

SUSTAINABLE ENVIRONMENTAL MANAGEMENT IN SHEEP-FARMING AREAS

Maria SAUER

Ioan PETROMAN

I. ȚIBRU

Daniela VĂLUȘESCU

Ana Gina ARMAȘ

Iulia MUNTEANU

Abstract: This paper presents a few approaches of sustainable environmental management in sheep-farming areas according to ATTRA (Appropriate Technology Transfer for Rural Areas, a trusted source of sustainable agriculture information). It presents the principles governing this type of management – climate change mitigation, conservation of natural resources, environment education and awareness, prevention of pollution, sustainable development, and waste management. Applied in sheep farming, these principles – which concern animal welfare, energy efficiency, genetic selection, grazing management, soil health, and water management – are illustrated with concrete examples provided in the references.

Keywords: sustainability, environment, management, sheep, farming, ATTRA

INTRODUCTION

Sustainable Environmental Management refers to the practice of managing human activities meant to ensure the responsible use of natural resources and the protection of the ecosystems for future generations through **economic, environmental, and social considerations** aiming at fostering long-term solutions for the preservation of the environment aiming at ensuring a healthy, thriving planet for generations to come. Thus, sustainable environmental management aims at creating a harmonious relationship between humans and nature through principles such as:

- **Climate change mitigation** refers to the implementation of measures meant to reduce greenhouse gas emissions and to enhance resilience to the impacts of climate change. Key strategies:
 - *Implementing specific incentives, policy, and regulations*, i.e., promoting low-carbon practices and technologies (e.g., carbon pricing, emissions trading systems, renewable energy mandates);
 - *Practicing a sustainable agriculture*, i.e., producing food and agricultural products while ensuring economic viability, improving

farmers' quality of life, and protecting the environment, through agroforestry, conservation tillage, crop rotation, integrated pest management, organic farming, and water management. (Petroman I. et al 2012)

- ***Practicing a sustainable forestry***, i.e., managing forest resources to produce paper, timber, and other forest products while maintaining the health and diversity of forest ecosystems, through afforestation and reforestation, ecosystem-based management, forest certification, reduced-impact logging, and selective logging;
 - ***Reducing emissions***, i.e., implementing measures to cut down on CO₂ and other greenhouse gas emissions from various sectors (e.g., agriculture, energy, industry, and transportations);
 - ***Renewing energy***, i.e., promoting the use of renewable energy sources such as geothermal, hydro, solar, and wind, which produce little to no greenhouse gases;
 - ***Sequestering carbon***, i.e., capturing and storing CO₂ from the atmosphere or emissions sources (e.g., power plants) through techniques such as afforestation carbon capture and storage technology, and reforestation;
 - ***Streamlining energy***, i.e., enhancing the efficiency of appliances, buildings, industrial processes, and vehicles to reduce energy consumption and emissions.
- **Conservation of natural resources** refers to the efficient use and protection of natural resources (biodiversity, soil, and water). Key strategies:
- ***Education and awareness***, i.e., educating people about the importance of conserving and encouraging sustainable practices;
 - ***Protection***, i.e., safeguarding biodiversity, ecosystems, and habitats from overexploitation and pollution; (Petroman I. & Petroman C. 2010)
 - ***Restoration***, i.e., repairing ecosystems and restoring them to their natural state;
 - ***Sustainable use***, i.e., using natural resources at a rate allowing them to regenerate.
- **Environment education and awareness** refers to the education of both individuals and communities about the importance of environmental protection and sustainable practices. Key strategies:
- ***Action and participation***, i.e., motivating individuals and communities to participate in environmental protection activities (e.g., advocacy, conservation efforts, and recycling);
 - ***Attitudes and values***, i.e., encouraging respect and responsibility toward the environment;

- ***Informed decision-making***, i.e., enabling people to make informed choices that consider the impact on the environment of their actions (e.g., at home, at work, in the community);
- ***Knowledge and skills***, i.e., teaching about biodiversity, climate change, ecosystems, pollution, and resource management, and equipping people with practical skills to address environmental issues.
- **Prevention of pollution** refers to the reduction of emissions of pollutants to air, land, and water, and to the minimization of the environmental impact. Key strategies:
 - ***Adopting policies and regulations***, i.e., implementing and enforcing laws and regulations limiting the amount of air, soil, and water pollutants;
 - ***Developing and using technological innovation***, i.e., technologies that reduce pollution (e.g., cleaner production methods, energy-efficient appliances, pollution control devices);
 - ***Embracing sustainable practices***, i.e., adopting eco-friendly practices in agriculture, daily life, and industry through the use of renewable energy sources and sustainable farming techniques;
 - ***Making people aware***, i.e., educating and informing people about the importance of pollution prevention and encouraging them to adopt environmentally responsible behaviours;
 - ***Reducing waste***, i.e., minimizing waste generation through composting, recycling, and using reusable products.
- **Sustainable development** refers to the promotion of economic development that meets present needs without preventing future generations to meet their own needs. Key strategies:
 - ***Economic growth***, i.e., promoting economic practices that lead to improved life quality and prosperity, while ensuring that they do not deplete natural resources;
 - ***Environmental protection***, i.e., conserving natural resources, mitigating the impact of climate change, and protecting ecosystems through sustainable practices in agriculture, industry, and urban development;
 - ***Social inclusion***, i.e., ensuring that people have access to basic resources, opportunities, and services (e.g., education, employment, healthcare) and reducing inequalities through the promotion of social justice.
- **Waste management** refers to the implementation of practices meant to recycle, reduce, and reuse waste materials. Key strategies:
 - ***Collection and transportation***, i.e., gathering waste from businesses, homes, and other sources and transporting it to treatment facilities;

- **Disposal**, i.e., safely dumping waste that cannot be recycled or treated in a way that protects the environment;
- **Recycling and reuse**, i.e., recovering useful materials from waste and reprocessing them into new products while reducing the need for raw materials and conserving natural resources;
- **Reduction**, i.e., decreasing the amount of waste through designing products with less packaging, encouraging the use of reusable items, and promoting sustainable consumption habits;
- **Treatment**, i.e., processing waste to reduce its volume and toxicity through composting, incineration, and recycling.

MATERIAL AND METHOD

The material used in this study consists of ATTRA (Appropriate Technology Transfer for Rural Areas, a trusted source of sustainable agriculture information) articles on *the sustainable environmental management in sheep-farming areas*, and the research method consists of analysing the content of the results presented in these researches.

RESULTS AND DISCUSSION

The sustainable environmental management in sheep-farming areas involves practices that ensure the economic viability of the sheep farm, land protection, and the well-being of the sheep, with focus on the following aspects:

- **Animal welfare**, i.e., ensuring the ethical treatment of sheep, aligned with sustainable farming practices. Key strategies:
 - **Behavioural needs**, i.e., allowing sheep to express natural behaviours (e.g., grazing, moving, socializing) to promote mental and physical stimulation;
 - **Ethical practices**, i.e., avoiding practices that cause unnecessary distress or pain (mutilating while lambing or shearing) and ensuring careful, humane procedures;
 - **Handling and transport**, i.e., minimizing stress, using low-stress handling techniques, and ensuring comfortable, safe transport conditions by being calm and patient, being careful of horns and sudden movements, moving slowly and deliberately, not probing or forcing livestock, restraining sheep (holding them under the chin, with a halter, against a fence or gate, or straddling them), and talking softly and in a low tone (Hale & Coffey, 2010; Coffey & Hale, 2021, Vrtosu & all, 2019);
 - **Health management**, i.e., monitoring sheep for signs of illness or injury and providing good nutrition, pasture management, regular veterinary care; selecting resistant animals (Coffey, 2012, 2017), providing treatments (Coffey, Reynolds & Hale, 2020; Coffey, 2021) – administering alternative treatments to treat coccidiosis

(Coffey, 2014, Văduva & all 2013); administering botanicals (Coffey, 2012); administering copper oxide wire particles to control barber pole worm, *Haemonchus contortus*, in sheep as an effective component of a ***holistic parasite management strategy*** (Hale *et al.*, 2007; Rinehart, 2008b; Hale & Coffey, 2010; Hale, 2015); administering sulpha drugs or amprolium to treat coccidiosis (Coffey, 2014); feeding high-tannin forage species such as *Sericea lespedeza* to control internal parasites in sheep (Coffey *et al.*, 2007); feeding ionophores to treat coccidiosis (Coffey, 2014) – and providing vaccinations to prevent and manage diseases;

- ***Housing***, i.e., ensuring that sheep have proper shelter (e.g., clean, dry, spacious) to protect from extreme weather conditions, predators, and other potential threats (Coffey, Reynolds & Hale, 2020);
- ***Nutrition***, i.e., providing a balanced diet (e.g., access to clean water and high-quality feed / forage) that meets the nutritional needs of sheep no matter the stage of their life, observing the following principles of ruminant nutrition: adequate quantities of green forage can supply most of the energy and protein ruminants need; excessive supplementation may reduce the ability of the rumen microbes to use forage; farmers need to feed the rumen microbes to maintain ruminant health and productivity; forage nutritional composition changes depending on grazing system, moisture, plant maturity, season, and species; ruminant nutritional needs change depending on age, stage of production, and weather; ruminants are adapted to use forage because of microbes in their rumen; supplementation may be necessary when grass is dormant, short, too mature, or if animal needs require it (Rinehart, 2008b, 2020).
- ***Energy efficiency***, i.e., reducing the carbon footprint by using energy-efficient practices (e.g., installing solar panels, using energy-efficient lighting, using proper insulation methods). Key strategies:
 - ***Efficient equipment***, i.e., using energy-efficient equipment and machinery (e.g., efficient water pumps, energy-saving lighting systems, insulated buildings) to reduce energy consumption;
 - ***Energy audits***, i.e., conducting energy audits to identify areas where energy use can be optimised or reduced, to improve energy efficiency, and to reduce costs;
 - ***Maintenance***, i.e., securing regular maintenance of equipment, machinery, and infrastructure to ensure efficient operation and energy saving;
 - ***Renewable energy***, i.e., installing renewable energy sources (e.g., solar panels, wind turbines) to power farm operations (e.g., heating, lighting, machinery);

- ***Sustainable practices***, i.e., implementing practices (e.g., rotational grazing) that improve soil health, reduce the need for chemical fertilisers, and reduce the need for energy-intensive inputs (Coffey, 2017; Rinehart, 2020);
- ***Water management***, i.e., using efficient irrigation systems (e.g., drip irrigation).
- **Genetic selection**, i.e., improving the flock through genetic selection to yield animals that are more resistant to diseases and environmental stress, and reducing reliance on chemical treatments (Hale & Coffey, 2010; Coffey, 2017; Coffey, Reynolds & Hale, 2020). Key strategies:
 - ***Adaptability***, i.e., selecting sheep well-suited to specific environmental conditions (e.g., climate, pasture availability);
 - ***Health and disease resistance***, i.e., selecting sheep resistant to common diseases (Hale & Coffey, 2010; Coffey, 2017);
 - ***Meat production***, i.e., choosing sheep with favourable traits for meat production (e.g., better muscle development, efficient feed conversion, faster growth rates);
 - ***Reproductive performance***, i.e., enhancing traits (fertility, lambing ease, maternal instincts) to ensure large numbers of healthy offspring;
 - ***Wool quality***, i.e., breeding sheep with higher quality wool (e.g., fibre length, fineness, strength).
- **Grazing management**, i.e., implementing rotational grazing systems to prevent overgrazing and soil erosion, and to maintain pasture biodiversity by moving the sheep from pasture to pasture to allow vegetation regeneration (Coffey, 2017). Key strategies:
 - ***Pasture management***, i.e., improving and maintaining pasture quality through fertilization, reseeding, and weed control to make it correctly stocked, dense, digestible, diverse, familiar to the animal, fresh, palatable, and plentiful (Rinehart, 2008b) by maintaining proper forage height, maintaining proper stocking rate, maintaining some “clean grazing” areas, managing problem areas, offering diverse forages and browse, using leader-follower grazing, using multispecies grazing, and using rotational grazing with long rest periods (Coffey & Hale, 2012; Rinehart, 2018, 2020);
 - ***Rotational grazing***, i.e., moving sheep between different pastures to allow vegetation to recover, maintain its nutritional quality, and prevent overgrazing (Coffey, 2017; Rinehart, 2020);
 - ***Seasonal management***, i.e., adjusting grazing practices to make the best use of forage appropriate minerals, appropriate supplementation, availability, density, diversity, intake, quality, and quantity, throughout the year (Rinehart, 2008b);

- **Soil health**, i.e., monitoring and managing soil to prevent compaction, erosion, and nutrient depletion;
- **Stocking rate**, i.e., determining the optimal number of sheep that can graze on a pasture without damaging it;
- **Water supply**, i.e., ensuring that sheep have access to clean sufficient water in grazing areas.
- **Soil health**, i.e., preserving soil structure and fertility by avoiding overstocking, cover cropping, minimizing mechanical tilling, and using organic fertilisers (e.g., composted sheep manure). Key strategies:
 - **Erosion control**, i.e., maintaining ground cover through erosion control structures and practicing rotational grazing (Rinehart, 2020);
 - **Microbial activity**, i.e., supporting an active, diverse soil microbial community to promote disease suppression and nutrient cycling, and practicing rotational grazing (Scott, 2018; Scott & Prater, 2018; Rinehart, 2020);
 - **Nutrient balance**, i.e., maintaining a proper balance of nutrients through proper fertilization, soil testing, and use of organic amendments (e.g., compost);
 - **pH level**, i.e., managing soil pH (e.g., with lime, sulphur) to keep it within the optimal range for plant growth;
 - **Soil organic matter**, i.e., increasing it by incorporating compost, cover crops, and manure, which results in better water infiltration; decreased crusting; fixation of atmospheric nitrogen; granulation of soil particles into water-stable aggregates; improved internal drainage; increased water and nutrient storage capacity; release of bound nutrients (Rinehart, 2008b);
 - **Soil structure**, i.e., ensuring good soil structure to support root growth and water infiltration.
- **Water management**, i.e., using water efficiently through drip irrigation, maintaining natural watercourses, and rainwater harvesting systems. Key strategies:
 - **Ecosystem protection**, i.e., ensuring that water management practices support the health of aquatic ecosystems and biodiversity through maintaining natural water flows and protecting wetland and rivers;
 - **Flood and drought management**, i.e., developing strategies to mitigate the impacts of extreme weather conditions through building flood defences, creating emergency response plans, and implementing drought-tolerant farming practices;
 - **Infrastructure development**, i.e., building and maintaining infrastructure (e.g., dams, distribution, reservoirs) to store, supply, and transport water efficiently;

- **Water allocation**, i.e., distributing resources equitably among the users (e.g., agriculture, environment, households, industry) through the management of water rights and the securing of fair access to water;
- **Water conservation**, i.e., implementing measures to reduce both water usage and water waste through fixing leaks, irrigation techniques, and water-saving appliances;
- **Water quality**, i.e., monitoring and managing the quality of water resources to ensure safe drinking water and prevent pollution through controlling pollutants from agricultural runoff, industrial discharges, and sewage treatment.

CONCLUSIONS

The key aspects of sustainable environmental management in sheep-farming areas according to ATTRA authors are: adaptive grazing; managing internal parasites in sheep – with emphasis on *alternative treatments, animal selection, effective use of dewormers, novel treatments, pasture management, selecting deworming, selecting resistant animals, and tannins*; multispecies grazing; nutrient cycling; sheep nutrition; sheep organic production; and sheep sustainable production – all of which are strongly intertwined.

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NOTES ON THE AUTHORS

Maria SAUER, Sheep and Goat Breeding Research and Development Station Caransebes, e-mail: scdocsb@yahoo.com

Ioan PETROMAN, Sheep and Goat Breeding Research and Development Station Caransebes, e-mail: ioan_petroman@yahoo.com

Ioan ȚIBRU, Sheep and Goat Breeding Research and Development Station Caransebes, e-mail: tibru_ioan@yahoo.com

Daniela VĂLUȘESCU, Sheep and Goat Breeding Research and Development Station Caransebes, e-mail: danavalusescu@gmail.com

Ana Gina ARMAȘ, Sheep and Goat Breeding Research and Development Station Caransebes, e-mail: gina_trica90@yahoo.com

Iulia MUNTEANU, Sheep and Goat Breeding Research and Development Station Caransebes, e-mail: scdocsb@yahoo.com