

Fertigation for Economic Growth: A Case Study of Chilli Cultivation by a Local Community Entrepreneur

Meor Hasmadi Meor Hamzah¹, Nadzri Mohd Sharif², Nor Fariza Baharuddin³, Liza Marziana Mohd Noh⁴, Fahmi Samsudin⁵

Faculty of Art and Design, University Technology MARA (UiTM) Malacca Branch, Malaysia

*Corresponding Author

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ABSTRACT

This study investigates the implementation of a chilli fertigation system by a local entrepreneur in Melaka, contextualised within sustainable agriculture and rural entrepreneurship. A qualitative case study design utilising interviews, field observations, and production records was employed to document individual experiences and communal effects. The study used a comparative approach, assessing the outcomes of the UiTM-assisted entrepreneur in relation to four local farmers who independently implemented the same system. Research indicates that fertigation increased chilli yields by 30-40%, improved fruit consistency, and minimised input wastage through more efficient utilisation of water and fertilisers. The entrepreneur sponsored by UiTM and a comparable farmer (Azam) attained the best yields (13-14 tonnes/ha) and profitability (35-38%), facilitated by technical training and market access. Conversely, Andre and M. Asrol achieved diminished yields (10-11.5 tonnes/ha) and profitability (20-25%) attributable to equipment malfunctions, nutritional deficiencies, pest infestations, and dependence on local markets. The growth performance and pest management were more uniform in the UiTM-associated initiative, but independent adopters had inconsistent canopy development, postponed fruiting, and increased insect prevalence. The findings underscore the enhanced benefits of institutional collaboration, facilitating knowledge transfer, systematic oversight, and reinforced buyer connections. The study indicates that fertigation has significant potential to improve rural livelihoods and foster community-based economic growth; nevertheless, sustained adoption necessitates organised support structures that encompass technical assistance, financing, and guaranteed market access.

Keywords: Chilli fertigation, rural entrepreneurship, sustainable agriculture, institutional collaboration, profitability, Malaysia

INTRODUCTION

Agriculture is essential to Malaysia's rural economy, impacting livelihoods and sustaining communities (Ahmad et al., 2021; Hassan & Shamsudin, 2022). Conventional agricultural methods often do not meet rising demand due to inadequate production, inconsistent crop quality, high water usage, and vulnerability to pests and diseases (Rahman et al., 2023; Zainal et al., 2021). To address these difficulties, various irrigation technologies like fertigation have been implemented. Fertigation, the simultaneous application of water and fertiliser using controlled irrigation systems, provides numerous advantages, including improved fertiliser uptake, less water waste, and alleviated environmental issues such as nutrient leaching (Rahman et al., 2023; Yahya et al., 2020).

Chilli (*Capsicum annum* L.) is a prominent horticultural crop in Malaysia, valued for its role in local cuisine and its increasing economic significance (Department of Agriculture Malaysia, 2022). Research indicates that fertigation can enhance chilli yields by three to fourfold relative to conventional approaches, improve fruit uniformity, and reduce input wastage (Sivamurugan et al., 2020; Tan et al., 2021). Nonetheless, the efficacy of

fertigation is significantly influenced by farmers' financial preparedness, access to market knowledge, and technical expertise (Salleh et al., 2024; Abdullah et al., 2019). Notwithstanding its evident advantages, the adoption by smallholders is constrained by elevated initial setup expenses, the apparent intricacy of the system, and inadequate familiarity with contemporary agricultural methodologies (Mustafa et al., 2022; Ismail et al., 2020).

This study investigates the application of chilli fertigation by local entrepreneurs in Melaka, with a particular focus on a community effort executed in partnership with Universiti Teknologi MARA (UiTM) Cawangan Melaka. It used a comparative methodology to juxtapose the results of the UiTM-supported effort with those of other local farmers who independently implemented fertigation. This dual analysis enables the assessment of both the technical and economic benefits of fertigation, together with the enhanced value of institutional partnership in promoting smallholder adoption. The results highlight the significance of information transmission, technical assistance, and market connections in maintaining acceptance by evaluating variations in yield, profitability, crop development, pest and disease control, and soil fertility (Salleh et al., 2024; Rahman et al., 2023). The study emphasises that fertigation, in conjunction with organised support systems, can enhance rural livelihoods, promote community entrepreneurship, and bolster sustainable agricultural development in Malaysia (Mustafa et al., 2022; Sivamurugan et al., 2020).

Problem Statement

Agriculture is an essential element of Malaysia's rural economy, maintaining livelihoods and ensuring food security (Ahmad et al., 2021; Hassan & Shamsudin, 2022). However, conventional farming methods are increasingly inadequate in meeting the demands of a growing population and evolving market expectations. Ongoing challenges, including diminished productivity, variable crop quality, ineffective water utilisation, and susceptibility to pests and diseases, persistently obstruct agricultural advancement (Rahman et al., 2023; Zainal et al., 2021). These difficulties hinder farmers' capacity to sustain stable earnings and diminish the overall competitiveness of Malaysia's agriculture sector amid modernisation and climate change.

To mitigate these limitations, sophisticated irrigation techniques like fertigation have been implemented as a sustainable alternative. Fertigation, the integration of fertiliser and water application via a regulated irrigation system, presents numerous benefits, including enhanced nutrient absorption, decreased water waste, and mitigated environmental effects like as nutrient leaching (Rahman et al., 2023; Yahya et al., 2020). Prior research indicates that fertigation can substantially elevate chilli yields by as much as three to four times relative to traditional methods while improving fruit uniformity and reducing production losses (Sivamurugan et al., 2020; Tan et al., 2021). Notwithstanding these advantages, the uptake among smallholder farmers in Malaysia remains constrained.

The primary obstacles to fertigation implementation are diverse, including substantial initial investment, insufficient technical knowledge, and limited access to financing and market networks (Salleh et al., 2024; Abdullah et al., 2019). Numerous smallholders perceive fertigation as a complicated and expensive procedure, especially in the absence of institutional support or formal training. The absence of organised capacity-building initiatives and ineffective knowledge transfer systems impede broad acceptance and enduring sustainability (Mustafa et al., 2022; Ismail et al., 2020). Thus, the revolutionary potential of fertigation to enhance smallholder productivity and fortify rural economies remains underexploited.

METHODOLOGY

This research utilised a qualitative case study methodology to attain a comprehensive understanding of the lived experiences of a local entrepreneur who implemented a chilli fertigation system in state of Melaka, as well as other local farmers who attain the same system of fertigation. A case study methodology was considered suitable since it facilitates the examination of intricate, real-world scenarios where several factors technological, economic, and social converge to influence the results of agricultural innovation. This design does not try to make broad statements about a big group of people. Instead, it focusses on getting detailed, contextualised information about how fertigation is used, kept up, and understood at the grassroots level.

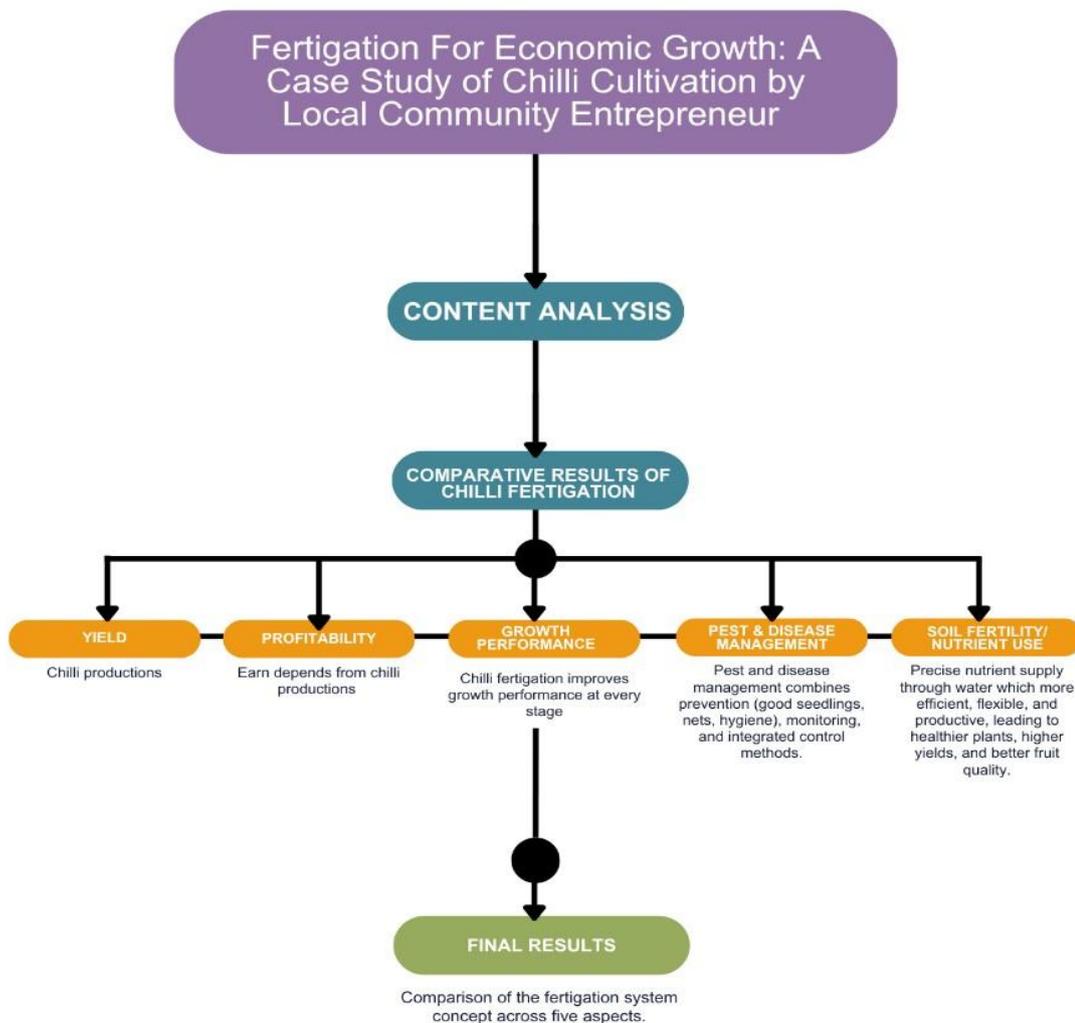


Figure 1; Framework of study

The participant was intentionally chosen due to their active utilisation of the chilli fertigation system for a minimum of one complete planting cycle. This criterion assured that the entrepreneur had both hands-on expertise with the technology and a connection to the local community, which made them a good case for the study. Their position as early adopters in the community also gave us a unique chance to look at how individual innovation might affect peer learning and encourage more general farming practices.

The collecting of data used several sources to make sure it was correct by using triangulation. The main method used was semi-structured interviews, which let the researcher ask the local farmer about their reasons for using fertigation, the benefits they saw from the system, the problems they faced in their daily work, and how much their efforts got the community involved. These interviews gave us a deeper understanding of both individual experiences and larger social and economic effects. In addition to the interviews, direct inspections on-site were made to record the physical layout of the fertigation system, the state of the crops, and the regular maintenance tasks. This strategy enabled the researcher to validate the entrepreneur's narratives with visual and empirical facts. This study as also looked at yield collections, profitability, growth performance, pest and disease management, and soil fertility and nutrient use. The combination of these three sources interviews, observations, and documented evidence made the conclusions more believable and gave a whole picture of the case.

RESULTS AND DISCUSSION

The use of the chilli fertigation system in Taman Seri Sutera demonstrates notable improvements in productivity, resource efficiency, and farmer welfare. The entrepreneur asserted that output improvements of 30%-40% were achieved compared to traditional open-field cultivation, along with enhanced consistency and fruit quality.

Fertiliser and water inputs were employed more efficiently, reducing waste and enabling long-term cost savings. However, challenges such as significant initial setup costs, ongoing maintenance, and technical troubleshooting persisted, especially in the absence of dependable expert support. This section contrasts the experiences of four additional local farmers utilising the same fertigation technology across key performance criteria for a comprehensive viewpoint.

Comparative Findings

The table below presents the comparative results of five farmers, including the case entrepreneur, who implemented chilli fertigation. In all instances, fertigation enhanced yield, with the majority of farmers achieving between 11.5 and 14 tonnes per hectare, in contrast to the conventional norm of 8-9 tonnes. Profitability exhibited a same pattern, with margins between 20% and 38%, while farmers possessing superior technical expertise and enhanced market access, exemplified by Azam, attained the largest returns. The growth performance was predominantly consistent and robust; nevertheless, deficiencies in system management such as erratic fertigation scheduling or equipment malfunctions led to inconsistent canopy development and postponed fruiting for certain farmers. The pressure from pests and illnesses was reduced during fertigation, especially for soil-borne diseases; nonetheless, farmers lacking constant monitoring continued to encounter difficulties from pests such as aphids and whiteflies. Fertigation significantly improved soil fertility and nutrient management efficiency; nevertheless, technical faults, such poor mixing or blocked drippers, diminished the advantages in some instances. The table 1 illustrates that although fertigation reliably enhances productivity and efficiency, the degree of success is significantly influenced by farmers' technical expertise and system upkeep.

Table 1; Comparison of local farmers in each aspects in details

Farmer	Yield (Kg)	Profitability (%)	Growth Performance	Pest & Disease Management	Soil Fertility / Nutrient Use
Entrepreneur Collab with UiTM	50	35	Uniform strong, 90 – 100 days	Fewer fungal infections, manageable pests	Efficient, reduced leaching
Shahrul	400	30	Uniform, strong	Reduced soil-borne disease	Good efficiency
Andre	350	25	Uneven canopy, irregular growth	Aphid infestations	Nutrient imbalance from mixing issues
Azam	700	38	Uniform vigorous, consistent	Low pest pressure, effective IPM	Optimal nutrient uptake, minimal waste
M. Asrol	250	20	Delayed fruiting due to pump issues	High whitefly incidence	Clogged drippers, localized deficiencies

Produce Yield

The businessman in Taman Seri Sutera only harvested an average of 50 kg per cycle, much less than Shahrul 400 kg and Azam 700 kg. Azam higher yields were due to his or her bigger farming scale and better technical know-how. Overall, the entrepreneur's output stayed the second lowest. This was mostly because the project was still new and the farmed area was not very big, which limited total output even though the system was used efficiently. Andre and M. Asrol both had technical problems that limited their yields, like uneven fertilisation and broken equipment that caused them to produce 350 kg and 250 kg, respectively. Despite these differences, all five cases showed that fertigation produces more consistently and reliably than traditional systems, which usually fall far below these amounts. This supports what Sivamurugan et al. (2020) said.

Expenditure And Profitability

The initial prices of installing fertigation infrastructure ranged from RM25,000 to RM30,000 per hectare. However, the farmers' ability to make money varied based on the size of their farms, how they were managed,

and how easy it was for them to get to markets. The business owner said he made the least money, only about RM 3,000 per cycle (35%). This was mostly because the project was new and could only grow crops in a small area, which limited the total harvest amount. Shahrul made about RM4,000 (30%) thanks to steady yields and a network of stable buyers. Due to inconsistent fertigation methods and higher system repair costs, Andre, profit was a little lower at about RM 3,500 (25%). Azam made the most money, almost RM5,000 (38%), because his farm was bigger, he was better at technology, and he had better market access, which paid better quality all around. M. Asrol only made about RM 3,200 (20%) because his tools broke down and he had to rely on local markets with small profit margins. Overall, profits from the five cases ranged from RM 3,000 to RM 5,000 per cycle, which is a 20% to 38% increase over traditional systems. This shows that while fertigation increases profits, the level of success depends a lot on technical skill, how well maintenance is done, and access to high-value markets.

Development Efficacy

The growth of crops that were fertilised was always even and strong, and most farmers said that the plants were healthier and that the crop cycles were shorter than with traditional methods. Even though the business owner was working on a smaller scale, made good progress, as the plants grew strongly and consistently with cycles cut down to about 90-100 days. In the case of the entrepreneur, the project is still new, but it has already gotten a lot of attention and help from agriculture experts and related groups. This attention not only proves that the project has promise, but it also gives the business owner access to technical advice, monitoring, and suggestions that make the system work better. Shahrul and Azam both reported strong and steady growth, which shows that they knew more about how to keep the system running and had more experience doing so. Andre, on the other hand, had uneven canopy growth because the timing of the fertigation was off, and M. Asrol had delayed fruiting because of a problem with his equipment. These comparisons show that growth performance depends a lot on technical know-how and the dependability of the system. However, the entrepreneur's story shows that with the help of institutions and proactive learning, even a small project that just started can show good results early on and lay the groundwork for further growth.

Management Of Pests And Diseases

Soil-borne diseases were cut down by a lot because fertilisation kept crops from coming into direct contact with soil, which is a frequent way for fungal infections and nutrient-related stress to happen in traditional farming systems. The business owner and Shahrul both said that fungal diseases had gone down a lot, and

Azam said that pests were very low because integrated pest management (IPM) methods were being used consistently. Andre, on the other hand, had to deal with chronic aphid infestations that needed repeated chemical control, and M. Asrol had a hard time with high whitefly populations because he wasn't keeping an eye on them regularly. One interesting thing about the entrepreneur's case is that even though they were growing crops on a smaller scale, the smaller farm size made it easier to keep an eye on things and make sure they were in good shape. Because the entrepreneur had fewer plants to keep an eye on, they could check on the crops more often, spot early signs of disease, and use targeted interventions more effectively than farmers who were in charge of bigger plots. This helped the project get off to a good start by keeping pests and diseases under control before they could spread to more people. The entrepreneur's eagerness to learn and the ongoing help from farming experts and related organisations made monitoring even better, which made the project work reliably even in its early stages. These results show that fertigation systems need ongoing pest management no matter what size farm it is. However, smaller farms may benefit from more flexibility and closer supervision, which can improve plant health and lower risks compared to larger farms that are not closely watched.

Soil Fertility

The use of nutrients became much more efficient with fertigation because the method makes sure that the right amount of water and fertilisers are delivered, which cuts down on waste and leaching into the environment. The business owner, along with Shahrul and Azam, said that plants were usually absorbing nutrients well and growing steadily and healthily. One important difference, though, is the type of dirt that is used. It was possible for Shahrul and Azam, as well as others with bigger businesses, to buy large farmlands with fresh, rich soil that

naturally helped crops grow better. The business owner, on the other hand, had to settle for dirt from the market because didn't have enough money to buy new land. This method helped the project begin with less money, but it might not have been as good at keeping nutrients in the soil or making it last for a long time. Even so, the entrepreneur was able to closely watch how much fertiliser was used on a smaller scale, which helped some with the growing medium's limits. Andre had nutrient imbalances because of mistakes in mixing, which made plants less vigorous. M. Asrol had problems with clogged drippers and uneven nutrient distribution, which led to shortages in certain areas. Putting these results together shows that fertigation can make nutrient management much better in a number of situations. However, its benefits rely on both the farmers' technical knowledge and the quality of the soil or substrate they use. The entrepreneur's story shows that good tracking and direction can help get the most out of limited resources, though investing in better soil or substrates may be needed for scaling up in the long run.

CONSOLIDATION OF RESULTS

The combined study shows that fertigation greatly increases the yield, profitability, and efficiency of resource use in chilli farming. One thing that is clear, though, is that success is not the same for all farms. Azam who had a lot of technical knowledge and access to more markets did better, while M. Asrol who had problems with their tools or didn't have as many buyers got less impressive results. In this range, the business owner's project stands out as one of the newest and most important examples of the fertigation system idea in Melaka. The project is important because it was the first time that people from Universiti Teknologi MARA (UiTM) Cawangan Melaka worked together on something like this. It was small and had a limited budget, but it was meant to be a way for people in the community to learn from each other. With its wealth of knowledge, the faculty of agro-based studies at UiTM Cawangan Melaka has been a key part of this process of sharing information, not only by helping the business but also by giving students chances to learn by doing.

The entrepreneur's farm was not as big as those of more experienced farmers, which at first limited its ability to produce and make money. But this limitation is on purpose and needed at the pilot stage so that there can be better oversight, more thorough review, and the community can slowly build up its technical skills. Not only have the project's results been higher yields, but it has also successfully created a model of agricultural innovation that other farmers in the area can use to learn and copy. In the future, this project is expected to last longer and cover more ground. This will allow more people in the community to get involved, make partnerships with public and private groups stronger, and speed up progress in terms of making money and being productive. At the end of the day, the entrepreneur's story shows that fertigation, when based on government support and community involvement, has the power to not only change people's lives but also help rural areas grow.

CONCLUSION

This study shows that fertigation improves chilli yield, profitability, and resource efficiency over conventional approaches. The comparison of one entrepreneur and four local farmers demonstrates that fertigation consistently beats traditional approaches, although to varying degrees. Farmers with larger farms, more technical expertise, and better market access had higher yields and profitability than those with inadequate skills, equipment failures, or weaker buyer links. These results show that fertigation's sustainability depends on systematic training, solid technical assistance, and market integration.

As Melaka's first benchmarking fertigation program, the entrepreneur's Taman Seri Sutera project is notable. The project began modest and had a restricted budget, but its major goal was to share knowledge with the local population. Universiti Teknologi MARA (UiTM) and its agro-based professors supported the initiative, giving students expert assistance and important experience. Despite modest production compared to larger farms, the entrepreneur's case demonstrated robust growth performance, reduced pest and disease problems, and efficient nutrient use. The project's small size allowed close monitoring and system maintenance, ensuring early success.

The project has great growth potential. It can improve productivity and profitability and serve as a model for rural agricultural innovation and community development in Malaysia with greater community participation, institutional support, and agency and market cooperation.

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