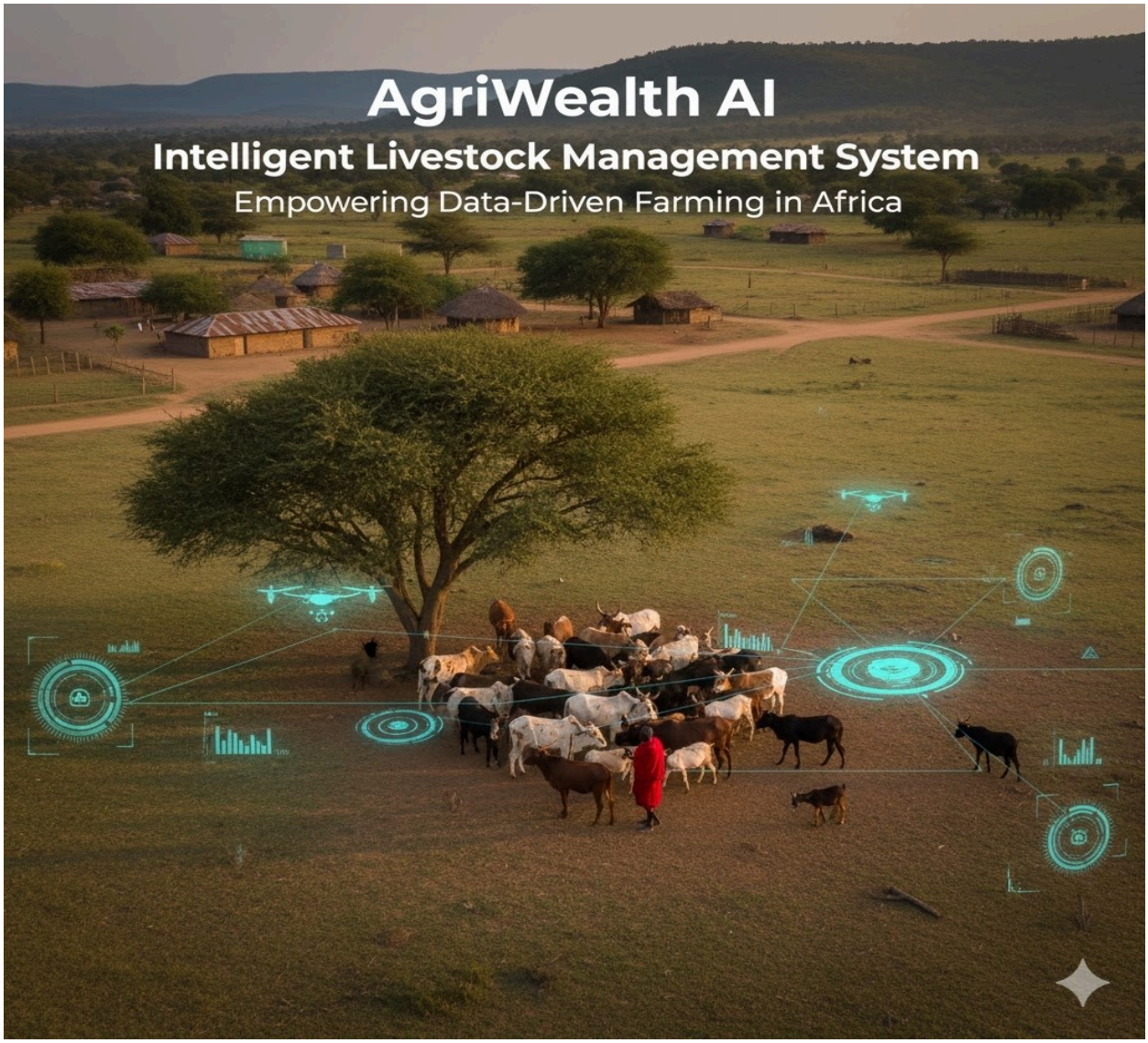

Project Goal

To implement an AI-powered, highly accessible conversational system (AgriWealth AI) that leverages synthesized farm data to deliver proactive, predictive management advice, aiming to achieve a minimum 15% increase in livestock yield (milk/weight gain) and a 5-10% reduction in mortality among smallholder farmers, thereby enhancing food security and mitigating environmental strain.

Key Technology

- Multi-Agent Intelligence (LangGraph)
- Generative AI (Gemini 2.5 Flash)
- Relational Data Backbone (SQLite)

Prepared for:

Unstacked Labs Kenya - Capstone Project
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Project Mission and Impact:

AgriWealth AI is a revolutionary project designed to democratize advanced agricultural technology for smallholder farmers across Africa. The central mission is to elevate the economic standing of these farmers by minimizing livestock losses and maximizing productivity through informed decision-making. By shifting the paradigm from 'reacting to crises' (e.g., disease outbreaks, poor yields) to 'managing proactively' based on real-time data, AgriWealth AI aims to create a sustainable pathway to increased food security and wealth generation at the grassroots level.

Target User Context and Customization

The project is specifically tailored for Smallholder African Farmers, acknowledging the unique constraints they face, such as limited capital, unreliable infrastructure, and varying levels of digital literacy. The solution is being engineered to function effectively in environments with intermittent internet connectivity and to be accessible on a range of devices, including more basic, affordable smartphones and even feature phones where possible. The AI models are trained on regional livestock data to ensure high accuracy and relevance to local breeds, diseases, and climate patterns.

AgriWealth AI Livestock Management System

Project Name	AgriWealth AI
Target Users	Smallholder African Farmers
Primary Goal	Transition farmers from reactive,traditional methods to data-driven, proactive livestock management practices.
Status	Advanced Prototype (Minimum Viable Product - MVP Stage)
Technology Focus	AI-driven mobile application (explicitly aimed for use on smartphones and feature phones) and low-cost sensor integration.

1. Problem Statement

Livestock farming is a critical pillar of food security and economic stability across Africa, contributing approximately **12% to the national GDP** and **42% to the agricultural GDP** in Kenya alone. In the vast **Arid and Semi-Arid Lands (ASALs)**, livestock is the **primary source of sustenance**. Despite this importance, smallholder farmers face disproportionately high losses. The central obstacle to dramatically increasing output is the fundamental difficulty in **data acquisition** at the farm level.

Key Challenges:

- **Productivity Gap (The Data Void):** Lack of continuous, data-driven advice on feeding and breeding cycles leads to suboptimal production (milk, weight gain). Farms typically have **no idea** about a single animal's specific consumption, movement, health data, or stress levels.
- **Disease Risk & Climate Vulnerability:** High incidence of preventable diseases due to missed vaccination windows. This risk is compounded as climate change directly affects **animal fertility and development** and causes increases in disease vectors like **Rift Valley Fever**.
- **Environmental Strain:** Unoptimized production practices contribute to environmental degradation. Livestock-related activities are estimated to contribute

92% of total GHG emissions from agriculture in Kenya (Referencing FAO/UNEP climate studies cited in the thesis). The current inefficiency must be addressed to align the sector with the national goal of becoming a **commercialized undertaking** (Goal of Kenya's National Livestock Policy, 2019).

"Livestock losses due to disease in Sub-Saharan Africa are estimated to cost billions annually, significantly impacting rural livelihoods and poverty reduction efforts."

The AgriWealth AI project was initiated to overcome these challenges by creating an **intelligent layer (AI)** that synthesizes disparate farm records and external knowledge into unified, actionable insights tailored for immediate implementation. **AI is essential** because it is the only way to effectively process the complex, multi-variable factors—diet, lifestyle, and environmental changes that directly affect **milk quantity and quality**.

2. Proposed Solution: AgriWealth AI System

AgriWealth AI is a conversational, multi-agent intelligence platform designed to manage and analyze farm data in real-time, providing highly contextual and customized advice. **Crucially, the system is explicitly designed for deployment on smartphones (via platforms like WhatsApp Web) to ensure high accessibility and reach among local farmers in rural areas.**

2.1 System Architecture: Multi-Agent and Relational Backbone

The system's core asset is its highly modular architecture, which ensures complex user requests are handled efficiently and reliably. The foundation is a well-structured relational database (SQLite), standardizing farm data across four normalized tables (ANIMALS, HEALTH_RECORDS, PRODUCTION_RECORDS, FARM_TRANSACTIONS) connected by explicit Foreign Keys. This structure is essential for enabling the sophisticated Multi-Query Planner agent, which uses LangGraph to orchestrate the workflow.

2.2 Core Functionalities (Validated in Technical Report)

The system’s effectiveness stems from its ability to connect time, data, and action:

- **Data Synthesis and Correlation:** The system breaks complex questions into multiple SQL queries and synthesizes the results. Example from testing: The system correlated a low milk yield trend (production_records) with the presence of "Chicken

Feed" as an expense item (farm_transactions), issuing a critical, urgent health warning to the farmer.

- **Time-Aware Logic and Life-Stage Advice:** By using the Dynamic Current Date context, the agent accurately performs age calculations. This ensures advice is specific to the animal's life stage (e.g., providing breeding readiness advice for a 19-month-old heifer like Bibi).
- **Safety and Data Integrity:** The system employs a strict SQL Safety Validator that blocks all DDL and DML commands (e.g., UPDATE, DROP), protecting the farmer's critical records from accidental or malicious input.
- **Intelligent Routing:** Queries are automatically routed to specialized pipelines (SQL, Web Search, or Disease Diagnosis) based on user intent, maximizing efficiency and response quality.

3. Technology Stack

The technology stack is designed for robustness, high performance (using Gemini 2.5 Flash), and potential deployment scalability in environments with limited infrastructure.

Component	**Technology**	**Rationale**
AI Core (LLM)	Google Gemini 2.5 Flash	High performance, multi-modal capability, superior reasoning, and core architecture optimized for highly accessible channels like **WhatsApp Web** to reach rural farmers.
Workflow Orchestration	LangGraph (Python)	Enables the defined multi-agent workflow (Planner, Executor, Synthesis) and robust error handling/retry logic.
Database	SQLite	Chosen for its zero-configuration nature,

		facilitating easy deployment, and inherent ability for local caching to function reliably **even during network outages (Offline Mode)**.
Core Languages	Python, SQL	Industry standards for AI and data management.
External Tooling	Google Search API	Provides real-time, up-to-date best practices and treatment protocols (General Knowledge RAG).

4. Expected Outcomes and Social Impact

The AgriWealth AI system is expected to deliver tangible benefits to smallholder farmers and support national environmental goals:

Outcome Area	Expected Benefit	Metric for Success
Economic	Improved productivity through optimized feeding and breeding cycles; reduction in unnecessary veterinary costs.	15% increase in milk/weight yield per animal monitored; 5-10% reduction in mortality.
Animal Health	Proactive disease prevention via timely vaccination reminders and early symptom identification. The data-driven approach directly counters the climate-change induced	95% compliance rate for scheduled vaccinations (when tracking is implemented).

	increase in disease risk.	
Environmental	Optimized feeding strategies driven by AI reduce the current strain on natural resources and indirectly contribute to reducing the sector's high contribution to **GHG emissions** (Referencing FAO/UNEP climate studies cited in the thesis).	**5% reduction in feed waste** per animal; quantifiable contribution to national policy goals of transforming the livestock sector into a **sustainable commercialized undertaking** (Goal of Kenya's National Livestock Policy, 2019).
Data Literacy	Empowers farmers to make data-driven decisions previously requiring external expertise.	High adoption rate and frequent user queries concerning analytical data (yield trends, cost breakdowns).

5. Project Scope, Limitations, and Immediate Fixes

Project Scope (MVP Completion) The core multi-agent system, data synthesis, and safe database retrieval mechanisms are complete and validated.

Critical Limitations Requiring Immediate Action The technical report highlighted two critical flaws that must be addressed before mass deployment:

1. **CRITICAL FIX (Database):** The SQLite Dialect Incompatibility prevents complex, time-aware queries (e.g., age calculations for breeding readiness) from executing successfully, as the LLM generates incompatible SQL functions. **Immediate Action:** The system requires injecting explicit SQLite-compatible templates into the SQL Planner's prompt to bypass this limitation.
2. **Web Agent Flaw:** The search_web agent sometimes fails to return a clean, final answer, requiring debugging of the parsing logic in this specific pipeline.

6. Roadmap for Future Improvements

Phase	Enhancement Focus	Description
Phase 2 (Immediate Post-MVP)	Data Write Functions, Modular Agent Scaling & Breeding Intelligence	Implement SAFE Database Write Functions (INSERT, UPDATE) to enable farmers to update records conversationally. The architecture will expand with a Farm-Stock Management Agent handling inputs, sales, and workers. Implement Predictive Service Planning (PSP) to calculate and recommend the precise month an animal (e.g., Bibi) should be bred.
Phase 3	Contextual Memory & Enhanced SQL Security & Data Integrity	Introduce a Memory Agent to retain context over multi-turn conversations. Implement Query Timeouts/Limits and Data Access Throttling in the SQL Executor. Introduce an autonomous Data Integrity Agent to scan records for inconsistencies.
Phase 4	Multimodal Integration	Fully integrate visual capabilities to allow farmers to upload images

		of symptoms (e.g., wounds, lesions) for immediate AI-driven preliminary diagnosis and treatment recommendations.