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Perspectives on Conservation Strategies and Survivorship Potentials Amongst Human, Birds, and Some Domestic Animals in the Eastern Province of Rwanda

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Abstract

Some communities live for decades with diverse populations of humans, birds, domestic animals and plant species interacting among themselves and the environment. In the Eastern Province of Rwanda, this is a common agricultural practice (agrosilvopastoralism). Causal observation was conducted across the province, and some domestic animals listed include cattle, goats, poultry, fisheries, rabbits and sheep, and some the crops documented include beans, cassava, carrots, onions, pepper, sugarcane while tree species include *Calliandra calothyrsus*, *Grevillea robusta*, *Leucaena leucocephala*, *Eucalyptus camaldulensis*, *Eucalyptus grandis*, *Erythrina abyssinica*, *Tithonia diversifolia*, *Maesopsis eminii*. Humans as higher animals have the strongest adaptation capacities, with the potentials to manipulate other populations through innovations. Domestic animals and crops are rated with high survivability potentials because of the protection and support given by humans through agricultural practice and research enforcement; however, they are vulnerable to epidemics. Tree species have high survivorship potential due to environmental protection laws while birds are rated moderate depending on the species (species-specific) and are sometimes highly vulnerable due migration. The long-term impacts of these interrelationships on the biophysical environment, socio-economic and even the health of the people and the co-inhabitant needs of be documented empirically. It is therefore important to investigate the ecological implications of such decades of coexistence. This research perspective is therefore a genuine quest to propose approaches that could be used in investigating in details, the long-term impacts of the agrosilvopastoralism on the livelihood of the community. A suggestive Hypothetical Research Approach (HRA) was designed whereby the General Objectives (GO) 1-6, and the Specific Objectives (SO) A-D could be deployed in answering the Research Questions (R1-R6). This is necessary in order to strategically respond quickly to any eventualities arising from any practical shift in ecological domains due to shock and consequent surprises (climate change, disease, flood, fire, etc.) among the interacting components within the community.

Keywords: Agricultural practices; Community; Conservation; Environment; Rwanda; Survivorship

Introduction

Agrosilvopastoralism is a dynamic integrated land-use system that deliberately combines the cultivation of trees and shrubs (silviculture), food and cash crop production (agriculture), and the raising of livestock

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(pastoralism) within the same spatial unit and/or temporal sequence [1]. This farming practice creates interconnected relationship between the components of the ecosystems. While there are numerous ecological niches overlap between human-eccentric goals and some domestic animals (pigs, goats, cattle, poultry), wildlife (especially bird species) and almost all other life forms directly and indirectly. The priorities sometimes remain uncertain, especially in such complex interrelationships, particularly, with arid-adapted species, which are often assumed to be resilient, but may be highly susceptible to climate warming due to their proximity to physiological tolerance limits [2,3].This coexistence creates opportunities for various communities (biotic - the living components and the abiotic- the non-living components) of the ecosystems to interact between and among themselves. Consequently, biogeochemical cycles are formed, and the outcome from these cycles could improve the livelihood of the community, and sometimes, even exacerbate climate change, support disease outbreak, enhance global warming and even escalate flood with many other diverse negative outcomes [4].

Traditionally, the practice of agrosilvopastoralism is envisaged to overcome these numerous negative consequences, through the application of climate resilient agricultural practices such as agroforestry, reforestation, bench terraces, animal husbandry and restoration of pasturelands at a large scale. Proper management of homestead farms at micro levels is necessary, and the real time impacts of these practices on humans and the entire system over such a long period of time needs to be investigated [5]. However, these are not always the priorities.

Over the decades, it is recorded that the primary bottleneck confronting the region include crop raiding, livestock depredation, disease transmission, and other crisis driven by competition for resources such as water, land, among other resources, which directly or indirectly impact the survivorship of humans, birds, and domestic animals [6]. Also. it is pertinent to note that human-wildlife conflicts involve some negative interplay where wildlife endangers human safety. For instant, in Kayonza district, Due to the proximity to Akagera National Park, it creates both constraints and opportunities for agrosilvopastoral development [7]. On one hand, human-wildlife conflict particularly with elephants (*Loxodonta. africana*), hippopothamus (*Hippopotamus amphibius*), and crop-raiding primates, and on the other hand agroforestry [7]. In other places, due to habitat loss, resources splitting , wildlife raids crops within the communities, the practice is not encouraged, therefore coexistence requires strategies through education, habitat management, and collaborative solutions to balance conservation with human needs within the farm settlement [2,8,9].

In Rwanda, ecofriendly agricultural systems are in practice [10], and some communities cohabit in common space and time (temporal and spatial scales) with other animals within the Eastern Province of Rwanda. Consequently, it was observed that some parts of the landscapes are diversified with clear pictures of landscape restoration and resilient with agricultural practices such as agroforestry and Silvopastoralism [11]. In the seven (7) Districts of Eastern Province of Rwanda, Agrosilvopastoral systems of agriculture is majorly in practice by the majority of the inhabitants [12]. This was aimed at building communities that are resilient to climate change, global warming, flood and other disasters, while providing food security. These practices over years have influenced the biogeochemical cycles and even the ecological systems of these localities.

In the context of this research perspective, there could be possible changes in ecological dynamics and subsequent changes could occur in the ecosystem domains across various ecological niches [13]. These interactions among the components of the ecosystem could manifest in the quality of air, water, vegetation cover, economic wellbeing (livelihoods), and these could impact the health of the people and that of plants as well as that of animal species.

In this perspective, there is therefore the need to investigate the extent to which the present ecological dynamics presented by the agricultural systems practiced by the inhabitants influence these communities. These opinions could either improve or decline certain practices depending on the outcomes (negative and positive). This research perspectives therefore, proposes methods needed to be deployed in investigating the impacts of the three major domains of interest that includes biophysical environment, socio-economic and health environment on the community.

Materials and Methods

The study area

Rwanda is a landlocked country in the great lakes region of East and Central Africa, administratively composed of four provinces and the City of Kigali, and is located between 1°04′ to 2°51′ South and 28°45′ to 31°15′ East (Figure 1), and borders Uganda to the north, Burundi to the south, the Democratic Republic of Congo (DRC) to the west, and Tanzania to the east [14]. The Eastern Province is the choice for this perspective because, it is the country's largest and most populous administrative unit, covering approximately 9,813 km² (about 37% of Rwanda's territory), and also, it is a home to a predominantly agrarian population whose livelihoods depend heavily on rain-fed farming because of drought risk and extensive livestock keeping [15,16]. The semi-arid conditions, population pressure, biodiversity conservation imperatives and the demand for innovative land-use solutions encourages the practice of agrosilvopastoralism [2,3].

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These features make Eastern Province a compelling case study for examining how agrosilvopastoral land-use systems may reshape ecosystem functions (soil, water, and vegetation) and how such changes cascade into livelihood outcomes of human and animal health.

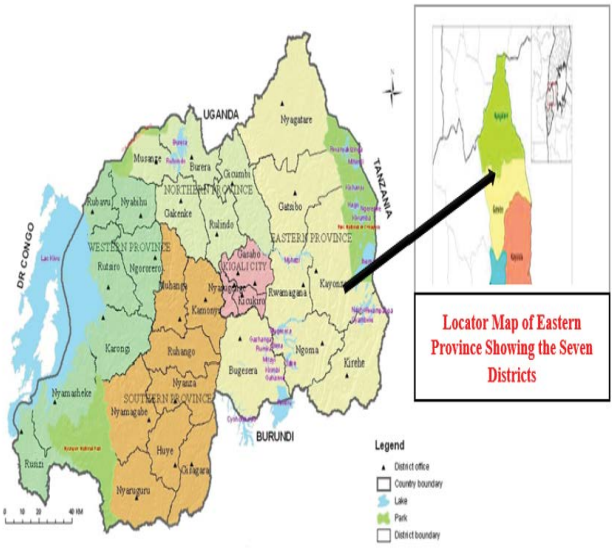

Figure 1: Map of Rwanda Showing the Provinces [17].

The study approach

In this perspective, secondary data, literatures searches, casual visits to the farms, random walk and watch along and across the length and breadth of some farmsteads [18-20] were carried out for illustrative observations. Birds heard (vocalization) and sighted were documented (Appendix B), and plant species encountered were recorded (appendix A). These recordings and illustrative observations were not conducted in any particular order; and only qualitative field outlooks were obtained. Domestic animals, crops, shrubs and tree types were listed. The objectives to be studied are aligned with proposed methods for data collection and assessment involving all environmental components such a biophysical, socio-economic, health indicators [18-20].

Results

Agrosilvopastoralism in the Eastern Province of Rwanda

Table 1 showed the names of the domestic animals, crops and shrubs/tree species documented in the agrosilvopastoral farms within the districts (Bugesera, Gatsibo, Kayonza, Kirehe, Ngoma, Nyagatare and Rwamagana) of the Eastern Province [21]. Cattle, goats, poultry, rabbits, fisheries, sheep, etc. and some crops such as maize, beans, soya beans, cassava, carrots, onions, tomato, pepper, sugarcane, Musa species (Banana) are domestic animals and crops were documented in the districts. Agroforestry tree species and some shrubs include *Grevillea robusta* (Silky Oak), *Calliandra calothyrsus* (Red Calliandra), *Leucaena leucocephala* (White Lead tree), *Eucalyptus camaldulensis* and E. *grandis* (Eucalyptus species), *Erythrina abyssinica* (Coral Tree), *Maesopsis eminii* (Musizi), *Tithonia diversifolia* (Mexican Sunflower), etc. were recorded.

Plate 1: Agrosilvopastoral practice in Gatsibo and Kayonza districts, January 2026.

Illustrative observations

Plate 1 showed pictures of the combinations of human habitats, domestic animals and plant species in spatial and temporal scales in a farm in Rwankuba village, Murambi Sector of Gatsibo and in Kayonza districts, Eastern Province, Rwanda. List of some avian and plants species documented are in Appendices A and B.

Proposed framework for research on Agrosilvopastoralism

As shown in Table 2, seven (7) Research Objectives (RO) in in terms of the Biophysical, Socio-economics and Health indicators were proposed to gear up the drive to investigate the impacts of agrosilvopastoralism on of the communities. These include identification and enumeration of (a) crops cultivated in the community (b) tree species in locality, (c) avian species in the locality, (d) enumeration of the domestic animals (pigs, goats, cattle, etc.) in the homestead farm, (e) establishment of the feeding relationships in the ecological systems, (f) evaluation of the physicochemical parameters, (f) evaluation of the ecosystem services and functions, and (g) investigation of the Social and Health Impact Assessment (SHIA). Using

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surveys, interviews, literature review, ethnobotany, periodic field observation and phenological studies for data gathering, Specific Research Questions (SRQ) poised could be addressed adequately. Such SRQ include, the ecology (reproductive strategies, distribution, composition, native and exotics) of the plant species, avian species composition (residents, local migrant, palearctic migrant, diurnal, nocturnal, seed eaters, frugivores, pollinators etc.), census and feeding needs of the domestic animals, food webs and food chains in the ecosystems, existing biogeochemical cycles to include air, water and soil qualities, ecosystems services (cultural, provisioning, supporting and regulatory services) rendered in the habitat over generations, demographics and health status of the inhabitants.

Table 1: Some domestic animals, crops and tree species cultivated in agrosilvopastoral farms the Eastern Province of Rwanda.

S/No	District (Pop and size)	Animals	Crops	Tree species (common names)
1	Bug sera (Approximately. 551,103 people and area of 1,360 km²)	Cattle, goats, poultry, rabbit, sheep and fisheries	Beans, cassava, carrots, onions, tomato, tomato tree, watermelon, pepper, sugarcane and maize	Grevillea, Mango, Avocado, Pawpaw, Calliandra, glicidia and native species (acacia ssp)
2	Gatsibo (Approximately 551,164 people and an area of 1,585.3 km²)	Cattle, goats, sheep, pigs, poultry and fisheries	Maize, beans, banana, rice, soya beans, coffee, cassava, cabbage, carrots, onions, Napier grass, Pepper and sugarcane	Grevillea, mango, Avocado, Eucalyptus, Calliandra and Native species such as Acacia, markhamia, maesopsis and Combretum
3	Kayonza (Approximately 457,156 people and an area of 1,935km²)	Cattle, goats, sheep, pigs and poultry	Maize, beans, banana, soya beans, coffee cassava, cabbage, Cassava, garden egg carrots, onions, beans, tomato and pepper	Grevillea, Calliandra, Cashew, mango, Avocado, Native species such as Acacia, markhamia and Combretum
4	Kirehe (Approximately 460,860 people and an area of 1,176 km²)	Cattle, goats, poultry, rabbit and sheep	Maize, beans, rice, banana, soya beans, Garden egg carrots, onions, pepper and tomato	Calliandra, Calliandra, Eucalyptus, Native species such as Acacia, markhamia and Combretum
5	Ngoma (Approximately 404,048 people and an area of 867.74km²)	Cattle, goats, poultry, rabbit and sheep	Maize, beans, banana, soya beans rice, eggplant carrots, onions, beans, pepper and pineapple	Grevillea, Calliandra, Eucalyptus, Leucaena, Native species such as Acacia, markhamia and maespsis
6	Nyagatare (Approximately 653,861 people and an area of 1,741 km²)	Cattle, goats, poultry, rabbit and sheep	Maize, beans, rice, soya beans Garden egg carrots, tomato, watermelon, pepper and sugarcane	Grevillea, Calliandra Eucalyptus, Leucaena, Native species such as Acacia, markhamia, maespsis and Combretum
7	Rwamagana (Approximately 484,953 people and an area of 682 km²)	Cattle, goats, poultry, rabbit and sheep	Maize, beans, soya beans, rice, banana, Cassava, garden egg carrots, onions, beans, tomato, watermelon, pepper, sugarcane, maize and eggplant	Grevillea, calliandra Sunflower, Eucalyptus

Source [21].

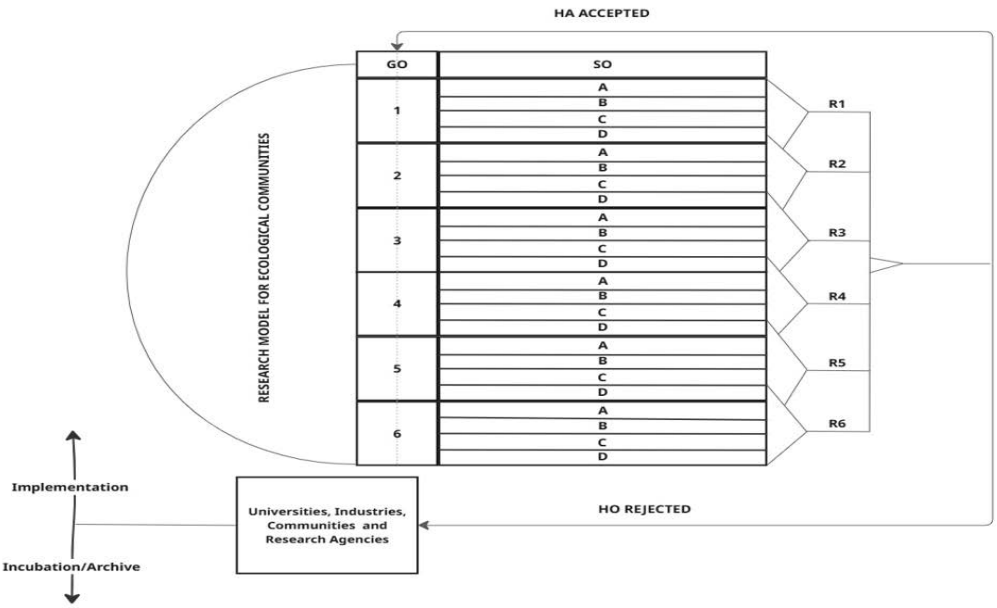

Figure 2: Proposed Illustrative Hypothetical Research Approach (HRA) for investigating outcome of agrosilvopastoral practice. (*Source: Researchers' Initiative*).

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Table 2: Proposed framework for data collection under agrosilvopastoralism.

S/No	Research Objectives (RO) Biophysical, Socio-economics and Health Indicators	Specific Research Questions (SRQ) (Specific Problems)	Proposed Methodology (Means of Investigation)
1	Identification and enumeration of crops and tree species in the community	a. What are the available plant species (native or exotic)?	*Surveys(diversity/rarity/abundance/distribution), #Interviews (FGD, Key Informant, Stakeholders, farmers), $Literature review (historical perspectives, status), %Ethnobotany (Past and present use of plant species)
		b. What are the reproductive strategies (seed or seedless)?	Periodic field observation, @phenological studies (flowers, fruits, seeds, foliage, etc.)
		c. What is the distribution of the plant species?	* Surveys, @phenological studies
		d. What is the composition of the plant species (Richness or rarity)?	* Surveys, @phenological studies
2	Identification and enumeration of avian species in the locality	a. What is the composition of the avian species in the community (residents, local migrant, palearctic migrant)?	* Surveys, observation/Identification
		b. What is the population of the avian species (diurnal and nocturnal)?	* Surveys, observations/Identification
		c. What are the feeding behaviors of the avian species (seed eaters, frugivores, pollinators etc.)?	* Surveys, observations/Identification
		d. What is the ecological niche of the individual avian species (height of forage)?	* Surveys, observations/Identification
3	Enumeration of the domestic animals (pigs, goats, cattle, etc.) in the homestead farm	a. What is the population of the domestic animal (pigs, goats, cattle, etc.) in the farm?	* Surveys, conduct animal census
		b. What are the sources of their food?	#Interviews, $Literature review, observations
		c. What kinds of food do the feed on?	#Interviews, $Literature review, Observations
4	Establishment of the feeding relationships in the ecological systems	a. What are linear and complex feeding relationship? e.g. food chain and food web	* Surveys and desktop review
5	Evaluation of the physicochemical Parameters	a. What are the biogeochemical cycles?	Sampling, laboratory analysis
		b. What is the air quality in the study? e.g. oxygen, ozone, carbon dioxide, carbon monoxide, methane, etc.	Sampling, laboratory analysis
		c. What is the nature of soil & water in the study is?	Sampling, laboratory analysis
		d. Any noise pollution?	Field observation
6	Evaluation of the ecosystem services and functions	a. What are the ecosystem services rendered by avian species and domestic animals (pigs, goats, cattle)?	*Surveys, field observation and desktop review
		b. What are the ecosystem services rendered by plant species (Cultural, provisioning, supporting and regulatory services)?	*Surveys, field observation and desktop #Interviews
		c. What are the ecosystem services rendered by human?	*Surveys, field observation and desktop review
7	Investigation of the Social and Health Impact Assessment of the inhabitants	What is the health status of the inhabitants?	*Surveys and #Interviews
		What is the demography of the inhabitants of the community?	*Surveys and field observation
		What are the available infrastructure and social amenity (clinic/hospitals, schools, roads, market etc.)?	*Surveys, field observation and #Interviews

Source: Authors,2026

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The proposed illustrative Hypothetical Research Approach (HRA)

As shown in Figure 2, a proposed illustrative Hypothetical Research Approach (HRA) was designed which can be deployed in studying the dynamics of the ecological communities that practice of agrosilvopastoralism. The components include the General Objectives (GO) that include Biophysical, Socio-economics and Health Indicators that situate within the complex investigative frameworks. The Specific Objectives (SO), looks at the elemental components or compartments which are the basic ingredients of the interactive processes involved in the nutrient recycling and flow of energy.

Discussion

Perspectives on Agrosilvopastoralism in the Eastern Province of Rwanda

Strategies for survival by plants, humans, domestic animals, birds and other terrestrial creatures cohabiting an area have evolved over time [19], with various potentials. Humans as higher animals have the strongest adaptation capacities, with the potentials to manipulate other populations with aid of innovations, science and technology. Domestic animals and crops are rated with high survivability potentials because of the protection and support given by humans through agricultural practice and research enforcement; however, they are vulnerable to epidemics. Tree species have high survivorship potential due to environmental protection laws while birds are rated moderate depending on the species (species-specific) and are sometimes highly vulnerable due migration. Birds are indicator species for ecosystem health, and their decline signals broader environmental stress [4]. The domestic animals provide food security but can degrade habitats if properly unmanaged, and it is therefore necessary to balance livestock production with preservation of the ecosystem.

Agrosilvopastoralism creates opportunities for the farm populations to interact among themselves, and the outcome could improve the livelihood of the community and, sometimes, exacerbate climate change, global warming and other worsening negative consequences [4]. Although, there are overwhelming benefits, however, there are also numerous challenges. Some of the key challenges identified as indicated in Table 3 include the pressure of population growth, competition for space, climate change and variability, habitat loss, hunting, disease, overgrazing, limited veterinary care, patchy land sizes, slash and burn and deforestation.

In order to overcome any unwholesome consequences and to ensure proper management of homestead farms, survival strategies as indicated in Table are required. These include research, provision of quality health services (e.g. veterinary services), protection of wetlands, anti-poaching, habitat restoration, integrated livestock management, crop breeding, tree planting, sustainable and climate resilient agricultural practices. Tree cover enhances ecosystems health in terms of ecological functions and services that include provisioning, regulating, supporting and cultural services [22].

Proposed framework for research on Agrosilvopastoralism

Perspectives on the Biophysical Environment

In the biophysical environment as indicated in Table 1, the required elements for investigation include air quality, level of noise and vibrations, surface water quality, groundwater quality, soil and sediment quality, access to farming and hunting grounds, hydrobiology, biodiversity (vegetation and wildlife). These elements further identify environmentally significant areas which revolve around the farm practice, habitat corridors, rare and endangered species (i.e. animals or plants and their habitats including migratory bird habitat, among other species at risk [23,24]. Quantitative and qualitative analysis is required in order to measure the concentrations of the various elements above or below the regulatory limits. If air is polluted due to the presence of domestic animals, it apparently means that the practice needs to be adjusted in other to accommodate all the component to exist or co-habit in harmony without distraught to any the components that form part of the agrosilvopastoral system.

Table 3: Key Challenges of coexistence in a community and survival Strategies.

Group	Key challenges	Survivorship potential	Strategies needed
Humans	Population growth, land competition, climate change	Moderate–high (strong adaptation capacity)	Sustainable farming, health services, climate resilience
Birds	Habitat loss, hunting, climate variability	Moderate (species-specific; migratory birds more vulnerable)	Protected wetlands, anti-poaching, habitat restoration
Domestic animals	Disease, overgrazing, limited veterinary care	High (due to human support, but vulnerable to epidemics)	Veterinary services, improved grazing, integrated livestock management
Crops	Disease, land smallness, climate change, population pressure	High (agricultural practice and research enforcement)	Research, Crop breeding, sustainable agricultural practices
Tree Species/ herbs	Slash and burn, climate change, deforestation	High (environmental protection laws)	Tree planting, sustainable agricultural practices

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Perspectives on the Socio-economic and Health Impact Assessment (HIA)

The proposed Socio-economic, and Health Impact Assessment (HIA) is an integrated approach aimed to identify and manage the effects of agroforestry practice on the livelihood, economy and health of the people. These key factors are considered to promote sustainable development [23-25], and according to World Bank [26], these components are required in defining and setting up the goals used in evaluating social and health impacts on the household practising agrosilvopastoral system. This will involve determinants, that considers broad factors affecting socioeconomic conditions (employment, income), wellness and community infrastructures.

Looking further into this aspect, some important elements for investigation are cost of living/inflation, opportunities for economic enhancement, skill acquisition, boom and bust economy, access to sanitation and waste management, balance in gender, lifestyle, morals and family values, current levels of youth restiveness, current level of workers safety, and current level of road traffic accidents. These are key to sustainable elements that are pivotal to ecosystems management that determines the survival of all the components without pronounced competition for the resources [23,26]. These values are central to understanding the essence of compatibility in a socio-economic context.

According to de Mello et al. [25], the key socio-economic features proposed are: a) Analysis of demographics and social structure of local population, household composition, and social organization in the farmstead, b) Assessment of the economic activities and the livelihoods of local, c) Evaluation of land use, resource access and land ownership pattern, d) Evaluation of the impacts of the infrastructural services on the farmers practicing agrosilvopastoralism, and e) Identification of the cultural heritage, archaeological sites, and intangible cultural heritage.

Perspectives on the Hypothetical Research Approach (HRA)

In balancing the outcomes of the interplay among the key ecological stakeholders, biophysical survey, socio-economic and health status needs to be investigated. As indicated in Table 1 above, approach involving all the proposed General Objectives (GO) should be the focus, so that the inputs resulting from the interrelationships in the ecosystem are understood and how survival is impacted. This forms the fulcrum of these perspectives, and all ecological indicators should be profiled constructively to align with the specific objectives and be subjected methodically using real-time problem-solving mechanisms. This should be done in order to balance the overall impacts of the interacting components (humans, birds, domestic animals and trees) on each other and the environment. Periodic Environmental, Social and Health Impact Assessment (ESHIA) studies frame-worked on the various outcomes of the long period of the coexistence is necessary in order to make adjustment to a healthier angle for survival if necessary. This consequently implicate the illustrative Hypothetical Research Approach (HRA).

Hypothetical statements or Hypothesis (H), that includes the Alternate Hypothesis (HA) and the Null Hypothesis (HO) are required to test research questions that could emanate from the proposed frameworks. Therefore, six (6) Specific Research Questions SRQ (R1-R6) interconnected and linked to the HA and the HO were proposed for decision making. The GO are simplified into achievable SO and tested using the RI-R6 hinged on HO and HA. If HO is rejected, it means the agrosilvopastoral practice has impacts (negative or positive) on the ecological survivorship and the research outcome is communicated to the appropriate organization (university, industries, communities and research agencies) for implementation or incubation. However, it becomes iterative, if HA is accepted, the research is reconducted from the general objectives of impact investigation, and it is repeated over and over again.

The Eastern Province of Rwanda and agrosilvopastoral practices

As indicate in Table 1, the Eastern Province of Rwanda provides a clear “living laboratory” of strong interdependence between humans, birds, domestic animals, crops and shrubs/tree species, shaped by the everyday realities of agrosilvopastoral land use [27,28]. The livestock convert biomass into food, income and manure; while the crops sustain households and local markets. This tight coupling means that any shift in management such as loss of the livestock, tree density, fodder species selection, farm practice, or seasonal burning can trigger cascading effects across biophysical integrity (soil-water–vegetation), socio-economic wellbeing, and health (human and animal disease risks and exposure pathways). Again, farmers typically integrate banana plantations, annual crops such as beans and maize, scattered trees including Acacia, Grevillea, and indigenous species, Table 1. This integration creates a mosaic landscape that provides habitat heterogeneity beneficial to all components while supporting human livelihoods especially.

Because agrosilvopastoral systems generate both benefits and trade-offs, conservation and development strategies in Eastern Province is holistic, with well-designed systems that enhanced drought buffering, stabilize livelihoods, improved soil cover, diversify diets and incomes, and support biodiversity [22]. The systems need to be properly optimized, to aviod overstocking, prevent inadequate tree regeneration, discourage erosion-prone cultivation, and protect unmanaged interfaces [22]. These outcomes are expected to prevent land degradation, improve water quality and reduce health risks.

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These effects are not uniform across districts or communities; but vary with local ecology (lowlands versus slopes, proximity to wetlands, soil types), household assets (land size, herd size, labor), and access to climate and market services.

Survivorship and resilience potentials also differ among the key components of the system. Humans can adapt through innovation (e.g., fodder banking, rotational grazing, water harvesting, improved breeds, agroforestry designs), but their adaptive capacity could be constrained by poverty, climate shocks and land pressure [22]. Domestic animals depend on human care and management decisions that determine feed availability, disease exposure and productivity. Birds and other indicator species are strongly dependent on habitat integrity, and they respond rapidly to changes in habitat structure, including that of water availability and vegetation cover. Tree cover and landscape connectivity can decline quickly when ecological thresholds are crossed. Trees and other plant species require protection and regeneration support to maintain ecosystem functions (erosion control, microclimate regulation, nutrient cycling) that underpin both agricultural productivity and biodiversity [22].

The domestic animal populations and pastoral livelihoods in the Eastern Province

Livestock keeping remains central to rural livelihoods in the Eastern Province, with cattle, goats, sheep, pigs, and poultry being the primary species [28]. The Ankole cattle breed, valued for its drought tolerance and cultural significance, has historically been the dominant cattle type, though crossbreeding with exotic breeds has increased in recent years. Interdependency of the livestock on folders from the plant species and the use of the animal manure as plant nutrients make agrosilvopastoralism important combinations that enhances livelihood and sustain ecosystems [28].

The survivorship potential of domestic animals in this region may face multiple constraints. As reported [7,28], forage availability has declined as grazing lands are converted to cropland or enclosed under land consolidation policies. Many farmers now practice zero-grazing or tethering systems, which increases labor demands and can compromise animal welfare when forage collection becomes difficult during dry seasons [28].

Also, as reported in Nsengimana et al. [16], disease remains a significant threat to domestic animal survival. East Coast Fever transmitted by ticks affects cattle populations, particularly exotic breeds that lack natural resistance. Foot and Mouth Disease outbreaks periodically devastate herds, with cross-border transmission from neighboring countries complicating control efforts, and limited access to veterinary services in remote areas exacerbates these challenges, with many farmers relying on informal animal health workers or traditional remedies [16]. The challenges are encrypted in the practice of agrosilvopastoralism and therefore, this advocate for regular conduct of research in farmstead existing with human over years is necessary [16].

Also, climate variability increasingly affects domestic animal survivorship. As reported by [27, 29], the Eastern Province experiences distinct wet and dry seasons, but the timing and intensity of rainfall have become less predictable. Prolonged dry spells stress animals through reduced forage availability and water access, while heavy rains can spread waterborne diseases and destroy infrastructure [29]. Small-scale farmers with limited resources for supplementary feeding and animal health care are particularly vulnerable during these climatic extremes [27].

The bird species diversity and conservation challenges in the Eastern Province

As reported by Rwanda GoR [28], the Eastern Province hosts significant avian biodiversity, with over 200 bird species recorded across its various habitats. These include wetland specialists in the Akagera wetlands and Lake Muhazi area, savanna woodland species in Akagera National Park's buffer zones, and agricultural landscape birds that have adapted to human-modified environments, that raid crops in the agrosilvopastoral systems [7].

Some bird species of concern in the region include the Grey Crowned Crane (*Balearica regulorum*), which has experienced population declines due to wetland drainage and capture for trade; the Papyrus Yellow Warbler (*Chloropeta gracilirostris*), the Shoebill (*Balaeniceps rex*), occasionally recorded in Akagera wetlands; and various raptors including the Martial Eagle (*Polemaetus bellicosus*) and African Fish Eagle (*Haliaeetus vocifer*). See appendix A for bird species encountered during casual observation [19].

The survivorship potential of these bird species depends heavily on habitat availability and quality. Apart from other environment within the homestead, wetland birds face particular challenges as wetlands are drained for rice cultivation and other agricultural uses [27]. This made the ecosystem fixated and largely not maneuverable to suit the survivorship of the species within the complex interacting community [27].

Agricultural landscape birds, including various weavers, firefinches, and doves, show greater resilience to landscape modification but still depend on the maintenance of certain structural features like in the agroforestry systems [27]. Trees scattered in agricultural fields provide nesting sites and perches for insectivorous species that contribute to pest control. The retention of hedgerows, small woodlots, and buffer vegetation along waterways is critical for maintaining bird communities in these human-dominated landscapes combined with the agrosilvopastoralism [27].

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The integration of conservation and livelihood strategies in eastern province

Effective conservation in the Eastern Province requires approaches that recognize the interdependence of human livelihoods, domestic animal welfare, and wild bird conservation [7,18]. In some home farmstead, bird species that are not domesticated are regular visitors, and including them in the concern for the practice of agrosilvopastoralism is vital. There is therefore the need to evolve multiple strategies that would show promise for enhancing survivorship potentials across these domains [7,18].

Agroforestry intensification represents a key strategy for maintaining landscape heterogeneity while improving agricultural productivity. Promoting systems that integrate nitrogen-fixing trees such as Calliandra and Leucaena provides fodder for livestock while creating vertical structure beneficial for birds. Fruit trees including avocado, mango, and papaya contribute to household nutrition and income while offering nesting sites and food resources for frugivorous and insectivorous birds [7,18]. The strategic placement of these trees can create connectivity between habitat patches, facilitating bird movement across agricultural landscapes [18]. Community-based monitoring programs that engage local people in bird surveys and farmstead health assessments can build stewardship while generating data for adaptive management [30,31].

Improved livestock management systems can enhance domestic animal survivorship while reducing pressure on natural habitats. The promotion of improved forage species such as Brachiaria grass and Desmodium, which can be grown in small plots or integrated into crop fields, increases forage availability without requiring extensive grazing lands [31]. Breed improvement programs that balance productivity with local adaptation help farmers increase output from smaller herds. Strengthening veterinary service delivery through mobile clinics, community-based animal health workers, and disease surveillance systems reduces mortality and improves animal welfare [30,31].

Conclusions

The most defensible pathway toward healthier and more sustainable coexistence in Eastern Province is evidence-based, which is in the practice of agrosilvopastoralism. Adaptive management and regular monitoring are required. Payment for ecosystem services schemes that could provide economic incentives for conservation-compatible practices is important. Farmers who maintain tree cover or preserve critical bird habitats could receive compensation through carbon credits, watershed protection payments, or biodiversity credits. Such mechanisms require careful design to ensure equitable benefit distribution and avoid creating perverse incentives.

Recommendations

The following recommendations were made based on the perspectives

1. It is suggested that periodic ESHIAs be carried out in farms practicing agrosilvopastoralism.
2. Track long-term changes in ecological dynamics (soil quality, vegetation structure, water quality, habitat condition) in order to ameliorate deficiencies.
3. Measure socio-economic outcomes (household resilience, productivity, income stability, equity impacts) to value gains accruable to the farmers.
4. Detect emerging health risks at the human–animal–environment interface (including zoonotic and vector-borne risks) in order to deploy the best approach in handling any negative approach strategically.

By systematically identifying both benefits and emerging risks over time, periodic ESHIAs can guide adaptive interventions refining practices that work, correcting practices that create harm, and enabling district-specific optimization strategies that support resilient livelihoods, healthier ecosystems, and improved human and animal health outcomes across the seven districts of Eastern Province.

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Conflicts of Interest:

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APPENDICES

Appendix A: Some avian species (wildlife) documented during casual observation.

S/no	Common Name	Scientific Name	Family
1	Common garden bulbul	*Pycnonotus barbatus*	Pycnonotideae
2	African thrush	*Turdus pelios*	Turdidae
3	Sunbirds	*Cinnyris* spp	Nectariniidae
4	Pied crow	*Corvus albus*	Corvidae
5	Warblers	*Phylloscopus* spp	Sylviidae
6	Speckled mouse bird	*Colius striatus*	Coliidae
7	Waxbill	*Estrilda astrild*	Estrildidae
8	Swallow	*Hirundo leucosoma*	Hirundinidae
9	Village weavers	*Ploceus cucullatus*	Ploceidae
10	Hooded vultures	*Necrosyrtes monachus*	Accipitridae
11	Long-crested eagle	*Lophaetus occipitalis*	Accipitridae
12	Hadada ibis	*Bostrychia hagedash*	Threskiornithidae
13	Hammerkop	*Scopus umbretta*	Scopidae
14	Cranes	*Balearica regulorum*	Gruidae
15	Cattle egret	*Bubulcus ibis*	Ardeidae
16	Martial eagle	*Polemaetus bellicosus*	Accipitridae
17	Verreaux's eagle	*Aquila verreauxii*	Accipitridae
18	African fish eagle	*Haliaeetus vocifer*	Accipitridae
19	Rüppell's vulture	*Gyps rueppelli*	Accipitridae

Appendix B: Some plant species documented in farms within the Eastern province of Rwanda.

S/no	Common Name	Scientific Name	Family
1	Avocado	*Persea americana*	Lauraceae
2	Octopus tree	*Heptapleurum actinophyllum (Schefflera actinophylla)*	Araliaceae.
3	Western silky Oak	*Grevillea robusta*	Proteaceae
4	Tree of iron	*Gliricidia sepium*	Fabaceae
5	Ficus spp	*Ficus benjamina*	Moraceae
6	Oil Palm	*Elaeis guineensis*	Arecaceae
7	Guava	*Psidium guajava*	Myrtaceae
8	*Calliandra*	*Calliandra calothyrsus*	*Fabaceae (Leguminosae)*
9	Pawpaw	*Carica papaya*	Caricaceae
10	Hibiscus	*hibiscus rosa-sinensis*	Malvaceae
11	Maize	*Zea mays*	Poaceae
12	Onions	*Allium cepa*	Amaryllidaceae
13	Carrot	*Daucus carota*	Apiaceae
14	Cabbage	*Brassica oleracea*	Brassicaceae
15	Lettuce	*Lactuca sativa*	Asteraceae
16	Amaranthus	*Amaranthus* spp	Amaranthoideae
17	Castor oil plant	*Ricinus communis*	Euphorbiaceae
18	Flat-top acacia	*Acacia abyssinica*	Fabaceae
19	Paperbark acacia	*Acacia sieberiana*	Fabaceae
20	White thorn acacia	*Acacia hockii*	Fabaceae
21	Black thorn acacia	*Acacia polyacantha*	Fabaceae
22	Sugarcane	*Saccharum officinarum*	Poaceae

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23	Coffee	*Coffea arabica*	Rubiaceae
24	Markhamia (Nile tulip tree)	*Markhamia lutea*	Bignoniaceae
25	Musizi	*Maesopsis eminii*	Rhamnaceae
26	Cedrela (Mexican cedar)	*Cedrela serrata*	Meliaceae
27	Mango	*Mangifera indica*	Anacardiaceae
28	Banana	*Musa spp.*	Musaceae
29	Water melon	*Citrullus lanatus*	Cucurbitaceae
30	Tomato	*Solanum lycopersicum*	Solanaceae
31	Tomato tree (tree tomato)	*Solanum betaceum*	Solanaceae
32	Pencil tree / Milk bush	*Euphorbia tirucalli*	Euphorbiaceae