farms, at transport and at slaughter.
- Animal welfare is a cost-factor.
- Digitalisation in animal welfare means shifting of costs from variable to fixed costs.
- Practice change analysis refers to changes in performances and costs after implementation of intervention dependent on the specific time horizon.

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Thank you!

Questions?

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aWISH – Animal Welfare Indicators at the Slaughterhouse (awish-project.eu)

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