Del. 4.2 - Filled fit-to-use/-purpose scores' matrix for indicators/indices

Deliverable Lead	CMCC
Deliverable due date	2024/07/31
Status	FINAL
Version	V1.0
Project	SEBASTIEN

Co-financed by the Connecting Europe Facility of the European Union

Agreement: INEA/CEF/ICT/A2020/2373580**Action**: 2020-IT-IA-0234

DOCUMENT INFORMATION

Title	Deliverable 4.2 - Filled fit-to-use/-purpose scores' matrix for indicators/indices
Agreement	INEA/CEF/ICT/A2020/2373580
Action	2020-IT-IA-0234
Creator	CMCC
Deliverable Description	Filled fit-to-use/-purpose scores' matrix for indicators/indices
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Requested deadline	M31
Reviewer	Marco Milanesi (UNITUS)

1. INTRODUCTION

The "Fit for Use and Fit for Purpose" matrix is a framework useful to evaluate the utility, reliability, and appropriateness of indicators or datasets in specific contexts. Here's how it works:

The **fit-for-use** evaluates whether an indicator or dataset meets the operational needs of the user. It focuses on **practical applicability** in real-world scenarios. It considers:

- If the data are accurate enough for the intended application;
- If the data are updated frequently enough to be relevant;
- If users can easily obtain and use the data in the desired formats;
- If the spatial and temporal resolutions are suitable for the user's requirements?

The **fit-for-purpose** examines whether an indicator or dataset is aligned with its **intended goal**. It considers:

- If the dataset provides the information needed to address the question or problem at hand.
- If the methods used to generate the data are appropriate and scientifically robust.
- If the data can be integrated or compared with other datasets as needed.
- If the indicator provides clear, actionable insights?

Indicators can be categorized based on their scoring in terms of fitting-for-use or fitting-for-purpose, the two extremes are considered below:

	Low Fit for Purpose	**High Fit for Purpose**
Low Fit for Use	Poor-quality or outdated datasets; unsuitable for operational use in any meaningful way.	Conceptually aligned but impractical due to issues like accessibility or scale.
High Fit for Use	Technically sound datasets that fail to meet broader strategic or conceptual needs.	Gold standard: well-designed, operationally applicable, and conceptually relevant.

When evaluating indicators, the matrix helps identify:

1. **Gaps** in data quality, utility, or conceptual alignment.
2. **Strengths** of datasets in specific contexts, guiding their application and adoption.
3. **Improvement Areas**, e.g., refining resolutions, enhancing accessibility, or improving modeling techniques.

For instance, for the **livestock sector**, climate indicators can play a critical role in ensuring resilience and productivity. Using the **Fit for Use and Fit for Purpose matrix**, we can evaluate how different climate indicators apply to decision-making in this sector.

2. Analysis of the SEBASTIEN services and related indices

2.1 Milk characteristics (yield, protein and fat content)

Fit for Use:

- **High:**
  - Predictions are generated using robust models that integrate accurate, real-time data inputs (e.g., feeding regimens, animal health, genetics, environmental factors).
  - Results are precise, and delivered promptly through accessible platforms (e.g., mobile apps or farm management systems).
  - Predictive algorithms are validated frequently, minimizing error margins and ensuring reliability.
- **Low:**
  - Predictions are based on outdated or incomplete datasets, leading to low accuracy and reduced reliability.
  - Platforms providing predictions are overly complex, not user-friendly, or inaccessible for farmers without advanced technical skills or high-cost infrastructure.

Fit for Purpose:

- **High:**
  - Predictions align closely with operational and strategic goals, such as optimizing feeding strategies, improving milk composition, and maximizing yield while maintaining animal health.
  - Forecasts support both short-term decisions (e.g., ration adjustments or health interventions) and long-term planning (e.g., breeding programs for milk quality and yield).
  - Predictive insights are integrated with other farm metrics (e.g., SCC - Somatic Cell Count, THI - Temperature Humidity Index, and feed quality) to provide a comprehensive decision-support system.
- **Low:**
  - Predictions are reactive rather than proactive, providing limited support for strategic goals like genetic improvement or sustainable production practices.
  - Lack of integration with environmental, health, or management indicators reduces their value for farm optimization.

In these terms, a prediction service for milk yield, protein, and fat content represents a useful tool for real-time decision-making, operational efficiency, and strategic planning in sustainable dairy farming (high fit-to-use and high fit-to-purpose).

Insights and Recommendations

Improving Fit for Use:

1. **Enhance Data Inputs and Model Accuracy:**
   - Incorporate genetic and health data to refine model accuracy for individual animals and herds.
2. **Regularly Validate and Update Models:**
   - Conduct frequent recalibrations of predictive algorithms using the latest datasets to ensure relevance and reliability.
   - Tailor models to regional conditions, species, breeds, and production systems for enhanced local applicability.

Enhancing Fit for Purpose:

1. **Integrate Predictions with Other Metrics:**
   - Link predictions to economic metrics (e.g., cost of feed, milk price) to evaluate profitability scenarios.
2. **Align with Sustainability Objectives:**
   - Link predictions to environmental impact metrics (e.g., carbon footprint per liter of milk) to identify opportunities for reducing emissions and waste.
   - Promote practices that enhance milk composition and yield while optimizing resource use.
3. **Develop Actionable Thresholds:**
   - Establish predictive thresholds that trigger alerts for potential issues (e.g., yield drops, protein deficiencies) and suggest targeted interventions (e.g., diet adjustments or veterinary checks).
4. **Enable Scenario Simulations:**
   - Offer tools for farmers to test the impact of various strategies (e.g., changes in feed, management practices) on predicted milk yield and composition.

2.2 Temperature and Humidity Index (THI)

Fit for Use:

- **High**:
  - If THI data is sourced from accurate, real-time weather stations and tailored for specific breeds of livestock in the region.
- **Low**:
  - If data is generalized, infrequent, or inaccessible to farmers due to technological or infrastructural barriers.

Fit for Purpose:

- **High**:
  - Aligns perfectly with the goal of reducing heat stress, improving feed management, and optimizing breeding cycles.
- **Low**:
  - Less useful for long-term climate adaptation strategies as it only addresses immediate, localized heat stress concerns.

In this term, the use of THI in the services is useful to reduce heat stress in livestock and its value is accurate because it is derived from solid databases (high fit-to-use and high fit-to-purpose).

Insights and Recommendations:

Improving Fit for Use:

- Increase the resolution and accessibility of key climate indicators, especially in remote areas.
- Provide user-friendly tools and platforms to interpret complex indicators like NDVI, number of tropical nights, warm spell duration index, etc.

Enhancing Fit for Purpose:

- Develop livestock-specific thresholds and models tailored to local breeds and environmental conditions.
- Integrate multiple indicators (e.g., combining NDVI, rainfall, and THI) for a comprehensive decision-support system.

2.3 Evaluation of pastures fresh biomass and dry matter

Fit for Use:

- **High:**
  - Data on dry matter and fresh biomass is obtained using precise, modern technologies such as remote sensing (drones, satellites) or ground-based methods (portable NIR sensors).
  - Measurements are accurate, frequent, and cover specific pasture areas, providing granularity and real-time updates.
  - Results are easily accessible via farm management systems or mobile applications, ensuring farmers can interpret and act on the data efficiently.
- **Low:**
  - Measurements are infrequent, generalized, or rely on outdated techniques, leading to low precision and reduced applicability.
  - Accessibility barriers exist, such as complex interfaces, lack of integration with farm management systems, or limited availability in remote areas.
  - Data resolution is insufficient, offering only average values over large areas.

Fit for Purpose:

- **High:**
  - The dry matter and fresh biomass indices align well with strategic pasture management goals, such as optimizing grazing schedules, improving forage quality, and balancing livestock nutrition.
  - Metrics support both immediate decisions (e.g., when and where to graze) and long-term strategies (e.g., pasture rotation, reseeding, or fertilization planning).
  - Insights are integrated with other indicators (e.g., weather data, soil fertility, livestock performance).
- **Low:**
  - Data is primarily used for basic monitoring without deeper integration into strategic planning or optimization efforts.
  - The indices fail to address broader goals like improving pasture sustainability, reducing overgrazing, or adapting to climate variability.
  - Lack of connection with livestock performance or economic outcomes reduces their value for farm-level decision-making.

The service for pasture dry matter and fresh biomass estimation using modern technologies represent more than a basic monitoring tool being an important component of precision pasture management, enhancing productivity, sustainability, and profitability for livestock operations (high fit-to-use and high fit-to-purpose).

Insights and Recommendations

Improving Fit for Use:

1. **Adopt Advanced Data Collection Techniques:**
   - Use drones to measure pasture biomass at high resolution, combined with ground-based tools to validate data.
   - Implement real-time monitoring systems to provide timely and precise updates, e.g., use IoT animal sensors to evaluate animal grazing, ingestion and combine with pasture estimation, evaluate where animals are grazing
2. **Standardize and Validate Measurements:**
   - Regularly validate collected data to ensure accuracy and consistency across different collection methods.
   - Tailor data collection to specific regional conditions and pasture types for enhanced reliability.

Enhancing Fit for Purpose:

1. **Integrate with Other Farm Metrics:**
   - Use indices to optimize livestock nutrition by matching pasture availability with animal requirements.
   - Include other evaluations (i.e. fiber components, proteins, etc.)
2. **Support Long-Term Sustainability:**
   - Use trends in dry matter and fresh biomass data to inform rotational grazing plans, reseeding strategies, and fertilization schedules, reducing overgrazing and soil degradation.
   - Save and display historical biomass availability
3. **Link to Economic Outcomes:**
   - Develop tools that calculate the economic impact of dry matter and fresh biomass availability, such as forage production costs, livestock productivity, and potential savings from reduced supplemental feeding.
4. **Enable Scenario Simulations:**
   - Provide simulations for different management strategies (e.g., grazing intensity, irrigation) to predict their impact on dry matter and fresh biomass levels.
5. **Develop Threshold-Based Alerts:**
   - Establish thresholds for dry matter and fresh biomass levels to trigger alerts, helping farmers identify overgrazed areas or underutilized pastures.

2.4 Somatic Cell Count estimation

Fit for Use:

- **High:**
  - SCC (Somatic Cell Count) predictions are generated using precise data inputs, including individual animal health records, milk quality data, environmental factors, and seasonal trends.
  - The predictive system is reliable, accessible via user-friendly platforms (mobile or desktop), and integrates seamlessly with farm management systems.
- **Low:**
  - Predictions are based on outdated, limited, or generalized data, failing to account for regional or breed-specific differences.
  - The system has a high error rate, delays in reporting, or technical barriers, such as requiring advanced skills or high-cost infrastructure.
  - Results are delivered infrequently or are inaccessible for farmers lacking internet connectivity or advanced tools.

Fit for Purpose:

- **High:**
  - Predicted SCC aligns well with livestock health goals, enabling early detection of mastitis, improving milk quality, and optimizing treatment plans.

◦ Supports long-term strategies, such as identifying animals prone to high SCC levels, optimizing breeding programs for mastitis resistance, and improving overall livestock health sustainability.
◦ Predictions integrate with other farm metrics (e.g., milk production, feeding data, THI) for comprehensive decision-making.

- **Low:**

◦ Predictions are reactive rather than proactive, addressing immediate health concerns but failing to support broader management goals.
◦ Limited relevance to long-term planning or strategic herd improvements.
◦ Lack of integration with other indicators (e.g., environmental data or feed quality) reduces the system utility.

Based on the previous analysis, a SCC forecast service achieves both high Fit-for-Use and Fit-for-Purpose, transforming from a basic operational tool into a strategic asset for improving livestock health, productivity, and long-term farm sustainability.

Insights and Recommendations

Improving Fit for Use:

1. **Increase Data Accuracy and Resolution:**

◦ Use advanced data collection technologies like automated milking systems, wearable animal sensors, and environmental monitors to provide granular and real-time data.
◦ Regularly update and validate predictive models using local datasets tailored to regional breeds and conditions.

2. **Overcome Barriers:**

◦ Provide offline functionality or low-cost solutions for farms in remote areas or with limited resources.
◦ Offer training programs to help farmers understand and leverage predictive tools effectively.

Enhancing Fit for Purpose:

1. **Integrate with Broader Management Systems:**

◦ Combine SCC predictions with other metrics (e.g., milk yield, fat/protein content) for a holistic view of herd health and productivity.
◦ Use predictive insights to optimize feeding schedules and milking protocols.

2. **Support Long-Term Strategies:**

◦ Use predictions to identify high-risk animals or patterns, aiding in genetic selection for mastitis resistance.

- Provide trend analyses for livestock-level improvements and long-term planning, such as targeted culling or resource allocation.

3. **Align with Economic and Sustainability Goals:**

- Quantify the financial benefits of reduced SCC through predictions (e.g., less discarded milk, lower treatment costs).
- Promote sustainability by linking SCC improvements to reduced antibiotic use and enhanced animal welfare.

2.5 Blue tongue spread in Sardinia

Fit for Use:

- **High:**
  - Predictive models are built using high-resolution, multi-source datasets, including climatic variables (e.g., temperature, humidity, rainfall), vector distribution, and livestock density.
  - The models are validated with historical outbreak data and regularly updated with the latest information to reflect evolving environmental and epidemiological conditions.
  - Predictions are easily accessible through intuitive platforms or applications that deliver actionable information to stakeholders, including farmers, veterinarians, and policymakers.
- **Low:**
  - Models rely on incomplete or outdated datasets, leading to inaccurate predictions.
  - Predictions lack spatial or temporal precision, providing generalized risk assessments that are less useful for targeted interventions.
  - Accessibility is hindered by overly complex systems, making it difficult for end users to interpret or act on the data effectively.

Fit for Purpose:

- **High:**
  - Predictive models align well with the strategic goals of mitigating disease risks, protecting animal health, and ensuring livestock productivity.
  - Forecasts support proactive measures, such as vaccination campaigns, vector control, and livestock movement planning, in line with long-term sustainability and resilience goals.
- **Low:**
  - Predictions are primarily reactive, addressing immediate outbreaks rather than supporting long-term planning or prevention strategies.
  - Lack of integration with broader livestock management or environmental sustainability goals limits their strategic utility.

Based on the previous analysis, a predictive model for Blue tongue spread achieves both high Fit-for-Use and Fit-for-Purpose representing a cornerstone of proactive livestock health management. This model not only addresses the immediate challenges posed by vector-borne diseases but also aligns with broader goals of sustainability, resilience, and socio-economic well-being.

With advancements in data integration, model resolution, and stakeholder accessibility, these predictions can help mitigate risks effectively, safeguard animal health, and strengthen the resilience of livestock systems against emerging challenges in a changing climate.

Enhancing Fit for Purpose:

1. **Align Predictions with Proactive Strategies:**
    - Incorporate risk assessments into national and regional livestock health policies for coordinated action.
    - Combine Blue tongue spread predictions with other livestock health and environmental indices to develop a broader management strategy.
    - Evaluate long-term climate adaptation scenarios to mitigate vector proliferation and disease risks effectively.
2. **Provide Socio-Economic Context:**
    - Offer cost-benefit analyses of preventive measures, helping stakeholders allocate resources efficiently.
    - Address the potential economic impacts of disease outbreaks on trade, productivity, and livelihoods to emphasize the value of early interventions.
3. **Enable Scenario Simulations:**
    - Develop tools to simulate the impact of various mitigation strategies (e.g., vector control intensity, vaccination rates) under different climate scenarios.
    - Provide region-specific recommendations based on simulation outputs, helping stakeholders tailor their responses to local conditions.

3. CONCLUSIONS

The SEBASTIEN project represents a transformative opportunity to revolutionize livestock farming through the implementation of ICT-based services that are tailored to meet the demands of a rapidly evolving agricultural landscape. By leveraging the Fit-to-Use and Fit-to-Purpose frameworks, the evaluation of indices such as THI (Temperature Humidity Index), milk yield and composition, pasture dry mass and fresh biomass, and SCC (Somatic Cell Count) and blue tongue spread underscores the potential for these tools to enhance decision-making and promote sustainable practices.

The matrices developed for these indices demonstrate the robustness of the project's approach:

1. **THI Analysis:** Provides actionable insights to mitigate heat stress impacts, optimize animal welfare, and support adaptive strategies for climate variability.
2. **Milk Yield and Composition:** Enables precise management of milk production, protein, and fat content, aligning operational decisions with strategic goals for quality and profitability.
3. **Pasture Biomass Evaluation:** Offers critical data for optimizing grazing management, improving pasture sustainability, and ensuring effective resource utilization.
4. **SCC Evaluation:** Facilitates early detection of health issues, improves milk quality, and contributes to long-term herd health strategies.
5. **Blue tongue Spread Prediction**: Delivers predictive insights to manage and mitigate the risks of disease outbreaks, particularly under changing climatic conditions. This allows for targeted vaccination campaigns, improved vector control, and the implementation of biosecurity measures tailored to regional needs.

These evaluations demonstrate a dual advantage: the indices are technically robust and practical for operational use (Fit-to-Use) while simultaneously aligning with strategic, socio-economic, and environmental goals (Fit-to-Purpose). The integration of these indices into SEBASTIEN's ICT-based framework ensures that farmers and stakeholders are empowered with precise, timely, and actionable data.

By aligning advanced data analytics, cloud computing, and high-performance computing (HPC) with the needs of smart livestock farming, SEBASTIEN sets a benchmark for innovation in the sector. These tools not only address the challenges of climate change, environmental stressors, and anthropogenic pressures but also seize the opportunities these factors present to reshape the future of livestock management.

The positive evaluation of the Fit-to-Use and Fit-to-Purpose matrices confirms the strategic relevance and operational viability of SEBASTIEN's indices, marking a significant step forward in achieving environmentally and socio-economically sustainable livestock farming.