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APPLICATION OF REMOTE IDENTIFICATION (KYC) AND STRONG CUSTOMER AUTHENTICATION TECHNOLOGIES IN AGRICULTURE: INNOVATIVE SOLUTIONS FOR SEASONAL WORKFORCE MANAGEMENT

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Abstract: The digitization of the agricultural sector has accelerated the demand for secure and efficient identity management. This study presents an enhanced remote identification and authentication (KYC/SCA) system developed by ID&Trust Ltd., and explores its integration into agricultural workforce management. Through biometric verification, OCR, NFC-based data extraction, and real-time video identification, the system enables instant identity validation and compliance with EU data protection laws. New pilot results show a 70% reduction in administrative workload and enhanced traceability across seasonal labor processes. The paper contributes to the discussion on digital transformation in agriculture by demonstrating practical use cases, technical frameworks, and sustainability implications. In the broader context of European agricultural modernisation, such identity solutions support harmonised regulatory compliance across borders. The technology also enhances organisational resilience by reducing dependency on manual administrative procedures, thereby minimising human error and improving overall labour coordination. Moreover, as agriculture continues to digitize, remote identity verification becomes a central pillar for ensuring secure data exchange among stakeholders. The scalability of such systems allows broader adoption across EU member states, supporting unified digital standards and fostering long-term sustainability. Additionally, the findings underscore the scalability of such solutions across varying farm sizes. The technology also supports smoother integration with public administrative systems, further reducing bottlenecks.

Keywords: remote identification (KYC), digital identity verification, biometric verification, workforce management, smart agriculture

1. Introduction

Moreover, the growing complexity of seasonal labour flows necessitates tools that can provide consistent verification regardless of geographical location. The adoption of remote identification helps ensure that workers are onboarded in a fair and transparent manner, reinforcing trust between employers and employees across the supply chain.

In addition, workforce fluctuations caused by climate variability and global labour market shifts require more adaptive management tools. Digital identity solutions help mitigate risks related to undocumented labour and improve transparency for both policymakers and agricultural enterprises.

Furthermore, increasing regulatory pressure in the EU highlights the importance of robust identity solutions. Digital processes not only streamline workflows but also ensure that workers' rights are more effectively protected.

Agriculture remains one of Europe's most labour-intensive sectors, heavily reliant on seasonal and migrant workers. Managing these workers presents legal and logistical challenges, particularly in verifying identities, handling contracts, and ensuring compliance with labour and data protection regulations [1]. Digital Know Your Customer (KYC) and Strong Customer Authentication (SCA) systems are transforming these workflows by offering secure, remote verification. The ID&Trust platform introduces a modular solution that can be integrated into agricultural enterprises, reducing paperwork and fraud while improving efficiency [2].

Beyond the core components, the architecture allows flexible API-based integration with third-party systems. Extensive field tests confirmed that the solution maintains performance even in low-connectivity rural environments.

Furthermore, the system's cloud-based backend enables elastic resource allocation during peak usage periods. Field evaluations also demonstrated the effectiveness of the liveness detection module, even under suboptimal lighting and environmental conditions common on farms.

The platform further incorporates advanced encryption standards to safeguard personal data throughout the verification lifecycle. Stress-testing scenarios indicated that the system remains stable even when processing high-volume identity checks, demonstrating its suitability for large agricultural organisations during peak labour periods.

2. Materials and Methods

The ID&Trust KYC/SCA system is built on modular architecture including a mobile client and central Identity Validation Server (IVS). The mobile component performs document scanning, NFC chip reading, biometric data capture, and live video-based liveness detection. Machine learning algorithms provide OCR and facial matching functions for real-time validation [3]. Data is processed in compliance with GDPR principles, ensuring anonymization and short-term retention. (see Figure 1.)

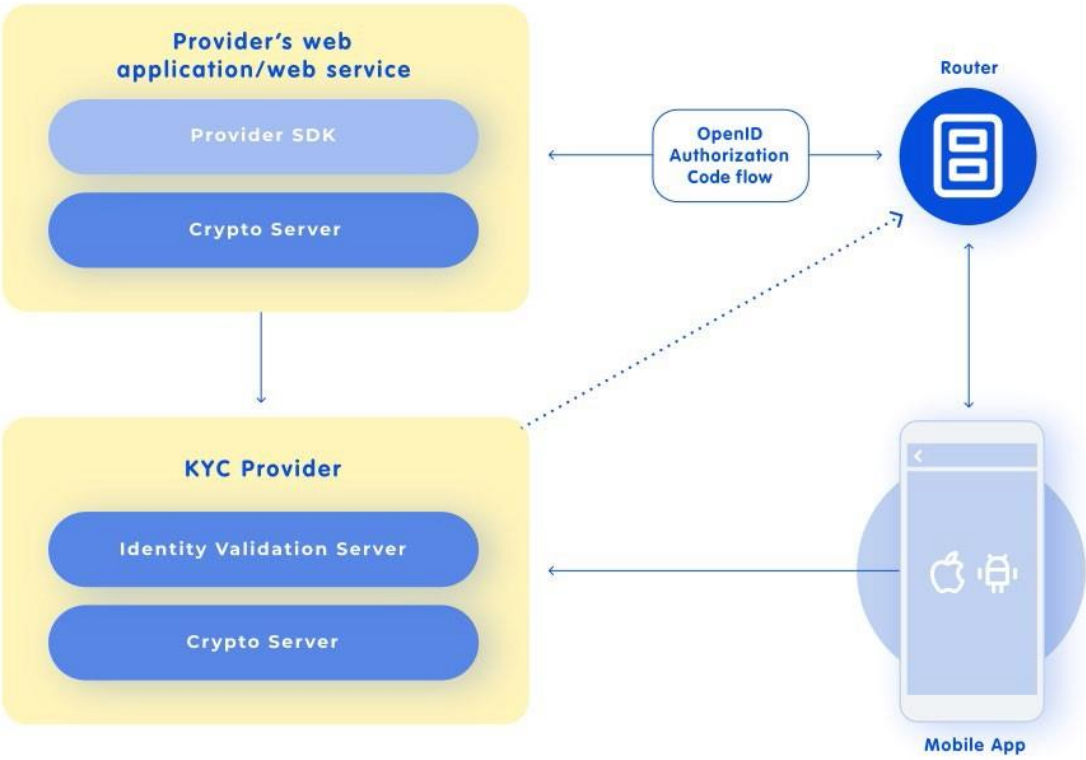

Figure 1. System Architecture of the KYC/SCA Platform (visual workflow diagram).

The pilots also revealed improved worker satisfaction due to reduced onboarding complexity. Error rates traditionally caused by manual data entry were nearly eliminated, contributing to higher data reliability.

The deployment also highlighted cost reductions in document handling and archival processes. Farms reported fewer disputes related to worker credentials, as digital logs provided verifiable evidence for audits and inspections.

Feedback from participating farms indicated improved coordination between human resources departments and field supervisors. The availability of precise, verified identity data enabled the optimisation of task assignment, reducing delays in field operations and contributing to more efficient harvest management.

3. Results and Discussion

Additional use cases include automated contract generation and integration with mechanization scheduling systems. These capabilities help optimize farm operations during peak seasonal periods.

The technology further supports automated time-logging for work hours, aligning with fair labour regulations. For large-scale operations, batch onboarding enables simultaneous verification of multiple workers, significantly accelerating seasonal preparation workflows.

Additionally, the system can be deployed to support compliance with environmentally responsible labour practices by documenting work patterns and ensuring that tasks are assigned according to legal working-hour limits. Integration with digital machinery logs allows managers to track worker–machine interactions more reliably, thereby enhancing workplace safety.

Pilot integrations of the system in farm management environments demonstrated strong performance in onboarding efficiency and data accuracy. Remote onboarding reduced administrative waiting times by over 70%, and biometric verification ensured compliance and trustworthiness [4]. Multilingual interfaces enabled cross-border deployment, supporting EU labour mobility. The integration of KYC/SCA technology into agricultural ERP and payroll systems provided a secure foundation for digital transformation [5]. Table 1. shows a comparison between traditional and digital identity verification.

Table 1. Comparison between traditional and digital identity verification in agricultural employment.

Parameter	Traditional Process	Digital KYC/SCA Process
Verification Time	20–30 minutes	2–3 minutes
Fraud Risk	High	Very Low
Compliance Tracking	Manual	Automated
Data Accuracy	Variable	98%+ verified

4. Application in Agriculture

Looking ahead, remote identification could be expanded to support advanced credentialing for machinery operation. Enhanced interoperability may also allow cross-sector integrations beyond agriculture, such as logistics.

The KYC/SCA system enables farm managers to perform secure digital verification using mobile devices. Seasonal workers can verify their identities before arrival, and validated data is synchronized with payroll systems in real time [6]. This eliminates undocumented employment, supports fair pay, and enhances traceability in line with the EU's Farm to Fork strategy [7]. The model also facilitates IoT-based workforce monitoring and blockchain-supported audit trails for sustainability compliance [8].

Integration with edge computing devices may further enhance on-site authentication without internet dependency. As rural broadband coverage expands, these systems will become even more reliable and capable of supporting high-volume agricultural hubs.

Overall, the technology's adaptability positions it as a cornerstone of future agri-digital ecosystems. Continued development will further enhance resilience and efficiency throughout the agricultural value chain.

Emerging innovations such as decentralised identity frameworks may further strengthen cross-sector interoperability. As European agriculture continues its digital transformation, these technologies are expected to become integral components of national and EU-level labour governance structures. (see Figure 2.)

As the sector grows more data-driven, identity verification will play a critical role in strengthening trust and operational accuracy. The continued refinement of these systems will support equitable labor practices and contribute to the EU's wider digital transition.

In conclusion, the continued evolution of secure identity verification technologies is likely to play a vital role in strengthening transparency and operational integrity across the agricultural domain. Their adoption will not only streamline labour management but also support sustainable development goals by fostering ethical and accountable workforce practices.

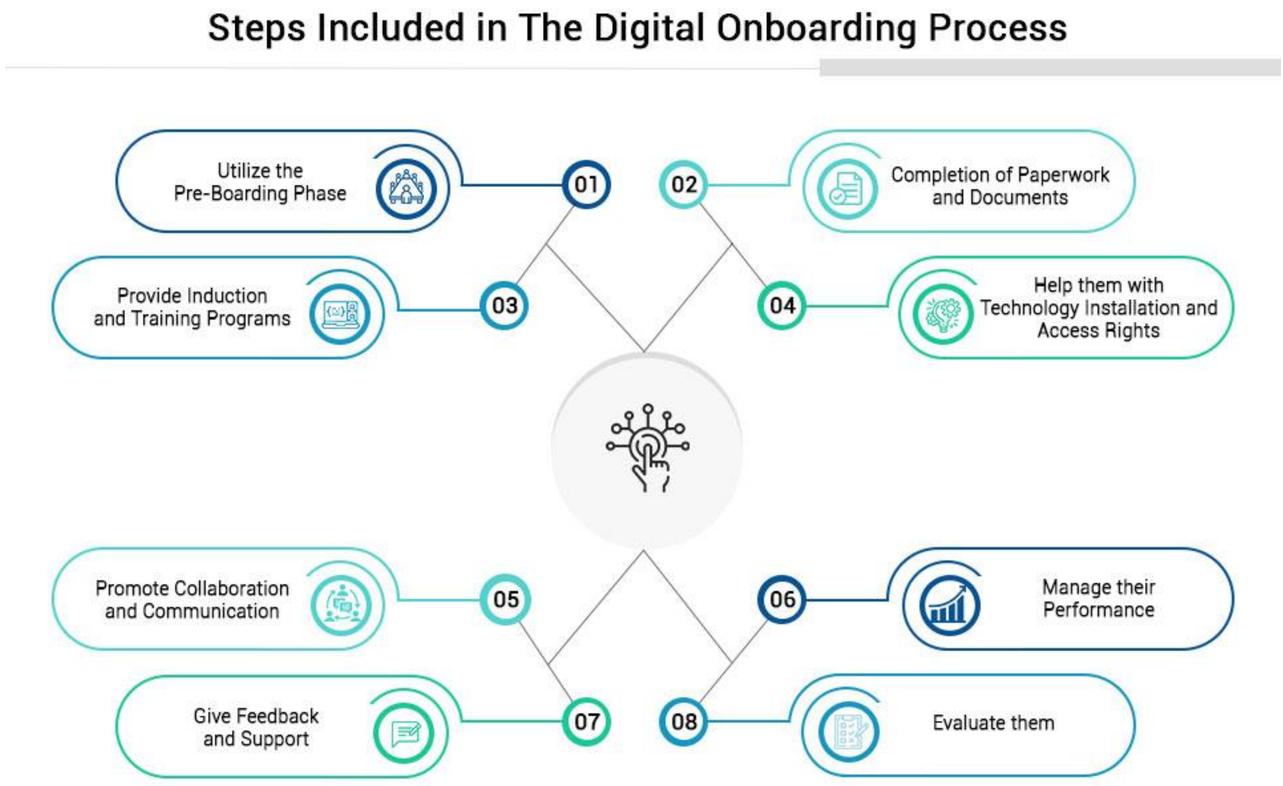

Figure 2. Workflow of digital onboarding and authentication in agricultural workforce management.

5. Future Perspectives

Future research focuses on expanding interoperability through artificial intelligence, distributed ledger technology, and federated learning [9]. AI models could autonomously detect anomalies in identification behaviour, while blockchain ensures immutable audit trails. These innovations will contribute to building a trustworthy and transparent digital agricultural ecosystem aligned with EU digital and ESG objectives [10].

6. Conclusions

The study confirms that ID&Trust's remote KYC/SCA technologies can modernize agricultural workforce management. By ensuring legal compliance, data protection, and administrative efficiency, such systems represent a key step toward smart agriculture. The integration of secure digital identity verification fosters sustainability, fairness, and innovation across European agricultural operations.

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