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PRIMA SCALA-MEDI

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

Deliverable D9.7

Report on exploitation of opportunities

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Lead contractor: UCSC

Partners involved: All SCALA-MEDI partners

Dissemination level: PU (public)

The SCALA-MEDI project has generated a set of tangible outputs (datasets, biological samples, standard operating procedures, analytical workflows, and stakeholder networks) and structural outcomes (capacity building and strengthened collaboration among Mediterranean partners). Exploitation of SCALA-MEDI outputs is intended in a broad sense, i.e., the use of project results by consortium partners and external stakeholders to deliver scientific, technical, socio-economic and policy impacts beyond the project lifetime. The opportunities outlined below are consistent with the Dissemination and Exploitation Plan (D9.1) and build on outputs generated across the technical work packages.

1. Breeding centres and sustainable breeding programmes

A core exploitation opportunity is the consolidation of breeding centres and coordinated breeding structures for local sheep and chicken genetic resources. Building on the project's phenotyping, genotyping and management guidelines, partners can support national and regional actors in establishing operational schemes for selecting and disseminating improved breeding stock while safeguarding within-breed diversity. In practice, this can be implemented by public breeding services, farmer associations and cooperatives, and public-private partnerships with hatcheries, multipliers and veterinary services. SCALA-MEDI knowledge provides the technical foundations to move from ad hoc improvement efforts to programmes with clear objectives, traceability, data recording, and monitoring of genetic progress and inbreeding.

2. Genomic selection in sheep reference flocks

The reference flocks developed and characterised within SCALA-MEDI are a strategic asset for genomic selection in Mediterranean sheep systems. The exploitation route includes (i) maintaining and expanding the reference population, (ii) continuing phenotype recording under relevant environmental conditions, and (iii) using genomic data to generate estimated breeding values and selection indices that explicitly integrate resilience and adaptation traits alongside productivity. This infrastructure can be leveraged in follow-up projects, national breeding programmes and service-oriented activities (e.g., genotyping services for breeding organisations), enabling a faster and more robust response to climate and market pressures.

3. Sensors and precision phenotyping as enabling technologies

SCALA-MEDI has developed sensors and field-deployable technologies to capture phenotypes that are difficult, expensive to measure or that can only be recorded infrequently with traditional

techniques. The sensor toolkit developed, field-validated on sheep in Sardinia (Monastir, AGRIS), includes solutions to continuously record body temperature (sub-cutaneous RFID microchips and surface temperature), heart-beat rate, movement and position, and related environmental variables. The project developed an interoperable data architecture for sensor data acquisition, storage and visualisation (including dashboards for end users), which can be reused in other livestock contexts. Post-project exploitation may take the form of (i) research and extension services for resilience monitoring and management advice, (ii) integration into breeding schemes as a source of improved phenotypes for selection, and (iii) further sensor development to reduce device size, improve ruggedness, provide alternative connectivity such as LoRa where 4G/NB-IoT coverage is weak, and integration into existing animal tags to support wider uptake. For poultry, SCALA-MEDI initiated miniaturisation and adaptation of the sensor approach to the needs of local chicken systems, enabling future exploitation through technology development.

4. Genetic markers and decision-support for breeding

Markers and genomic regions associated with adaptation, can be exploited as components of breeding tools. Depending on the trait architecture and the level of validation, exploitation opportunities include marker-informed management and mating decisions and genomic prediction for multi-trait selection indices that explicitly include resilience and adaptation. SCALA-MEDI analyses identified candidate genotype-environment associations in both species. For example, in sheep a locus mapped to HMGA2, a gene already known to influence growth and body size traits that under harsh environments, was associated with adaptation to climatic variability, specifically seasonal precipitation. In chickens, a set of climate-associated loci were linked to host-pathogen interactions, development and fertility (e.g., MXRA8, EGFR, CUL1, PLD6), providing a starting point for further validation and for the design of reduced marker panels on which to base decision rules. Exploitation requires clear governance: defining which results can be released as open knowledge and which elements (e.g., curated panels, software implementations, training materials) can be packaged as services by partner institutions.

5. Online tools, portals and reusable digital assets

SCALA-MEDI developed portable digital tools can be exploited to reduce transcription errors and standardise field data collection across countries. The ODK suite was used for questionnaires and on-farm records, while OwnCloud supported secure document sharing and controlled access among

partners. A key SCALA-MEDI exploitable output is the project Data Lake, which provides a controlled-access environment to store and retrieve structured and unstructured materials produced by the project (e.g., phenotypes, genotypes and sequencing files, socio-economic datasets, climatic layers, sensor streams, protocols and reports), while supporting harmonisation and quality control. Beyond the project, partners can maintain the portal and repository as a reference point for stakeholders, host updated materials (protocols, training content, policy briefs) and provide decision-support tools (e.g., guidance on sampling, recording, and interpretation of results). Where appropriate, parts of the software stack and workflows can be released as open resources to facilitate uptake in future research and innovation actions, while sensitive data remain governed by the project data management and access rules. The Data Lake aggregates non-structured resources (documents, images and photos) and is complemented by a structured database to store datasets and metadata in a form that is easier to query and reuse. The repository includes phenotypes geo-referenced sampling information with farm structure and management descriptors, WorldClim climatic layers, socio-economic survey datasets, DNA quality information and the project SOPs. These combined resources can be exploitated in follow-up research, training and decision support, provided that access rules and privacy constraints are respected.

6. National multi-actor platforms linking research and production

The project has fostered exchanges among research organisations, breeding services, farmers, veterinarians, value-chain actors and policy-makers. A concrete exploitation action is the formalisation of these interactions into national multi-actor platforms that continue after project end, with periodic meetings focused on priorities including breeding objectives, data recording, animal health, market requirements and product valorisation. Such platforms reduce fragmentation and speed up the transfer of knowledge and technology to the field.

7. Scientific collaboration and biobank networking across the Mediterranean

The geo-referenced biological material collected across diverse and extreme environments is a long-term asset. Exploitation relies on ensuring quality-controlled storage, clear governance rules, and conditions for access and reuse, including harmonised material transfer arrangements when needed. SCALA-MEDI encouraged the alignment of national biobanking initiatives and the creation of a Mediterranean network that can interact with existing European and international infrastructures.

This networking enables future comparative studies, method standardisation, and more efficient mobilisation of resources for follow-up research and innovation.

8. Benchmarking socio-economic data and actionable recommendations

The socio-economic work (value chain analysis, stakeholder mapping, and surveys) can be exploited through evidence-based recommendations supporting policy and investment decisions. Key outputs include benchmark indicators, identification of bottlenecks and leverage points, and context-specific suggestions to improve organisation, market access, product differentiation and resilience of local farming systems. These results can be translated into policy briefs and practical guidance for extension services and farmer organisations.

9. SOPs and data collection tools for future projects and services

SCALA-MEDI has developed and tested standard operating procedures (SOPs) for sampling, data management and socio-economic data collection. These SOPs are immediately exploitable as 'ready-to-use' tools for new projects, national programmes and training activities, supporting harmonisation and comparability across sites and countries. Reuse of SOPs reduces start-up time, improves data quality, and facilitates interoperability when datasets are integrated or compared.

10. Scientific publications and long-term dissemination

Peer-reviewed publications, conference contributions and public-oriented communication will continue beyond the formal project end. This is an essential exploitation pathway to maximise scientific impact, ensure visibility of local genetic resources and production systems, and create the basis for new collaborations and funded initiatives. In addition to scientific outputs, WP9 activities created a durable communication infrastructure (project website, newsletters, social channels and public events) that can be reused to keep stakeholders informed as results mature into operational breeding tools. The consortium will continue leveraging the channels and governance mechanisms defined in the Dissemination and Exploitation Plan (D9.1) to maintain momentum, support technology transfer, and stimulate uptake by farmers, breeding services and policy actors.

11. Analytical pipelines and reproducible workflows

The analytical pipelines developed within the project are reusable, reproducible workflows for multi-omics, genomics, sensor data and socio-economic analyses that can be exploited in further research and development. For example, landscape-phenomics workflows are implemented in R-

Markdown to support transparent reporting and reproducibility, while epigenomic RRBS analyses were organised as modular pipelines (e.g., nf-core/methylseq in Nextflow) run through container platforms to simplify deployment across platforms. In practice, this approach combines standard quality control and trimming, dedicated bisulfite-aware alignment and methylation calling, and downstream differential methylation analyses in a documented, version-controlled environment. By maintaining documentation, parameter transparency and versioning, users can apply these pipelines to additional datasets and make them available for training and capacity building. This strengthens methodological consistency and accelerates the analysis-to-impact cycle in follow-up actions.

12. Capacity building as a durable asset

Training activities carried out during SCALA-MEDI (for young researchers, technicians and stakeholders) have generated competencies that persist beyond the project. The training portfolio covered both enabling tools (e.g., ODK-based field data capture and harmonised sampling procedures) and advanced scientific workflows (genomics, cryopreservation, sensor-based phenotyping, epigenetics and bioinformatic/statistical analyses). A practical exploitation route is to reuse the developed training materials and recordings (stored within the consortium repositories) to repeat and scale modules, embed them into academic curricula, and offer targeted sessions for practitioners (farmers, veterinarians, breeding organisations). This human-capital component is central to the sustainability of any breeding, data and innovation infrastructure established through the project.

Conclusion

Overall, SCALA-MEDI exploitation is expected to occur through a combination of institutional uptake (breeding services, research infrastructures), stakeholder-driven adoption (farmers and value-chain actors), and continued research and innovation actions that build on SCALA-MEDI assets. The Data Lake hosted at the University of Tuscia, which will be maintained through 2028, provides a mechanism to preserve and reuse datasets and documentation. In longer-term sustainability will be achieved by depositing the curated datasets in appropriate public repositories, continued maintenance of key tools, and the consolidation of breeding and stakeholder structures created during the project. WP8 results and tools will provide additional decision-support outputs that can further strengthen exploitation and uptake in operational settings. Exploitation should

therefore be viewed as a portfolio of pathways, combining open-science outputs with practical services and capacity building tailored to Mediterranean production systems.