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Implementation of Lean and Ergonomics in the Socialization of Increasing Productivity in Horticultural Nursery Businesses

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ABSTRACT
This community service activity aims to increase the efficiency and productivity of horticultural nursery businesses through the application of Lean principles and ergonomic improvements. The outreach was conducted at CV. Roberkat's nursery business is located in Huta Paung, Pollung District, Humbang Hasundutan Regency, North Sumatra. This business partner produces a minimum of 40,000 vegetable seedlings (chili, cabbage, potato) per day and serves farmers from various regions. The main problems identified included irregular workplace layout, wasteful movement and transportation due to long material storage distances, and complaints of physical fatigue among workers. The implementation method used a descriptive qualitative approach with participatory action methods through training, simulations, direct mentoring, and the application of Lean tools such as 5S, Value Stream Mapping (VSM), Kaizen, and Just-In-Time (JIT). The results of the activity showed that the implementation of 5S successfully reorganized the workplace, moving planting media and compost closer to the production area, thereby reducing worker travel distances. Waste identification using VSM found wasteful transportation, unnecessary movement, and waiting time. Ergonomic improvements reduced risky work postures and worker fatigue. In conclusion, the socialization and implementation of Lean and ergonomics have been proven to increase work efficiency, reduce waste, improve worker comfort, and encourage a mindset of continuous improvement (Kaizen) in horticultural nursery businesses.

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1. INTRODUCTION

The horticultural sector has become one of the strategic pillars in supporting food security, regional economic growth, and agricultural sustainability in Indonesia. The government's Food Estate program, implemented in several regions, including Humbang Hasundutan Regency, North Sumatra, has accelerated the growth of agricultural activities, especially horticultural cultivation and seedling production. The increasing demand for superior vegetable seedlings such as chili, cabbage, and potatoes has encouraged the rapid development of horticultural nursery businesses around the Food Estate area. As a result, nursery enterprises are required to improve their production capacity, efficiency, and service quality to meet farmers' needs. In this context, productivity improvement in horticultural nursery businesses becomes highly important because the quality and availability of seedlings directly influence agricultural yields and farmer welfare.

The horticultural nursery industry plays a crucial role in providing high-quality seedlings that determine the success of crop production. A nursery process that is ineffective and inefficient may lead to delays in planting schedules, seedling damage, increased operational costs, and reduced product quality. In many small and medium-scale nursery businesses, operational activities are still carried out conventionally without systematic management of workflow, material handling, inventory, and workplace organization. Such conditions often create various forms of waste, including unnecessary movement, waiting time, overstocking, defects, and inefficient transportation. Consequently, productivity decreases while operational expenses increase. Therefore, introducing management

approaches that focus on efficiency and waste reduction is essential for improving the competitiveness of horticultural nursery businesses. [1][2][3].

One of the approaches widely used to improve operational efficiency is Lean Manufacturing or Lean Management. Lean emphasizes the elimination of activities that do not add value to the production process while continuously improving workflow efficiency and product quality. Originally developed in the manufacturing sector, Lean principles have gradually been adopted in various industries, including services, healthcare, logistics, and agriculture. The implementation of Lean focuses on identifying and reducing waste, optimizing resource utilization, improving process flow, and increasing customer value. Through these principles, organizations are expected to achieve higher productivity with lower operational costs and improved service quality.

Several previous studies have demonstrated that Lean implementation can significantly improve production efficiency and operational performance. Proença and Lima explained that Lean optimization techniques contribute to improving production flow and logistics management efficiency in agricultural businesses. Similarly, Martins introduced the concept of Lean Farm, emphasizing the application of Lean tools and concepts in agricultural production systems to reduce inefficiencies and improve productivity. In manufacturing industries, Syakhroni et al. also reported that Lean Manufacturing successfully reduced waste and improved process performance in plywood production. These studies indicate that Lean principles have broad applicability and can be adapted to different sectors, including agriculture and horticulture.

In addition to Lean principles, ergonomics is another important factor influencing productivity and worker performance in agricultural activities. Ergonomics focuses on designing work systems, tools, and environments that fit human capabilities and limitations. In agricultural operations, poor ergonomic conditions often lead to worker fatigue, musculoskeletal disorders, and decreased productivity. Oliveira and colleagues emphasized that the integration of Lean Production and ergonomics can create synergy in improving productivity and working conditions simultaneously. Furthermore, Possebom et al. highlighted the importance of ergonomic assessment in agricultural machinery operations to reduce occupational health risks and improve worker efficiency. Therefore, combining Lean implementation with ergonomic improvement can provide more comprehensive benefits for nursery businesses.

Although studies related to Lean implementation in agriculture have been increasing, research specifically focusing on horticultural nursery businesses remains limited. Most previous studies primarily examined Lean applications in manufacturing industries or large-scale agricultural production systems. Meanwhile, the nursery sector, especially small and medium-scale horticultural nurseries, has received relatively little academic attention. This indicates a research gap regarding how Lean principles can be adapted and implemented effectively in nursery operations that involve manual handling, seed preparation, media arrangement, and intensive labor activities. Thus, more practical and contextual studies are needed to explore Lean implementation in horticultural nursery environments.

Another limitation of previous studies is that many of them focused only on operational efficiency without considering ergonomic aspects and worker welfare. In reality, nursery activities involve repetitive movements, manual lifting, prolonged standing, and awkward working postures that may negatively affect workers' physical conditions. If Lean implementation only emphasizes speed and productivity without improving workplace ergonomics, it may create additional physical burdens for workers. Therefore, integrating Lean concepts with ergonomic approaches becomes important to ensure that productivity improvements are achieved without compromising worker health and safety. This integration remains insufficiently explored in previous studies, particularly in horticultural nursery businesses.

From a practical perspective, horticultural nursery businesses also face several operational problems that require immediate solutions at CV. Roberkat nursery business, for example, increasing customer demand has created challenges related to workflow organization, material placement, inventory management, and worker movement efficiency. Workers often spend excessive time transporting planting media and arranging seedlings due to poor workplace layout. In addition, the distance between storage areas and nursery locations contributes to unnecessary motion and transportation waste [3]. Such inefficiencies may reduce operational productivity and increase worker fatigue [4][5][6]. Consequently, practical interventions are needed to help nursery businesses improve efficiency and maintain sustainable productivity growth.

The implementation of Lean principles through socialization, training, and direct mentoring is considered a practical solution to address these challenges. Lean tools such as Value Stream Mapping (VSM), 5S, Kaizen, and Just-In-Time (JIT) can help identify waste sources, improve workplace organization, optimize process flow, and increase operational efficiency. At the same time, ergonomic improvements can enhance worker comfort, reduce physical strain, and improve overall work performance. By applying these approaches simultaneously, horticultural nursery businesses are expected to achieve better productivity, lower operational costs, and improved seedling quality. Furthermore, the implementation of Lean and ergonomics may support the sustainability of agricultural businesses by promoting more efficient resource utilization and environmentally friendly operations.

Based on the background and existing research gaps, this study is important because it provides practical insights into the implementation of Lean principles and ergonomics in horticultural nursery businesses, a sector that has been relatively underexplored in previous studies. This study not only contributes to the development of Lean applications

in agricultural contexts but also offers practical solutions for improving nursery productivity and worker welfare. Moreover, the study supports sustainable agricultural development by encouraging efficient operational management in horticultural production systems.

Therefore, the purpose of this study is to socialize and implement Lean principles in the horticultural nursery business at CV. Roberkat in order to identify operational waste, improve work efficiency, reduce unnecessary activities, optimize workplace ergonomics, and ultimately increase productivity and nursery yields. The study also aims to evaluate the effectiveness of Lean tools such as 5S, Value Stream Mapping, Kaizen, and Just-In-Time in improving operational performance and supporting the sustainability of horticultural nursery businesses.

2. METHOD

This study used a qualitative descriptive approach with a participatory action method through community service activities conducted at the horticultural nursery business CV. Roberkat, located in Huta Paung, Pollung District, Humbang Hasundutan Regency, North Sumatra. The qualitative descriptive approach was chosen because this study aimed to describe the implementation process of Lean principles in nursery business activities, identify operational waste, and explain changes in work efficiency and productivity after the implementation of Lean concepts [7]. Meanwhile, the participatory action approach was applied because the activities involved direct interaction between the community service team, business owners, and workers in identifying problems, implementing improvements, and evaluating the outcomes collaboratively.

The study was conducted on Monday, July 21, 2025, involving the owner of CV. Roberkat and eight nursery employees as participants. CV. Roberkat was selected as the research location because it is one of the active horticultural nursery businesses supporting the Food Estate program in Humbang Hasundutan Regency and experiences high production demand every day. The nursery produces and distributes approximately 40,000 vegetable seedlings daily, including chili, cabbage, and potato seedlings, to farmers from various districts both inside and outside the regency. The high operational intensity and manual production activities made this nursery an appropriate location for analyzing the implementation of Lean principles and ergonomic improvements.

The implementation of this study consisted of three main stages, namely the preparation stage, implementation stage, and evaluation and reporting stage. During the preparation stage, the research team conducted preliminary observations and field surveys to understand the existing operational conditions in the nursery business. This stage included identifying workflow patterns, workplace layout, material handling systems, worker movements, production bottlenecks, and ergonomic risks experienced by employees. In addition, interviews and informal discussions were conducted with the business owner and workers to identify operational challenges and inefficiencies occurring during nursery activities.

The implementation stage focused on the socialization and application of Lean principles in the nursery production process. The socialization activities were carried out through direct training sessions, simulations, discussions, and mentoring activities involving all participants. The materials presented included the concept of Lean Manufacturing, identification of the seven wastes (overproduction, waiting, transportation, overprocessing, inventory, unnecessary motion, and defects), implementation of 5S principles, Value Stream Mapping (VSM), Kaizen, and Just-In-Time (JIT) concepts. Participants were also introduced to ergonomic principles related to workplace arrangement, working posture, and material handling techniques to improve worker comfort and reduce physical fatigue.

Data collection in this study used observation, interviews, documentation, and direct field measurements [8]. Observations were conducted to identify operational workflows, worker movements, workplace organization, and production activities before and after Lean implementation [9]. Interviews were conducted with the owner and employees to obtain information regarding operational obstacles, work experiences, and perceptions of Lean implementation [10], [11]. Documentation techniques included collecting photographs, activity records, workplace layouts, and process flow diagrams to support data analysis [12]. Direct measurements were also carried out to evaluate changes in work efficiency, including material transportation distance, time required for work activities, workplace arrangement efficiency, and productivity improvements after implementing Lean principles [13].

The study also applied Value Stream Mapping (VSM) as an analytical tool to identify activities that added value and activities categorized as waste within the nursery production process. Through VSM analysis, the research team mapped the flow of materials, information, and work processes from seed preparation to seedling distribution. This analysis helped identify bottlenecks, unnecessary transportation, waiting time, and inefficient workplace arrangements that reduced productivity. Based on the findings, several improvement strategies were developed collaboratively with the participants to optimize workflow efficiency and reduce waste.

In addition, ergonomic analysis was conducted to evaluate worker posture, movement patterns, and physical workload during nursery activities. Ergonomic assessment focused on identifying work activities with potential risks of fatigue and musculoskeletal discomfort caused by repetitive motion, manual lifting, prolonged standing, and awkward body posture. The results of ergonomic observations were used to redesign workplace arrangements, improve the placement of tools and materials, and optimize work methods to create a safer and more comfortable work environment for employees.

The implementation of Lean improvements was carried out gradually through direct mentoring and practical application in the workplace. Several improvement actions included rearranging planting media storage areas closer to the nursery location, implementing 5S principles to improve workplace organization, reducing unnecessary worker movement, optimizing material placement, and improving work procedures to minimize delays and inefficiencies. Kaizen principles were also introduced to encourage continuous improvement and increase worker participation in identifying operational problems and proposing practical solutions.

Data analysis in this study used descriptive qualitative analysis supported by simple quantitative comparisons [14], [15]. Qualitative analysis was conducted by interpreting observation results, interview findings, and documentation data related to operational changes after Lean implementation. Meanwhile, quantitative comparisons were used to evaluate changes in productivity, work efficiency, time reduction, and workplace organization improvements. The analysis focused on comparing operational conditions before and after the implementation of Lean principles and ergonomic improvements to determine their effectiveness in increasing nursery productivity and reducing operational waste.

To ensure data validity and reliability, this study applied triangulation techniques by comparing data obtained from observations, interviews, documentation, and direct measurements. Triangulation was conducted to confirm the consistency of findings from different sources and strengthen the credibility of the research results. In addition, continuous discussions with participants were carried out during the implementation process to verify findings and evaluate the effectiveness of the applied improvement strategies.

Through this methodological approach, the study was expected to provide a comprehensive understanding of how Lean principles and ergonomic improvements can be implemented effectively in horticultural nursery businesses to improve operational efficiency, reduce waste, enhance worker comfort, and increase overall productivity and nursery yields.

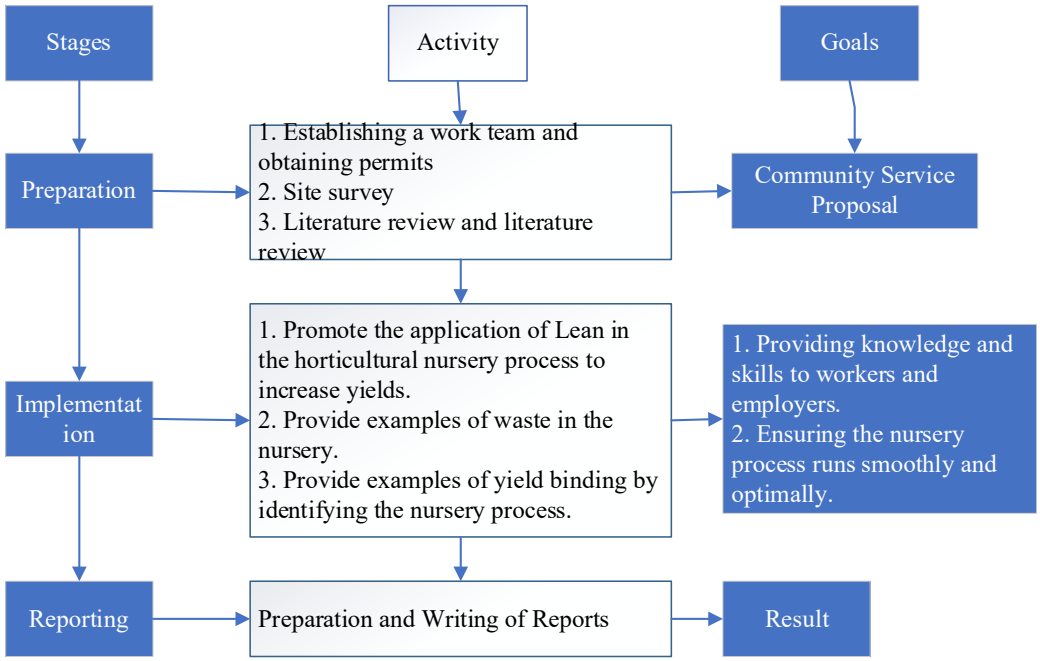

Figure 1. Flow Diagram

3. RESULTS AND DISCUSSION

3.1 Initial Operational Conditions in the Horticultural Nursery Business

The initial observations were conducted at CV. Roberkat showed that the nursery business experienced several operational inefficiencies during daily production activities. The production process involved seed preparation, planting media arrangement, seedling transfer, watering, and distribution activities carried out manually by workers. The workplace layout was not systematically organized, causing workers to spend excessive time transporting materials and moving between work areas. Compost and planting media storage areas were located relatively far from the seedling nursery area, creating unnecessary transportation and worker motion.

Field observations also indicated that workers frequently repeated movements while carrying planting media and arranging seedlings. Several tools and work materials were placed in unorganized locations, making workers spend additional time searching for equipment. During observations, some employees were seen manually transporting compost repeatedly over considerable distances between the storage area and nursery location. This condition reduced operational efficiency and increased worker fatigue.

Interview results with the business owner confirmed these operational problems. The owner stated:

"Workers often spend too much time moving materials from one place to another because the storage area is far from the nursery location."

Similarly, one employee explained:
"Sometimes we have to walk back and forth many times just to take planting media or tools because everything is placed separately."

These findings indicated that unnecessary movement and transportation waste became major operational problems affecting productivity in the nursery business.

3.2 Identification of Waste in Nursery Production Activities

The implementation of Value Stream Mapping (VSM) helped identify several forms of waste occurring in the nursery production process. Based on direct observations and workflow mapping, the research team identified waste related to transportation, waiting time, unnecessary motion, and inefficient workplace organization.

Transportation waste was found when workers carried planting media from distant storage areas to nursery locations repeatedly throughout the day. Waiting waste occurred when workers had to wait for the availability of tools or materials that were not properly organized. Motion waste appeared in the form of excessive worker movement caused by poor workplace layout and scattered work equipment.

Observation data showed that workers required longer operational time due to repeated transportation activities. Before workplace reorganization, workers frequently crossed the production area to retrieve materials and tools. The research team documented that the average material transportation activity involved repeated walking between the storage area and the seedling location during a single work cycle.

Documentation photographs also revealed that pallets, compost, and planting media were initially placed far from operational workstations. This arrangement created inefficient workflow patterns and increased physical workload among employees.

Figure 2. Placement compost as media and pallets as receptacles

Figure 3. The location of media and pallets with the nursery was far

3.3 Improvement of Workplace Organization Through 5S Implementation

The implementation of the 5S principles resulted in noticeable improvements in workplace organization and cleanliness. After the socialization and direct mentoring process, workers began reorganizing tools, materials, and planting media according to work needs and operational flow.

Observation results showed that the workplace became cleaner, more structured, and easier to navigate. Planting media and compost were relocated closer to the nursery production area to reduce transportation distance. Frequently used tools were arranged systematically near workstations to minimize unnecessary worker movement.

One worker stated:

"After the tools and materials were arranged properly, our work became faster because we no longer needed to search for equipment repeatedly."

Another employee explained:

"The workplace feels cleaner and more comfortable now, and we can move more easily while working."

Field observations also documented a reduction in the time required to locate tools and materials. The owner reported that work activities became more organized after the implementation of 5S practices. According to observation records, the time spent searching for tools and materials decreased significantly after workplace rearrangement. The implementation of 5S also improved seedling management conditions. Seed trays and planting materials were arranged more systematically, making monitoring and maintenance activities easier for workers.

3.4 Changes in Work Efficiency After Lean Implementation

The application of Lean principles through Value Stream Mapping, workplace reorganization, and workflow improvement contributed to increased operational efficiency. Several unnecessary activities identified during the initial observation stage were successfully reduced after implementing process improvements.

The relocation of compost and planting media storage areas closer to nursery locations reduced transportation activities and worker travel distance. Observation results showed that workers could complete material preparation activities more quickly compared to previous operational conditions. The production flow became smoother because work materials were available closer to operational areas.

One employee explained:

"Previously, carrying compost took a lot of time because the location was far away. Now the materials are closer, so the work is much faster."

The business owner also reported operational improvements after Lean implementation:

"Workers are now more efficient, and nursery activities run more smoothly than before."

Based on direct field measurements, operational efficiency improved after workplace layout adjustments and process simplification. The reduction of unnecessary movement and waiting time contributed to faster workflow completion during nursery activities.

Figure 5. Compost as a medium is placed close to the nursery location.

3.5 Ergonomic Improvements and Worker Comfort

Ergonomic observations conducted during the study showed that workers initially experienced physical discomfort caused by repetitive movements, prolonged standing, and manual lifting activities. Several work activities required workers to bend repeatedly while arranging seedlings and transporting planting media manually.

After ergonomic improvements were introduced, work activities became more comfortable for employees. Planting materials and tools were repositioned according to worker reach and workflow patterns. Workstations were adjusted to reduce excessive bending and repetitive movements during nursery operations.

One worker stated:

"The new arrangement makes our work less tiring because materials are easier to reach."

Another employee explained:
"Previously, we often felt tired because we had to carry materials repeatedly over long distances. Now the work feels lighter."

Field observations also showed smoother worker movement and reduced congestion in production areas after workplace reorganization. Employees appeared to move more efficiently during operational activities, and the work environment became safer and more comfortable. [6].

Figure 6. Arrangement of seeds with ergonomics

3.6 Increased Productivity in Nursery Operations

The implementation of Lean principles and ergonomic improvements contributed to increased productivity in the nursery business. According to observations and reports from the business owner, nursery operations became more organized and efficient after the socialization activities.[3]. The owner explained:

"After applying these improvements, work activities became faster and more efficient, and the production process could be managed better."

Observation records also showed that the nursery environment became cleaner and more structured, supporting smoother operational activities. Workers completed daily production tasks more effectively due to reduced unnecessary movement and improved workplace organization.

The implementation of Lean practices also encouraged workers to become more aware of efficiency and continuous improvement during operational activities. Employees began actively maintaining workplace cleanliness, organizing tools properly, and improving coordination during work processes.

Overall, the results demonstrated that the socialization and implementation of Lean principles in the horticultural nursery business positively affected workplace organization, operational efficiency, worker comfort, and productivity improvement at CV. Roberkat.

Figure 7. Socialization together with the owner's CV. Roberkat's business and employees

Figure 8. ISTP lecturers and students visit the nursery location

4. DISCUSSION

The findings of this study demonstrate that the implementation of Lean principles in horticultural nursery businesses can significantly improve operational efficiency, workplace organization, worker comfort, and productivity. The results indicate that operational problems at CV. Roberkat was primarily caused by inefficient workplace layouts, excessive worker movement, poor material organization, and non-value-added activities. Through the implementation of Lean tools such as 5S, Value Stream Mapping (VSM), Kaizen, and Just-In-Time (JIT), these inefficiencies were reduced, resulting in smoother workflow processes and better productivity performance. These findings confirm that Lean principles are not only applicable in manufacturing industries but can also be effectively adapted to labor-intensive agricultural environments such as horticultural nursery businesses.

The improvement in workplace organization after implementing 5S supports Lean theory, which emphasizes that workplace orderliness and standardization contribute directly to operational efficiency and productivity improvement. The reduction in time spent searching for tools and transporting materials reflects the elimination of non-value-added activities, which is one of the primary objectives of Lean implementation. These findings are consistent with the study conducted by Ertuğrul et.al., regarding Lean Farm applications, which explained that systematic workplace management and waste reduction can improve agricultural operational performance [16]. Similarly, Solano et.al. found that Lean optimization techniques help streamline production flow and logistics processes in agricultural activities [17]. Therefore, the current study strengthens previous evidence that Lean concepts are highly relevant for agricultural operational management.

The identification of transportation waste, unnecessary movement, and waiting time in nursery operations also supports the core assumptions of Lean theory proposed in manufacturing and operational management literature. Lean theory explains that waste in production systems reduces productivity and increases operational costs. In this study, the relocation of planting media and compost closer to production areas successfully reduced transportation activities and worker travel distance. This finding aligns with the Value Stream Mapping concept, which focuses on identifying bottlenecks and eliminating activities that do not provide value to the production process. Consequently, the study confirms that even relatively simple operational adjustments can create measurable improvements in agricultural workflow efficiency.

In addition to supporting Lean theory, this study also expands the application of Lean concepts within the agricultural sector, particularly in small-scale horticultural nursery businesses. Previous studies have predominantly focused on Lean implementation in manufacturing industries or large-scale agricultural production systems. However, this study demonstrates that Lean principles can also be adapted successfully to smaller and more labor-intensive operational settings [18]. The findings suggest that Lean implementation does not necessarily require sophisticated technology or large financial investment. Instead, practical workplace reorganization, process simplification, and worker involvement can already generate substantial operational improvements. In this sense, the study expands existing Lean implementation literature by providing empirical evidence from the horticultural nursery sector, which remains underrepresented in previous research.

Another important finding of this study is the integration of ergonomic improvements within Lean implementation activities. The results revealed that workers initially experienced fatigue and discomfort due to repetitive movement, prolonged standing, and inefficient workplace arrangements. After ergonomic adjustments were introduced, workers reported improved comfort and reduced physical burden during operational activities. This

finding supports the argument proposed by Brito et.al. and colleagues that Lean production and ergonomics can create synergistic effects in improving productivity and working conditions simultaneously [19]. The study also confirms previous ergonomic research conducted by Possebom et al., which emphasized the importance of workplace design and posture assessment in agricultural operations.

However, this study does not merely support previous theories but also extends the understanding of how ergonomics can strengthen Lean implementation in agricultural contexts. Many previous Lean studies mainly focused on operational efficiency and waste reduction without sufficiently addressing worker welfare and physical workload. The findings of this study indicate that operational efficiency and worker comfort are interconnected rather than contradictory objectives. Improvements in workplace layout and material positioning not only reduced waste but also minimized worker fatigue and repetitive movement. Therefore, the study expands the theoretical perspective that Lean implementation in labor-intensive agricultural businesses should incorporate ergonomic considerations to achieve sustainable productivity improvement.

The findings of this study explicitly answer the research objective regarding whether Lean implementation can improve efficiency and productivity in horticultural nursery businesses. The results demonstrate that the socialization and application of Lean principles successfully reduced operational waste, improved workplace organization, increased workflow efficiency, and enhanced worker comfort. Furthermore, the implementation encouraged workers to adopt a more systematic and continuous improvement-oriented mindset. This indicates that Lean implementation is not limited to technical operational changes but also influences organizational behavior and work culture within nursery operations.

From a scientific perspective, this study contributes to the development of Lean implementation literature in non-manufacturing environments, particularly within horticultural nursery businesses. The study provides empirical evidence that Lean principles can be adapted effectively in small and medium-scale agricultural enterprises with relatively simple operational structures. Additionally, the integration of ergonomics into Lean implementation contributes to interdisciplinary discussions between operational management and occupational health within agricultural systems. This contribution is important because many previous studies have treated operational efficiency and worker welfare as separate issues rather than integrated management concerns.

Practically, the findings offer several applicable implications for nursery business owners and agricultural practitioners. First, a simple workplace reorganization based on 5S principles can significantly improve workflow efficiency without requiring expensive technological investment. Second, placing frequently used materials closer to operational areas can reduce worker fatigue and improve productivity. Third, involving workers in continuous improvement activities through Kaizen principles can encourage operational awareness and a long-term efficiency culture within agricultural businesses. These implications are particularly relevant for small-scale nursery enterprises that often operate with limited resources and manual production systems.

From a policy perspective, the findings suggest that agricultural development programs, including the Food Estate initiative, should incorporate operational management training and ergonomic awareness into farmer empowerment activities. Government agencies and agricultural institutions can support nursery businesses not only through production assistance but also through managerial capacity building focused on efficiency improvement and sustainable workplace practices. Such interventions may improve agricultural productivity while simultaneously protecting worker health and welfare.

Nevertheless, this study has several limitations that should be acknowledged honestly. First, the study was conducted only in a single horticultural nursery business with a limited number of participants, which may reduce the generalizability of the findings to other agricultural settings. Second, the duration of the implementation and observation process was relatively short, making it difficult to evaluate the long-term sustainability of Lean practices within nursery operations. Third, the study primarily relied on qualitative observations and simple operational measurements rather than comprehensive quantitative productivity analysis. Therefore, the findings mainly describe practical implementation outcomes rather than statistically measurable productivity relationships.

Future research should build upon these findings by examining long-term Lean implementation in multiple horticultural nursery businesses across different agricultural regions. Comparative studies between nurseries that implement Lean principles and those using conventional operational systems may provide stronger evidence regarding productivity improvement and operational efficiency. In addition, future studies should explore quantitative ergonomic measurements, worker fatigue analysis, and economic performance indicators to better understand the relationship between Lean implementation, worker welfare, and financial sustainability in agricultural operations. Further research may also investigate how digital technologies and smart farming systems can be integrated with Lean principles to optimize nursery management in modern agricultural environments.

5. CONCLUSION

Based on the results of the community service activities implemented, the following conclusions can be drawn:

1. Improved Process Efficiency: Lean socialization and training successfully helped business owners and workers identify non-value-added activities (waste) in the nursery process. This impacted time and energy efficiency, especially after the relocation of compost and planting media storage.
2. Waste Reduction: The introduction of Lean principles such as 5S and Just-In-Time enabled workers to reduce material waste, waiting time for tools, and errors in the nursery process. A tidier layout also minimized unnecessary movement.
3. Increased Productivity and Seedling Quality: A more organized work environment through 5S and more standardized processes contributes to increased daily productivity and produces healthier and more uniform seedlings.
4. Change in Worker Mindset: Socialization activities encourage workers to think more systematically and focus on continuous improvement (Kaizen), pursuing not only short-term results but also long-term efficiency.
5. Potential for Replication and Sustainability: This Lean and ergonomics implementation model shows potential for replication in other farmer groups or small- to medium-scale nursery businesses, and can be part of a community empowerment strategy based on efficiency and quality.

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