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Enabling Agricultural Data Sovereignty Through Digitally Enforced Usage Control Policies

Farmers, regardless of their farm sizes or their main production types (such as tillage, beef, dairy, pork, etc.) generate and use data. This data is generated through a diverse ecosystem of technologies embedded in daily agricultural operations (Atik, 2022; Atik, 2023). Machinery such as tractors and combine harvesters now routinely collect metrics on fuel efficiency, soil compaction, and crop yields via onboard sensors that monitor everything from engine performance to real-time grain quality during harvest (Ibrahim and Truby, 2023). Beyond field equipment, livestock management systems generate critical datasets through wearable devices, such as smart collars tracking cattle movement, rumination patterns, and body temperature or environmental sensors in barns that monitor air quality, humidity, and feeding schedules to optimize animal welfare (Wiseman et al., 2019).

Data sharing is essential to unlocking agriculture's full potential among stakeholders, including farmers, researchers, policymakers, and corporations because shared datasets can influence market dynamics, policy decisions, and technological innovation (Atik, 2022; Luyckx and Reins, 2022). Yet current data governance frameworks rely on static legal contracts or informal trust-based agreements, which lack mechanisms to enforce dynamic or context-specific data usage terms. Hence, farmers, particularly smallholders, often lack control over how their data is used, exposing them to exploitation by corporate entities or misalignment with local priorities (Jouanjean et al., 2020). These tensions underscore the urgency for improved and stronger agricultural data sovereignty, which ensures farmers define usage and sharing terms for data they generate to ensure that they benefit equitably from their data.

This research proposes implementing digitally enforced usage control policies (UCON) (Park and Sandhu, 2004) to enable true agricultural data sovereignty, where farmers define granular, context-specific rules for their data. These machine-readable policies are embedded within the data infrastructure, enabling real-time, automated enforcement of terms (like purpose, recipient, duration, and prohibitions) via integrated policy decision and enforcement points. This technical foundation creates enforceable trust, allowing all stakeholders (farmers, researchers, industry) to collaborate confidently, knowing data rights are preserved. By ensuring fair control and equitable benefits for data originators, this approach unlocks agriculture's full data potential to address global challenges in productivity, sustainability, and equity.