Content list available at http://epubs.icar.org.in, www.kiran.nic.in; ISSN: 0970-6429

Indian Journal of Hill Farming

June 2023, Volume 36, Issue 1, Page 176-184

Income augmentation through strategic climate resilient interventions at Kyrdemkulai village, Meghalaya

N. Uttam Singh • P. Lyngdoh • P. Paul • K.P. Biam • C. Gowda H.R. • Rakesh Kumar • Tasvina R. Borah • B.U. Choudhury • Anjoo Yumnam • N. Lyngdoh • V.K. Mishra

ICAR Research Complex for NEH Region, Umiam, Meghalaya 793 103

ARTICLE INFO

Article history:
Received: 25 October, 2022
Revision: 24 January, 2023
Accepted: 02 February, 2023

Key words: *Technological intervention, Income, Farmers, Climate change.*

DOI: 10.56678/iahf-2023.36.01.23

ABSTRACT

The present paper highlights the impact of climate resilient technologies demonstrated in Krydemkulai village of Meghalaya during the period 2019-2021 under different implementation-modules of Technology Demonstration Component and Scheduled Caste Sub Plan of NICRA by ICAR RC for NEH Region, Umiam, Meghalaya. The interventions, zero tillage pea in paddy fallow and raised & sunken bed technologies under Natural Resource Management module proved to be an effective adaptive measure to combat moisture stress during winter and has provided better land utilization and maximized the cropping intensity. Intervention of intercropping under crop based module served as a contingency even if the main crop (mint) fail as the farmers could still obtain income from the second crop (cauliflower). The mushroom cultivation enterprise has provided both nutritional and income security for the farm families with the option to further use of the spent mushroom beds as protein-fortified cattle feed, organic manure or substrate for vermicomposting. Under the livestock module, scientific interventions in piggery and cattle farming reduce morbidity and mortality rate, improve productivity and reduce exposure to erratic climatic conditions. The climate resilient technologies have created a significant impact in improving the productivity and income augmentation of the farmers of the village.

1. Introduction

Climate change is a threat on a global scale with the potential to bring substantial economic losses. According to the Intergovernmental Panel on Climate Change (IPCC), the current rate of greenhouse gas emissions is likely to cause average temperatures to rise by 0.2˚C per decade, reaching by 2050 the threshold of 2˚C above pre-industrial levels. The impact of climate change is visible in the agricultural sector which increases the risk of food insecurity in the most vulnerable regions. The Hill agricultural systems are more vulnerable to climate change due to the occurrence of extreme weather events such as rainfall, drought, floods, and cold waves (Malla, 2014). The manifestation of climate change in the form of increasing temperatures and weather variability is already being observed in Meghalaya too. Feroze et al., (2018) reported a significant increasing trend in maximum and minimum temperature over the period 1975 - 2013 in Meghalaya. The annual rainfall substantially decreased during 2008-2013 in the state, during which the productivity of rice, ginger, potato, and pineapple also reduced. To maintain the productivity level, strategic adaptation and mitigation measures are required to be placed in farmers' fields. In response to these concerns, ICAR launched a flagship network project National Innovations in Climate Resilient Agriculture (NICRA) in 2011. ICAR RC for NEH region has been involved in research, demonstration and awareness on climate resilient technology to offset the impact of climate change in the region since 2011.

Present paper highlights the impact of climate resilient technologies demonstrated in Krydemkulai village during the period 2019-2021 under the different modules of Technology Demonstration Component (TDC) and SCSP (Scheduled Caste Sub Plan) of NICRA by ICAR RC for NEH Region, Umiam, Meghalaya with the objectives i) To demonstrate site-specific climate resilient technology packages under different modules on farmers' fields and ii)

*Corresponding author: uttamba@gmail.com

To assess the impact of the selected adopted technologies on the income level of the farmers

2. Methodology

Study area

Impact of technological interventions was assessed in the village Kyrdemkulai adopted by NICRA. This village is located in Ri-Bhoi District of Meghalaya, India, within Latitude 25°43'59.1"N – 25°45'3.46"N and Longitude 91°50'36.19"E – 91°51'47.72"E with an elevation of 791 m above Mean Sea Level (MSL). The village comes under the C&RD Block, Umsning and the Mylliem syiemship of the Khasi Autonomous District Council.

The village has a total of 110 households with population consisting of 58% ST (Scheduled Tribes) and 42% SC (Scheduled Castes). A large section of the society of this village is mainly dependent on agriculture. The climate is sub-tropical warm and humid, with average annual rainfall of

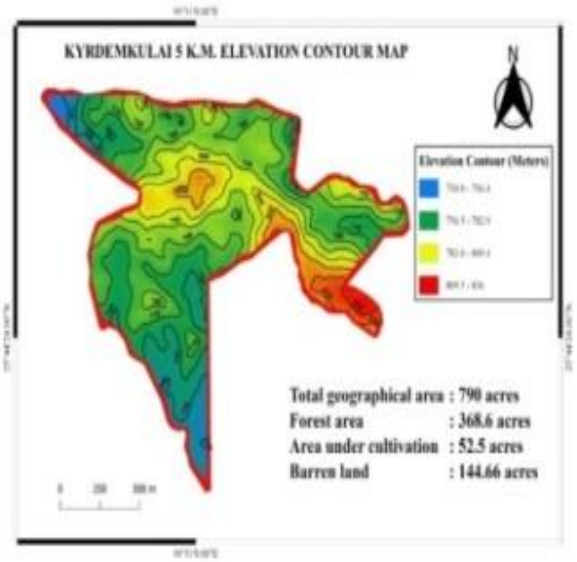

Figure 1: Map of Kyrdemkulai village

2771 mm and average maximum temperature of 24.8°C and average minimum temperature of 15.8°C. Agriculture productivity of the village is mainly affected by weather instability as the village suffers moisture stress during post-monsoon months (Dec-Feb) and pre-monsoon months (Mar-Apr). On the other hand, the village has water surplus during the months May-Oct in the same year. This makes the village vulnerable to variability in climate variables in absence of a strategic adaptation mechanism.

Implementation of interventions

The following technology interventions were made in the village under the five modules of NICRA (Table 1). The interventions were made based on the challenges faced by the farmers as well as climatic variations that occur in the region

Table 1. Technology Intervention Modules

Technologies Intervened	Area covered (ha)	Number of beneficiaries
A. Natural Resources Module		
• Zero till pea cultivation	0.4	15
• Raised and sunken Beds for Vegetables cultivation in Paddy field	2.0	20
B. Crop Module		
• Intercropping (mint & cauliflower)	0.6	20
C. Enterprise Module		
• Oyster mushroom cultivation		26
D. Livestock Module		25

• Scientific pig rearing • Low-cost cow shed • Paddock construction	7 Community
E. Institutional Intervention Module • Formation of Self Help Groups (SHGs) • Linking of mushroom farmers with spawn producers.	23

Impact assessment

The impact of the interventions was assessed for the period 2019-2021. Data on various variables like cost of production, yield, income, etc. were collected from the project site for the different interventions made. An interview schedule was prepared to assess the perceived impact of socio-technological interventions among the beneficiaries. The data were collected by personal interview and analysed using frequency and percentages. The economics were estimated before and after the interventions to describe the impact of the interventions.

3. Results and Discussion

a. Natural resources Module:

Zero till Pea Cultivation

Fallow land, low cropping intensity, moisture stress during winter and mono-cropping pose a major problem to the farmers of this village. As a strategy to increase the cropping intensity and solve the case of moisture stress in winter, zero till pea cultivation in rice fallow was introduced in the village (Figure 2a).

Mechanical tillage of the soil is in practice to achieve a fine seed bed, eliminate weeds, and reduce leaching and percolation losses to achieve higher land productivity, but it has been shown in the long run to have negative effects on soil properties, structure, and ultimately the environment. Climate change mitigation and adaptation processes identify zero tillage (ZT) method as environmentally friendly (Bhatt, 2017). Zero-tillage/conservation agriculture, crop rotation over time and leaving crop residues on the surface reverse the historically accelerating degradation of soil organic matter (SOM) and soil structure, while increasing soil biological activity and helping to eliminate wind and water erosion, reducing soil moisture loss through the mulch (Landers et. Al., 2013). Moreover, modified tillage methods and crop rotation diversification may be possible to increase N fixation by grain legumes. Pea N-fixation was 31% higher when grown with zero tillage than when grown with conventional tillage (Matus et al., 1997)

This technology has provided increased crop productivity per ha in a year and has given additional net income of ₹31,783/- per ha with minimal labour costs since the cultivation practices have been minimized (Table 2). The intervention has proved to be an effective adaptive measure to combat moisture stress during winter and has provided better land utilization and maximized the cropping intensity.

Raised and sunken beds for vegetables cultivation after paddy

In the village due to very high rainfall the drainage is problematic during rainy season. The excess water from up-lands comes down as runoff and creates temporary flooding. Therefore especially in low-land after kharif rice, it practically becomes impossible to take a second crop. In such scenario, raised and sunken bed technology is a promising solution. The beds are prepared with the height of 30-45 cm and width of three to four feet for clear drainage. With this

Table 2. Economics of Intervention on zero-till pea

	Yield (q/ha)	Gross cost (₹/ha)	Gross income (₹/ha)	Net income (₹/ha)	B: C ratio
Farmers Practice: Paddy	30	8,600	15,000	6,400	1.74
Intervention: Zero till pea	26	25,042	56,825	31,783	2.26
Pea + paddy	56	33,642	71,825	38,183	2.13

Table 3. Economic return of Cabbage

Interventions	Gross cost (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
Cabbage, Cauliflower, Brocolli and Lettuce	100250	480500	38025	4.79

technology, cultivation of seasonal vegetable crops in the low land paddy fallow was introduced for optimum utilization of water-logged areas and to overcome the practice of rice monocropping.

The cultivation of vegetables in raised and sunken beds after harvesting of paddy not only multiplies the income but increases the productivity and promotes proper utilization of land and resources. This also helps in diversification of crops and increases sustainability. Also, farmers who lack source of irrigation can cultivate vegetables even in the water scarce conditions with good crop growth in the paddy fields with good water retention (Table 3).

b. Crop Production Module:

Intercropping- A way forward to doubling farmers' income (Mint and cauliflower)

Mint is an important cash crop in the village and serves as the main source of income for the farmers. The farmers showed reluctance in cultivating other crops because mint could be grown all year round. However, mono-cropping poses manifold risks as heavy losses may occur due to damages caused by uncertain climate such as drought, heavy rainfall, hails storm, insect, pests and diseases. This will result in low productivity, slow growth and also lack of crop diversification.

Lulie et al., (2014) showed that maize intercropped in spacing between rows of spearmint yielded a higher monetary advantage than planted sole. Their study indicated that planting maize between spearmint rows is biologically efficient, economically viable, and more profitable than planting alone. Therefore to aid the farmers in enhancing their profit, intercropping of cauliflower, a widely cultivated winter crops in the village, was introduced on the border of mint beds. Mint is a dense and shallow-rooted crop that needs proper sunlight and aeration for growth and development. Therefore, the cropping pattern was modified where cauliflower was grown on the border rather than in between rows, to prevent harboring of insects, pests, and diseases (Figure 2b).

By adopting this technology, the farmers were able to enhance their income by ₹2.48 lakhs per ha during the same season (Table 4). Even if the main crop (mint) was affected, farmers could obtain income from the second crop (cauliflower).

c. Enterprise Module

Mushroom Cultivation- A short-term, effortless and lucrative enterprise for doubling farmers' income.

Oyster mushroom cultivation is currently the most important and economically viable option for converting waste plant residues into protein-rich foods that help overcome the problem of protein malnutrition in developing countries like India. Nearly 60 Kg of mushroom is produced in 100 Kg straw (Shukla and Tomar 2018). Mushroom cultivation not only caters to food and nutritional needs but is also a lucrative mode of enhancing the income of farm families (Sayuti et al., 2019).

Table 4. Economic return of mint and cauliflower intercropping

	Gross cost (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
Farmers practice: Mint cultivation	3,05,540	15,85,000	12,79,460	5.19
Intervention: Intercropping with cauliflower	1,12,000	3,60,000	2,48,000	3.21
Mint + Cauliflower	4,17,540	19,45,000	15,27,460	4.66

Paddy is one of the major kharif crops grown extensively in Kyrdemkulai village. Generally, the farmers sell the paddy straws or feed them to the cattle. However due to lack of knowledge on proper utilization and diversified use of paddy straw, the excess straws are burnt which pose a major environmental risk. To provide an efficient climate smart method of paddy straw utilization and also to enhance the income of the farm families, mushroom cultivation on paddy straw was popularised in the village. In this regard, capacity-building exercises like demonstrations, and hands-on training programmes were organized on mushroom cultivation technology by the project team. Further, a self-help group of 10 women was also assisted to undertake mushroom cultivation (Figure 2c).

The cultivation of mushroom has provided a subsidiary income for the farm families by utilizing their existing resources and infrastructure. A unit of mushroom production consisting of 10 bags of 20 Kg straw each yielded almost 90 Kg mushroom, which provided an average net income of ₹2,250/- with minimal cost and effort. The enterprise has provided both nutritional and income security for the farm families. This intervention has not only attracted farm women of Kyrdemkulai village but also the farmers of adjacent villages as well. The spent mushroom beds can be further recycled as protein-fortified cattle feed, organic manure, or substrate for vermicomposting (Table 5).

d. Livestock Module:

Scientific Pig Farming

Lack of scientific rearing methods, access to feed, medicines and vaccines pose a major problem in swine production in the changing climatic conditions. Heat stress resulted in reduced feed intake and in turn reduced productivity. Since the pigs are more vulnerable to heat stress it requires proper housing management during extreme climatic events. Taking this into account ICAR under this project has conducted training and field days on scientific pig production including the breeding strategy. To enhance the income generation of village farmers 75 number of improved varieties of piglets (Lumsniang/ Large Black) were intervened to 25 number of beneficiaries along with advisory on modern scientific pig pen construction (concrete walls and floors with tin-roof) as per ICAR suggestions; feed management {Twenty percent (20%) of pig feed is purchased from the locally available market and eighty percent (80%) feed arranged through kitchen waste, agricultural waste i.e. tubers, rice husk, etc.}; and proper health care management such as regular deworming, regular supplements of mineral mixtures (to ensure proper growth and maintenance of the reproductive cycle) and regular vaccinations.

Table 5. Economic return of mushroom cultivation

Gross cost (₹/Unit)	Gross return (₹/Unit)	Net return (₹/Unit)	B:C ratio
6,500	8,750	2,250	1.34

Figure 2. Intervened Technologies (a) Zero till Pea Cultivation; (b) Intercropping (mint+cauliflower); (c) Mushroom Cultivation; (d) Paddock- An enclosure for pasturing (e) Low-cost cowshed

The productive and reproductive traits with disease incidence were recorded in the farmer's field. When compared to the local indigenous pigs, the improved pig variety gained higher body weight, feed conversion efficiency, and litter size at birth and after weaning. A unit of pig farming consisting of two sows and one boar reared for both fattening and breeding using the scientific packages provided by ICAR gave a net income of ₹1.28 lakhs in a year (Table 6).

Low-cost cowshed: An improved, affordable structure to enhance the health and maximize the productivity of cattle.

Traditional cowsheds are unhygienic, less spacious and lack proper aeration resulting in disease incidences and even death to the animals due to improper management. Roofing straws harbor insects, pests, fungus, ticks, mites, etc. which can pose a threat to health of the cattle. Roofing straw is light and can easily be blown away during a storm or heavy wind. The annual cost for repairing the paddy straw-rooftops is approximately Rs. 30,000/-. On observing the difficulties faced by the farmers, the team conducted a training cum awareness programme on scientific dairy management to impart knowledge on proper care, management, and sanitation of cattle and sheds. Further, input distribution cum animal health camps were organized wherein seven farmers were distributed steel galvanized GC sheets of 0.33 mm thickness for roof construction of a low-cost cow shed (Figure 2e). To supplement the health and feeding of the cattle, mineral mixtures, medicines, and anthelmintic were distributed to 22 beneficiaries.

Table 6. Economic return of pig farming

Gross Return (₹/Unit)	Gross cost (₹/Unit)	Net income (₹/Unit)	B.C. Ratio
2,15,400.00/-	87,862.00/-	1,27,538.00/-	2.45

Table 6. Training programme conducted for animal husbandry

Nature of Programme	No. of beneficiaries	Inputs distributed
Input Distribution Cum Animal Health Camp on 27/02/2021	22	Mineral mixtures, medicines, and anthelmintic for 22 beneficiaries 7 bands per cowshed for 7 dairy farmers 0.33mm
Training on scientific dairy management on 17/03/2021	22	
Sensitization programme on utilization of proper dairy marketing channels on 24/01/2022	20	

Table 7. Economics of rearing a unit of dairy cattle under low-cost cow-shed

Particulars	Before Intervention (₹ Lakhs/Unit)	After Intervention (₹ Lakhs/Unit)
Gross returns	8.12	10.44
Total operational cost	2.86	2.46
Net Income	5.26	7.98
BC ratio	2.84	4.24

The economics of rearing a unit of dairy cattle consisting of 10 milch cow under traditional cow shed and low cost cow shed is given in Table 7. The introduction of low cost cow shed using steel galvanized GC sheets have reduced the operational cost from ₹2.86 lakhs to ₹2.46 lakhs and improved the net income by ₹ 2.72 Lakhs per unit in a year.

Most of the dairy farmers of Kyrdemkulai village were resource-poor and cannot afford suitable infrastructure and sufficient feed and fodder, particularly during the lean season. Besides, the farmers were habituated to the conventional practices of dairy farming which led to high mortality, low yield, and morbidity of the cattle. The intervention benefitted the farmers in acquiring knowledge on management practices of their cowsheds and in producing healthier and more productive cattle. Replacing paddy straw as roofing material with steel galvanized GC roof sheet has not only eradicated the need for yearly repairing of rooftops which has been a major misspending expenditure but also allowed the farmers to utilize the excess paddy straw for mushroom cultivation and also protected the cattle from exposure to extreme weather conditions. Region-specific mineral mixtures and vitamin supplementation resulted in the maintenance of milk productivity and in certain cases, helped farmers increase their milk productivity per day per animal.

Paddock- An enclosure for pasturing and milch welfare

Grazing ground, physical activity and exposure to sunlight are important for comprehensive development of dairy animals. Due to lack of grazing ground in Kyrdemkulai, cattle are usually reared confined in the cowsheds. Besides, open grazing may cause damage on adjacent cultivated lands. Insufficient activity and inadequate sunlight exposure for the dairy animals due to confined rearing makes them susceptible to diseases and decrease their general growth and milk production. ICAR under the project introduced the construction of paddock in the village which enabled open grazing within an enclosure (Figure 2d). For the construction of a paddock, a site with an open space, proper sunlight, aeration and proper drainage was selected. Financial assistance of ₹9200/- for construction of paddock was provided along with dissemination of knowledge on the benefit of paddock and grazing. With the construction of paddock, farmers were able to take their cattle for grazing which improved its health, appetite and milk production. After the intervention, the annual expenditure on health care was almost halved from ₹6500 to ₹3500. Milk production also improved remarkably from 5 liters per day to 7 liters per day (Table 8).

Table 8. Economic return of paddock utilization

Intervention	Health expenditure (₹/year)	Milk production (L/day)
Before	6500	5
After	3500	7-8

e. Institutional Interventions module:

Mushroom cultivation- Linking farmers with spawn producers

The major problem in mushroom cultivation is the short supply of the planting material (spawn). Since mushroom production technology has attracted a large section of the farmers in Meghalaya, the availability of spawn had become limited and prolonged by the farmers to avail the next batch for cultivation. This not only discouraged the farmers but also forced them to halt the production creating disinterest amongst them. On observing this difficulty an intervention was made to link mushroom cultivators with different spawn producers. This intervention had enabled timely provision of mushroom spawn to the farmers whenever they required. The farmers were satisfied with this initiative as they were able to cultivate mushroom three times a year providing them with maximum income.

MEGHDOOT- A Mobile App for Weather-Based Agro-Advisories

Unpreparedness to weather vagaries such as heavy rainfall, hail storm, etc., severely affects the crops and reduces their productivity. In most cases, farmers are unable to utilize the information on weather forecast for their farm management. To enable the farmers to make informed decisions in such cases, an Awareness Programme on "Importance of Weather Based Agro-advisory and Popularization of MEGHDOOT Mobile App" was conducted by the project team in collaboration with the Gramin Krishi Mausam Sewa (funded by the Indian Meteorological Department) at Kyrdemkulai village. This programme aimed to provide scientific knowledge to the farmers on the importance of weather-based agro-advisory, its effects and benefit on crops, animal husbandry and farm operations. The installation process of the app on mobile phone was also demonstrated. The app has enabled the farmers to obtain prior information on any weather anomalies, thereby helping them to take weather-sensitive decisions like the sowing of crops, application of pesticide and fertilizer, irrigation scheduling and vaccination of animals. A total of 28 farmers installed the app and receiving weather-based advisories daily. With the introduction of this app, the farmers are now well aware of the adverse climatic weather events likely to occur such as heavy rainfall, storm, hails stone, heat or cold waves, and the occurrence of frost or cloud, which can adversely affect the farming community.

Self Help Group - A collective approach to empowering the farming community

The dearth of functional SHGs in the village had excluded it from financial assistance under various schemes and funds from funding departments or banks, since most financial institutions prefer assisting groups or organizations of farmers. Therefore, an awareness programme on the importance of SHG and its formation and on how they can link and avail benefits with various institutions viz. National Rural Livelihood Mission (NRLM), National Bank for Agriculture and rural Development (NABARD), North Eastern Regional Agricultural Marketing Corporation Ltd. (NERAMAC) etc. was organised. Sensitization of the existing but non-operational groups to revive their group activities as per their aim and objectives was conducted. The project team mobilized and assisted in forming a new group comprising 10 numbers of Schedule Caste farmers and this newly formed group focused on improving the adoption of mushroom cultivation (Table 9). The existing five numbers of groups have resumed their activities by collecting a monthly contribution of ₹20/- from each member.

Table 9. Information on SHGs in the village

Name of SHG	No. of members	The activity of the SHG	Activities to be undertaken by the SHG
		Existing Groups	
Iaryntihlang SHG	10	Groups have resumed their activities by collecting ₹20/- on weekly basis from each member	Vermicomposting, Mushroom cultivation, Community pig farming, and Value addition of agricultural produce.
Lumtynrai SHG	10		
Lumlang SHG	10		
Monlang SHG	10		
Iasnohktilang SHG	10		
		New group	
Bio SHG	10	Mushroom cultivation	Value addition of surplus milk

4. Conclusion

Climate resilient interventions made under the NICRA TD and SCSP have created a significant impact in improving the adaptive capacity of the farmers towards climate change as well as productivity and livelihood of the farmers of Kyrdemkulai village, Ri Bhoi, Meghalaya by increasing their income with minimum input cost. The Farmers' feedback based on various interventions under different modules have revealed that the intervened technologies were found to be very useful in mitigating the effect of erratic climatic event. Since the interventions are simple and economically viable, high possibility of adoption is expected not only in the particular village but also in the adjoining villages. Over and above the introduction of sustainable climate resilient technologies, many human resource development activities were imparted. Sensitization towards reviving the existing social groups and creating new ones has brought cohesiveness in income generation and augmentation for overall livelihood improvement of the villagers with the locally available resources. Thus, the technologies are proven and effective in improving the adaptive capacity of the indigenous farmers of Meghalaya towards climate change.

5. References

Bhatt, R. (2017). Zero tillage impacts on soil environment and properties. *Journal of Environmental and Agricultural Sciences*, 10, 1-19.

Feroze, S. M., Dkhar, S. E., Singh, R., Marboh, P., Rani, P. M. N., & Singh, K. J. (2018). Impact of climate variability on farming: What the farmers of Meghalaya perceive? In (ed) Mawlong, BL, Climate change and developing countries. 154-165.

Landers, J. N., Rass, G., Freitas, P. D., Basch, G., González Sanchez, E., Tabaglio, V., ... & Giupponi, L. (2013). Effects of Zero Tillage (No-Till) Conservation Agriculture on soil physical and biological properties and their contributions to sustainability.

Lulie, Belstie, Haymanot Getu, and Tesfa Bogale. (2014). Intercropping of Maize (Zea mays L.) with Spearmint (Mentha spicata L.) as Supplementary Income Generation at Wondo Genet Agricultural Research Center, South Ethiopia. *International Journal of Recent Research in Life Sciences,* 1, 31-43.

Malla, G. (2014). Innovative measures for mitigating negative effects of climate change on hill agriculture in Nepal. *Journal of Hill Agriculture*, 5(2), 87-91.

Matus, A., Derksen, D. A., Walley, F. L., Loeppky, H. A., & Kessel, C. V. (1997). The influence of tillage and crop rotation on nitrogen fixation in lentil and pea. *Canadian Journal of Plant Science*, 77(2), 197-200.

Sayuti, M., Puspasari, C., Anshar, K., & Zeki, M. (2019, June). Potensial use of backyard for oyster mushroom (Pleurotus ostreatus) cultivation to increase family income; studies on break-event point analysis. In *IOP Conference Series: Materials Science and Engineering* (Vol. 536, No. 1, p. 012132). IOP Publishing.

Shukla, R., & Tomar, A. (2018). Oyster mushroom cultivation: As alternative source of income a profitable enterprise. *The Pharma Innovation Journal*, 7(4), 856-858.