**Project Theme:**

The project falls within the following themes:

* **Agriculture and Food Security**: In Rwanda, agriculture, while being a key economic driver, faces challenges related to food security, land insecurity, and low productivity.
* **Territorial and Rural Dynamics**: Issues related to isolation and soil degradation in areas like the Burera district.
* **Agricultural Production Systems**: The multifunctional role of cattle farming in the context of diversified crop-livestock farming systems.
* **Sustainable Development and Agroecology**: Analysis of the sustainability of agricultural systems in connection with agricultural policies.
* **Climate Change and Erosion**: Effects of agricultural intensification and livestock farming practices on ecological balances.

**Subject Description, Schedule, and Project Timeline (maximum 2 pages):**

In the Burera district in Rwanda, land and demographic pressure, along with food insecurity, make it essential to characterize diversified crop-livestock micro-farms in isolated areas and analyze energy flows. One of the qualities of these farms is their involvement in short supply chains, with sales of minimally processed agricultural products in local markets.

In the second phase, the diagnostic of the agri-food system of the Burera district (AFS, Figure 1) will be conducted, focusing on cattle production, its transformations, and the resulting flows, as well as its contribution to local consumption. The sustainability of the system will be analyzed by examining its evolution and how it fits into climate challenges (erosion and warming) and territorial issues. The resilience of the AFS will be studied through dairy cattle farming, using a metabolic approach at both the micro-farm and district levels: material and energy flows will be identified, named, quantified at these two scales, and then modeled. Simulations on the AFS incorporating geographical, biogeochemical, and economic fluctuations, particularly those linked to energy, will allow for the evaluation of its resilience. The role of stakeholders, including their social and cultural dimensions, and the effects of governance will also be considered.

In the third phase, an analysis at the national level will take into account inputs and outputs, particularly the food contribution of the AFS and its dependence on incoming fertilizer flows, completing the analysis of the contributions of livestock and its place in relation to national agricultural policies promoting specialization and intensification. This scaling-up to the national level will further the analysis of the sustainability and resilience of the AFS. The nested approach of these scales through systemic analysis aims to provide a better understanding of the food system. The identification of discriminating factors and their modeling will highlight the processes of diversification and specialization, as well as material and energy flows. A reasoned sampling will be conducted to establish a representative sample of micro-farms at the district level. Additionally, interviews with stakeholders from the sector and institutions (May, 2021) will be conducted. A diachronic analysis of policies will be integrated into the territorial approach (Cochet, 2005; Knoepfel et al., 2006). This comprehensive approach will allow for the assessment of the sustainability of the AFS.

The conceptual and methodological advances stemming from the questions on the sustainability of food systems, by integrating the livelihood approach and the approach of food and energy flows, will lead to the publication of two scientific articles. The thesis contribution will enrich discussions on the roles of livestock farming, its interactions, and its dynamics in relation to livelihoods and policies within territorialized food systems.

This thesis proposal aligns with the strategic thematic areas of Angers Loire Métropole in that it explores the roles of livestock farming in Southern countries, livestock farming practices and their environmental impacts (Biodiversity, Agroecological Transition), the multiple orientations and adaptations of households and food system actors interacting with livestock systems (Food Systems) in response to global changes and the environmental impacts of livestock farming (Climate Change), from the scale of farms to national levels (Territorial Approaches). It also addresses the food and social roles of livestock farming, including the issues of human and animal health, and plant health through the need for fodder production (One Health). These questions resonate with those of farmers in both the North and South, allowing for an exploration of farmers' adaptation strategies.

The thesis will be co-supervised between the UMR Selmet and ISTOM’s own research unit Agro-Development and Innovation in the South (UPR ADISUDS). It will benefit from the framework of the DeSIRA project ("Capacity Development for Innovation in Rwanda: strengthening innovation partnerships in six districts: Burera, Rutsiro, Gatsibo, Nyagatare, Bugesera, and Ruhango"), led by the Food and Agriculture Organization (FAO) and ISTOM as an international research partner, in collaboration with the University of Rwanda and the Rwandan Agricultural Research Institute (RAB). A multidisciplinary team from ISTOM, including Dr. Andrés, researcher in agricultural economics and value chains, Dr. Alhamada, researcher in animal science, and Dr. Vaillant, researcher in agricultural economics, will co-supervise the thesis through their involvement in the project and their support in fieldwork. The University of Rwanda, a partner in the DeSIRA project, will also collaborate by providing technical and human resources.

**Expected Results and Project Follow-up / Project Success Indicators (maximum 1 page):**

The expected results include:

* The establishment of multidisciplinary doctoral research and the development of an innovative methodology to address the challenging issue of cattle farming sustainability.
* The production of an original study on the sustainability of livestock farming in Rwanda.
* Increased involvement of faculty supervisors from the UPR Adisuds research unit.
* Scientific reflections on crop-livestock interactions and the role of public policies in the evolution of agricultural systems.

The success indicators for the thesis include its continuation of the candidate’s previous work in her final year thesis, which has already been partially disseminated through communications and a paper currently under submission. This track record highlights the candidate’s ability to produce and share scientific results. Another success factor is the thesis’s supervision by an experienced thesis advisor from Cirad, supported by a research laboratory already active in Rwanda through the DeSIRA project for four years. Additionally, ISTOM and Cirad have a partnership agreement, and this thesis will further strengthen the relationship between the two institutions. Finally, the thesis co-advisor is a research professor at ESA, reinforcing the territorial grounding of the project and fostering increased collaboration between ESA and ISTOM.