

and a rice processing line. Although this structure provides strong operational support for modern rice production, it also explains why many smaller organizations and ordinary farming households cannot easily replicate such a model independently.

Existing research supports this concern. Studies on agricultural mechanization and grain production efficiency in China have repeatedly shown that although machinery can improve productivity and operational efficiency, high acquisition and upgrading costs remain major barriers, especially in regions characterized by small farm sizes and uncertain returns (Liu and Li, 2023; Li et al., 2024). Advanced grain dryers, intelligent transplanting systems, plant-protection machinery, and digital management equipment require not only initial investment, but also continuous expenditures for maintenance, fuel, electricity, repair, and replacement.

For Mashan Agricultural Service Center, this means that future development depends on maintaining a balance among policy support, service income, and operational scale. If service demand decreases, it becomes more difficult to absorb high fixed costs. Conversely, if machinery technology upgrades too quickly relative to local service revenues, the center may face financial pressure despite maintaining advanced equipment. Therefore, capital intensity is not simply an issue of investment; it is also a long-term issue of operational sustainability.

6.2 Shortage of professional agricultural machinery technicians

The Mashan materials indicate that the center currently employs seven full-time workers and maintains a 100% certification rate among machinery operators. While this reflects a relatively standardized management structure, it also reveals an important vulnerability. A limited number of technical personnel are expected to support multiple services simultaneously, including seedling cultivation, machinery dispatching, machinery maintenance, pest-control coordination, grain drying, storage management, and farmer training.

As agricultural service systems become more integrated and digitalized, the demand is no longer limited to machine operators alone. Service centers increasingly require multi-skilled technicians capable of managing scheduling systems, field operations, equipment repair, drying control, safety supervision, operational records, and digital agricultural platforms.

This issue has already been recognized in recent agricultural modernization research. Studies on smart agricultural machinery and digital farming systems show that many service organizations still face barriers related to technical training, digital literacy, management ability, and operational competence (Gong et al., 2024; Hashim et al., 2024; Li et al., 2024). The effectiveness of advanced agricultural machinery does not depend solely on subsidies or equipment ownership. It also depends heavily on whether operators and service personnel can use the technology effectively under practical farming conditions.

For Mashan, this suggests that human-resource limitations may become the next major bottleneck after machinery investment. Even well-equipped service centers may struggle to achieve their expected efficiency if they lack enough qualified personnel capable of operating, maintaining, and coordinating modern agricultural systems. As the center moves toward more quality-oriented and digitalized production models, the importance of technical talent will continue to increase.

6.3 Differences in mechanization levels among small-scale farmers

Although regional agricultural service centers can reduce inequality in technology access, they cannot completely eliminate differences among farmers. In practice, smallholder farms still differ greatly in land fragmentation, road accessibility, irrigation conditions, willingness to pay for services, awareness of quality-oriented production, and acceptance of standardized farming management.

Research on agricultural socialized services in China has consistently shown that service outcomes vary according to regional conditions, land fragmentation levels, and household characteristics. Farmers with stronger production orientation, lower land fragmentation, or higher digital capability often benefit more quickly from mechanized services (Liao et al., 2025; Zeng et al., 2025).