PROSPECTS AND CONSTRAINTS OF GINGER (*Zingiber officinale* Rosc.) CULTIVATION IN MON AND ZUNHEBOTO DISTRICTS OF NAGALAND

Thesis
submitted to

NAGALAND UNIVERSITY

In partial fulfilment of requirements for the Degree

of

Doctor of Philosophy

in

Agricultural Extension Education

by

AZUMI SWU

Admn. No. Ph 219/16 Regn No. Ph.D/AEX/00112

Department of Agricultural Extension Education

School of Agricultural Sciences,

Nagaland University, Medziphema Campus- 797106

Nagaland

2024

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DECLARATION

I, Miss Azumi Swu, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form the basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis had not been submitted by me for any research degree in any other university/institute.

This is being submitted to Nagaland University for the degree of Doctor of Philosophy in Agricultural Extension Education.

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CERTIFICATE-I

This is to certify that the thesis entitled "**Prospects and constraints of ginger (*Zingiber officinale* Rosc.) cultivation in Mon and Zunheboto districts of Nagaland**" submitted to Nagaland University in partial fulfilment of the requirements for the award of Degree of Doctor of Philosophy (Agriculture) in Agricultural Extension Education is the record of research work carried out by Ms. Azumi Swu Registration No. Ph.D./AEX/00112 under my personal supervision and guidance.

The result of the investigation reported in the thesis has not been submitted for any other degree or diploma. The assistance of all kinds received by the students has been duly acknowledged.

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CERTIFICATE-II

VIVA VOCE ON THESIS OF DOCTOR OF PHILOSOPHY IN AGRICULTURAL EXTENSION EDUCATION

This is to certify that the thesis entitled "**Prospects and constraints of ginger (*Zingiber officinale* Rosc.) cultivation in Mon and Zunheboto districts of Nagaland**" submitted by Miss Azumi Swu, Admission No. Ph-219/16 Registration No. Ph.D/AEX/00112 to NAGALAND UNIVERSITY in partial fulfilment of the requirements for the award of degree of Doctor of Philosophy in Agricultural Extension Education has been examined by the Advisory Board and External Examiner on .....

The performance of the student has been found **Satisfactory/Unsatisfactory.**

Examiners	Signatures
1. Dr.N.K.Patra (Supervisor and chairman)	.....
2. ..... (External examiner)	.....
3. Dean, SAS (Pro Vice Chancellor Nominee)	.....
4. Dr.K.K.Jha	.....
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ACKNOWLEDGEMENTS

There are many people who have helped me in the course of my Ph.D. research but the first and foremost person for whom I am filled with utmost gratitude and must truly acknowledge is my Supervisor Dr. N. K. Patra, Professor, Head of Department of Agricultural Extension Education, SAS, Medziphema campus whose unwavering support and constant guidance helped me in completing the thesis. I remain indebted to his exceptional guidance, logical advice, insightful discussions, wise suggestions and continuous motivation throughout my research work, particularly during times when I found myself unsure of my progress. Without his guidance, this thesis would not have been possible and I shall forever be grateful to him for his mentorship.

I also thank all the members of my advisory committee, Prof. K .K. Jha, Prof. J. Longkumer, Department of Agricultural Extension Education, Dr. Sanjoy Das, Department of Agricultural Economics and Prof. Manoj Dutta, Department of Soil Conservation for their invaluable help, support, encouragement and assistance during the course of my research work.

I extend my sincere gratitude to Mrs. Aben, Mr. Limasangwa and all the staff members of the department of Agricultural Extension Education for their immense help rendered throughout my research work. I express my sincere thanks to all the staff members of Academic Cell for helping me in processing all the paper works on time.

My heartfelt gratitude goes to all the respondents and Village Council Members of the study areas who spared their valuable time and shared their input to the best of their knowledge as required for the study. Without their participation, my research would have remained inconclusive and incomplete.

A special thanks goes to my friends Dr. Virosanuo Solo, Dr. Avicha Tangjang, Ms. Aliho Shikhu, Dr. Drusilla Jishing Rengma, Dr. Jongpongrenla Jamir, Dr. Alexso Ngadong, Mrs. Purlemla Jamir, Mr. Keneisezo Nakhro and Ar. Chumrenthung Ngullie for being there for me as my support system.

To imu, Dr O. Amihe Swu, for his endless patience and support, for sharing his expertise and experience in giving shape to this thesis.

I thank my Parents Otova Swu and Ashely Swu for always believing in me and their prayers, and also imu Milto, imu Elonto, ichi Ayin and all my family members who supported me in every way possible. My family have been amazing in accommodating my needs and ensuring that I received all the help possible to complete my thesis without hindrance and I am deeply appreciative of all the little things they did to help me in my research.

Above all I give praise and thank the Lord Almighty who has protected and guided my path throughout my journey and in all my works.

Date:

Place: *(AZUMI SWU)*

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LIST OF ABBREVIATIONS

Abbreviations/Symbols	Meaning
M	: Mean
F	: Frequency
%	: percent
N	: Number of respondents
<	: less than
>	: more than
μ	: mean
Kg	: Kilogram
Fig	: Figure
=	: equal to
Σ	: Summation
g/l	: gram per litre
ha	: Hectare
gm	: gram
cm	: centimetre
i.e.	: that is
viz	: namely
ADO	: Agriculture Development Officer
AFA	: Agriculture Field Assistant
Agri	: Agriculture
ATMA	: Agricultural Technology Management Agency

DAP	: Days after planting
FAO	: Food and Agriculture Organization
FYM	: Farm Yard Manure
GON	: Government of Nagaland
HDO	: Horticulture Development officer
KVK	: Krishi Vigyan Kendra
LRDO	: Land Resource Development Officer
NGO	: Non-Governmental Organization
NHB	: National Horticulture Board
NPK	: Nitrogen, Phosphorus and Potassium
NRLM	: National Rural Livelihood Mission
SAS	: School of Agricultural Sciences
SD	: Standard Deviation
TV	: Television
VET	: Veterinary

ABSTRACT

The study entitled, "**Prospects and constraints of ginger (*Zingiber officinale* Rosc.) cultivation in Mon and Zunheboto districts of Nagaland**" was carried out to investigate the feasibility of ginger cultivation in Mon and Zunheboto districts of Nagaland, focusing on the practices used by ginger farmers and identifying the challenges they face in growing ginger. The objectives of the study were 'to assess the knowledge level and the extent of adoption of improved practices in ginger cultivation', 'to assess the existing seed system in ginger cultivation', 'to study the sustainable performance of ginger cultivation' and 'to identify the various constraints in ginger cultivation and measures suggested for improvement'. Descriptive research design was followed in this study. Six blocks were selected from two districts and 18 villages from 6 blocks (3 villages from each block). Further, 15 ginger growers were selected as respondents from each village. Altogether, 270 respondents (135 from each district) were selected, which constituted the sample size of the study. An interview schedule was constructed for the study and data were captured from all the respondents using the constructed interview schedule through personal interview method by researcher. The interview schedule was pre-tested in February 2019, and data collection was carried out from 2019 to 2021. The collected data were tabulated, collated and explored using frequency, percentage, ranking, mean, standard deviation and correlation. The important findings from the study are presented as follows: the majority (57.55%) of the respondents were in the age group between 35-55 years, 82.97 per cent of the respondents belonged to medium sized family, 67.04 per cent of the respondents belonged to the male gender, 89.63 per cent of the respondents can read and write. It was also seen that 79.63 per cent of the respondents were members in an organization. Most (97.40%) of the respondents had agriculture as their primary occupation, 77.40 per cent had more than 6 years of experience in ginger cultivation. Around 42.60 per cent of the respondents had a high level (>1,768 kg) of ginger production. It was found that 96.29 per cent of the respondents were acquainted with ATMA functionaries. Under land holding, 80.00 per cent of the respondents had a medium sized (0.85-3.91 acre) land holding, 78.51 per cent had a medium sized (0.63-1.70 acre) operational land holding and 71.48 per cent had a medium sized (0.55-1.5 acre) of land under ginger cultivation. It was seen that the majority (74.44 %) of the respondents had income ranged from ₹33,324 to ₹1,20,573 annually and 67.03 per cent of the respondents had an income ranging from ₹24,484 to ₹95,303 as their income from ginger cultivation. The majority (83.33%) of the respondents did not attend any training regarding ginger cultivation. All the respondents were aware of climatic condition, land preparation, growing ginger in different field every year, required seed weight, seed size, depth of sowing of ginger and use of disease free seeds, planting time, planting materials, and harvesting time of ginger cultivation. Further, respondents were unaware of seed treatment, disease and insect of the crop,

use of fertilizers and chemical control of pest for ginger cultivation. All respondents adopted recommended land preparation, use of insect and disease free seeds and optimum time of harvesting. Further, respondents did not adopt seed treatment, manures and fertilizers and plant protection measures of ginger cultivation. Concerning seed system, all the respondents knew about different planting materials, renewal of seeds every year, appropriate soil parameters and plot for growing seed-rhizome and use of disease and insect-free large-sized rhizomes as seeds. However, they had no knowledge about certified seeds and different high yielding seeds. All respondents knew about the importance of seed renewal every year. In respect of marketing, 70.37 per cent marketed their product through wholesale. On the other hand, availability of seed shops for purchasing quality seed rhizome was an important constraint in the study area followed by non-availability of quality seeds. It is evident from the assessment of sustainable performance of ginger that the overall mean score (the average score of economic sustainability 3.44, human sustainability 3.88, social sustainability 3.82 and environment sustainability 3.84) was 3.74. Therefore, it can be concluded that ginger cultivation in the study area was a sustainable farming or livelihood activity/component. In respect of constraints in ginger cultivation, lack of technical guidance, lack of knowledge about the recommended seed rate, lack of knowledge about seed treatment, lack of technical know-how about curing of rhizomes, lack of extension support, lack of credit facilities were the main constraints faced by the respondents. The important policy prescriptions based on the study are: i) most of the ginger growers were practicing traditional method and their knowledge and adoption level on improved cultivation practices were inadequate with low productivity; therefore, more emphasis should be given to promote the modern cultivation practices, ii) further, knowledge and adoption level of farmers in respect of seed system were in pitiable state, therefore, concerned authorities may take the initiative to mitigate the issues. iii) Sustainable performance of ginger was highly satisfactory; therefore, cultivation of this crop should be promoted in the face of climate change and livelihood security.

Keywords: *Adoption index, constraints, ginger, knowledge, Nagaland, seed system, sustainability index*

CHAPTER I
INTRODUCTION

INTRODUCTION

Ginger (*Zingiber officinale* Rosc.) is among the most important spices in the world. The English term ‘Ginger’ originated from the Sanskrit word ‘Sringavera’ where ‘sringam’ means ‘horn’ and ‘vera’ means ‘body’. The origins of ginger can be traced to tropical South-East Asia and was introduced into the West Indies, African countries and other tropical countries of the world through colonial trade. The major ginger producing countries of the world are India, Nigeria, China, Indonesia and Nepal. In the year 2019, India ranked first, contributing 43.81% of the total world ginger production, followed by Nigeria (16.94%), China (14.24%), Nepal (7.29%) and Indonesia (4.27%) (FAO, 2019).

Botany of Ginger

Ginger is a rhizome or it can be understood as the underground modified stem of a plant belonging to the *Zingiberaceae* family. Ginger is an herbaceous perennial crop which is cultivated for its rhizome, a modified system. It is an aromatic herb with an underground rhizome and an erect stem which grows up to a height of 75 cm. Its leaves are green, simple sheathing at the base, alternate, acuminating at the apex, glabrous, 1520 cm long, sessile, and linear-lanceolate with prominent mid-rib and parallel venation. The inflorescence is a spike on a distinct scape: with flowers densely arranged, irregular and bisexual. Each subtended by a persistent bract (Gudade *et al.* 2020).

Ginger is composed of many chemicals such as 3%-6% fatty oil, 9% protein, 60%to 70% carbohydrates, 3% to 8% crude fibre, 8% ash, 9% to 12% water and 2% to 2% to 3% volatile oil (Baliga *et al.* 2011). Ginger is widely

used in food, and a staple of the beverage, confectionery and medicine industries. It is sold as fresh ginger or, more frequently, in a peeled and split dried form.

Climatic requirement for Ginger cultivation

It grows well in warm and humid climates and can be cultivated from sea level to altitudes of 1,500 m above sea level. It can be grown both under rain fed and irrigated conditions. For successful cultivation of the crop, moderate rainfall at sowing time till the rhizomes sprout, fairly heavy and well distributed showers during the growing period and dry weather for about a month before harvesting are necessary conditions. Ginger thrives best in well drained soils, like sandy loam, clay loam, red loam or lateritic loam. A friable loam with a pH of 6.0 to 6.5 rich in humus is ideal. The crop performs well in a temperature range of 19°C- 28°C and a humidity of 70-90% (ICAR-Indian Institute of Spices Research, 2015). However, being an exhausting crop, growing ginger is not desirable in the field year after year.

Nutritional facts about Ginger

Ginger is a rich source of micro-nutrients and macronutrients. It contains fat, sodium, carbohydrate, fibre, sugar, protein, magnesium and potassium. Ginger also has medicinal value as it has been seen to lower blood sugar in those with diabetes, and it contains anti-cancer properties and decreases inflammation.

Ginger production in India and Nagaland

Ginger is one of India's most important cash crops and spices. The Ginger varieties commonly grown in India are Rio-de-Janeiro, Thingpui, Wynad, Maran and Nadia. India is the leading producer of ginger in the world (FAO, 2021). The National Horticulture Board (NHB) in its 2021-22 report shows that India has a total production of 2,219.47 million metric tonnes with

Madhya Pradesh having the largest share contribution at 31.18% or 692.11 million metric tonnes. This is followed by Karnataka with 306.34 million metric tonnes (13.80%) Assam with 170.73 million metric tonnes (7.69%) Maharashtra 164.23million metric tonnes (7.40%), and West Bengal with 135.07 million metric tonnes (6.09%) as the five largest producer states of ginger in India amounting to 66.16% of total production and the remaining 33.84% are produced in varying degrees by the other states. Nagaland with 40.81 million metric tonnes has a 1.84% contribution to the total ginger production of the country and is currently the 13th largest producing state of India (NHB, 2021).

On a more local front, the North-Eastern region comprising of 8 states, namely, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura has tremendous potential for the production of spice crops. The climatic condition of the region is highly suitable for cultivating a large number of spices such as ginger, turmeric, chilli, tejpat, large cardamom, coriander, and garlic. North-east India is also considered an important ginger-growing area, and the states of Assam, Sikkim, Meghalaya are the leading ginger producing states. The total contribution of the North Eastern States in ginger cultivation amounts to 23.06% of the national production (NHB, 2021-22). Ginger cultivation is used to conduct as the main crop in upland or in *jhum* system (or shifting cultivation), bun system in Meghalaya, *zabo* system in Nagaland, *tila* in Tripura and Assam, and terrace cultivation in Sikkim.

Table 1.1 Highlights the area, production and productivity under cultivation of the various important spices (including ginger) in India.

Table1.1 Area, production and productivity of major spices in India during 2020-21

Sl. No.	Spices	Area (000 ha)	Production (000 tonnes)	Productivity (Kg/ha)
1	Cumin	1241.297	856.505	690
2	Red Chilli	732.212	1988.304	2,715
3	Coriander	628.618	822.184	1,308
4	Garlic	384.924	3118.143	8,101
5	Turmeric	294.690	1102.318	3,714
6	Fenugreek	133.229	203.360	1.526
7	Ginger	175.664	1882.157	10,715

Source: Directorate of Arecanut and Spices Development data, 2020-21

Ginger is an important spice in Nagaland. The total area under ginger cultivation is 4,694 ha and the total production is 34,848 metric tonnes (Govt. of Nagaland, 2021). Ginger is grown in all the districts, but the leading ginger producing districts are Peren, Zunheboto, Kohima and Mon, with an area of 429 ha, 355 ha, 282 ha and 452 ha under ginger cultivation and 5,395 MT, 4,939 MT, 4,802 MT and 3,380 MT as their production output, respectively. Several cultivated types of ginger are available in the state, which have their local names specific to the area they are grown in. Aside from the local varieties grown by the farmers, Nadia is very popular among the ginger growers of the state due to its low fiber content (4.20%) and high yield capacity. Ginger is cultivated on a large scale due to its commercial value. The spice is used in culinary preparations, soups, curries and pickles. It is also used as a spice in its dried form. It is used as a flavouring agent in bakery products and confectionery. It is used in various food products like ginger bread, and curry powder and the manufacture of certain soft drinks like ginger tonic.

Table 1.2 Area and Production of major spices in Nagaland during 2020-21

Sl. No	Spices	Area	Production
1	Cardamom	4,020	2,323
2	Turmeric	649.5	9,102.1
3	Ginger	4,694	35303.00
4	Naga king Chilli	595	12,757.8

Source: Govt. of Nagaland, 2021

Table 1.3 District, State and National level area, production and productivity of Ginger for the year of 2017-2018 and 2020-2021

Sl. No.	District	Area (ha)	Production (mt/ha)	productivity	Area (ha)	Production (m.t/ha)	Productivity (Kg/ha)
1	Dimapur	195	3250	16.66	165	2,750	16.67
2	Kohima	281	4800	17.08	282	4,802	17.03
3	Mokokchung	220	3500	15.90	113	1,198	10.60
4	Mon	450	6000	13.33	452	3,380	7.48
5	Longleng	295	4388	14.87	275	3,380	12.29
6	Phek	386	538	1.39	385	2,315	5.69
7	Peren	430	5520	12.83	429	5,395	9.16
8	Tuensang	373	5203	13.94	400	2,276	13.91
9	Wokha	310	5118	16.50	340	3,115	0.80
10	Zunheboto	350	4896	13.98	355	4,939	13.91
11	Kiphire	1568	392	0.25	1498	1198	0.79
State		4826	43605	9.04	4,694	35303.00	7,520
India		160.80	1048.30	6.519	1,76,000	18,87,000	10,721

Source: Govt. of Nagaland, 2021and Govt. of India, 2021

Profile of the study area

The state Nagaland is situated in the North-Eastern part of India and it lies between 25º6' and 27º4' latitude North of the Equator and between the Longitudinal lines 93º20' East and 95º15'East and with a geographical area of 16,527 sq. Km. (Govt. of Nagaland, 2021) and with a total population of 19,78,502. Nagaland has a sub-tropical temperate climate with altitudes varying from 200 to 3,840 m, annual rainfall of 200 to 250 m, and temperature ranges from 4°C to 31°C. The topography of the state is largely hilly, with the only plain areas being found in the district of Dimapur and some portions of the Mokokchung, Mon and Wokha districts bordering Assam. Nagaland has a beautiful landscape and consists of 16 administrative districts *viz.* Kohima, Dimapur, Kiphire, Longleng, Mokokchung, Mon, Peren, Phek, Tuensang, Wokha, Zunheboto, Noklak, Tseminyu, Niuland, Chumukedima, and Shamator. Out of the total geographical area of the state, 43.37% is the cultivable area. Currently, 71.1 per cent of the population lives in rural areas and 55.2 per cent of the total population is engaged in farming (Maongtoshi and Sinha, 2014). Therefore, agriculture plays a vital role in the people's lives, and the state's economy largely depends on agriculture and allied sectors.

Agriculture is the mainstay of the majority of the population, being the chief livelihood activity. Agriculture in the state is very much diversified as a result of both individual enterprise and state-initiated projects and cultivation of field crops, horticultural crops and vegetables cultivation. Local industries and enterprises generally are limited to small scaled production levels of various goods and services. The largest sector of employment is generated through the public sector. Education is another important area that generates employment and livelihood opportunities.

Traditionally, forest products and timber trade have been a constant source of livelihood which supplements agriculture as the primary livelihood

alternative for the rural sector, which comprises the majority of the population. Accordingly, the state government is still continuing promotion and development of agriculture and allied sectors. However, agriculture and allied sectors are accommodating employment of 68.00% of the state's total population. These sectors contribute roughly 21.00% of the Net State Domestic Product, which shows that the sectors have the potential for significant development as long as the people engaged in agriculture and allied sectors (Maongtoshi and Sinha, 2014). Agriculture already provides employment to the largest section of the state population. Contribution of agriculture to the state economy and the livelihood alternatives of the rural population can be enhanced if value-added products like ginger which has a high potential for growth and scale, are promoted and supported.

Statement of the problem

The area of ginger cultivation in Nagaland has increased from 2,600 to 5,300, ha from 2007-08 to 2014-15. Subsequently, the area under ginger cultivation in Nagaland has further decreased from 4862-4694 ha from 2017-18 to 2020-21 and production also decreased from 43,605 to 35,303 MT for the year 2017-18 to 2020-21. Accordingly, productivity also decreased from 8968kg/ha to 7520kg/ha respectively in the year of 2017-18 and 2020-21.

To explore the reasons for remarkable decline in respect of area, production and productivity of ginger in Nagaland, despite the lack of documented data, various reasons are reported or given by progressive farmers, extension workers and faculties of SAS, Nagaland University. Some of the significant reasons are inadequate knowledge and adoption of technologies in farming, substandard and repeated use seeds and growing as a mixed crop in *jhum* fields, where income and production sustainability was ignored. It is also evident that there is much room for development with some interventions. Accordingly, in this research, knowledge level adoption behaviour of ginger

growers, existing seed systems in ginger cultivation and sustainable performance of ginger cultivation and constraint in ginger cultivation were taken into consideration.

Research on the adoption process can help in understanding the reasons for the gap between the potential yield and the actual yield in the farmer's field. Research also helps to formulate proper extension strategies for reducing the gap by critically analyzing the factors causing the gap. Therefore, it is critically beneficial to examine and understand the potential and prospects of the crop and the factors limiting those aspects of cultivation. Thus, assessing the farmers' knowledge level and status of technology adoption in ginger cultivation is essential to address the problems in cultivation and to modernize the cultivation.

On the other hand, seed system can be defined as the combined activity of actors, making use of plant materials and knowledge, which together are necessary for supplying seeds to farmers (Cromwell *et al.* 1993). Seed system is also referred to as a range of technologies, organizational set-ups, and market and non market institutions through which seeds are accessed and used (McGuire and Sperling, 2013).

A well-functioning seed system should provide farmers with sustainable access to high-quality seeds that meet their needs and purposes, delivered at the right time and at a fair price, considering their investment. Seed systems are typically categorized into two types: informal and formal. In the informal seed system, farmers produce, select, distribute, and obtain seeds from their own harvests, as well as through exchanges, gifts from friends and relatives, or purchases from local grain markets; and in contrast, the formal seed system involves a structured process starting with formal plant breeding, often resulting in genetically improved varieties (Sperling *et al.* 2022). Understanding the type of seed system farmers use provides valuable insights

for strengthening the system, helping them to produce and access the seeds they require.

On the other hand, sustainability refers to the capacity to uphold something consistently over time. In the context of agriculture, sustainability involves a complex interplay between social, human, economic, and environmental dimensions, each with its own priorities and objectives. Changes in ginger production are influenced not only by variations in planting area and productivity but also by various sustainability factors. Hence, understanding the factors contributing to sustainable production requires examining the interaction between social, human, economic, and environmental variables.

Similarly, research on assessing the different challenges encountered by ginger farmers can help us identify the key issues they face and offer recommendations to enhance production and improve cultivation practices. This understanding will enable the implementation of strategies that promote better yields and more efficient farming techniques. Also, present study will enable the policy process and aid the arming sector to take up measures to increase the area, production and productivity of ginger.

Keeping in view all the issues, a study entitled "Prospects and constraints of ginger (*Zingiber officinale* Rosc.) cultivation in Mon and Zunheboto districts of Nagaland" was carried out with the following objectives:

Objectives

1. To assess the knowledge level and the extent of adoption of improved practices in ginger cultivation,
2. To assess the existing seed system in ginger cultivation,

3. To study the sustainable performance of ginger cultivation, and

4. To identify the various constraints in ginger cultivation and measures suggested for improvement.

Limitations of the study

The present study had the limitations of time and resources, usually faced by a student researcher. The present study was done to know the status and prospects of ginger cultivation in two selected districts out of a number of ginger-growing districts of Nagaland. Due to the wide spread nature of ginger grown area across the state, the need for resources to explore the whole ginger-growing area was a limiting factor. However, thought and effort were adopted and exercised to minimize the influence of limiting factors and making the study as effective and systematic as possible. The data so collected for the study were based on individual honesty and sincerity. Therefore, the information obtained for the study may entirely not be free from the individual biases of respondents.

Organization of the study

The thesis is organized as follows. The second chapter, following the first introduction, deals with the review of literature related to the study. The third chapter deals with the research methodology of the study. The next chapter contains results and discussions. Chapter 5 presents the summary and conclusions and recommendations of the study. The references and appendices have been given respectively and form the last section of the thesis.

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

This chapter focuses on a literature review concerning ginger cultivation. Conducting a comprehensive literature review is crucial for gaining useful insights and establishing an appropriate analytical framework for the study. Therefore, relevant literature was gathered with the objectives presented and the collected reviews were then organized in chronological order and presented under the following sub heads:

2.1 Knowledge level and extent of adoption of improved practices.

2.2 Seed system in crop cultivation.

2.3 Sustainability and sustainable performance of crops/components.

2.4 Constraints in crop cultivation and measures suggested for improvement.

Knowledge level and extent of adoption of improved practices

Mohapatra (2006) in his study on adoption behaviour of ginger growers categorised ginger growers according to their cultivation practices into three levels: In the 1stcategory, i.e., high with >55% of adoption, while, 2nd or medium category with 46.55%, and the last category denoted as low category having up to 45% of adoption. The study also reported that different categories of farmers (small, marginal and large farmers) had different levels of adoption of improved technologies.

Kumar and Pepat (2010) opined that socio-economic and psychological factors, such as caste, education, farm size, social participation, economic motivation, market orientation, and perception, were positively and significantly associated with knowledge level of groundnut farmers.

Vankataramulu *et al.* (2010) revealed that the majority of respondents (63.33%) were categorised as medium adopters, while20.00% of the respondents were in the low adoption category. The remaining 13.33% were in the high adoption category.

Arya *et al.* (2012) observed in their study that among large and medium turmeric growers had the adoption level of soil selection were 88.20% and 80.80%, respectively. On the other hand 73.10% of the small turmeric growers had adopted timing of sowing.

Choudhary and Ramakant (2012) revealed that 69% of respondents had a medium level of knowledge about chilli crop interventions, with no respondents reporting a low level of knowledge. Additionally, 31% of respondents had a high level of knowledge about chilli cultivation practices.

Rajni and Sodhi (2013) reported that most respondents (70.00%) had a medium level of knowledge about soyabean processing technologies, while 20% had a low level and 10% had a high level of knowledge.

Shehu *et al.* (2013) in their study reported that both educational level and degree arming of growers had impacted the adoption of innovation in ginger farming which reflected in the productivity of ginger.

Matouleibi *et al.* (2014) from the analysis revealed that most respondents (88.67%) chose hill areas for planting pineapples, while 11% opted for moderate slopes and none of the respondents selected plain areas for planting.

Sabi *et al*. (2014) performed out a survey on the knowledge and technological gaps in the adoption of recommended wheat cultivation practices. They found that most respondents (49.16%) had a medium level of

knowledge about these practices, followed by 28.33% with high knowledge and 22.50% with low knowledge.

Husman *et al*. (2015) indicated that a farmer's education level and the scale of their farming operations facilitated the adoption of advanced ginger farming practices, leading to increase productivity.

Shruti *et al*. (2015) performed a study for assessing the knowledge of tribal farmers about scientific animal husbandry practices and the evaluation revealed that the majority of the respondents (64.37%) had a low level of knowledge, while 35.63% had a medium level of knowledge.

Ashwani and Narinder (2016) reported that about^{2}/3 of the respondents had a medium level of knowledge, 25% had a low level of knowledge, and remaining10% had a high level of knowledge in respect of black gram cultivation.

Chandrika (2016) carried out an evaluation on the technological gap in recommended sesame production practices among farmers in Sihora district. The study concluded that 53.00% of sesame growers had a medium level of knowledge, while 38.00% had high level of knowledge, and the remaining 9.00% had a low level of knowledge on sesame cultivation. Additionally, it was found that 46.00% of farmers had a medium level of adoption, while 27.00% each fell into the low and high adoption categories.

Navyashree (2016) stated that 45.00% of pomegranate growers had a high level of knowledge about pomegranate cultivation practices, while 31.11% had low knowledge and 23.89% had medium knowledge. The assessment also found that 42.22% of respondents had a medium level of adoption of pomegranate cultivation practices, with 33.33% having a high level of adoption and 24.45% having a low level of adoption.

Ramachari (2016) reported that 47.20% of growers had a medium level of knowledge about vegetable pea, 29.60% had a low level of knowledge, and 23.20% had a high level of knowledge. Further, the study revealed that 51.20% of pea growers had a medium level of adoption, 31.20% had a low level of adoption, and 17.60% had a high level of adoption.

Gohil *et al*. (2017) found in their study that most garlic growers (65.00%) had a medium level of knowledge with regard to recommended garlic production technology, while 20.00% had a high level of knowledge and 15.00% had a low level of knowledge.

Jakkawad *et al*. (2017) found in their research that approximately 68.75% of ginger growers had a medium level of knowledge about ginger cultivation. Additionally, the study revealed that 67.50% of the respondents had a medium level of adoption of ginger cultivation practices.

Reddy *et al*. (2018) discovered in their assessment that the smallest adoption gap in nursery management was 30.00%, which was observed for the size of the seed bed and seed rate, while the largest adoption gap, at 94.66%, was found for seed treatment. In main field cultivation, the smallest adoption gap was 21.33% for the timing of transplanting, whereas the largest gap was 90.00% for disease management. Additionally, the study indicated that most respondents (76.00%) had a medium level of adoption gap.

Miso *et al*. (2020) detected that 70.83% of ginger growers were categorized under a medium level of adoption, while 15.83% fell into the low adoption category, and 13.33% were in the high adoption category. The overall index of the respondents to various recommended ginger cultivation practices in the study area was 49%, indicating a medium level of adoption..

Sundreshah *et al*. (2020) stated that most respondents (60.00%) had a high level of knowledge about improved ginger cultivation practices. In contrast, 12.25% had medium knowledge and 18.75% had low knowledge; the assessment also further revealed that over half of the ginger growers (53.75%) were categorized under high adoption level. Additionally, 25.00% of the ginger growers were in the medium adoption category, while 21.25% were in the low adoption category.

Kharphuli *et al*. (2021) reported that most respondents (65.83%) had a medium level of overall knowledge about improved ginger cultivation technology and it was followed by 21.67% of respondents with low knowledge and 12.50% with high knowledge.

Sahoo *et al*. (2022) stated that farmers had a knowledge index exceeding 90% for land preparation, cultural management, harvesting, and post-harvest management. Additionally, most farmers (71%) had a medium level of knowledge about organic turmeric cultivation. The investigation also found that factors such as contact with extension agents, annual income, land area dedicated to turmeric cultivation, and total landholding were significantly related to the farmers' knowledge of turmeric cultivation.

Chhetri *et al*. (2023) reported that 72.7% of ginger farmers adopted storage methods for their harvested ginger, while only 7.6% practiced washing. All respondents used manual grading, but none employed commercial grading methods and the value addition activities were observed, with 65% of respondents practicing sorting and 25% engaging in packaging. Awareness of ginger post-harvest practices differed among ginger farmers, with 75.76% having low awareness, 16.66% having medium awareness, and 7.58% having high awareness. The assessment highlights the need for adopting modern post-harvest practices to boost production, enhance product quality, and secure better market prices.

Lalhlimpuii *et al*. (2023) opined that the overall level of knowledge about various improved ginger cultivation practices was medium. Regarding soil type, varieties, planting time, chemical fertilizers, and harvesting majority of the respondents were fully knowledgeable. However they had only partial knowledge about seed treatment, spacing, organic nutrient sources, pest and disease control measures, and weeding. The investigation also revealed that factors such as annual income, sources of information, scientific orientation, mass media exposure, and extension contact had a positive and significant correlation with farmers' knowledge of improved ginger cultivation practices.

Sharma *et al*. (2023) recognised that most respondents had high knowledge about land preparation, optimal sowing times, and the favourable climate and soil conditions for achieving maximum yield. However, only about one-third of them were knowledgeable about manures and fertilizers. The majority of respondents also had a strong understanding of harvesting, processing, and storage. A significant finding was that freshly harvested ginger was often sold directly in the market, leading to lower prices for growers due to a lack of processing and quality storage facilities. The investigation concluded that the overall knowledge level of respondents regarding recommended ginger cultivation practices in the area was at a medium level.

Leduc and Hansson (2024) reported from Sweden that behavioural factors significantly impact the adoption behaviour of farmers practicing agro-forestry and they also identified certain factors that did not affect this adoption behaviour.

Aryal *et al*. (2024) reported that demographic factors such as age, gender, education, and experience in ginger cultivation did not influence the adoption of postharvest technologies and they also highlighted that poor

marketing was the most significant constraint to adopting these technologies in ginger cultivation.

Seed system in crop cultivation

Thijssen *et al*. (2008) stated that smallholder farmers rely on informal seed systems, such as self-saved seed or farmer-to-farmer seed exchange, for 90% of their seed needs, with improved seed making up less than 10% of their total seed usage.

Alemu (2010) recognised that open-pollinated variety seeds are frequently stored in farmer unions and cooperatives, and inefficient distribution systems limit their availability to farmers.

Atilaw (2010) stated that most Ethiopian farmers prefer the informal seed system for several key reasons: it is generally more affordable and readily available in their villages when needed, it allows for the use of seeds that have been tested by early adopters, and it is considered more reliable and sustainable compared to the formal seed system.

Beyene (2010) highlighted that understanding seed producers' preferences is crucial for developing a sustainable seed supply system and positively shaping the perceptions of both seed producers and users.

According to Gera *et al*. (2010) there are a number of important variables that can affect how well stakeholders links work in seed systems. These factors include the level of formality and intensity of interactions, the way in which people contact, the degree to which stakeholders are aware of one another’s roles, the importance of services, the timeliness and urgency of interactions, accessibility, and quality of communication, control over relationships, and the mandate of representatives.

Malope (2011) examined the prospects and challenges of seed sector privatization in Botswana. Notion of privatization was raised as a result of some short comings in the current system. It included supply of poor seed production and distribution, low returns to Department of Agriculture Research. However, it suggested that seed sector need over all changes in institutional and policy frame work to support the entry of private firms.

Orky (2011) found that Nigeria has both formal and informal rice seed systems. The informal system includes local seed dealers, while the formal system consists of public sector institutions. The dynamics of the informal rice seed system was more suited to rural lifestyle. The study suggested the need to develop a synergy between the two systems. While formal system focuses on variety dissemination, the local seed dealers should concentrate on bulk demand of rice in Nigeria.

Rana *et al.* (2011) in their study suggested that rice seed production and distribution system in Nepal could be broadly classified into two, formal and informal seed system. Formal system comprised of research institutions, government seed companies and private seed companies expected to deal with clearly defined products, i.e., certified seed of specific varieties. The informal seed system comprised of farmer retained seeds and farmer exchange seeds. The study highlighted the significance of farmers' seed system in improving access to seed and fro maintaining biodiversity. Farmers' seed selection practices included best plot selection, panicle selection and roughing of off types.

Sapkota *et al.* (2011) in their study reported that two rice seed system existed in Nepal, i.e., formal and informal seed systems. It was found that 92.3 % of rice seed requirement was met from informal seed system. The investigation revealed that most farmers relied on seeds saved from their own

farms and those exchanged with other farmers, rather than seeds distributed by public and private institutions.

Eskandari (2012) found that the seed quality helps to attain potential crop yield in two ways. One if through rapid emergence of seedlings giving rise to highly vigorous plant and second through the optimal plant population that could be achieved as a result of uniform germination of seed.

The assessment carried out by Sofijanova *et al.* (2012) to compare the economics of wheat production using certified and uncertified seeds revealed that there was a definite increase in average productivity of wheat by 22.5%. Although cost of cultivation using certified seed was 11.3 % more than that using uncertified seed, the net profit per hectare for wheat was almost 26.5% higher than that using uncertified seed.

Louwaars *et al*. (2012) reported that over 80% of smallholder farmers in Africa primarily obtain their seeds through informal channels, such as purchases from nearby grain or seed markets, farm exchanges, and seed stored from their own farms. The informal seed system is often inadequately equipped to handle pests and diseases and frequently faces issues related to the loss of agro-biodiversity.

Tesfaye *et al*. (2012) found that collaborations with public organizations, including research institutes, agricultural bureaus, and cooperatives, are crucial for demonstrating new varieties, expanding farmer-based quality seed production, and implementing out-grower schemes. Over the past decade, there has been a notable increase in the use of quality seeds of improved varieties.

Etwire *et al*. (2013) suggested in their assessment of the formal and informal seed systems that these systems have historically overlapped. They

propose that a hybrid system, integrating elements from both the formal and informal systems, could be developed to better address the needs of smallholder farmers.

Beye and Wolperies (2014) identified three primary seed systems in Sub-Saharan Africa: the conventional seed system, the traditional seed system, and the integrated seed system. Strategic models were developed based on the roles of different actors in seed system. These models included state managed, research and extension based seed system, seed sector by private seed companies, seed sector by small holder farmers and also seed sector run by small scale seed enterprises.

Roy (2014) in his study conducted in West Bengal stated that farmer participatory quality seed production is one of the best methods to increase productivity. Suphala Beej Swarnirbhar Gosti was a self-help group that was formed in the year 2008 to enhance the participatory seed production of major crops such as rice, potato, pulses and mustard. The study claimed that seed replacement rate of major crops was increased along with the improvement of living standards of farmers involved in seed production.

Haq *et al.* (2014) in their study found that one of the basic inputs to cultivate crop is quality seed. When a seed possesses varietal purity, freedom from weed seeds and physical impurities and has a germination capacity of above 90% it can be referred to as quality seed. They also reported that the use of quality seed alone can account for 10-15% increase in crop yield and it is impossible to attain potential growth rate in agriculture sector without the use of good quality seeds.

A study was conducted in Assam by Kakoty and Barman (2015) to analyze sources of rice seed and factors contributing to the low seed replacement rate in paddy. It was found that the most important source of seed

was self-retained seed. It was also found that the major reasons for low seed replacement rate in paddy included lack of awareness about seed replacement rate, farm size, inadequate supply of seed.

Surekha *et al*. (2015) found in their study that using high-quality seeds can significantly reduce cultivation costs. This was achieved by lowering the seed rate, enhancing germination rates, ensuring a uniform crop stand, promoting rapid seedling establishment, minimizing off-types and weeds, reducing pest and disease incidence, and achieving uniform maturity without mixtures and these factors collectively contribute to higher market prices for the produce.

Deepana and Girish (2016) in their study found that the rice market in Mandya District of Karnataka was controlled by two agencies, Karnataka State Seed Corporation Ltd. (KSSC) and National Seeds Corporation (NSC). It was found that KSSC was a major shareholder in the market with 78% whereas NSC had only 10 % of the market share.

Kunwar *et al.* (2016) in their study found that there were two approaches for seed production and distribution in Timor-Leste under the Ministry of Agriculture and Fisheries. The first one is the centralized seed production and distribution which was in practice from 2010 to 2011 and the second one is decentralized community based commercial seed production and distribution which started during 2012-2015. It was found that decentralized approach was 2.3 times more expensive than the other one. However, it was seen that there was a tremendous increase in seed replacement rate from merely 4 % to 20% in 2015. Hence the ministry chose to continue with second approach.

In a research carried out by Moe *et al.* (2016), it was discovered that the major source of seed to rice farmers in Tatkon, Myanmar was informal sources

that constitute farmer saved seed and farmer exchange seed. It was found that most of the farmers (59.16%) got information on rice seed from fellow farmers. they also analyzed the quality of seed from farmer saved seed and from formally supplied seed. The results showed that formally supplied seed was of high quality and the other was of low quality and the investigation also emphasized the necessity of enhancing farmers' rice seed systems through targeted training.

Jabo (2018) reported from Ethiopia that supply of improved seeds has always been shorter than the demand. He reported that formal extension service is the main source of information and credit facility has direct influence of adoption of other technologies along with certified seeds.

Mihretu (2019) opined that quality seed can bring many folds of productivity of various vegetable crops and this had a great potential to boost the income of small farmers and improve their livelihoods.

Afzal *et al.* (2019) viewed that quality seed can increase the yield up to 5-20%. Mode of production and pattern of pollination have direct influence on quality seed production, which are also responsible for genetic quality and stability in seed.

Ojiewo *et al.* (2020) reported that inadequate seed systems have increased the nutrition insecurity and poverty. Also opined that seed systems' viability and sustainability depends on market demand, established partnership in seed marketing, institutional arrangement and policy support.

Mulesa *et al.* (2021) Opined that seed security is crucial for small farmers assured crop production. They also recognised seed insecurity in their study area and intermediate seed system may be the alternative to address the issues of inadequacy in seed systems of the country.

Louwaars and Manicad (2022) viewed that quality seeds are crucial for food and nutrition security of the planet. Both the seed systems (formal and farmers) are facing various types and degrees of challenges. Further, viewed that resilient seed system may accelerate to achieve the seed security.

Nabuuma *et al.* (2022) viewed that seed system have huge potential to address the nutrition security along with the food security. It has also an impact on quality food intake of the people.

Sharma *et al*. (2023) identified that none of the ginger growers were familiar with seed treatment.

Sooganna *et al.* (2023) viewed that seed system is the most vital component in agricultural system for optimum agricultural production. The convergence of formal and informal seed system may fulfil the demand of high quality seeds in Indian farming sector.

Sustainability and sustainable performance of crops/components

Esty (2001) conducted a critique of the Environmental Sustainability Index (ESI) in Switzerland to assess the overall progress of developed countries toward environmental sustainability. Data was gathered from 142 developed nations and analyzed using comparative techniques. The ESI scores were derived from 22 core indicators, each incorporating two to six variables, totaling 67 underlying variables. These indicators and variables were selected through a thorough review of environmental literature and available data, along with extensive consultation and analysis. In the 2001 ESI rankings, Finland, Norway, and Canada were the top three countries, while Haiti, Saudi Arabia, and Burundi ranked the lowest. A high ESI ranking indicates a country has achieved a higher level of environmental sustainability compared to most others, whereas a low ESI ranking reflects significant challenges in achieving environmental sustainability across various dimensions.

Milla *et al*. (2001) examined agricultural sustainability by exploring concepts, principles, and evidence to develop and test a method for assessing changes in sustainability at the farm level. They collected and analyzed primary and secondary data from 150 farmers using an exploratory factor design method and the investigation evaluated changes in sustainability on three conventional farms that had transitioned to organic production systems in the United Kingdom. They developed a set of indicators for assessing farm sustainability, drawing on the French IDEA method, which includes environmental, social, and economic dimensions and these findings indicated that the shift to organic production enhanced the social sustainability of all the farms studied.

Nagabhushanam and Nanjaiyan (2001) evaluated the level of agricultural sustainability in Indian watersheds and the data was collected from government websites and used a Likert scale for analysis. About ten agro-environmental indicators were identified, including crop diversity, land productivity, input use index, integrated pest management, ecosystem management, soil environment level, crop productivity, enterprise support capacity, social equity, and carrying capacity. These indicators were determined through expert judgment and by calculating relevancy coefficients and their intensity in measuring sustainability. The results indicated that crop diversity, input use index land productivity, and integrated pest management were crucial in assessing agricultural sustainability.

Somashekarappa (2002) investigated the sustainability of various farming systems across different categories of farmers using a multi-criteria approach adapted from Abazzo and Boggia (1998) to reflect the specific characteristics of these farming systems. The sustainability index was calculated based on six components: gross income per hectare, benefit-cost ratio, fertilizer productivity, pesticide productivity, the percentage cost of eco-

friendly inputs relative to total cultivation costs, and the ratio of the cost of owned inputs to total cultivation costs. The investigation noted that medium-scale farmers had the highest sustainability index at 0.87, followed by small-scale farmers with an index of 0.78. Marginal farmers had a sustainability index of 0.71, while large-scale farmers were relatively less sustainable, with an index of only 0.56.

Prada *et al*. (2003) investigated the trade-off between short-term agricultural productivity and sustainability through a statistical analysis of low-input agriculture in Argentina. The findings revealed that more larger farm sizes, corporate land leasing, and more intensive land leasing tend to increase immediate revenues at the expense of sustainability.

Raju *et al*. (2005) studied agriculturesustainability in Andhra Pradesh's Mahaboob Nagar district which focused on two watershed areas with data from 200 farmers. Ten indicators were identified by experts, including soil environment level, integrated pest management, ecosystem management, crop diversity, input use index, information self-reliance, land productivity, crop yield security, enterprise support capability, and carrying capacity and these indicators were chosen based on their relevance. The study highlighted that these agro-environmental indicators were crucial for assessing agricultural sustainability in watershed environments. Results showed that (57%) of the respondents had a medium level of sustainability, while 22% had a low level and the remaining 21% had a high level of sustainability.

Hutchins and Sutherland (2008) studied the social sustainability of supply chains in Dalian's Ganjinzi district, China, which focused on the evaluation of social sustainability measures. The study showed that sustainability involves the interdependence of ecological, social, and economic systems and it explored the connection between business decision-making and

social sustainability, initially focusing on national-level measures. They proposed a general strategy for integrating social sustainability measures and outlined various indicators of Corporate Social Responsibility (CSR) demonstrating their application in supply chain decision-making through examples.

Dillon *et al*. (2009) developed a set of economic, environmental, and social indicators to assess the sustainability of Irish farming and they selected indicators based on their overall relevance and the availability of data from the National Farm Survey (NFS) where the analysis covered a decade, from 1996 to 2006. They reported that dairying and tillage systems were more economically viable than other farming systems, while cattle systems remained less viable overtime. Methane emissions from dairy farms were significantly higher and stable over the decade. Socially, there was minimal change in demographic viability across farming systems, with only a slight decrease in the number of households with at least one member under 45 years of age.

Castoldi and Bechini (2010) integrated 15 economic and environment indicators to assess the sustainability of arable land of Northern Italy. On the whole, any of the rice cultivating farms hardly had high degree of sustainability because of the poor practices adopted in pest and soil management and weak energy gain. Contrarily, permanent meadows had good performance in the environment dimension. Growing rice continuously was worse than any of the crop combination with rice. However, continuous maize cropping received intermediate sustainability due to good economic and energy indicators' performance.

Ponnusamy *et al*. (2010) identified several key factors contributing to sustainable livelihoods in Tamil Nadu's farming systems. These factors include

livestock holdings, landholding size, marketing behaviour, perceptions of integrated farming systems, and communication practices.

Shrama and Shradendu (2011) developed Agricultural sustainability index (ASI) for rural parts of eastern India and employed for 150 farms over a time period of 60 years. It included 30 variables, 10 each for economic, ecological and social sustainability. They recorded history of agricultural practices from 1980– 1990, 1991-2000 and 2001–2010 from the eldest person of the sample household and ASI values had obtained. Through one-way ANOVA, ASI values were assessed for three periods. It was found the ASI values had not changed significantly between the three periods thus the region has maintained more or less consistency in agricultural sustainability

Reig-martinez *et al.* (2011) computed composite indicator for agricultural sustainability, employing data envelopment analysis and multi criteria decision making methods. Twelve individual indicators were selected and applied to 163 dry land farm located in Spanish Northern Plateau. Average score of composite sustainability indicator was 0.561 on the scale of 0 to 1, with a standard deviation of 0.098. It was observed that composite indicators of economic and environment were positively correlated. However, social indicator did not show such relation. Results also have shown that though the farms had similar edapho-climatic, technologies and market, they were heterogeneous in terms of sustainability.

Amarnath and Sridhar (2012) examined the challenges faced by turmeric growers practicing organic farming using Garrett's ranking technique. They found that the primary issue was labor scarcity, scoring 68.54, as most local workers preferred jobs under the Mahatma Gandhi National Rural Employment Guarantee Scheme. The second significant challenge was the delay in obtaining organic certification for turmeric and cotton, scoring 55.02,

highlighting the need for more efficient certification facilities. Additionally, high wage rates were identified as another major problem, with a score of 47.65.

Jalilian (2012) conducted a sustainability assessment in Piranshahr County, Iran, revealing the use of chemical fertilizers and pesticides had the strongest positive correlation with the sustainability index (r = 0.64). This was followed by social and individual characteristics of farmers (r = 0.52), crop production (r = 0.45), and crop residual management (r = 0.35).

Longhitano *et al.* (2012) developed the Sustainable Farm Index (SuFI) by identifying 26 indicators based on consensus build among the stakeholders. They reported that farms with bovine livestock demonstrate higher sustainability, largely due to the extensive grassland areas they typically have. In contrast, viticulture and other crops showed lower sustainability due to their heavy reliance on chemical inputs, and this trend was also evident in the environmental context, where intensive arable crops, viticulture, and other crops show lower sustainability.

Barghi *et al.* (2013) in their study for investigating determinants of sustainability in agriculture in rural areas of the Central district of Marivan town of Iran revealed that for the factors explaining agricultural sustainability the supporting service infrastructure factor accounted for 22 per cent, factor of sustainable agricultural operations accounted for 14 per cent, factor of social participation defined almost 9 per cent. Ecological and economic factors were also identified as significant in this study and they accounted for 6 per cent of the total variance, each

Hennessy *et al*. (2013) developed a set of farm-level sustainability indicators for Ireland, focusing on economic, environmental, social, and innovation dimensions. They identified five economic indicators: land use

productivity, labour productivity, profitability, market orientation, and economic viability. Environmental indicators included total greenhouse gas emissions per farm, emissions per unit of product, emissions from energy and fuel use, and nitrogen balance per hectare. Social indicators encompassed farm economic vulnerability, household demographics, risk of isolation, work-life balance, and education level. Each indicator was uniquely measuredusing the min-max method. Analysis showed that dairy farms were the most economically sustainable, followed by tillage farms. Socially, dairy and tillage farms also performed well, though differences between systems were less significant compared to economic indicators.

Majewski (2013) with the help of experts in farm sustainability identified the 56 important indicators of sustainability out of which 12 comprised of economic dimension, 11 comprised of environmental dimension, 12 of social dimension, 11 of farm management practices and rest of belongs to quality aspect which is known as synthetic farm sustainability index. The estimated economic, social, ecological, farm management and quality aspect were 0.57, 0.52, 0.59, 0.44, and 0.50 respectively. The composite index measured was 0.52.

Markulev and Long (2013) defined sustainability as the ability to maintain an activity or process over an indefinite period and this concept applies to various economic, social, or environmental activities and can have different interpretations depending on the field of study.

Solomon *et al.* (2013) stated that farm size, planting materials, fertilizers, and hired labour significantly affected ginger production at 5% level, whereas chemicals and family labourdid not. Furthermore, they found that technical efficiency in ginger crop production could be improved by 0.68% with current technology. The study further suggests that increasing the

use of land, planting materials, fertilizers, and hired labour can contribute to more sustainable ginger production in the area.

Buragohain *et al*. (2014) carried out an assessment in Assam on agricultural sustainability, defining it as a balance of environmental health, economic profitability, and social equity. They used the Sustainable Livelihood Security Index (SLSI) to evaluate this balance across various districts. The SLSI comprises three indices: the Ecological Security Index (ESI), Economic Efficiency Index (EEI), and Social Equity Index (SEI). The assessment recognised significant variation in agricultural systems across districts, with those scoring an SLSI of 0.40 or above classified as advanced and those below as backward. Notably, 56% of Assam districts had an SLSI above 0.5, while only Dhubri fell below the 0.40 threshold.

Kamaruddin and Samsudin (2014) developed a Sustainable Livelihood Index (SLI) for the Baling district in Kedah, Malaysia, to assess various aspects of rural poor households' livelihoods. They identified 22 indicators of livelihood assets and outcomes, categorized into human, physical, natural, social, and financial assets, as well as food security and health status. Each household’s SLI was calculated by combining these indicators with equal weight.. The study found that 73% of the households had an SLI below 0.5, with an average SLI of 0.47. The SLI, which correlates closely with total household income, indicated that 90.91% of households in extreme poverty had an SLI below 0.5 and the assessment indicated that the SLI is a more comprehensive measure of poverty and preparedness than income alone.

Sunanda *et al*. (2014) observed that in Bishnupur district of Manipur, key factors contributing to sustainable livelihood included age, family size, land holdings, annual income, intensity of animal enterprise, nutrition, farm size, yield, technology utilization, and economic motivation.

Wrzaszcz (2014) measured the level of economic sustainability of farms in Poland using agriculture census data of year 2011. The study was based on majorly five economic indicators and four land holding size groups. Farmers with 5-25 ha and 25-50 ha showed better productivity than >5 ha and >50ha farmers, which describes the parabolic relation of productivity and size of holdings. Nevertheless, labour productivity had direct relationship with size of holdings. It was found that there exists a complementary relationship between environment and economic sustainability to some extent at farm level.

Hasanshahi *et al.* (2015) formed a composite index (CI) by including economic, social and ecological dimensions having 11 indicators to assess the sustainability of the farming system in the Marvdasht plain, it was categorized into six distinct zones. Firstly, indicators were identified that belong to each sub-index and then sub-indices were computed. Weightage was derived and combined it with sub-indices to form composite index. They have employed Principal Component Analysis for assigning weightage to each indicator. The results identified four categories of sustainability:zone 6 was deemed unsustainable, zone2 and 3 were clearly classified as relatively unsustainable, zone 5 as relatively sustainable, and zones 1 and 4 as sustainable.

Singh (2015) noted that using organic manure combined with the recommended amount of chemical fertilizers, known as integrated nutrient management, had a significant impact on the growth and yield of ginger.

Bachev (2017) revealed that, overall, farms in Bulgaria demonstrate good sustainability, with strong performance in environmental and social aspects, and however, they displayed weaker results in governance and economic sustainability.

Gaviglion *et al.* (2017) assessed farm sustainability usingfive methodologies (IDEA, RISE, SAFE, SOSTARE and MOTIFS)identifying 42

indicator actors across economic, social and ecological dimensions. A comparison of 41 conventional farms and 9 organic farms revealed that organic farms scored higher in most environmental components, except for energy input, likely due to the larger size. Organic farms also outperformed conventional farms in product quality and territory (37.7 vs. 18.6), short supply chains and related activities (29.0 vs. 14.0), and work (30.9 vs. 21.8), these higher scores also reflected improved performance in ethics and human development (27.4 vs. 17.8) and society, culture, and ecology (33.2 vs. 23.8), indicating that organic farming requires a higher level of culture, education, and training. However, conventional farms excelled in economic performance, achieving higher scores in economic viability, persistence, and farming independence.

Kareemulla *et al*. (2017) identified 13 indicators for assessing economic, social, and ecological variables, using literature surveys and state-level data availability. Economic indicators included food grain productivity (kg/ha), agricultural output value, per capita income (Rs/head), and female work participation rate (%). Social indicators encompassed community-managed institutions, the proportion of area under marginal and small holdings (%), and the Human Development Index (HDI). Ecological indicators comprised population density, forest cover (%), cropping intensity (%), livestock density (per sq. km), poultry density (per sq. km), and groundwater draft (% of exploited and critical sources). The overall agricultural sustainability was calculated as the average of these indices for two reference years, 2001 and 2011. In 2001, Himachal Pradesh ranked highest, followed by Punjab, while Bihar, Uttar Pradesh, and Jharkhand were at the bottom while in 2011, Himachal Pradesh maintained its top position, with Kerala and Punjab following.

Siva and Damani (2017) explored the development and application of the Farm Assessment Index (FAI) to evaluate farming systems in Wardha, Maharashtra, and Dharmapuri, Tamil Nadu. They found that organic farms typically scored higher on FAI compared to chemical farms. Although chemical farms often generated higher gross income, organic farms had superior economic performance due to a higher benefit-cost ratio, reduced risk, and more efficient resource use. Moreover, organic farms excelled in social and environmental indices due to adverse effects associated with theexcessive use of fertilizers and pesticides. The findings suggest that promoting organic farming could enhance both the long-term economic viability of farmers and the ecological sustainability of agriculture.

Maurya *et al*. (2018) evaluated the status of SLS in Uttar Pradesh state of India. The study relied on secondary and cross sectional data. The Ecological Security Index research (ESI), Economic Efficiency Index research (EEI), and Social Equity Index research (SEI) studies found that the ecological and social equity components of all districts' agricultural systems differ significantly from their economic aspects. Sustainable Livelihood Security (SLS) is a broad concept that encompasses current challenges and policy considerations related to sustainable development. The topic of SLS becomes even more significant for the farm industry in light of the changing social, economic, and climatic environment. Agricultural diversification is being considered as a possible SLS tactic. Districts with higher SLSI scores are typically referred to as advanced, and vice versa. As a result, SLSI has been discovered to reflect a district's total performance in three areas of sustainability. Twelve districts in the state have an index value of more than 0.5, while only five have an index value of less than 0.4, based on their overall performance in terms of their SLSI.

Poudel *et al*. (2018) concluded that ginger production could become a successful enterprise by placing greater emphasis on improving source seed production and distribution.

Applying sustainable intensification (SI) indicator framework, Snapp *et al.* (2018) evaluated maize-legume diversification. Fifteen SI indicators were applied to four cropping method: sole maize, with nil fertilizers and recommended fertilization, pigeon-pea-maize intercrop with half rate of fertilizers, and continuous legume rotation. The assessment was based on experimental as well as survey data. Environment performance of pigeonpea-pigeonpea and pigeonpea-maize rotation was better than the sole maize cultivation because of biological nitrogen fixation, vegetative biomass gain and crop cover. For the social dimension of sustainability, legume integration with maize was superior to any of the sole crops. Income derived in all the four cropping pattern was rewarding and net income was observed least in sole crop of maize grown under zero nutrition condition

Hina and Naseer (2019) investigated how improved management practices influence sustainable cotton farming in Punjab. Their study aimed to assess how Better Management Practices (BMPs) for cotton could alleviate pressure on limited natural resources and they surveyed 150 respondents from Khanewal district and analyzed the data using regression analysis. The investigation found that respondents' education levels and landholding sizes positively influenced the adoption of sustainable practices, while farmers' age and experience negatively impacted BMP adoption rates. The regression results indicated that various agricultural inputs and BMPs significantly affected cotton yields. Specifically, factors like farmer age, education, fertilizer use, irrigation, water scouting, cotton acreage, farmyard manure, hybrid seed varieties, and sowing methods had positive effects, whereas pesticide use had a

negative effect. BMP adopters achieved gross margins of Rs.20,283 per acre, compared to Rs.12,707 per acre for non-adopters.

Benjongtoshi (2020) recognised that the sustainability of French bean cultivation, when evaluated in terms of economic, human, social, and environmental aspects, was considered to be highly sustainable.

Yiridomoh *et al*. (2021) documented that ginger farming significantly boosts women's income and economic empowerment by providing them with access to and ownership of productive assets. Additionally, the study noted that production of ginger has improved women's health, increased their societal recognition, and enhanced their decision-making power within their households and communities, however, it was also reported that women still have limited access to production resources.

Divyashree *et al*. (2022) reported that ginger, being a nutrient-demanding crop, requires proper nutrient supply at key growth stages, whether through chemical fertilizers, organic manuring, or a combination of both. To achieve high-quality and abundant ginger rhizomes while maintaining soil health and environmental quality, effective nutrient management is essential to minimize excessive use of chemical fertilizers. Integrated Nutrient Management (INM) is recommended for sustainable ginger production as it plays a vital role in sustainable agriculture by managing resources to meet evolving human needs while preserving environmental quality and conserving essential natural resources.

Jamir (2022) identified in his investigation that ginger production in Longleng district, Nagaland, could become a viable enterprise if there is a greater emphasis on creating a supportive environment, improving the investment climate, subsidizing farm inputs, and offering affordable loans to smallholder farmers for sustainable production and the assessment also

highlighted that organic ginger farming could be particularly advantageous and market-oriented.

Gamage *et al*. (2023) documented that the modern agricultural practices impact the environment through various factors such as nutrient cycles, soil erosion, , among other ecological processes. They found that organic farming is an effective approach to reducing the environmental and ecological impacts associated with sustainable development. By minimizing the use of chemical fertilizers, pesticides, growth hormones, and feed additives in livestock, organic farming can significantly reduce its environmental footprint and embracing innovative methods and new trends in organic farming could contribute to sustainable farming systems, boost agricultural productivity, and improve farmers' quality of life in an environmentally friendly manner.

Guo *et al.* (2023) depicted that the overall livelihood sustainability of rural households was assessed as moderate, with a score of 0.4436. Among the factors influencing rural livelihoods, sanitation conditions were identified as a crucial element with a positive impact. This was followed by the frequency of online shopping, family expenditure, and the management capability of village leaders while improving rural household income was found to indirectly enhance the sustainability of rural livelihoods.

Ukaew *et al*. (2023) found that the rising demand for ginger, due to its medicinal and culinary uses, raises concerns about soil carbon loss due to agricultural practices. The assessment identified that waste disposal from pickled ginger was a major source of greenhouse gas emissions, with sustainable waste management practices potentially reducing emissions by over 60%, Furthermore, adopting methods like reduced tillage, retaining crop residues, and preventing deforestation in ginger plantations could enhance soil carbon levels.

Puspitasari *et al.* (2024) documented that the rise in garlic production cannot be solely explained by the expansion of planting areas and increased productivity. Instead, it is closely linked to sustainable production factors, which results from the interaction ecological, economic and social variables. The ecological aspect may include providing environmentally friendly technological assistance and reducing the dependence of chemical inputs.

Siregar *et al*. (2024) presented that ginger functions as a botanical insecticide against *Spodoptera frugiperda*. Recent studies have highlighted the effectiveness in pest management, underscoring its ecological advantages and sustainable practices. Ginger-based botanical pesticides contribute to environmental sustainability and present promising economic potential. The study also emphasized the importance of pest management training to maximize economic benefits and ensure the sustainable use of ginger-based pesticides. The research and practices related to ginger provide a model for effective, cost-efficient, and sustainable farming.

Constraints in crops cultivation and measures suggested for improvement

Rajan *et al*. (2002) identified that diseases pose significant production constraints for ginger, frequently linked to pathogens such as *Fusarium oxysporum, Ralstonia solanacearum, Pratylenchus coffeae* and *Pythium* spp.

Kaphle (2004) revealed that major production challenges included the unavailability of essential inputs, inadequate irrigation facilities, insufficient technical knowledge, lack of access to loans, and pest issues. Ginger growers also faced marketing problems such as low prices for ginger, price fluctuations, a lack of organized markets and transportation facilities, insufficient processing and storage options, and inadequate market-related information.

Mohapatra and Acharya (2006) in their study stated that the primary barriers to adopting improved technologies among respondents were a lack of

technical guidance (39%), followed by ignorance (38.4%) and the high cost of agro inputs.

Nayak (2007) documented that all respondents faced issues with the absence of regulated markets, while nearly all farmers struggled with low market prices for their produce (97.50%). Other reported problems included micronutrient deficiencies in soil (92.50%), lack of storage facilities (88.12%), inadequate technical guidance (85.63%), absence of processing units (80.00%), and high labour costs and unavailability (70.63%). Additionally, 60% of respondents reported exploitation by pre-harvest contractors, 57.50% experienced issues with middlemen, and 33.12% faced challenges with the timely availability of necessary fertilizers.

Elpo *et al*. (2008) identified several key issues in ginger production, including the lack of soil analyzes, insufficient acquisition and storage of propagation units, excessive pesticide use, pest and disease problems related to cultivation and crop management, poor quality of water for irrigation and cleaning newly harvested rhizomes, and inadequate storage facilities and they recommended improving the transfer of technical information to producers, particularly regarding the application of good agricultural practices.

Geta (2011) revealed that the production and marketing of ginger in these areas are hindered by factors such as low-quality varieties, inadequate pre- and post-harvest handling practices, low market prices for the product, and limited access to markets.

Islam *et al*. (2012) found that farmers in the study area reported several issues affecting ginger production, including root rot disease, high seed prices, and insect infestations.

Singh *et al*. (2012) identified the primary production and marketing challenges faced by turmeric growers as severe weed infestations, lack of seed availability, shortages of farmyard manure (FYM) and labour, insufficient market information, and fluctuating prices.

Yadav *et al.* (2012) in their study revealed that low and fluctuating prices, costly packing materials, high transportation cost, malpractices adopted in markets, high commission charges, non-availability of packaging materials, absence of open auction sale as the major constraints in the marketing of turmeric.

Bako *et al*. (2013) indicated that the top production constraints were inadequate credit or capital, which was ranked highest at 43.30%, followed by poor ginger prices at 37.30%, and farmers' conservatism at 23.30%.

Mohan *et al*. (2013) highlighted that Indian farmers face significant challenges in the spice market, including low productivity, poor product quality at the farm level, ineffective legal provisions, insufficient surplus for exports, and a lack of quality spices.

Sawant *et al*. (2013) cited that turmeric growers faced significant constraints in cultivation and marketing, including the unavailability of quality seeds, high seed costs, rhizome fly infestations, high commission agent fees, and low market prices. The growers suggested several improvements, such as ensuring reasonable selling prices, demonstrating methods to control rhizome fly attacks, providing timely access to quality seeds and credits, offering guidance from Village Extension Workers (VEWs), organizing farmer rallies and exhibitions, eliminating middlemen in marketing, and supplying fertilizers and pesticides at subsidized rates.

Shehu *et al*. (2013) identified inadequate credit or capital (43.30%), low ginger prices (37.30%), and farmers' conservatism (23.30%) as the primary constraints in ginger cultivation. They recommended that extension agents play a more active role in technology transfer to farmers and that agricultural credit facility be provided at lower interest rates.

Vanrammawia and Thanga (2013) in their study on the marketing of ginger in Mizoram revealed that unorganized and non- transparent marketing channels, uncertain prices, ineffective market intervention scheme by the state government followed by its adverse impact upon the procurement prices that prevailed in the open market, shortage of storage facilities were the constraints faced by the farmers in marketing of the produce.

Ayodele (2014) highlighted that the major issues impacting ginger production were risks and uncertainties (81.56%), insufficient fertilizer supply (80.31%), a lack of modern farming equipment (76.25%), and inadequate credit facilities (74.1%) and the findings suggested that the farmers' challenges primarily revolve around the mobilization of inputs.

Janailin, Tripathi, and Anoop (2014) presented that turmeric farmers faced significant production constraints including inadequate knowledge about pest control, insufficient farm power, and pest attacks. For marketing, the main constraints were high price fluctuations, the absence of regulated markets, and a lack of access roads.

Karthick and Amarnath (2014) studied the constraints of production of turmeric in Tamil Nadu. The investigationindicated that non-availability of labour, attack of pest and diseases, high wage rate, high cost of fertilizers and water scarcity were the major production constraints faced by the farmer,

Thirumalesh and Bhagyalakshmamma (2014) represented that the main marketing constraints faced by spice growers included fluctuating prices, the presence of too many middlemen, insufficient finance, a lack of transportation facilities, and the absence of grading facilities in the market.

Titilayo (2014) identified that the major issues affecting ginger production were risks and uncertainties (81.56%), insufficient fertilizer supply (80.31%), lack of modern farming equipment (76.25%), and inadequate credit facilities (74.1%) and the findings suggested that the primary challenges for farmers were related to the mobilization of inputs.

Ovhar (2014) reported that 55.56% of farmers encountered the issue of not having access to improved seeds and seedlings at the right time, followed by 22.22% facing inadequate availability of farmyard manure (FYM). In terms of technical constraints, 61.11% of farmers dealt with irregular electricity supply. Regarding marketing, the majority (72.22%) faced low turmeric prices, while 63.33% struggled with labour shortages during transplanting and harvesting. For storage, 61.11% of respondents had problems with the lack of proper storage facilities. Additionally, 40.00% of farmers faced high labour wages, and 38.89% struggled with insufficient financial resources for agriculture.

Bheemudada (2016) recognised that most ginger growers identified the lack of pest and disease-resistant varieties as a major concern.

Damor *et al*. (2017) identified that the primary constraints faced by papaya growers were the high cost of inputs (95.83%), followed by insufficient finance (95%), the lack of high-yielding varieties (93.33%), high seed costs (90.83%), poor marketing facilities (88.33%), non-remunerative prices for the product (85.83%), and high labor wages (84.16%).

Ezra *et al*. (2017) identified the main constraints hindering ginger production as insufficient inputs, poor transportation facilities, high labour costs, and inadequate credit and they recommended enhancing extension services to educate farmers on the use of agrochemicals, inputs, and agricultural practices to boost production. Additionally, they suggested that farmers should form cooperative groups to provide timely and substantial credit to their members.

Jakkawad *et al*. (2017) recorded that ginger growers in the Aurangabad district of the Marathwada region faced several constraints, including very low market prices for ginger, a shortage of labour, lack of knowledge about post-harvest technology and processing, power outages, and delays and high costs in the supply of fertilizers.

Jatapara *et al*. (2017) identified that most gram growers encountered significant constraints, including the high cost of farm inputs (95.00%), labour shortages (90.83%), and a lack of plant protection equipment (85.83%). Additionally, 90.00% of the growers recommended providing production inputs at subsidized rates, offering timely technical information (85.00%), and establishing village information centres or kiosks in each village (65.00%).

Mmasa (2017) identified that the major issues affecting ginger farming were low prices received (54.5%) and insufficient capital to run the business (27%). Other challenges included poor transportation, drought, and a lack of labour. The assessment noted that higher labour returns in ginger farming could be attributed to the adoption of labour-saving technologies, such as oxen-ploughs and improved seeds. Ginger farming significantly contributes to household income, highlighting the need for increased public awareness about its potential. The investigation also recommended expanding cultivation areas,

strengthening the role of farmers' unions, and addressing low farm gate prices by establishing selling points that offer value addition and storage facilities.

Nisha *et al*. (2017) detected that the primary constraint for most ginger growers was the lack of proper storage facilities. While farmers suggested various solutions to their problems, the most frequently recommended measure was for the government to provide adequate storage facilities.

Ravikumar *et al*. (2017) disclosed that pest diseases were the main production constraint for farmers, while the primary marketing constraint was a lack of information about prices and difficulty in predicting curry leaf prices.

Sonwani *et al.* (2018) identified that the main challenges in ginger cultivation were high labor costs, and the prices of seeds and fertilizers. In terms of marketing, the key issues were the lack of storage facilities and the absence of standardization and grading at the grower level. The research suggested that introducing mechanization in both production and post-harvest management could address these problems.

Basnet (2018) reported that the main issues in ginger production in Nepal were small-scale conventional farming, a lack of improved cultivars, insufficient technical knowledge, limited extension services, and problems with rhizome rot and bacterial wilt.

Dewanarayana *et al*. (2018) identified several major marketing issues in ginger farming, including price fluctuations, land ownership problems, the lack of quality seeds, and the scarcity and high costs of fertilizers and other inputs. Additional challenges were insufficient scientific knowledge on farming and post-harvest handling, as well as inadequate extension services. Despite these challenges, the study highlighted several positive aspects of ginger cultivation,

such as high profitability, reduced workload for farmers, suitability for small-scale farming, appeal to younger generations, and natural disease resistance

Kumar *et al*. (2018) recorded that farmers faced significant technological constraints due to a lack of knowledge about high-yielding varieties and insufficient technical guidance, with mean percent scores (MPS) of 89 and 87, respectively. Input supply issues included the non-availability of improved high-yielding varieties (MPS 84) and a lack of processing facilities (MPS 82). Economic and marketing constraints were marked by high market price fluctuations (MPS 89) and high input costs (MPS 84). Additionally, general constraints included a lack of resources and farmers' low risk-bearing abilities, with MPS of 78 and 70, respectively.

Ghimere *et al*. (2019) identified rhizome rot as a major issue in ginger cultivation. Other challenges for ginger growers included difficulties in obtaining quality planting materials, inadequate irrigation facilities, a shortage of quality inputs, and labor shortage and the investigation also revealed that, despite many respondents being literate, their awareness of quality seed rhizomes and disease control measures was very low, indicating a weak connection between researchers and ginger growers.

Balana *et al*. (2020) found that smallholder farmers struggle to access affordable credit, which impedes their ability to invest in modern inputs and technologies.

Garedew *et al*. (2020) identified bacterial diseases, nematodes, insufficient rainfall, improper fertilizer use, and soil type as the major constraints affecting ginger cultivation in their study area.

Gogoi (2020) in his research found that the major constraint in ginger cultivation is the technological gap.

Kala *et al*. (2020) disclosed that farmers faced several significant marketing challenges for green chili, including low prices, inadequate storage facilities in markets, fluctuating market prices, difficulties in maintaining quality standards, high transportation costs, weight reductions by buyers due to moisture shrinkage, and delays in receiving payments, which could extend for weeks or months.

Panme *et al*. (2021) identified key challenges affecting ginger production and marketing in their study area, including price fluctuations, inconsistent ginger quality, and limited innovations specific to ginger cultivation, inadequate storage facilities, and land tenure issues. Despite these challenges, the study noted that ginger cultivation remains promising due to its profitability and low investment requirements.

Soni *et al*. (2022) reported that ginger farmers faced several constraints, including traditional jhum farming methods, unavailability of quality planting materials, high production costs, inadequate marketing channels, and post-harvest losses. These factors collectively contributed to the low production of ginger.

Kifile *et al*. (2023) reported that ginger production in Ethiopia faces several significant challenges, including a high prevalence of ginger diseases, sub-optimal farming practices, limited marketable surplus due to poor quality, insufficient attention from policymakers and development practitioners, and financial constraints such as limited access to credit.

Olaniyi (2023) identified several challenges in adopting and applying Good Agricultural Practices (GAP) in the ginger value chain in Nigeria. These include poor farming and marketing practices, insufficient knowledge of GAP principles and protocols, lack of awareness about premium prices for organically produced ginger, inadequate organic farm inputs, and varying

country-specific standards that complicate adherence to GAP. Despite these challenges, forming accessible and manageable farmer clusters or cooperatives is seen as a key strategy to improve the adoption of GAPs in the ginger sector.

Aryal *et al.* (2024) in the investigation indicated that the major adoption status of ginger post-harvest practices were poor marketing system followed by unavailability of improved processing technologies. The study further reported that, labor crisis was the least ranked constraint.

Shrivastava (2003) disclosed that most chili growers (90.00%) recommended having access to disease-resistant chili varieties as a priority. Other suggestions included providing early-maturing chili varieties (65.00%), ensuring timely access to credit (63.33%), reducing the costs of fertilizers and pesticides (61.76%), offering technical knowledge (56.67%), and ensuring the timely availability of hybrid chili varieties (33.33%).

Babu *et al.* (2007) found that most vegetable growers (92.22%) advocated for subsidies on inputs, followed by enhancements in credit facilities (91.11%), the establishment of cold storage facilities (88.80%), and the creation of vegetable processing units and value addition centres (72.22%).

Sawant *et al.* (2013) documented that farmers desired several key improvements: assured and fair prices for turmeric (96.67%), organized demonstrations for controlling rhizome fly attacks (93.34%), timely guidance from extension workers (98.83%), timely and adequate credit availability (90.00%), prompt access to quality seed material (84.17%), removal of middlemen (78.33%), subsidies on fertilizers and pesticides (75.83%), and the organization of farmer rallies and exhibitions (71.67%). Additionally, they suggested establishing a turmeric research station in Satara (60.83%).

Soni *et al.* (2022) revealed that increasing ginger production could be achieved through several scientific interventions. These include providing targeted farmer training on good agricultural practices for ginger, ensuring

timely access to high-quality planting material, using soil solarization and pre-planting rhizome treatments, implementing crop rotation and intercropping with other crops, and managing pests and diseases promptly.

Aryal *et al.* (2024) disclosed that ginger farmers in Nepal continue to use traditional post-harvest methods, indicating considerable room for improvement. The investigation concluded that providing effective training and support aligned with the recommended practices could significantly enhance post-harvest procedures in ginger farming.

Zindler *et al*. (2024) indicated that stakeholders were eager to exchange ideas and provided detailed recommendations for improvements and specific actions. They also recognized the importance of environmental protection and biodiversity in agricultural landscapes and emphasized the need for financial support-programs.

CHAPTER III

RESEARCH METHODOLOGY

RESEARCH METHODOLOGY

This chapter outlines the study area and the research methods employed to carry out the research. The detailed procedures and methods adopted for the study are presented under the following headings:

3.1 Locale of the study and sampling procedure

The current investigation was carried out in Nagaland (fig 3.1), a state bordered by Arunachal Pradesh to the northeast, Manipur to the south, Assam to the west and northwest, and sharing an international boundary with Myanmar to the east. Agriculture plays a significant role in the region, with key crops including rice, maize, ginger, French beans, pineapple, kiwi, and cardamom. Ginger is an important spice of the state and is grown in all the

districts of the state. However, it must be noted that Mon, Zunheboto and Peren districts of Nagaland are the leading ginger growing districts of the state (Govt. of Nagaland, 2016)

3.1.1 Sampling strategy of the study

Sampling is a method of selection of fraction of the population in such a way that it represents the whole population (Ray and Mondal, 2011). The sampling focuses on acquiring the highest possible information about the whole population with the lowest possible expenditure of resources; and to achieve a reliable estimate. For this study, the selection of districts, blocks, villages, and respondents was done intentionally. For selection of the districts under the study, Statistical Handbook of Nagaland (Govt. of Nagaland, 2016) was consulted to take a cognizance about the statistics of ginger production.

3.1.2 Selection of districts

In this study, two ginger growing districts of Nagaland, namely, Mon and Zunheboto were selected as they have the highest output in terms of ginger production within the districts of the state. Mon district is located at the northern most part of the state. To the north, it is bordered by Arunachal Pradesh, with Assam to the west and Myanmar to the east. Longleng is located to its southwest, while Tuensang lies at the southern end of Mon district. Mon is the third largest district in Nagaland by area (Govt. of India, 2021). It is also home to the Konyak Nagas, the largest tribe among the Nagas. The altitude of Mon district is 897.64 meters above sea level.

Zunheboto district is one of the most centrally located of all the districts of Nagaland and shares no inter-state or international boundary unlike Mon.However, it borders more districts than any other in the state, with Mokokchung district to the north, and Wokha and Tseminyu districts to the west, Kohima towards the South-West, Phek towards the south, and Tuensang

Fig: 3.1 Map showing the study area

and Kiphire districts in the east. Due to its location it is almost equidistant from the furthest northern tip of the state in Mon as it is from the southernmost point at Peren. It is home to the Sumi Nagas. This district has a higher altitude at 1,874.22 meters above mean sea level.

3.1.3 Selection of blocks and villages

Much of the ginger cultivation is being carried out in the rural and far flung areas of the state. It is worth noting that official published data on the area, production, and productivity of ginger at the block or district level were unavailable. As a result, blocks that consistently demonstrated a significant presence of ginger farmers were selected based on consultations with reliable officials from the state department of agriculture. In each of the two districts, three blocks were identified, and from each block, three villages were chosen. In total, six blocks and eighteen villages were selected for the study. The following table provides detailed information about the research locations.

3.1.4 Selection of respondents

The respondents for this study were intentionally selected, where respondents were selected based on certain established characteristics. To delimit the number of respondents, farmers having experience in ginger cultivation for more than three years and above were identified and selected. Furthermore, village council chairmen, and lead farmers of the selected villages were also consulted to acquire a better representation of the sample as well as to mitigate errors in the sampling. As a result, upon following the established criteria, 15 farmers growing ginger were selected from each village i.e., 45 farmers from each block and 135 farmers from each district were included as respondents for the present study. In total, 270 ginger growing farmers were purposively selected for the study (fig 3.2)

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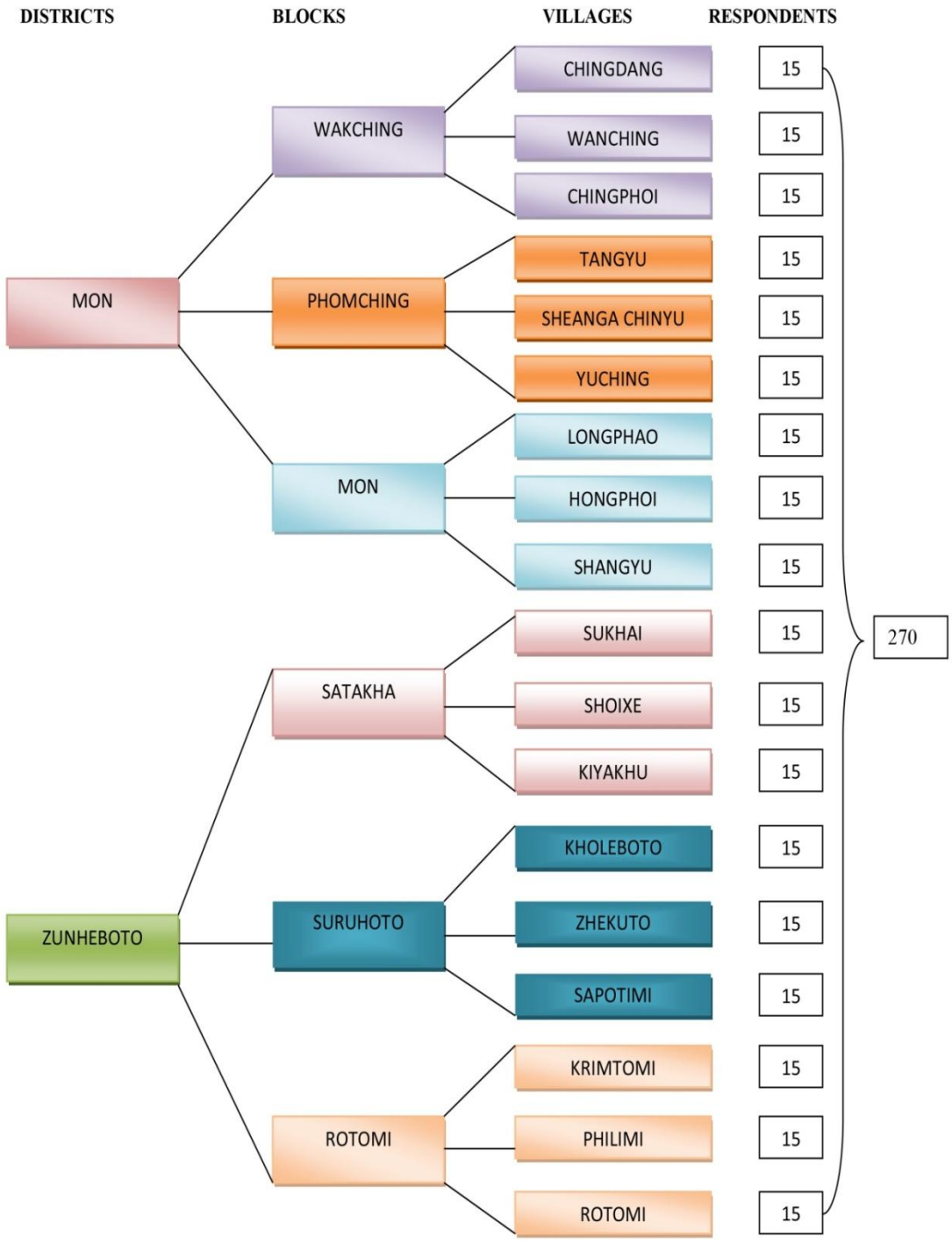


Fig. 3.2. Model showing the methods for showing selection of villages and respondents for the present study

3.2 Research design

A research design is a comprehensive outline indicating how a study or a research is going to take place. It includes collection of data, the particular tools to be used, correct manner in which these tools will be used and the proper way of analyzing the data that has been collected. A research design is a procedure for collecting, analyzing, interpreting and reporting data in research studies (Creswell and Plano, 2007).

This research utilized a descriptive research design. A descriptive research design is a structured approach aimed at gathering detailed information to accurately depict an event, situation, or population and it gives precise information, concerning the existing status of a situation and enables to develop an in-depth understanding of the research being studied.

3.3 Selection of variables and their empirical measures

In the present study, selection of appropriate variables and their empirical measures were made by consulting the subject experts, advisory committee members and from review of literature. In this section, the selection of variables and their empirical measures is explained in accordance with the specific objectives of the research and the theoretical foundation behind them.

The various variables chosen for this study are listed below:

1. Age
2. Gender
3. Educational qualification
4. Occupation
5. Size of land holding
6. Size of operational land holding
7. Land under ginger cultivation

8. Annual income
9. Income from ginger cultivation
10. Training exposure
11. Extension contact
12. Source of information utilized
13. Marketing channel
14. Knowledge level
15. Adoption level
16. Sustainability- Economic, social, human and environment
17. Seed system

3.3.1 Socio-economic characteristics of the ginger growers

The different socio-economic variables which were taken into account to categorize the ginger growers are presented accordingly.

3.3.1.1 Age

For the study the age of the farmers at the time of conducting the interview was taken into account. Farming being a traditional source of livelihood does not have restrictions on practice. Thus the respondents varied quite a lot in terms of age.

In this study, age is referred to as how old or young the respondent was at the time of the interview. The respondents were distributed under three categories as per the procedure proposed by MHRD (Govt. of India, 2011). Accordingly, the three groups are young aged farmers, medium aged farmers and old aged farmers. The empirical measures used for this variable were frequency, percentage, mean, range and standard deviation.

The following table shows the details about the measurement of age.

Sl. No	Category	Frequency	Percentage	Mean	SD	Range
1	Young (<35 years)					
2	Medium (>35-55 years)					
3	Old (>55 years)					

3.3.1.2 Gender

Gender refers to the arrangement of the respondents into male and female. Empirical measures used for the gender variable are frequency and percentage which is presented in the following table.

Sl. No	Category	Frequency	Percentage
1	Male		
2	Female		

3.3.1.3 Literacy rate

The respondents were categorized as illiterate, can read only, and can read and write. The empirical measures used were frequency and percentage.

Sl. No.	Category	Frequency	Percentage
1	Illiterate		
2	Read		
3	Read and write		

3.3.1.4 Educational qualification

Educational qualification pertains to the highest level of formal education attained by the respondents at the time of the interview. Based on their educational qualifications, respondents were categorized into seven groups according to their academic levels: illiterate, nursery, primary, middle school, secondary, higher secondary, and graduate or above.

The empirical measures used for an educational variable were frequency and percentage, given in the following table.

Sl. no	Category	Frequency	Percentage
1	Illiterate		
2	Nursery		
3	Primary		
4	Middle		
5	Secondary		
6	Higher secondary		
7	≥Graduate		

3.3.1.5 Family size

Respondents were classified into three groups—small, medium, and large family size—based on the number of family members. The empirical measures employed for analysis included frequency, percentage, mean, and range. Following table is showing the details about empirical measures of categorization based on family size.

Sl. No.	Category	Frequency	Percentage	Mean	SD	Range
1	Small					
2	Medium					
3	Large					

3.3.1.6 Occupation

Occupation refers to a person's primary or main job or business, particularly as a means of earning a living (www.thesaurus.com). The occupation was classified according to the source through which the respondents earned their livelihood. Frequency and percentage were the statistical tools used for empirical measurement of the occupation variable, given in the following table.

Sl. No.	Occupation	Frequency	Percentage
1	Agriculture		
2	Government Service		
3	Business		
4	Others		

3.3.1.7 Experience in ginger cultivation

Knowledge and experience are simultaneously important to efficiently accomplish the work. Farmers' knowledge and experience related to crop cultivation have an immense influence to bring innovations in the farming and sustainability in agriculture. In this study, experience denotes the number of years respondents have spent cultivating ginger.

For the present study, a farmer with the experience of more than three years of ginger cultivation was considered as respondent. Additionally, respondents were classified into four experience categories based on their years of ginger cultivation: 3 to 5 years, 6 to 8 years, 9 to 11 years, and over 12 years, respectively. Frequency, percentage, mean, SD and range were the empirical measures used for this variable. The details about the measurement of experience and categorization of ginger growers are given in the following table.

Sl. No.	Category	Frequency	Percentage	Mean	SD	Range
1	3 to 5 years					
2	6 to 8 years					
3	9 to 11 years					
4	12 years above					

3.3.1.8 Size of land holding

In this study, "land holding" refers to the total area of land owned by the respondents, measured in acres and the respondents were categorized based on their land size using the mean ± standard deviation. The empirical measures applied in this study included frequency, percentage, mean, and standard

deviation. Following table shows how the farmers were grouped according to the land under ginger cultivation.

Sl. No	Category	Criteria	Frequency	Percentage	Mean	SD
1	Small	<Mean – SD				
2	Medium	Mean ± SD				
3	Large	>Mean + SD				

3.3.1.9 Operational land holding

The operational land holding by a respondent indicates units of land that is used wholly or partially for agriculture, livestock and/or poultry production. The unit used for measuring the land was acre. Based on operational land holding, respondents were grouped using mean ± SD. For this study, the empirical measures used were frequency, percentage, mean and standard deviation. Following table shows how the farmers were grouped according to the land under ginger cultivation.

Sl. No	Category	Criteria	Frequency	Percentage	Mean	SD
1	Small	<Mean - SD				
2	Medium	Mean ± SD				
3	Large	>Mean +SD				

3.3.1.10 Land under Ginger cultivation

This term refers to the total land holding of the respondents specifically allocated to ginger cultivation. The unit used for measuring the land was acre. Based on the land under ginger cultivation, respondents were grouped using mean ± SD. For this study, the empirical measures used were frequency, percentage, mean and standard deviation. Following table shows how the farmers were grouped according to the land under ginger cultivation.

Sl. No	Category	Method of categorization	Frequency	Percentage	Mean	SD
1	Small	<Mean – SD				
2	Medium	Mean ± SD				
3	Large	>Mean + SD				

3.3.1.11 Annual income

The annual income indicates the total income in rupees earned by the respondents from all sectors: agricultural as well as non-agricultural sectors in a given year. In this study, the respondent's annual income was calculated by adding income from both on-farm and off-farm sectors. The empirical measures used for the annual income variable included frequency, percentage, mean, and standard deviation. Categorization of respondents based on annual income is presented in the following table.

Sl. No	Income	Frequency	Percentage	Mean	SD
1	Low				
2	Medium				
3	High				

3.3.1.12 Income from ginger cultivation

Income from ginger cultivation refers to the annual revenue earned by respondents from ginger farming and production, measured in rupees. Respondents were classified into three categories—low, medium, and high—using mean ± standard deviation. The empirical measures employed in this study were frequency, percentage, mean, and standard deviation. The following table presents how the respondents were distributed according to the level of income.

Sl. No	Category	Method of categorization	Frequency	Percentage	Mean	SD	Range
1	Low	<Mean –SD					
2	Medium	Mean ± SD					
4	High	>Mean + SD					

3.3.1.13 Annual production of ginger

For the present study, ginger production was operationalized as the total production of ginger in kg by the respondents in one year. The total production of ginger was carefully analyzed and categorized into low, medium and high

production using mean ±SD. The empirical measures used were frequency, percentage, mean and SD.

Sl. No.	Category	Method of categorization	Frequency	Percentage	Mean	SD	Range
1	Low	<Mean – SD					
2	Medium	Mean ± SD					
3	High	>Mean + SD					

3.3.1.14 Training exposure

Training involves providing farmers with new technologies, information, knowledge, and skills. It is a crucial element for the effective and swift dissemination of agricultural technologies (Jaiswal *et al.* 2019). Training is defined as a structured process through which individuals acquire knowledge and/or skills for a specific purpose (Dale S. Beach). Training exposure is the level of training that the respondent has been exposed to with regard to ginger cultivation. Frequency and percentage were the empirical measures adopted for this variable.

The respondents were grouped in two, viz. 'attended training' and 'not attended training' on ginger cultivation and given a score of '1' and '0' respectively. The classification of the respondents based on training exposure is given in the following table.

Sl. No	Category	Score	Frequency	Percentage
1	Attended training			
2	Not attended training			

3.3.1.15 Extension contact

It refers to the number of times of meetings and contact that took place between the respondents and the extension personnel. The availability of the extension personals like Agriculture Development Officer (ADO), Agriculture Field Assistant (AFA), KVK personals, ATMA etc., to the respondents was measured according to the respondent's degree of accessibility of the extension

personals which was then categorized into four groups i.e., ‘most often’, ‘often’, ‘sometimes’ and ‘never’ with scoring 3, 2, 1 and 0, respectively, which is given in the following table.

Sl. no	Extension contact	Awareness about the Extension agent		Degree of visit to the farmer place		
		Yes	No	Most often	Sometimes	Never
1	ADO					
2	LRDO					
3	HDO					
4	VET					
5	AFA					
6	KVK Functionaries					
7	Input dealers					
8	NGO personnel					
9	Progressive farmers					
10	Agriculture scientists					
11	ATMA Functionaries					
12	Others, Please specify					

3.3.1.16 Sources of information utilized

In agriculture, information encompasses the diverse sets of data and messages pertinent to farmers' activities, including crop production and protection, animal husbandry, and natural resource management and conservation (Tadesse, 2008). Information sources serve as tools that can address the needs of various user categories. In this study, the respondents were asked to what extent they use the sources of information such as TV, radio, newspaper, relatives/friends, progressive farmers, ATMA, extension

workers, NGOs, local markets/mandis to gather information regarding high yielding rhizomes, ginger production techniques, market price and procedure for seed production. Frequency and percentage were the empirical measures used for this variable, and presented in the following table.

Sl. No	Sources	High yielding rhizomes		Crop/Ginger production technique		Market price and produce		Seed production	
		F	P	F	P	F	P	F	P
1	TV								
2	Radio								
3	Newspaper								
4	Relatives/ friends								
5	Progressive farmers								
6	ATMA functionaries								
7	Extension worker								
8	NGO workers								
9	Local markets/ mandis								

3.3.1.17 Social participation

In this study, Social participation refers to the extent of respondents' involvement in formal and informal organizations, whether as members, office bearers, or in both roles. Frequency and percentage were the empirical measures used for this variable, presented in the following table.

Sl. No.	Statement	Frequency	Percentage
1	Member in an organization		
2	Member in more than one organization		
3	Office bearer in one organization		
4	Official member in more than one organization		

3.3.2 Knowledge level of respondents and the extent of adoption of improved practices in ginger cultivation

It was imperative to understand the knowledge level of the respondents and thus also measure the extent to which they had adopted the various improved practices for ginger cultivation.

Knowledge can be defined as facts, information and skills that are acquired over the course of time through experience or through formal education. Thus the level of information that a respondent has during the time of data collection can be directly referred to as the knowledge level of individual respondents (ginger growers). In this study, the respondent's knowledge was assessed on the general practices followed in ginger cultivation which was presented under 18 categories such as knowledge of- climatic condition, soil, land preparation, seed treatment, seed rate, spacing, planting time, propagation, cultivars, manures and fertilizers, types of manures, importance of fertilizers, mulching, plant protection measures, disease management, water management, harvesting and post-harvest management. For each question, respondents would give a score of '2' and '1' to indicate whether they are fully or partially aware and a score of '0' for lack of knowledge (unaware). The following table shows the different parameters (aware and unaware) that were adopted to measure the knowledge level of the respondents. The empirical measures used for assessing the knowledge were frequency and percentage.

Sl. no	Particulars	Aware				Unaware	
		Fully aware		Partially aware			
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	Climatic condition						
2	Soil						
3	Land preparation						
4	Seed treatment						
5	Seed rate						
6	Spacing						
7	Planting time						
8	Propagation						
9	Cultivars						
10	Manures and fertilizers						
11	Types of fertilizers						
12	Importance of fertilizers						
13	Mulching						
14	Plant protection measures						
15	Disease management						
16	Water management						
17	Harvesting						
18	Post-harvest management						

Adoption refers to the decision to fully implement an innovation as the most effective approach available. In this study, it pertains to the degree to which respondents have embraced the improved practices in ginger cultivation were measured under the following criteria, namely, climatic condition, soil, land preparation, seed treatment, seed rate, spacing, planting time, propagation, cultivars, manures and fertilizers, types of manures, mulching, plant protection measures, disease management, water management, and harvesting. The respondents answered each question with a score of '2', '1' and '0' for fully adopted, partially adopted and not adopted, respectively.

The following table shows the different parameters used for measuring the adoption level of the respondents. Frequency and percentage were the empirical measures used for measuring the adoption level.

Sl. No	Category	Fully adopted		Partially adopted		Not adopted	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	Climatic condition						
2	Soil						
3	Land preparation						
4	Seed treatment						
5	Seed rate						
6	Spacing						
7	Planting time						
8	Propagation						
9	Cultivars						
10	Manures and fertilizers						
11	Types of fertilizers						
12	Importance of fertilizers						
13	Mulching						
14	Plant protection measures						
15	Disease management						
16	Water management						
17	Harvesting						
18	Post-harvest management						

3.3.2.1 Knowledge index

The knowledge level of the respondents was measured using the knowledge index.

$$\text{Knowledge Index} = \frac{Total\ score\ obtained}{\text{Maximum possible score}} X100$$

The respondents were further grouped as Low, Medium and High level of knowledgeable by using mean and standard deviation as shown in the table below.

Sl. no	Category	Method of categorization
1	Low	<M – SD
2	Medium	>M to M ± SD
3	High	>M + SD

3.3.2.2 Adoption index

Adoption level of the respondents was measured by using adoption index.

$$\text{Adoption Index} = \frac{Total\ score\ obtained}{\text{Maximum possible score}} X100$$

The respondents were further classified as Low, Medium and High level of adopter based on the scores obtained by using Mean and Standard Deviation as shown in the table below.

Sl. No	Category	Method of categorization
1	Low	<M – SD
2	Medium	>M to M ± SD
3	High	>M + SD

3.3.3 Existing Seed system in ginger cultivation

In agriculture, a seed is any part of a plant used for multiplication or production, and when intended for consumption, it is referred to as an edible

plant part or grain. Seeds are crucial agricultural inputs, as they are essential for harvests. A seed can be defined as the reproductive unit of a flowering plant, capable of developing into a new plant (Vasquez, 2016). Botanically, a seed represents the embryonic stage in the plant life cycle and is typically divided into three components: the embryo, the endosperm, and the seed coat. The embryo is the small plant within the seed, consisting of a root, a stem, and one or more leaves. In agriculture, any material used for propagation and multiplication of crop is seed and simultaneously and widely, known as planting material. For instance, various propagules are bulb, corm, rhizome, sucker and bits.

Planting material for ginger rhizome (a modified subterranean thicken stem with root, shoot and node. A seed or planting material should be good enough to get optimum yield from the crop. Therefore, to be considered a quality seed, seed-rhizome, or planting material, it should possess several characteristics: high germination rates, vigorous seedling growth, a robust crop stand, superior quality, early maturity, freedom from diseases and insects, good adaptability, and high yield potential. In the present study special emphasis was given on ginger seed system.

3.3.3.1 Awareness of quality planting materials for optimum yield and adoption of those concepts in ginger cultivation

Seed quality helps to attain potential crop yield. In this regard, 4 pertinent issues related to the quality seed-optimum yield continuum were included, such as the importance of seed in productivity, importance of disease free seed to control seed borne diseases, the importance of disease free seed for higher yield, and the importance of insect-pest free seed for higher yield. Respondents were asked to response as aware or not aware, and also asked to reply if it is in full use, partial use or not in use.

The following table shows the different parameters used for the assessment of their knowledge and status of adoption of those parameters as well as methods of measurement. Frequency and percentage were adopted as empirical measures.

Sl. No.	Parameters	Awareness		Adoption level					
		Frequency	Percentage	Fully adopted		Partially adopted		Not adopted	
				F	P	F	P	F	P
1	Do you know the importance of seed in productivity?								
2	Do you know the importance of disease free seed to control seed borne diseases?								
3	Do you know the importance of disease free seed for higher yield?								
4	Do you know the importance of insect-pest free seed for higher yield?								

3.3.3.2 Types of planting material

Successful growing of a crop always depends on the type of planting materials and the climatic conditions. The following table shows how much the respondents know regarding the various planting material in the selected study area. In the investigation, respondents were questioned about the various types of planting material such as seed, rhizome, tuber, stem and bulb.

Frequency and percentage were the empirical measures used for measuring this parameter.

Sl. No	Planting material	Frequency	Percentage
1	Seed		
2	Rhizome		
3	Tuber		
4	Stem		
5	Bulb		

3.3.3.3 Types/grades of seeds

Seeds are classified into various classes, as shown in the following table. In the present study, the respondents were asked about various seeds, like local seeds, hybrid seeds, high yielding seeds, breeder's seeds, foundation seeds, certified/commercial seeds and truthful labelled seeds to assess their awareness of various seeds. The informal or the local seed can be defined as the seeds used for agricultural production, and selected by the farmers from the previous harvest or those which are obtained from within the local community. Hybrid seeds are usually defined as seeds that are produced by cross pollinated plants. High-yielding seeds are those that grow more quickly than typical seeds, allowing for crops to be harvested in a shorter time. Breeder's seeds are produced under the direct supervision of a qualified plant breeder. Foundation seeds are pure seed stocks cultivated by or under the oversight of a public agency, intended for use in producing registered and certified seeds. Certified or commercial seeds are derived from breeder or foundation seeds and are produced under controlled conditions to maintain genetic purity and variety identification. Truthful labelled seeds are produced by growers or private seed companies and sold with accurate labelling.

The empirical measures used for measuring the respondent's knowledge regarding the type of seeds were frequency and percentage.

Sl. No	Types of seed	Frequency	Percentage
1	Local seed		
2	Hybrid seed		
3	High yielding seed		
4	Breeder seed		
5	Foundation seed		
6	Certified/commercial seed		
7	Truthful labelled seed		

3.3.3.4 Criteria for considering the plot/crop for seed

Production of quality seed or planting material is primarily concerned for seed production. Seed should be genetically pure and retain all good characters of parental sources. To retain all favourable characters from pre-degree in seed/planting material is essential consideration for seed production and to ensure the same, property of the field for cultivation plays an important role, which selected for seed production. Farmers are producing and maintaining seeds/planting material since time immemorial. In this section emphasis was given to explore the different criteria followed by the ginger growers to maintain the noble parental properties in the seed-rhizome and to produce quality seed rhizome for higher productivity in next cultivation for production of ginger. Based on literature on seed production and agronomical practices for ginger cultivation, various issues for selection of plot for seed production and parameters for quality seed were taken into account and presented in consecutive two tables. The different parameters for selection of plot for seed production were included, namely, loose soil, black soil and slopping area, fertile soil and plot free from shed. Similarly, large sized rhizome, rhizomes with more bits, rhizomes free from diseases, and rhizomes not infested by pest were included under the use of quality planting materials for quality crop production.

Against all the selected parameters respondents were asked to response if they have knowledge about the issues. Further respondents were asked to reply for the adoption/use of the given parameters with three continuums namely; fully adopted, partially adopted and not adopted.

The empirical measures that were used for these variables were frequency and percentage.

Sl. No.	**Criteria for considering plot**	**Awareness**		**Adoption level**					
		Percentage	**Frequency**	**Fully adopted**		**Partially adopted**		**Not adopted**	
				F	**P**	**F**	**P**	**F**	**P**
1	Loose soil								
2	Preferably black soil								
3	Sloping area								
4.	Fertile soil								
5	Plot free from shed								

Sl. No.	**Criteria for considering seed**	**Awareness**		**Adoption level**					
		Percentage	**Frequency**	**Fully adopted**		**Partially adopted**		**Not adopted**	
				F	**P**	**F**	**P**	**F**	**P**
1	Larger sized rhizome								
2	Rhizomes with more bits								
3	Seed free from disease								
4	Not infested by pest								

3.3.3.5 Steps in seed processing

Seed processing or seed conditioning consists of the various steps that are followed in the preparation of harvested seed to be marketed to the farmers. Seed processing is a fundamental step which is followed in order to ensure high quality seed. It is the process of procuring high quality seed with lowest rate of contamination. Seed processing is done for the purpose of lowering the expenses of additional processes such as storage and transport. It also helps in reducing the bulk quantity of the seed lot where debris is cleaned, and empty and fractured or bad seeds are eliminated. It also increases the seed life span by drying seed to safe moisture content. It further helps in maintaining the uniformity in the shape and size of the seed by grading and pelleting. The different steps involved in seed processing. In this study 13 steps namely, careful cultivation of ginger crop, careful harvesting of rhizome, careful plucking of rhizome, cleaning of excess soil attached with rhizome, washing of rhizome, drying, grading, checking, treating, quality testing, packaging, labelling/tagging and storing were included.

In this regard, respondents were asked to response against each statement as they are aware or unaware, and respondents were asked about the status of use of the idea or concept.

The empirical measures used for assessing these were frequency and percentage.

Sl. no.	**Particulars**	**Awareness**		**Adoption**					
		Frequency	**Percentage**	**Fully adopted**		**Partially adopted**		**Not adopted/never**	
				F	**P**	**F**	**P**	**F**	**P**
1	Careful cultivation of ginger crop								
2	Careful harvesting of rhizome								

3	Careful plucking of rhizome					
4	Cleaning of excess soil attached with rhizome					
5	Washing of rhizomes					
6	Drying (process of elimination of moisture from the seed)					
7	Grading Are you aware about grading? (division of seeds according to size, shape, density and color)					
8	Checking To judge the quality as seed material/ quality in terms of seed					
9	Treating Are you aware about treating? (biological, physical and chemical agents and techniques applied to seed to provide protection and improve the establishments of healthy crops)					
10	Quality testing (seed tested for germination to determine how they will perform when planted in the field, the garden or in					

	seedling nursery)					
11	Packaging (placing of a counted or weighed sample of seeds into a container which is sealed ready for storage)					
12	Labelling/tagging					
13	Storage					

3.3.3.6 Awareness about certification and renewal of seeds

Seed certification can be defined as a legally sanctioned system to control the quality in seed production and multiplication. Therefore, it is a mechanism to ensure the supply of genuine and quality seeds/planting materials to the farmers or growers. Further, use of quality seeds ensures an enhancement of production up to 20 to 25 %. Therefore, change/replacement of old seeds after certain interval is essential to achieve consistently good production and the process of changing the seeds is termed as seed renewal. In this study, emphasis was given to assess the awareness level of ginger growers about seed certification and seed renewal. Altogether, four parameters were included to assess the awareness level of the respondents in relation to the above mentioned issues.

The empirical measures used for this variable were frequency and percentage.

Sl. No.	Parameters	Frequency	Percentage
1	Are you aware about seed certification?		
2	Do you know about any seed certification agencies?		
3	Are you aware about seed renewal period?		

4	Are you aware about the importance of renewal/changing of seed?		

3.3.3.7 Market channel

Market channel can be defined as the route that the seed follows to reach its consumer. A marketing channel consists of the people, the organizations, and the various activities that are required to transfer the ownership of goods starting from the stage of production to the consumption. Distribution of seeds can be carried out through a number of sectors; as such this aspect has two key subsystems: that of sourcing the seeds and the other for selling the seed.

3.3.3.8 Source of quality ginger seed-rhizome

It is widely accepted the seeds or planting materials are important for getting optimum yield. Use of appropriate seed can enhance about 20-25% of yield. In this section emphasis was given to explore the use of different sources for getting/procuring quality seed-rhizome of ginger by respondents. The following table illustrates how respondents utilized various methods to obtain or collect seed-rhizomes for ginger cultivation. The empirical measures used for this variable were frequency and percentage.

Sl. No.	Source	Percentage	Frequency
1	Friends/neighbours		
1	Progressive farmers		
2	Seed retailers		
3	Through agricultural department		
4	Local market		

3.3.3.9 Market channel for selling seed

Conversely this table will show the respondent's preference in selling their produce and whether the market channels available to them are being utilized beneficially or whether the respondent's remain reliant on the

traditional marketing (barter exchange) place which caters to lower yields or whether the farmers have transitioned to using the more efficient market channels which support the production capacity of high yielding seeds and crops.

A market is a venue where buyers and sellers come together to trade goods and services (Well Kenton, 2023). Marketing channels are the pathways through which products and services reach consumers. This study examined and documented the marketing channels utilized by the respondents and the empirical data for this variable were collected using frequency and percentage measures. The table below illustrates how respondents were categorized based on their access to various market channels.

Sl. No.	Channel	Frequency	Percentage
1.	Wholesale market		
2.	Seed retailers		
3	Both		
4	Fellow farmers		

3.3.3.10 Constraints in marketing/selling of seed ginger

The primary obstacle that limits the farmers from engaging in large scale high yield farming generally is tied to their capacity for marketing their produce. There are a number of factors that weigh on the marketability of produce ranging from a short shelf life, volume of the produce, unfavourable prices, pathological and pest concerns, lack of channels and so on. The respondents were asked to give inputs on the factors that ultimately determined their decision in limiting the scale of production and which constraints were the most challenging. This would potentially shed light on the steps that can be taken to either mitigate the problems associated with promoting the production of ginger or insulate the farmers from losses incurred through a market system which was not favourable to the sale of their produce. Accordingly, seven issues pertinent to constraints in marketing of produce were included and

respondents were asked to respond with five point continuum viz. very high, high, average, low and very low. Frequency and Percentage were the empirical measures used for this variable.

Sl. No.	Particulars	Very high		High		Average		Low		Very low	
		F	P	F	P	F	P	F	P	F	P
1	Perish-ability										
2	Transportation (bulkiness)										
3	Low price										
4	Susceptible to insect-pest attack										
5	Susceptible to disease attack										
6	Non availability of market										
7	Non availability of purchasing agent										

3.3.3.11 Constraints faced in Procuring/ purchasing of seed ginger

In a similar fashion, both the quality and quantity of the produce that the farmers can output is restricted by the quality and variety of the seeds they use for cultivation. It is important to mention that quality seed is an essential to achieve optimum production and productivity. In general, farmers are encountering problem for get quality planting materials, and ginger growers were not the exception and they were facing various constraints to get quality seed-rhizome of ginger. In this section, ten important issues related to seed availability and constraints were included and respondents were asked to respond against each statement or items with five point continuum viz. very high, high, average, very low and low. Following table shows the details about the issues included and method of study. The empirical measures used for this variable were Frequency and Percentage.

Sl. No	Particulars	Very high		High		Average		Low		Very low		Not aware/ concerned	
		F	P	F	P	F	P	F	P	F	P	F	P
1	Good quality/pure seed												
2	Authentic source of seed												
3	Authentic seller												
4	High price												
5	Perish-ability												
6	Transportation (bulkiness)												
7	Non-availability of disease free seed												
8	Non availability of seeds free												
	from pest attacks												
9	Non availability of market												
10	Non availability of seed supply agent												

3.3.4 Sustainable performance of ginger cultivation

Research conducted on the livelihoods of pineapple growers in the West Siang district of Arunachal Pradesh (Gamlin, 2016) and a study on the livelihoods of French bean growers in Nagaland (Benjongtoshi, 2020) were consulted in order to draw inferences on the sustainable characteristics documented across different crops and parameters regarding different types of sustainability. To assess the sustainability of ginger cultivation the following parameters were taken into consideration namely economic sustainability, human sustainability, social sustainability and environmental sustainability. Based on review of literature for each parameter a set of eleven statements were taken into account and included in the interview schedule. Respondents were asked to view and give response on all statement under each parameter. Each statement also had a five point continuum namely: most often/very high,

often/high, sometimes/average, rare/low, very rare/very low with scoring of 5-1 on the continuum scale, which was well informed to each of the respondents by the researcher during the time of interview and asked to response accordingly.

3.3.4.1 Economic sustainability

Goodland and Daly (1995) define economic sustainability as consuming only the interest rather than the capital, meaning that one should be able to maintain their economic well-being over time by consuming a portion of their income while preserving their overall wealth. For this study, economic sustainability was determined by assessing whether ginger cultivation generated sustainable economic values for the farmers. The following table enumerates all the statements included under this and details about measurement/scoring for economic sustainability.

Sl. No	**Parameters**	**Most Often/ Very high (5)**	**Often/ High (4)**	**Sometimes / Average (3)**	**Rare / Low (2)**	**Very rare/ Very low (1)**
1	Productivity is assured / Giving assured productivity					
2	Potential for steady and standard income					
3	Income from per unit area is higher compare to other crops					
4	Supporting livelihood					
5	Cost: benefit ratio is higher					
6	Cost of cultivation is in favour of the growers					

7	Scope/risk/income uncertainty of economic loss Vulnerable/less susceptible to economic loss					
8	Resilient in terms of productivity at the time of environmental stress condition					
9	Potential to fetch a higher income (during non peak season/ off season of peak harvesting time)					
10	Round the year, price is relatively consistent					
11	Requirement of external assistance for cultivation is less /minimum					

3.3.4.2 Human sustainability

Human sustainability focuses on preserving and enhancing the human capital within a society. For this study, human sustainability focus on the degree of ginger cultivation with emphasis on strategic areas targeted at improving and preserving the quality of human life. The particulars about human sustainable parameters and its measurements are given in the following table.

Sl. No	**Parameters**	**Most often/ very high (5)**	**Often/ high (4)**	**Sometimes/ average (3)**	**Rare/ low (2)**	**Very rare/ very low (1)**
1	Reducing poverty					
2	Addressing food security					
3	Addressing issues of nutrition					
4	Addressing issues of Health					
5	Generating employment					
6	Access to better education					

7	It has potential to protect us from illness					
8	It has Curative/Remedial quality to protect from illness					
9	Cultivation is not a hindrance/ obstacle in social participation/issues					
10	Cultivation does not include harmful impact on human/growers					
11	No influence on religious and spiritual aspect					

3.3.4.3 Social sustainability

With regard to social sustainability the impact of ginger cultivation on the community as a whole was the primary focus and furthermore the study also looked at how the social status of farmers changed as a result of ginger cultivation if any and the positive impact/s it may have had on the community by extension. The particulars about social sustainable parameters and its measurements are given in the following table.

Sl. No	**Parameters**	**Most often/ very high (5)**	**Often/ high (4)**	**Sometimes/ average (3)**	**Rare/ low (2)**	**Very rare/ very low (1)**
1	Recognition (being engaged in something worthwhile)					
2	Up scaling the social prestige					
3	Maintaining happiness/peaceful family life					
4	Compatible with food habit					
5	Compatible with social norms and values					
6	Up-scaling the social cohesiveness/togetherness					
7	Maintaining the gender equality					

8	Gender participation in cultivation's decision making					
9	All age group can take part in cultivation process					
10	Gender biasness is absent in cultivation and post-harvest activities					
11	It can be grown traditionally					

3.3.4.4 Environmental sustainability

In the case of environmental sustainability, the study focused on how large scale ginger cultivation impacted the cultivable areas, whether it promoted a move towards a healthy environment and supported the local ecosystems; in short whether the outcome was positive or negative and sustainable. The study also looked at whether farmers engaged in activities that may accrue towards sustainable cultivation in the long term. The details about environmental sustainable parameters and the measurements are given in the following table.

Sl. No	**Parameters**	**Most often/ very high (5)**	**Often/ high (4)**	**Sometimes/ average (3)**	**Rare/ low (2)**	**Very rare/ very low (1)**
1	Restore ecological balance and biodiversity					
2	Not Undermining/deteriorating the natural resources					
3	Favorable for organic cultivation and without chemical inputs					
4	Control soil erosion					
5	Can grow in less favorable climatic condition / climatic stress condition					

6	Ability to cope with shocks					
7	Responsive to integrated nutrient management, integrated water management					
8	Emission of greenhouse gas from crop residue is less					
9	Suitable in less fertile soil Crop is suitable to cultivate in less fertile					
	soil					
10	Cultivation is suitable for recycling of farm waste					
11	Suitable for shifting cultivation					

3.3.5 Constraints in ginger cultivation and measures suggested for improvement

Identifying the constraints involved in activities is an essential element for further improvement of the same. Accordingly, in the present study, identification of constraint in ginger cultivation was taken into consideration. Analysing the constraints helps to determine the gap in adoption of technologies and subsequently disseminate the proper technologies required by the ginger growers to solve the problems faced by them.

For this study, various parameters regarding constraints and potential problems related to ginger cultivation were taken into consideration. These problems fall into multiple categories according to the nature of the constraints. First area, the study identified was limitations related to availability of material resources and input. These issues included delays in the availability of inputs, the absence of improved high-yielding varieties of ginger, and the high demand for manures and fertilizers needed for high-yielding varieties.

Another area that posed problems for the ginger farmers was related to the supply chain and existing market system and infrastructure. These challenges include inadequate storage facilities, irregular seed supply, high input costs, unavailability of fertilizers during peak seasons, a shortage of processing units, significant market price fluctuations, limited credit facilities, expensive planting materials, disorganized marketing systems, high transportation costs, insufficient market information, lack of transport options, absence of post-harvest technologies and machinery, and inadequate extension support for farmers, weak research extension farmers linkage, non-availability of institute and lack of co-ordination with different departments.

A third area that challenged the farmers in their efforts towards maximizing production was the limited knowledge and non-availability of efficient farming methods. The following issues were considered: insufficient technical knowledge regarding cultivation, unfamiliarity with high-yielding varieties (HYVs), inadequate understanding of land preparation for ginger cultivation, lack of knowledge about seed rates, poor field management practices, timely weed control in ginger cultivation, insufficient information on recommended seed rates, lack of expertise in curing rhizomes, inadequate knowledge about rhizome storage, poor management of insect pests and diseases, inadequate understanding of proper fertilizer application and recommended dosages, lack of knowledge on ginger value addition, low risk management capabilities among farmers, insufficient technical guidance, and limited training programs for farmers.

Finally, farming also comes with its own inherent challenges which are often beyond the control of the farmer particularly problems related to adverse climatic condition at the critical stage of the crop, site selection, harvesting at proper time, non-availability of labour or lack of skilled labour, or high cost of labour if at all labour is available. Above all these problems and existing

challenges, the farmer has to tackle with the threat of natural calamities that may happen any time and in any degree of intensity.

The empirical measures used for these variables were frequency and percentage. Furthermore, to eliminate and reduce the problems faced by the farmers, different remedial measures suggested by the farmers were documented and analyzed.

3.4 Tools and techniques for data collection

The data for the current investigation were derived from both primary and secondary sources. Primary data were collected from selected respondents using a structured and pre-tested interview schedule through personal interviews. The pre-testing of the interview schedule was conducted in February 2019. Data collection took place over the years 2019 to 2021, with delays due to the Covid-19 pandemic; hence, data were gathered both before and after the pandemic. Additionally, relevant secondary data were sourced from the Department of Horticulture and other concerned sources like the Department of Agriculture, the Village Development Boards of the various villages under the study, and local organizations functioning in the state.

3.5 Statistical tools and analysis of data

The data gathered from respondents were carefully examined, organized, and analyzed using suitable methods. Descriptive statistical tools were used to analyze the data. The different statistical tools and methods namely Mean, Percentage, Rank, Frequency, Standard Deviation, and Correlation were used for this study.

Mean

Mean can be defined as the average value of the distribution which is achieved by dividing the sum of the scores in the distribution by a number of observations. The formula for mean is given below:

$$\bar{X} = \frac{\sum_1^N x}{N}$$

Where, $\bar{X}$= mean of the scores.

x =sum of the individual score, and

N= number of observation

Frequency

Frequency can be defined as the rate at which something occurs over a particular period of time or in a given sample.

Percentage

Percentage is defined as any proportion or share in relation to a whole. For calculating percentage, the frequency is multiplied by the total number of respondents and multiplied by 100.

Rank

Rank can be defined as the transformation of data in which numerical ordinal values are replaced by their rank when the data are sorted.

Standard Deviation

Standard Deviation can be defined as the arithmetic mean divided by the number of observation and the formula is given below:

$$S=\sqrt{\frac{(x-\bar{x})^2}{n-1}}$$

Where, S= standard deviation of the sample

x= individual score

$\bar{x}$= mean of the scores

N=number of observation

Correlation

Correlation can be defined as the degree of relation between two or more variables. For example, when an increase or decrease of one variable affects the increase or decrease of another variable, the two variables are said to be correlated.

$$Y=\frac{N\sum XY-(\sum X)(\sum Y)}{\sqrt{[N\sum X^2-(\sum X^2\,]\,[N\sum Y^2-\sum Y)^2]}}$$

Where, X and Y = original scores in variable X

N= number of paired scores

$\sum XY$=each X multiplied by corresponding Y, then summed

$\sum X$=sum of X scores

$\sum X^2$= each X squared, then summed

$(\sum X)^2$= sum of X scores, squared

$\sum Y$ =sum of Y scores

$\sum Y^2$ = each Y squared, then summed

$(\sum Y)^2$ = sum of Y score, squared

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

In this chapter, the research findings are presented and analyzed using appropriate statistical tools, aligned with the specific objectives of the study.

4.1 Characterize the ginger growers and their socio-economic status

4.1.1 Age

Table 4.1(fig. 4.1) displays the age distribution of the respondents. The data reveals that approximately 57.78% of the respondents fell into the middle age group, while 25.55% were in the older age group, and 16.67% were in the younger age group. Additionally, the average age of the respondents was 46 years, with a standard deviation of 11.65. The majority of the respondents were between 35 and 55 years old, indicating that most of the ginger growers were middle-aged.

It can be concluded that approximately 50.00% of the respondents were aged between 35 and 55 years, with the younger age group being minimal. This finding is consistent with Harsha (2022), who reported that the majority (84%) of ginger growers were also in the middle age range of 31 to 50 years, aligning with the results of the current study.

4.1.2 Gender

Table 4.2 (fig 4.2) illustrates the gender distribution of the respondents. It reveals that 67.04% of the respondents were male, while 32.96% were female.

The study indicates that men were more actively involved in ginger production in the selected area. This finding is consistent with Magar *et al.*

(2021), who also reported that a majority of respondents in ginger production were male.

4.1.3 Literacy rate

Table 4.3 presents the literacy rates among respondents, indicating that 89.63% of them are able to read and write, while 8.89% are illiterate, and 1.48 per cent could only read.

This finding is consistent with Lalthlamuanpuii *et al*.(2024), who also reported that majority(88.86%) of the farmers in Lunglei district were literate.

4.1.4 Educational qualification

To assess the educational level of the selected respondents, they were categorized into seven groups: illiterate, nursery, primary, middle, secondary, higher secondary, and graduate and above. Table 4.4 (fig 4.3) illustrates the distribution of respondents according to their educational qualifications. It reveals that 37.04% had a middle school education, 30.37% had completed secondary school, 19.25% had primary education, and 3.33% had higher secondary education. Additionally, 8.89% of respondents were illiterate. Only 0.74% had attended nursery, and another 0.74% had achieved a graduate level of education. These findings align with the results reported by Peter *et al*. (2021).

4.1.5 Family size

Based on members of the family, the respondents were classified into three categories: small, medium, and large families. According to the data in Table 4.5 (fig 4.4) 82.97% of the respondents were from medium-sized families, 13.33% were from large families, and 3.70% were from small families.

This finding aligns with the research of Vasane *et al.* (2024) who also found that majority of the ginger growers had medium family size.

Table 4.1 Distribution of respondents according to their age N=270

Sl. No.	Category	Frequency	Percentage	Mean	SD	Range
1	Young (<35)	45	16.67	45.61	11.65	18-75
2	Medium (35-55)	156	57.78			
3	Old (>55)	69	25.55			
Total		270	100			

Table 4.2 Distribution of respondents based on gender N=270

Sl. No	Category	Frequency	Percentage
1	Male	181	67.04
2	Female	89	32.96
Total		270	100

Table 4.3 Distribution of respondents based on literacy rate N=270

Sl. No.	Category	Frequency	Percentage
1	Illiterate	24	8.89
2	Read	4	1.48
3	Read and write	242	89.63
Total		270	100

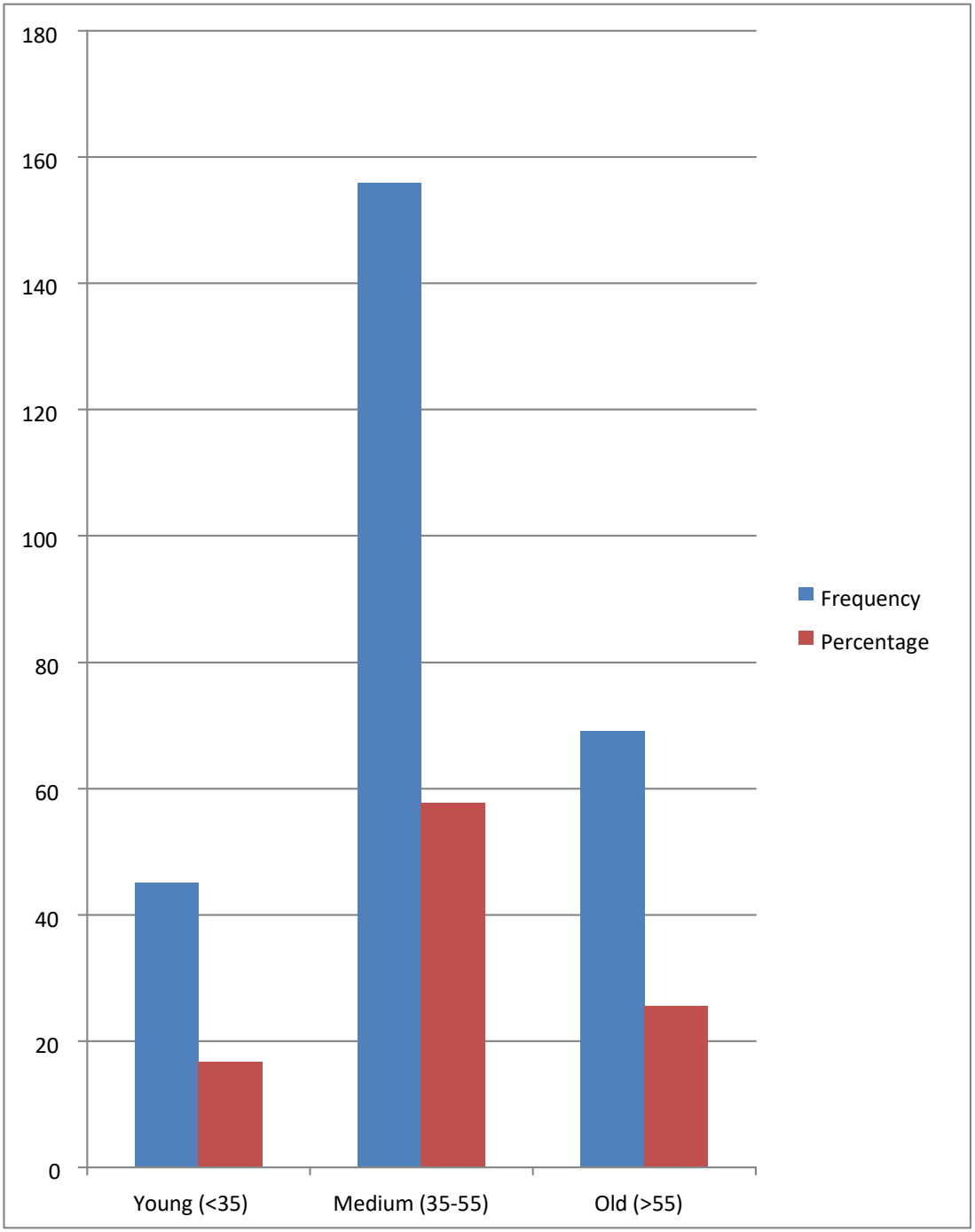


Fig 4.1 Distribution of respondents according to age

Plate No.1 Interviewer with Respondents from Hongphoi village, Mon District

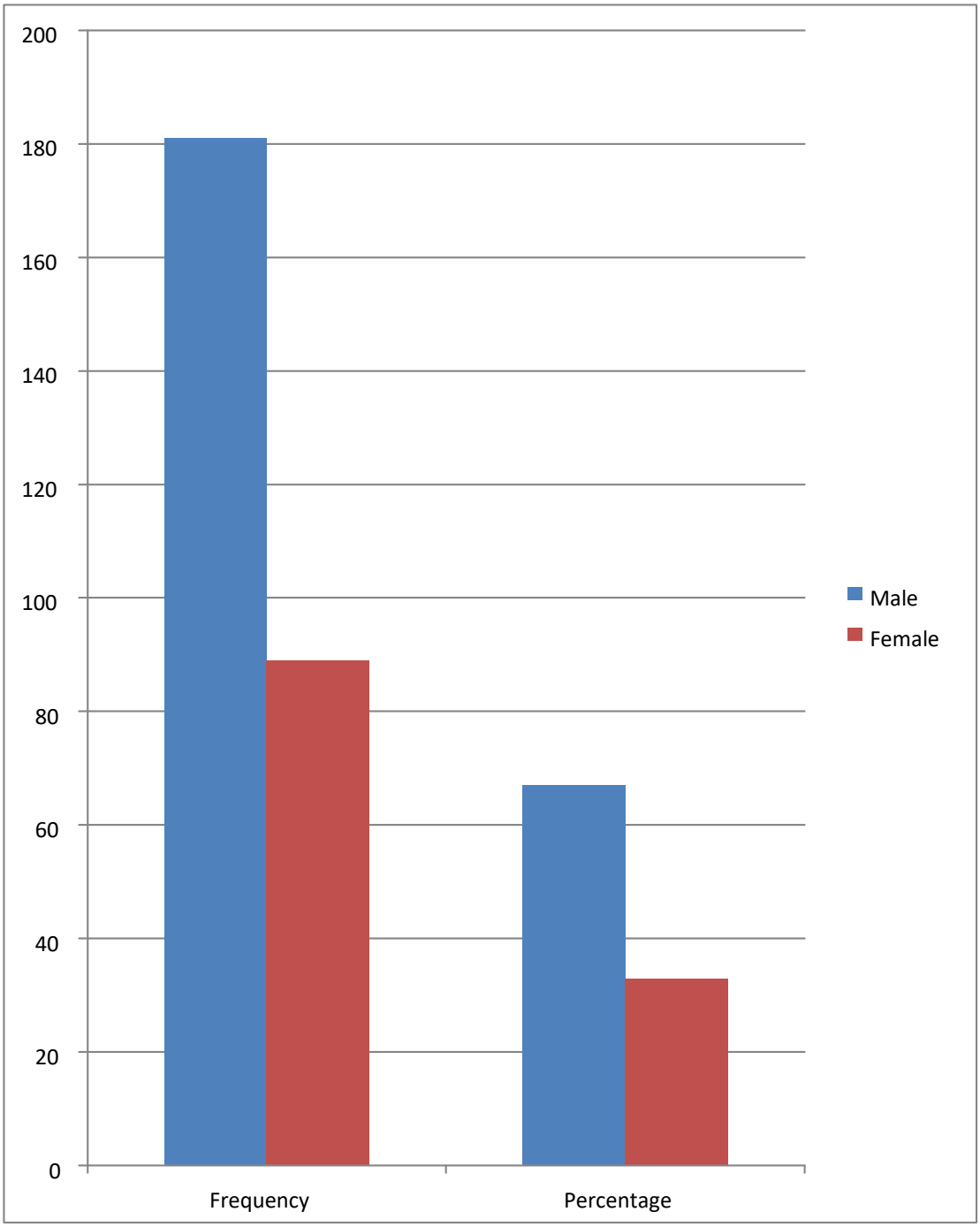
Plate No. 2 Interviewer with respondents from Chingphoi village, Mon district

Plate No. 3 Interviewer with respondents from Kholeboto village,

Zunheboto district

Plate no. 4 Interviewer with respondents from Rotomi village,

Zunheboto district



4.2 Distribution of respondents according to gender

4.1.6 Occupation

Table 4.6 (fig. 4.5) displays the distribution of farmers by occupation. It indicates that 97.40% of the respondents primarily engaged in agriculture, while 1.48% was involved in business and 1.11% worked in government services.

The findings suggest that most respondents in the study area were predominantly occupied with agricultural activities. This aligns with Peter *et al*. (2021), who also found that agriculture was the primary occupation for ginger farmers.

4.1.7 Experience in Ginger cultivation

Table 4.7 (fig. 4.6) presents the distribution of respondents based on their experience in ginger cultivation. It shows that 31.49% of respondents had 6 to 8 years of experience, while 28.89% had 9 to 11 years of experience. Additionally, 22.59% had 3 to 5 years of experience, and 17.03% had 12 years or more. The average experience in ginger cultivation was 8.81 years, with a standard deviation of 3.04, ranging from 3 to 16 years.

4.1.8 Distribution of respondents based on their land holdings

Table 4.8 (fig. 4.7) illustrates the distribution of respondents based on their land holdings. It shows that the majority, 80.00%, had medium-sized land holdings (ranging from 0.85 to 3.91 acres). In contrast, 15.92% had large-sized land holdings (over 3.91 acres), and 4.08% had small-sized land holdings (around 0.85 acres). The average land holding among respondents was 2.38 acres, with a standard deviation of 1.53. This finding is consistent with Roy *et al*. (2013), who reported that most respondents in Almora district of Uttarakhand also had medium-sized land holdings.

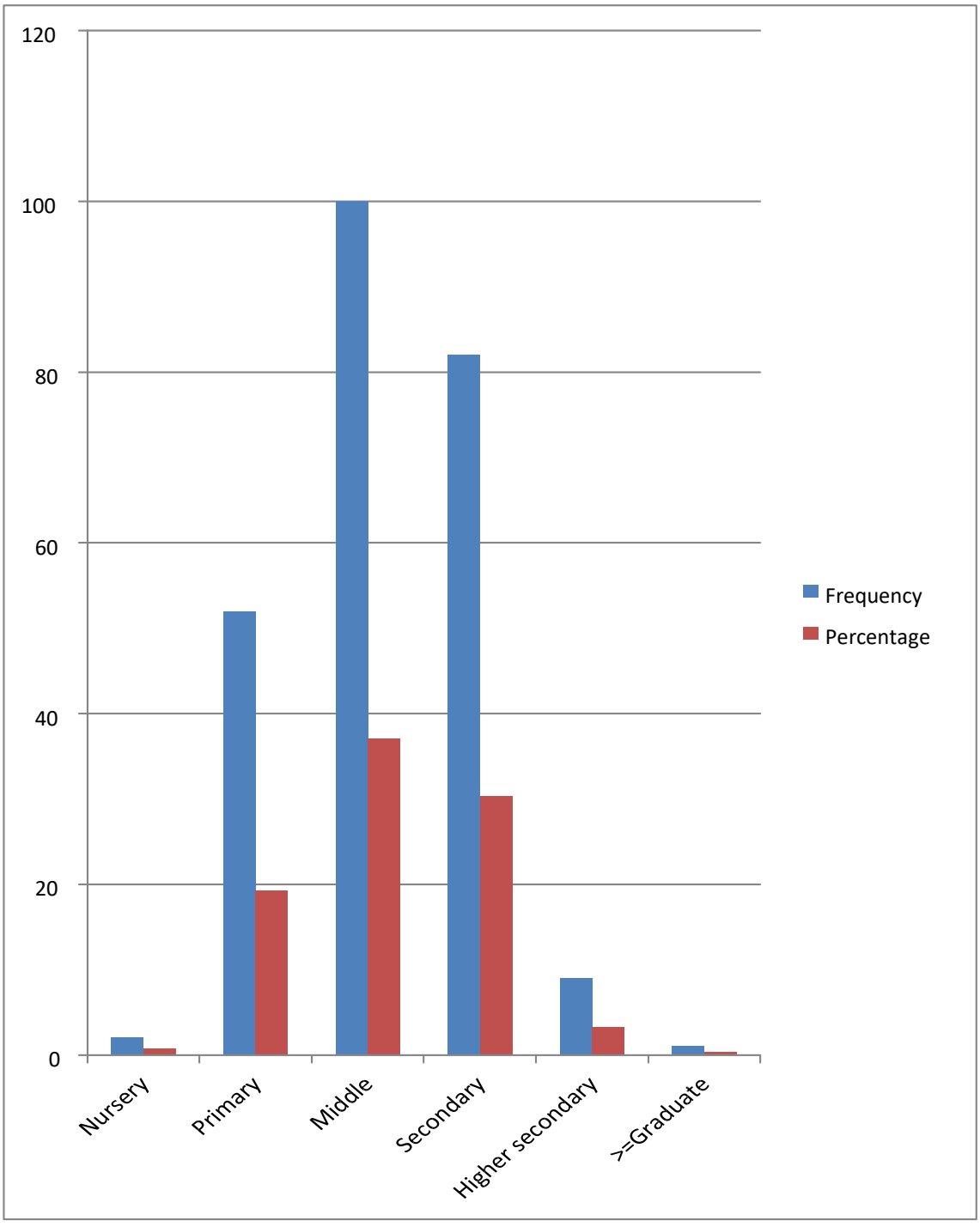


Fig 4.3 Distribution of the respondents according to their educational qualification

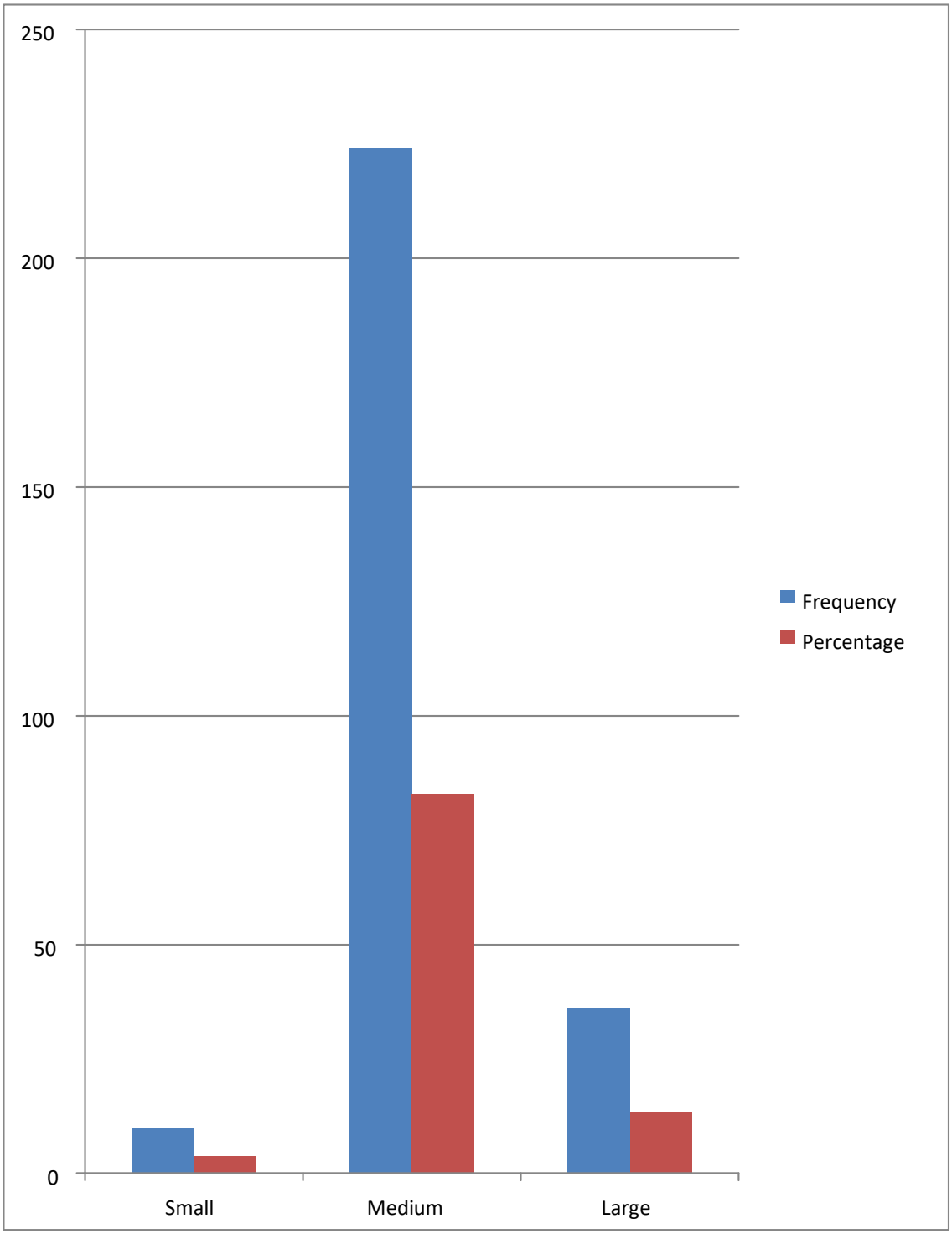


Fig 4.4 Distribution of respondents according to the family size

Table 4.4 Distribution of respondents on educational qualification.N=270

Sl. No.	Category	Frequency	Percentage
1	Illiterate	24	8.89
2	Nursery	2	0.74
3	Primary	52	19.25
4	Middle	100	37.04
5	Secondary	82	30.37
6	Higher secondary	9	3.33
7	≥Graduate	1	0.38
T otal		270	100

Table 4.5 Distribution of respondents based on family size N=270

Sl. No.	Category	Frequency	Percentage	Mean	SD	Range
1	Small	10	3.70	5.4	1.86	2-13
2	Medium	224	82.97			
3	Large	36	13.33			
Total		270	100			

Table 4.6 Distribution of respondents based on their occupation N=270

Sl. No	Occupation	Frequency	Percentage
1	Agriculture	263	97.40
2	Government service	3	1.11
3	Business	4	1.49
Total		270	100

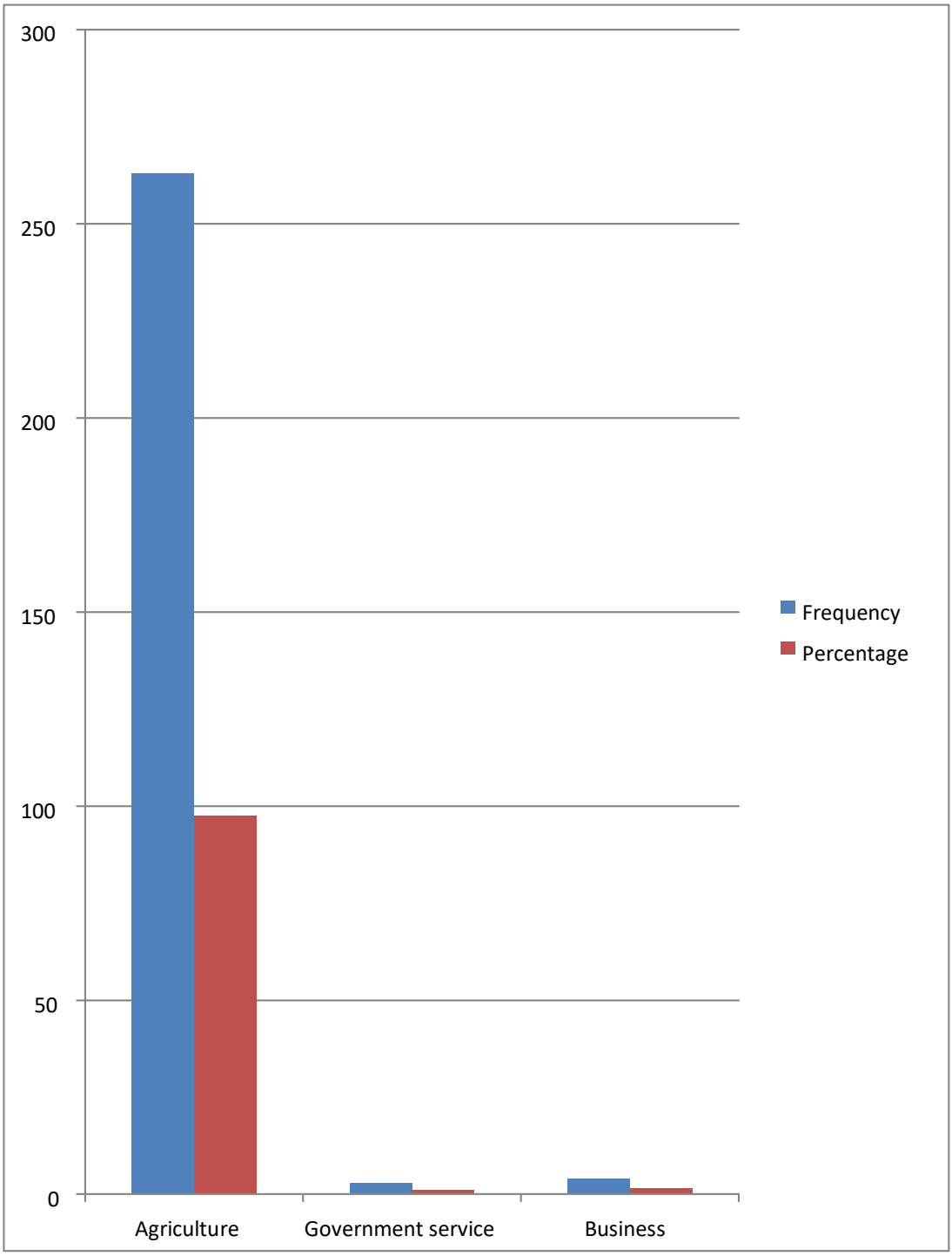


Fig 4.5 Distribution of respondents according to occupation

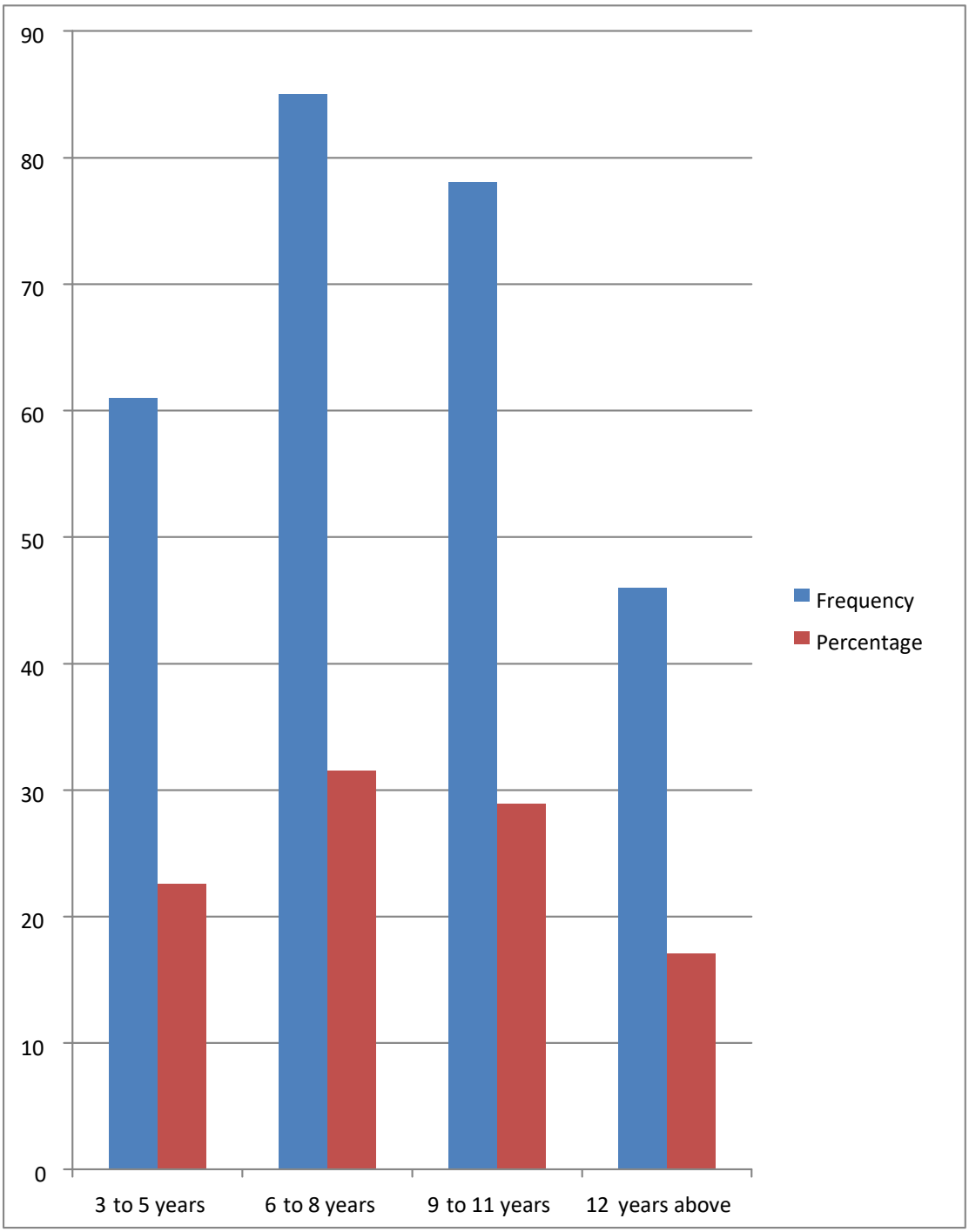


Fig 4.6 Distribution of respondents according to experience in ginger cultivation

Table 4.7 Distribution of respondents according to experience in Ginger cultivation (years) **N=270**

Category	Frequency	Percentage	Mean	SD	Range of experience
3 to 5 years	61	22.59	8.18	3.04	3-16
6 to 8 years	85	31.49			
9 to 11 years	78	28.89			
12 years above	46	17.03			
Total	270	100			

Table 4.8 Distribution of respondents on based land holding (in acres)

N=270

Sl. No.	Category	Criteria (in acres)	Frequency	Percentage	Mean	SD	Range
1	Small	Less than 0.85	11	4.08	2.38	1.53	0.66-8
2	Medium	From 0.85-3.91	216	80.00			
3	Large	More than 3.91	43	15.92			
Total			270	100			

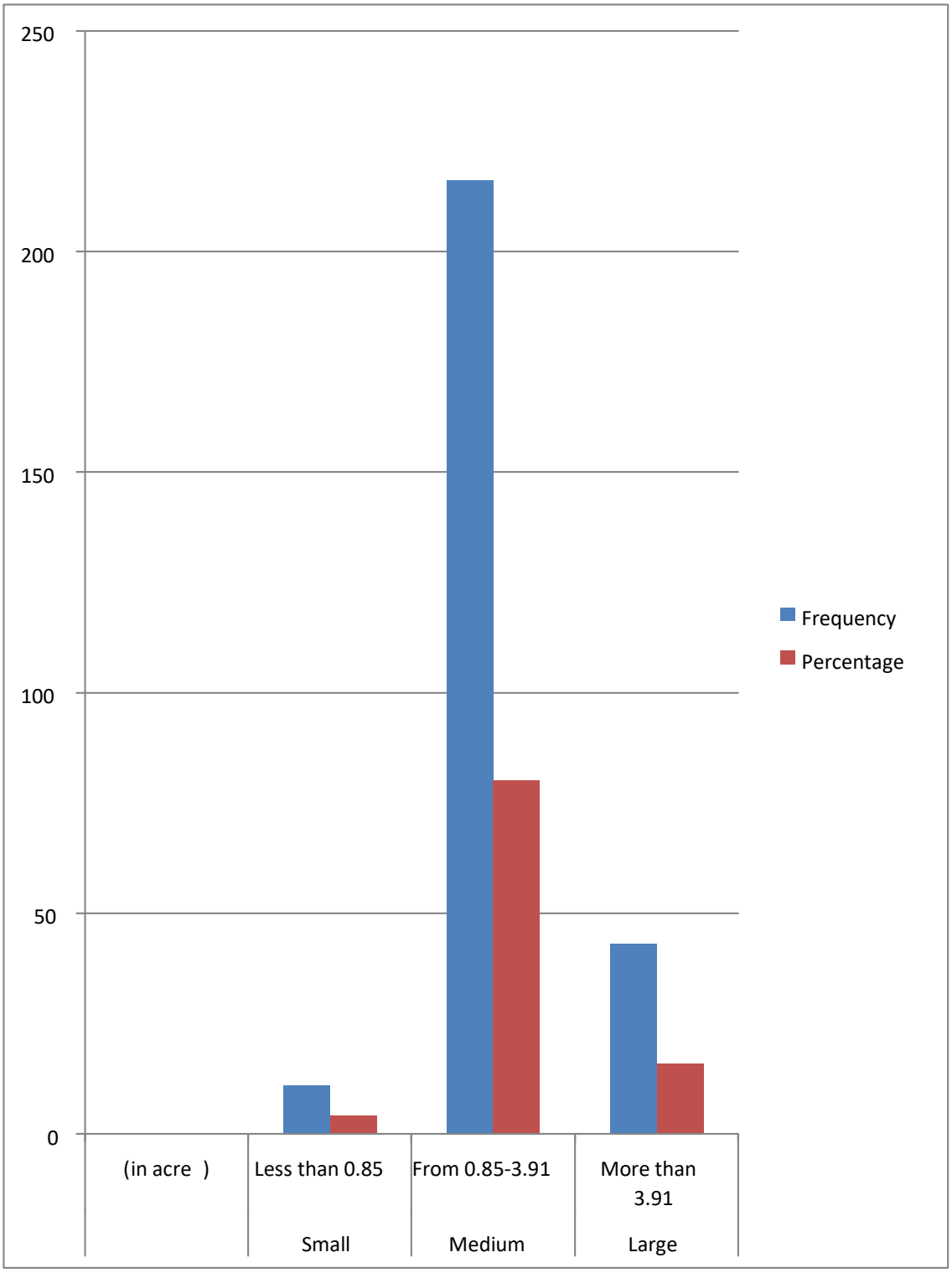


Fig 4.7 Distribution of respondents based on land holding

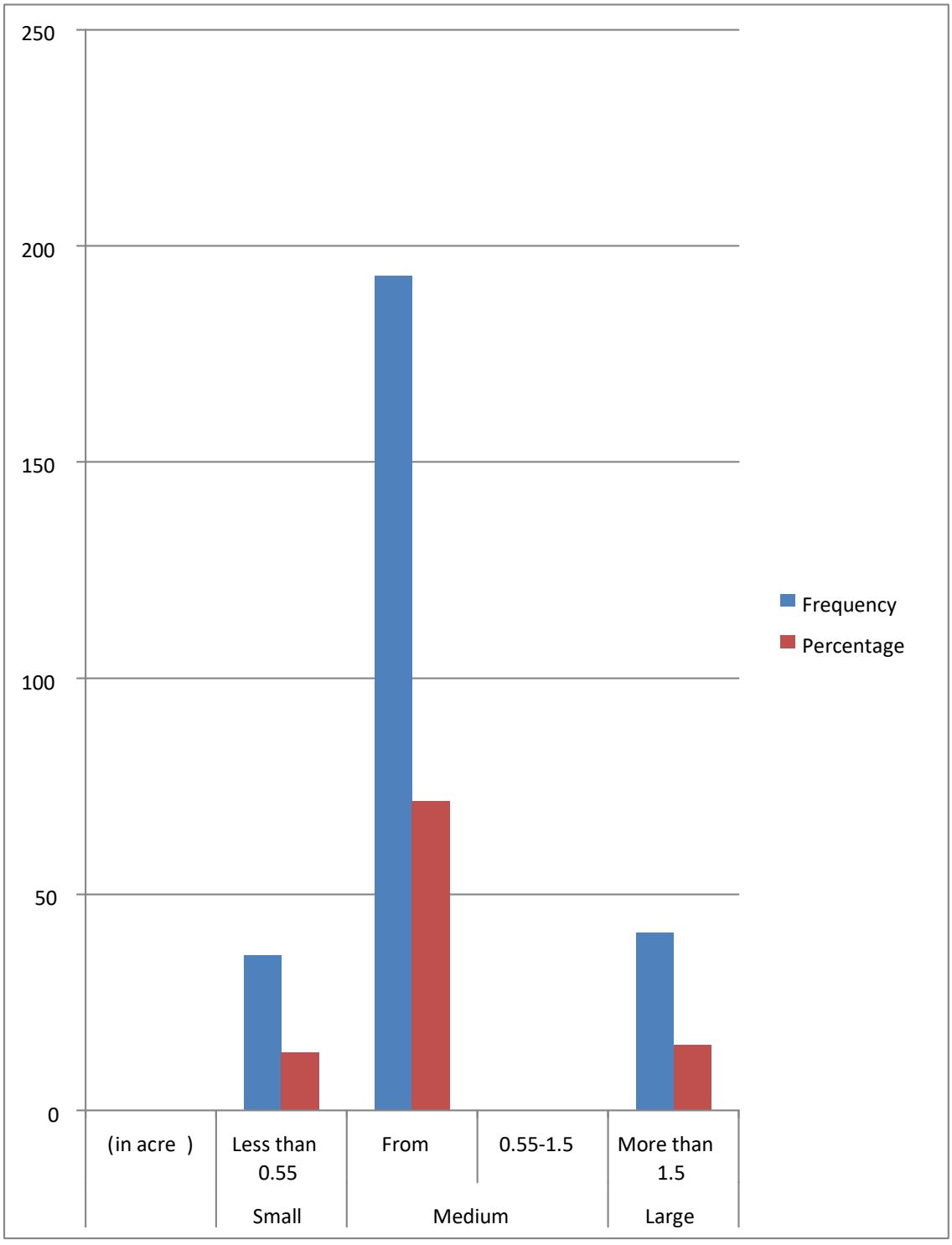


Fig 4.8 Distribution of respondents based on land under ginger cultivation

Plate No. 5 Ginger field in Yuching village, Mon district

Plate No. 6 Ginger field in Shoixe village, Zunheboto district

Plate No. 7 Farmers and labourers harvesting the crop,

Chingdang Village, Mon district

4.1.9 Distribution of respondents based on operational land holding

Table 4.9 presents the distribution of respondents according to the size of their operational land holdings and this revealed that 78.51% of respondents had medium-sized operational land holdings (ranging from 0.63 to 1.70 acres), 13.34% had large-sized holdings (over 1.70 acres), and 8.15% had small-sized holdings (less than 0.63 acres). This aligns with Harsha (2022), who found that the majority (52%) of respondents had medium-sized land holdings.

4.1.10 Distribution of respondents according to the land under ginger cultivation

Table 4.10 (fig 4.8) shows the distribution of the respondents according to the land holding under ginger cultivation. It was seen that the majority (i.e., 71.48 per cent) of the respondents had medium-sized (0.55-1.5% acre) of land under ginger cultivation. It was also seen that 15.19 per cent and 13.33 per cent of the respondents had large sized (more than 1.5% acre) and small-sized (less than 0.55 acre) of land under ginger cultivation, respectively.

4.1.11 Distribution of respondents according to the annual income

Table 4.11 displays the distribution of respondents based on their annual income and it showed that the majority, 74.44%, fell into the medium-income group, with annual incomes ranging from ₹33,324 to ₹1,20,573. Additionally, 14.07% of respondents had annual incomes exceeding ₹1,20,573, placing them in the high-income group, while 11.49% had annual incomes below ₹33,324, categorizing them as low-income. The average income of respondents was ₹76,949, with a standard deviation of ₹43,624.81.

Table 4.9 Distribution of respondents based on operational land holding (in acre) N=270

Sl. No.	Category	Criteria (in acre)	Frequency	Percentage	Mean	SD	Range
1	Small	Less than 0.63	22	8.15	1.69	0.53	0.33-2.66
2	Medium	From 0.63-1.70	212	78.51			
3	Large	More than 1.70	36	13.34			
Total			270	100			

Table 4.10 Distribution of respondents based on land under ginger cultivation (in acre) N=270

Sl. No.	Category	Criteria (in acre)	Frequency	Percentage	Mean	SD	Range
1	Small	Less than 0.55	36	13.33	1.03	0.47	0.33-2.66
2	Medium	From 0.55-1.5	193	71.48			
3	Large	More than 1.5	41	15.19			
Total			270	100			

4.1.12 Distribution of respondents according to the income from ginger cultivation

Table 4.12 presents the distribution of respondents based on their income from ginger cultivation and this indicates that 67.03% of respondents earned between ₹24,484 and ₹95,303 from ginger cultivation. Additionally, 17.79% of respondents had incomes exceeding ₹95,303, while 15.18% had incomes below ₹24,484.

4.1.13 Distribution of respondents according to the annual production of ginger

Table 4.13 (fig. 4.9) shows the distribution of the respondents based on annual production of ginger. The table reveals that 42.60 per cent of the respondents had high level (>1,768 kg) of production of ginger cultivation. It was also seen that 40.00 per cent of the respondents had a medium level (789-1,768 kg) of production of ginger.

The remaining 17.40% of respondents had low ginger production, producing less than 789 kg while the average production was 1,673.42 kg, with a standard deviation of 884.08 kg. This indicates that most ginger growers in the study area achieved high levels of ginger production, however higher range of production is 4800 kg which is very less and it started from 250 kg only.

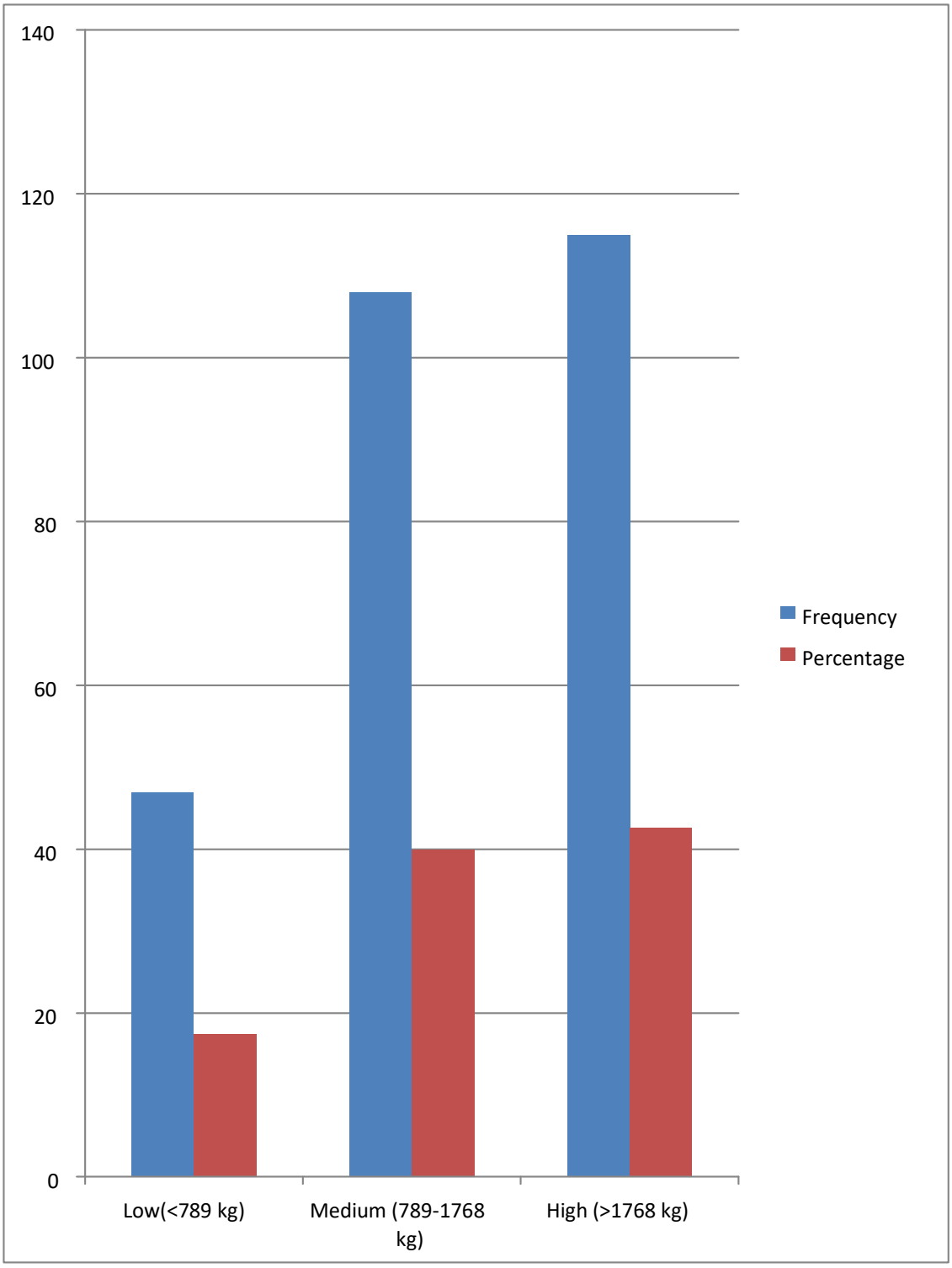


Fig 4.9 Distribution of respondents based on annual production of ginger

Plate No. 8 Ginger harvested and ready for marketing,

Chingdang village, Mon district

Plate No. 9 Sample of Nadia variety of ginger

Table 4.11 Distribution of respondents based on annual income N=270

Sl. No.	Category	Method of categorization	Frequency	Percentage	Mean	SD	Range
1	Low	Less than ₹33,324	31	11.49	76,949	43,624.81	11,750-1,88,000
2	Medium	From ₹33,324-₹1,20,573	201	74.44			
3	High	More than ₹1,20,573	38	14.07			
Total			270	100			

Table 4.12 Distribution of respondents based on income from Ginger Cultivation N=270

Sl. No.	Category	Method of categorization	Frequency	Percentage	Mean	SD	Range
1	Low	Less than ₹24,484	41	15.18	59,894	35,409.23	8,000-1,80,00
2	Medium	From ₹24,484-₹95,303	181	67.03			
3	High	More than ₹95,303	48	17.79			
Total			270	100			

Table 4.13 Distribution of respondents based on annual production of ginger N=270

Sl. No.	Category	Method of categorization	Frequency	Percentage	Mean	SD	Range
1	Low	Less than 789 kg	47	17.40	1,673.42	884.08	250-4800
2	Medium	From 789-1768 kg	108	40			
3	High	More than 1768 kg	115	42.60			
Total			270	100			

4.1.14 Distribution of respondents according to the training exposure

Table 4.14 shows the distribution of the respondents based on the training attended. It was seen that majority (83.33%) of the respondents did not attend any training regarding Ginger cultivation and the remaining (16.67%) of the respondents attended training. This finding aligns with the results of Mahat *et al.* (2019), where majority (69%) of the farmers did not participate in training.

4.1.15 Distribution of respondents based on level of acquaintance with change agent

Table 4.15 (fig.4.10) shows the distribution of respondents according to acquainted with change agents in the study area. It was seen from the study that most (96.29 per cent) of the respondents were aware about ATMA functionaries. The table further showed that 76.67 per cent of the respondents were acquainted with HDO in the study area. It was also found that 71.67, 46.11, 42.23, 41.11, 38.89, 12.22, 4.44 and 1.85 per cent of the respondents were acquainted with LRDO, KVK, ADO, NRLM(others), AFA, VET, progressive farmers and NGOs, respectively. The investigation revealed that none of the respondents were aware of input dealers.

Table 4.14 Distribution of respondents based on training attended N=270

Sl. No.	Particulars	Frequency	Percentage
1	Attended	45	16.67
2	Not attended	225	83.33
Total		**270**	**100**

Table 4.15 Distribution of respondents based on awareness about change agent N=270

Sl. No.	Extension Agent	Awareness/acquainted with Extension Agent	
		Frequency	**Percentage**
1	ADO	114	42.23
2	LRDO	193	71.48
3	HDO	207	76.67
4	VET	33	12.22
5	AFA	105	38.89
6	KVK	125	46.29
7	Input dealers	0	0
8	NGO	5	1.85
9	Progressive farmers	12	4.44
10	Agri. Scientist	0	0
11	ATMA	260	96.29
12	Others	111	41.11

*multiple responses were obtained

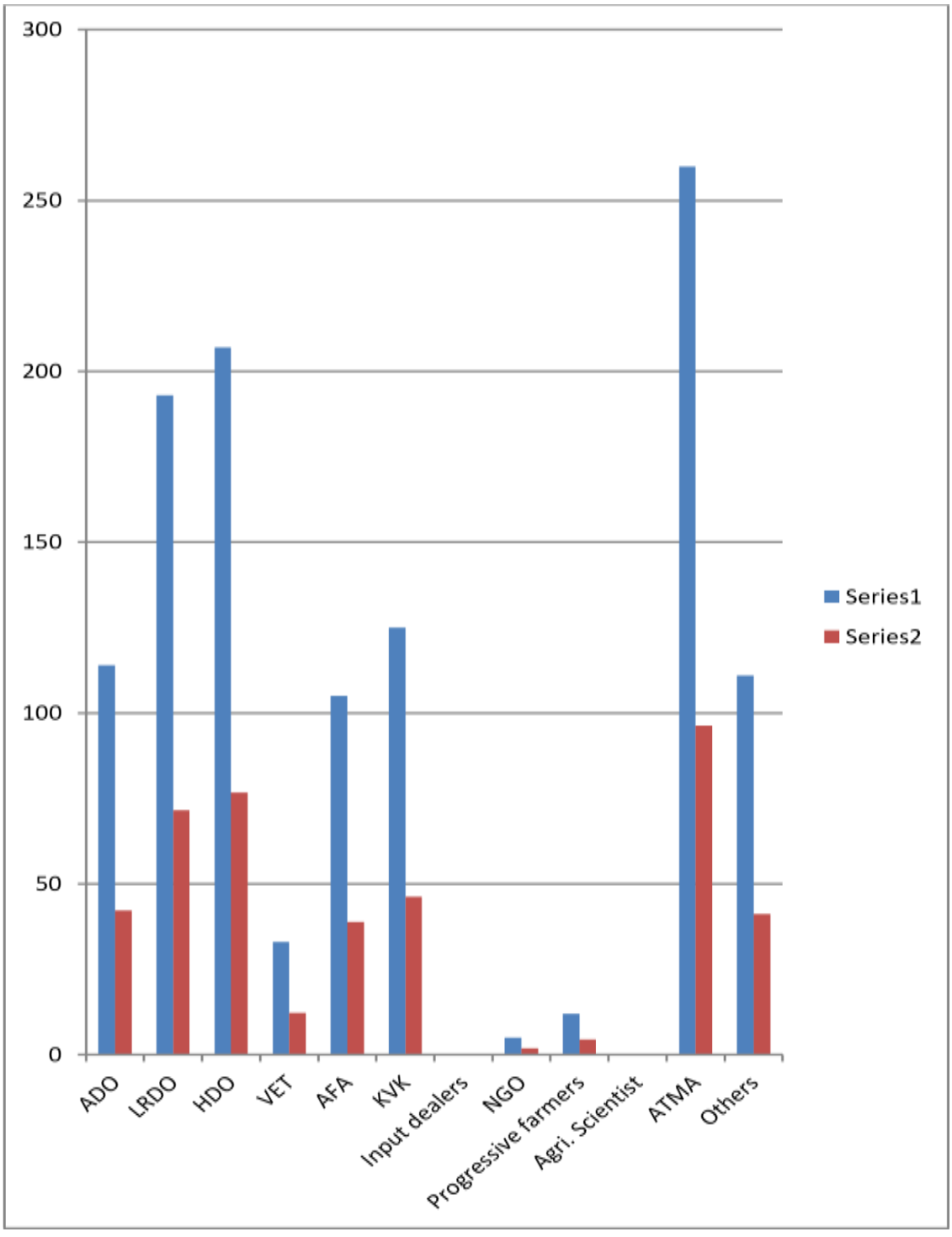


Fig 4.10 Distribution of respondents based on awareness about change agents

4.1.16 Distribution of respondents according to the rate of contact

Table 4.16 shows the distribution of the respondents according to the rate of extension contact. The study revealed that 37.78 and 21.48 per cent of the respondents contacted ATMA and HDO sometimes, respectively. The study also showed that 17.78%, 15.56%, 12.23% of the respondents contacted LRDO, NRLM (others), and AFA sometimes, respectively. It is further seen from the table 4.16 that 13.33%, 8.89%, 2.96% and 1.11% of the respondents contacted ADO, KVK, VET and progressive farmers sometimes, respectively. It was also seen from table 4.16 that none of the respondents contacted input dealers or NGOs.

4.1.17 Type of information sources used by farmers in decision-making on various cultivation practices

Table 4.17 details the sources respondents used for decision-making regarding various cultivation practices. It was found that none of the respondents obtained information about different cultivation practices from TV, radio, newspapers, progressive farmers, NGOs, or extension workers. Instead, 64.07% and 52.96% of respondents received information about high-yielding rhizomes from relatives and friends and from ATMA functionaries, respectively. Additionally, 80.74% and 11.49% of respondents learned about ginger and other crop production techniques from ATMA functionaries and relatives and friends, respectively. Furthermore, 80.74% and 61.49% of respondents obtained information about market prices from local mandis and from relatives and friends, respectively. Contradicting to this study, Kharjana *et al.* (2017) reported that respondents used newspaper (35%), radio (50.83%) and TV (38.34%) as a source of information.

Table 4.16 Distribution of respondents based on rate of extension contact

N=270

Sl. No.	Extension Agent	Frequency of contact					
		Most often		Sometimes		Never	
		F	P	F	P	F	P
1	ADO	0	0	36	13.33	234	86.67
2	LRDO	0	0	48	17.78	222	82.22
3	HDO	0	0	58	21.48	212	78.52
4	VET	0	0	8	2.96	262	97.04
5	AFA	0	0	33	12.23	237	87.77
6	KVK	0	0	24	8.89	246	91.11
7	Input dealers	0	0	0	0	270	100
8	NGO	0	0	0	0	270	100
9	Progressive farmers	0	0	3	1.11	267	98.89
10	Agri. Scientist	0	0	0	0	270	100
11	ATMA	0	0	102	37.78	168	62.22
12	Others	0	0	42	15.56	228	84.44

*multiple responses were obtained

Table 4.17 Distribution of respondents based on access of information sources in decision-making on various cultivation practices N=270

Sl. No	Sources	High yielding rhizomes		Crop/Ginger production technique		Market price produce		Seed production	
		F	P	F	P	F	P	F	P
1	TV	0	0	0	0	0	0	0	0
2	Radio	0	0	0	0	0	0	0	0
3	Newspaper	0	0	0	0	0	0	0	0
4	Relatives/ friends	173	64.07	31	11.49	166	61.49	0	0
5	Progressive farmers	0	0	0	0	0	0	0	0
6	ATMA	143	52.96	218	80.74	0	0	0	0
7	Extension worker	0	0	0	0	0	0	0	0
8	NGO'S	0	0	0	0	0	0	0	0
9	Local markets/ mandis	0	0	0	0	218	80.74	0	0

*multiple responses were obtained

Table 4.18 Distribution of respondents based on social participation

N=270

Sl. No.	Statement	Frequency	Percentage
1	Member in an organization	215	79.63
2	Member in more than one organization	85	31.48
3	Office bearer in one organization	9	3.33
4	Office bearer in more than one organization	1	0.37

4.1.18 Social participation

Table 4.18 revealed that 79.63% of respondents were members of an organization. Additionally, 31.48% of these respondents belonged to more than one organization. The study also found that 3.33% of respondents held office in at least one organization, while 0.37% served as office bearers in more than one organization.

4.1.19 Knowledge level and adoption of recommended package of practices of farmers in ginger cultivation

This section deals with the details about knowledge level of respondents concerning different improved technologies and cultivation practices of ginger subsequently, this section covers the adoption behaviour of respondents in respect of improved ginger cultivation practices.

4.1.20 Distribution of respondents according to the knowledge level on climatic requirements, soil and land management for ginger cultivation

Table 4.19 shows the distribution of the respondents according to the knowledge about climatic conditions required for ginger cultivation. It was found that all (100%) respondents had full knowledge about ginger requiring warm climatic conditions for its cultivation. The table further showed that all (100%) respondents were unaware that ginger grew well in humid climatic condition.

The table also presents the respondents' knowledge levels regarding recommended soil management practices. It was found that 67.78% of respondents were fully aware that ginger requires rich, well-draining soil for optimal cultivation, while 32.22% were only partially aware of this. Additionally, 70.00% of respondents were fully informed about the importance

of aeration for ginger cultivation, with 30.00% having partial awareness. Furthermore, 72.22% of respondents were fully aware that sandy loam soil is ideal for growing ginger, whereas 27.78% were partially aware of this fact.

Regarding land preparation, all respondents demonstrated a high level of knowledge about field preparation for ginger cultivation. Table 4.20 shows that 100% of respondents were fully aware of the need to plough the land before planting. The table also indicates that the majority (83.70%) were fully aware of and about 16.30% were partially aware of the recommended land preparation practices for optimal ginger cultivation. Furthermore, 100% of respondents knew that ginger should not be planted in the same field year after year. This high level of knowledge about land preparation is likely due to its fundamental importance in ginger cultivation. The findings are consistent with those of Sundresha *et al.* (2020).

4.1.21 Distribution of respondents based on knowledge level on seed treatment, seed rate and spacing

Table 4.20 shows the distribution of the respondents according to the knowledge level of the respondents on recommended seed treatment. The study showed that all (100%) respondents were unaware about treating the rhizome with cow urine for half an hour for better rhizome growth before planting. It was also seen that all (100%) respondents were unaware of seed treatment for effective control of diseases. Apart from a lack of knowledge about seed treatment due to respondents not attending trainings regarding seed treatment, it is also likely that the general unavailability of cattle in the region makes such processes foreign and inaccessible to the local farmers.

Table: 4.19 Distribution of respondents according to the knowledge level on climatic requirements, soil and land management for ginger cultivation

N=270

Sl. No	Particulars	Recommended Practices	Fully Aware		Partially aware		Unaware	
			F	P	F	P	F	P
1	Climatic Conditions	a. Do you know that ginger grows well in warm climate?	270	100	0	0	0	0
		b. Do you know that ginger grows well in humid climatic condition?	0	0	0	0	270	100
2.	Soil management	a. Do you know that a rich soil with good drainage is good for ginger cultivation?	183	67.78	87	32.22	0	0
		b. Do you know that soil aeration is ideal for ginger cultivation?	189	70.00	81.	30.00	0	0
		c. Do you know that sandy loam soil type is the best type of soil for ginger cultivation?	195	72.22	75	27.78	0	0
3.	Land preparation	a. Do you plough your field before planting?	270	100	0	0	0	0
		b. Do you know that it requires 3-4 pulverizing/ ploughing to bring the soil to fine friable?	226	83.70	44	16.30	0	0
		c. Do you know that Ginger should not be planted in the same field year after year?	270	100	0	0	0	0

It was seen that 56.67 per cent of the respondents were partially aware of the planting 1,200-1,500 kg of seed/ha of land. It was also seen that 26.66 per cent and 16.67 per cent of the respondents were unaware and fully aware about the recommended seed rate for 1 hectare, respectively. The study further showed that all (100%) respondents were fully aware about the seed weight, seed size, the importance to use true to type rhizomes and the importance of seeds to be free from diseases and pests.

Regarding knowledge of spacing, it was also found that 94.07 per cent of the respondents were fully aware about the requirement of 30 cm spacing between rows for ginger cultivation. It was found that the remaining 5.93 per cent of the respondents were unaware about the same. The study further showed that 92.22 per cent and 7.78 per cent of the respondents were fully aware and unaware about the requirement of 25 cm of spacing between plant to plant for better rhizome growth, respectively. In the case of depth of sowing, it was observed that all (100%) respondents were fully aware that rhizomes should be placed at a depth of 4-5 cm in furrows and covered with soil. The respondents were reasonably aware about the recommended spacing and depth of sowing.

Sundresha *et al.* (2020) also had similar findings with the present study and they reported that majority of the ginger growers had full knowledge on recommended seed rate and optimum spacing.

4.1.22 Distribution of respondents based on knowledge level on planting time

Regarding knowledge about the month of sowing, it was noted from table 4.21 that 83.33 per cent of the respondents were unaware that April to May is the optimum time for sowing ginger and it was further seen that 16.67 per cent of the respondents were fully aware of the optimum planting time of ginger. This was attributed to the traditional schedule, where ginger is sown

between January– February, which is ideal for the region. April-May is becoming unsuited for sowing due to the prevalent harsh of the climatic cycle of the areas interviewed.

This study aligns with Odyuo *et al.* (2022) who found that only 0.83% of the respondents had knowledge on recommended planting time.

4.1.23 Distribution of respondents based on knowledge level on planting material and cultivars

Table 4.22 showed that all (100%) respondents were fully aware about using 4-5 cm long sprouted bud as planting material. It was also seen that all (100%) respondents were fully aware about the Nadia variety. However, it must be noted that all other varieties, such as China, Maran and Varada were unknown to all (100%) respondents in the study area. The lack of knowledge or the general awareness of varieties and planting material can be directly traced to the popularity of the commonly grown varieties which generally exhibit or require similar transplanting conditions.

Table 4.20 Distribution of respondents based on knowledge level on seed treatment, seed rate and spacing for ginger cultivation **N=270**

Sl. No.	Particulars	Recommended Practices	Fully aware		Partially aware		Unaware	
			F	P	F	P	F	P
1	Seed treatment	a. Do you know that before sowing, rhizomes should be dipped in cow urine for half an hour?	0	0	0	0	270	100
		b. Do you know that drenching the soil with Dithane Z-78 @2g/l of water at 30 days interval is effective for control of diseases?	0	0	0	0	270	100
2.	Seed rate	a. Do you know that 1200 to 1500 kg is required for 1 ha of land?	45	16.67	153	56.67	72	26.66
		b. Do you know the recommended Seed weight is 15-25 gms?	270	100	0	0	0	0
		c. Do you know that the recommended Seed size is 5-10 cms?	270	100	0	0	0	0
		d. Do you know that the rhizomes should be true to type?	270	100	0	0	0	0
		e. Do you know that the seeds should be free from diseases and pests?	270	100	0	0	0	0
3.	Spacing	a. Do you know that Spacing of 30 cm between rows is ideal for growing ginger?	254	94.07	0	0	16	5.93
		b. Do you know that 25 cm between plants is considered ideal for Ginger?	249	92.22	0	0	21	7.78
		c. Do you know that the rhizomes are placed at a depth of 4-5 cm in furrows and covered with soils?	270	100	0	0	0	0

Table 4.21 Distribution of respondents based on knowledge level on planting time N=270

Sl. No.	Particulars	Recommended Practices	Fully aware		Partially aware		Unaware	
			F	P	F	P	F	P
1.	Planting time	Do you know that April to May is the optimum time for sowing Ginger?	45	16.67	0	0	225	83.33

Table 4.22 Distribution of respondents based on knowledge level on planting material and cultivars N=270

Sl. No.	Particulars	Recommended Practices	Fully aware		Partially aware		Unaware	
			F	P	F	P	F	P
1.	Propagation material	Do you know that Four to five cm long sprouted buds are required?	270	100	0	0	0	0
2.	Cultivars	a. Do you know about the variety Nadia?	270	100	0	0	0	0
		b. .Do you know about the variety China ?	0	0	0	0	270	100
		c. Do you know about the variety Maran?	0	0	0	0	270	100
		d. Do you know about the variety Varada?	0	0	0	0	270	100

4.1.24 Distribution of respondents based on knowledge level on manures and fertilizers

It was seen from table 4.23 that 92.59 per cent of the respondents were fully aware about using manure to improve the soil's condition. The study also showed that 7.41 per cent of the respondents were partially aware about the same. It was also found that 93.70 per cent of the respondents were fully aware that using manure is good and thus helps in increasing the production of ginger. It was seen that 6.30 per cent of the respondents were partially aware about the same. The study further showed that all (100%) respondents in the study area were unaware about the dosage of application of FYM and the time to apply it. This is basic farming knowledge and is expected from any farming community.

The study showed that all (100%) respondents were fully aware about FYM and pig manure as alternate sources of soil nutrients for ginger. The study also showed that 92.22 per cent and 7.78 per cent of the respondents, respectively, were fully and partially aware that poultry manure is an alternate source of soil nutrient for ginger cultivation in the study area.

It was seen that 72.59 per cent of the respondents were unaware about the importance of fertilizers for soil health management. The study further showed that 18.52 per cent and 8.89 per cent of the respondents were fully and partially aware about using fertilizer for soil health management, respectively. It was also seen that 72.59 per cent of the respondents were unaware about using fertilizer for higher ginger production. Furthermore, it also showed that 18.52 per cent and 8.89 per cent of the respondents were fully and partially aware about using fertilizer for higher production of ginger, respectively. The study further showed that none of the respondents knew about the dosage of fertilizers to be used for higher production of ginger. These responses roughly explain rural farmers' quantitative and qualitative production levels compared

to those who reproduce high-yield outputs by applying optimum inputs and practices. A large section of the respondents did not expect that the application of fertilizers would impact crop yield with certain degree. It was clear that the farmers were ignorant about the empirical approach towards the use of fertilizers and the appropriate dosage for higher ginger production. There is also the added factor of the jhum (shifting) of cultivation that makes the added step of using fertilizers somewhat inconvenient. This is further aggravated by the belief among the local cultivators that natural soil is already fertile enough without the need to use additives to improve soil productivity.

4.1.25 Distribution of respondents based on knowledge level on mulching

Table 4.24 shows that 50.38% of respondents were fully aware of mulching practices, 34.81% had partial awareness, and 14.81% were unaware. The table also indicates that 50.38% were fully aware of the purpose of mulching, 27.40% were partially aware, and 22.22% were unaware. Additionally, 50.38% of respondents understood that mulching is used for weed management, while 26.66% had partial awareness and 22.96% were unaware of this aspect. The table further reveals that 80.00% of respondents were unaware of using paddy straw as a mulching material, whereas 20.00% used paddy straw for this purpose. Using paddy straws as mulch is a traditional practice, and the respondents were generally knowledgeable about this activity as an important step in mitigating weed growth. There were some outliers to the expected response, which be contributed to the farmers not engaging in paddy cultivation.

This finding aligns with Odyuo *et al.* (2022), who found that (53.16%) of the respondents had knowledge about mulching.

Table 4.23 Distribution of respondents based on knowledge level on manures and fertilizers N=270

Sl. No	Particulars	Recommended practices	Fully aware		Partially aware		Unaware	
			F	P	F	P	F	P
1	Manures And Fertilizer	a. Are you aware that manure is good for soil health management?	250	92.59	20	7.41	0	0
		b. Are you aware that manure is good for higher production of ginger?	253	93.70	17	6.30	0	0
		c. Do you know that, FYM 3-5 tonnes per ha is ideal for ginger cultivation?	0	0	0	0	270	100
		d. Do you know that FYM should be applied at the time of field preparation?	0	0	0	0	270	100
2.	Types of manures	a. FYM	270	100	0	0	0	0
		b. Poultry	249	92.22	21	7.78	0	0
		c. Pig manure	270	100	0	0	0	0
		d. Others	0	0	0	0	270	100
3.	Fertilizers	a. Are you aware that fertilizer is good for the soil health management?	50	18.52	24	8.89	196	72.59
		b. Are you aware that fertilizer is good for higher ginger production?	50	18.52	24	8.89	196	72.59
		c. Do you know that dose of NPK @ (100:90:90 kg/ha) should be applied in the form of chemical fertilizer?	0	0	0	0	270	100
		d. Do you know that 1/3 Nitrogen should be applied as basal?	0	0	0	0	270	100
		e. Do you know that full doses of phosphorus and potassium should be applied at the time of sowing?	0	0	0	0	270	100
		Do you know that 1/3 of nitrogen should be applied at 45 DAP. Remaining 1/3 Nitrogen should be applied 90-95 DAP?	0	0	0	0	270	100

Table 4.24 Distribution of respondents based on knowledge level on mulching N=270

Sl. No.	Particulars	Recommended practices	Fully aware		Partially aware		Unaware	
			F	P	F	P	F	P
1.	Mulching	a. Are you aware about mulching practices?	136	50.38	94	34.81	40	14.81
		b. Are u aware of the purpose of mulching?	136	50.38	74	27.40	60	22.22
		c. Are you aware that purpose of mulching is for weed management?	136	50.38	72	26.66	62	22.96
		d. Are you aware that paddy straw can be used as mulching material?	0	0	54	20	216	80

Table 4.25 Distribution of respondents based on knowledge level on plant protection measures and disease management N=270

Sl. No.	Particulars	Recommended practices	Fully aware		Partially aware		Unaware	
			F	P	F	P	F	P
1.	Plant protection measures	a. Are you aware about the chemical control of weeds in ginger cultivation?	0	0	0	0	270	100
		b. Are you aware of the harmful effects of insects?	201	74.44	69	25.56	0	0
2.	Disease management	a. Are you aware of the various diseases of ginger?	80	29.63	97	35.93	93	34.44
		b. Soft rot	0	0	270	100	0	0
		c. Bacterial wilt	0	0	0	0	270	100
		d. Dry rot	0	0	0	0	270	100
		e. Leaf spot	0	0	121	44.81	149	55.19
		f. Do you know that soft rot is the most severe disease of Ginger?	0	0	0	0	270	100
		g. Do you know that rhizome treatment with trichoderma @ 8-10 gm/ litre water helps in managing soft rot?	0	0	0	0	270	100

4.1.26 Distribution of respondents based on knowledge level on plant protection measures and disease management

It was found that all (100%) respondents were unaware about the chemical control of weeds in ginger cultivation. Table 4.25 showed that 74.44 per cent of the respondents were fully aware about the harmful effects of insects. It was also found that 25.56 per cent of the respondents were partially aware about the harmful effects of insects. This response shows once again the inclination of the cultivators to follow traditional knowledge systems in the production of cash crops, which is both a detrimental approach towards profitable yield as well as exhibits the limitations of the economic capacity of the respondents. The fact that the majority of the respondents understood the threat posed by crop-assailing insects indicates that the constraints of the economy may play a large role in limiting the potential of ginger cultivation on a large scale. This is especially the case where mono-crop farming exaggerates the reproduction and prevalence of target insects.

It was found that 35.93 per cent of the respondents were partially aware about the soft rot disease of ginger. It was also seen that 34.44 per cent and 29.63 per cent of the respondents were unaware and fully aware about soft rot, respectively. However, it was found that all (100%) respondents were unaware about soft rot being the most severe disease of ginger.

The study also showed that all respondents (100%) were unaware about bacterial wilt and dry rot of ginger. It was also found that 55.19 per cent of the respondents were unaware about the leaf spot and 44.81 per cent of the respondents were partially aware about the leaf spot disease of ginger.

The study also showed that none of the respondents knew about treating the rhizome with trichoderma @ 8-10 gm/l water, which helps in managing the soft rot of ginger. Based on these four (bacterial wilt, dry rot, leaf spot and soft

rot) responses, it is safe to say that the respondents had little to no plant pathogen familiarity. Such lack of information and awareness leads to poor yield output and defeats the purposes of large-scale production.

4.1.27 Distribution of respondents based on knowledge level on water management

Table 4.26 showed that 70.37 per cent and 29.63 per cent of the respondents were fully and partially aware of water management in ginger cultivation, respectively. The study also showed that 85.19 per cent of the respondents were fully aware about the appropriate time for first irrigation that should be done immediately after plating, and 14.81 percent of the respondents were partially aware. It was also seen that 85.19 per cent of the respondents were fully aware about the importance of irrigation in ginger cultivation and 14.81 per cent were unaware. It was further seen that all (100%) respondents were unaware of the time of irrigation in ginger cultivation. However, the majority of respondents being aware of irrigation practices post transplanting can be attributed to general farming practices both in traditional and modern systems. The concerning aspect is that all of the farmers had no idea about the irrigation requirements of their crops, which naturally leads to either the crops being neglected or causing the crops to produce poor yield as a result of insufficient, untimely or over-saturated watering. The other factor that may have contributed to irrigation being relegated to a second aspect may be the terrain that is harsh and not easy to irrigate or basically lacks a naturally available convenient water supply which is often the case.

Table 4.26 Distribution of respondents based on knowledge level on water management N=270

Sl. No.	Particulars	Recommended practices	Fully aware		Partially aware		Unaware	
			F	P	F	P	F	P
1.	Water management	a. Are you aware about the water management in ginger cultivation?	190	70.37	80	29.63	0	0
		b. Do you know that the first irrigation should be done immediately after planting?	230	85.19	40	14.81	0	0
		c. Are you aware ofthe importance of irrigation in ginger cultivation?	230	85.19	0	0	40	14.81
		d. Do you know the time of irrigation in ginger cultivation?	0	0	0	0	270	100

Table 4.27 Distribution of respondents based on knowledge level on harvesting N=270

Sl. No.	Particulars	Recommended practices	Fully aware		Partially aware		Unaware	
			F	P	F	P	F	P
1.	Harvesting	a. Do you know that the optimum harvesting time of Ginger is 8 to 10 months after planting?	270	100	0	0	0	0

4.1.28 Distribution of respondents based on knowledge level of harvesting

Harvesting is the most important activity in agriculture and it needs maximum care to achieve the maximum income. Further, it is directly associated with keeping the quality and fetching the maximum price from the produce. For instance, in ginger, harvesting of immature rhizome is directly associated with keeping quality and fetching the optimum price from the buyers. Therefore, fully matured ginger rhizome has good keeping quality for long term post-harvest storage and which get optimum price. According in this study, it was seen that all (100%) respondents were fully aware about the optimum time of harvesting which is 8-10 months after planting.

Odyuo *et al.*(2022) also had similar findings with the present study and they reported that majority of the ginger growers had full knowledge on time of harvesting.

4.1.29 Distribution of respondents based on adoption of recommended package of practices of climatic condition, and soil and land management of ginger cultivation

Table 4.28 depicts the adoption of improved practices of ginger cultivation in the selected area. It was found that all (100%) respondents partially adopted the practice of following proper drainage of water from the ginger field. The study further showed that 70.00 per cent of the respondents followed ideal soil aeration of ginger field. It was also seen that 61.11 per cent of the respondents partially adopted planting of ginger in sandy loam soil and 11.11 per cent fully adopted the same. Another, 27.78 per cent of the respondents did not adopt the same (i.e., growing ginger in sandy loam soil). These categories of responses are consistence with their knowledge level (Table 4.28). Soil condition ideal for a crop can be determined, and the

respective crop is sown therefore, the basic knowledge of which crops perform best in a particular type of soil is shared to upscale community knowledge

Regarding field preparation, it was found that all (100%) respondents fully adopted the practice of ploughing their field before planting of ginger rhizome. The study also showed that 51.85 per cent and 48.15 per cent of the respondents were fully and partially adopted about the land requiring 3-4 pulverizing to bring the soil to fine friable, respectively. Once again, the initial condition of ploughing is one that the respondents, within their capacity as cultivators, can and must manage for improved crop yield.

4.1.30 Distribution of respondents based on adoption of recommended seed treatment, seed rate and spacing of ginger cultivation

In the case of seed treatment, it was found that all (100%) respondents did not adopt the dipping of rhizome in cow urine and drenching the soil with Dithane Z78@2g/l of water for effective control of diseases. As mentioned in a previous section this is unconventional practice and further made impractical by the lack of cattle rearing on a scale that makes such practices feasible. This aligns with the findings of Miso *et al*. (2020) which indicated that none of the respondents had adopted seed treatment due to a lack of knowledge.

Further, table 4.29 shows that 71.85 per cent of the respondents did not adopt the recommended seed rate and the remaining 28.15 per cent partially adopted the recommended seed rate. It was also seen that 88.89 per cent and 11.11 per cent of the respondents partially adopted and fully adopted the recommended seed weight, respectively. It was also seen that 83.34 per cent and 11.11 per cent of the respondents partially and fully adopted the recommended seed size respectively. It was also seen that 5.55 per cent of the respondents did not adopt the recommended seed size. This systemic disinclination to apply (or to adopt) optimum choices in seed rate can be

attributed to the lack of knowhow as well as the employment of skilled labor force who are not necessarily ginger cultivators and therefore do not able to follow and implement standardized practices. As for the respondent's inability to adopt recommended seed size can be largely recognized as a problem with the supply chain where the respondents are limited by the choice of seeds available rather than that of ignorance.

Furthermore, it was seen that all (100%) respondents had fully adopted the usage of insect and disease free true to type of rhizomes.

Regarding the recommended seed rate for ginger cultivation, it was observed that 99.26% of respondents partially adopted the recommended seed rate, while only 0.74% fully adhered to it. Additionally, most respondents (97.78%) fully followed the recommended spacing between plants. For the placement of rhizomes at the recommended depth, 60.74% of respondents partially adhered to the guidelines, and 39.26% fully followed them. These findings indicate that cultivators generally understood the practices for growing ginger and, whether through extension support or personal farming experience, adhered to a reasonable extent of the recommended practices. This is consistent with the findings of Jakkawad *et al*. (2017).

Table 4.28 Distribution of respondents based on adoption of recommended package of practices of climatic condition, and soil and land management of ginger cultivation N=270

Sl. No.	Particulars	Recommended practices	Fully Adopted		Partially Adopted		Not adopted	
			F	P	F	P	F	P
1.	Climatic condition	a.Ginger should be grown in humid climatic condition	270	100	0	0	0	0
2.	Soil management	a. Ginger should be grown in well drained rich soil	0	0	270	100	0	0
		b. Ginger should be grown in well aerated soil	0	0	189	70	81	30
		c. Ginger should be grown in sandy loam soil type?	30	11.11	165	61.11	75	27.78
3.	Land preparation	a. Do you plough your field before planting	270	100	0	0	0	0
		b. Ginger requires 3-4 pulverizing/ploughing to bring the soil to fine friable?	140	51.85	130	48.15	0	0
		c. Ginger should not be planted in the same field year after year?	270	100	0	0	0	0

Table 4.29 Distribution of respondents based on adoption of recommended seed treatment, seed rate and spacing of ginger cultivation **N=270**

Sl. No.	Particulars	Recommended practices	Fully adopted		Partially adopted		Not adopted	
			F	P	F	P	F	P
1	Seed treatment	a. Before sowing, rhizomes should be dipped in cow urine for half an hour?	0	0	0	0	270	100
		b. Drenching the soil with Dithane Z-78 @2g/l of water at 30 days interval is effective for control of diseases?	0	0	0	0	270	100
2.	Seed rate	a. 1200 to 1500 kg is required for 1 ha of land?	0	0	76	28.15	194	71.85
		b. Seed weight should be 15-25 gms	30	11.11	240	88.89	0	0
		c. Seed size: should be 10-15 gms	30	11.11	225	83.34	15	5.55
		d. Rhizomes should be true to type?	270	100	0	0	0	0
		e. Seeds should be free from diseases and pests?	270	100	0	0	0	0
3.	Spacing	a. Spacing of 30 cm between rows is ideal for growing ginger?	2	0.74	268	99.26	0	0
		b. 25 cm between plants is considered ideal for Ginger?	0	0	264	97.78	6	2.22
		c. Rhizomes are placed at a depth of 4-5 cm in furrows and covered with soils?	106	39.26	164	60.74	0	0

4.1.31 Distribution of respondents based on adoption of recommended planting time of ginger cultivation

Regarding the time of planting, it was seen that 83.33 per cent of the respondents did not adopt the recommended time of planting. It was also seen from the table 4.30 that 16.67 per cent of the respondents fully adopted the recommended time of planting. This has been explained previously as potentially a consequence of the climatic conditions of the region not being fully suited to the recommended practices.

4.1.32 Distribution of respondents based on adoption of recommended planting materials and cultivars of ginger

It was seen (table 4.31) that 92.96 per cent and 7.04 per cent of the respondents partially and fully adopted the recommended number of sprouted bits required for better production of ginger, respectively.

With regard to the adoption of improved varieties, it was observed from table 4.31 that all (100%) respondents had fully adopted the Nadia variety. However, it was seen that none of the respondents planted or adopted any other variety in the study area. While it is encouraging that the ginger cultivators were motivated to take up cultivation of a higher yielding variety than the generic local variant, this response also shows that the cultivation of the crop in the region is at greater risk of an epidemic from either insects or other pathogens due to the highly skewed preference of crop where it almost exhibits mono-cropping characteristics. Kharjana *et al.* (2017) also reported that 100 % of the respondents fully adopted growing of improved varieties like Nadia.

Table 4.30 Distribution of respondents based on adoption of the recommended planting time for ginger cultivation N=270

Sl. No.	Particulars	Recommended practices	Fully adopted		Partially adopted		Fully adopted	
			F	P	F	P	F	P
1.	Planting time	April to May is the optimum time for sowing Ginger?	45	16.67	0	0	225	83.33

Table 4.31 Distribution of respondents based on adoption of the recommended planting materials and cultivars of ginger N=270

Sl. No.	Particulars	Recommended practices	Fully adopted		Partially adopted		Not adopted	
			F	P	F	P	F	P
1.	Propagation material	Four to five cm long sprouted buds are required?	251	92.96	19	7.04	0	0
2.	Cultivars	a. Are you growing the cultivars Nadia?	270	100	0	0	0	0
		b. Are you growing the cultivar China?	0	0	0	0	270	100
		c. Are you growing the cultivar Maran?	0	0	0	0	270	100
		d. Are you growing the cultivar Varada?	0	0	0	0	270	100

Table 4.32 Distribution of respondents based on adoption of the recommended manures and fertilizers in ginger cultivation N=270

Sl. No.	Particulars	Recommended practices	Fully adopted		Partially adopted		Not adopted	
			F	P	F	P	F	P
1	Manures and fertilizers	a. Ginger requires 3-5 tonnes of FYM per ha for its cultivation?	270	100	0	0	0	0
		b. FYM should be applied at the time of field preparation?	270	100	0	0	0	0
2	Types of manures	a. Have you adopted application of FYM in your field	0	0	0	0	270	100
		b. Have you adopted application of Poultry	0	0	0	0	270	100
		c. Have you adopted application of pig manure	0	0	0	0	270	100
		d. Others	0	0	0	0	270	100
3	Fertilizers	a. Have you adopted application of fertilizer for the soil health management?	0	0	0	0	270	100
		b. Have you adopted application of fertilizer for higher ginger production?	0	0	0	0	270	100
		c. NPK @ (100:90:90 kg/ha) should be applied in the form of chemical fertilizer?	0	0	0	0	270	100
		d. 1/3 Nitrogen should be applied as basal?	0	0	0	0	270	100
		e. Full doses of phosphorus and potassium should be applied at the time of sowing?	0	0	0	0	270	100
		f. 1/3 of nitrogen should be applied at 45 DAP. Remaining 1/3 Nitrogen should be applied 90-95 DAP?	0	0	0	0	270	100

4.1.33 Distribution of respondents based on adoption of the recommended manures and fertilizers in ginger cultivation

The data shows (table 4.32) that all the respondents in the study area did not adopt usage of any kind of manure and FYM for the better management of soil health of the ginger field and higher production of ginger.

It was seen that none of the respondents in the study area adopted the recommended dose of fertilizer dosage in their ginger field.

The findings align with Kharjana *et al.* (2017), and Odyuo *et al.* (2023) who reported that none of the respondents had adopted the use of fertilizers for ginger cultivation. In contrast, Jakkawad *et al*. (2017) found that the majority (81.25%) of respondents had implemented the recommended fertilizer dosage for growing ginger.

4.1.34 Distribution of respondents based on adoption of mulching in ginger cultivation

It was seen from table 4.33 that 80.00 per cent of the respondents did not adopt any kind of mulching practices. It was also seen that 20.00 per cent of the respondents partially adopted straw mulching in the ginger field for weed management of the ginger field.

Regarding the low positive response rate towards healthy cultivation practices of replenishing soil fertility and manure application, the terrain and the lack of large scale manure production contribute towards the absence of such practices. This is also in addition to the respondents' assumption that external supplementary work in regard to soil replenishing is not a mandatory practice.

Table 4.33 Distribution of respondents based on adoption of mulching in ginger cultivation N=270

Sl. No.	Particulars	Recommended practices	Fully adopted		Partially adopted		Not adopted	
			F	P	F	P	F	P
1.	Mulching	a. Have you adopted mulching practices?	0	0	54	20	216	80
		b. Have you adopted mulching for weed management?	0	0	54	20	216	80
		c. Have you adopted the usage of paddy straw as mulching material?	0	0	54	20	216	80

*multiple responses were obtained

Table 4.34 Distribution of respondents based on adoption of recommended plant protection measures in ginger cultivation N=270

Sl. No	Particulars	Recommended practices	Fully adopted		Partially adopted		Not adopted	
			F	P	F	P	F	P
1.	Plant protection measures	a. Have you adopted usage of chemical for control of weeds in ginger cultivation?	0	0	0	0	270	100
2	Disease management	b. Have you adopted rhizome treatment with trichoderma @ 8-10 gm/ litre water for managing soft rot?	0	0	0	0	270	100

*multiple responses were obtained

4.1.35 Distribution of respondents based on adoption of recommended plant protection measures in ginger cultivation

It was observed that none of the respondents used chemical methods for weed management in ginger cultivation. Additionally, none of the respondents applied the recommended treatments for disease control in ginger.

The absence of chemical control for weed management or disease treatment can both be attributed to lack of awareness as well as the limitations of economic capacity.

Kharjana *et al.* (2017) and Odyou *et al.* (2023) conducted a study consistent with the present research, reporting that none of the respondents (100%) adopted the recommended plant protection practices for ginger cultivation.

4.1.36 Distribution of respondents based on the adoption of recommended water management practices in ginger cultivation

Table 4.35 showed none of the respondents followed the recommended time for irrigation in ginger cultivation in the study area as ginger growers in the selected research area depended solely on rainfall for its water management.

This reflects the findings reported by Odyuo *et al*.(2023), which reported that none of the respondents had adopted the recommended irrigation practices because the farmers primarily rely on rain for their water needs.

Table 4.35 Distribution of respondents based on the adoption of recommended water management practices in ginger N=270

Sl. No.	Particulars	Recommended practices	Fully adopted		Partially adopted		Not adopted	
			F	P	F	P	F	P
1.	Water management	a. Have you adopted recommended water management practices required for ginger cultivation?	0	0	0	0	270	100
		b. Have you adopted the recommended time of irrigation for ginger cultivation?	0	0	0	0	270	100

Table 4.36 Distribution of respondents based on adoption of proper time of harvesting of ginger N=270

Sl. No.	Particulars	Recommended Practices	Fully adopted		Partially adopted		Not adopted	
			F	P	F	P	F	P
1.	Harvesting	Ginger should be harvested in 8 to 10 months after planting?	270	100	0	0	0	0

4.1.37 Distribution of respondents based on adoption of proper time of harvesting of ginger

Regarding the adoption of harvesting time, Table 4.36 indicates that 100% of respondents fully adhered to the optimal harvesting time for ginger. This is consistent with the study by Jakkawad *et al*. (2017), which reported that the majority (87.50%) of ginger growers followed the recommended harvesting guidelines.

4.1.38 Overall knowledge (knowledge index) of the respondents on recommended cultivation practices of Ginger

To assess the respondents' knowledge levels, they were categorized into three groups—low, medium, and high—based on the calculated mean and standard deviation of their knowledge scores. The distribution of respondents within each category is presented in Table 4.37.

Table 4.37 shows that most respondents (81.48%) had a medium level of knowledge; meanwhile, 32.00% of ginger growers had a high level of knowledge, and 18.00% had a low level of knowledge.

The present findings are in accordance with the findings of Meena (2006) who found that the majority of the Ajwain growers (70%) had a medium knowledge level. The findings are also in line with the findings of Meena (2001) who observed that the majority of the trained (61.67%) and untrained (50%) farmers had medium level of knowledge about onion production technology.

Table 4.37 Distribution of the respondents based on knowledge level on recommended cultivation practices of Ginger N=270

Sl. No	Method of Categorization	Frequency	Percentage	Mean	SD
1	Low	18	6.67	31.89815	2.875401
2	Medium	220	81.48		
3	High	32	11.85		
Total		270	100		

Table 4.38 Distribution of the respondents based on adoption level on recommended cultivation practices of Ginger N=270

Sl. No	Method of Categorization	Frequency	Percentage	Mean	SD
1	Low	20	7.41	31.89815	2.875401
2	Medium	220	81.48		
3	High	30	11.11		
Total		270	100		

4.1.39 Overall adoption of recommended cultivation practices of ginger by the respondents

To provide an overview of the adoption levels among respondents, they were classified into three groups: low adoption, medium adoption, and high adoption. This classification was based on the mean and standard deviation of the adoption scores obtained. The results, presented in Table 4.38, reveal that the majority (81.48%) of respondents were in the medium adoption group, while 11.11 per cent were in the high adoption group, and 7.41 per cent were in the low adoption group.

Additionally, an effort was made to correlate various socio-economic variables with the adoption index of the ginger growers (table 4.30) reveals that age, educational qualification, occupation, land holding annual income, income from ginger, training, extension contact, information source and marketing had positive correlation with knowledge level. On the contrary, gender, occupation, land holding, occupational land holding and land under ginger cultivation negatively correlated with the adoption level.

4.1.40 Relationship between various socio-economic factors and knowledge index of ginger growers

The relationship study shown in Table 4.39 indicates that age, annual income, income from ginger, training, extension contact, sources of information, and marketing all have a significant correlation with the knowledge index, as reflected by their correlation values of 0.228, 0.237, 0.328, 0.665, 0.252, 0.259, and 0.309, respectively.

On the other hand, occupation, land holding, operational land holding, and land under ginger cultivation was found to have a significant but negative

correlation with the knowledge index with a correlation value of -0.205, -0.296, -0.210, and -0.210, respectively.

4.1.41 Relationship between various socio-economic factors and adoption index of ginger growers

Here an attempt was made to correlate various socio-economic variables and adoption index of the ginger growers. Table 4.40 reveals that age, annual income, income from ginger, training, extension contact, information source and marketing had a positive correlation with adoption level. On the contrary, occupation, land holding, occupational land holding and land under ginger cultivation had a negative correlation with the adoption level.

Age, annual income, income from ginger, training, extension contact, information source and marketing had a significant correlation with the adoption index with a correlation value of 0.227, 0.350, 0.296, 0.797, 0.182, 0.328 and 0.273.

Occupation, land holding and operational land holding had a significant but negative correlation with the adoption index with a correlation value of -0.270, -0.207 and -0.180 respectively.

Table 4.39 Relationship between various socio-economic factors and knowledge index of ginger growers

Sl. No	Variables	Value of r	P value
1	Age	0.228**	0
2	Gender	-0.03	0.623
3	Educational qualification	0.089	0.144
4	Occupation	-0.205**	0.001
5	Land holding	-0.296**	0
6	Operational land holding	-0.210**	0
7	Land under ginger cultivation	-0.210**	0.223**
8	Annual income	0.237**	0
9	Income from ginger	0.328**	0
10	Training	0.665**	0
11	Extension contact	0.252**	0
12	Information source	0.259**	0
13	Marketing	0.309**	0

*Significant at 5 per cent, table value: 0.195; **Significant at 1 per cent level, table value: 0.158

Table 4.40 Relationship between various socio-economic factors and adoption index of ginger growers

Sl. No	Variables	Value of r	P value
1	Age	0.227**	0
2	Gender	-0.091	0.623
3	Educational qualification	0.079	0.144
4	Occupation	-0.270**	0.001
5	Land holding	-0.207**	0
6	Operational land holding	-0.180**	0
7	Land under ginger cultivation	-0.097**	0
8	Annual income	0.350**	0
9	Income from ginger	0.296**	0
10	Training	0.767**	0
11	Extension contact	0.182**	0
12	Information source	0.328**	0
13	Marketing	0.273**	0

*Significant at 5 per cent, table value: 0.195; **Significant at 1 per cent level, table value: 0.158

4.2 Study the existing Seed system

This objective was considered with the aim of understanding the present seed system that exists in the selected study area. Seed can be considered as the most important component in the agricultural context as it is the efficient means of propagating crops. Under this objective, the knowledge level about the different types of seeds available and the extent to which the respondents know about these seeds were considered. The various means of how seeds were procured, and constraints faced in procurement and selling of seeds were considered in this objective.

4.2.1 Awareness about different types of planting material

Table 4.41 shows the respondent's knowledge about the various planting material in the study area. The table showed that 100 per cent of the respondents were aware about the different planting materials such as seed, rhizome, tuber, stem and bulb.

4.2.2 Awareness about types of seeds

Table 4.42 contains the distribution of the respondents according to the knowledge they have on the type of seeds. The study showed that 100 per cent of the respondents in the selected study area had knowledge about the local seeds and high yielding seeds (Nadia).

It was also seen that 100 per cent of the respondents did not have knowledge about hybrid seeds, breeder seeds, foundation seeds, certified/commercial seeds and Truthful labelled seeds.

Table 4.41 Distribution of respondents based on awareness about planting materials N=270

Sl. No	Planting material	Awareness about planting material	
		Frequency	Percentage
1	Seed	270	100
2	Rhizome	270	100
3	Tuber	270	100
4	Stem	270	100
5	Bulb	270	100

Table 4.42 Distribution of respondents based on awareness about types of seeds N=270

Sl. No	Types of seed	Awareness about Types of seeds	
		Frequency	Percentage
1	Local seed	270	100
2	Hybrid seed	0	0
3	High yielding seed	270	100
4	Breeder seed	0	0
5	Foundation seed	0	0
6	Certified/commercial seed	0	0
7	Truthful labelled seed	0	0

*multiple responses were obtained

4.2.3 Level of awareness about importance of seed for higher productivity and status of adoption of the same

From table 4.43, it was seen that all (100%) respondents were aware about the importance of seeds in productivity, the importance of disease-free seeds to control seed-borne diseases, the importance of disease-free seeds for higher yield and the importance of insect-pest free seeds for high yield. It was also seen that all (100%) respondents from the study area had fully adopted the disease- free seeds to control seed-borne diseases, disease-free seed for higher yield and insect pest free seed for higher yield.

4.2.4 Considering different criteria for the selection of plot

Table 4.44 shows the distribution of the respondents based on adoption of different criteria for selection of plot for growing ginger. The parameters taken into account to consider a plot were suitable for ginger cultivation were loose soil, black soil and sloppy area. The table shows that 100 per cent of the respondents followed the criteria for considering the plot for planting ginger, which is loose soil. It was also seen that 72.22 per cent of the respondents preferred black soil and 100 per cent of the respondents were aware of the benefits of planting ginger in sloppy area, however, 84.81 per cent of the respondents were seen to fully adopt planting of ginger in sloppy areas, and 15.19 per cent of the respondents did not adopt planting of ginger in sloppy area.

Table 4.43 Distribution of respondents based on awareness about the importance of seeds for higher productivity and status of adoption of the same ` N=270

Sl. no.	Parameters	Awareness		Adoption level					
		Frequency	Percentage	Fully		Partially		Never	
				F	P	F	P	F	P
1	Do you know the importance of seeds in productivity?	270	100	270	100	0	0	0	0
2	Do you know the importance of disease-free seeds to control seed borne diseases?	270	100	270	100	0	0	0	0
3	Do you know the importance of disease-free seeds for higher yield?	270	100	270	100	0	0	0	0
4	Do you know the importance of insect-pest free seeds for higher yield?	270	100	270	100	0	0	0	0

Table 4.44 Distribution of respondents based on awareness and adoption of criteria for selection of plot for ginger cultivation N=270

Sl. No.	Criteria for considering plot	Awareness		Adoption level					
		Frequency	Percentage	Fully adopted		Partially adopted		Not adopted	
				F	P	F	P	F	P
1	Loose soil	270	100	270	100	0	0	0	0
2	Preferably black soil	195	72.22	195	72.22	0	0	75	27.78
3	Sloppy area	270	100	229	84.81	0	0	41	15.19

4.2.5 Criteria considered for selection of rhizome as seed

Table 4.45 details the distribution of respondents based on their awareness and adoption of various criteria for selecting ginger seed-rhizomes for cultivation. It was found that all respondents (100%) were aware of the importance of selecting larger rhizomes for seed. Among them, 79.26% fully adopted the practice of planting larger-sized rhizomes, while 20.74% partially adopted it. Additionally, all respondents (100%) recognized that planting rhizomes with more bits was a crucial criterion for seed selection. Of these, 75.56% fully adopted this criterion, and 24.44% partially adopted it. Furthermore, 100% of respondents were aware of the need to select disease-free and pest-free rhizomes for seed use, and all (100%) fully adopted this practice.

4.2.6 Procurement of various varieties of ginger for seed-rhizomes from different sources by the respondents

Table 4.46 presents the distribution of respondents based on how they obtained different varieties of seeds in the selected area. It was found that 16.66% of respondents received the Nadia variety through free distribution, 12.59% purchased it, 32.22% obtained it from neighbouring villages, and 88.14% acquired it within their own village. Additionally, 4.44% and 45.55% of respondents sourced the local variety (which is smaller in size) from neighboring villages and within their own village, respectively

It was also seen that 71.11 per cent, 17.40 per cent and 7.40 per cent of the respondents acquired the local variety which was of large sized from their village, from the neighbouring village and purchased from the market, respectively.

Table 4.45 Distribution of respondents based on awareness and adoption of different criteria for selection of seed rhizomes N=270

Sl. No.	Criteria for considering seed	Awareness		Adoption level					
		Frequency	Percentage	Fully adopted		Partially adopted		Not adopted/ never	
				F	P	F	P	F	P
1	Larger sized rhizome	270	100	214	79.26	56	20.74	0	0
2	Rhizomes with more bits	270	100	204	75.56	66	24.44	0	0
3	Seed free from disease	270	100	270	100	0	0	0	0
4	Not infested by pest	270	100	270	100	0	0	0	0

Table 4.46 Distribution of respondents based on procurement of seeds

N=270

Sl. No.	Name of the variety	Procurement of different varieties of seed							
		Free distribution		Purchased		From neighbouring village		Within the village	
		F	P	F	P	F	P	F	P
1	Nadia	45	16.66	34	12.59	87	32.22	238	88.14
2	Local variety(small sized)	0	0	0	0	12	4.44	123	45.55
3	Local variety (big sized)	0	0	20	7.4	47	17.40	192	71.11

The findings of this study align with those of Neupane *et al.* (2019), which reported that the majority of respondents (66.25%) used seeds saved from their own production, while only 6.25% of farmers purchased seeds from the market.

4.2.7 Adoption of different steps for production of quality ginger rhizome seed

Seed processing can be defined as a process that is responsible for improving the seed quality by eliminating foreign material, inert matter, undersized or oversized seeds, weed seeds, off-size and deteriorated and damaged seeds and furthermore improving the quality of the planting condition of the seed and also protecting the seeds by applying chemical protection measures. Table 4.47 reveals that in the selected study area, all respondents (100%) adhered to careful practices in cultivating ginger, including careful harvesting, careful plucking, cleaning excess soil from rhizomes, and grading the rhizomes. The table further indicates that 100% of respondents fully implemented these practices. The table also showed that none of the respondents followed the process of washing of rhizome, drying, checking, treating, quality testing and labelling.

Table 4.47 Distribution of the respondents based on awareness and adoption of processing techniques of rhizome seed N=270

Sl. no.	Particulars	Awareness		Adoption level					
		Frequency	Percentage	Fully adopted		Partially adopted		Not adopted	
				F	P	F	P	F	P
1	Careful cultivation of ginger crop	270	100	270	100	0	0	0	0
2	Careful harvesting of rhizome	270	100	270	100	0	0	0	0
3	Careful plucking of rhizome	270	100	270	100	0	0	0	0
4	Cleaning of excess soil attached with rhizome	270	100	270	100	0	0	0	0
5	Washing of rhizome	0	0	0	0	0	0	270	100
6	Drying (the process of reducing moisture content from the seed)	0	0	0	0	0	0	270	100
7	Grading Are you aware about grading?	270	100	0	0	0	0	0	0
8	Checking To judge the quality of seed material	0	0	0	0	0	0	270	100
9	Treating	0	0	0	0	0	0	270	100
10	Quality testing	0	0	0	0	0	0	270	100
11	Packaging	0	0	0	0	0	0	270	100
12	Labelling/ tagging	0	0	0	0	0	0	270	100
13	Storing	0	0	0	0	0	0	270	100

4.2.8 Awareness about certification and renewal of seeds

Table 4.48 showed that none of the respondents in the study area were aware or knew about seed certification or seed certification agencies. The table further showed that 100 per cent of the respondents knew about the seed renewal period and the importance of renewing and changing of seed.

4.2.9 Sources for procuring ginger seed rhizomes

Table 4.49 details the sources through which respondents in the study area obtained seeds for ginger cultivation. It shows that 39.63% of respondents procured seeds through friends and neighbors, 7.77% acquired them from the market, and 11.48% obtained seeds through agricultural departments. These findings are consistent with Moe *et al*. (2016), which reported that the majority of farmers (59.16%) received information about rice seeds from fellow farmers.

4.2.10 Marketing channel

Table 4.50 illustrates the various marketing channels used by respondents to sell their products. The data reveals that the majority, 70.37%, sold their produce through wholesale markets. Additionally, 18.89% of respondents used both wholesale and retail channels to market their products. A smaller portion, 10.74%, relied on retail sales within local markets. The study also highlighted that 24.81% of respondents participated in a traditional exchange system, bartering ginger rhizomes to be used as seed. This reflects the persistence of bartering practices in some rural areas, where direct trade remains a practical and culturally significant means of exchange.

Table 4.48 Distribution of respondents based on awareness about certification and renewal of seeds N=270

Sl. No.	Parameters	Frequency	Percentage
1	Are you aware about seed certification?	0	0
2	Do you know about any seed certification agencies?	0	0
3	Are you aware of the seed renewal period?	270	100
4	Are you aware of the importance of renewal/ changing of seed?	270	100

Table 4.49 Distribution of respondents based on the use of market channel for procuring ginger seed rhizomes

N=270

Sl. No.	Source	Frequency	Percentage
1	Friends/ neighbours	107	39.63
2	Progressive farmers	0	0
3	Seed retailers	0	0
4	Through agricultural department	31	11.48
5	Local market	21	7.77
6.	Not using market channel	111	42.22
Total		270	100

4.2.11 Constraints in marketing/selling of seed ginger

Table 4.51 outlines the challenges encountered by respondents in marketing or selling ginger seeds or rhizomes. The findings reveal that all respondents (100%) experienced minimal issues with the perishability of ginger rhizomes.

In terms of transportation, 61.11% of respondents reported very few problems, while 38.89% faced issues of low intensity.

Regarding pricing, 55.56% of respondents faced significant problems due to low prices for harvested ginger, with the remaining 44.44% experiencing high levels of difficulty.

For susceptibility to insect-pest attacks, 55.56% of respondents reported very low levels of concern, while 38.88% and 5.56% reported low and average levels of susceptibility, respectively. Additionally, 50.00% of respondents indicated either low or very low levels of problems related to disease attacks in the study area

It was also found that 38.89% of respondents reported high to average levels of difficulty concerning the non-availability of markets, while 22.22% experienced very high levels of constraint due to the lack of market access.

The study also showed that 55.56 per cent of the respondents showed an average degree of problem regarding non availability of purchasing agent followed by 44.44 per cent of the respondent having very high level.

It is important to mention that farmers are not growing ginger as seed rhizome rather they are cultivating ginger in general for production and the plot or part of the plot with good and bigger plant is considered for seed purpose. Based on this, the respondents responded on constraints in ginger seed selling or marketing

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Table 4.50 Distribution of the respondents according to the different marketing channels used for selling ginger seed N=270

Sl. No	Channel	Frequency	Percentage
1	Wholesale	190	70.37
2	Retail	29	10.74
3	Both	51	18.89
4	Fellow farmers	67	24.81

*multiple responses were obtained

Table 4.51 Distribution of the respondents based on constraints faced in marketing/selling of seed ginger N=270

Sl. no.	Particulars	Very high		High		Average		Low		Very low	
		F	P	F	P	F	P	F	P	F	P
1	Perish-ability	0	0	0	0	0	0	0	0	270	100
2	Transportation (bulkiness)	0	0	0	0	0	0	105	38.89	165	61.11
3	Low rates	150	55.56	120	44.44	0	0	0	0	0	0
4	Susceptible to insect-pest attack	0	0	0	0	15	5.56	105	38.88	150	55.56
5	Susceptible to disease attack	0	0	0	0	0	0	135	50	135	50
6	Non availability of market	60	22.22	105	38.89	105	38.89	0	0	0	0
7	Non availability of purchasing agent	120	44.44	150	55.56	0	0	0	0	0	0

*multiple responses were obtained

4.2.12 Constraints in procuring/ purchasing of ginger seed

Table 4.52 presents the challenges faced by respondents in procuring ginger seeds in the study area. It indicates that 50.00% of respondents encountered average problems in obtaining good quality or pure seeds, while 44.44% experienced a high level of difficulty in this regard. Additionally, 5.56% of respondents faced very high levels of constraints in acquiring good quality or pure seeds.

The study also showed that 100 per cent of the respondents had a low level of constraints regarding the authentic source of seed and were unaware about the authentic seller in the selected study area.

A total of 55.56 per cent of the respondents faced a high level of constraint regarding the high price of rhizome, followed by 44.44 per cent of the respondents with an average level.

It was also seen from the table that 55.19 per cent of the respondents had a low level of problem regarding the perish-ability of the rhizome and 44.81 per cent had a very low level of problem regarding the perish-ability of the rhizome seed.

The study also showed that 44.44 per cent of the respondents had a low level of transportation problem, 38.89 per cent showed a very low level of transportation problem and 16.67 per cent of the respondents had an average level of transportation problem.

It was also seen that 50.37 per cent and 49.63 per cent of the respondents had an average and low level of problem, respectively, regarding non-availability of disease-free seed, and 54.07 per cent and 45.93 per cent of the respondents faced a low and very low level of problems, respectively regarding non availability of seeds free from pests' attacks.

Furthermore, it was seen that 44.81 per cent of the respondents in the study area had a high level of problem regarding non-availability of the market, followed by 38.89 and 16.30 per cent of the respondents facing a very high and average level of problems, respectively, for non-availability of the market. The study also showed that 55.56 per cent of the respondents faced a very high level of problem regarding non availability of seed, followed by 44.44 per cent of the respondents who also faced high level of constraints regarding non-availability of seed.

In general, there are two recognized seed system like formal and informal seed systems. From this study it is concluded that there was no formal seed system.

Table 4.52 Distribution of the respondents based on constraints faced in Procuring/ purchasing of seed ginger

N=270

Sl. No.	Particulars	Very high (6)		High (5)		Average (4)		Low (3)		Very low (2)		Not aware/ concerned (1)	
		F	P	F	P	F	P	F	P	F	P	F	P
1	Good quality/pure seed	15	5.56	120	44.44	135	50	0	0	0	0	0	0
2	Authentic source of seed	0	0	0	0	0	0	0	0	270	100	0	0
3	Authentic seller	0	0	0	0	0	0	0	0	0	0	270	100
4	High price	0	0	150	55.56	120	44.44	0	0	0	0	0	0
5	Perish-ability	0	0	0	0	0	0	121	44.81	149	55.19	0	0
6	Transportation (bulkiness)	0	0	0	0	45	16.67	120	44.44	105	38.89	0	0
7	Non availability of disease free seed	0	0	0	0	0	0	136	50.37	134	49.63	0	0
8	Non availability of seeds free from pest attacks	0	0	0	0	0	0	146	54.07	124	45.93	0	0
9	Non availability of market	105	38.89	121	44.81	44	16.3	0	0	0	0	0	0
10	Non availability of seed supply agent	150	55.56	120	44.44	0	0	0	0	0	0	0	0

4.3 Sustainable performance of ginger cultivation

Sustainability is the practice of fulfilling the needs of the present generation without undermining the ability of future generations to meet their own needs. It involves a holistic approach that considers environmental, human, social, and economic development. Accordingly, the UN (2015) proposed the international development agenda (2030) with the sustainable endeavour, which is composed of 17 sustainable development goals (SDGs) and with 169 sub components/ sub-targets. SDG-2, i.e., zero hunger is emphasized to eradicate poverty from the world through achieving food and nutrition security by promoting sustainable agriculture with an emphasis to support the small scale farmers. Under this goal, target 2.3 has taken the challenge of augmenting the agriculture productivity and income of small scale farmers into doubled in 2030 than the base year of 2015. And target 2.4 is accepted to ensure a sustainable food production system with resilient agriculture practices. (UN, 2015 and 2022; Taroli and Straffelini, 2020)

In response to climate change and global warming, sustainable agriculture emerges as the essential solution for ensuring food and nutrition security and combating hunger (Gamlin *et al*., 2021). This study evaluates the sustainability of ginger cultivation by examining four key dimensions: economic, human, social, and environmental sustainability, where 44 issues/items were also included.

4.3.1 Economic sustainability of ginger cultivation

Table 4.53 shows the performance of ginger in terms of economic sustainability. A total of 11 parameters were selected for studying the economic sustainability with a maximum achievable score of 5 and the midpoint value of 2.5. In the case of “giving assured productivity”, the mean score was 3.80 with a standard deviation value of 0.48. The table further

reveals that with regard to “potential for steady and standard income”, the mean score was 3.5 with a standard deviation value of 0.62.

Similarly, for the parameter “income from per unit area is higher compared to other crops”, the mean score was 3.60 which greater than the midpoint value with a standard deviation value of 0.58. The mean score for the parameter “supporting livelihood” was 3.50 with a standard deviation value of 0.73.

Similarly, with respect to the parameters “cost: benefit ratio is higher”, “cost of cultivation is in favor of the growers” the mean scores were 3.60 and 3.50 with standard deviation value of 0.56 and 0.57, respectively.

Likewise, for parameters “less susceptible to economic loss”, “resilient in terms of productivity at the time of environmental stress condition” the mean scores were 3.60 and 3.60 with standard deviation of 0.50 and 0.47 respectively. The mean scores for “potential to fetch a higher income (during peak season) due to good keeping life” and “round the year, price is relatively consistent” were 2.90 and 2.80 with standard deviation values of 0.56 and 0.51 respectively. Table 4.53 also reveals that the mean score for “requirement of external assistance for cultivation is less/minimum was 2.80 with a standard deviation of 0.51.

For all 11 parameters related to economic sustainability, the mean scores exceeded the midpoint score of 2.50. The overall mean score for economic sustainability was 3.44, indicating a notably high level of performance and satisfaction in terms of economic sustainability for ginger cultivation.

Table 4.53 Economic sustainability of ginger cultivation N=270

Sl. No	Parameters	Maximum achievable score	Mean	SD	Range of score
1	Productivity is assured / Giving assured productivity	5	3.8	0.48	3 to 5
2	Potential for steady and standard income	5	3.5	0.62	2 to 5
3	Income from per unit area is higher compare to other crops	5	3.6	0.58	2 to 5
4	Supporting livelihood	5	3.5	0.73	2 to 5
5	Cost: benefit ratio is higher	5	3.6	0.56	2 to 5
6	The cost of cultivation is in favour of the growers	5	3.5	0.57	2 to 5
7	Scope/risk/income uncertainty of economic loss Vulnerable/less susceptible to economic loss	5	3.6	0.50	2 to 5
8	Resilient in terms of productivity at the time of environmental stress condition	5	3.6	0.47	3 to 5
9	Potential to fetch a higher income (during non-peak season/ off-season of peak harvesting time)	5	2.9	0.65	2 to 5
10	Round the year, price is relatively consistent	5	2.8	0.56	2 to 4
11	Requirement of external assistance for cultivation is less /minimum	5	2.8	0.51	1 to 4
Overall mean			**3.441**		

4.3.2 Human sustainability of ginger cultivation

Table 4.54 shows the performance of ginger cultivation with respect to human sustainability. A total of 11 parameters were selected for human sustainability with a maximum achievable score of 5 and a midpoint value of 3. From the table 4.54, with respect to reducing poverty, it is seen that the mean score is 3.50 and the standard deviation value is 0.61. For the parameters "addressing food security" the mean score was seen to be 3.60 with a standard deviation of 3.60 and for "addressing issues of nutrition the mean was 3.6 with a standard deviation value of 0.47. Also for "addressing issues of health" the mean score was 3.60 with a standard deviation value of 0.49.

In terms of generating employment, the mean score was 2.9 with a standard deviation value of 0.79. The mean score for "access to better education" was 3.40 with a standard deviation value of 0.86.

Similarly, the mean score in respect to "potential to protect us from illness" was found to be 3.80 with a standard deviation value of 0.44 and the mean score for the parameter "curative/remedial quality to protect from illness was seen to be 3.80 with the standard deviation of 0.39.

For the parameter "cultivation is not a hindrance/obstacle in social participation/issues" the mean score was 4.30 with 0.66 as the standard deviation value. Similarly, the mean score for the parameter "cultivation does not include harmful impact on human growers was 4.60 with a standard deviation of 0.48.

In terms of the parameter "no influence on religion and spiritual aspect" the mean score was found to be 5.00.

Table 4.54 Human sustainability of ginger cultivation **N=270**

Sl. No	Parameters	Maximum achievable score	Mean	SD	Range of score
1	Reducing poverty	5	3.5	0.61	2 to 5
2	Addressing food security	5	3.6	0.50	2 to 5
3	Addressing issues of nutrition	5	3.6	0.47	2 to 4
4	Addressing issues of Health	5	3.6	0.49	2 to5
5	Generating employment	5	2.9	0.74	2 to 5
6	Access to better education	5	3.4	0.86	2 to 5
7	It has the potential to protect us from illness	5	3.8	0.44	2 to 5
8	It has Curative/Remedial quality to protect from illness	5	3.8	0.39	2 to 5
9	Cultivation is not a hindrance/ obstacle in social participation/issues	5	4.3	0.66	3 to 5
10	Cultivation does not the include harmful impact on human/growers	5	4.6	0.48	3 to 5
11	No influence on religious and spiritual aspects	5	5	0	5
Overall mean			**3.884**		

With regard to all the parameters under human sustainability, we found that the mean score was higher than the midpoint value and the table further shows that the overall mean of human sustainability was 3.88 which are highly satisfactory.

4.3.3 Social sustainability of ginger cultivation

Table 4.55 shows the performance of ginger cultivation with regard to social sustainability. Under social sustainability, 11 parameters were included with a maximum achievable score of 5 and a medium value of 2.50. The table reveals that the mean scores for "recognition (being engaged in something worthwhile)" and "up scaling the social prestige" were 3.50 and 3.90 with a standard deviation of 0.80 and 0.79 respectively. The table further shows that the mean score for the parameter "maintaining happiness/ peaceful family life" was 3.50 with 0.77 as the standard deviation value.

Similarly, the mean scores for the parameters "compatible with food habit" and "compatible with social norms and values" were found to be 3.90 each with standard deviation of 0.26 and 0.25, respectively. Furthermore, the table also shows that the mean score for "up-scaling the social cohesiveness/ togetherness was 3.80 with a standard deviation of 0.42.

Likewise, for parameters "maintaining the gender equality", "gender participation in cultivation's decision making", "all age group can take part in cultivation process" and "gender biasness is absent in cultivation and post-harvest activities" the mean scores were 3.80, 3.40, 3.80 and 3.70 with 0.40, 0.88, 0.35 and 0.43 as the standard deviation values respectively. The table also shows that the mean score for "it can be grown traditionally" was 4.90 with a standard deviation of 0.30.

Table 4.55 Social sustainability of ginger cultivation **N=270**

Sl. No	Parameters	Maximum achievable score	Mean	SD	Range of score
1	Recognition (being engaged in something worthwhile)	5	3.5	0.80	2 to 5
2	Up scaling the social prestige	5	3.9	0.79	2 to 5
3	Maintaining happiness/peaceful family life	5	3.5	0.77	2 to 5
4	Compatible with food habit	5	3.9	0.26	3 to 5
5	Compatible with social norms and values	5	3.9	0.25	2 to 5
6	Up-scaling the social cohesiveness/togetherness	5	3.8	0.42	2 to 5
7	Maintaining the gender equality	5	3.8	0.40	3 to 4
8	Gender participation in cultivation's decision making	5	3.4	0.88	1 to 4
9	All age groups can take part in the cultivation process	5	3.8	0.35	2 to 4
10	Gender biases are absent in cultivation and post-harvest activities	5	3.7	0.43	2 to 4
11	It can be grown traditionally	5	4.9	0.30	4 to 5
Overall mean			**3.827**		

The study revealed that the overall mean score for social sustainability was 3.80, which is above the midpoint value, indicating that the performance of ginger cultivation in terms of social sustainability was satisfactory.

4.3.4 Environmental sustainability of ginger cultivation

Table 4.56 reveals the environmental sustainable performance of ginger. For this study, 11 parameters were included, with 5 being the maximum achievable score and 2.50 as the midpoint value. For parameters “restore ecological balance and biodiversity” and “not undermining/deteriorating the natural resources” the mean scores were 3.70 and 3.90 with 0.49 and 0.61 as the standard deviation values respectively.

Similarly, the mean scores for “favourable for organic cultivation and without chemical inputs”, “controls soil erosion”, “can grow in less favourable climatic condition/ climatic stress condition”, and “ability to cope with shocks” were 4.08, 3.70, 3.90 and 3.90 with 0.42, 0.48, 0.33, 0.35 as their standard deviation values, respectively.

Likewise, for the parameters “responsive to integrated nutrient management, integrated water management”, emission of greenhouse gases from crop residue is less”, “crop is suitable to cultivate in less fertile soil”, “cultivation is suitable for recycling of farm waste” and “suitable for shifting cultivation” the mean scores were found to be 3.20, 3.20, 3.80, 3.60 and 4.80 with standard deviation values of 0.52, 0.46, 0.38, 0.47 and 0.34, respectively.

The table further shows that the overall mean score was found to be 3.84 and higher than the midpoint value indicating that the performance of ginger cultivation concerning under environmental sustainability was found to be satisfactory.

Table 4.56 Environmental sustainability of ginger cultivation N=270

Sl. No	Parameters	Maximum achievable score	Mean	SD	Range of score
1	Restore ecological balance and biodiversity	5	3.7	0.49	3 to 5
2	Not Undermining/deteriorating the natural resources	5	3.9	0.61	2 to 5
3	Favourable for organic cultivation and without chemical inputs	5	4.08	0.42	3 to 5
4	Control soil erosion	5	3.7	0.48	3 to 5
5	Can grow in less favourable climatic condition / climatic stress condition	5	3.9	0.33	3 to 5
6	Ability to cope with shocks	5	3.9	0.35	3 to 5
7	Responsive to integrated nutrient management, integrated water management	5	3.2	0.52	2 to 5
8	Emission of green-house gases from crop residue is less	5	3.2	0.46	2 to 4
9	Suitable in less fertile soil Crop is suitable to cultivate in less fertile soil	5	3.8	0.38	2 to 4
10	Cultivation is suitable for recycling of farm waste	5	3.6	0.47	3 to 4
11	Suitable for shifting cultivation	5	4.8	0.34	4 to 5
Overall mean			**3.847**		

4.4 Study the constraints in ginger cultivation and suggest measurements for mitigation

This objective was chosen to gain a deeper insight into the various challenges faced by respondents in ginger cultivation within the study area. It also involved gathering and integrating suggestions from the respondents to enhance ginger production and recommending measures to improve their cultivation practices.

From the table 4.57, it depicted that all (100%) respondents encountered problems with lack of processing unit, lack of technical guidance, lack of knowledge about the recommended seed rate, lack of knowledge about seed treatment, lack of technical know-how about the curing of rhizomes, lack of extension support, and lack of credit facilities and furthermore impeded by unorganized marketing. Accordingly, these problems were emerged as the most (1^{st}) important problem.

The study further showed that 96.29 per cent of the respondents faced constraints with regard to ginger cultivation being a labour-intensive crop and labour intensive was considered as the second most important constraint. It was also seen that 94.44 per cent of the respondents faced constraints due to lack of knowledge about high-yielding varieties. Accordingly, it was regarded as the third most important constraint in ginger cultivation.

The study further shows that 93.33 per cent of the respondents had trouble with non-availability of post-harvest technologies, followed by 87.40 per cent of the respondents who experienced problems resulting from insufficient training programs and 85.93 per cent of the respondents faced problems with an untimely supply of seed material in the study area. Subsequently, these problems were ranked as IV, V and VI constraints.

The table also indicates that 83.33 per cent of the respondents had issues regarding a lack of knowledge about the value addition of ginger, suffered from lack of market information and were subjected to high fluctuations in market price. It was also seen that 67.78 per cent of the respondents faced problems because of lack of training program for ginger cultivation in the study area. The table also shows that 64.07 per cent of the respondents faced constraints in ginger cultivation because of a lack of knowledge about insect-pest and disease management. This indicates the poor knowledge of the farmers and the associated problems emerging from ignorance about diseases endemic to cash-crop cultivation. It was also seen that 62.97 per cent of the respondents in the study area faced difficulties during the harvesting of ginger.

The study also showed that 44.81 per cent of the respondents had difficulties with timely non-availability of input. It was also seen that 39.63 per cent of the respondents faced challenges due to non-availability of plant protection measures at the right time. It was also seen that 36.29 per cent of the respondents were concerned about lack of proper knowledge about storage of rhizome in the study area. Further, the study showed that 29.63 per cent of the respondents felt the need to introduce improved high-yielding varieties of ginger. The study also showed that 28.15 per cent of the respondents consistently struggled with the availability of transport facilities.

In order to achieve better ginger cultivation practices, respondents were asked to provide suggestions which they felt necessary. While there were a number of suggestions received, they can be largely categorized under the following broad area. The following are the responses accordingly grouped as provided by the respondents of the study.

The most important suggestion was a demand for the provision of proper market linkage for better and easy marketing of ginger produce. Due to a lack of awareness of proper marketing channels, ginger growers rarely

received optimum return from their crop productions. Therefore, respondents were primarily concerned about the marketing process and expressed the need for awareness programs with respect to marketing systems and channels.

Another significant suggestion emerging from the study was that the respondents believed the various concerned organizations and authorities in the region should focus on mobilizing initiatives for training, organizing demonstrations, and awareness programs regarding ginger cultivation, which would influence positive changes in the ways of cultivation contrasted with contemporary practices. In this regard the respondents in the study area showed interest in willing to learn the new practices of cultivating ginger and their suggestions conveyed the same. This can be largely attributed to farmers in the study area growing ginger traditionally, which does not involve any advanced cultivation practices. The different field management practices such as planting, weeding, seed rate, seed treatment, disease management, harvesting, post-harvest management as seen through the study, continues to be carried out in an old-age traditional way, which is both inefficient and incompatible with the nature of the crop.

On the other hand, respondents expressed were the absence of a support system in the financial area, like grants and easily accessible subsidies and the non-availability of inputs such as improved seed varieties. Respondents expressed that extension functionaries could take up initiative in implementing various rural development programs. It should be noted that the farmers in the study are primarily rural subsistence cultivators. Therefore, their capacity for implementing of innovative and efficient cropping/cultivation methods are severely limited both in terms of availability of capital, and adequate knowledge about alternative cultivation methods. Thus, this matter is a valid issue that requires the intervention of the different agencies which can

Table 4.57 Constraints in ginger cultivation with the degree of severity as perceived by respondents

N=270

Sl. No.	Category	Frequency	Percentage	Rank
1	Harvesting	170	62.97	X
2	Non-availability of post-harvest technologies	252	93.33	V
3	Timely non-availability of input	121	44.81	XI
4	Lack of timely availability of plant protection measures	107	39.63	XII
5	Lack of proper knowledge about the storage of rhizome	99	36.67	XIII
6	Non-availability of improved high-yielding varieties of ginger	80	29.63	XV
7	Untimely supply of seed material	232	85.93	IV
8	Lack of processing facilities	270	100	I
9	Lack of knowledge about the value addition of ginger	225	83.33	VII
10	Lack of knowledge about high-yielding varieties	255	94.44	III
11	Timely weed management in ginger cultivation	270	100	I
12	Lack of knowledge about the recommended seed rate	270	100	I
13	Lack of technical know-how about the curing of rhizomes	270	100	I
14	Lack of knowledge about seed treatment	270	100	I
15	Lack of knowledge about insect-pest and disease management	173	64.07	IX
16	Lack of technical guidance	270	100	I

Contd...

17	Adverse climatic conditions at the critical stage of the crop	98	36.29	XIV
18	Lack of extension support to farmers	270	100	I
19	Weak research-extension farmer linkage	270	100	I
20	Labour intensive crop	260	96.29	II
21	Non-availability of labour	80	29.63	XVI
22	Lack of credit facilities	270	100	I
23	Unorganized marketing	270	100	I
24	Lack of market information	225	83.33	VII
25	High fluctuation in market price	225	83.33	VII
26	Non-availability of transport facilities	76	28.15	XVII
27	Insufficient training program	236	87.40	VI
28	Lack of training program	183	67.78	VIII

potentially enhance the capacity of these beneficiary farmers in a positive direction through the suggested support mechanisms.

4.4.1Prospects of ginger Cultivation

The reports comparing ginger production and the total land area used for ginger cultivation for Nagaland for the years 2010-11, 2015-16, and 2020-21 are 2,300 ha, 4,819 ha, and 4,694 ha respectively. Here, it shows a significant increase in the area for cultivation from 2010 to 2015 but a marginal reduction by the year 2020. The crop productions for the years are respectively 33,000 MT, 43,076 MT, and 34,848 MT. Here, there are two exciting numbers. For the first, we find that the yield increased by approximately 10’000 MT for an increase in 2,519 ha, more than the original area cultivated at 2,300 ha. This tells us that despite doubling the area under cultivation, the yield increased by less than a third of the original amount. Furthermore, by 2020 the area under cultivation had decreased marginally by 125 ha and the yield had significantly reduced by 8,228 MT, to 34,848 MT which was a little more than what the state produced with half of the area under cultivation in 2010.

Specifically, for Mon in 2010-11, 2015-16 and 2020-21 the areas under cultivation were 150 ha 450 ha and 452 ha respectively with each of these years production being 2,500 MT, 6,000 MT, and 3,380 MT. It is showing a trajectory that is similar to the state report where the amount of land under cultivation does not reflect on the production output particularly in 2020-21 where the total land under cultivation was three times the original size but the yield was only 880 MT more than the output of 2,500 MT yielded in 2010-11.

For Zunheboto the years 2010-11, 2015-16, and 2020-21 had 200 ha 350 ha and 355 ha under cultivation producing 3,000 MT, 4,896 MT and 4,939 MT respectively. To a large extent, the yield to land under cultivation ratio was stable for Zunheboto while also showing marginal progress.

The data of these three years shows clearly that ginger cultivation in Nagaland has shown plenty of potential for sustainable and profitable growth

in the initial stages. However, the yield has not been reflective of the land invested in cultivation. This, therefore, suggests that there are problem areas that the ginger farmers have hit against and are either unable to overcome or unaware of resolving. By addressing these latent issues, it is possible that ginger cultivation can become far more profitable and become a stable income generating livelihood alternative for rural farmers. The farmers would also benefit from having their labour and finance invested in ginger production to yield healthy outputs rather than practice unsustainable large-scale farming without the resources or the knowledge necessary to carry out cash crop cultivation. These problems therefore become areas of potential growth and can be addressed individually, as a community, and through state agencies.

There are several areas where ginger cultivation in Nagaland and specifically the study areas of Mon and Zunheboto are underperforming in terms of production and productivity. The fact that the output does not meet the expectations means there is a lot of scope for growth if the stakeholders are given proper support and impetus. The respondents are local farmers who have taken up ginger cultivation on a large scale or are considering a similar entry into the market but have been skeptical due to the current profitability of ginger cultivation. They do understand however that there is a very viable market for the crop not just within the state but beyond state borders especially in the case of Mon with its proximity to Assam.

The areas where ginger cultivation can be given a positive thrust can be seen as a three pronged approach.

1. Supply
2. Cultivation
3. Marketing

The current supply system of seeds is local and does not follow standardized norms or recommended seed sizes and weights. By creating awareness about optimum seed size and weight, it is likely that the crop harvest can be positively influenced. It is also possible to help the farmers have access to an efficient and available seed supply outlet. Perhaps the government can invest in setting up an infrastructure that procures and stores good quality seeds and becomes a seed source for farmers. This infrastructure can also be a supply point for other varieties, which can help to mitigate the problems associated with mono cropping.

As regards cultivation, there are multiple areas where improvements can be implemented. First and foremost is to educate the respondents on the necessity of fertilizer use, which supplements the soil quality and increases crop yield. The right amount and the right products to be used in accordance with the soil type and region specific conditions is something that different agencies like ATMA, KVK, Department of Agriculture and those related to agriculture can look into via training programs etc.

An important area that needs attention is the impact of diseases and disease management. Currently, there is only one variety of ginger, i.e. Nadia, which is primarily cultivated by the farmers in Nagaland aside from the other local varieties. This means there is a real threat of disease and epidemic, which is endemic to mono-cropping. While the majority of the farmers have some degree of awareness about the important diseases that affect ginger, there is little to no awareness on the disease management or treatments necessary for remedying crop infections. The farmers can be sensitized to recognize and identify ginger diseases that impacts crop yield. This would help reduce losses incurred due to diseases.

The field study showed that farmers were aware of the harmful effects of insects. Therefore, recognizing and eliminating potential insect infestation

conditions is another area that can be done to improve crop yield. As stated before, this can be done by cropping multiple varieties of ginger and using of pesticides and safe chemical usage. The amount and type of chemicals to be used to combat infestations is something that the farmers can be educated on.

Irrigation techniques are a bigger challenge due to the terrain. However, it is possible to instruct the farmers on the right amount of irrigation that can be given to saplings so that the transplanted sapling has a better chance of survival and offers a better possibility of higher yield.

While irrigation options may be limited by terrain, the fields can be supplemented by using natural and locally produced, like pig, poultry and cattle manure, as well as compost and other bio by-products and food waste if it is feasible. The respondents would also benefit from being educated on proper mulching techniques.

The use of multiple varieties of ginger is also absent as a practice; therefore, it would be prudent to introduce the respondents to the benefits of cropping different ginger varieties and the value of having options in terms of products, such as being able to offer choices for marketing like the taste, fiber content and texture, shelf life, size of rhizome, spiciness, disease-resistant varieties etc. Cultivating multiple variants will also act as a buffer against invasive pathogens and insects which may destroy an entire batch of crops of the same variety. While there may be a marginal decrease in productivity if farmers plant varieties with a lower yield, outweigh the cons of such a practice. The nodal agencies of the government can assist the farmers by providing easier access to such varieties as well as raising awareness on the benefits of such practices.

The third aspect where there is potential for growth is in the marketing of ginger produce. This is one area where state intervention would be

necessary, along with the farmers mobilizing themselves, so that they can become active participants in the supply chain. The profitability of ginger cultivation is limited by a number of factors which are generally problems associated with rural farming and the remote location of many of these farms in other words, transport and connectivity, as well as the lack of infrastructure specifically geared towards sustainable storage.

Developing roads and improving connectivity, to reduce the dependence on the few suppliers, who directly purchase from the cultivators and often negotiate for prices that negate the profit margin for the farmers, is a much-needed step that the government needs to attend to. It would also drastically improve various other aspects of cultivation, such as reducing the labour involved in harvesting and transport charges for marketing, and promote the capacity of the farmers to practice activities like fertilizer use and product-intensive chemical treatments, as well as regular management of the farms.

Secondly, with improved connectivity, the governmental agencies could also set up an intelligent supply chain by either providing trucks/small carrier vehicles at subsidized rates or in the form of schemes to enable the farmers to deliver their raw products to the market at an affordable and manageable cost. The lack of resources for transport management often leaves farmers susceptible to greedy middlemen who pocket the bulk of the profits.

Thirdly, the government could also monitor the market rates so that the farmers do get a fair deal. A recognized agency that ensures both the farmers and the suppliers get a fair price for the produce. This is, however, a solution that creates more problems than it resolves. An easier alternative is for the farmers to establish a cooperative where they can delegate one among themselves to be the marketing agent, and it could be done in turn. They could also then pool in resources to acquire the machinery needed for marketing and transport. Thus, without depending on the state agency, the farmers could

mobilize themselves to increase their profit margins. This approach could easily be assimilated into schemes aimed at providing subsidized assistance to farmers.

Fourthly, the infrastructure needed for storage so that the crops can be harvested at the optimal time and be perennially available for sale, thus eliminating farmers' dependence of farmers on the irregular visits of suppliers who can dictate prices, will greatly improve the conditions of the farmers. These structures can be set up with the cultivators as stakeholders and the state agency providing the raw material at subsidized rates.

This is supported by a study conducted by Jamir (2022) reported that ginger cultivation can be made into a viable enterprise in the state with more focus on conducive environment and also by subsidizing farm inputs and also providing affordable loans to the smallholder farmers for sustainable production.

CHAPTER V

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

Ginger (*Zingiber officinale* Rosc.) is a key spice in Nagaland and in the state; various cultivated ginger types are typically named after the regions where they are grown. Among these, Nadia is particularly favoured by ginger growers for its low fibre content (4.2%).Ginger is cultivated on a large scale due to their commercial value. Ginger is used in culinary preparations, soups, curries and pickles and is also utilized as a dried spice, serving as a flavouring agent in baked goods and confectionery. It is incorporated into various food items such as gingerbread, curry powder, and some soft drinks like ginger tonic. This study aimed to examine the potential of ginger cultivation in the Mon and Zunheboto districts of Nagaland and it sought to explore the different practices adopted by ginger growers and identify the various challenges encountered in ginger cultivation.

Therefore, in doing so, the study would provide valuable information to the academicians, planners, policy makers and extension workers about the existing practices, potential, prospects and prominent contributions of the crop to the traditional cultivators of the state, the documentation and database development about ginger which is immensely lacking. Therefore, considering all these factors, an assessment was carried out with the title, "**Prospects and constraints of ginger (*Zingiber officinale* Rosc.) cultivation in Mon and Zunheboto Districts of Nagaland**" with the following objectives:

1. To assess the knowledge level and the extent of adoption of improved practices in ginger cultivation,

2. To assess the existing seed system in ginger cultivation,

3. To study the sustainable performance of ginger cultivation, and

4. To identify the various constraints in ginger cultivation and measures suggested for improvement.

RESEARCH METHODOLOGY

The research was conducted in two districts of Nagaland viz. Mon and Zunheboto were purposively selected. Further, six blocks from each district, namely Wakching, Phomching, Mon, Satakha, Suruhoto and Rotomi were also purposively included. Again, 18 villages were selected by taking three villages from each block. Finally, 15 ginger growers from each selected village (45 growers from each block and 135 growers from each district) were selected as respondents for the study. Thus, in total, 270 ginger growers were purposively selected as respondents for the study. Data were gathered through one-on-one interviews using a structured interview schedule.

Findings of the study

Socio-economic profile of the respondents

It was identified that most respondents (57.78%) were in the middle age group, with 67.04 per cent of the ginger growers being male. In terms of educational background, 91.11 per cent of respondents were literate, while 8.89 per cent were illiterate. The investigation also revealed that the majority (82.97%) of respondents had medium-sized families, while concerning occupation, 97.40 per cent of the respondents listed agriculture as their primary occupation.

The study also observed that most respondents (80.00%) had medium-sized land holdings, ranging from 0.85 to 3.91 acres. In terms of the operational land holdings it was found that 78.51 per cent of respondents had active cultivable land areas between 0.63 and 1.70 acres.

Regarding land under ginger cultivation, the majority (71.48%) of the respondents had a medium size of land under ginger cultivation (0.55-1.5 acre).

The study indicated that 74.44per cent of the respondents had a medium annual income, ranging from ₹33,324 to ₹1,20,573. Additionally, 67.03per cent of respondents reported a medium income from ginger cultivation, ranging from ₹24,484 to ₹95,303; while furthermore, 42.60per cent of the respondents achieved high levels of ginger production, exceeding 1,768 kg.

The investigation revealed that a large majority (96.29%) of respondents were familiar with ATMA functionaries, though only 37.78per cent had actually contacted them. ATMA and relatives/friends were identified as the main sources of information for the respondents and additionally, it was observed that most respondents (83.33%) did not participate in training sessions.

The results of the investigation are summarized below, aligned with the respective objectives:

Knowledge of recommended practices of ginger cultivation

The research clearly shows that all (100%) respondents were fully aware that ginger requires warm climatic conditions for its cultivation, and all (100%) respondents were uninformed about ginger growing well in humid climatic conditions.

The investigation revealed that 67.78 per cent of respondents were fully knowledgeable that ginger requires rich, well-drained soil for cultivation, while 32.22 per cent had only partial awareness. Additionally, 70.00 per cent of respondents were fully informed that soil aeration is optimal for ginger cultivation, with 30.00 per cent having partial awareness. Furthermore,

72.22per cent of respondents were fully aware that sandy loam is the ideal soil type for ginger, while 27.78 per cent were only partially aware of this.

All (100%) respondents were fully aware of the ploughing of the land before planting. It was also found that the majority (83.70%) and 16.30 per cent of the respondents were fully and partially aware of the recommended land preparation practices for better ginger cultivation. All (100%) the respondents were fully aware that ginger should not be planted in the same field year after year.

The study showed that all (100%) respondents had no knowledge of treating rhizomes with cow urine for half an hour for better rhizome growth before planting. It was also seen that all (100%) respondents were unaware of seed treatment for effective control of diseases.

The investigation revealed that 56.67 per cent of respondents had partial knowledge about planting 1,200-1,500 kg of seed per hectare. Additionally, 26.66 per cent of respondents were unaware of the recommended seed rate for one hectare of ginger, while 16.67 per cent were fully informed and further showed that all (100%) respondents were fully aware of the seed weight, seed size, the importance of using true-to-type rhizomes and the importance of diseases and pests free seed-rhizome.

Most of the respondents (94.07%) were fully aware about the requirement of 30 cm spacing between rows for ginger cultivation, but a small number (5.93%) of the respondents were unaware about such practices. Moreover, 92.22 per cent of respondents were fully aware of the need to maintain 25 cm spacing between plants for optimal rhizome growth, while only 7.78 per cent were unaware of this requirement. All (100%) respondents were fully aware that rhizomes should be placed at a depth of 4-5 cm in furrows and covered with soil.

Around 83.33 per cent of the respondents were unaware of April to May being the optimum time for sowing ginger, while the remaining 16.67 per cent were fully aware about the optimum planting time of ginger.

All (100%) respondents were fully aware of the popular variety, i.e., Nadia. They also used 4-5 cm long sprouted bits as planting material.

Most respondents (92.59%) were fully informed about the benefits of using manure to enhance soil conditions, while 7.41per cent had only partial knowledge. Additionally, 93.70 per cent of respondents were fully aware that manure improves ginger production, whereas 6.30per cent had partial awareness of this benefit. All (100%) respondents in the selected study area were, however, completely ignorant about the dosage of application of FYM or the time to apply it. This was despite responses showing that all (100%) respondents were fully aware of FYM and pig manure. The assessment further showed that most (92.22%) of the respondents were fully aware, and the remaining 7.78 per cent partially aware of the poultry manure in the study area, respectively.

Around 72.59 per cent of the respondents were unaware about the importance of fertilizers for good soil health management. Going further, 8.89 per cent of the respondents were partially aware, and only 18.52 per cent were fully knowledgeable about the usage of fertilizer for soil health management. It was therefore, natural that the same statistics would show 72.59 per cent of the respondents responding negatively about using fertilizer for higher ginger production as with the 18.52 per cent and 8.89 per cent of the respondents who were fully and partially aware about using fertilizer for higher production of ginger, respectively. Another significant finding was that the study found none of the respondents had any knowledge about the appropriate fertilizer dosage needed for increasing ginger production.

The investigation disclosed that 50.38 per cent of respondents were fully knowledgeable about mulching practices, 34.81 per cent had partial awareness, and 14.81 per cent were unaware. It also found that 50.38 per cent were fully aware of the purpose of mulching, 27.40 per cent had partial knowledge, and 22.22 per cent were unaware. Additionally, 49.62 per cent of respondents were fully aware that mulching helps in weed management, while 26.66 per cent had partial awareness and 22.96 per cent were unaware and the study further indicated that 80.00 per cent of respondents did not know about using paddy straw as a mulching material, whereas 20.00 per cent used paddy straw for this purpose.

Another important finding was that all (100%) respondents were unaware about the chemical control of weeds in ginger cultivation. This was despite the study also revealing that 74.44 per cent of the respondents were fully aware and 25.56 per cent of the respondents being partially aware about harmful effects of insects.

The investigation found that 35.93 per cent of respondents had partial awareness of the soft rot disease affecting ginger. Additionally, 34.44 per cent were unaware of the disease, while 29.63 per cent were fully knowledgeable about it, respectively. The study showed that all (100%) respondents were unaware of soft rot being the most severe disease of ginger and control measures to manage disease infestation.

The study also showed that all (100%) respondents were unaware about bacterial wilt as well as dry rot of ginger. It was also found that 44.81 per cent of the respondents were partially aware about leaf rot, whereas 55.19 per cent were completely unaware of the disease.

The study showed that 70.37 per cent and 29.63 per cent of the respondents were fully aware and partially aware about water management in

ginger cultivation, respectively. The study also showed that the majority (85.19%) of the respondents were fully aware of the first irrigation that should be done immediately after planting, and 14.81 percent of the respondents were only partially aware. The majority (85.19%) were also fully aware about the importance of irrigation in ginger cultivation, while 14.81 per cent of the respondents did not know its importance. However, all (100%) respondents were unaware about the time of irrigation in ginger cultivation. The study did reveal that all (100%) of the respondents were fully aware about the optimum time of harvesting, which is 8-10 months after planting.

Adoption of recommended practices for ginger

The study revealed that all (100%) respondents partially adopted the practice of following good drainage soil for ginger cultivation. Further, 70.00 per cent of the respondents followed ideal soil aeration conditions. It was also seen that 11.11 per cent and 61.11 per cent of the respondents, respectively had fully and partially adopted the cultivation of ginger in sandy loam soil. The study indicated that only a portion of the respondents, specifically 27.78 per cent, did not implement the practice.

Thorough land preparation is a prerequisite for optimum production from rhizome and root crops. The study also showed that 51.85 per cent and 48.15 per cent of the respondents fully and partially adopted the practice of well pulverizing the land as required to bring the soil to be fine friable, respectively.

The study revealed that all (100%) respondents did not adopt the dipping of rhizome in cow urine and drenching the soil with suitable fungicide for effective control of diseases.

The investigation showed that a majority of the respondents (71.85%) did not adopt the recommended seed rate though the remaining 28.15 per cent

did. It was also seen that 88.89 per cent and 11.11 per cent of the respondents partially and fully adopted the recommended seed weight, respectively. While slightly lesser, about 83.34 per cent and 11.11 per cent of the respondents partially and fully adopted the recommended seed size, respectively

Some positive responses were that all (100%) respondents had fully adopted the usage of true-to-type and rhizomes free from pests and diseases, as also 99.26 per cent of the respondents partially adopted the recommended spacing ideal for growing ginger. It was also seen that 97.78 per cent of the respondents had fully adopted the recommended spacing between plants for ginger growing. Placement of the rhizome at the recommended depth partially adopted by 60.74 per cent, and the remaining 39.26 per cent of the respondents fully adopted, respectively.

Some of the more concerning findings were that only 16.67 per cent of the respondents fully adopted the recommended time of planting, whereas 83.33 per cent did not. Most (92.96%) of the respondents also only partially adopt the recommended number of sprouted bits required for better production of ginger.It was also observed from the study that all (100%) respondents had fully adopted the Nadia variety. But crucially, the same study also revealed none of the respondents planted or adopted any other variety in the study area.

With regard to Manure and Fertilizer these were the findings: None of the respondents in the study area adopted any kind of manure and fertilizer for the better production of ginger.

Around 80.00 per cent of the respondents did not adopt any mulching practices, and only 20.00 per cent of the respondents partially adopted mulching practices for weed management using straw as the mulching material. None of the respondents adopted any chemical control for weed

management in ginger cultivation. None of the respondents followed the recommended treatment for disease control in ginger.

None of the respondents followed the recommended time for irrigation in ginger cultivation in the study area and growers as rain-fed crop.

Existing seed system in ginger cultivation

The investigation revealed that all respondents (100%) were knowledgeable about the various planting materials such as seed, rhizome, tuber, stem and bulb and all (100%) respondents in the selected study area knew the local seeds and high yielding seeds (Nadia) but no knowledge about hybrid seeds, breeder seeds, foundation seeds, certified/commercial seed and Truthful labelled seed.

The study also showed that all (100%) respondents were aware of the importance of seed in productivity, the importance of disease-free seed to control seed-borne diseases, the importance of disease-free seed for higher yield and the importance of insect-pest free seed for high yield. They also fully adopted the selection of disease-free seeds to control seed-borne diseases, disease-free seeds and insect-pest free seeds for higher yield.

All (100%) respondents following the criteria for considering the plot for planting ginger, i.e. loose soil and sloping terrain and 72.22 per cent of the respondents preferred black soil. However, the study showed that only 84.81 per cent of the respondents were seen to fully adopt planting of ginger in sloped areas, and the remaining15.19 per cent did not follow such considerations.

The study showed that 100 per cent of the respondents knew about the selection of larger rhizome for seed purpose. The majority (i.e., 79.26%) of the respondents fully adopted planting of larger sized rhizomes and the remaining 20.74 per cent of the respondents partially adopted the same. All (100%)

respondents knew that planting rhizomes with more bits was also a criterion to be considered for seed, but it was found that only 75.56 per cent of the respondents fully adopted, and 24.44 per cent partially adopted the same.

All (100%) respondents knew about the selection of disease-free and pest-free rhizomes to be considered for seed. Similarly, 100 per cent of the respondents fully adopted using of disease-free and pest-free rhizomes for seed purposes.

Regarding the procurement of seeds, the study revealed that the farmers resorted to multiple channels; however, only 16.66 per cent of the respondents acquired the Nadia variety through free distribution. Procurement through purchase was a method that accounted for 12.59 per cent. The remainder was procured through other means of barter or from seed stores of the previous harvest. Around 88.14 per cent of the respondents responded that they sourced from within their own village but 32.22 per cent also accessed neighbouring villages as a source.

It was also seen that 4.44 per cent and 45.55 per cent of the respondents acquired the local variety of seed-rhizome, which is of a small size from the neighbouring and within their own village, respectively. The numbers for procuring the local variety which is of large size came to71.11 per cent, 17.40 per cent, and 7.40 per cent of the respondents from their village, from the neighbouring village and purchased from the market, respectively.

The study showed that 100 per cent of the respondents had followed careful cultivation of ginger crop, careful harvesting of rhizome, careful plucking of rhizome, cleaning of excess soil attached with rhizome and grading of rhizome and had fully adopted careful cultivation of ginger crop, careful harvesting of rhizome, careful plucking of rhizome, cleaning of excess soil attached with rhizome and grading of rhizome. However, none of the

respondents followed the process of washing of rhizome, drying, checking, treating, quality testing, or labelling.

All (100%) respondents were unaware of seed certification or seed certification agencies. The study also showed that 100 per cent of the respondents knew about the seed renewal period and the importance of renewing and changing seed. The study showed that 39.63 per cent of the respondents acquired seeds through friends and neighbours. The study also showed that 7.77 per cent of the respondents got their seed from the market and 11.48 per cent acquired their seed through the Department of agriculture.

Constraints in ginger seed system

The investigation revealed that 100 per cent of the respondents faced very low problems regarding the perish-ability of ginger rhizome at the time of marketing. It was also seen that 61.11 per cent of the respondents had a negligible problem with respect to transportation at the time of marketing.

Around 55.56 per cent of the ginger farmers responded to facing very high levels of constraints related to low ginger price rates, followed by 44.44 per cent experiencing high-level constraints while selling harvested ginger. Another 55.56 per cent of the respondents also reported facing a very low level of susceptibility of ginger crop to insect-pest attacks, and 38.88 per cent with a low susceptibility of ginger. The study also showed that 50.00 per cent of the respondents showed low level of problem regarding susceptibility of disease attack to ginger crop.

Around 38.89 per cent of the farmers responded with high and average level of problems regarding non-availability of the market, and 22.22 per cent of the respondents showed very high constraints with regard to non-availability of the market.

Another 55.56 per cent of the respondents of the study also responded having an average degree of difficulty regarding non-availability of purchasing agents but the remaining 44.44 per cent of the respondents shared experiencing a very high level of difficulty.

The investigation discovered that half (50.00%) of the respondents experienced moderate issues in obtaining high-quality or pure seed-rhizomes, while 44.44per cent faced significant difficulties. Additionally, a small proportion (5.56%) encountered very severe constraints in acquiring good quality or pure seed-rhizomes.

All (100%) respondents had faced low levels of constraints regarding the authentic sources of seed-ginger. A total of 55.56 per cent of the respondents faced a high level of constraint regarding the high price of seed-rhizome, followed by 44.44 per cent with the average level of constraint.

Regarding the procurement of seed-rhizome, the majority (55.19%) of the respondents had a low level of problem regarding perishability of the rhizome, and 44.81 per cent had a very low level of problem regarding perishability of the rhizome seed. It was seen that 44.44 per cent of the respondents had faced low levels of transportation problems, 38.89 per cent showed very low levels of problems and the remaining 16.67 per cent of the respondents experienced average levels of problems during transportation of procured seed-rhizome from market to residential place or field.

Responses also showed that a little more than half (50.37%) of the respondents faced average levels of problems regarding non-availability of disease-free seed, and the remaining 49.63 per cent quoted low levels of problem. Similarly, 54.07 per cent and 45.93 per cent of the respondents faced low and very low levels of problems, respectively, regarding non-availability of seed rhizome free from pest attacks.

Concerning procurement of seed-rhizome, 44.81 per cent of the respondents in the study area, had high levels of difficulty due to non-availability of a market, followed by 38.89 of the respondents facing very high issues with non-availability of a market. Only 16.3 per cent considered it an average problem.

In a similar manner, the results of the study indicated that 55.56 per cent of the respondents faced a very high problem regarding non-availability of ginger seed supply, followed by 44.44 per cent of the respondents also reporting high levels of constraints regarding non-availability of ginger seed-rhizome supply.

Sustainable performance of ginger cultivation

Economic sustainability of ginger cultivation

To assess the economic sustainability of ginger cultivation, 11 parameters viz. productivity is assured/giving assured productivity, the potential for consistent and reliable income is significant, with income per unit area being higher compared to other crops, Supporting livelihood, Cost: benefit ratio is higher, Cost of cultivation is in favour of the growers, Scope/risk/income uncertainty of economic loss Vulnerable/less susceptible to economic loss, Resilient in terms of productivity at the time of environmental stress condition, Potential to fetch a higher income (during nonpeak season/ off season of peak harvesting time), Round the year, price is relatively consistent, Requirement of external assistance for cultivation is less /minimum, were considered and in all respect the mean scores were found to be higher than the midpoint (2.50) score.

The overall mean score of 3.44 for economic sustainability indicates that the performance of ginger cultivation in terms of economic sustainability was satisfactory.

Human sustainability of ginger cultivation

In the study, 11 parameters were examined, including poverty reduction, food security, nutrition, health issues, employment generation, and access to better education. The parameters also assessed ginger's potential to prevent illness, its curative qualities, its non-obstructive nature on social participation, its lack of harmful effects on growers, and its neutral impact on religious and spiritual aspects. For all these parameters, the mean scores were found to be above the midpoint (i.e., 2.50).

The overall mean score of 3.88 for human sustainability indicates that ginger cultivation performed exceptionally well in terms of human sustainability.

Social Sustainability of ginger cultivation

Similar to the previous assessments, the social sustainability evaluation examined 11 parameters, including: recognition for engaging in meaningful activities, enhancing social prestige, maintaining family happiness and peace, compatibility with food habits, alignment with social norms and values, strengthening social cohesion, ensuring gender equality, involving all genders in decision-making, participation from all age groups, absence of gender bias in cultivation and post-harvest activities, and the potential for traditional cultivation. The study found that the mean scores for all these parameters exceeded the midpoint (i.e., 2.50).

The investigation also found that the overall mean score of 3.82, which was above the midpoint, indicates that the performance of ginger growers in terms of social sustainability was satisfactory.

Environmental sustainability of ginger cultivation

Lastly, in respect of environmental sustainability, 11 parameters were studied viz. restoration of ecological balance and biodiversity, the preservation of

natural resources, suitability for organic cultivation without chemicals, soil erosion control, adaptability to less favorable or stressful climatic conditions, resilience to shocks, effectiveness in integrated nutrient and water management, minimal greenhouse gas emissions from crop residues, suitability for cultivation in less fertile soils, compatibility with farm waste recycling, and appropriateness for shifting cultivation. All these parameters received mean scores above the midpoint of 2.50.

The investigation revealed that the overall mean score was 3.84, which is above the midpoint score, indicating that ginger cultivation performs satisfactorily in terms of environmental sustainability. Additionally, the average score across all sustainability dimensions—economic (3.44), human (3.88), social (3.82), and environmental (3.84)—was 3.74. This suggests that ginger cultivation in the study area is a sustainable farming practice or livelihood component.

Constraints in ginger cultivation in the study area

The investigation revealed that all (100%) respondents faced issues related to the absence of processing units, insufficient technical guidance, lack of information on recommended seed rates, inadequate knowledge of seed treatment, limited understanding of rhizome curing techniques, and lack of extension support, inadequate credit facilities, and difficulties due to unorganized marketing.

The study also revealed that 96.29 per cent of respondents encountered challenges due to ginger cultivation being labour-intensive. Additionally, 94.44 per cent of the respondents faced difficulties due to a lack of knowledge about high-yielding varieties.

The study also indicated that 93.33 per cent of respondents struggled with the unavailability of post-harvest technologies. Additionally, 87.40 per

cent faced issues due to inadequate training programs, while 85.93 per cent experienced difficulties with the delayed supply of seed material in the area.

The analysis also noted that 83.33 per cent of respondents experienced issues related to insufficient knowledge about value addition of ginger, lack of market information, and significant market price fluctuations. Additionally, 67.78 per cent faced problems due to the absence of training programs specifically for ginger cultivation in the area. The study further indicated that 64.07 per cent of respondents struggled with ginger cultivation because of inadequate knowledge about managing insect pests and diseases, highlighting a lack of understanding about these issues among farmers and furthermore, 62.97 per cent of respondents faced challenges during the harvesting process of ginger.

The investigation also revealed that 44.81 per cent of respondents had issues with the timely availability of inputs. Additionally, 39.63 per cent faced challenges due to the lack of timely plant protection measures. Furthermore, 36.29 per cent of respondents were concerned about inadequate knowledge regarding the proper storage of rhizomes in the area. The study also highlighted that 29.63 per cent of respondents desired improved high-yielding ginger varieties, and 28.15 per cent consistently struggled with transport facility availability.

Some important suggestions proposed by the respondents to mitigate the recognized problems were: proper market linkage for better and easy marketing, conducting training by concerned organizations and authorities for ginger growers, organizing demonstrations and awareness programs for improved ginger cultivation, provision of financial assistance through banking and other financial institution’s linkage, provision of supply of seed-rhizome, new variety of seed ginger and other inputs.

In the previous section, we explored the potential of ginger cultivation as a cash crop which has a unique place in Nagaland because it has shown potential to be grown profitably, but in the subsequent years after a very successful introduction, the spice has experienced a steep fall in production and consequently impacted productivity. This outcome can be attributed to the attempts to scale up crop production through extensive farming without proper training and awareness of the needs of large-scale ginger cultivation.

However, there is a clear indication that the decline in crop harvest is currently impacted by a number of factors, as the field study has shown. More significantly, the research shows that there are several areas where the respondents can equip themselves individually to affect the production, factors such as choosing the recommended seed size, seed weight, seed rate, planting of multiple varieties of ginger, improving knowledge on crop disease and disease management, which are all rudimentary aspects that can have great influence when scaled up. However, they seem unimportant for small scale cultivation. It is more difficult to implement some factors due to the terrain and connectivity problems but the use of fertilizers and natural manure supplements to improve soil quality are also steps that can have a positive bearing.

The ginger farmers can also strengthen their positions by forming a community that works towards protecting their interests. This would also streamline the efforts of the governmental agencies to more effectively carry out projects and missions to improve the conditions of the farmers, as well as work hand in glove to ensure that the welfare of the ginger cultivators is sheltered.

Finally, at the macro level, the state agency could promote ginger cultivation through the general improvement of network and connectivity, introducing of subsidized schemes aimed at the benefit of ginger cultivation,

and setting up a manageable micro-scale infrastructure that would support ginger storage and distribution. The responsibility of regulating the rates and monitoring fair prices would still be on the government to ensure reasonable terms for the farmers. The existence of a functional association consisting of knowledgeable farmers themselves as a community would also make regulating prices easier to control.

Conclusions

1. Most ginger growers were middle-aged men from medium-sized families who were literate. They were typically involved in agricultural organizations and had agriculture as their primary occupation, with over six years of experience in ginger cultivation, while most respondents achieved a high level of ginger production, exceeding 1,768 kg.
2. Most respondents had a moderate level of knowledge and adoption regarding ginger cultivation and their knowledge was positively and significantly associated with factors such as annual income, income from ginger, training, extension contact, information sources, and marketing. Conversely, knowledge was negatively associated with gender, occupation, land holding, operational land holding, and the area of land used for ginger cultivation. Additionally, age, annual income, income from ginger, extension contact, information sources, and marketing had a positive and significant association with the adoption of ginger cultivation practices.
3. All respondents in the study area were knowledgeable about different planting materials while most were also informed about the various technical aspects of quality ginger seed-rhizomes and understood the significance of using high-quality seed rhizomes for achieving optimal yields.All respondents knew about the importance of seed renewal every year for optimum yield. However, they had no knowledge about

certified seeds, seed certification and different high-yielding varieties of ginger.

4. In the investigation site, the existence of a formal seed system was absent. Informal and self-managed seed systems exist. Further, barter exchange of ginger and other seeds was also prevailing. However, adoption of seed production was neglected, and the seed marketing system had not been established in the study area.
5. Concerning the sustainable performance of ginger cultivation, study brought to light that ginger cultivation was a highly sustainable farming activity with and it was also sustainable performed in respect of economic, human, social and environmental sustainability dimensions.
6. The primary challenges faced by the respondents included insufficient technical guidance, limited knowledge about recommended seed rates and seed treatment, inadequate technological expertise for curing rhizomes, lack of extension support, and unavailability of credit facilities.

Recommendations

- Most of the ginger growers were practicing the traditional method of ginger cultivation. Therefore, farmers' awareness should be up-scaled on the new packages of practices of ginger cultivation to maximize production.
- The study shows that respondents had inadequate awareness/knowledge about the importance of quality seed, different types of seed and seed certification, and farmers were not concerned about the role of quality seeds in productivity. Therefore, the relevant authorities should take steps to enhance farmers' and growers' awareness of the significance of quality seeds for improving productivity, which will ultimately lead to increased overall ginger production.

- In the study area, the existence of a formal seed system was absent. Informal and self-managed seed systems exist. Further, barter exchange of ginger and other seeds was also prevailing. However, the adoption of seed production was neglected, and a seed marketing system had not established in the study area. Therefore, concerned authorities may kindly take the initiative to develop a better ginger-seed system as well as for other important crops.
- In terms of the sustainability performance of ginger cultivation, it was observed that the performance of ginger is highly sustainable in respect of economic sustainability, human sustainability, social sustainability and environmental sustainability. Therefore, more focus should be given to ginger cultivation to maintain the environmental and socio-economic sustainability of the farming sectors.
- Due to the mountainous terrain of the investigation site, farmers were solely dependent on the manual workforce for intercultural operations, land preparation, planting, weeding, and harvesting. Furthermore, user-friendly equipment and farm machinery were not available. Therefore, concerned authorities should introduce and implement farmer-friendly equipment and machinery engineered towards performing in hilly terrain farming systems.
- The study also observed that the majority of the ginger growers do not have extension contact resulting in inadequate knowledge about improved technology and their adoption. Therefore, more emphasis should be given on establishing a good relationship between farmers and extension agents to mitigate the said problems.
- In the study area, farmers cultivated ginger without chemical supplements or fertilizers, indicating a strong potential for organic ginger production. Authorities should promote the certification and marketing of organic ginger to capitalize on this opportunity.

- The study identified major constraints in ginger cultivation, including inadequate processing facilities, limited technical knowledge on curing rhizomes and harvesting, lack of post-harvest management options, and insufficient knowledge about rhizome storage. Therefore, concerned authorities should take the initiative to help farmers to avoid these constraints for more productive ginger cultivation

Suggestions for future studies

1. The current assessment was conducted in just two districts of Nagaland. viz. Mon and Zunheboto were the leading ginger-producing regions, when the research commenced. With ginger growing expanding widely into other districts, extended research can be further conducted including other ginger-growing districts with a greater number of respondents to obtain a more complete understanding of ginger's potential both as a crop and a product.
2 This study emphasized the ginger seed system and support to map the existing ginger seed system in the study area. Similar type of studies may be conducted on different crops under different regions. Ginger is a promising and viable cash crop, but its performance in the study area falls short of expectations. While there is a study on the impact of ginger cultivation on income generation and its role in creating employment and livelihoods, further research on its socio-cultural effects could be beneficial.

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APPENDICES

INTERVIEW SCHEDULE
on

PROSPECTS AND CONSTRAINTS OF GINGER (*Zingiber officinale* Rosc.) CULTIVATION IN MON AND ZUNHEBOTO DISTRICTS OF NAGALAND

Respondent no: ……..
General Information

Part – I

1.Name of the respondent ……
2.Phone No.: ……
3.Name of the village ……
4.Block ……
5.District ……

Part – II

Socio-Economic Profile of the Respondent

1. Age (in years): …….
2. Sex: ……(M/F)
3. Educational status: …….
   (illiterate/can read/ read & write/class: I-Master/Ph.D)
4. Family size: ……
5. Occupation: ……
6. Experience in ginger cultivation:_____
5. Total land holding: ……(acre)
6. Operational/cultivable land holding……(acre)
7. Area under ginger cultivation: _____ acre/ hectare/ bigha
8. Annual income:
9. Income from ginger cultivation
10. Annual production of ginger

11.Training exposure:

Sl. No.	**Name of the training**	**Subject covered**	Methods of farmers' training
1.			
2.			
3.			

12. Extension contact

Sl. No.	Extension Contact	Do you know about these change agents?		How often does the change agent pay visit to you?		
		Yes	No	Most often	Sometimes	Never
i.	Development officers a. ADO b. LRDO c. HDO d. VET					
ii.	AFA					
iii.	KVK personnel					
iv.	Input dealers					
v.	NGO personals					
vi.	Progressive farmers					
vii.	Agriculture Scientist					
viii.	ATMA personnel a.BTM b. ATM					
ix.	Others, please specify					

13. Types of information sources used by farmers in decision making on various cultivation practices:

Sl. No.	Sources	High yielding rhizomes		Crop/Ginger production techniques		Market price and produce.		Seed production
		Yes	No	Yes	No	Yes	No	
1.	T. V.							
2.	Radio							
3.	Newspaper							
4.	Relatives/ Friends							
5.	Progressive Farmers							
6.	ATMA							
7.	Extension							
	Workers							
8.	NGO's							
9.	Local markets/ Mandi							

14. Social participation: Tick ('√') the appropriate option.

a. Member in an organization

( )

If yes, name of the organization:

Member in more than one organization ( )

If yes, name of the organizations:

b. Office bearer in one organization ( )

c. Office bearer in more than one organization ( )

OBJECTIVE I

To assess the knowledge level and adoption of improved practices of Ginger cultivation

Sl. No.	Particulars	Practices	Knowledge			Adoption		
			Fully aware	Partially aware	Unaware	Fully adopted	Partially adopted	Not adopted
1	Climatic Condition	a. Do you know that ginger grows well in warm climate						
		b. Do you know that ginger grows well in humid climatic condition?						
2.	Soil	a. Do you know that a rich soil with good drainage is good for ginger cultivation?						
		b. Do you know that soil aeration is ideal for ginger cultivation?						
		c. Do you know that sandy loam soil type is the best type of soil for ginger cultivation?						
		a. Do you plough your field before planting seeds						
		b. Do you know that it requires 3-4 pulverizing/ploughing to bring the soil to fine friable						
		c. Do you know that ginger should not be planted in the same						

3.	Land preparation	field year after year?						
4.	Seed Treatment	a. Before sowing rhizomes should be dipped in cow urine for half an hour?						
		b. Drenching the soil with Dithane Z-78 at 2g/l of water at 30 days interval is effective for control of diseases?						
5	Seed rate	a. Do you know that 1,200- 1,500 kg is required for 1 ha of land?						
		b. Do you know the recommended seed weight is 15-25 gms?						
		c. Do you know that the recommended seed size is 510 cms?						
		d. Do you know that the rhizomes should be true to type?						
		e. Do you know that the seeds should be free from diseases and pests?						
		a. Do you know that spacing of 30 cms between rows is ideal for growing ginger?						
		b. Do you know that 25 cms between plants is considered ideal for ginger?						
		c. Do you know that rhizomes are						

6.	Spacing	placed at a depth of 4-5 cms in furrows and covered with soils?						
7	Planting time	a. Do you know that April-May is the optimum time for sowing ginger?						
8.	Propagation	a. Do you know that 4-5 cms long sprouted bits are required?						
9.	Cultivars	a. Do you know about the important types of cultivars?						
		i. Nadia						
		ii. China						
		iii. Maran						
		iv. Varada						
		v. Any others. Please specify						
10	Manures and fertilizers	a. Are you aware that manure is good for soil health management?						
		b. Are you aware that manure is good for higher production of ginger?						
		c. Do you know that 3-5 tonnes of FYM/ha is ideal for ginger cultivation?						
		d. Do you know that FYM should be applied at the time of field preparation?						
		a. Are you aware of the different types of manures?						

11	Manures	i. FYM						
		ii. Poultry						
		iii. Pig manure						
		iv. Others						
12	Fertilizers	a. Are you aware that fertilizers are good for soil health management?						
		b. Are you aware that fertilizers are good for higher ginger production?						
		c. Are you aware that fertilizers are good for higher ginger production?						
		d. Do you know that 1/3 Nitrogen should be applied as basal?						
		e. Do you know that full doses of Phosphorous and Potassium should be applied at the time of sowing?						
		f. Do you know that 1/3 of Nitrogen should be applied 45 DAP and remaining 1/3 should be applied 90 DAP.						
		a. Are you aware about mulching practices?						
		b. Are you aware of the purpose of mulching? (For weed management and moisture conservation)						
		c. Are you aware that mulching is for weed management?						

13	Mulching	d. Are you aware that paddy straw can be used as mulching material?						
		e. Polythene cover?						
		f. Green Leaves						
14	Plant protection measures	a. Are you aware of the chemical control of weeds in ginger cultivation?						
		b. Are you aware of the harmful effects of insects?						
15	Disease management	a. Are you aware of the various diseases of ginger?						
		i. Soft Rot						
		ii. BacterialWilt						
		iii. Dry Rot						
		iv. Leaf Spot						
		b. Do you know that soft rot is the most severe disease of ginger?						
		c. Do you know that rhizome treatment with trichoderma @ 8-10 gm/l water helps in managing soft rot?						
16	Water management	a. Are you aware about the water management in ginger cultivation?						
		b. Do you know that the first irrigation should be done immediately after planting?						
		c. Are you aware of the importance of						

		irrigation in ginger cultivation?						
		d. Do you know the time of irrigation in ginger cultivation?						
17.	Harvesting	a. Do you know that ginger is harvested in the months of January-February						

OBJECTIVE II

To study the existing seed system in ginger cultivation

1. Do you know the importance of seed in productivity?
   Yes/No

Partially	Fully	Not adopted

2. Do you know the importance of disease free seed to control seed borne diseases? Yes/No

Partially	Fully	Not adopted

3. Do you know the importance of disease free seed for higher yield?
   Yes/No

Partially	Fully	Not adopted

4. Do you know the importance of insect-pest free seed for higher yield?
   Yes/ No

Partially	Fully	Not adopted

5. Are you aware about the different types of planting material?
   Yes/no

Sl. No	**Planting material**	**Awareness about planting material**	
		Yes	**No**
1	Seed		
2	Rhizome		
3	Tuber		
4	Stem		
5	Bulb		

6. Do you know about the different types of seeds?

Sl.	**Types of seed**	**Awareness about Types of seeds**

No		Yes	No
1	Local seed		
2	Hybrid seed		
3	High yielding seed		
4	Breeder seed		
5	Foundation seed		
6	Certified/commercial seed		
7	Truthful labelled seed		

7. Criteria for considering the plot

Sl. No.	Criteria for considering plot	Awareness		Adoption level					
		Yes	No	Fully adopted		Partially adopted		Not adopted	
				F	P	F	P	F	P
1	Loose soil								
2	Preferably black soil								
3	Sloppy area								

8. Criteria for considering seed

Sl. No.	Criteria for considering seed	Awareness		Adoption level					
		Yes	No	Fully adopted		Partially adopted		Not adopted	
				F	P	F	P	F	P
1	Larger sized rhizome								
2	Rhizomes with more bits								
3	Seed free from disease								

4	Not infested by pest								

9. Do you follow recommended steps for ginger seed processing? Yes/No
10. Steps in seed processing

Sl. No.	**Particulars**	**Awareness**		**Adoption level**					
		Yes	**No**	**Fully adopted**		**Partially adopted**		**Not adopted**	
				F	**P**	**F**	**P**	**F**	**P**
1	Careful cultivation of ginger crop								
2	Careful harvesting of rhizome								
3	Careful plucking of rhizome								
4	Cleaning of excess soil attached with rhizome								
5	Washing of rhizome								
6	Drying								
7	Grading Are you aware about								
	grading? (division of seeds according to size, shape, density and color)								
8	Checking To judge the Quality as seed material / quality in terms of seed								
9	Treating Are you aware about treating?								
10	Quality testing								
11	Packaging								

12	Labeling/ tagging								
13	Storing								

11. Awareness about certification and renewal of seeds:

Sl. No.	Parameters	Awareness	
		Yes	No
1	Are you aware about seed certification?		
2	Do you know about any seed certification agencies?		
3	Are you aware of the seed renewal period?		
4	Are you aware of the importance of renewal/ changing of seed?		

12. Market channel used procuring ginger seed-rhizome

Sl. No.	Source	Yes	No
1	Friends/ neighbours		
2	Progressive farmers		
3	Seed retailers		
4	Through agricultural		
	department		
5	Local markets		

13. Market channel for selling seed

Sl. No.	Channel	Frequency	Percentage
1.	Wholesale market		
2.	Seed retailers		
3	Both		
4	Fellow farmers		

14. Constraints faced in marketing/selling of seed ginger

Sl. No.	Particulars	Very high	High	Average	Low	Very low

1	Perishability					
2	Transportation (bulkiness)					
3	Low rates					
4	Susceptible to insect-pest attack					
5	Susceptible to disease attack					
6	Non availability of market					
7	Non availability of purchasing agent					

15. Constraints faced in procuring/ purchasing of seed ginger

Sl. No.	**Particulars**	**Very high**	**High**	**Average**	**Low**	**Very low**
1	Good quality/ pure seed					
2	Authentic source of seed					
3	Authentic seller					
4	High Price					
5	Perishability					
6	Transportation (bulkiness)					
7	Non availability of disease free seed					
8	Non Availability of seed free from pest attack					
9	Non availability of market					
10	Non availability of seed supply agent					

OBJECTIVE- III

To study the sustainable performance of Ginger cultivation (√ mark in appropriate box)

Sl. No.	Statement	Most Often (Very high) (5)	Often (High) (4)	Sometimes (Average) (3)	Rare (Low) (2)	Very rare (Very low) (1)
Economic sustainability						
1	Productivity is assured / Giving assured productivity					
2	Potential for steady and standard income					
3	Income from per unit area is higher compare to other crops					
4	Supporting livelihood					
5	Cost: benefit ratio is higher					
6	Cost of cultivation is in favour of the growers					
7	Less susceptible to economic loss					
8	Resilient in terms of productivity at the time of environmental stress condition					

9	Potential to fetch a higher income (during non peak season) due to good keeping quality					
10	Round the year, price is relatively consistent					
11	Requirement of external assistance for cultivation is less/minimum					
Human sustainability						
1	Reducing poverty					
2	Addressing food security					
3	Addressing issues of nutrition					
4	Addressing issues of Health					
5	Generating employment					
6	Access to better education					
7	It has potential to protect us from illness					
8	It has Curative/Remedial quality to protect from illness					
9	Cultivation is not a hindrance/obstacle in social participation/issues					
10	Cultivation does not include harmful impact on human/growers					

11	No influence on religious and spiritual aspect					
Social Sustainability						

1	Recognition (being engaged in something worthwhile)					
2	Up scaling the social prestige					
3	Maintaining happiness/peaceful family life					
4	Compatible with food habit					
5	Compatible with social norms and values					
6	Up-scaling the social cohesiveness/togetherness					
7	Maintaining the gender equality					
8	Gender participation in cultivation's decision making					
9	All age group can take part in cultivation process					
10	Gender biasness is absent in cultivation and postharvest activities					
11	It can be grown traditionally					
Environmental Sustainability						
1	Restore ecological balance and biodiversity					
2	Not Undermining/deteriorating the natural resources					
3	Favourable for organic cultivation and without chemical inputs					
4	Control soil erosion					
5	Can grow in less					

	favourable climatic					
	condition/climatic stress condition					
6	Ability to cope with shocks					
7	Responsive to integrated nutrient management, integrated water management					
8	Emission of green house gases from crop residue is less					
9	Crop is suitable to cultivate in less fertile soil					
10	Cultivation is suitable for recycling of farm waste					
11	Suitable for shifting cultivation					

OBJECTIVE-IV

To identify the various constraints in ginger cultivation and measures suggested for improvement

Sl. No.	Category	Yes	No	Rank
1	Harvesting			
2	Non availability of post-harvest technologies			
3	Timely non availability of input			
4	Lack of timely availability of plant protection measures			
5	Lack of proper knowledge about storage of rhizome			

6	Non availability of improved high yielding varieties of ginger			
7	Untimely supply of seed material			
8	Lack of processing facilities			
9	Lack of knowledge about value addition of ginger			
10	Lack of knowledge about high yielding varieties			
11	Timely weed management in ginger cultivation			
12	Lack of knowledge about the recommended seed rate			
13	Lack of technical know how about curing of rhizomes			
14	Lack of knowledge about seed treatment			
15	Lack of knowledge about insect-pest and disease management			
16	Lack of technical guidance			
17	Adverse climatic condition at the critical stage of the crop			
18	Lack of extension support to farmers			
19	Weak research-extension farmer linkage			
20	Labour intensive crop			
21	Non availability of labour			
22	Lack of credit facilities			
23	Unorganized marketing			
24	Lack of market information			
25	High fluctuation in market price			

26	Non availability of transport facilities			
27	Insufficient training program			
28	Lack of training program			