SUSTAINABLE POTATO FARMING FOR ENTREPRENEURSHIP DEVELOPMENT: A STUDY OF POTATO GROWERS IN NORTH EAST INDIA

Thesis

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in

AGRICULTURAL EXTENSION

by

RAJIB DAS

Admn. No. Ph– 203/16Regn. No. 831/2019

Department of Agricultural Extension

School of Agricultural Sciences and Rural Development,

Nagaland University, Medziphema Campus – 797106

Nagaland

2021

DECLARATION

I, **Rajib Das**, 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 has 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**.

Date:
Place: **Medziphema** **(Rajib Das)**

Prof. K. K. Jha
Supervisor

NAGALAND UNIVERSITY
Medziphema Campus
School of Agricultural Sciences and Rural Development
Medziphema – 797106, Nagaland

Dr. K. K. Jha
Professor and Head
Department of Agricultural Extension

CERTIFICATE – I

This is to certify that the thesis entitled "**SUSTAINABLE POTATO FARMING FOR ENTREPRENEURSHIP DEVELOPMENT: A STUDY OF POTATO GROWERS IN NORTH EAST INDIA"** submitted to Nagaland University in partial fulfillment of the requirements for the award of degree of Doctor of Philosophy in **Agricultural Extension** is the record of research work carried out by Mr. **Rajib Das** Registration No. 831/2019 under my personal supervision and guidance.

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

Date:
Place: Medziphema

Dr. K. K. Jha
Supervisor

NAGALAND UNIVERSITY
Medziphema Campus
School of Agricultural Sciences and Rural Development
Medziphema – 797 106, Nagaland

CERTIFICATE – II

VIVA VOCE ON THESIS OF DOCTOR OF PHILOSOPHY IN AGRICULTURAL EXTENSION

This is to certify that the thesis entitled "SUSTAINABLE POTATO FARMING FOR ENTREPRENEURSHIP DEVELOPMENT: A STUDY OF POTATO GROWERS IN NORTH EAST INDIA" submitted by Rajib Das, Admission No. Ph 203/16, Registration No.831 (2019) to the NAGALAND UNIVERSITY in partial fulfillment of the requirements for the award of degree of Doctor of Philosophy in Agricultural Extension has been examined by the Advisory Board and External examiner on ………………...........

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

Members	Signature
1. Prof. K. K. Jha (Supervisor)	………………………….
2. Prof. Utpal Barman (External examiner)	………………………….
3. Prof. J Longkumer	………………………….
4. Dr. N K Patra	………………………….
5. Prof. Amod Sharma	………………………….
6. Prof. S P Kanuajia	………………………….

Head
Department of Agricultural Extension

Dean
School of Agricultural Sciences and Rural Development

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Date: / /2021
Place : Medziphema ***(RAJIB DAS)***

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ABSTRACT

Sustainable agriculture must go along with proper management of agricultural resources to meet the future needs of people and at the same time maintain or improve natural resources and put a stop to environmental degradation. Entrepreneurship is not simply running a business, albeit successfully but it is growing through innovative and novel ideas. Entrepreneurship has proved to be one of the key drivers of economic growth. The present study entitled "**Sustainable potato farming for entrepreneurship development: A study of potato growers in North East India"** was carried out to examine the knowledge and attitude of potato farmers towards sustainable practices of potato farming, to find out the status of sustainability of potato farming practiced by farmers, to examine the entrepreneurial behaviour of the potato farmers, to study the relationship of socio- psychological and economic characteristics of potato farmers with their knowledge and attitude towards sustainable potato farming and to identify the constraints being faced by potato growers and suggest appropriate strategies to overcome them. The study was conducted using ex-post facto research design in the states of Assam, Meghalaya, Tripura and Nagaland selecting one highest potato producing district from every state. Multi stage sampling was followed to select eight blocks, sixteen villages and 480 respondents for data collection using pre tested interview schedule. Findings revealed that majority (76.25%) of the potato growers in the selected states of North-east belonged to the middle age group between 35-55 years, 51.46 per cent of them were male, majority (78.33%) of them had medium family size (4-7 members), 27.92 per cent of them had education up to secondary as well as higher secondary level, majority (58.54%) of them belonged to the marginal land holding category, most (62.29%) of them had 0.1-0.2 ha land under potato, about 31.81 per cent of total land was utilized by them under potato cultivation and average productivity (2016-2019) of potato was found highest in the state of Tripura(17.6 t/ha) and lowest in Nagaland (11.17 t/ha). Highest mean annual income (Rs. 55739.92), from potato cultivation was obtained by the semi-medium farmers, majority (47.50 %) of them had training exposure between 10-20 days only, 72.29 per cent of them had medium level of information sources utilization, most (49.58%) of them had medium level of extension contact, majority (62.71%) of them had medium level of scientific orientation, most (80.21%) of them had low level of social participation and majority (39.79%) of them utilized farmers to consumer model of marketing channel. Majority (68.54%) of them had medium knowledge level but 64.58 per cent of them possessed favourable attitude towards adoption of sustainable potato cultivation practices wherein variables education, marketing orientation, extension contact, sources of information utilized, farming experience, scientific orientation and knowledge had positive and significant association and age and family type had negative and significant association with Attitude. 88.9 per cent, 70.21 per cent and 74.58 per cent of them had medium level of economic sustainability, social sustainability and environmental sustainability respectively. Social sustainability contributed highest (52.79%), followed by environmental sustainability (37.07%) and economic sustainability (10.14%). Variables age, family size, education, size of land holding, area under potato, productivity, sources of information, scientific orientation, social participation, marketing channel and knowledge had positive and significant association with Sustainability of potato farming. Entrepreneurial behaviour of the potato farmers was found to be at medium level. Most (86.25%) of the farmers had medium level of risk management ability. Variables productivity, knowledge, size of land holding, area under potato, annual income, sources of information and marketing channel had positive and significant association with Entrepreneurship. PCA revealed that decision making ability, achievement motivation innovativeness and management orientation were the top contributors in deciding the entrepreneurial behaviour of potato farmers. Majority of the farmers faced constraints in production, storage, marketing and getting required extension support services. Provision of warehouses, quality inputs, need based training to enhance the knowledge of farmers in managing the pest and disease problems as well as balanced use of fertilizers and integrated nutrient management, needed extension support, establishing regulated market and promoting on line / e – marketing may be helpful to overcome the constraints, promoting sustainable potato cultivation and establishment of potato based entrepreneurial ventures.

Keywords: Entrepreneurship, sustainability, constraints, potato farming, north east India

CHAPTER I

INTRODUCTION

INTRODUCTION

"The principal idea of sustainability is easily defended and can be supported in general terms by nearly all people involved in the production, processing, marketing, research, service and consumption of agricultural commodities. The goal of increasing the sustainability of agricultural systems is noble and typically desirable by all members of the agricultural industry" (Bussan *et al*.2008).

"Sustain (the root word of sustainable) has multiple definitions including supplying with food, drink, and other necessities of life, to keep in existence; maintain and to provide (an institution or the like) by furnishing means or funds. Based on these simple definitions, it is evident that American agriculture and the potato industry specifically has been sustainable in many ways as the nation has been provided with an abundant and safe potato supply, the potato industry continues to exist and the marketing of potatoes have provided the means and funds for farms, processors service industries, and other agri-businesses to survive and persist" (Bussan *et al*.2008). Each farmer is a business person. For most, it is tideless work and long hours. Whilst it can be minimize and admistered, it is impossible to avoid risk in agriculture. Indeed, few industries have prices are unstable as ours, or are so highly exposed to unmangable influences, mostly the weather. So it's difficult and risky but does this make farmers entrepreneurial? The answer is 'not necessarily'. Purely handling a business and taking the risks linked with that are not entrepreneurial. Uplifting a firm, through performing more of the same or operating proven procedures quick or better does not exhibit vision, change and creation.

Sustainable agriculture is a kind of agriculture which benefits more people, more efficient uses of resources and environmental balance. Sustainable agriculture must go with true management of agricultural resources to fulfill the needs of people and at the same time preserves natural resources and prevent environmental degradation.

"Entrepreneurship is not simply running a business, albeit successfully but it is growing it through innovative and novel ideas. It is not simply taking risks, trying something new will inherently involve a level of uncertainty which should be addressed but it's not necessarily taking on more commercial risk. There is a difference between (farm) business management and entrepreneurship. Farm business management is about better planning, implementation and control and managing risk. Entrepreneurship is about looking forward, identifying opportunities, creating a vision of how the business will grow, innovating and making a difference. Entrepreneurial farmers look at their farms and see ways to make them more profitable, develop ideas and then translate them into action" (Kahan, 2012).

"Potato is the most important crop cultivated worldwide. It is grown in more than 125 countries and consumed almost daily by more than a billion people. Hundreds of millions of people in developing countries depend on potatoes for their survival. Potato cultivation is expanding strongly in the developing world, where the potato's ease of cultivation and nutrient content has made it a valuable food security and cash crop for millions of farmers. Once harvested, potatoes can be used for a variety of purposes such as fresh vegetable for cooking at home, as raw material for processing into food products, food ingredients, starch and alcohol, as feed for animals, and as seed tubers for growing the next season's crop. Potato development and agricultural development in general requires empowerment of small farmers through improved access to production inputs, credit and markets" (Lutaladio *et al*, 2009).

"Good Agricultural Practices (GAPs) formulated by the Food and Agriculture Organization of the United Nations may be used as a guideline for sustainable potato production. By definition, GAPs are principles and codes of practice that are applied to on-farm production and post-production processes and aim at ensuring safe and healthy food and non-food agricultural products while taking into account economic, social and environmental sustainability" (Lutaladio *et al.*, 2009).

"Sustainable agriculture integrates environmental health, economic profitability as well as social and economic equity. Worldwide interest in potato as a valuable food security crop is increasing, because it is not globally traded, the prices are determined by local production costs and due to its beneficial impact on human nutrition. The key indicators of sustainability may include fertility management and crop protection, yield level, tuber quality and environmental impact" (Pawelzik and Möller, 2014).

Fresh produce locally grown more sustainably and it is good for health and also decreases the dependency on costly imported foods. Promotion of locally grown sustainable agricultural produce in North East India has the potential to improve food security in a socially and also environmentally sustainable way by promoting entrepreneurship.

"Entrepreneurs are key persons of any country as they are the driving force for promoting economic growth and technological change. The development of entrepreneurship is directly related to the socio-economic development of the society. Eighty per cent of the population resides in the rural areas and seventy per cent of the work force depends on agriculture for their livelihood. Therefore role of farmers is very important in agricultural and socio-economic development of the nation. Entrepreneurial behavior of farmers is operationally defined as cumulative outcome of six components namely, innovativeness, economic motivation, decision making ability, risk orientation, information seeking behavior, and leadership" (Balasaravanan and Vijayadurai, 2012**). "**Entrepreneurship in agriculture is also an important issue in Europe. Policy makers, researchers, farmers' unions and advisory services are all working on the development of entrepreneurship in agriculture" (Bolliger *et al*., 2006).

"Entrepreneurship is a formation of human-behaviour. It is essential for widening and management of the society. Normally, entrepreneur is regarded as a person who organizes, initiates activities; direct the event of business component incorporating the element of goods and services from production to supply chain. Entrepreneurial behaviour can be attributed as the change in knowledge, skills and attitude of entrepreneurs in the enterprise they have taken up" (Kumar and Poonam, 2019).

"The development of any nation depends primarily on the important role played by entrepreneurs. They play a vital role in the development of a country. In all economic development activities, more attention is being given to entrepreneurship development. An entrepreneur is primarily concerned with changes in the formula of production over which he has full control. Further, it is commonly believed that an entrepreneur is basically an intelligent person and has a definite ability to create something new to prove its worthiness. The entrepreneurial behaviour is not necessarily doing new things but also doing things in a new way that has been already done. However, entrepreneurs are not simply innovators, they have a will to act, to resume risk and to bring about a changes through organization of human efforts" (Dannof, 1949). "It is evident that economic growth and development of the advanced countries is largely due to entrepreneurship among their community rather than to capital.

Entrepreneurship is not confined to any one particular industry, country or group of persons; it exists in everybody but depends on individual’s desire. Enterprising behaviour has been found in all societies, and in all types of economic circumstances. Considerable amount of research about the personal qualities and behaviour of entrepreneurs has been conducted, but the precise identification of entrepreneurial skills remains elusive. Generally, the entrepreneur is considered as a person who initiates, organizes the activities, manages and controls the affairs of business unit combining the factors of production to supply goods and services. Farmers deciding to take particular crop or use scientific methods to grow crops also exhibit entrepreneurial behaviour. Understanding of such behaviour is essential to improve the quality of extension services offered by institutional and non-institutional agencies. Farming is a capital intensive and risky activity hence farmers need to possess the ability to take risk, innovativeness, imitative and capacity to marshal resources in order to run the enterprise successfully. These characteristics enable them to decide and accept to adapt to appropriate scientific farming methods. Entrepreneurial behaviour is influenced by individual, situational, psychological, social and experiential factors” (Wanyonyi and Bwisa, 2012).

Various reasons of biotic and abiotic factors like lack of HYV seed, rain fed condition, not following recommended package of practices, insects and diseases; unavailability of suitable infrastructures facilities like cold storage, credit facilities, marketing facilities, etc. hinders the sustainable agricultural production and market development. North east India offers a huge opportunities for development of agro based enterprise like agro, food processing, horticulture and other agro based industries. Involvement of private sector in the state economy will increase local job opportunities and entrepreneurship development.

1.1 History of Potato Cultivation

The history of the potato gives a grim caution of the need to maintain genetic diversity in our major food crops. In the 19th century, Ireland was heavily dependent on only on few potato varieties, and those varieties were not resistance to the devastating disease known as late blight. When late blight wiped out the 1845-1846 potato crop, widespread famine followed. It was estimated that, one million people starved to death and more than a million were forced to migrate abroad. In Europe and North America, potato is a major food crop but in India it is still a vegetable.

1.2 Spread of Potato

"Potato was introduced to Europe on two occasions, firstly into Spain in 1570 AD and secondly to England 1590AD" (Hawkes, 1967). "From Spanish introduction, it diffused throughout Europe and Asia. Its introduction into Spain led to an unimaginable growth and distribution of a new food crop with profound economical and historical results. From Spain potato was taken into neighboring European countries and in less than 100 years, it was being grown fairy extensively in many regions of Europe. Distribution beyond Europe soon occurred with the introduction into India in about 1610, China in 1700 and Japan in 1766. Irish immigrants introduced potato in North America in early 1700s. After their origin in Peru Bolivian Region in Andes, it spread to the surrounding regions of South America like Columbia. The Incas spread the growing of potato throughout their empire. The first Virginia potato to reach North America continent was indeed brought to Virginia but they did not come from South America. In 1613, potatoes were carried to Bermuda from England, they were planted and soon became a major food crop for the colonists so when two chests full of provisions were sent in 1621 to the new colony in James Town Virginia, potatoes were naturally included and were cultivated in Virginia from that time onwards. Potato growing in American colonies did not start on a large scale until 1719 when Irish immigrants brought potatoes to their settlement in London. The potato arrived in Africa much later. A few grew in South Africa as early as 1830 but British and German colonists and missionaries did not introduce potato in East Africa until about 1880. In North and East Africa the two world wars were the main stimulus for the crop introduction. While Africa is not a major producer in terms of volume, more African countries grow potato today, than any other continent" (Singh and Yogesh, 2016).

1.3 Status of potato cultivation in North East India

North-East India includes eight states namely Arunachal Pradesh, Mizoram, Nagaland, Manipur, Meghalaya, Tripura and Sikkim. This zone lies between 21.57° to 29.30° North latitude and 89.46° to 97.30° East longitude. NE region fills almost 9 per cent of the area of India, and about 4.5 per cent of its population. About 10 per cent potato area of India lies in the North-East India. The main reasons for the low productivity are timely unailability of important farm inputs like fertilizers, plant protection chemicals, quality seeds and poor management practices, and regular occurance of serious diseases like late blight and brown rot, and pests like potato tuber moth and white grubs.

"Potato holds about 21.90 per cent area of total vegetables under cultivation, having the highest of 28.90 per cent among production of vegetables in India. India ranked third with an area of 21, 42,000 ha, while it ranked second with 5, 13, 90,000 tonnes of production, whereas it ranked at 68th with very low productivity of 23.95 MT / ha only among the potato producing countries. Among the North eastern states, Assam has the highest production of potato followed by Meghalaya and Tripura whereas, Tripura has the highest productivity 18.09MT/ha" (NHB, 2018). "North East region of India covers almost 9.00 per cent of the area and 4.30 per cent of the total agricultural production of India" (Anon, 2011). "Majority of the population is dependent on agriculture, horticulture and allied land based activities. The agricultural production system in the region is mostly rain fed, mono-cropped, and at subsistence level. Productivity of the potato is much less than the national average of 23.95 MT/ha while, average productivity of north-east was 7.52 MT/ha" (NHB, 2018)

1.4 Statement of the problem

"Entrepreneurship has received increasing attention in the past and has been shown to be one of the key drivers of economic growth (Wanyonyi and Bwisa, 2012). Entrepreneurial activities such as innovations, entrepreneurial behaviour and networking are identified as important for enterprise development in an economy (Wanyonyi and Bwisa, 2012). Despite the task environmental constraints like customers, financiers and competitors that make it hard for entrepreneurs in small enterprise to enter and stay in those sectors, most educated entrepreneurs who innovatively adopt improved methods of farming and reduced costs of production were found to have achieved high income and profit. Entrepreneurial behaviour has been examined mainly from the psychological point of view that focuses on personal traits of an entrepreneur. Wanyonyi and Bwisa (2012) reported that psychological factors influenced the likelihood that people exploited new venture opportunities. Despite the significant role of entrepreneurial behavioral in enterprises such as formal SME's and public corporation little is pronounced in farm enterprises such as small scale farmers in horticultural production" (Wanyonyi and Bwisa, 2012).

"Potato is an important crop in the North Eastern Region in India especially the hilly tracts, where the crop is grown under rain fed conditions. The crop is grown throughout the year in one or the other part of the North Eastern region contributing about 10 per cent of the total area under potato in the country" (Gupta *et al.,* 2004). "Potato crop forms an important part of prevailing cropping systems as well as the dietary food habits of the people of the region" (Kumar *et al.,* 2006). "The semi perishability and bulkiness are the innate characteristic of potato that causes problems in its marketing. Marketing of potato in North eastern states of India is further constrained by hilly topography that comprises about 70 per cent of the total area" (Sah *et al*., 2011), "limits its movement which ultimately affects the resource poor farmers of the region. Marketing and storage were also identified as important weaknesses of potato production in India" (Anonymous, 2007). "The facilities of storage, processing and marketing are deficient for perishable commodities as technological constraint for agricultural development in north eastern region of India. Owing to the highlighted weaknesses, the rural marketing in the region is confined primarily to unorganized sector with domination of private traders" (Saikia, 2001). Potato farmers of North East India have shown tendencies of entrepreneurial behaviour such as autonomy, risk taking, need for achievement, creativity and locus of control. However, the factors influencing the tendencies are not known. In this context some research questions need to be addressed as follows:

1. Up to what extent the potato farmers are aware about the latest technologies of sustainable potato production?
2. Do they have the entrepreneurial mindset while producing potato?
3. How the entrepreneurial behavior may be further enhanced?
4. What factors contribute towards promoting entrepreneurial ventures and sustainable production of potato?
5. What strategies can be followed for promoting entrepreneurial ventures and sustainable production of potato?

Considering these issues, a research study entitled "**Sustainable potato farming for entrepreneurship development: A study of potato growers in North East India"** was undertaken with the following objectives:

1.5 Objectives

1.5.1 To study socio- psychological and economic characteristics of potato farmers.

1.5.2 To examine knowledge and attitude of potato farmers towards sustainable practices of potato farming

1.5.3 To find out the status of sustainability of potato farming practised by farmers

1.5.4To examine the entrepreneurial behaviour of the potato farmers

1.5.5 To study the relationship of socio- psychological and economic characteristics of potato farmers with their knowledge and attitude towards sustainable potato farming

1.5.6 To identify the constraints being faced by potato growers and suggest appropriate strategies to overcome them

1.6 Scope and importance of study

The present study shall make an attempt to examine the potential of the potato based farming system in increasing farm productivity, income, entrepreneurial development among the farmers as well as sustainability of the potato farming practices. The outcome of the study shall be helpful in examining the entrepreneurial potential and the constraints faced by the potato farmers of NE region.

This study might be helpful to identify and develop suitable strategy for promoting sustainable potato farming practices for the North east. It also might be useful to know the entrepreneurial behaviour pattern of the farmers of

North-east in general and potato farmers in particular. Further accordingly potato based enterprises can also be promoted.

The findings of the study is expected to help in formulating strategies and policy guidelines for promoting entrepreneurial ventures, scaling up the required technologies for sustainable potato production minimizing the constraints faced by the farmers and adoption of sustainable farming practices by the potato cultivators.

1.7 Limitations of the study

Limited time, resources, finance and transportation facilities including Covid-19 Pandemic situations posed constraints during the completion of the study. The applicability of the findings may be limited to other potato growing areas with similar agro- ecological settings.

1.8 Organisation of the thesis

Thesis has been organised in order of the following chapters:

Chapter 1“**INTRODUCTION**”**-** It includes importance of study, statement of the problems, objective, scope and limitations of the study.

Chapter 2 “**REVIEW OF LITERATURE**”**-** It has dealt with the available literatures related to the present study.

Chapter 3 “**RESEARCH METHODOLOGY**” – This constitute research methods and procedures followed in the study.

Chapter 4 “**RESULTS AND DISCUSSION**”**-** This chapter includes the findings of the study and the essential discussion.

Chapter 5 “**SUMMARY AND CONCLUSION**”**-** It summarizes the study and gives implications, recommendations and suggestions for further research.

References and Appendices have been included at the end of the thesis. For writing reference, the style of Indian Journal of Agricultural Sciences has been followed.

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

In research, a body of literature is a collection of published information and data relevant to a research question. A review of the literature is an crucial part of any educational research project. The review is a watchful examination of a body of literature pointing toward the answer to our research questions and objectives. Literature reviewed essaentially includes scholarly journals, scholarly books, and authoritative databases etc. Review of literature has been listed under the following heads:

2.1 Socio – psychological, economic, personal characteristics of potato farmers

2.2 Concept of entrepreneurs and entrepreneurship.

2.3 Sustainability of potato cultivation practices

2.4 Knowledge and attitude of potato farmers towards sustainable practices of potato farming

2.5 Factors affecting entrepreneurial behaviour and sustainability of potato farming.

2.6 Constraints faced by the farmers in cultivation and management of crops

2.1 Socio – psychological, economic, personal characteristics of potato farmers

2.1.1Age

Wase (2001) conducted a study on “knowledge and adoption and found that majority of the farmers (52.50%) were in the age group of 36 to 50 years i.e middle age category”.

Arneja *et al*. (2009) in their study on “constraints in potato cultivation faced by the potato growers found that 54.66 per cent of the respondents were from the age group of 40-55 years”.

Bagheri (2010) studied “Potato farmers' perceptions of sustainable agriculture in case of Ardabil province of Iran and reported that the demographic characteristics of respondents showed that their mean age was 43 years with 23.3 years of farming experiences”.

Joneydi (2012) reported “that there is a positive and significant relationship between age, farming experience, type of agriculture, agricultural land area, and area of cultivated land, ecological characteristics, social status, knowledge”.

Kafle and Shah (2012) in their study on “Adoption of improved potato varieties in Nepal: A case of Bara district of Nepal’ found that 56.00 per cent respondents belonged to 30-50 years aged category followed by 44.00 per cent above 50 years aged category and 0.00 per cent belonged to below 30 years aged category and it also found that age have positive influences on adoption of improved potato varieties”.

Jaisawal *et al*. (2013) conducted a study on “training need of farmers and found that 58.00 per cent of vegetable growers belonged to medium aged group”.

Kalita and Chabukdhara (2014) in their study on “level of modernization of vegetable growers of Lakhimpur district of Assam found that most of the respondents were young to middle aged”.

Neisy *et al*. (2014) in their study on "sustainable soil management in potato farm in South Dezfoul Region found that the average age of 30.55 years".

Sharma *et al*. (2014) revealed that "the most (41.11%) of potato growers belonged to the young age group (below 38 years), followed by 36.67 per cent of them in the age of old group (above 58 years) and the remaining 22.22 per cent of them having in the age of middle group (38 to 58 years)".

Chavai *et al*. (2015) in their study on "adoption of potato production technology by the farmers of Maharashtra found that a majority (56.36%) of the potato growers belonged to age between 36 to 50 years".

Sharma *et al*. (2016) found that "age was negatively and significantly associated with the knowledge of organic farming practices in trained as well as untrained respondents".

Hameed *et al*. (2019) found that "the age of respondents, who participated in the study ranged from 18 to 65 years. The mean age of respondents was 31.33 years with the standard deviation of 4.90. Respondents were placed under four age categories. The respondents aged 42–53 and 54–65 were in the majority (81.59%), followed by the age group 30–41 (15.13%), next by the age group 18–29 years (3.28%)".

Kumar *et al*. (2021) in their study on "socio-economic profile of sugarcane growers in east Champaran district of Bihar revealed that majority of the respondents were found in middle age group (56%)".

2.1.2 Gender

Ojo and Jibowa (2008) and Mazvimavi (2011) reported in their study, that "leadership and decision making roles are dominated by men. Women, on the other hand, have rights to the land and bear the bulk of domestic work and are less devoted to the agricultural work".

Sadati *et al*. (2010) in their study on "Farmer's Attitude on Sustainable Agriculture and its Determinants: A Case Study in Behbahan County of Iran'found majority (56.7%, n =118) of respondent were 30-54 years old andall of the respondents in the study were male".

Bajracharya and Sapkota (2017) in their study on "profitability and productivity of potato (*Solanum tuberosum*) in Baglung district, Nepal foundthat90 per cent households were male headed in the study area. It was also observed that the higher percentage of male-headed household (91.70%) in Bobang as compared to Tara VDC (88.3%)".

Hayran *et al*. (2018) conducted a study on"Farmers sustainable agriculture perception in Turkey: The case of Mersin province andfound that all the sample farmers were male; their age ranged from 18 to 81 and the mean age was 47.77 years".

Hameed and Sawicka (2019) in their study on "Farmers knowledge of sustainable potato cultivation techniques in Poland revealed that 93.42 per cent of farmers were males, while 6.58 per cent were females. It is obvious that majority of respondents are males most of the farm work is undertaken by men in the study area, because work on the farm is generally perceived to be too physically strenuous, and this is suitable for men more than women because of the man's physical strength".

Hameed *et al*. (2019) in their study on "Farmers knowledge of sustainable potato cultivation techniques in Poland revealed that 93.42 per cent of farmers were males, while 6.58 per cent were females".

Henry *et al*. (2020) in their study on “factors influencing implementation of bylaws on sustainable crop intensification: Evidence from potatoes in south-western Uganda found female farmers were far less on average in bylaws implementation compared to the male farmers”.

2.1.3 Family size

Krishnamurthy *et al*. (2008) in their study on “adoption level and constraints in adoption of improved practices among farmers of Chikmagalur district, Karnataka found that most of the respondents had small sized families of one to six members”.

Sadati *et al*. (2010) conducted a study on “Farmer’s Attitude on Sustainable Agriculture and its Determinants: A Case Study in Behbahan County of Iran’ and found that average number of family size of farmers was five people”.

Jha (2012) in his study on “entrepreneurial behaviour of farmers in Nagaland found that majority of them (51.67%) had family size consisting of 4 to 8 members”.

Kafle and Shah (2012) in their study on “Adoption of improved potato varieties in Nepal: A case of Bara district of Nepal’ found that 51.00 per cent of the respondents had family size of 5-8 members, followed by 40.00 per cent who had above 8 members and remaining 9.00 per cent had family size below 5 members”.

Sharma *et al*. (2014) in their study found that “majority (46.67%) of the potato growers had medium size of family (5 to 9 members), followed by 28.89 per cent of them having small size of family (below with 5 members) and the remaining 24.44 per cent of them having big size of family (above 9 members)”.

Boruah *et al*. (2015) in his study found that "majority (50.84%) of the vegetable growers in Jorhat district of Assam, belonged to medium sized family".

Chavai *et al*. (2015) in their study on " Adoption of potato production technology by the farmers of Maharashtra' found that the 64.55 per cent had 6 to 8 members in their family"**.**

Bajracharya and Sapkota (2017) in their study on "Profitability and productivity of potato (*Solanum tuberosum*) in Baglung district, Nepal' foundthataverage household size wassix members with a minimum of two members and maximum of 13 members inthehousehold. It also found thatthe average household size was almost similar for both VDCs as well".

Hameed and Sawicka (2017) in their study on "Farmers ' attitudes towards sustainable agriculture practices in Lublin Province' found that number of family members of the farmers ranged from (2 to 10) with an average of (5.2). The highest proportion (56.47%) of the farmer had number of family (4-6). The percentage of respondents who hadfamily size below 4 and 7 to 9 was (28.23%), 14.11% respectively.While, the percentage of respondents who had family sizemore than 9 members was (1.19%)".

Honaryar (2019) in his study on "An economic analysis of production, marketing and value chain of potato in Bamyan province' indicated that the small, medium and large farmers hadaverage of 6.37, 5.42 and 6.95 family members, respectively".

Shree *et al*. (2020) in their study on "socio-economic assessment of farm women in Rice cultivation revealed that family size was found to be positively correlated with knowledge and adoption of the rice cultivation practices".

2.1.4 Education

Arun (2001) found that "majority of respondents (38.00 %) had medium level of education, whereas 37.50 per cent and 24.50 per cent of the respondents had low and high education respectively".

Arneja *et al*. (2009) in their study on "constraints in potato cultivation faced by the potato growers found that 32.66 per cent of the respondents having education up to matriculation".

Bagheri (2010) in his study on "Potato farmers' perceptions of sustainable agriculture: the case of Ardabil province of Iran 'reported that the education level of 31 per cent of them had diploma or higher education, out of them 6.40 per cent were graduate from agricultural schools or colleges".

Kafle and Shah (2012) in their study on "Adoption of improved potato varieties in Nepal: a case of Bara district of Nepal' found that 51.00 per cent of the respondents had primary (up to 5 class) level of education followed by 38.00 per cent and 11.00 per cent respondents had lower secondary and higher and no level of education. It also found that level of education had positive influence on adoption of improved potato varieties and recommended that adult education should be provided to the adult farmers and the number of extension agents should be increased who would help introduce new potato varieties and improve technical and managerial skills of farmers through improved extension services".

Kalita and Chabukdhara (2014) in their study on "Level of modernization of vegetable growers of Lakhimpur district of Assam" found that about 30.00% of the respondents had education upto higher secondary level".

Chavai *et al*. (2015) in their study on “Adoption of potato production technology by the farmers of Maharashtra’ found that 48.18 per cent of the respondents completed secondary education”.

Hameed and Sawicka (2017) concluded in their study that “the percentage graduates of primary reached (11.76%), secondary (11.76%) and the percentage of respondents who had a certificate of the School of Vocational Education and College was (36.49%) and (29.41%) respectively”.

Hameed and Sawicka (2019) conducted a study on “Farmers’ knowledge of sustainable potato cultivation techniques in Poland’ and found that the percentage of farmers with primary education was 3.28 per cent. About 15.13per cent and 11.84 per cent of respondents had vocational education in agriculture, and other vocational education, respectively. Meanwhile, 34.21 per cent of the farmers attained secondary education in agriculture and 13.15 per cent received other secondary education. 17.13 per cent of the farmers had higher education in agriculture and 5.26 per cent of the farmers had other higher education”.

Islam *et al*. (2021) in their study on “knowledge level about important production practices of high density apple growers of Kashmir Valley found that education had significant relationship with the knowledge level of the respondents”.

2.1.5 Size of land holding

Arneja *et al*. (2009) in their study on “constraints in potato cultivation faced by the potato growers found that more than 50.00 per cent of them were having 2 to 38 acres of operational landholding”.

Sah *et al*. (2011) found that “the average land holding size among the sampled farmers in Barpeta and Nagaon districts of Assam was found to be

1.36 and 1.67 ha, wherein average land under potato cultivation was observed to be 0.63 and 0.64 ha (46 % total land), respectively".

Kafle and Shah (2012) in their study on "Adoption of improved potato varieties in Nepal: A case of Bara district of Nepal found that majority of the farmers (87.00%) had farm size less than 2 ha that means majority of them were small farmers".

Archana (2013) found that "majority (42.22%) of the farmers belonged to medium land holding category".

Jaisawal *et al*. (2013) conducted a study on "training needs of vegetable growers and found that 63.34 per cent of the vegetable growers were growing vegetables in marginal land holding size".

Modi *et al*. (2013) found that "around one-third (34.17%) of respondents possessed small land holding".

Neisy *et al*. (2014) in their study found that "the average total land owned in the statistical population was 25.05 acres with a standard deviation of 1.12".

Sharma *et al*. (2014) found that "majority (75.56%) of potato growers were having medium size of land (1.70 to 4.88 ha), followed by 15.56 per cent of them having big size of land (above 4.88 ha) and the remaining 8.89 per cent having the small size of land (below 1.70 ha)".

Boruah *et al*. (2015) found that "majority of the vegetable growers (37.50%) in Jorhat district of Assam possessed small size operational land holdings".

Chavai *et al*. (2015) in their study on "adoption of potato production technology by the farmers of Maharashtra found that 50.91 per cent had small land holding upto 2.00 ha"**.**

Bajracharya and Sapkota (2017) in their study on "Profitability and productivity of potato (*Solanumtuberosum*) in Baglung district, Nepal' found that the average landholding was 0.89 hectare (ha) which was higher than the national average of landholding (0.68 ha). The average landholding was low (0.53 ha) in Bobang in comparison with Tara (1.23 ha), and the difference was statistically significant at 1% level. Similarly, the average landholding under potato cultivation was 0.19 ha".

Kumar *et al*. (2021) in their study on "socio-economic profile of sugarcane growers in east Champaran district of Bihar revealed that majority (45%) of the respondents had semi-medium size of land holding".

2.1.6 Area under potato

Sah *et al*. (2011) found "the average land holding size among the potato farmers in Barpeta and Nagaon districts of Assam was found to be 1.36 and 1.67 ha, wherein average land under potato cultivation was observed to be 0.63 and 0.64 ha (46 % total land), respectively and the average land holding size in East Khasi Hill district of Meghalaya was 1.35 hectares, while the average area under potato was 1.24 ha (92 %)".

Bajracharya and Sapkota (2017) in their study on "Profitability and productivity of potato (*Solanum tuberosum*) in Baglung district, Nepal found that the average area under potato cultivation was significantly higher (0.19 ha) in Bobang as compared to Tara (0.17 ha) which was statistically significant at 1 per cent level".

Lama and Bordoloi (2017) found that "area under potato cultivation in Assam increased from 81 thousand hectares in 2000-01 to 105 thousand hectares in 2012-13. The compound annual rate of growth (CAGR) of area was 2 per cent during the period 2000-01 to 2012-13. During the period 2000-01 to 2006-07, however there was fall in area under potato. The CAGR of area during this period was (-) 1.4 per cent; but during the period 2007-08 to 2012-13 the area under potato registered a high CAGR of 6.9 per cent".

Honaryar (2019) conducted a study on "An economic analysis of production, marketing and value chain of potato in Bamyan province' and found that the average area under potato cultivation increased with the increase in the size of farms and the average area under potato cultivation per farmer were estimated to be about 2.03 hectares. Per head, area under potato cultivation ranged from 0.0062 to 0.51 hectares".

Akter and Akram (2020) in their study on "economics of potato production: a case study on the farmers of Munshiganj area in Bangladesh found that the cultivable area of potato is increasing day by day with an average increasing rate of 12.50%".

2.1.7 Productivity of potato

Sah *et al*. (2011) found the "average potato production among the respondents in Barpeta district of Assam was found to be 100 quintal per season with average productivity of 158 quintals/ha, whereas in Nagaon district the average potato production was found to be 81 quintals with average productivity of 128 quintals per hectare".

Bajracharya and Sapkota (2017) in their study on "Profitability and productivity of potato (*Solanum tuberosum*) in Baglung district, Nepal found that the average productivity was found 9.89 ton per hectare (ha) in the study area. The low productivity was due to disease infestation on crop".

Lama and Bordoloi (2017) observed that "during the period 2000-01 to 2012- 13 productivity of potato in the state declined from 8254 kg/ha in 2000-01 to 7675 kg/ ha hectare in 2012-13 at an annual rate of (-0.4 percent). This fall in productivity during the period 2000-01 to 2006-07, however was much sharper at (-) 5.4 per cent. Later in the period 2007-08 to 2012-13, potato productivity increased significantly with CAGR of 2.3 per cent".

Honaryar (2019) conducted a study on "An economic analysis of production, marketing and value chain of potato in Bamyan province' to compare the productivity of 13 different varieties of potato in Bamyan (Mullah Ghulam Research Farm). Results indicated that among all 13 varieties of potato 'Marabel' gave higher yield that was 67.47 tonnes per ha followed by Lourawich which yielded 65.37 tonnes per ha. Similarly, the lowest yield recorded was recorded from Badsha that was 32.37 tonnes per ha".

Sinha and Singh (2019) in their study in "Northern Hills of Chhattisgarh found that overall yield per hectare of potato was75.71 quintals. It was observed that highest yield was accrued to the large farmers (81.35 q.) followed by medium (77.51 q.), small (73.56 q.) and marginal (70.42 q.) farmers. Yield of potato increased with the size of holdings".

Akter and Akram (2020) in their study on "economics of potato production: a case study on the farmers of Munshiganj area in Bangladesh found that the production and productivity is increasing over the years in all categories of farmers".

2.1.8 Annual income

Kafle and Shah (2012) in their study on "Adoption of improved potato varieties in Nepal' found that majority of the farmers (64.00%) lacked non-farm sources of income".

Jaisawal *et al.* (2013) in their study on "Training need of vegetable growers' found that maximum 69.17 per cent of the vegetable growers had low income from vegetable cultivation".

Neisy *et al.* (2014) in their study found that "the potato grower's annual gross income was between 2.5 to 660 million USD".

Sharma *et al.* (2014) found that "majority (86.67%) of potato growers belonged to the medium range of annual income (Rs. 12,432/- to Rs. 1, 08,977/-), followed by 13.33 per cent in the high range of annual income (above Rs. 1, 08, 977/-), whereas none of them were in low range of annual income (below Rs. 12,432/-)".

Boruah *et al.* (2015) found that "majority (51.67 %) of the respondents had income ranging between Rs. 25001 to Rs. 50000".

Chavai *et al.* (2015) in their study found that "75.46 per cent had medium annual income between Rs. 180001 to Rs. 4, 20,000".

Hameed and Sawicka (2019) reported in their study that "farmers keep a farm, including both agricultural and non-agricultural resources withdistribution of respondents into four categories based on their source of income. Most of respondents (74.34%) in the study region worked in agriculture and treated farm as a major source of income; 23.04% of respondents working on a farm also had additional source of income besides the farm".

Kharumnuid *et al.* (2021) in their study on "Potato production for nutritional security and doubling farmers' income found that potato is a potential crop for doubling farmers' income".

Kumar *et al.* (2021) in their study on "socio-economic profile of sugarcane growers in east Champaran district of Bihar revealed that a higher percentage (71.67%) earned medium annual income between Rs. 64,000-3,40,000".

2.1.9 Income from potato production

Bajracharya and Sapkota (2017) in their study on "Profitability and productivity of potato (*Solanum tuberosum*) in Baglung district, Nepal found that the per ha total cost of potato production was Rs. 197,186 with the total income of Rs. 268,047. The cost of FYM (45.32%) was highest followed by seed and human labor. The per hectare profit from potato production was NRs. 70,861 with *B*/*C* ratio of 1.44. An increase in 1% cost of human labor, seed and FYM would increase the total income of potato by 0.075, 0.639 and 0.190%, whereas 1% increase in the cost of bullock labor and intercultural operations would decrease income by 0.015 and 0.047%, respectively. The return to scale was found 0.842 which indicates decreasing return to the scale".

Lama and Bordoloi (2017) reported that "about 95 per cent of produce went to the market. The average price of potato received by the farmers varied from Rs. 9.5 in Naduar block to Rs. 7.6 in Sakomotha block. The gross revenue per hectare is dependent on yield rate and price".

Sinha and Singh (2019) in their study on "Economics of Potato Production in Northern Hills of Chhattisgarh' reported that average cost of potato cultivation was Rs. 47408.91 per ha, average gross income was Rs. 92766.74 per ha and average net income was Rs.45357.83 per ha. The net income from the crop might be increased if they get remunerative prices of their produce and this is possible only if they get higher share in the market price of their produce".

Akter and Akram (2020) in their study on "economics of potato production: a case Study on the farmers of Munshiganj area in Bangladesh found that cost of production was higher but price of potato was lower at the time of harvest and so farmers are getting very less income from potato cultivation".

2.1.10 Training exposure

Patel *et al*. (2011) in their study on "Perception of the farmers about transfer of technology system in North Gujarat' reported that majority (54.00%) had not attended any training while 37.00 per cent of the respondents had attended one-two training and 29.00 per cent of them had attended more than two trainings".

Srivastava *et al*. (2012) in their study on "assessment of the level of knowledge and training needs of potato growing tribal farmers of Meghalaya found that farmersrequire thorough training on improved potato production technologies so as to make them capable of practicing scientific method of potato cultivation".

Gupta *et al*. (2014) in their study on "Decision making ability of agri-entrepreneurs at Jammu and Kathua districts of J & K state' found that majority (61.72%) of entrepreneurs received training for a period of seven days followed by 23.46 per cent of them who got training for fifteen days and 14.81% who attended thirty days training".

Kalita and Chabukdhara (2014) in their study on "Level of modernization of vegetable growers of Lakhimpur district of Assam' found that a huge number of respondents (42.50%) did not have any training exposure".

Adusei (2020) investigating the factors that "affect the adoption of organic agriculture in ASOKWA, KUMASI METROPOLIS found that effective extension monitoring and training were needed to enhance the adoption and sustainability of organic agriculture".

2.1.11 Sources of Information

Singh *et al*. (2004) in their study found that "maximum score (123) was reported by the respondents utilizing television in getting information of improved crop production technology followed by progressive farmer (94) and Radio (78) whereas agricultural scientist scored minimum".

Arneja *et al*. (2009) in their study on "Constraints in potato cultivation faced by the potato growers' found that 68.00 per cent of them had medium level of mass media exposure".

Patil *et al*. (2010) reported that "majority of organic vegetable growers were regularly watching agricultural programmes in television (73.57%), followed by radio (36.00%), newspaper (32.86%) and farm magazines (22.86%)".

Jha (2012) in his study found that "majority of the respondents (54.17%) had medium level of utilization of various information sources for adoption ofimproved agricultural practices".

Shailesh *et al*. (2013) conducted a study and found that "most of the vegetable growers (82.50%) hadmedium category of sources of information utilization".

Chavai *et al*. (2015) in their study on "Adoption of potato production technology by the farmers of Maharashtra' found that 58.18 per cent of the respondents had medium level of utilization ofdifferent information sources".

Kharumnuid *et al*. (2021) in their study on "Potato production for nutritional security and doubling farmers' income concluded that people should be made aware of the nutritional value of potatoes through mass media and other awareness programmes".

2.1.12 Extension contact

Caswell (2001) reported that "extension contacts are considered to be important tools for promoting the adoption of new production practices".

Kumar (2001) found that "maximum technological gap existed among the farmers having low extension contacts and the comparatively less technological gap was noticed among farmers having high extension contacts. The technological gap ranged from 37.00 per cent to 81.08 per cent, 19.67 to 72.09 per cent and 6.14 per cent to 59.82 per cent for farmers with low, medium and high extension contacts".

Kumar (2009) found that "majority of the tribal farmers had medium contact with extension personnel".

Kafle and Shah (2012) in their study on "Adoption of improved potato varieties in Nepal' found that Farmers' access to extension agents (29.00%) was low".

Singh (2014) in his study "On use of communication sources used by farmers in Abhanpur block of Raipur district of Chhattisgarh state' found that maximum number of the respondents (46.15%) had medium level of contact with extension agencies".

Islam *et al*. (2021) in their study on "knowledge level about important production practices of high density apple growers of Kashmir Valley found that extension contact had significant relationship with the knowledge level of the respondents".

Kumar *et al*. (2021) in their study on “socio-economic profile of sugarcane growers in east Champaran district of Bihar revealed that majority (60%) of the respondents had medium level of contact with the extension personnel’s”.

2.1.13 Scientific orientation

Jaisawal *et al.* (2013) in their study found that “higher per percentage of the vegetable growers (45.83%) had high scientific orientation about the improved vegetable production technology”.

Kalita and Chabukdhara (2014) in their study on “Level of modernization of vegetable growers of Lakhimpur district of Assam’ found that majority of the respondents (74.17%) had medium level scientific orientation”.

Sharma *et al*. (2014) conducted a study on “entrepreneurial behaviour of potato growers in Kohima district of Nagaland and found that majority of the potato cultivators had medium level of knowledge about scientific orientation programme”.

Kulkarni and Jahagirdar (2015) in their study on “Technological gap in recommended cultivation practices in Dharwad district, Karnataka’ found that 38.33 per cent of the respondents had medium level of scientific orientation category, followed by 31.66 per cent and 30.00 per cent of the respondents who had high and low level of scientific orientation, respectively. It might be due to this reason that respondents with higher scientific orientation had less technological gap”.

Islam *et al*. (2021) in their study on “knowledge level about important production practices of high density apple growers of Kashmir Valley found that scientific orientation had significant relationship with the knowledge level of the respondents”.

2.1.14 Social participation

Srivastava *et al*. (2012) in their study on “Assessment of the level of knowledge and training needs of potato growing tribal farmers of Meghalaya’reportedthat half of the respondents possessed membership in some organizations like Self Help Group, church or youth club”.

Jaisawal *et al*. (2013) in their study on “Training need of vegetable growers’ found that 61.67 per cent vegetable growers had low social participation”.

Chavai *et al*. (2015) in their study on “Adoption of potato production technology by the farmers of Maharashtra’ found that 57.29 per cent had medium level of social participation”.

Sharma *et al*. (2016) found “16.67 per cent trained farmers had low social participation and remaining 22.22 per cent trained farmers had high level of social participation. In case of untrained farmers, majority (43.33%) had low social participation”.

Shree *et al*. (2020) in their study on “socio-economic assessment of farm women in Rice cultivation found that rice farmers had very low social participation”.

2.1.15 Marketing channel

Baksi and Banerjee (1983) in their study in Burdwan District, West Bengal, found that “two potato marketing channels were predominant i.e., (i) producer-wholesaler-retailer-consumer and (ii) producer-cold storage-wholesaler-retailer-consumer. This system was considered inefficient in view of excessive profits for middlemen. Traders used the cold storage facilities which further reduced the producer's share from 80.00 per cent to 50.00 per cent".

Banafar *et al.* (2006) "examines the marketing cost and price spread under different marketing channels in Ambikapur of Chhattisgarh in India. The most efficient marketing channel was found to be Channel II (producer-processors of wholesale dealers-consumer) and Channel I (producer-village merchant-wholesale dealers-consumers) was least efficient".

Cadilhon *et al.* (2006) in their study "synthesized research findings on supply chain arrangements and mechanisms in the business-to-business relationships encountered in supply chains distributing fresh vegetables to Ho Chi Minh City and found the five elements of good supply chain management practice which are reviewed the degrees in all of supply chains as strategies to achieve higher levels of performance, as all stakeholders in the fresh produce marketing channels - from small farmers and rural collectors to an urban Cash & Carry outlet and its customers in the catering industry - strive to reach a common goal of better performance".

Singh *et al.* (2009) conducted a study by "collected primary data from randomly selected 240 respondents scattered in eight villages of Mahendragarh and Bhiwani districts of Haryana and it was observed that gross returns and net returns were found higher on small farms as compared to medium and large farms in both the selected districts. Two major marketing channels observed were Channel-I: Producer - Commission agent - Oil-expeller/oil-miller - Retailer - Consumer, and Channel-II: Producer - Commission agent - Wholesaler - Oil-expeller / Oil-miller - Retailer - Consumer. Among both the channel-I is most prevalent route through which majority of the farmers sell more than three-fourth of their quantity sold in different markets of the area.

The share of producers in consumer's rupee under channel-I was almost the same in all the four markets".

Meena and Singh (2012) studied "the price spread and efficiency of marketing of pea in Rajasthan and found that the marketable surplus was higher on small farms (1314 q) followed by medium (1007 q) and large farms (743 q). There was no difference in marketable and marketed surplus of pea. There were two marketing channels used viz., (i), Producer - Commission agent cum wholesaler - Retailer - Consumer, and (ii) Producer - Village trader - Commission agent cum wholesaler - Retailer - Consumer. In channel-I producer's share was 67.65 per cent. Total marketing cost accounted for 13.29 per cent and marketing margins were 19.06 per cent of consumer's rupee in Jaipur mandi. In Bundi, producer's share was 68.18 per cent. Total marketing cost accounted for 12.73 per cent and marketing margins were 19.09 per cent of consumer's rupee. In channel-II, producer's share was 58.82 per cent. Total marketing cost accounted for 15.07 per cent and marketing margins were 26.11 per cent of price paid by the consumer in Jaipur Mandi. In Bundi, producer's share was 57.57 per cent. Total marketing cost accounted for 11.33 per cent and marketing margins were 28.55 per cent of price paid by the consumer. Marketing efficiency was 2.09 and 1.43 in Jaipur mandi and 2.14 and 1.51 in Bundimandi for channel-I and channel-II, respectively. Hence, channel-I was more efficient for pea marketing".

Yadav (2013) studied "marketing pattern and price spread of major vegetable crops in Uttar Pradesh during 2009-2010 and foundthat Producers disposed of their surplus vegetables in three marketing channels, viz. channel I (producers-consumers), channel II (producers-retailers-consumers) and channel III (producers-wholesalers-retailers-consumers). Major share of the vegetable surplus was sold through marketing channel II (P-R-C), followed by channel III (P-W-R-C) and very small quantity in channel I (P-C). Producers' share of the price paid by the consumers varied between 97.2 to 67.4per cent in potato, 97 to 62.6per cent in tomato, 98 to 73.5 per cent in green pea and 95.3 to 56.6per cent in cauliflower. Marketing cost included for producers' share in consumers' rupees varied between 5.6 to 4.7per cent in cauliflower, 5.4 to 3per cent in tomato, 4.3 to 2.8per cent in potato and 2.9 to 2per cent in green pea crop. Retailers' margin varied between 7.7 to 9.7per cent in cauliflower, 7.3 to 8.8per cent in tomato, 6 to 7.1per cent in potato and 5.5 to 6.2per cent in green pea crops. Share of wholesaler varied between 13.5per cent in cauliflower, 11per cent in tomato, 9.3per cent in potato and 7.6per cent in green pea crops. About 13-21per cent of the producers' share moved to retailers' pocket, while 10-16per cent in wholesalers' account".

Kharumnuid *et al*. (2021) in their study on "Potato production for nutritional security and doubling farmers' income found that the government and policy makers should formulate and implement proper production and marketing strategies to ensure sustainable and higher production and remunerative prices for the farmers".

2.2 Concept of entrepreneurs and entrepreneurship

According to Mallya (2011) "Entrepreneurship is an economic activity whichemerges and functions in sociological and cultural environment. It could be conceived as an individual's free choice activity or a social group's occupation or profession".

According to Ram *et al*. (2012) "entrepreneurship helps reduce the concentration of economic power. It stimulates the equitable concentration of wealth, income and even political power in the interest of the country and also promotes the country's export trade which is an important ingredient in the economic development".

Peng *et al*. (2012) in their study on "entrepreneurial intentions and its influencing factors: a survey of the university students in Xi'an China' found that the perceived subjective norm of university students had significantly positive influence on their entrepreneurial attitude and the entrepreneurial self-efficacy while all these factors influence their entrepreneurial intentions significantly".

Gupta *et al*. (2014) conducted a study on "decision making ability of agri- entrepreneurs at Jammu and Kathua districts of J & K state, India and found that one-half (50.48%) of the agri-entrepreneurs were in the high category of decision making ability followed by medium (46.19%) and low (3.33%) levels. Majority (76.67%) of vegetable entrepreneurs had high level of decision making ability. Majority (61.43%) of entrepreneurs had not received any training".

Wanole (2018) opined that "an entrepreneur is a person who initiates, organizes, manages and controls the occurrence of a venture that merge the components of manufacturing to provide products and facility in any section".

Kumar and Poonam (2019) defined an entrepreneur as someone who produces for the market.

Khode and Palsingh (2021) found that "trained persons had higher entrepreneurial behavior as compared to untrained persons and the multiple regression co-efficient had also underlined training participants as an important variable contributing towards entrepreneurial competencies of respondents".

2.3 Sustainability of potato cultivation practices

Swaminathan (1995) "identified 14 major dimensions of sustainable agriculture; and according to him, sustainable agricultural technology should be technologically appropriate, economically feasible and viable, environmentally sound, stable over the long run, efficient in resource use, locally adaptable, socially acceptable and sustainable, implementable in existing political set-up and bureaucratic structure, culturally desirable, renewable, equitable and productive".

Hegde (2000) reported that "sustainable agriculture is a set of farming practices which can continue to maintain the farm productivity, efficiency and productivity in the long run, without depleting the natural resources and environment".

Kumaraswamy (2001) enumerated "the principles of sustainable agriculture as follows:

1) Conservation of natural resources like soil and water is an essential part

2) Cost effective environment friendly weed control measures

3) Efficient soil oriented and crop oriented water management

4) Environment protection

5) High yielding and high quality varieties of crops must be chosen and grown.

6) Improved agronomic practices from land preparation to efficient harvest technology must be adopted.

7) Integrated soil fertility management practices to improve the physical, chemical and biological properties of the soil using organic manures, fertilizers and bio fertilizer must be followed".

Paracchini *et al*. (2011) in his study on "aggregation framework to link indicators associated with multifunctional land use to the stakeholder evaluation of policy option used multi scale framework for measuring sustainability including three dimensions viz., economic, social and environmental".

Pawelzik and Möller (2014) studied "the sustainable potato production worldwide, wherein organic and conventional potato productions were assessed by means of key indicators for sustainability. These indicators were fertility management and crop protection, yield level, tuber quality and environmental impact. The evaluation of several studies showed that each system has advantages and disadvantages. None of the production systems is per se more sustainable than the other. Each of them has potential for improvement of the system performance".

Christine *et al*. (2015) in their study on "sustainable agriculture and climate change with respect to potatoes (*Solanum tuberosum* L.) and bush beans (*Phaseolus vulgaris* L.) for improved food security and resilience in a Canadian community found that potatoes and bush beans could be grown successfully in the subarctic without the use of greenhouses with yields comparable to more conventional high-input agricultural methods. In subarctic Canada, sustainable local food production can help to promote social capital, healthier lifestyles, and food security".

Khan *el al*. (2020) in their study on "trends and perspectives of sustainable potato production in ALIGARH district of INDIA found that sustainability of potato production in the district was directly associated with the socio-economic growth of farmers".

2.4 Knowledge and attitude of potato farmers towards sustainable practices of potato farming

2.4.1 Knowledge on sustainable farming practices

Bagheri (2010) conducted a study and “the results of correlation analysis revealed that there was positive significant relationship between knowledge and perceptions of farmers about sustainable agriculture”.

Sadati *et al*. (2010) in their study on’Farmer’s Attitude on Sustainable Agriculture and its Determinants: A Case Study in Behbahan County of Iran’ showed that majority of farmers had low and very low knowledge about sustainable agriculture (52.4%) and 53.8 of farmers had low and very low level use of methods of sustainable agriculture”.

Joneydi (2012) in his study shows that “there is a positive and significant relationship between age, farming experience, type of agriculture, agricultural land area, and area of cultivated land, ecological characteristics, social status and knowledge”.

Srivastava *et al*. (2012) assessed the “level of knowledge and training needs of potato growing tribal farmers of Meghalaya and foundthat 65.3 per cent potato growers had medium level of knowledge in land preparation and planting followed by 24.60 per cent and 10.00 per cent of the respondents with low and high level of knowledge respectively. Around 64.60 per cent respondents had medium level of knowledge regarding fertilizer and manure application followed by 26per cent and 9.3per cent of the respondents with low and high level of knowledge respectively. As regard to intercultural operation and irrigation management nearly 60.6 per cent respondents had medium level of knowledge while 21.3per cent and 18per cent of the respondents had low and high level of knowledge respectively. Nearly 70.6per cent respondents had medium level of knowledge regarding plant protection measures followed by 26 per cent and 3.3 per cent of the respondents with low and high level of knowledge respectively. Nearly 63.3 per cent respondents had medium level of knowledge in harvesting and post-harvest care followed by 23.30 per cent and

13.30 per cent of the respondents with low and high level of knowledge respectively”.

Pawelzik and Möller (2014) found that “sustainable agriculture integrates environmental health, economic profitability as well as social and economic equity. Worldwide interest in potato as a valuable food security crop is increasing, because it is not globally traded, the prices are determined by local production costs and due to its beneficial impact on human nutrition. In the present review, organic and conventional potato productions were assessed by means of key indicators for sustainability. These indicators were fertility management and crop protection, yield level, tuber quality and environmental impact. The evaluation of several studies shows that each system has advantages and disadvantages. None of the production systems is per se more sustainable than the other. Each of them has potential for improvement of the system performance. In organic production, for example, by establishment of improved fertilization (e.g., application of more N-efficient base organic fertilizers) and crop management strategies (e.g., pre-sprouting of seed tubers, bio-based fungicides), in conventional farming by implementation of more target-oriented fertilization and pesticide spraying schedules. To meet the future challenges with increasing food demand while simultaneously decreasing its environmental impact, efforts on increasing the performance of both conventional and organic production systems, e.g., improving the nutrient use efficiency, are necessary”.

Hameed and Sawicka (2019) found “among the socio-economic variables, the level of education and occupation were the most important factors influencing the knowledge of a farmer-producer of potato with sustainable agricultural techniques in the studied area. The significant differences occurred between knowledge about potato cultivation for sustainable agricultural techniques according to variables in categories (age, level of education and profession). Only three independent variables had a significant link to the adoption of innovation in agriculture: source of income, level of education and occupation. The farmers were divided into three categories according to the knowledge of potato farmers about sustainable farming techniques. As it has been shown, only 27.6per centof the respondents were ranked in the low category of knowledge of potato farmer (100–129), whereas most respondents were placed in the medium category (130–159), which was 52.0per cent, and high category (160–189), which was 20.4per cent. This shows that the knowledge of potato farmers on sustainable farming techniques is medium with a tendency to low. The low popularity of association of Polish producers into producer groups and marketing groups may contribute to this state, which limits the impact on wholesale market recipients".

Hameed and Sawicka (2019) in their study on "Farmers' knowledge of sustainable potato cultivation techniques in Poland' and it was found that only 27.60 per cent of the respondents were ranked in the low category of knowledge of potato farmer (100–129), whereas most respondents were placed in the medium category (130–159), which was 52.0 per cent and high category (160–189), which was 20.40 per cent This shows that the knowledge of potato farmers on sustainable farming techniques is medium with a tendency to low".

Shree *et al*. (2020) in their study on "socio-economic assessment of farm women in Rice cultivation found that women farmers had high knowledge and participation in all activities related to agriculture".

Yenagi *et al*. (2020) in their study on "knowledge level of farmers about drip irrigation technology found that 22.50 per cent, 58.00 per cent and 19.50 per cent beneficiary farmers were in low, medium and high knowledge level regarding drip irrigation technology".

2.4.2 Attitude of farmers towards sustainable farming practices

Tatlıdil (2009) in his study revealed that “the higher the socio-economic status (more frequent contact with extension services, higher education, ownership of land, etc.) greater is the access to information, favorable attitude, andgreater is the perceived importance of sustainable agricultural practices”.

Bagheri (2010) in this study on “Potato farmers' perceptions of sustainable agriculture: the case of Ardabil province of Iran’ revealed that farmers had favourable attitude towards sustainable practices such as resource conservation, negative effects of agrochemicals, pests' invasion arising from successive cultivation. However, they had moderate attitude towards the negative environmental effects of modern agricultural technologies”.

Sadati *et al*. (2010) in their study on “Farmer’s Attitude on Sustainable Agriculture and its Determinants: A Case Study in Behbahan County of Iran’ analysed the attitude of farmers towards concepts of sustainable agriculture, and found that attitudes of 45.7per cent (n = 95) of respondents on sustainable agriculture was at the low level. In addition, 21.2per cent (n = 44) of respondents had high attitude and 18.7per cent of them (n = 39) had moderate attitude and 14.4per cent of them (n = 30) had very low attitude on the concepts of sustainable agriculture”.

Hameed and Sawicka (2017) in their study indicated that “the majority of the respondents (69.44%) had neutral attitudes and about 30.59 % of them had Favourable and Unfavourable attitudes towards sustainable agriculture practices”.

Hayran *et al*. (2018) in their research results showed that “a majority (94.14%; n=225) of the farmers had favourable perception towards sustainable agriculture in Mersin. In addition, the study showed that farmers highly interested in protecting natural resources for future generations. They had concern about negative effects of agrochemicals on human and animal health. Besides, they had positive perceptions about sustainable agricultural practices such as application of organic fertilizers, application of cover crops, crop rotation and diversification, application of soil tests before applying fertilizers, not burning of plant residues after harvest etc".

Verma *et al*. (2018) in their study reported that "majority (40.83%) of the respondents had low category of attitude towards improved technology of sustainable agriculture".

Ntawuruhunga *et al*. (2020) in their study on "farmer's knowledge, attitudes and practices (KAP) on production of African indigenous vegetables in Kenya found that farmers showed positive attitude towards African indigenous vegetables".

2.5 Factors affecting entrepreneurial behaviour and sustainability of potato farming.

Khanka (2009) reported about "the personal characteristics of successful entrepreneurs as hard work, desire for high achievement, high optimism, independence, foresight, good organising capacity and innovativeness. According to the author, success of a small enterprise to a great extent was attributed to the success of the entrepreneurial behavior".

Bagheri (2010) in his study on "Potato farmers' perceptions of sustainable agriculture: the case of Ardabil province of Iran' and found that lack of functional literacy implies that application of sustainable practices is not easy. Most of them were working in their own farms and according to Carolan (2006), there is a suitable situation for applying sustainable practices. Land fragmentation is one of the main obstacles of sustainability. In this case, respondent had about 4.4 pieces of farmlands. Farm diversification is a main component influencing sustainability".

Joneydi (2012) "in multivariable regression analysis for identifying the influencing factors to sustainability revealed that variables viz., production, attitude to sustainable agriculture, the amount of intake facilities, social association, and relational properties were positively correlated with the attitudes towards sustainable agricultural production".

Jha (2012) in his study of "entrepreneurial behaviour of farmers in Dimapur district of Nagaland revealed that majority of thempossessed high level of self-confidence, low level of scientific orientation and medium level of knowledge about improved practices of pineapple .The variables namely-indigenous knowledge, farm decision making ability, self-confidence and economic motivation were found important in influencing the entrepreneurial attributes of the pineapple growers".

Seemaprakalpa and Arora (2012) studied "the level of achievement motivation of 60 women entrepreneurs in Agra district of Uttar Pradesh and stated that majority of the entrepreneurs were possessing moderate achievement motivation".

Joneydi (2012) in his study reported that "variables i.e., production, attitude, the amount of intake facilities, social association, influenced sustainability of farming practices".

Gupta *et al*. (2014) in their investigation on "210 agri-entrepreneurs thirty each from seven agri-enterprise namely vegetable, strawberry, dairy farming, mushroom growing, bee-keeping, poultry farming and flower in Jammu and Kathua districts of Jammu and Kashmir found that that high level of decision making ability of agri- entrepreneurs might be due to individual ownership, high achievement motivation and high risk taking capacity. The appropriate decisions with regard to finalizing different technical, financial and marketing aspects at right time, results in the progress of the enterprise".

Sharma *et al*. (2014) in their study on “entrepreneurial behaviour of potato growers in Kohima district of Nagaland found that majority of the potato cultivators had medium level of knowledge about improved package of practices of potato cultivation, farm decision making ability, family size, economic motivation, marketing orientation programme and scientific orientation programme”.

Abdullah (2015) found that “Sustainability index for potato farming systems ranged from 39.6 to 64.8. Ecological dimension (52.4), the economic dimension (64.8), institutional dimension (56.5), and the technological dimension (56.7) which was quite sustainable, while social dimension (39.6) had less sustainable status”.

Barbeau *et al*. (2015) reported that “through the use of more sustainable agricultural practices, potatoes were successfully produced alongside bush beans in subarctic Ontario, Canada. Community members acknowledged the benefits of local food production and believed that there was a future for more sustainable food production in their community. Introducing local food production systems in northern Aboriginal communities worldwide may foster empowerment and enhance community resilience toward future challenges such as climate change”.

Ratang *et al*. (2016) in their study on “entrepreneurship development and market orientation found that variables viewing and taking opportunities, systematic planning, the strategy to influence, confidence, persuasive ability, coordination with related agencies, didn’t have a significant effect on the mind-set of farmers on entrepreneurship collectively. Variables that had a significant effect on the mind-set of farmers on entrepreneurship were: competitor orientation, consumers orientation, specificity, orientation on efficiency, work commitment, Focus on high performance levels, seeking information, persistence and initiative, they significantly and positively effect on the mind-set of farmers on entrepreneurship".

Chouhan *et al*. (2018) in his study showed that "majority (51%) of farmers had medium level of scientific orientation which influenced the entrepreneurial behaviour of farmers".

Chigadolli *et al*. (2019) in their study revealed that "majority of the farmers (47.50%) had medium level of adoption of improved technologies hindering acceptance of sustainable agricultural practices".

Kaimal *et al.* (2020) in their study on "entrepreneurial potential of agripreneurs in south Kerala found that principal component analysis on the dimensions of entrepreneurial potential, based on Eigen vectors revealed that the three dimensions viz., entrepreneurial motivation, management competencies and social competencies had influenced the entrepreneurial potential of the agripreneurs".

2.6 Constraints faced by the farmers in cultivation and management of crops

Meena *et al*. (2009) in their study stated that "the farmers faced many ecological, technological, economical, sociological and psychological problems which make them unable to adopt the innovative technologies of arid horticulture".

Bagheri (2010) found "land fragmentation is one of the main obstacles of sustainability. In this case, respondent had about 4.4 pieces of farmlands. Farm diversification is a main component of sustainability".

Lal *et al*. (2011) in their study on "constraints perceived by the farmers in adoption of potato technology found that involvement of middle man, cheating by the traders, low sale price of potato, shortage of electricity, gluts, poor quality and adulterated fungicides, lack of cold storage facilities, low risk bearing ability of the potato farmers, lack of motivation from SDA and State Department of Horticulture and unavailability of good quality potato seed to the farmers were the most serious constraints".

Nath and Biswas (2011) conducted a study on "production constraints of vegetable cultivation in West Tripura and found that out of the technological constraints; lack of knowledge of scientific crop production ranked I (79.52%), lack of frequent visit by extension personnel to villages ranked II (76.67%) and poor fertility of soil ranked III (72.38%). Again, as regards to the infrastructural constraints; less cultivable land ranked I (92.86%), non-availability of quality seed ranked II (90.48%) and Non-availability of processing industries (value addition) ranked III (85.23%) whereas, out of the economic constraints; non-availability of labour during peak period ranked I (91.42%), non-availability of timely credit facilities ranked II (83.33%) and high cost of agricultural chemicals ranked III (74.28%)".

Biswas and Nath (2013) conducted study on "constraints in adoption of recommended true potato seed (TPS) production technology in Tripura andfound that lack of adoption of technology in large scale followed by lack of agricultural labour, lack of sufficient loan and low yield were reported as the major constraints. In case of technical constraints maximum number of respondents agreed with the fact about non availability of agricultural inputs".

Singh *et al.* (2013) indicated that "the major constraints in vegetable cultivation in Mizoram where productivity is low was due to the existing practice of jhum cultivation, poor water harvesting structures, mono-cropping, minimum use of biological, physical and chemical inputs and inadequate post harvest management and processing technologies".

Papang and Tripathi (2014) conducted a study on “the constraints faced by turmeric producers in Jaintia Hills District of Meghalaya and revealed that the major constraints faced by the farmers in production is the lack of pest management whereas the fluctuation in disposal price of turmeric ranks first among the marketing constraints faced by farmers”.

Basavaiah and Kallimani (2020) in their study on “constraints faced in the adoption of technologies by Chawki rearing centre entrepreneurs, revealed that shortage of farm labourers, scarcity of irrigation water, lack of technical guidance in pest and disease management, difficulty in harvesting leaf and shootlet alternatively and high labour wages were the major constraints in adoption of mulberry leaf production technologies, inadequate rearing space, scarcity of skilled workers, lack of space for supporting activities, lack of technical guidance to diagnose diseases and high wages of skilled workers were the major constraints in adoption of silkworm rearing technologies”.

Khan *et al*. (2020) in their study on “trends and perspectives of sustainable potato production in Aligarh district of India found that the potato farmers facing the constraints such as fluctuation in potato price, storage problems, potato seeds, irrigation, high price of diesel, didn’t get pesticides and fertilizers easily on subsidized rates. Many potato farmers’ especially small farmers stored a small portion of their crops but faced so many problems in cold storage”.

CHAPTER III

RESEARCH METHODOLOGY

RESEARCH METHODOLOGY

Research methodology is a way to systematically work out the research problem. It is the structural arrangement of the study for conducting research within the frame work of the objectives. It consist methods, tools, techniques and approaches for any research work. Methodology provides the building block, back bone of the process of enquiry and reasoning, data generation as well as processing. In total, research methodology is concerned with the objective verification of generalization which requires logical and systematic analysis of problems and formulating appropriate procedure to obtain evidence.

The research methods and procedures used for conducting the study are described into the following heads:

3.1 Research design
3.2 Locale of research
3.3 Sampling procedure
3.4 Selection of variables
3.5 Tools and techniques for data collection
3.6 Hypothesis formulation
3.7 Analysis of data

3.1 RESEARCH DESIGN

According to Kerlinger (1995), “research design is the plan, structure and strategy of investigations so as to obtain answers to research question to control variance”.

The research design helps the researcher to test the hypothesis by reaching valid and objective conclusions regarding the relationships between independent and dependent variables. It enables the researcher to arrive at as valid, objective, accurate and economic solution of the given problem as possible. An appropriate research design helps to control the variables which may influence the research outcome, but in which the researcher is not interested at the moment. In short, a research design suggests to the researcher how to collect data to testing hypothesis, which variables should be treated as control variables, what methods of manipulation will be relevant in a particular situation, what types of statistical analyses should be performed, thus enabling the researcher to draw a valid and objective answer to the research problem. There are different types of research design which are – random observation study, exploratory or formulative study, descriptive research design, diagnostic study or analytical studies, survey method design, case study method design, experimental study design and evaluative study design. The basic factor in experimental study is the control over the subject of the study and artifice of the independent variable to study its effect upon the dependent variable. Experimental design classified into Chapin's and Greenwood's classification of experimental design where the former is further classified into cross-sectional experimental design, projected experimental design and ex-post-facto research design and the latter into trial and error experiment, controlled observation study, natural experiment, ex-post-facto experiment and laboratory experiment.

Ex-post-facto research design was used in the present research. It is the narration of the present situation as an effect of some previously acting casual factors and effort to trace back, over an interval of time to some assumed casual complex of which started operating at an earlier date.

3.2 Locale of research

The present study was conducted in North East India. North East India consists of states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. These states cover almost 9 per cent of the area and 4.3 per cent of the total production of India. “The area under potato in the region is153.93 thousand ha with a production of 1209.31 thousand MT. Although the yield level (7.85 MT) is quite low due to various reasons but the per capita availability of potato in the region is higher than at the national level” (NHB, 2018). Therefore North East India was selected purposively for the present study.

3.2.1 Selection of state

North East India consists of eight states. Among the eight states, Assam tops in area and production of potato having 102.87 thousand ha area with production of 720.97 thousand MT followed by Meghalaya having 18.92 thousand ha and production of 187.95 thousand MT, Tripura having 7.99 thousand ha and production of 144.53 thousand MT and Nagaland having 4.92 thousand ha and production of 65.102 thousand MT (NHB, 2018).In other four states area and production of potato is negligible. Thus, the above four states were selected having higher production and productivity of potato.

Assam

The state of Assam is located in the northeastern part of the country and is bound to the north by the kingdom of Bhutan and the state of Arunachal Pradesh, to the east by the states of Nagaland and Manipur, to the south by the statesof Mizoram and Tripura and to the west by Bangladesh and the states of Meghalaya and West Bengal. The name Assam is derived from the word *asama*, meaning “peerless” in the now extinct Ahom language. The neighboring states of Arunachal Pradesh, Nagaland, Mizoram, and Meghalaya

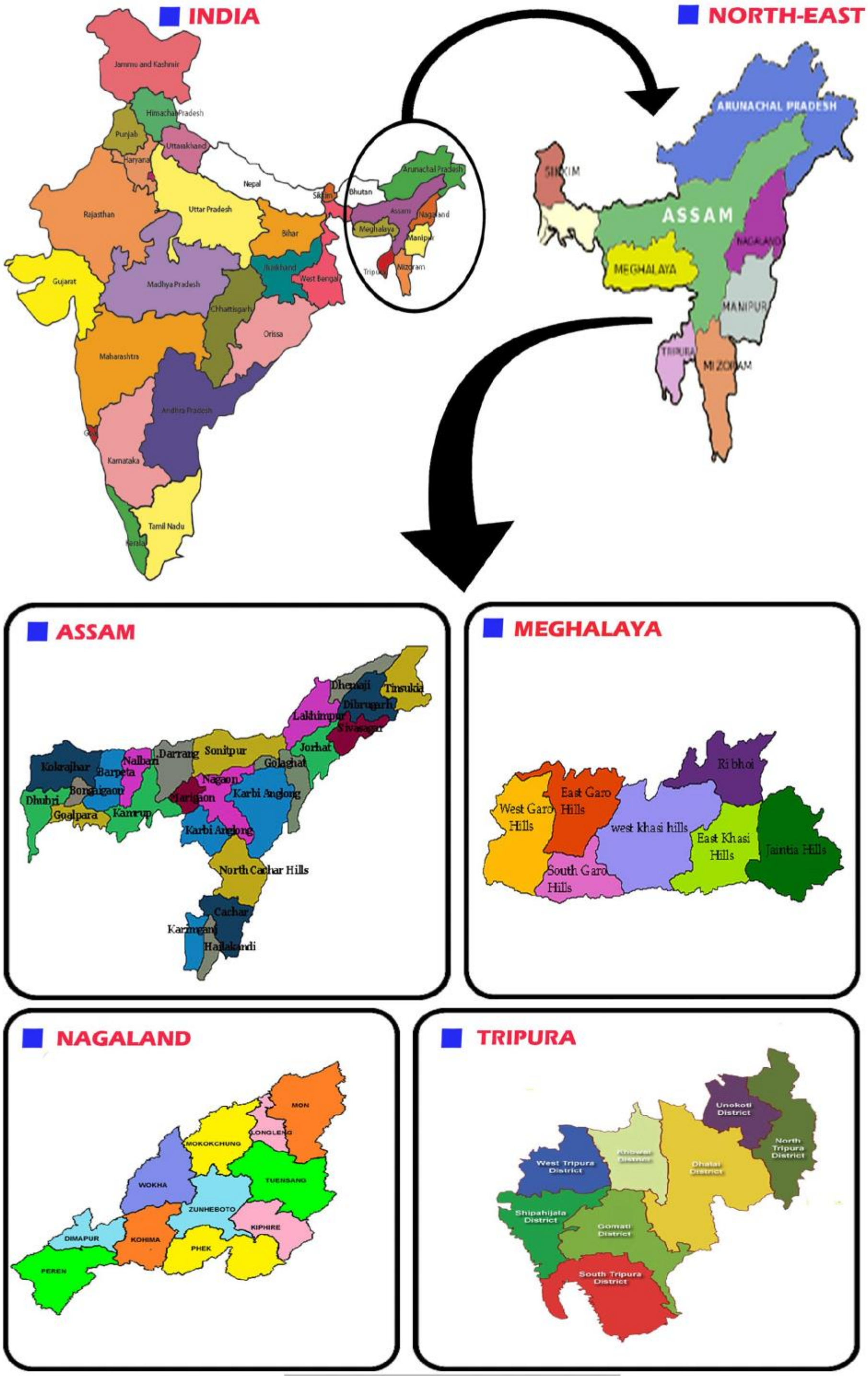

Fig 3.2.1: Selection of States

were once a part of Assam. The capital, formerly Shillong (now the capital of Meghalaya), was shifted to Dispur, a suburb of Guwahati, in 1972. Total geographical area of Assam is 78,438 square km and population is 31,169,272 (2011 census). "Assam, which is shaped roughly like a Y lay on its side, is a land of plains and river valleys. The state has three principal physical regions: the Brahmaputra river valley in the north, the Barak River (upper Surma river) valley in the south, and the hilly region between Meghalaya (to the west) and Nagaland and Manipur (to the east) in the south-central part of the state. Of those regions, the Brahmaputra River valley is the largest. According to hindu mythology, the Brahmaputra rises as the son of the god Brahmafrom a sacred pool known as the Brahmakund, in neighboring Arunachal Pradesh. The river enters Assam near Sadiya in the extreme northeast and runs westward through the length of Assam for nearly 450 miles (725 km) before turning south to enter the plains of Bangladesh. Studded with low, isolated hills and ridges that rise abruptly from the plain, the valley is rarely more than 50 miles (80 km) wide and is surrounded on all sides, except on the west, by mountains. Numerous streams and rivulets that flow from the neighboring hills empty into the Brahmaputra. Although only a small portion of the Barak River valley lies within Assam's borders, it nevertheless forms an extensive lowland area that is important for agriculture in the state's southern region" (Annonymous, 2020a).

"Average temperatures in Assam range from high in the upper 90s F (about 36 °C) in August to low in the mid-40s F (about 7 °C) in January. The cool season generally lasts from October to February and is marked by fogs and brief showers. The state escapes the normal Indian hot, dry season. Although some rain occurs from March through May, the heaviest precipitation comes with the southwest monsoon, which arrives in June, stays through September, and often causes widespread and destructive flooding. Annual rainfall in Assam is not only the highest in the country but also ranks among the highest in the world; its annual average rainfall varies from about

70 inches (1,800 mm) in the west to more than 120 inches (3,000 mm) in the east. In the early 21st century about one-third of Assam was covered with various types of woodlands, including tropical evergreen and deciduous forests, broad-leaved hill forests, pine forests, and swamp forests, as well as grasslands. Assam is home to some 75 species of trees, many of which have commercial value. Sal (*Shorearobusta*) and hollong (*Dipterocarpusrhetusus*) trees are among the most bountiful of the hardwoods. Bamboo, orchids, and ferns are also abundant. Assam has numerous wildlife sanctuaries, the most prominent of which are two UNESCO World Heritage sites—the Kaziranga National Park (designated in 1985), on the bank of the Brahmaputra River, and the Manas Wildlife Sanctuary (designated in 1992), near the border with Bhutan. Both are refuges for the fast-disappearing Indian one-horned rhinoceros, and the sanctuary at Manas is known especially for its tigers and leopards. Among the other notable inhabitants of Assam's forests are elephants, gaurs (wild oxen), wild pigs, various species of deer, and primates, such as langurs and hoolock gibbons. Common birds include cormorants, herons, ducks, and other water birds, as well as warblers, thrushes, owls, and peacocks. Hornbills are characteristic of Assam, although they are endangered in some areas. The state also has dozens of species of reptiles, including poisonous snakes, such as kraits, cobras, and vipers; an array of lizards, skinks, and geckos; and many types of turtles" (Annonymous, 2020a).

"The people of the plains of the Brahmaputra and Barak valleys are mainly of Indo-Iranian ancestry. By the time of their arrival in the region, however, the local Aryan peoples had become intermixed with Asiatic peoples. The Ahom people, who arrived in the region from mainland Southeast Asia during the 13th century, ultimately stem from Yunnan province of southern China. A significant minority of the population consists of rural indigenous peoples who fall outside the Indian caste system; as such, they are officially designated as Scheduled

Tribes. The Bodo constitute the largest of these groups. Most of the Scheduled Tribes live in the south-central hill region and are of Asiatic descent. Assamese, an Indo-Aryan language, is the official and principal language of the state, and an unbroken record of Assamese literary history is traceable from the 14th century. Tibeto-Burman languages are spoken by most of the Scheduled Tribes, although the Khasi people speak an Austroasiatic tongue; some groups have adopted Assamese as their first language. The people in the Barak valley in southern Assam mostly speak Bengali (also called Bangla), which, like Assamese, is an Indo-Aryan language" (Annonymous, 2020a).

"About three-fifths of the Assamese are Hindus, the majority of whom follow Vaishnavism, which venerates the deity Vishnu. Roughly one-third of the population practices Islam, most Muslims being settlers from Bangladesh or converts from the lower strata of Hindu society. Although many of the Scheduled Tribes have converted to Christianity, some continue to practice traditional local religions; the Mikir and Kachari peoples are mostly Hindus" (Annonymous, 2020a).

"Agriculture is of basic importance to Assam, engaging about half of the total working population and generating roughly one-third of the state's gross product. Rice accounts for more than two-thirds of the sown area. Tea and jute, widely cultivated in the Brahmaputra valley, are important foreign-exchange earners. Assam grows a large portion of the country's tea. Other crops include oilseeds, pulses (legumes, such as peas, beans, or lentils), corn (maize), sugarcane, rape (an oil-yielding plant, the leaves of which are used for fodder), mustard, potatoes, and fruits. Through improved cultivation methods, some farms yield more than one crop per year. Livestock and dairy farming have shown moderate growth since the late 20th century, largely promoted by the government. Nevertheless, those activities remain but small contributors to the state's economy. Sericulture (raising of silk worms), on the other hand, is well established, and Assam is a major producer of silk" (Annonymous, 2020a)

Meghalaya

"The state of Meghalaya is located in the northeastern part of the India country. It is bound by the state of Assam to the north and northeast and by Bangladesh to the south and southwest. The state capital is the hill town of Shillong, located in east-central Meghalaya. Meghalaya—*alaya* ("abode") and *megha* ("of the clouds")—occupies a mountainous plateau of great scenic beauty. It became a state in 1972. It has an area of 8,660 square miles (22,429 square km) with population of 2,964007" (2011 census, GoI).

"The climate of Meghalaya is generally mild. In August the mean temperature of Shillong (in the Khasi Hills) is low 70s F (about 21–23 °C) and it falls to 40s F (about 8–10 °C) in January. One of the world's wettest regions is found in Meghalaya – 'Cherrapunji', which has an average annual precipitation of about 450 inches (11,430 mm) during monsoon season (from May to September). (Rainfall at Cherrapunji may be exceeded, however, by that at Mawsynram, a village directly west of Cherrapunji, where rainfall totals of some 700 inches [17,800 mm] per year have been recorded.) Annual rainfall in Shillong, which is only about 50 miles (80 km) from Cherrapunji, is about 90 inches (2,290 mm). During the winter months (December to February), the climate is relatively dry" (Anonymous, 2020b).

"Meghalaya is blanketed in lush forests, and pines, sals, and bamboo are plentiful. Other species include oak, birch, beech, and magnolia. Elephants, tigers, leopards, deer, wild pigs, gaurs (wild bison), mithan (or gayals, the domesticated form of the gaur), wolves, anteaters, monkeys, apes, squirrels, snakes, hares, and sambar deer are all found in the state. Birds in Meghalaya include peacocks, partridges, pigeons, hornbills, jungle fowls, mynas, and parrots" (Anonymous, 2020b).

Most of the inhabitants of Meghalaya are Tibeto-Burman (Garos) or Mon-Khmer (Khasis) in origin, and their languages and dialects belong to these groups. The Khasis are the only people in India who speak a Mon-Khmer language. Khasi and Garo along with Jaintia and English are the state's official languages; other languages spoken in the state include Pnar-Synteng, Nepali, and Haijong, as well as the plains languages of Bengali, Assamese, and Hindi. Shillong is the largest town; other urban centres, listed in descending order of population, include Tura, Mawlai, Nongthymmai, and Jowai" (Anonymous, 2020b).

"Agriculture is the dominant economic activity of the state. The main crops grown in Meghalaya are rice, millet, corn (maize), potatoes, pepper, chilies, cotton, ginger, jute, betel nuts, fruits (including oranges and mangoes), and vegetables. Communal land ownership is common, but *jhum* (shifting cultivation) is quite prevalent" (Anonymous, 2020b).

"Meghalaya is rich in tribal culture and folklore. Drinking and dancing to the accompaniment of music from *singa*s (buffalo horns), bamboo flutes, and drums are integral parts of religious ceremonies and social functions. Marriages are exogamous. However, the advent of Christianity in the mid-19th century, along with its strict morality, disrupted many of the tribal and communal institutions" (Anonymous, 2020b).

"Apart from accounts of the more important Khasi kingdoms in the chronicles of the neighbouring Ahoms and Kacharis, little is known of Meghalaya prior to the British period. In the early 19th century, however, the British desire to build a road through the region to link Bengal and Assam led to a treaty (1827) with the ruler (*syiem*) of the Khasi principality of Nonkhlaw.

Opponents of the treaty persuaded the *syiem* to repudiate it in 1829, and a subsequent attack on the British led inevitably to British military operations against the Khasis. By the mid-1830s, most of the local rulers had submitted to the British. For the next century, the British exercised political control over the area, then known as the Garrows and Cossiya (Khasi) States, but the tribes, left to themselves, were able to preserve their traditional way of life in seclusion"(Anonymous, 2020b).

Nagaland

"The state of Nagaland, lying in the hills and mountains of the Northeastern part of the country is one of the smaller states of India (26.1584° N, 94.5624° E.) Nagaland is bounded by the Indian states of Arunachal Pradesh to the northeast, Manipur to the south, and Assam to the west and northwest and the country of Myanmar (Burma) to the east. The state capital is Kohima, located in the southern part of Nagaland. Total area of Nagaland is 16,579 square km and population is 1,978,502(2011 Census). Nagaland has a monsoonal (wet-dry) climate. Annual rainfall averages between 1,800 to 2,500 mm and is concentrated in the months of the southwest monsoon (May to September). Average temperatures decrease with greater elevation; in the summer temperatures range from the low 70s F (about 21–23 °C) to the high 100s F (about 38–40 °C), while in the winter it drops below 40 °F (4 °C), though frost is common at higher elevations. Humidity levels are generally high throughout the state" (Annonymous, 2020c).

The Nagas, an Indo-Asiatic people, form more than 20 tribes, as well as numerous subtribes, and each one has a specific geographic distribution. Though they share many cultural traits, the tribes have maintained a high degree of isolation and lack cohesion as a single people. The Konyaks are the largest tribe, followed by the Aos, Tangkhuls, Semas, and Angamis. Other tribes include the Lothas, Sangtams, Phoms, Changs, Khiemnungams, Yimchungres, Zeliangs, Chakhesangs (Chokri), and Rengmas.

The Naga tribes lack a common language; there are about 60 spoken dialects, all belonging to the Sino-Tibetan language family. In some areas dialects vary even from village to village. Intertribal conversation generally is carried on through broken Assamese /Nagamese and many Nagas speak Hindi and English. English is the official language of the state.

In the 19th century, with the advent of British rule, Christianity was introduced, and Baptist missionaries became especially active in the region. As a result, the population is about two-thirds Christian, with Hindus and Muslims following in numbers of adherents. (Remains of the Hindu kingdom that was destroyed by the Ahom in the 16th century are at Dimapur [the ancient Kachari capital, on the eastern border of Nagaland facing Assam.)

“Agriculture employs about nine-tenths of the population. Rice, corn, small millets, pulses, oilseeds, fibres, sugarcane, potato, and tobacco are the principal crops. Nagaland, however, still has to depend on imports of food from neighboring states. The widespread practice of *jhum* has led to soil erosion and loss of soil fertility. Only the Angamis and Chakhesangs of the southern regions of Kohima use terracing and irrigation techniques. Traditional implements include the light hoe, the *dao* (a multipurpose heavy knife), and the sickle; except in the plains, the plough is not used. Forestry is also a primary source of income and employment” (Annonymous, 2020c).

“After India became independent in 1947, the Naga territory initially remained as a part of Assam. However, a strong nationalist movement began seeking a political union of the Naga tribes. In 1957, after an agreement was reached between Naga leaders and the Indian government, the Naga Hills region of Assam and the Tuensang frontier division to the northeast werebrought together under a single unit directly administered by the Indian government. Despite the agreement, unrest continued in the form of non-cooperation with the Indian government, non payment of taxes. A further accord reached at the Naga People's Convention meeting of July 1960 resolved that Nagaland should become a constituent state of the Indian union. Nagaland achieved statehood in 1963, and a democratically elected government took office in 1964" (Annonymous, 2020c).

Tripura

"**The state of Tripura**, an erstwhile princely state, became a part of the Indian union on 15th October, 1949. It was declared a union territory on November 1, 1957 and elevated to the status of a full-fledged state on January 21, 1972. The state covers an area of 10491.69 square km, lies between the north latitude 22 degrees 56' and 24 degrees 32' and between longitude 91 degrees 0' and 92 degrees 20' east, the West with its highest point at an elevation of 15 metres above MSL. Tripura is a state in North-East India which borders Bangladesh, Mizoram and Assam. It is surrounded by Bangladesh on its north, south and west. The length of its international border is 856 km (84.00% of its total border). It shares a 53 km long border with Assam and a 109 km long border with Mizoram. The state is connected with the rest of India by only one road (NH-44) that runs through the hills to the border of Karimganj district in Assam and then winds through the states of Meghalaya, Assam and North Bengal to Calcutta. The state has 8 administrative districts viz. West Tripura, Sepahijala, South Tripura, North Tripura, Unokoti, Khowai, Dhalai and Gomati. Tripura district lies approximately between latitude 23 degrees 16' to 24 degrees 14' north and longitude 91 degrees 09' east to 91 degrees 47' east" (Anonymous , 2020d)..

"Tripura is the 2nd smallest state in terms of area, but the 2nd most populous state in the North-Eastern (NE) region. Although the state is small with a population of only over three million, the social composition of the population of Tripura is diverse. In particular, around one-third of the population comprises people belonging to the Scheduled Tribes. Tripura is one of the most important states among the North-Eastern state because of higher production and productivity of horticultural crops. Although Tripura has very limited cultivable land but most of the horticultural crops like potato, chillies, okhra, brinjal, gourds, mango, jackfruits, pineapple, banana, lemon, tea, rubber and many more can be grown easily because of its suitable climate condition" (Anonymous , 2020d).

3.3 Sampling procedure

Sampling procedure for selection of respondents has been displayed in Fig 3.6

3.3.1 Selection of district

From each of the selected states one highest potato producing district was selected purposively for the study. Lakhimpur district of Assam state is having the highest potato production of 87,584 tonnes (Anonymous, 2019a), East Khasi Hills district of Meghalaya is having the highest potato production of 1,21,787 MT (Anonymous, 2019b), South Tripura district is the highest potato producing district of Tripura with potato production of 2,92,546 MT (Anonymous, 2019c) and Kohima district of Nagaland is the leading district in potato production of 15,050 MT (Annonymous, 2019 d)Thus, these four districts were selected purposively for the present study.

Lakhimpur District

The Lakhimpur district was a part of old Pragjyogtishpur during 7th and 8th centuries. Lakhimpur district is bounded on the north by Subansiri and Siang district of Arunachal Pradesh, on the east by a portion of Lohit district of

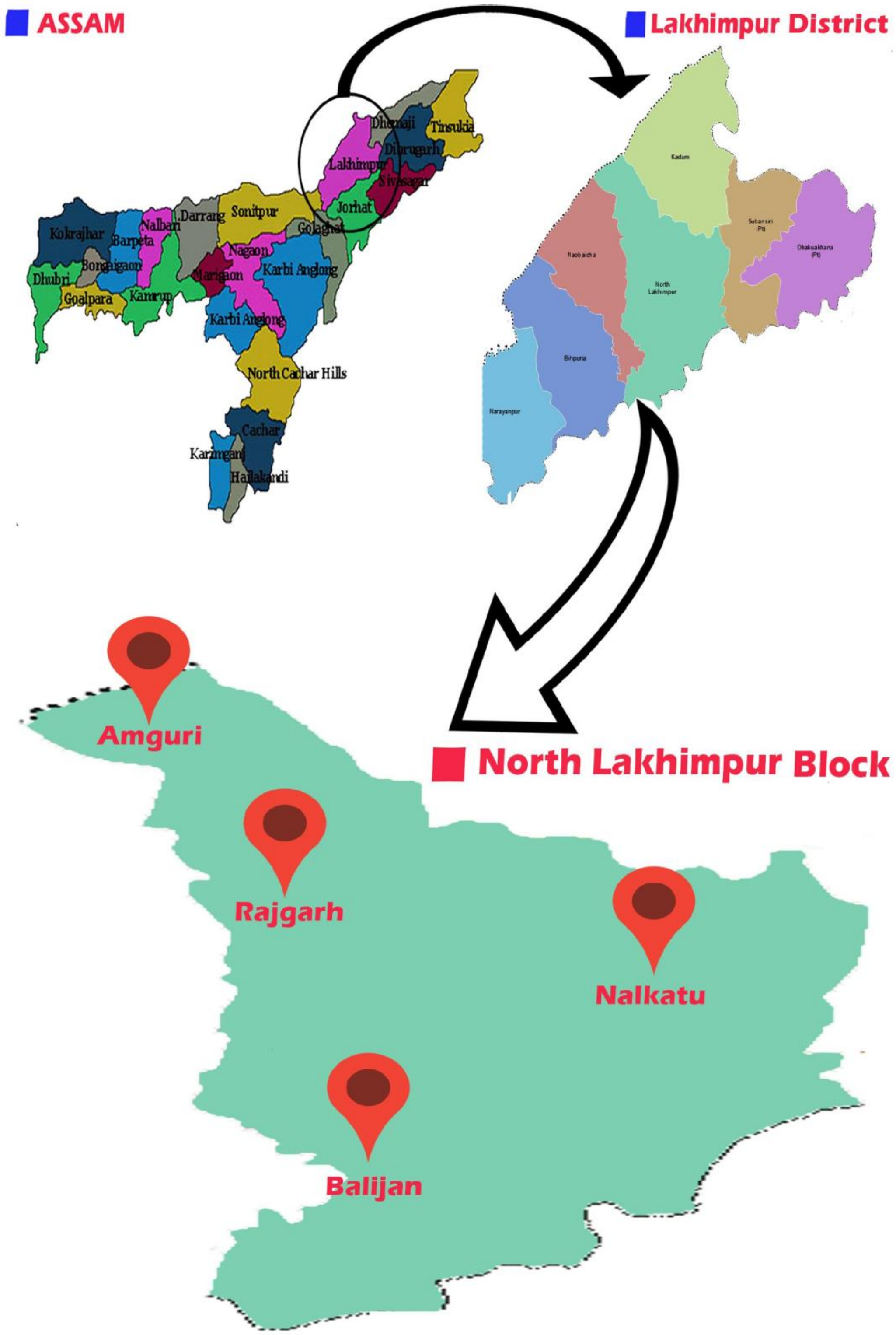

Fig 3.3.1a: Selection of Lakhimpur District from Assam.

Arunachal Pradesh and a part of Dhemaji district, on the south by Jorhat and on the west by Sonitpur district. It is said that the name of district was closely associated with Lakshmi, daughter of Monohar who ruled over a part of north bank of the river Brahmaputra. Lakshmi appeased Sun God by whom she had two sons - Santanu and Samanta. Santanu became Vaisnava and migrated to Nagaon and Samanta, a staunch follower of Saktapanth remained there and the place was named after their grandmother Lakshmi. It came to be known as Lakhimpur.

"The early history of the district can be traced only after 1228 A.D. Nothing definite is known prior to Ahom invasion. Source of information confines to fragmentary references in Mahabharata, the Puranas and theTantras and other similar records was the old capital of Lakhimpur district and all the rulers were Hindus who hailed from Pal dynasty. The Pal rulers ruled there when the formidable Chutiyas belonging as they were to the Tibeto-Burman origin took over the rule from them in about 11th century. TheChutiyas entered into Assam from North-East corner and look possession of the upper Brahmaputra valley. But confrontations with the Ahom rulers were on the rampage and as a result of continuous bickering with the Ahoms, the Chutiyas were Crushed down after some centuries. The Ahom, a 'shan' tribe who had descent from the Patkai region entered Sibasagar at about 360 years before. Thus Sibsagar district and Lakhimpur district along with the rest of Assam formed a part of the territories of the Ahom rulers. The edifice of the Ahom kingdom was greatly shaken when the high priests of the Moamorias, a Vaisnavite sect, raised their ugly heads against the reigning Ahom kings. The Ahom rulers managed to drive away the Moamorias by completely desolating them from the Lakhimpur district lying south of the Brahmaputra" (Anonymous, 2020 e). "The name Lakhimpur is believed to be originated from the word ***Lakshmi***, the goddess of prosperity. The district is mainly dependent upon agriculture and paddy. Paddy is regarded locally as ***Lakhimi***. The word ***pur*** means ***full***. Lakhimpur therefore means full of paddy or the place where paddies are grown abundantly. Besides, the soil of the district is alluvial and fertile for which crops flourish without use of any artificial manure or hard labour. Over and above fish, meat, vegetables, milk were abundant in this district. Others say that the word originated from ***Lakhsmi Devi***, the mother of Bhuyan Raja who was the descendent of King Arimatta. Total population of the district is 1,042,137. Lakhimpur District is situated on the North East corner of Assam and at the north bank of the River Brahmaputra. The district lies between 26º48' and 27º53' Northern latitude and 93º42' and 94º20' East longitude (approx.)It is bounded on the north by Siang and Papumpare district of Arunachal Pradesh and on the east by Dhemaji District and Subansiri river. The river Brahmaputra along with Majuli District stands on the southern side and Gahpur sub division of Biswanath district is on the West". (Annonymous, 2021)

East Khasi Hills District

The Khasi Hills District was divided into two districts, viz., the East Khasi Hills District and the West Khasi Hills District on 28th October 1976. On June 4th, 1992, East Khasi Hills District was further divided into two administrative districts of East Khasi Hills District and Ri-Bhoi District. Shillong is the districts headquarter of East Khasi Hills District. The district consists of 11(Eleven) Community and Rural Development blocks at present. East Khasi Hills District forms a central part of Meghalaya and covers a total geographical area of 2,748 Sq. Kms.. It lies approximately between 25°07" & 25°41" N Latitude and 91°21" & 92°09" E Longitude. The northern portion of the district is bounded by the plain of Ri-Bhoi District gradually rising to the rolling grasslands of the Shillong plateau interspersed with river valleys and then falls sharply in the Southern portion forming a deep

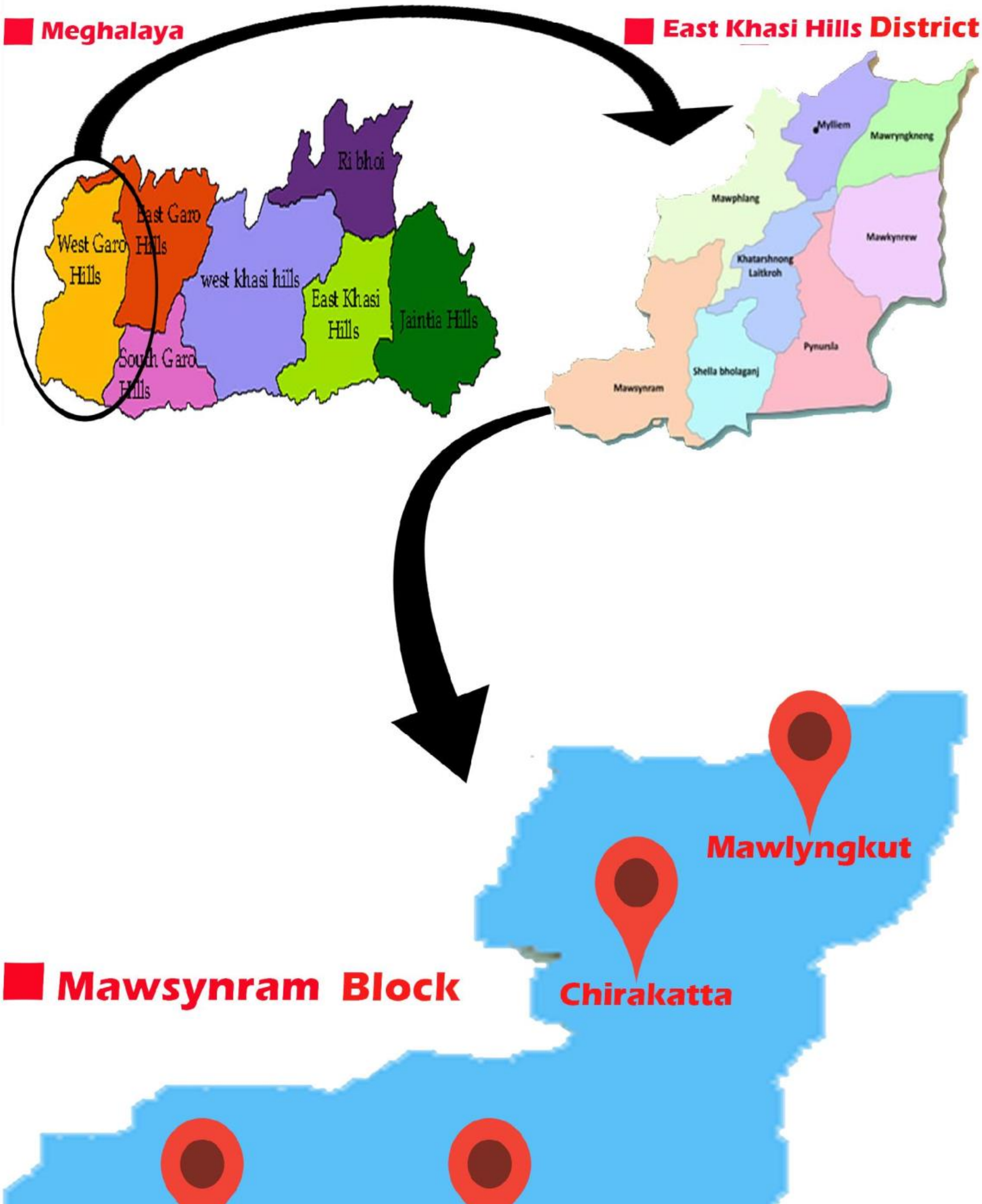

Fig 3.3.1b: Selection of East Khasi Hills District from Meghalaya

gorges and ravines in Mawsynram and Shella-Bholaganj, community and rural development block, bordering Bangladesh. The district is bound by the Jaintia Hills District to the east and the west by West Khasi Hills District.

“The East Khasi Hills District is mostly hilly with deep gorges and ravines on the southern portion. The most important physiographic features of the district is the Shillong Plateau interspersed with river valley, then fall sharply in the southern portion forming deep gorges and ravine in Mawsynram and Shella-Bholaganj bordering Bangladesh. Shillong peak lying 10 Kms. from the city, offer a panoramic view of the scenic country side and is also the highest point in the district as well as in the State. In the evening, the city light below appears like a star studded abyss” (Anonymous. 2020 f).

“The climate of the district ranges from temperate in the plateau region to the warmer tropical and sub-tropical pockets on the Northern and Southern regions. The whole of the district is influenced by the south-west monsoon which begins generally from May and continues till September. The weather is humid for the major portion of the year except for the relatively dry spell usually between December and March. The headquarter of the district, Shillong which is also the capital city of State, is connected to Guwahati and Silchar by NH 44 of 103 Kms. and 240 Kms. respectively. The nearest Rail head and airport are situated at Guwahati. There is an airstrip suitable for small aircrafts at Umroi which is 35 Kms. from Shillong. The agricultural and other products are transported by trucks, jeeps and tractors. Shillong is well connected with other parts of the State by motorable road. Similarly, all the block headquarters in the district are also connected by roads. However, the villages in the interior areas are poorly connected and transport services are inadequate” (Anonymous. 2020 f).

Kohima District

“Kohima, is a hilly district of India’s north eastern state of Nagaland, sharing its borders with Assam State and Dimapur District in the west, Phek district in the east, Manipur state and Peren district in the south and Wokha district in the north. One of the oldest among the twelve districts of the state, Kohima is the first seat of modern administration as the headquarters of Naga hills district (then under Assam) with the appointment of G.H. Damant as Political Officer in 1879. When Nagaland became a full-fledged state on 1st December, 1963, Kohima was christened as the capital of the state. Since then, parts of Kohima district have been carved out thrice – the first in 1973 when Phek district was created, then in 1998 Dimapur was carved out and declared as a separate district and it was in 2004 for the third time that Kohima district once again gave birth to one of the youngest districts in the state called Peren district. The name Kohima is so called because the British could not pronounce its original name “KEWHIRA” which is the name of the village where Kohima town is located. Kohima village also called ‘Bara Basti’ which is the second largest village in Asia forms the north-eastern part of Kohima urban area today” (Anonymous, 2020g).

Kohima, situated in the south at an altitude of 1444m above sea level, occupies pride of place as the capital city of Nagaland. Sharing its borders with Dimapur and Peren district in the west, Zunheboto and Phekdistrict in the east, Manipur state in the south and Wokhadistrict in the north. One of the oldest among the eleven districts of the state, Kohima is the first seat of modern administration as the headquarters of Naga Hills District (then under Assam).

“As of 2011 Census, Kohima district has a population of 267,988. Male constitute 138,966 of the population and females 129,022. Kohima has an

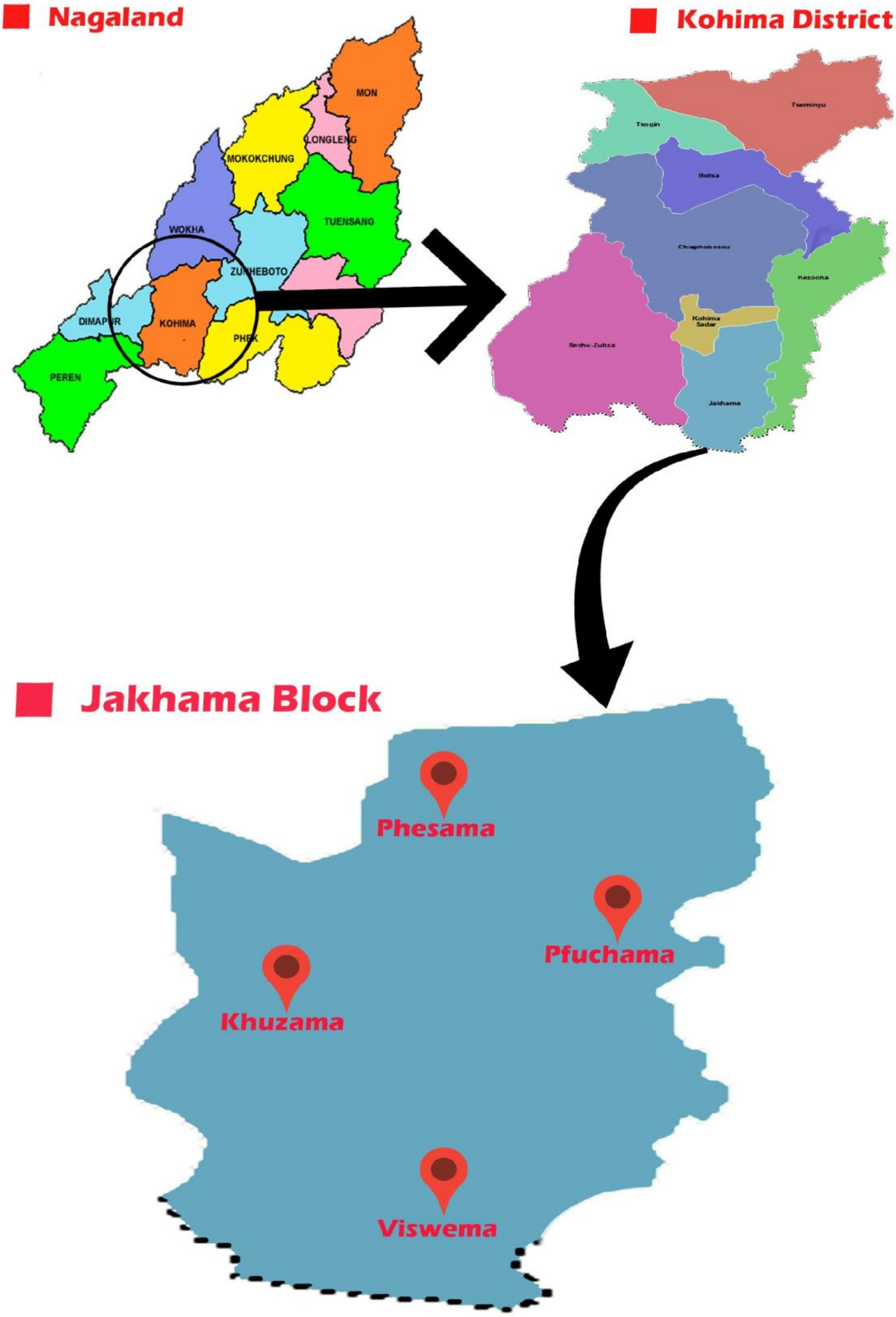

Fig 3.3.1c: Selection of Kohima District from Nagaland

average literacy rate of 85.23per cent, higher than the national average of 74.04 per cent: male literacy is 88.69 per cent and female literacy is 81.48 per cent. In Kohima, 36,286 of the population are under 6 years of age with boys constituting 18,297 of the population and girls, 18,007. The main indigenous inhabitants of Kohima district are the Angami Nagas and the Rengma Nagas. But Kohima being the capital city, it is a cosmopolitan city with all the tribes of Nagaland as well as mainland India residing here" (Anonymous, 2020g).

"Kohima features a more moderate version of a humid subtropical climate. Kohima has a pleasant and moderate climate – not too cold in winters and pleasant summers. December and January are the coldest months when frost occurs and in the higher altitudes, snowfall occurs occasionally. During peak summer months from July-August, temperature ranges an average of 80-90 fahrenheit. Heavy rainfall occurs during summer. Kohima is located at 25º40'N 94º07'E 25.67ºN 94.12ºE and covers an area of 1,463 sq. km; with a density of 213 per sq. km. Kohima town is located on the top of a high ridge and the town serpentines all along the top of the surrounding mountain ranges" (Anonymous, 2020g).

South Tripura District

"The South Tripura district with its head quarter is at Belonia. The district lies between latitude and longitude of 23.2317° N, 91.5596°, created with the objective of ensuring better delivery of public services to a population of 4, 53,079, a major chunk of whom live in rural areas. This district has 3 Sub-divisions, 8 RD blocks, 1 AMC, 2 Nagar Pachayats, 90 GPs and 70 ADC villages. The climate in the area is characterized by moderate temperature and is highly humid in nature. There are three prominent seasons summer, rainy and winter. The summer season spans from March to May and is followed by SW monsoon lasting till September. Alluvium and Sandstone are the two

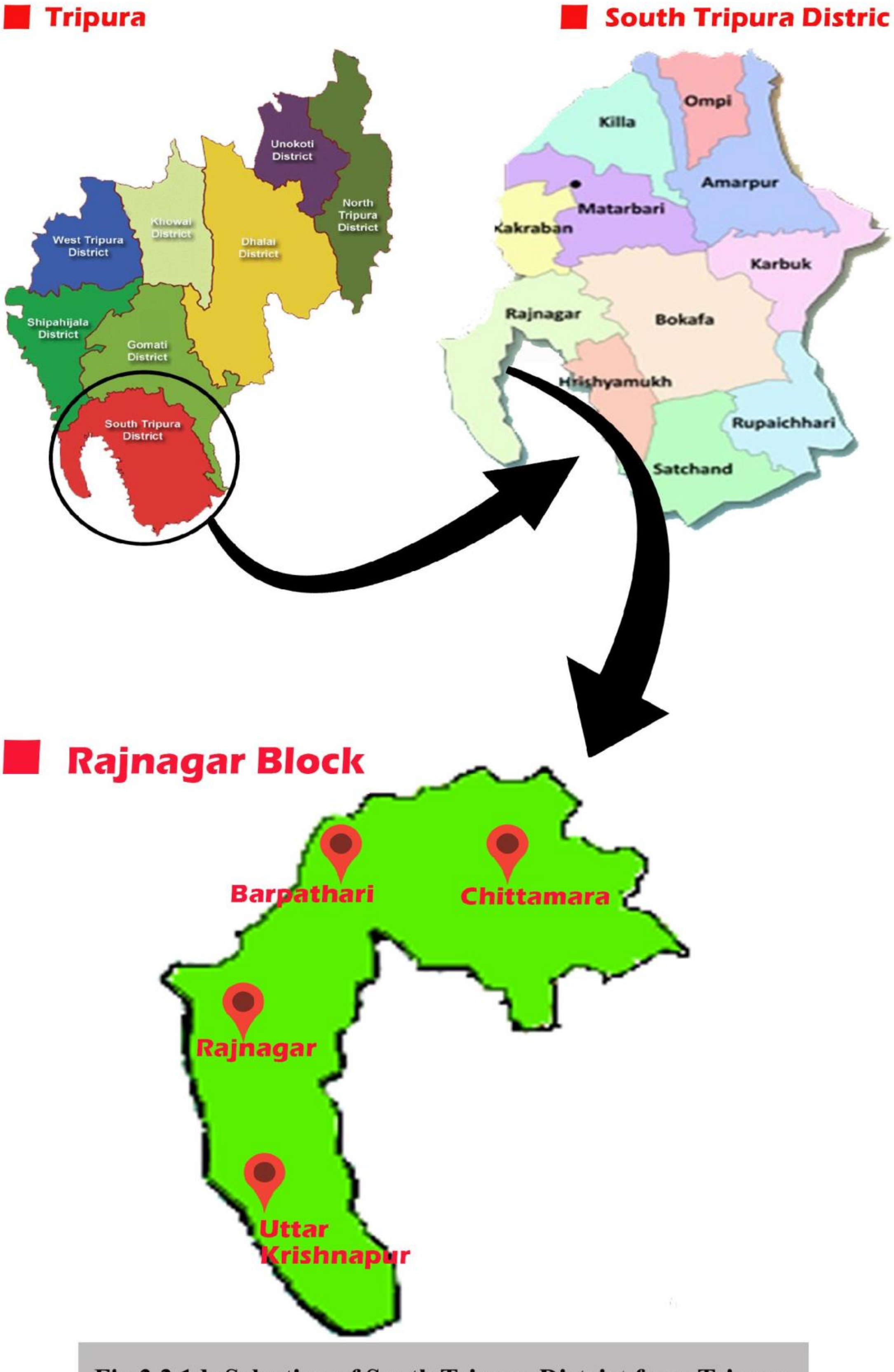

Fig 3.3.1d: Selection of South Tripura District from Tripura

major landscape found in South Tripura district. Soils of the district, falls under nine physiographic classes of which majority of the area falls under Hillocks/hummocks/ subdued hills followed by upper pediplains. About 94.05 per cent of the district area is under very deep soils followed by moderately deep soils (2.54%) and deep soils (1.5%).The total geographical area of the district is 1514.322 Sq. Km. although the district is situated in the southernmost tip of the state; it has the advantage of being connected with the state capital through national highway 44. The project for extension of railway line up to Sabroom town via Belonia would further improve the transportation and communication link with the rest of the state. Efforts are being made to connect the unconnected habitations by all-weather roads as early as possible. While Trishna wildlife sanctuary under Rajnagar block and Pilak under Jolaibari have the potential to become major tourist attractions, Belonia and Sabroom towns have the potential tobecome major export-import hub" (Anonymous, 2020 h)

3.3.2 Selection of block

From each of the selected districts, one highest potato producing block was selected purposively. Thus, four blocks viz., North Lakhimpur block of Lakhimpur district of Assam, Mawsynram block of East Khasi hills district, Jakhama block of Kohima district and Rajnagar block of South Tripura district were selected for the present study.

3.3.3 Selection of villages

A list of potato growing villages were prepared under each of the selected blocks and four villages were selected randomly from each of the selected blocks. Thus, 16 villages were selected for the present study, namely Amguri, Nalkatu, Balijan, Rajgarh, Mawlyngkut, Chirakatta, Dopho, Mawpen, Pfuchama, Phesama, Viswema, Khuzama, Barapathari, Rajnagar, Chittamara, Uttar Krishnapur as shown below:

Table 3.1 Number of respondents selected from each villages

Sl. No.	**Selected District**	**Selected Block**	**Selected villages**	**No of respondents selected from each villages**
1	Lakhimpur	North Lakhimpur	Amguri	**30**
			Nalkatu	**30**
			Balijan	**30**
			Rajgarh	**30**
2	East Khasi Hills	Mawsynram	Mawlyngkut	**30**
			Chirakatta	**30**
			Dopho	**30**
			Mawpen	**30**
3	Kohima	Jakhama	Pfuchama	**30**
			Phesama	**30**
			Viswema	**30**
			Khuzama	**30**
4	South Tripura	Rajnagar	Barapathari	**30**
			Rajnagar	**30**
			Chittamara	**30**
			Uttar Krishnapur	**30**

Source: Census, 2011, Govt. of India

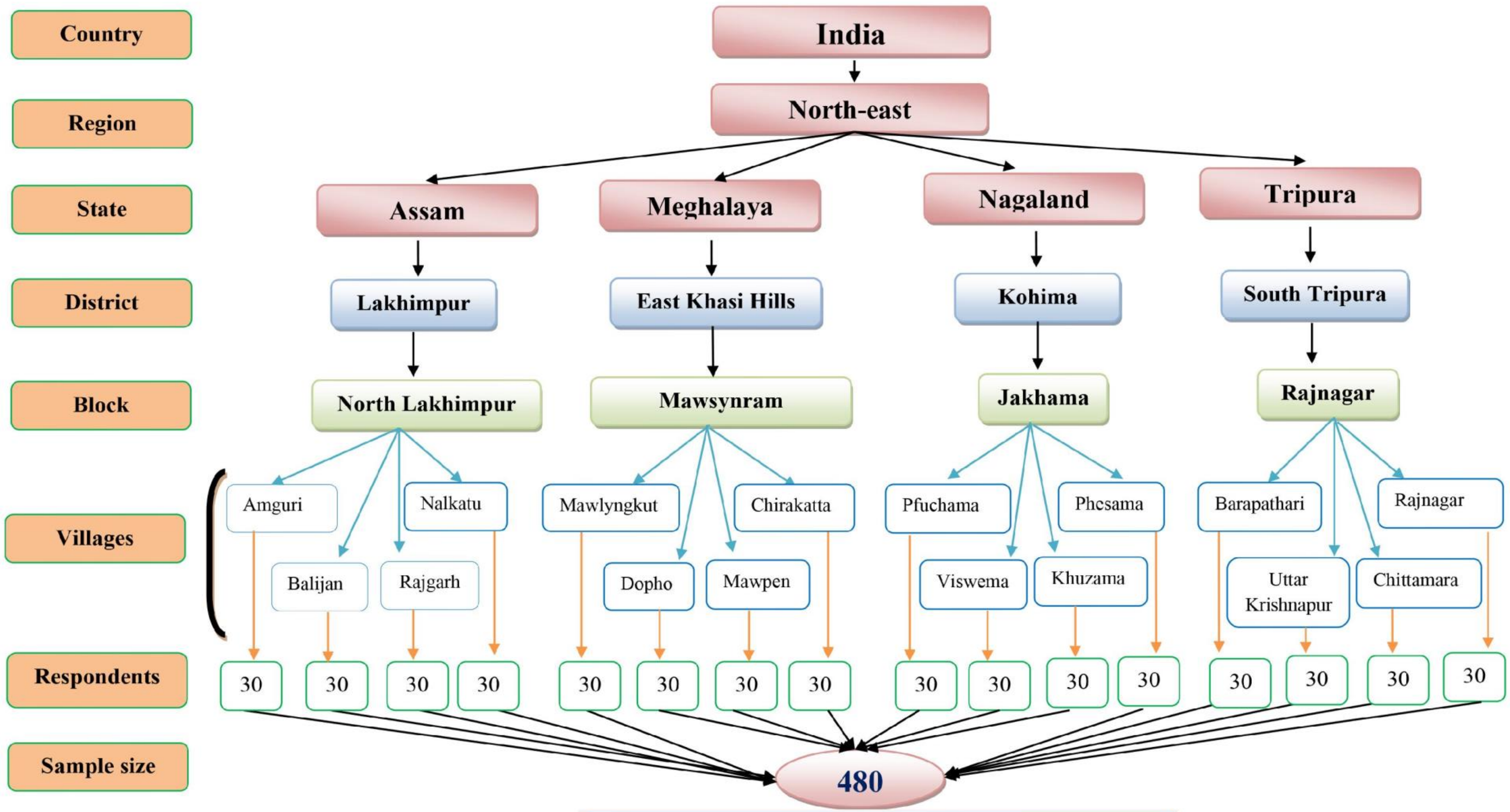

Fig 3.6: Sampling design

3.3.4. Selection of respondents

From each of the selected village 30 respondents (having at least three years of continuous experience in potato production) were selected randomly to make a sample size of 480 respondents. (Table 3.1)

3.4 Selection of variables and their empirical measurements

Table 3.4.1: Selection of variables and their empirical measurement

Sl. No.	Variables	Empirical measurement
A	**Independent variables**	
1	Age	Chronological age in years
2	Gender	Structured schedule
3	Family size	Structured schedule
4	Education	Modified scale of Venkataramaiah (1983) revised in 1991 with slight modification
5	Size of land holding	Structured schedule
6	Area under potato	Structured schedule
7	Productivity of potato	Structured schedule
8	Annual income	Structured schedule
9	Income from potato production	Structured schedule

10	Training Exposure	Structured schedule
11	Sources of information utilized	Scale developed by Ramchandran (1974)
12	Extension contact	Structured schedule
13	Scientific orientation	Scale developed by Supe (1969)
14	Social participation	Structured schedule
15	Marketing Channel	Structured schedule
16	Knowledge about sustainable farming practices	Knowledge index
17	Attitude towards sustainable farming practices	Scale was developed using Likert (1932) technique
B	**Dependent variables**	
1.	Sustainability of potato farming practices	Sustainability index
2.	Entrepreneurial behavior	Entrepreneurial behaviour index

A. Empirical measurement of independent variables

i. Age

Age was counted as the number of years already completed by respondents at the time of conducting interview. The respondents were grouped under following categories:

Sl. No.	Category of age	Age (Years)
1.	Young	Less than 35
2.	Middle Age	35-55
3.	Old Age	More than 55

ii. Gender

It has been conceptualized as the biological and psychological characteristics in terms of male and female. The respondents were classified into two categories, male scored as '1' and female as '2' respectively as presented below. Further frequency and percentage was calculated.

Sl. No.	Category of caste	Score
1.	Male	1
2.	Female	2

iii. Family size

Family size was conceptualized as the total number of members of the family. Respondents are categorized under following categories and tabulated below based on the mean ($\bar{\chi}$) value and standard deviation (σ):

Sl. No.	Family size	Score range
1.	Small (Less than 4)	$<\bar{\chi} - \sigma$
2.	Medium (4-7)	$\bar{\chi} - \sigma$ to $\bar{\chi} + \sigma$
3.	Large (More than 7)	$>\bar{\chi} + \sigma$

iv. Education

"Education was operationalized as the ability of the respondents to read and write or the extent of formal education possessed by them". Education was qualified using modified scale of Venkataramaiah (1983) revised in 1991 with slight modifications. A list of all selected respondents with their educational qualification was collected. Farmers were further classified into seven categories as follows:

Sl. No.	Category	Score
1.	Illiterate	0
2.	Primary	1
3.	Middle	2
4.	Secondary	3
5.	Higher Secondary	4
6.	Graduation	5
7.	Post-graduation& above	6

v. Size of land holding

It refers to the total actual cultivable land possessed by a respondent's family. Mean ($\bar{\chi}$) value and standard deviation (σ) was also calculated. For frequency and percentage analysis the respondents were classified in the following categories as follows:

Sl. No.	Category	Range
1.	Marginal	< 1 ha
2.	Small	1 – 2 ha
3.	Semi Medium	2-4 ha
4.	Medium	4-10 ha
5.	Large	> 10 ha

vi. Area under potato

Area under potato was calculated based on the total land utilized under potato crop by the selected farmerduring the last season. For frequency and percentage analysis, area under potato was categorized as follows:

Sl. No.	Category	Score
1.	< 0.1 ha	1
2.	0.1 – 0.2 ha	2
3.	0.2-0.3 ha	3
4.	0.3-0.4 ha	4
5.	> 0.4 ha	5

vii. Productivity of potato

Productivity describes various measures of the efficiency of production. Often a productivity measure is expressed as the ratio of an aggregate output to a single input or an aggregate input used in a production process, i.e output per unit of input, typically over a specific period of time. Here productivity of potato was calculated by dividing total production with the area from which output was obtained. It was measured in t/ha. Further productivity was tabulated and classified based on the category of farmers viz., Marginal, Small,Semi medium, Medium and large farmers as discussed earlier. Average productivity was calculated for the period of 2016-2019. 'Z' value was also calculated to know the significant difference of productivity among the selected four states of NE.

viii. Annual Income

Annual income was calculated as the total amount of earnings from all available sources (i.e. Primary and secondary sources) by the respondents and his/her family members. It was expressed in rupees.'Z' value was also calculated to know the significant difference of annual income among the selected four states of NE. Farmers under different category of land holding were categorized based on the mean annual income as follows:

Sl. No.	Category	Mean annual income (Rs)
1.	Marginal (<1ha)	
2.	Small (1-2 ha)	
3.	Semi medium (2-4 ha)	
4.	Medium (4-10 ha)	
5.	Large (>10 ha)	

ix. Income from potato production

Income from potato production was calculated as the total amount of earnings from potato cultivation in a crop season by the respondents and his/her family members. It was expressed in rupees. 'Z' value was also calculated to know the significant difference of income from potato among the selected four states of NE. Farmers under different category of land holding were categorized based on their mean income from potato as follows:

Sl. No.	Category	Mean income from potato (Rs)
1.	Marginal (<1ha)	
2.	Small (1-2 ha)	
3.	Semi medium (2-4 ha)	
4.	Medium (4-10 ha)	
5.	Large (>10 ha)	

x. Training exposure

Training is one of the means by which farmers acquire new knowledge and skill. It was measured in terms of total number of technology training received by the farmers in the last five years. The scoring was done as one (1) for each of the training attended by the farmers and zero (0) score was given to the respondents who did not receive any trainings. Further total number of days of training received was also calculated. Based on the score of mean and standard deviation value was calculated and the farmers were classified under the following categories:

Sl. No.	Level of training exposure	Range
1.	Low ($<\bar{\chi} - \sigma$)	Below 10 days
2.	Medium ($\bar{\chi} - \sigma$ to $\bar{\chi} + \sigma$)	10-20 days
3.	High ($>\bar{\chi} + \sigma$)	Above 20 days

Further frequency and percentage was calculated for training need areas of the potato farmers using Training Importance Score (TIS) based on assigning score of 2 to most needed areas, score of 1 to needed areas and score of 0 to not needed areas of training. **Mann Whitney u test** was employed to find out the test of significance between the differences in training need areas among the four selected states.

xi. Sources of information utilized

Information sources utilization referred to the various sources of information utilized by the respondents for sustainable cultivation of potato. Information sources utilized was classified based on the use of mass-media sources, formal information and informal information sources using Ramchandran scale (1974).

a) Mass-media information sources

Under mass-media sources, five sources of information (radio, television, exhibition, extension publications and newspaper) were included and their frequency of use was scored as Most often (2), Sometimes (1) and Never (0). Based on the total score, the farmers were classified into three categories; low, medium and high level using mean ($\bar{\chi}$) value and standard deviation (σ) are as follows:

Sl. No.	Level Information utilized	Score range
1.	Low	$<\bar{\chi}$ - σ
2.	Medium	$\bar{\chi} - \sigma$ to $\bar{\chi} + \sigma$
3.	High	$>\bar{\chi} + \sigma$

b) Formal information sources

Formal information sources included the information received through the contact of six sources of information (VEW, Agricultural officer, SDAO, HO, KVK, ATMA, NGOs, ICAR institutes) and their frequency of use was scored as Most often (2), Sometimes (1) and Never (0). Based on the total score, the farmers were classified into three categories; low, medium and high level using mean ($\bar{\chi}$) value and standard deviation (σ) are as follows:

Sl. No.	Level Information utilized	Score range
1.	Low	$<\bar{\chi}$ - σ
2.	Medium	$\bar{\chi} - \sigma$ to $\bar{\chi} + \sigma$
3.	High	$>\bar{\chi} + \sigma$

c) Informal information sources

Informal information sources referred to the information obtained through contact with four sources of information viz., friends, relatives, neighbours and progressive farmers for agricultural purposes. Their frequency of use was scored as Most often (2), Sometimes (1) and Never (0).

Based on the total score, the farmers were classified into three categories; low, medium and high level using mean ($\bar{\chi}$) value and standard deviation (σ) are as follows:

Sl. No.	Level Information utilized	Score range
1.	Low	$<\bar{\chi}$ - σ
2.	Medium	$\bar{\chi} - \sigma$ to $\bar{\chi} + \sigma$
3.	High	$>\bar{\chi} + \sigma$

'Z' value was calculated to know the significant difference of information sources utilized among the selected four states of NE.

xii. Extension contact

Extension contact is conceptualized as contact with the extension personnel's (AO/HO/VDO/HDO/Agri. Scientist/KVK SMS) for getting the required information on sustainable cultivation of potato. The frequency of contact was classified as most often, often and never and it was scored as 2, 1 and 0. Based on the total score obtained by the potato farmers were classified into three categories; low, medium and high level using mean ($\bar{\chi}$) value and standard deviation (σ) are as follows:

Sl. No.	Level of extension contact	Score range
1.	Low ($<\bar{\chi} - \sigma$)	<2
2.	Medium ($\bar{\chi} - \sigma$ to $\bar{\chi} + \sigma$)	2-3
3.	High ($>\bar{\chi} + \sigma$)	> 3

'Z' value was also calculated to know the significant difference of extension contact level among the selected four states of NE.

xiii. Scientific orientation

Scientific orientation was conceptualized as the inclination of farmers towards scientifically recommended practices for sustainable potato cultivation by the farmers. It was measured with the help of scale developed by Supe (1969). Based on the total score, the farmers were classified into three categories; low, medium and high level using mean ($\bar{\chi}$) value and standard deviation (σ) are as follows:

Sl. No.	Level of orientation	Score range
1.	Low (<$\bar{\chi} - \sigma$)	< 15
2.	Medium ($\bar{\chi} - \sigma$ to $\bar{\chi} + \sigma$)	$15 - 23$
3.	High (>$\bar{\chi} + \sigma$)	> 23

'Z' value was also calculated to know the significant difference on level of scientific orientation among the selected four states of NE.

xiv. Social participation

Social participation refers to the degree with which the respondents were involved in formal organization as members or social bearers and regularity in their attendance to meetings. Thus, social participation is a voluntary sharing in persons to group and group to group relationships, beyond the immediate household. The scoring was done as one (1) for each positive answer and zero (0) score negative answer. Based on the total score, the farmers were classified into three categories; low, medium and high level using mean ($\bar{\chi}$) value and standard deviation (σ) are as follows:

Sl. No.	Level of social participation	Score range
1.	Low ($<\bar{\chi} - \sigma$)	<1
2.	Medium ($\bar{\chi} - \sigma$ to $\bar{\chi} + \sigma$)	1-2
3.	High ($>\bar{\chi} + \sigma$)	> 2

'Z' value was also calculated to know the significant difference of social participation among the selected four states of NE.

xv. Marketing channel

A marketing channel comprises of people, organisations and activities necessary to transfer the ownership of goods from the point of production to the point of consumption. A marketing channel is a useful instrument for management and is crucial to creating an effective and well planned marketing strategy.

Marketing channel included eight channels. Channels were scored from 1-8. Further most used channel by the farmers for marketing potatoes was expressed in terms of frequency and percentage for classification. Further **Mann Whitney u test** was employed to find out the test of significant difference between the use of marketing channels among the four selected states of NE.

xvi. Knowledge

"Knowledge arises when an individual or other decision making unit is exposed to an innovation's existence and gains some understanding of how it functions. Knowledge seeking is initiated by an individual and is greatly influenced by one's predispositions" (Ray, 2013).

In the present study, schedule of knowledge on sustainable potato cultivation was prepared by following the standard procedure with the help of experts in the discipline. It included 59 statements. For each correct response a score of 1 was awarded and for each wrong answer 0 was awarded. Maximum possible score of any farmer was 59 Based on the total score obtained, 'knowledge index' was developed using the formula given below:

$$Knowledge\ index = \frac{Total\ score\ obtained}{Maximum\ possible\ score} \times 100$$

Further based on the score obtained by the farmers, they were further classified into low, medium and high knowledge group as follows:

Sl. No.	Level of knowledge	Score range
1.	Low	$<\bar{\chi}-\sigma$
2.	Medium	$\bar{\chi}-\sigma$ to $\bar{\chi}+\sigma$
3.	High	$>\bar{\chi}+\sigma$

'Z' value was also calculated to know the significant difference in knowledge on sustainable cultivation of potato among the selected four states of NE.

xvii. Attitude towards sustainable farming practices

Rogers and Shoemaker (1971) "explained attitude as a relatively enduring organisation of individual's belief about an object that pre-disposes his action. Attitude in this study referred to the degree of positive or negative disposition of an individual's towards the recommended selected horticultural crop cultivation practices".

Attitude scale was developed by using Likert (1932) technique to measure attitude of the potato farmers.

Construction of attitude scale

The attitude scale was developed as by following standard research procedure. A list of statements on sustainable cultivation of potato consisting of 61 items was prepared by using relevant literatures and also by discussing with the subject experts. To check the relevancy of the 60 items included initially, the test was administered to 25 judges having expertise in the field. The judges were asked to indicate their degree of agreement against each item in three point continuum (MR- Most relevant, R- relevant and LR- less relevant). Out of this 14 items were rated as less relevant by 80 per cent of the judges. Hence these items were discarded from the original list.

Item analysis

Item analysis is an important step in the construction of a valid and reliable scale. The purpose of an item analysis is to find those items that form an internally consistent scale and to eliminate from other inconsistent items. 48 statements were subjected to item analysis to delineate the items that discriminate between persons having favorable and unfavorable responses.

The response of respondents for each statements were obtained on a five point continuum ranging from, 'strongly agree', 'agree', 'undecided', 'disagree', and 'strongly disagree' with the scores of 5, 4, 3, 2, and 1 respectively for positive statements and reverse scoring of 1,2,3,4,5 for negative statements. The total score for each individual was computed by summing up the scores for all the items.

Computation of 't' value

For computation of t value, all 46 scale items were administered to a random sample of 20 farmers from non-sampled area. Total scores were obtained for each the respondents based on the sum of the scores of all individual 48 statements on 5 point continuum as stated above. The top 27 per cent of respondents having high total score (high group) and the bottom 27 per cent of the respondents with low score (low group), were used as criterion group to evaluate individual scale items. Thecritical ratio (t-value) for each item was calculated by using the formula given by Edwards (1957) as follows:

$$t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{\sum(X_H - \bar{X}_H)^2 + \sum(X_L - \bar{X}_L)^2}{n(n-1)}}}$$

Where,

$$\sum(X_H - \bar{X}_H)^2 = \sum x_{H^2} - \frac{(\sum X_H)^2}{n}$$

$$\sum(X_L - \bar{X}_L)^2 = \sum x_{L^2} - \frac{(\sum X_L)^2}{n}$$

$\bar{X}_H$= Mean score of given statement of high group

$\bar{X}_L$= Mean score of given statement in low group

$\sum(X_H)^2$= Sum of squares of individual score on a given statement for high group

$\sum(X_L)^2$= Sum of squares of individual score on a given statement for low group

$\sum X_H$= Summation of scores on given statement for high group

$\sum X_L$= Summation of scores on given statement for low group

n = Number of respondents in each group

Critical ratio (‘t’ value) for all the scale statements was used for final selection of statements. Items or statements were selected on the basis, ‘t’ value equal to or greater than 1.75. Statements were arranged in descending order based on their‘t’ values. Finally 21 statements (18 positive and 3 negative) were selected as follows:

Sr. No.	Statements	t- value
1	Sustainable potato farming is a profitable venture as compared to other farming in the longer run (+)	10.614
2	Input requirements are high for sustainable potato farming (-)	8.552
3	Sustainable nutrient management of potato farming increase the cost (-)	8.222
4	Sustainable farming helps in increased economic status of farmers (+)	6.668
5	Potatoes produced by following sustainable potato farming practices has better keeping quality than that produced from traditional methods (+)	6.532
6	Sustainable potato farming helps towards generation of farm employment (+)	6.53
7	A farmer should practice sustainable potato farming as it is helpful in improvement of microclimate and the ecological balance (+)	6.324
8	Green leaf manuring and green manuring in-situ are advised to enhance the soil fertility for sustainable potato farming (+)	6
9	Sustainable management of potato pest and disease helps in maintaining ecological balance (+)	5.902

10	I prefer to participate in soil and water conservation activities in relation to promote sustainable potato farming (+)	5.715
11	More and more farmers should undertake sustainable potato farming practices (+)	5.715
12	I feel there is an important reason for judicious use of the resources like soil, water and vegetation for sustainable potato farming (+)	5.715
13	Sustainable potato farming increases overall production without much financial burden (+)	5.692
14	Sustainable farming helps to increase farm income for sustainable livelihood (+)	4.856
15	Sustainable farming helps towards a secured occupation (+)	4.81
16	Incidence of pest and disease attack is considerably reduced in by following sustainable potato farming practices (+)	4.427
17	I go for scientific land management for sustainable potato farming (+)	4
18	Sustainable potato farming use locally available materials so management is quite easy	4
19	Sustainable potato farming is difficult to practice (-)	3.779
20	It is preferable to adopt sustainable potato farming practices than traditional methods (+)	3.465
21	Sustainable potato farming is better in promoting soil and water conservation measures than the traditional methods (+)	2.449

Reliability and validity of the scale

Split-half method was used to determine the reliability of the scale. The two halves were administered randomly to 20 farmers in a non-sampled area. The Pearson product moment correlation between scores of odd and even groups was found to be 0.72. Thus the scale was found to be reliable.

The validity of the scale was examined for its content validity by determining how well the content of the scale represented the domain subject matter under study. The statements of the attitude scale were derived from books, journals, and consultations with concerned experts in the field. The 't' values were significant for all the 21 statements indicating high discriminating values. It inferred that the scores obtained by utilising the present scale would measure the intended items under the present study. Thus the scale was considered valid based on the content validity criterion.

The final attitude scale developed for measuring the attitude of farmers towards sustainable farming practices of potato was administered to all the respondents under the present study. The response of respondents for each statements were obtained on a five point continuum ranging from, 'strongly agree', 'agree', 'undecided', 'disagree', and 'strongly disagree' with the scores of 5, 4, 3, 2, and 1 respectively for positive statements and reverse scoring of 1,2,3,4,5 for negative statements. The scores obtained from each statement were further added to arrive at the total score for each respondent. Respondents were grouped into three categories based on mean and standard deviation values as follows:

Sl. No.	Level of attitude	Score range
1.	Less favourable ($<\bar{\chi} - \sigma$)	< 79
2.	Favourable ($\bar{\chi} - \sigma$ to $\bar{\chi} + \sigma$)	79-91

3.	Highly favourable ($>\bar{\chi} + \sigma$)	> 91

'Z' value was also calculated to know the significant difference in 'Attitude' towards sustainable cultivation of potato among the selected four states of NE.

B. Dependent Variables:

i. Sustainability of potato farming practices

"Sustainable agriculture as a practice that meets current and long-term needs for food, fiber, and other related needs of society while maximizing not benefits through conservation of resources to maintain other ecosystem services, functions, and long-term human development. Agricultural sustainability is not about technical fixes and expertise. It is development processes that need to integrate ecological and societal knowledge through changes in policy, institutions, and behavior. Sustainable agriculture considers not only the future requirements of production increase, but also maintains the quality of environment and water and soil" (Joneydi, 2012).

'Sustainability' was measured by developing a sustainability index. First of all it was divided into three dimensions viz., Environmental sustainability, Economic sustainability as well as Social sustainability. Each of these dimensions were measured on the basis of indicators. Finally sustainability index was calculated using the following formula as follows:

$$Sustainibility\ Index = \sum_{i=1}^{3} \frac{\sum_{j=1}^{n} x_1, x_2, \ldots\ldots, x_n}{\sum_{j=1}^{n} a_1, a_2, \ldots\ldots., a_n}, \frac{\sum_{k=1}^{n} y_1, y_2, \ldots\ldots, y_n}{\sum_{k=1}^{n} b_1, b_2, \ldots\ldots., b_n}, \frac{\sum_{l=1}^{n} z_1, z_2, \ldots\ldots, z_n}{\sum_{l=1}^{n} c_1, c_2, \ldots\ldots., c_n} \text{ X } 100$$

Where,

$x_1, x_2, .. x_n$ = Score obtained by individual farmers in economic sustainability

$a_1, a_2, .. a_n$ = Maximum possible core obtained by individual farmers in economic sustainability

$y_1, y_2, .. y_n$ = Score obtained by individual farmers in social sustainability

$b_1, b_2, .. b_n$ = Maximum possible core obtained by individual farmers in social sustainability

$y_1, y_2, .. y_n$ = Score obtained by individual farmers in environmental sustainability

$c_1, c_2, .. c_n$ = Maximum possible core obtained by individual farmers in environmental sustainability

i= Economic sustainability, Social sustainability & Environmental sustainability

j= Total number of farmers in economic sustainability

k= Total number of farmers in social sustainability

l= Total number of farmers in environmental sustainability

ii. Entrepreneurial behaviour

Entrepreneurial behaviour of respondents was measured in terms of their innovativeness, achievement motivation, risk taking ability, management orientation, scientific orientation, economic motivation and decision making ability.

1.**Innovativeness:** This refers to the individual behaviour pattern who seeksinterest and desire changes of farming technique and readily available to influence such changes in practical and feasible operations. It was measured by using the scale developed by Sakharkar (1995). The scale consisted of five statements. All the positive statements were assigned the score of 4, 3, 2, 1, 0for Strongly Agree (SA), Agree (A), Un Decided (UD), Disagree (DA) and Strongly Disagree (SDA) and vice versa for negative statements.

After obtaining the total scores, the respondents were further classified into three categories by using mean ($\bar{x}$) and standard deviation (σ) presented below:

Sl. No.	Level of innovativeness	Score Range
1.	Low	Below ($\bar{x}$-σ)
2.	Medium	Between ($\bar{x}$-σ) and ($\bar{x}$+σ)
3.	High	Above ($\bar{x}$+σ)

2. **Achievement motivation**: It was operationalized as the eagerness for excellence to attain perception of personal accomplishment. It was measured by using the scale developed by Visweswaram (1979). The scale consisted of six statements. All the positive statements were assigned the score of 4, 3, 2, 1, 0 for Strongly Agree (SA), Agree (A), Un Decided (UD), Disagree (DA) and Strongly Disagree (SDA) and vice versa for negative statements.

After obtaining the total scores, the respondents were further classified into three categories by using mean ($\bar{x}$) and standard deviation (σ) presented below:

Sl. No.	Level of Achievement motivation	Score Range
1.	Low	Below ($\bar{x}$-σ)
2.	Medium	Between ($\bar{x}$-σ) and ($\bar{x}$+σ)
3.	High	Above ($\bar{x}$+σ)

3. Risktaking ability: Risk taking ability or risk orientation was operationalized as the degree to which individuals are aligned towards risk uncertainty against constraints in farming. It was measured by using the scale developed by Supe (1969) with slight modification. The scale consisted of five statements. All the positive statements were assigned the score of 4, 3, 2, 1, 0 for Strongly Agree (SA), Agree (A), Un Decided (UD), Disagree (DA) and Strongly Disagree (SDA) and vice versa for negative statements.

After obtaining the total scores, the respondents were further classified into three categories by using mean ($\bar{x}$) and standard deviation (σ) presented below:

Sl. No.	Level of Risk orientation	Score Range
1.	Low	Below ($\bar{x}$-σ)
2.	Medium	Between ($\bar{x}$-σ) and ($\bar{x}$+σ)
3.	High	Above ($\bar{x}$+σ)

4. Management orientation: It refers to the degree to which potato farmers directed human and material resources for increasing efficiency to the farm. It was measured by using the scale developed by Samanta (1977). Management orientation was classified into three parts viz., Planning, Production and Marketing orientation. The scale consisted of six statements under each heads. All the positive statements were assigned the score of 4, 3, 2, 1, 0 for Strongly Agree (SA), Agree (A), Un Decided (UD), Disagree (DA) and Strongly Disagree (SDA) and vice versa for negative statements.

After obtaining the total scores, the respondents were further classified into three categories by using mean ($\bar{x}$) and standard deviation (σ) presented below:

Sl. No.	Level of Management orientation	Score Range
1.	Low	Below ($\bar{x}$-σ)
2.	Medium	Between ($\bar{x}$-σ) and ($\bar{x}$+σ)
3.	High	Above ($\bar{x}$+σ)

5. Scientific orientation: Scientific orientation was operationalized as the degree to which individuals are inclined to undertake potato farming based on scientific recommendations. It was measured by using the scale developed by Supe (1969) with slight modification. The scale consisted of twelve statements. All the positive statements were assigned the score of 4, 3, 2, 1, 0 for Strongly Agree (SA), Agree (A), Un Decided (UD), Disagree (DA) and Strongly Disagree (SDA) and vice versa for negative statements.

After obtaining the total scores, the respondents were further classified into three categories by using mean ($\bar{x}$) and standard deviation (σ) presented below:

Sl. No.	Level of Scientific orientation	Score Range
1.	Low	Below ($\bar{x}$-σ)
2.	Medium	Between ($\bar{x}$-σ) and ($\bar{x}$+σ)
3.	High	Above ($\bar{x}$+σ)

6.Economic motivation: Economic motivation was operationalized as the degree to which individuals were eager to take up potato farming for economic gains and profit maximisation. It was measured by using the scale developed by Supe (1969) with slight modification. The scale consisted of six statements. All the positive statements were assigned the score of 4, 3, 2, 1, 0 for Strongly Agree (SA), Agree (A), Un Decided (UD), Disagree (DA) and Strongly Disagree (SDA) and vice versa for negative statements.

After obtaining the total scores, the respondents were further classified into three categories by using mean ($\bar{x}$) and standard deviation (σ) presented below:

Sl. No.	Level of Economic Motivation	Score Range

1.	Low	Below ($\bar{x}$-σ)
2.	Medium	Between ($\bar{x}$-σ) and ($\bar{x}$+σ)
3.	High	Above ($\bar{x}$+σ)

7. Decision making ability: It was operationalized as the degree to which individuals were capable of taking pertinent decisions with regards to sustainable potato farming practices. It was measured by using the scale developed by Supe (1969) with slight modification. The scale consisted of eight statements which were evaluated on the basis of three parameters, viz., not considered was scored (0), Considered after consulting others was scored (1) and Considered independently was scored (2).

After obtaining the total scores, the respondents were further classified into three categories by using mean ($\bar{x}$) and standard deviation (σ) presented below:

Sl. No.	Level of Economic Motivation	Score Range
1.	Low	Below ($\bar{x}$-σ)
2.	Medium	Between ($\bar{x}$-σ) and ($\bar{x}$+σ)
3.	High	Above ($\bar{x}$+σ)

The overall level of entrepreneurial behaviour was measured by developing an Entrepreneurial index as follows:

Entrepreneurial index (EI) = $\frac{EBh}{n}$ x100

Where,

$EBh = \sum_{i=1}^{n} Ei$

Ei – is the ratio of the scores obtained by the respondents to the maximum obtainable score in a particular entrepreneurial behaviour component;

n –is the number of entrepreneurial behaviour components.

After obtaining the scores of "Entrepreneurial Index (EI)", the respondents were grouped in three categories based on Mean ($\bar{\chi}$) and Standard deviation (σ) as follows:

Sl. No.	Level of overall entrepreneurial behaviour	Score Range
1.	Low	Below ($\bar{\chi}$ - σ)
2.	Medium	Between ($\bar{\chi}$ - σ) and ($\bar{\chi}$ + σ)
3.	High	Above ($\bar{\chi}$ + σ)

3.5 Formulation of Hypothesis:

Following null hypothesis were formulated to test the relationship between the dependent variables viz., 'Sustainability of potato farming practices', 'entrepreneurial behaviour of potato farmers' and the selected personal, socio-economic and psychological variables specified earlier under the heading selection and measurement of variables :

Null Hypothesis H_o1: There is no significant association between the selected personal, socio-economic and psychological characteristics of the farmers with 'sustainability of potato farming practices'.

Alternate HypothesisH_o1_a: There exists a significant association between the selected personal, socio-economic and psychological characteristics of the farmers with 'sustainability of potato farming practices'.

Null Hypothesis H_o2: There is no significant association between the selected personal, socio-economic and psychological characteristics of the farmers with 'entrepreneurial behaviour of potato farmers'.

Alternate HypothesisH_o2_a: There exists a significant association between the selected personal, socio-economic and psychological characteristics of the farmers with 'entrepreneurial behaviour of potato farmers'.

3.6 Tools and techniques used for data collection

An interview schedule directed towards the objectives of the study was developed for data collection. The schedule was prepared with references from similar research materials from within and outside the institution.

3.6.1 Development of interview schedule

An interview schedule aimed towards the objectives of the study was developed for data collection. The schedule was prepared with references from similar research materials from within and outside the institutions.

3.6.2 Pre-testing of interview schedule

Before the actual interview, a preliminary .interview was conducted in the selected villages; a sample of 20 respondents which did not constitute the respondents sample was selected for pre-testing the schedule. Based on the pre-tested results, few difficulties and ambiguous questions were deleted from the draft schedule.

3.6.3 Method of data collection

For the present study, two types of data viz., primary and secondary data were collected. The primary data was collected through personal interview by the researcher using pre tested interview schedule by conducting personal interview. The secondary data was collected from various publications, magazines, relevant text books and other sources.

3.7 Analysis of data

The data collected from the respondents were scored, tabulated and analysed to calculate frequency, percentage, mean, standard deviation, correlation, ‘Z’ test, factor and path analysis. Statistical analysis was done using SPSS and R software.

3.7.1 Percentage:

Percentage was calculated by frequency multiplied by 100 and divided by total number of observation of respondents in a particular category.

$$\text{Percentage} = \frac{\boldsymbol{number\ of\ observations\ recorded}}{\boldsymbol{total\ number\ of\ observations}} \text{x } 100$$

3.7.2 Mean and standard deviation

According to Chandra *et al*. (2013) the **Mean or Arithmetic mean** is generally known as the average. It is simplest of all averages and it is also known as true average. It was calculated as follows:

$$\bar{\chi} = \frac{\sum Xi}{n}$$

Where,

$\bar{\chi}$is a symbol for the mean of sample

$\sum \boldsymbol{Xi}$is the sum of each of the score in turn, and

nis the total number of scores in the distribution.

According to Karl Pearson (1923) Standard deviation is defined as (Sahu, 2018) the square root of the average of squared deviations of the frequency distribution.

Means and standard deviation were used to classify the respondents into the categories based on scores obtained through Mean ± SD values.

$$s = \sqrt{\sum_{i=1}^{n} \frac{(X_i - \bar{\chi})^2}{n}}$$

Where,

Σ is the standard deviation,

$X_i$is each score in turn**,**

$\bar{\chi}$is mean of the sample and

n is the total number of scores in the distribution

3.7.3 Correlation

Correlation is a statistical measurement that indicates the extent to which two or more variables fluctuate together. If the change in one variable affects the change in the other variable, the variables are said to be correlated (Sahu, 2018). In other words, the correlation between a set of data is a measurement of how well they are related. The correlation coefficient, *r* is given as the ratio of covariance of the variables *x* and *y* to the product of the standard deviations of *x* and *y*. symbolically, it can be simplified as:

$$r = \frac{\boldsymbol{N\sum xy - \sum(x)(y)}}{\sqrt{[\boldsymbol{N}\sum \mathbf{x2} - \sum(\mathbf{x})\mathbf{2}]\ [\boldsymbol{N}\sum \mathbf{y2} - \sum(\mathbf{y})\mathbf{2}]}}$$

Where,

r = Pearson r correlation coefficient

N = number of value in each data

$\sum x$ = sum of x scores

$\sum y$ = sum of y scores

$\sum xy$ = sum of the products of paired scores

$\sum x^2$ = sum of squared x scores

$\sum y^2$ = sum of squared y score

CHAPTER IV

RESULT AND DISCUSSION

RESULTS AND DISCUSSION

Results of the present study with relevant discussions are presented in this chapter. The data were tabulated, analysed and organized in line with the objectives of the study. The results and discussion of the study has been presented under the following headings:

4.1 Socio- psychological and economic characteristics of potato farmers.

i. Age

It was revealed from Table 4.1.1.1 and Fig 4.1.1.1 that among all the potato farmers majority (86.67 %) of the potato growers in Assam belonged to middle age group (35-55 years), followed by 78.34 per cent of Meghalaya's potato growers, 71.67 per cent of Nagaland's potato growers and 68.33 per cent of the Tripura's potato growers respectively. In case of farmers above 55 years, the majority (25.00%) of the potato growers belonged to Tripura followed by 13.33 per cent potato growers from Nagaland, 10.83 per centfrom Meghalaya and 8.33 per cent potato growers from Assam. While farmers age below 35 years was recorded highest of 15.00 per cent in Nagaland followed by 10.83 per cent in case of Meghalaya's farmers, 6.67 per cent in case of potato growers of Tripura and about 5.00 per cent in case of potato growers of Assam.

Table 4.1.1.1: Distribution of Potato farmers based on age N=480

Sr. No.	Age of farmers ↓	Assam		Meghalaya		Nagaland		Tripura		Total farmers	
		No	(%)	No	(%)	No	(%)	No	(%)	No	(%)

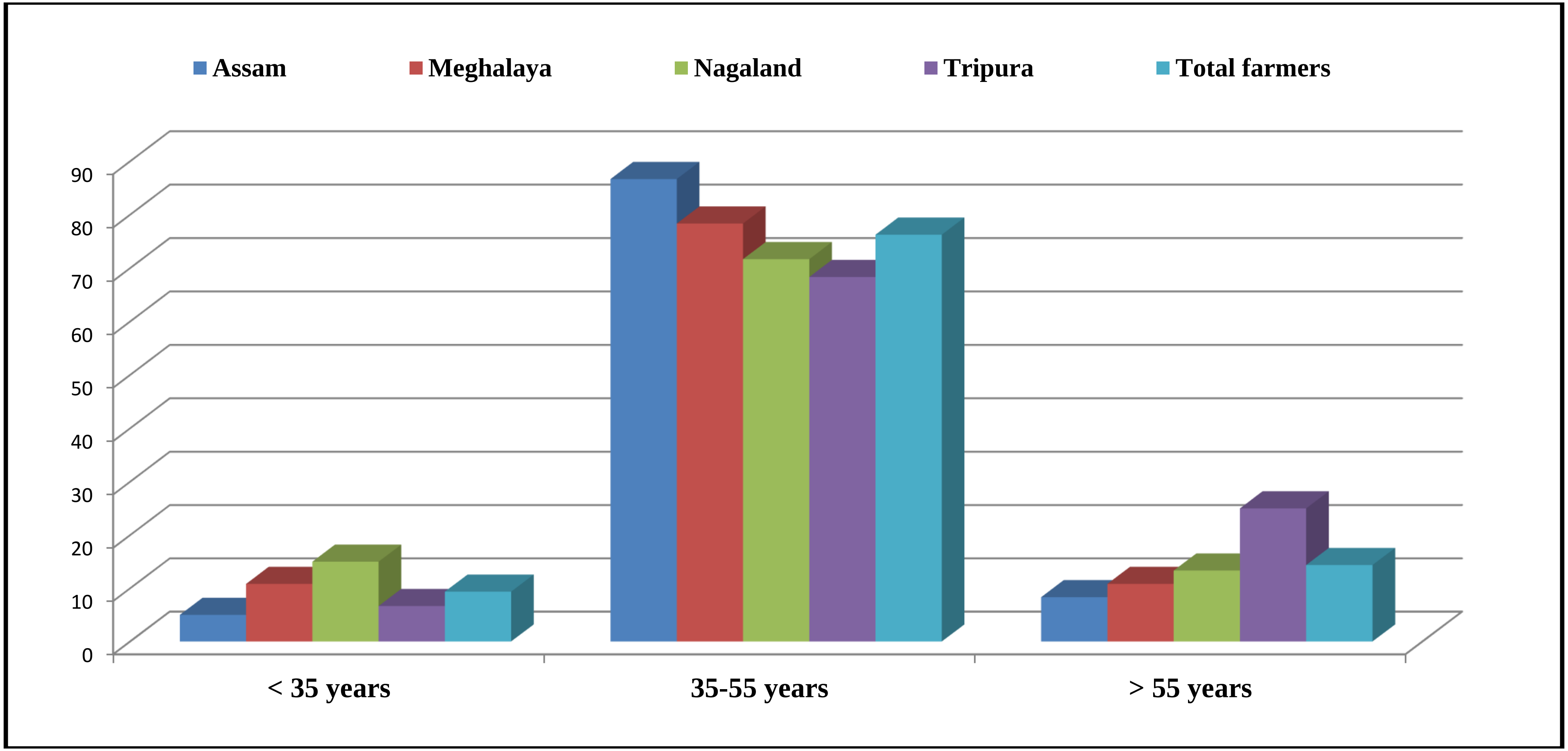

Fig 4.1.1.1: Distribution of Potato farmers based on age

1	< 35 years	6(5.00)	13(10.83)	18(15.00)	8 (6.67)	45(9.37)
2	35-55 years	**104(86.67)**	**94(78.34)**	**86(71.67)**	**82(68.33)**	**366(76.25)**
3	> 55 years	10(8.33)	13(10.83)	16(13.33)	30(25.00)	69(14.37)
4	Total farmers	120 (100)	120 (100)	120 (100)	120 (100)	480(100)
5	Mean Age (Years)	47.11	49.08	47.32	46.28	47.45
6	SD	8.20	10.11	7.18	9.91	8.99

It was also observed from the above table that majority (76.25%) of the potato growers of North-east belonged to the age group between 35-55 years followed by 14.37 per cent potato growers of North-east belonged to the age above 55 years and 9.37 per cent of the potato farmers of North-east found in age group below 35 years. This study was in accordance with the study of Wase (2001), Arneja *et al*. (2009), Kafle and Shah (2012) and Kumar *et al*. (2021).

Table 4.1.1.2: Comparative account of age of respondents

Sr. No	Name of the state	Age (μ)	z value	P
1	Assam	47.11	-1.655	>0.05
	Meghalaya	49.08		
2	Meghalaya	49.08	-1.554	>0.05
	Nagaland	47.32		
3	Nagaland	47.32	0.921	>0.05
	Tripura	46.28		
4	Tripura	46.28	0.700	>0.05
	Assam	47.11		
5	Tripura	46.28	**-2.157***	<0.05
	Meghalaya	49.08		
6	Assam	47.11	0.209	>0.05
	Nagaland	47.32		

* significant at 5% level of probability

From the Table 4.1.1.2, it is clear that the age of the respondents of Tripura and Meghalaya was statistically significant (p-value <0.05) at 5% level of significance. Except this, the age of the respondent between other states were not statistically significant (p-value is >0.05) and similar study was found by Joneydi (2012).

ii. Gender

From Table 4.2.1 and Fig 4.2.1 it can be concluded that majority (81.67%) of the potato farmers from Tripura were male followed by 65.83 per cent of the potato farmers of Meghalaya were female, 62.50 per cent of farmers of Nagaland were female and about 52.50 per cent of the potato farmers of Assam were male.

Table 4.1.2: Distribution of respondents based on Gender N=480

Sr. No.	Category of Sex ↓	Assam	Meghalaya	Nagaland	Tripura	Total farmers
		No (%)	**No (%)**	**No (%)**	**No (%)**	**No (%)**
1.	Male	63(52.50)	41(34.17)	45 (37.50)	**98(81.67)**	**247(51.46)**
2.	Female	57(47.50)	79(65.83)	75(62.50)	22(18.33)	233(48.54)
3.	**Total farmers**	120 (100)	120 (100)	120(100)	120 (100)	480(100)

From the above table it can also be concluded that majority about 51.46 per cent of the potato farmers of North-east India were male and about 48.54 per cent were female. Similar study was found by Hameed *et al*. (2019).

iii. Family size

Table 4.1.3.1 and Fig 4.1.3.1 revealed that majority (88.33%) potato farmers of Nagaland had medium family size of 4-7 members, followed by

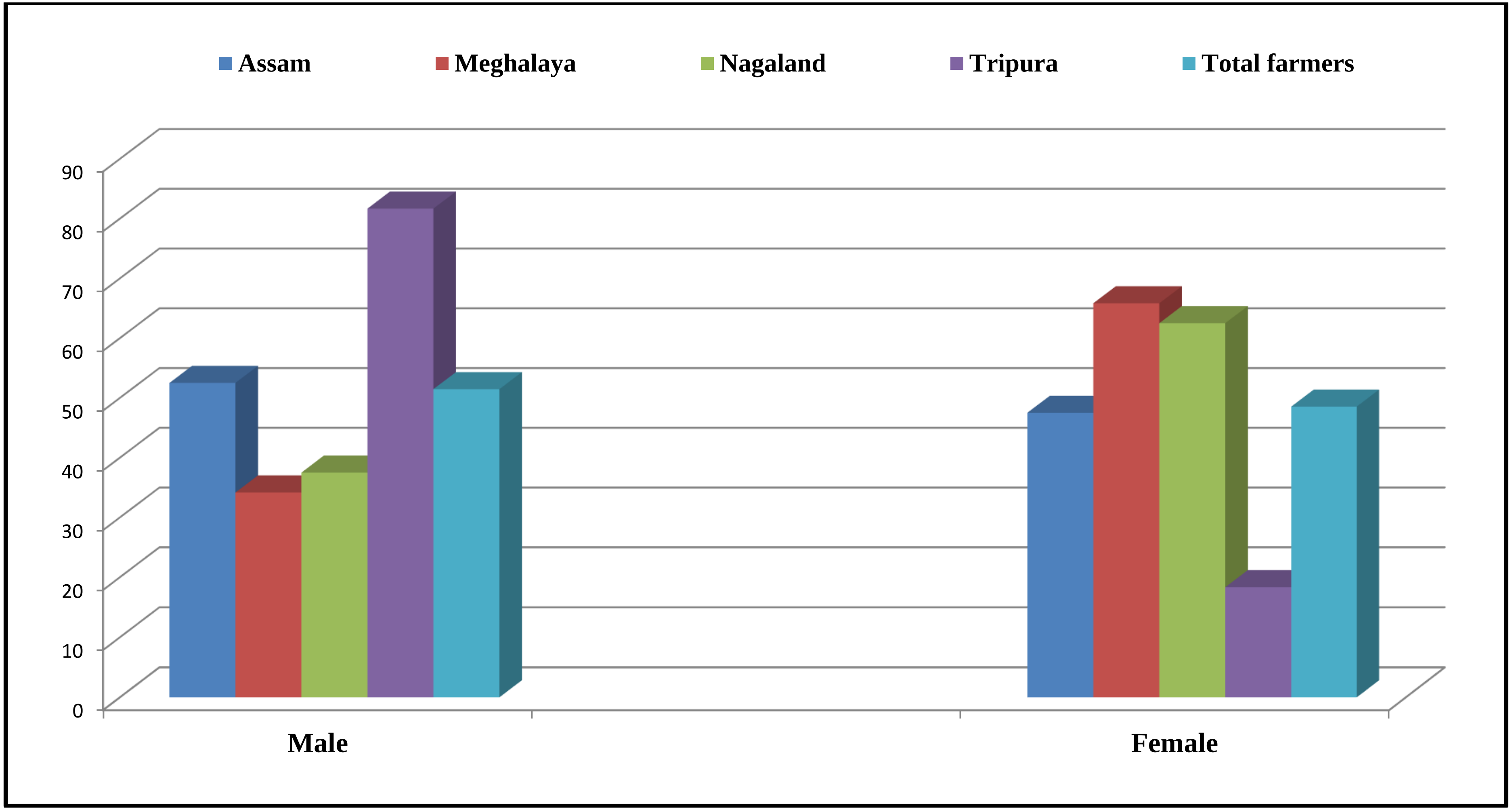

Fig 4.1.2: Distribution of respondents based on Gender

77.50per cent of the potato farmers of Assam, 76.67 per cent of the potato farmers of Tripura and 70.83 per cent of potato farmers of Meghalaya belonged to medium family size. Further majority (78.33%) of the potato farmers of North-east belonged to medium family size (4-7 members), followed by 12.29 per cent of them having small family size (less than 4 members) and remaining 9.38 per cent of them belonged to large family size having more than 7 family members. This might be because of the farmer's awareness about the benefits of small family. It was also found that in case of all different types of farmers, medium family size was predominant. These findings were in accordance with the findings of Jha (2012), Boruah*et al*. (2015), Kulkarni and Jahagirdar (2015) and Shree *et al*. (2020)

Table 4.1.3.1: Distribution of respondents based on family size N=480

Sr. No.	Family Size	Assam	Meghalaya	Nagaland	Tripura	Total farmers
		No (%)	No (%)	No (%)	No (%)	No (%)
1	Small (< 4)	26(21.67)	0(0.00)	5(4.17)	28(23.33)	59(12.29)
2	Medium (4-7)	**93(77.50)**	**85(70.83)**	**106(88.33)**	**92(76.67)**	**376 (78.33)**
3	Large (>7)	1(0.83)	35(29.17)	9(7.50)	0(0.00)	45(9.38)
4	Total farmers	120(100)	120 (100)	120 (100)	120 (100)	480(100)
5	Mean family size	4.86	6.67	5.71	4.49	5.43
6	SD	1.37	1.53	1.23	1.13	1.57

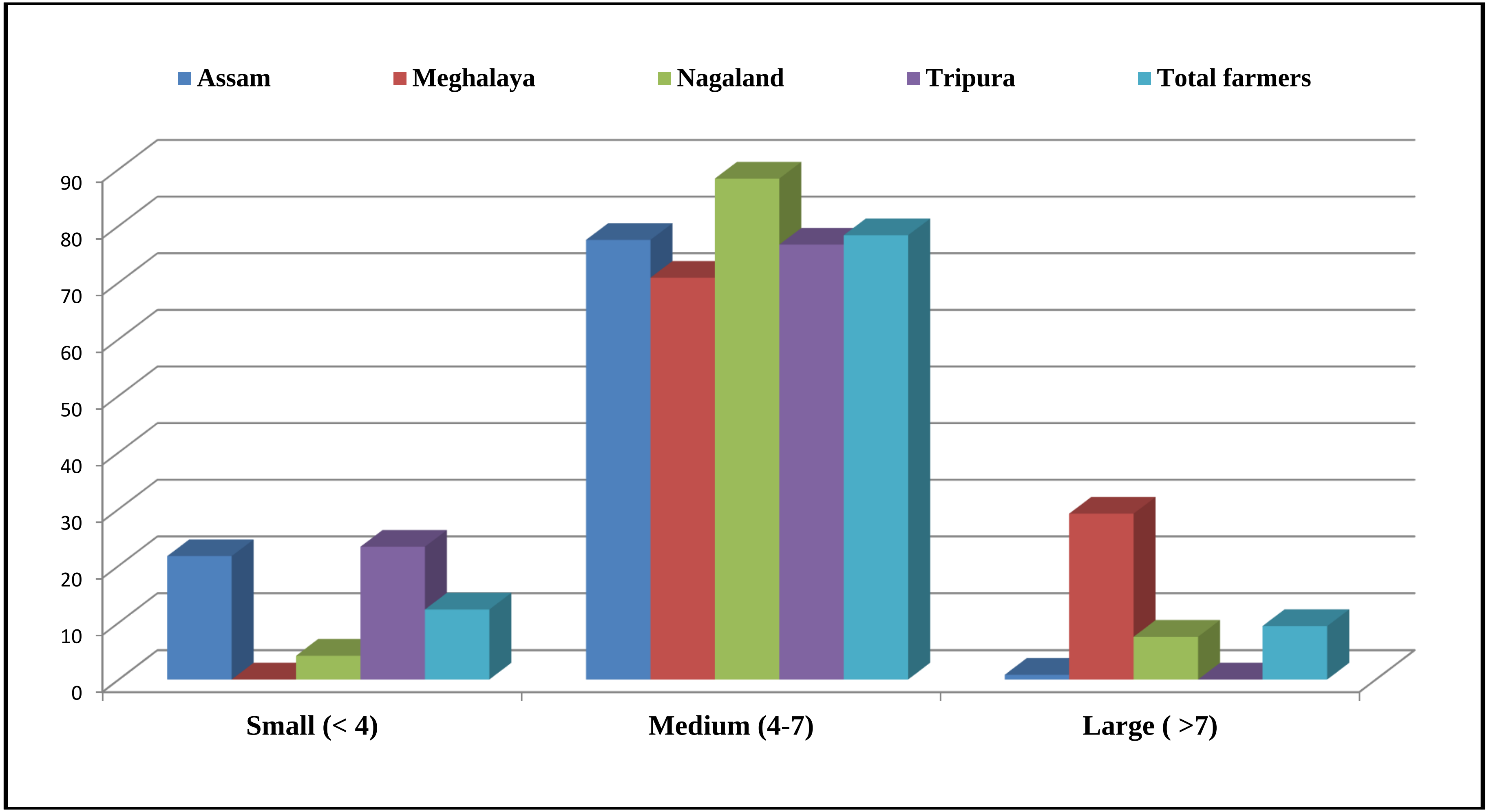

Fig 4.1.3.1: Distribution of respondents based on family size

Table 4.1.3.2: Comparative account of family size of respondents

Sr. No	Name of the state	Family size (µ)	z value	p
1	Assam	4.86	**-9.598****	<0.01
	Meghalaya	6.67		
2	Meghalaya	6.67	**-5.336****	<0.01
	Nagaland	5.71		
3	Nagaland	5.71	**7.951****	<0.01
	Tripura	4.49		
4	Tripura	4.49	**2.249***	<0.05
	Assam	4.86		
5	Tripura	4.49	**12.471****	<0.01
	Meghalaya	6.67		
6	Assam	4.86	**-5.035****	<0.01
	Nagaland	5.71		

** Significant at 1% level of probability, * Significant at 5% level of probability

From Table 4.1.3.2, it was evidentthat the family size of the respondents among all the states (i.e. Assam, Meghalaya, Nagaland, and Tripura) was statistically significant at 1 per cent level of significance except the respondentsof Assam and Tripura;which was significant at 5% level of significance.

iv. Education

It was observed from Table 4.1.4.1 and Fig 4.1.4.1that in case of potato growers of Assam majority (35.83%) had education upto secondary level followed by 31.67 per cent of the potato growers of Tripura having education upto higher secondary level, 30.00 per cent of potato growers of Nagaland had education upto secondary level and about 24.17 per cent of the potato growers of Meghalaya had education upto higher secondary level. Further 27.92 per cent of the total farmers of North-east had education up to secondary level as well as higher secondary level followed by 13.12 per cent of them had education upto graduation, 12.50 per cent farmers were illiterate, 12.08 per cent of the farmershad education upto middle school, 5.63 per cent of them had education upto primary school and 3.33 per cent of the farmers of North-east had education of PG and above.Adequate literacy level might have helped the farmers to adopt the recommended practices. These findings were in accordance with the findings of Arneja*et al*. (2009), Chavai *et al*. (2015) and Islam *et al*. (2021).

Table 4.1.4.1: Distribution of respondents based on their education level N=480

Sr. No.	Educational level of the farmers	Assam	Meghalaya	Nagaland	Tripura	Total farmers
		No (%)	No (%)	No (%)	No (%)	No (%)
1	Illiterate	14 (11.67)	26(21.67)	12(10.00)	8 (6.67)	60 (12.50)
2	Primary Education	5 (4.17)	13 (10.83)	8 (6.67)	1 (0.83)	27 (5.63)
3	Upto Middle School	14 (11.67)	19 (15.83)	19 (15.83)	6 (5.00)	58 (12.08)
4	Upto Secondary	**43 (35.83)**	27 (22.50)	**36 (30.00)**	28 (23.33)	**134 (27.92)**
5	Upto Higher Secondary	35 (29.16)	**29 (24.17)**	32 (26.67)	**38 (31.67)**	**134 (27.92)**
6	Graduation	9 (7.50)	6 (5.00)	13 (10.83)	35 (29.17)	63 (13.12)
7	PG & Above	0 (0.00)	0 (0.00)	0 (0.00)	4 (3.33)	4 (3.33)
8	Total farmers	120 (100)	120 (100)	120 (100)	120 (100)	480 (100)
	Mean	2.89	2.32	2.89	3.73	2.96
	SD	1.38	1.59	1.42	1.39	1.53

Table 4.1.4.2: Comparative account of education of respondents

Sr. No	Name of the state	Education (μ)	Mann Whitney u test	P
1	Assam	2.89	**-2.737****	<0.01
	Meghalaya	2.32		

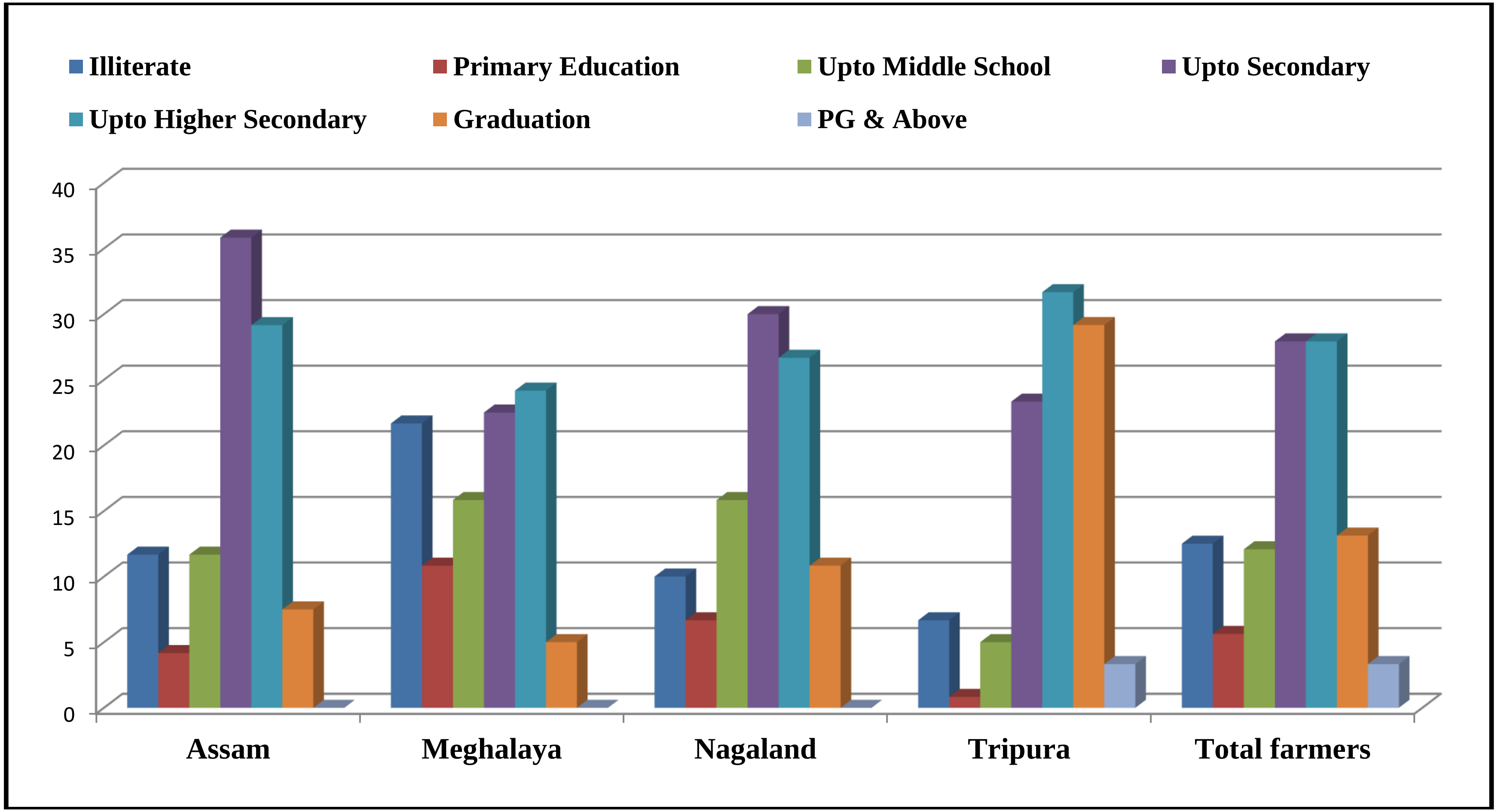

Fig 4.1.4.1: Distribution of respondents based on their education level

2	Meghalaya	2.32	**-2.693****	<0.01
	Nagaland	2.89		
3	Nagaland	2.89	**-4.869****	<0.01
	Tripura	3.73		
4	Tripura	3.73	**-5.048****	<0.01
	Assam	2.89		
5	Tripura	3.73	**-6.815****	<0.01
	Meghalaya	2.32		
6	Assam	2.89	-2.737	>0.05
	Nagaland	2.89		

** significant at 1% level of probability

From Table 4.1.4.2, it was clear that the education level of respondent between all the states were statistically significant at 1% level of significance except Assam and Nagaland (p-value >0.05).

v. Size of the land holding

Table 4.1.5.1 and Fig 4.1.5.1 revealed that among the potato farmers of different states of North-east, majority (85.83%) of the potato growers of Tripura, 66.67 per cent of the potato growers of Meghalaya, 55.83 per cent of the potato growers of Assam and 25.83 per cent of the potato growers of Nagaland belonged to the marginal land holding category.

Table 4.1.5.1: Distribution of respondents based on category of size of the land holding **N=480**

Sr. No.	Category of land holdings	Assam	Meghalaya	Nagaland	Tripura	Total farmers
		No (%)	**No (%)**	**No (%)**	**No (%)**	**No (%)**
1	Marginal (< 1 ha)	**67 (55.83)**	**80(66.67)**	**31 (25.83)**	**103 (85.83)**	**281(58.54)**
2	Small (1 – 2 ha)	23 (19.17)	19(15.83)	24 (20.00)	10 (8.33)	76(15.84)

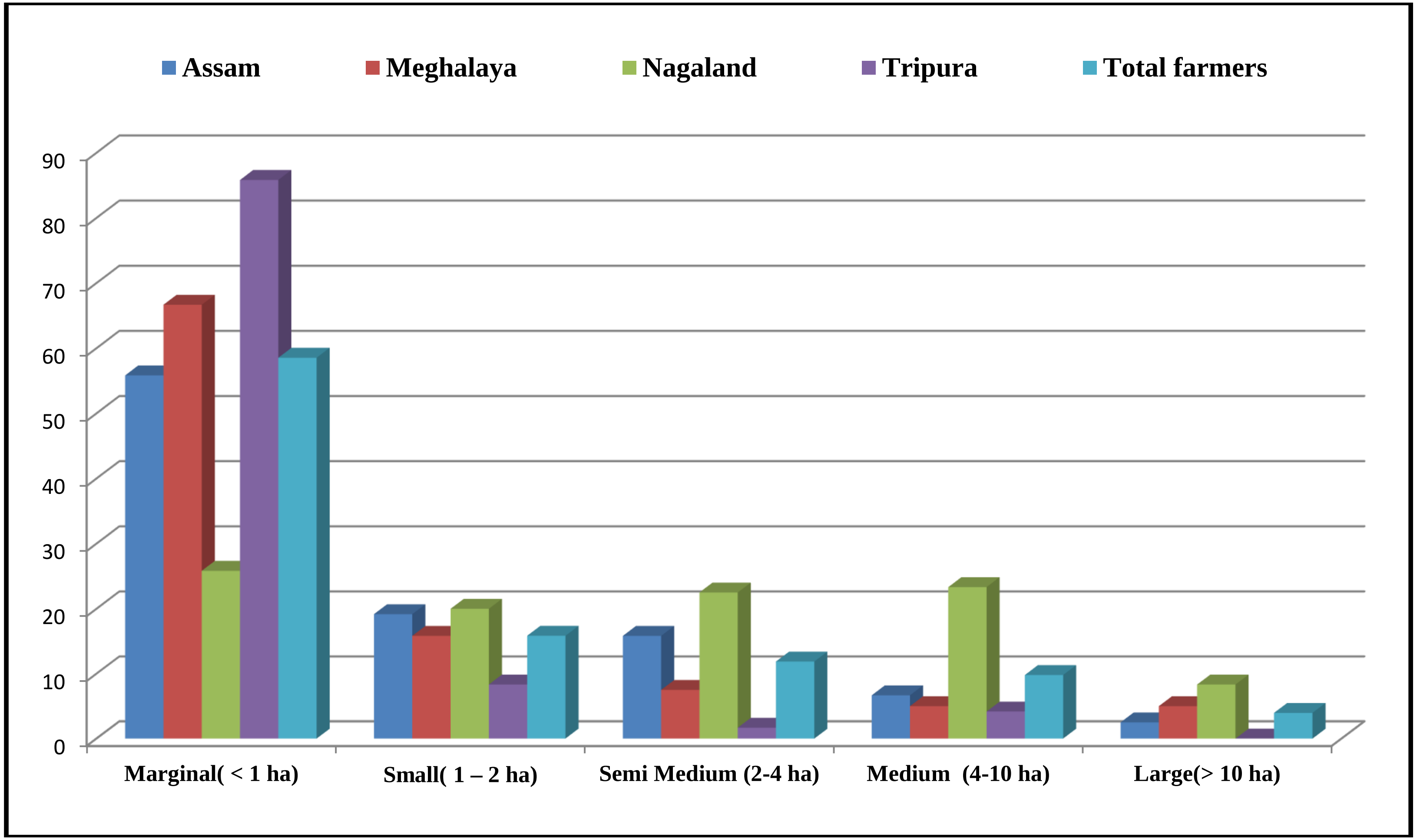

Fig 4.1.5.1: Distribution of respondents based on category of size of the land holding

3	Semi Medium (2-4 ha)	19(15.83)	9(7.50)	27 (22.50)	2 (1.67)	57(11.87)
4	Medium (4-10 ha)	8 (6.67)	6 (5.00)	28(23.33)	5 (4.17)	47(9.79)
5	Large (> 10 ha)	3 (2.50)	6 (5.00)	10 (8.33)	0 (0.00)	19(3.96)
6	Total farmers	**120** (100)	**120** (100)	**120** (100)	**120** (100)	**480** (100)
7	Mean (ha)	1.52	1.42	2.95	0.69	1.65
8	SD	1.94	2.43	2.96	0.86	2.33

It was also found that majority (58.54%) of the potato famers of North-east belonged to the marginal land holding category, followed by 15.84 per cent, 11.87 per cent, 9.79 per cent and 3.96 per cent of them who belonged to small, semi-medium, medium and big land holding categories respectively. These findings were in accordance with the findings of Jaisawal *et al*. (2013) and Kumar *et al*. (2021).

Table 4.1.5.2: Comparative account of total land holding (LH) size of respondents

Sr. No	**Name of the state**	**LH size (µ)**	**Z value**	**P**
1	Assam	1.52	0.332	>0.05
	Meghalaya	1.42		
2	Meghalaya	1.42	**-4.364****	<0.01
	Nagaland	2.95		
3	Nagaland	2.95	**8.052****	<0.01
	Tripura	0.69		
4	Tripura	0.69	**4.285****	<0.01
	Assam	1.52		
5	Tripura	0.69	**3.134****	<0.01

	Meghalaya	1.42		
6	Assam	1.52	**-4.426****	<0.01
	Nagaland	2.95		

** significant at 1% level of probability

From Table 4.1.5.2 it was clear that the level of education of respondent between all the four states were statistically significant at 1% level of significance except Assam and Meghalaya (p-value >0.05).

vi. Area under potato

Table 4.1.6.1 represents the different categories of farmers and their sizes of land holdings under potato. Farmers were categorized in five different categories i.e<0.1 ha, 01-0.2 ha, 0.2-0.3 ha, 0.3-0.4 ha and above 0.4 ha. It can be concluded from the table that majority 67.50 per cent of the potato farmers of Nagaland had area under potato in the range of 0.1-0.2 ha, followed by 62.50 per cent of the potato farmers both from Tripura and Meghalaya and 56.66 per cent farmers from Assam also had area under potato in the range of 0.1-0.2 ha.

Table 4.1.6.1: Distribution of respondents based on size of land holding under potato N=480

Sr. No.	Size of land holding under potato	Assam	Meghalaya	Nagaland	Tripura	Total farmers
		No (%)	**No (%)**	**No (%)**	**No (%)**	**No (%)**
1	<0.1 ha	30(25.00)	29(24.17)	37(30.83)	23(19.17)	119(24.79)
2	0.1-0.2 ha	**68(56.66)**	**75(62.50)**	**81(67.50)**	**75(62.50)**	**299(62.29)**
3	0.2-0.3 ha	2(1.67)	0(0.00)	2(1.67)	2(1.67)	6(1.25)
4	0.3-0.4 ha	17(14.17)	12(10.00)	0(0.00)	13(10.83)	42(8.75)

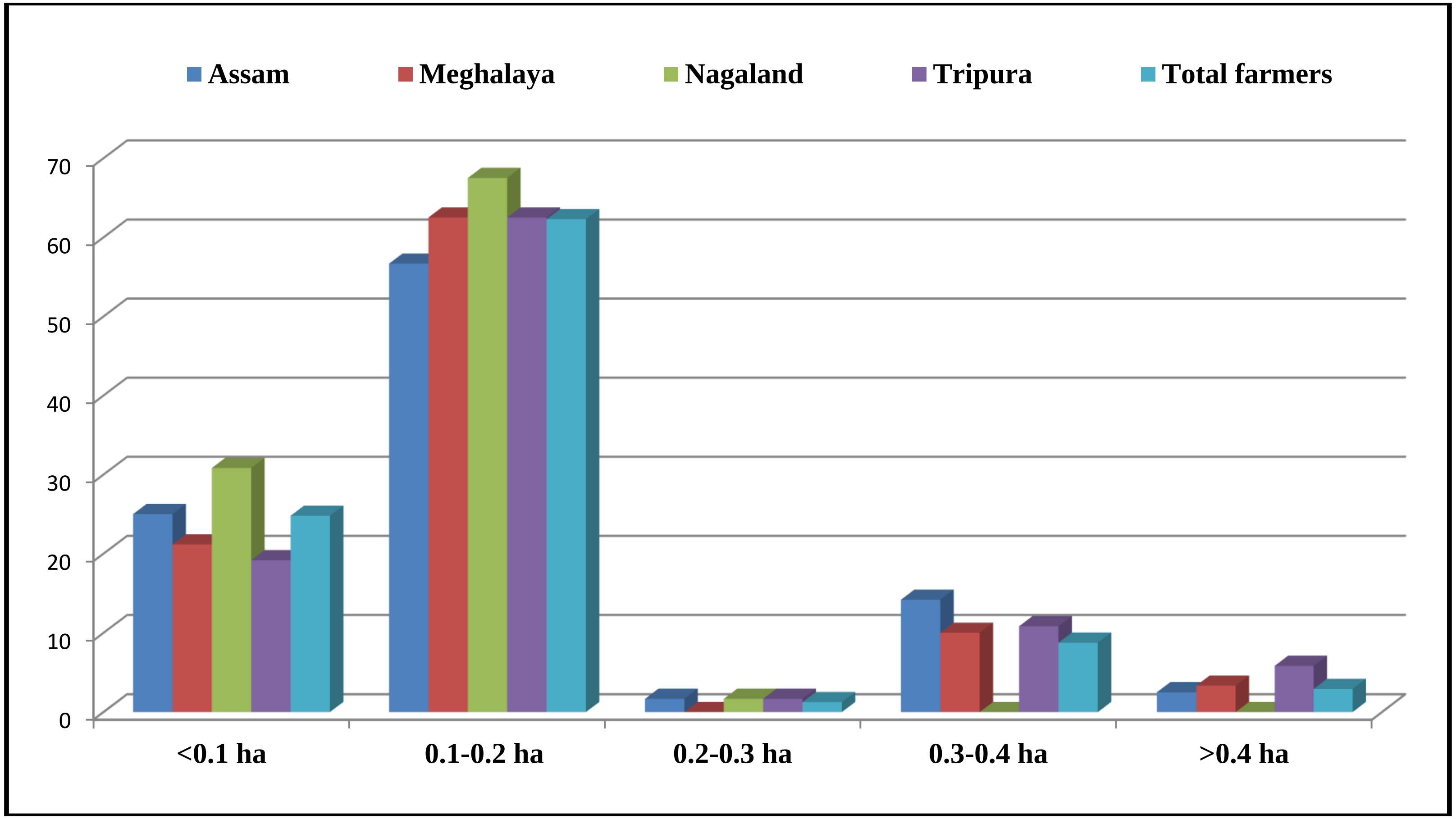

Fig 4.1.6.1: Distribution of respondents based on size of land holding under potato

5	>0.4 ha	3(2.50)	4(3.33)	0(0.00)	7(5.83)	14(2.92)
6	Total farmers	**120**(100)	**120**(100)	**120** (100)	**120** (100)	**480** (100)
	Mean (ha)	0.172	0.163	0.122	0.180	0.159
	SD	0.107	0.104	0.046	0.112	0.099

It maybe concluded from the above table that most (62.29%) of the potato farmers of North-east has land under potato in the range of 0.1-0.2 ha followed by 24.79 per cent, 8.75 per cent, 2.92 per cent and 1.25 per cent has area under potato in the range of less than 0.1 ha, 0.3-0.4 ha, above 0.4 ha and 0.2-0.3 ha respectively. Similar study was found by Sah *et al*. (2011) and Kumar *et al*. (2021).

Table 4.1.6.2: Comparative account of land holding (LH) size under potato

Sr. No	Name of the state	LH size under potato(μ)	z value	p
1	Assam	0.172	0.614	>0.05
	Meghalaya	0.163		
2	Meghalaya	0.163	**3.987****	<0.01
	Nagaland	0.122		
3	Nagaland	0.122	**-5.225****	<0.01
	Tripura	0.180		
4	Tripura	0.180	-0.583	>0.05
	Assam	0.172		
5	Tripura	0.180	-1.196	>0.05
	Meghalaya	0.163		
6	Assam	0.172	**4.629****	<0.01
	Nagaland	0.122		

** Significant at 1% level of probability

Table 4.1.6.2 represents the status of land holding (LH) size under potato of the respondents among all the states. It was found that the land holding (LH) size under potato between Meghalaya vs. Nagaland, Nagaland vs. Tripura and Assam vs. Nagaland was statistically significant at 1% level of significance (p-value <0.01). This study was in accordance with the study of Joneydi (2012).

Table 4.1.6.3 describes the mean percentage of land under potato out of total land under cultivation. Farmers were categorized based upon their overall land holding size and accordingly their mean percentage of land under potato were recorded. It was found that in case of farmers of Tripura most (37.66%) of the potato land belonged to marginal farmers, followed by 31.26 per cent potato land of Assam, 30.26 per cent potato land of Meghalaya and 28.08 per cent potato land of Nagaland belonged to marginal farmers.

Table 4.1.6.3: Mean percentage of land under potato out of total land under cultivation N=480

Sr. No.	Category of farmers	Mean percentage of land under potato out of total land under cultivation				
		Assam	**Meghalaya**	**Nagaland**	**Tripura**	**Mean**
1	Marginal (< 1 ha)	**31.26**	**30.26**	**28.08**	**37.66**	**31.81**
2	Small (1 – 2 ha)	12.65	13.46	7.48	18.71	13.08
3	Semi Medium (2-4 ha)	8.23	11.31	4.55	22.07	11.54
4	Medium (4-10 ha)	7.73	6.72	3.42	8.15	6.51
5	Large (> 10 ha)	1.79	3.59	1.80	0	1.80

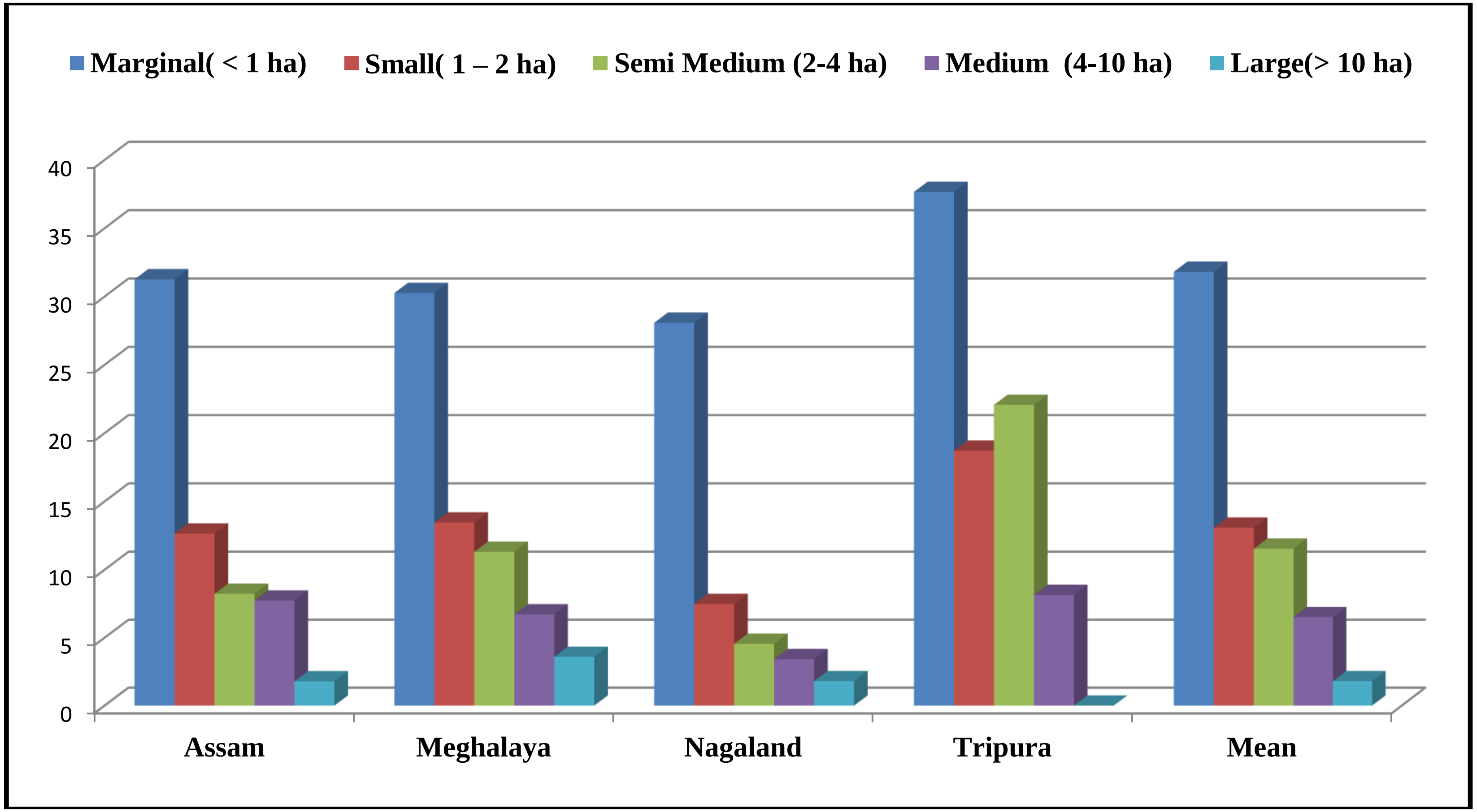

Fig 4.1.6.3: Mean percentage of land under potato out of total land under cultivation

	Mean (ha)	12.33	13.07	9.07	17.32	12.95
	SD	10.07	9.26	9.69	12.82	10.23

Table 4.1.6.4: Comparative account of Mean percentage of land under potato out of total land under cultivation of respondents

Sr. No	Name of the state	Age (μ)	z value	P
1	Assam	47.11	0.614	>0.05
	Meghalaya	49.08		
2	Meghalaya	49.08	**3.987****	<0.01
	Nagaland	47.32		
3	Nagaland	47.32	**-5.408****	<0.01
	Tripura	46.28		
4	Tripura	46.28	-0.608	>0.05
	Assam	47.11		
5	Tripura	46.28	-1.196	>0.05
	Meghalaya	49.08		
6	Assam	47.11	**2.970****	<0.01
	Nagaland	47.32		

* significant at 1% level of probability

Table 4.1.6.4 represents the status of land under potato out of total land under cultivation of the respondents between all the states. From the above table it was clear that the land under potato were statistically significant at 1% level of probability between Meghalaya vs. Nagaland, Nagaland vs. Tripura and Assam vs. Nagaland.

vii. Productivity of potato

Table 4.1.7.1 depicts the comparison of average area, average production and average productivity of potato inthree consecutive years of four potato growing states of North-east. It was found that in the year 2016-17, highest average area of 0.17 ha was recorded in case of farmers of Assam and Tripura, highest average production of 2.92 t and highest average productivity of 16.97 t/ha was recorded in case of farmers of Tripura. In the year 2017-18, highest average area of 0.17 ha was recorded in case of farmers of Assam and Tripura, highest average production of 3.07 t and highest average productivity of 17.64 t/ha was recorded in case of farmers of Tripura. In the year 2018-19, highest average area of 0.18 ha was recorded in case of farmers of Assam and Tripura, highest average production of 3.29 t and highest average productivity of 18.19 t/ha was recorded in case of farmers of Tripura. Similar result were reported by Sah *et al*. (2011) and Akter and Akram (2020).

Table 4.1.7.1: Average Area, Production & Productivity of potato (2016-2019)

Sr. No	State	Average area (ha)				Average production (t)				Average productivity (t/ha)			
		2016-17	2017-18	2018-19	Mean	2016-17	2017-18	2018-19	Mean	2016-17	2017-18	2018-19	Mean
1.	Assam	0.17	0.17	0.18	0.17	2.13	2.26	2.57	2.32	12.55	13.23	14.59	13.46
2.	Meghalaya	0.14	0.16	0.16	0.15	1.79	2.03	2.19	2.00	12.54	12.84	13.24	12.87
3.	Nagaland	0.11	0.11	0.12	0.11	1.16	1.23	1.34	1.24	10.97	11.04	11.49	11.17
4.	Tripura	0.17	0.17	0.18	0.17	2.92	3.07	3.29	3.09	16.97	17.64	18.19	17.60

Table 4.1.7.2 includes the average area, production and productivity of potato among different categories of farmers in different states of North-east (2016-2017) and it was found that in case of Assam state, the average highest (0.31 ha) area was recorded by the big farmers, average highest production (3.54 t) was found in case of medium farmer and average highest (13.08 t/ha)

productivity was found in case of marginal farmers. In case of potato farmers of Meghalaya, highest (0.33 ha) average area under potato was recorded by the big farmers, average production (4.40 t) was found in case of big farmers and average productivity also found highest (13.37 t/ha) in case of big farmers. In case of potato farmers of Nagaland, highest average area (0.16 ha) and average production (1.68 t) was recorded in case of big farmers and average productivity (13.66 t/ha) was recorded highest in case of medium farmers. In case of potato farmers of Tripura, highest average area (0.30 ha) and average production (5.38 t) was found in case of semi-medium farmers, average productivity (16.95 t/ha) was found in case of marginal farmers.

Table 4.1.7.2: Average Area, Production and Productivity of potato among different categories of farmers (2016-2017) N=480

Sr. No	State	Category of farmers	Average area (ha)	Average production (t)	Average productivity (t/ha)
1.	Assam	Marginal	0.13	1.71	**13.08**
		Small	0.15	1.85	12.24
		Semi Medium	0.24	2.82	10.95
		Medium	0.30	**3.54**	10.44
		Large	**0.31**	3.44	11.62
		Mean (μ)	0.17	2.13	12.55
2.	Meghalaya	Marginal	0.11	1.35	12.33
		Small	0.13	1.62	12.41
		Semi Medium	0.22	2.65	11.14
		Medium	0.24	3.09	11.28
		Large	**0.33**	**4.40**	**13.37**
		Mean (μ)	0.14	1.79	12.54
3.	Nagaland	Marginal	0.08	0.84	10.49
		Small	0.09	0.97	11.03
		Semi Medium	0.11	1.13	10.78
		Medium	0.13	1.45	**13.66**
		Large	**0.16**	**1.68**	9.58
		Mean (μ)	0.11	1.16	11.50

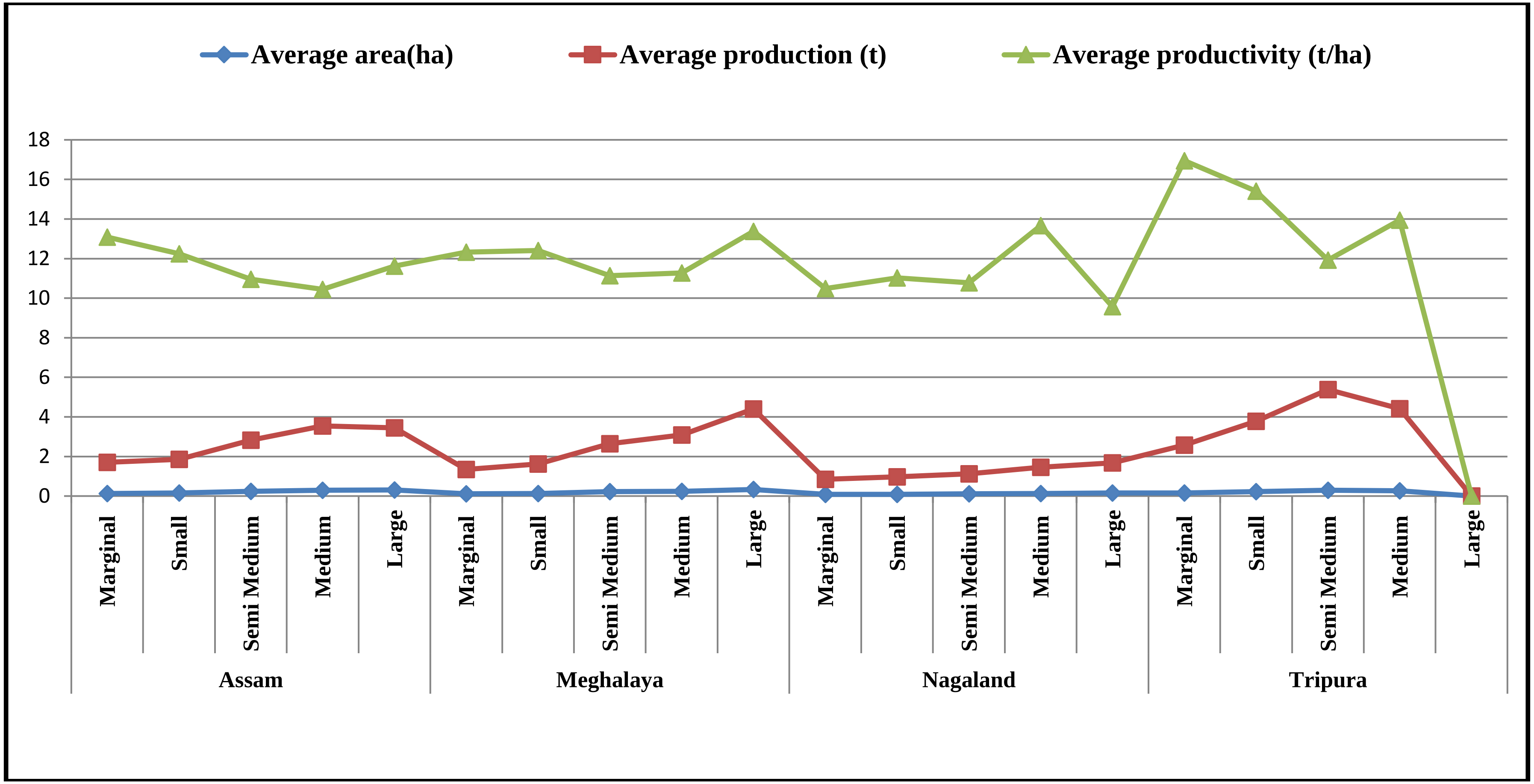

Fig 4.1.7.2: Average Area, Production and Productivity of potato among different categories of farmers (2016-2017)

4.	Tripura	Marginal	0.15	2.58	**16.95**
		Small	0.22	3.78	15.41
		Semi Medium	**0.30**	**5.38**	11.92
		Medium	0.26	4.41	13.95
		Large	0	0	0
		Mean (μ)	0.17	2.92	16.97

Table 4.1.7.3 includes the average area, production and productivity of potato among different categories of farmers in different states of North-east (2017-2018) and it was found that in case of Assam the average highest (0.32 ha) area was recorded by the big farmers, average highest production (3.60 t) was found in case of medium farmer and average highest (13.49 t/ha) productivity was found in case of marginal farmers. In case of potato farmers of Meghalaya, highest (0.34 ha) average area, average production (4.54 t) and average productivity (13.48 t/ha) was found in case of big farmers. In case of potato farmers of Nagaland, highest average area (0.16 ha) and average production (1.84 t) was recorded in case of big farmers and average productivity (11.11 t/ha) was recorded highest in case of small farmers. In case of potato farmers of Tripura, highest average area (0.27 ha) and average production (4.87 t) was found in case of semi-medium farmers, average productivity (17.63 t/ha) was found in case of marginal farmers.

Table 4.1.7.3: Average Area, Production and Productivity of potato among different categories of farmers (2017-2018) N=480

Sr. No	State	Category of farmers	Average area (ha)	Average production (t)	Average productivity (t/ha)
1.	Assam	Marginal	0.13	1.79	**13.49**
		Small	0.15	2.02	13.27
		Semi Medium	0.25	3.09	12.30
		Medium	0.31	**3.60**	10.42
		Large	**0.32**	3.35	12.55

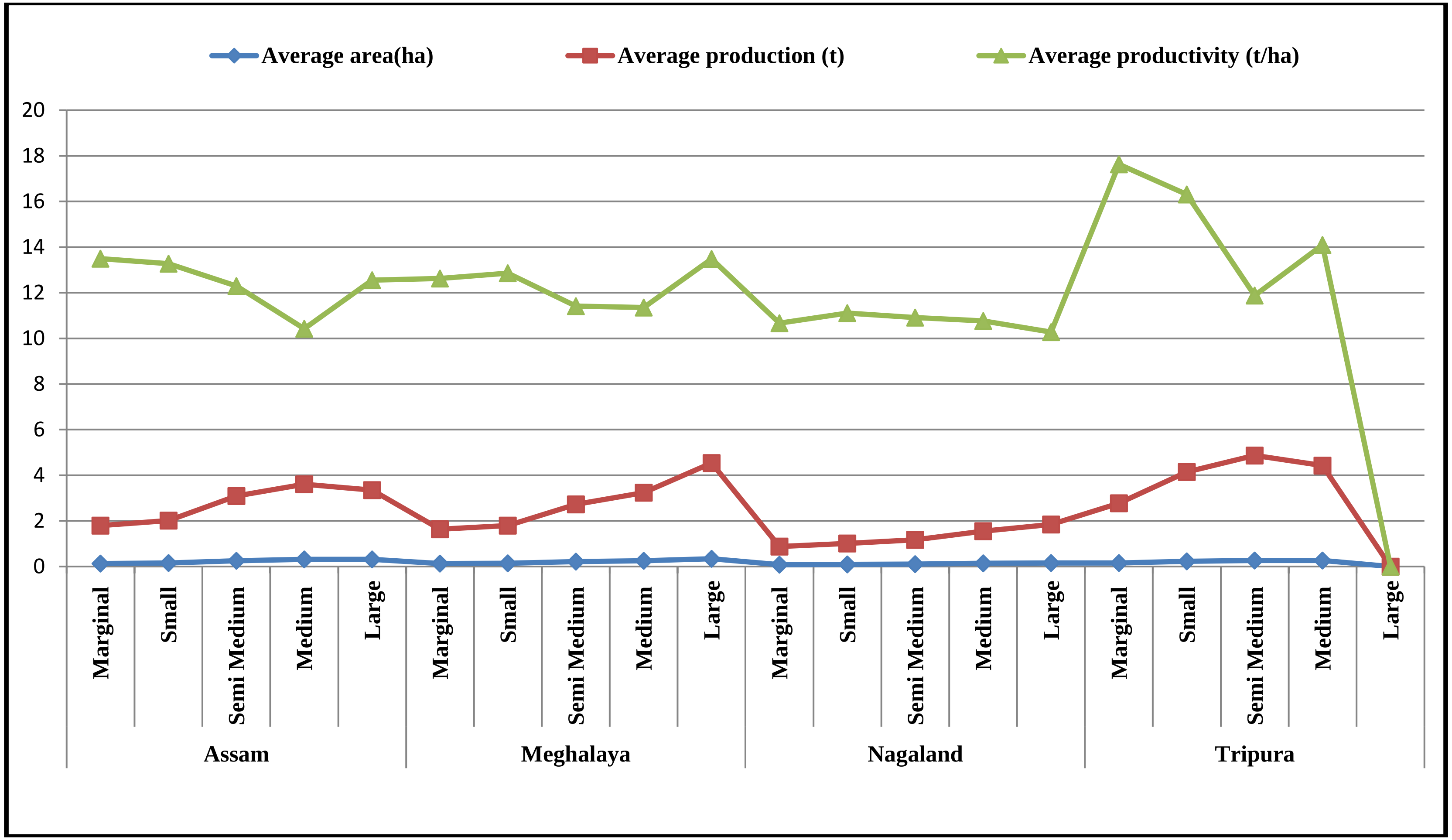

Fig 4.1.7.3: Average Area, Production and Productivity of potato among different categories of farmers (2017-2018)

		Mean (µ)	0.17	2.25	13.23
2.	Meghalaya	Marginal	0.13	1.63	12.62
		Small	0.14	1.79	12.86
		Semi Medium	0.22	2.72	11.42
		Medium	0.25	3.24	11.35
		Large	**0.34**	**4.54**	**13.48**
		Mean (µ)	0.16	2.03	12.84
3.	Nagaland	Marginal	0.08	0.88	10.67
		Small	0.09	1.01	**11.11**
		Semi Medium	0.11	1.17	10.91
		Medium	0.14	1.55	10.77
		Large	**0.16**	**1.84**	10.27
		Mean (µ)	0.11	1.23	10.97
4.	Tripura	Marginal	0.16	2.77	**17.63**
		Small	0.23	4.14	16.31
		Semi Medium	**0.27**	**4.87**	11.88
		Medium	0.26	4.43	14.09
		Large	0	0	0
		Mean (µ)	0.17	4.00	17.64

` Table 4.1.7.4 includes the average area, production and productivity of potato among different categories of farmers in different states of north-east (2018-2019) and it was found that in case of Assam the average highest (0.32 ha) area and average highest production (3.97 t) was found in case of big farmer and average highest (15.11 t/ha) productivity was found in case of marginal farmers. In case of potato farmers of Meghalaya, highest (0.0.39 ha) average area, average production (5.50 t) and average productivity (14.29 t/ha) found highest in case of big farmers. In case of potato farmers of Nagaland, highest average area (0.18 ha) and average production (1.96 t) was recorded in case of big farmers and average productivity (11.20 t/ha) was recorded highest in case of semi medium farmers. In case of potato farmers of Tripura, highest average area (0.32 ha) and average production (6.00 t) was found in case of semi-medium farmers, average productivity (18.21 t/ha) was found in case of marginal farmers.

Table 4.1.7.4: Average Area, Production and Productivity of potato among different categories of farmers (2018-2019)

N=480

Sr. No	State	Category of farmers	Average area ha	Average production (t)	Average productivity (t/ha)
1.	Assam	Marginal	0.14	2.04	**15.11**
		Small	0.17	2.36	14.60
		Semi Medium	0.26	3.54	13.27
		Medium	0.31	3.78	11.02
		Large	**0.32**	**3.97**	12.99
		Mean (μ)	0.18	2.57	14.59
2.	Meghalaya	Marginal	0.12	1.56	13.08
		Small	0.17	2.14	12.96
		Semi Medium	0.25	3.23	11.96
		Medium	0.28	3.60	11.03
		Large	**0.39**	**5.50**	**14.29**
		Mean (μ)	0.16	2.15	13.24
3.	Nagaland	Marginal	0.08	0.92	10.75
		Small	0.09	1.04	10.97
		Semi Medium	0.12	1.36	**11.20**
		Medium	0.16	1.71	10.86
		Large	**0.18**	**1.96**	10.05
		Mean (μ)	0.12	1.34	11.04
4.	Tripura	Marginal	0.16	2.91	**18.21**
		Small	0.23	4.29	16.83
		Semi Medium	**0.32**	**6.00**	12.50
		Medium	0.29	5.11	14.20
		Large	0	0	0
		Mean (μ)	0.18	3.29	18.19

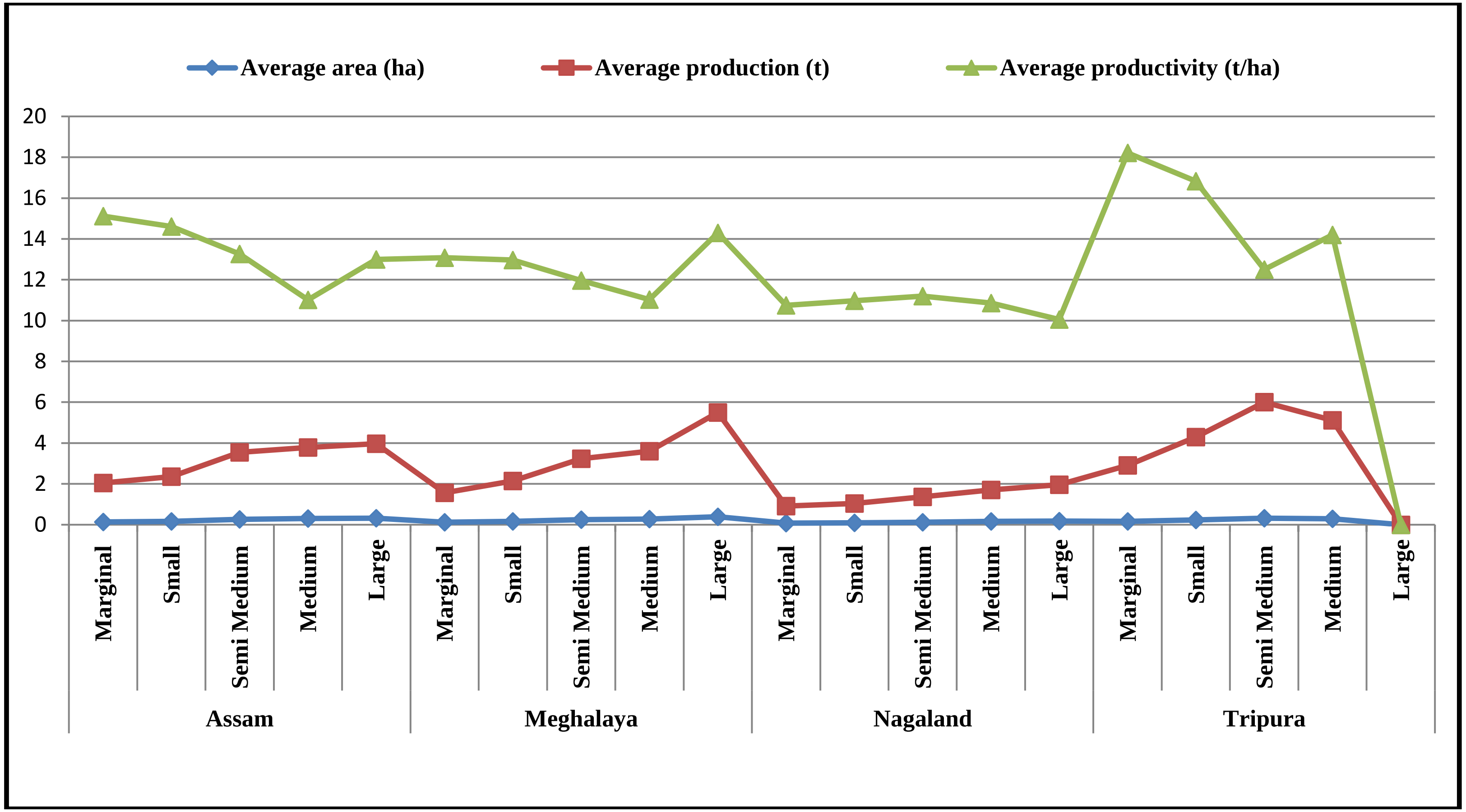

Fig 4.1.7.4: Average Area, Production and Productivity of potato among different categories of farmers (2018-2019)

Table 4.1.7.5: Percentage change in Area, production & productivity of Potato in Assam N=120

Sr. no.	Category of farmers	2017-2018 Percentage change			2018-2019 Percentage change		
		Area	Production	Productivity	Area	Production	Productivity
1	Marginal	2.85	5.18	3.17	0.99	3.17	**11.92**
2	Small	1.14	**9.09**	8.38	7.02	8.38	10.05
3	Semi Medium	5.32	9.07	**12.37**	4.42	**12.36**	7.90
4	Medium	2.57	1.69	0.26	0.36	0.26	5.49
5	Large	**7.32**	2.58	7.96	**11.36**	7.96	3.48

Table 4.1.7.5 represents the percentage change in area, production, and productivity of potato farmer in Assam. It was observed that large farmer occupied the highest percentage of area (7.32%), small farmer occupied the highest production (9.09%) and semi-medium farmer occupied the highest productivity (12.37%) in the year 2017-18. But in 2018-19, it was observed that large farmer occupied the highest percentage of area (11.36%) semi-medium farmer occupied the highest production (12.36%) and marginal farmers occupied the highest productivity (11.32%).

Table 4.1.7.6: Percentage change in Area, production & productivity of Potato in Meghalaya N=120

Sr. no.	Category of farmers	2017-2018 Percentage change			2018-2019 Percentage change		
		Area	Production	Productivity	Area	Production	Productivity
1	Marginal	**9.88**	**15.37**	2.33	6.42	4.10	3.68
2	Small	7.72	10.36	**3.61**	**18.87**	19.28	0.77
3	Semi Medium	1.39	3.85	2.50	13.24	17.68	4.69
4	Medium	4.82	4.85	2.28	14.94	11.06	0.63
5	Large	3.03	3.10	0.79	13.72	**21.10**	**5.98**

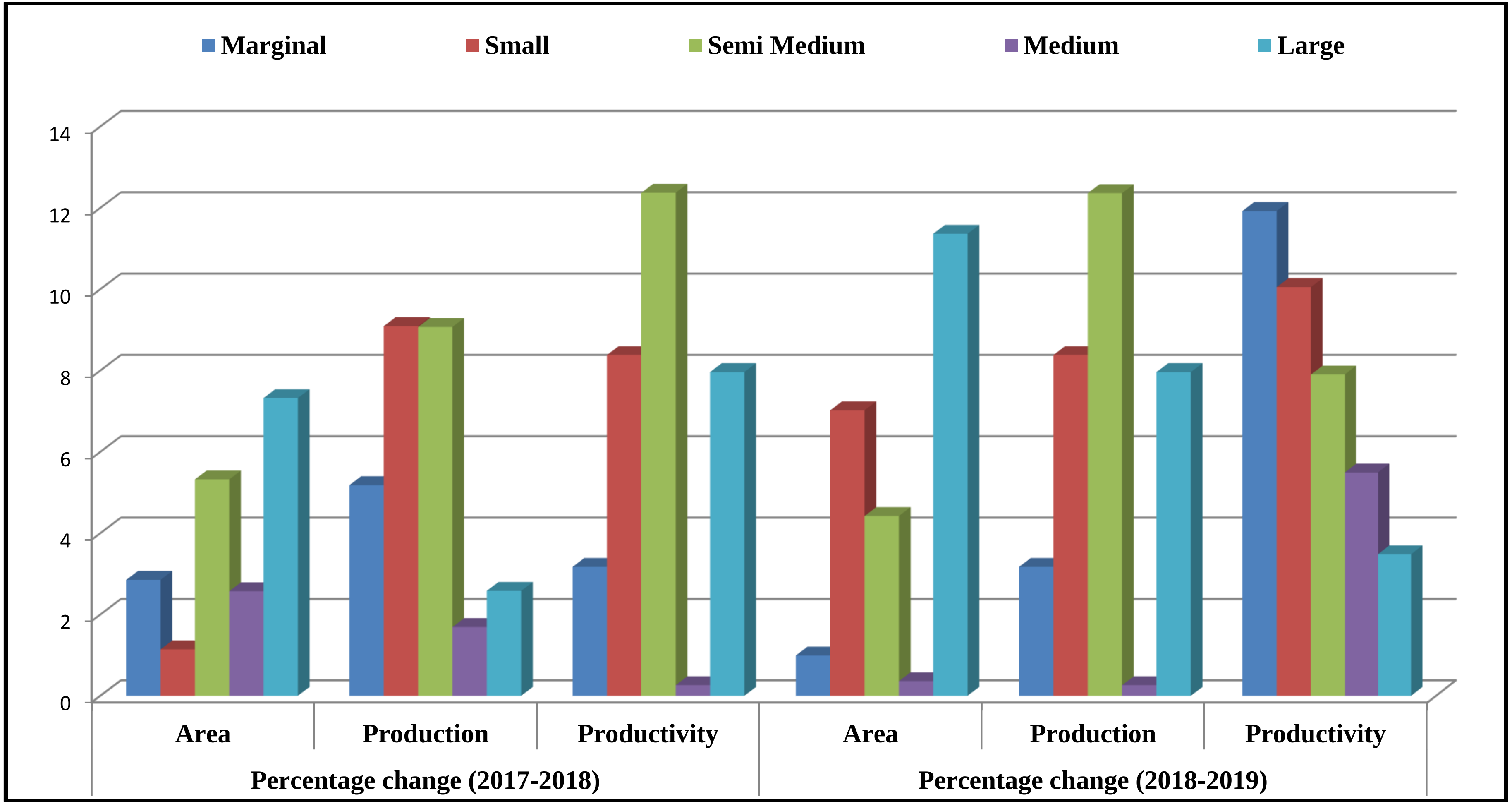

Fig 4.1.7.5: Percentage change in Area, production &productivity of Potato in Assam (2016-2019)

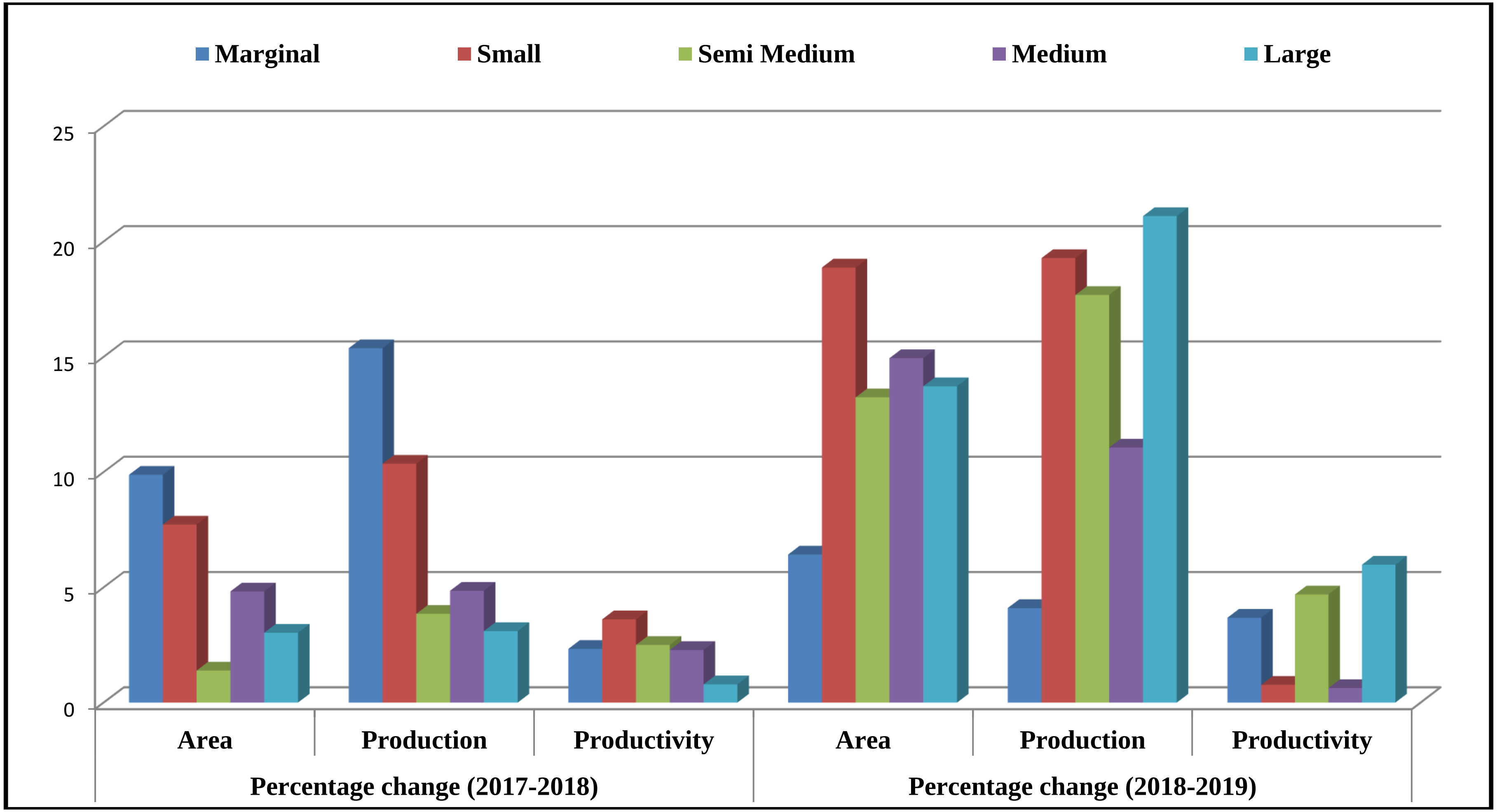

Fig 4.1.7.6: Percentage change in Area, production & productivity of Potato in Meghalaya (2016-2019)

Table 4.1.7.6 represents the percentage change in area, production, and productivity of potato farmer in Meghalaya. It was observed that marginal farmer occupied the highest percentage of area (9.88%) and production (15.37%) and small farmer occupied the highest productivity (3.61%) in 2017-18. But in 2018-19, it was observed that small farmer occupied the highest percentage of area (18.87%) and large farmers occupied the highest production (21.10%) and productivity (5.98 %).

Table 4.1.7.7: Percentage change in Area, production & productivity of Potato in Nagaland N=120

Sr. no.	Category of farmers	2017-2018 Percentage change			2018-2019 Percentage change		
		Area	**Production**	**Productivity**	**Area**	**Production**	**Productivity**
1	Marginal	3.98	5.54	1.67	2.68	4.33	0.75
2	Small	2.36	3.57	0.61	5.07	3.53	0.72
3	Semi Medium	1.39	3.23	1.21	**13.01**	**16.35**	**2.69**
4	Medium	**9.51**	6.86	1.01	9.68	10.59	0.89
5	Large	2.27	**9.40**	**4.88**	8.88	6.67	2.13

Table 4.1.7.7 represents the percentage change in area, production, and productivity of potato farmer in Nagaland. It was observed that medium farmer occupied the highest percentage of area (9.51%) and large farmer occupied the highest production (9.40%) and productivity (4.88%) in 2017-18. But in 2018-19, it was observed that semi-medium farmer occupied the highest percentage of area (13.01%), production (16.35%) and productivity (2.69%).

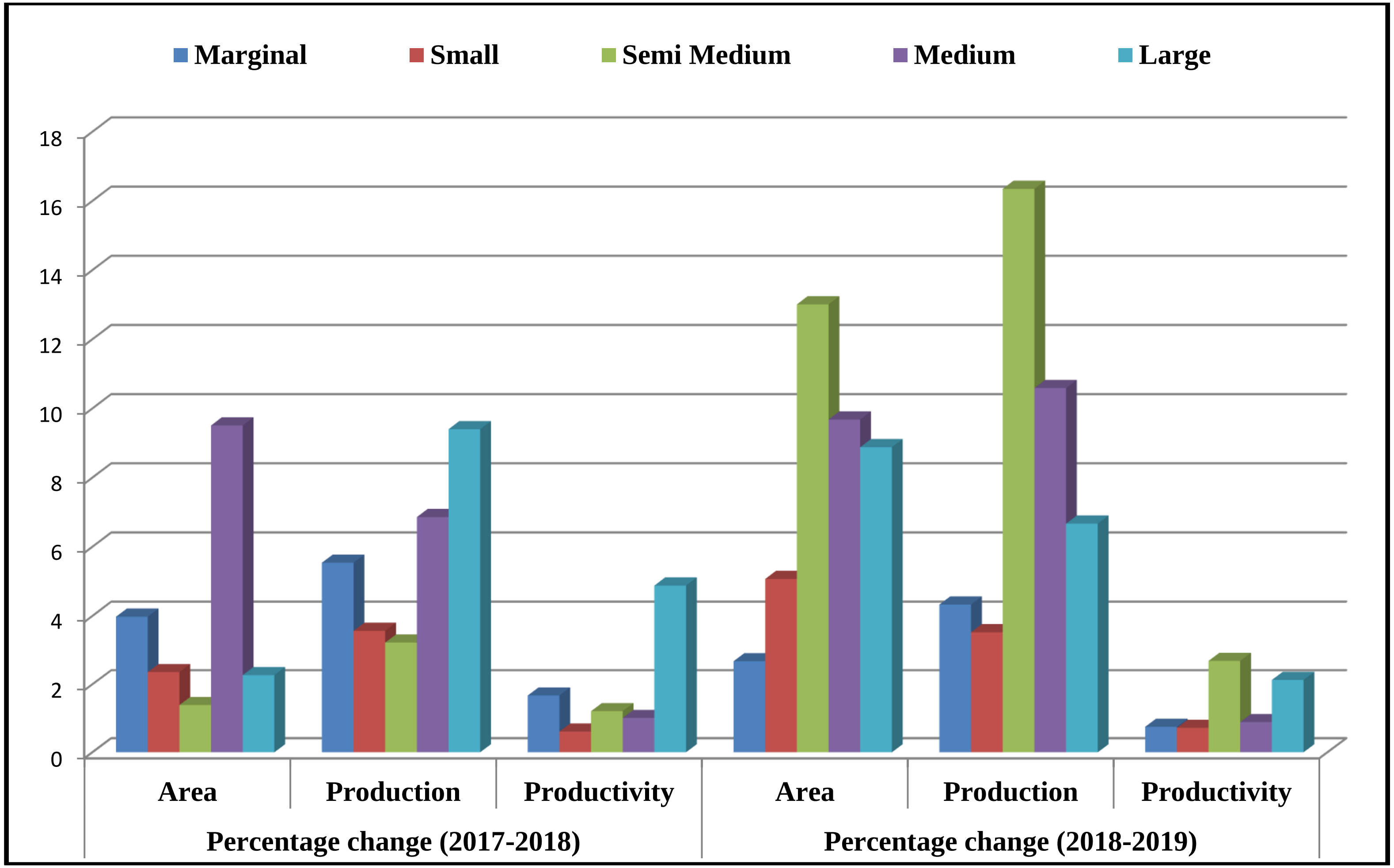

Fig 4.1.7.7: Percentage change in Area, production & productivity of Potato in Nagaland (2016-2019)

Table 4.1.7.8: Percentage change in Area, production & productivity of Potato in Tripura N=120

Sr. no.	Category of farmers	2017-2018 Percentage change			2018-2019 Percentage change		
		Area	**Production**	**Productivity**	**Area**	**Production**	**Productivity**
1	Marginal	2.64	7.34	4.06	2.13	4.79	3.26
2	Small	4.56	9.61	**5.82**	1.59	3.75	3.21
3	Semi Medium	2.76	**11.11**	1.43	**17.07**	**23.29**	**5.17**
4	Medium	**6.94**	0.51	1.01	14.28	15.21	0.78
5	Large	0	0	0	0	0	0

Table 4.1.7.8 represents the percentage change in area, production, and productivity of potato farmer in Tripura. It was observed that medium farmer occupied the highest percentage of area (6.94%) and semi medium farmer occupied the highest production (11.11%) and small farmer occupied the highest productivity (5.82%) in 2017-18. But in 2018-19, it was observed that semi-medium farmer occupied the highest percentage of area (17.07%), production (23.29%) and productivity (5.17%).

Table 4.1.7.9: Comparative account of Productivity of potato (2016-2019)

Sr. No	Name of the state	Productivity of Potato(μ)	z value	Probability
1	Assam	13.46	**2.801****	<0.01
	Meghalaya	12.87		
2	Meghalaya	12.87	**15.317****	<0.01
	Nagaland	11.17		
3	Nagaland	11.17	**-47.596****	<0.01
	Tripura	17.60		
4	Tripura	17.60	**-17.986****	<0.01
	Assam	13.46		

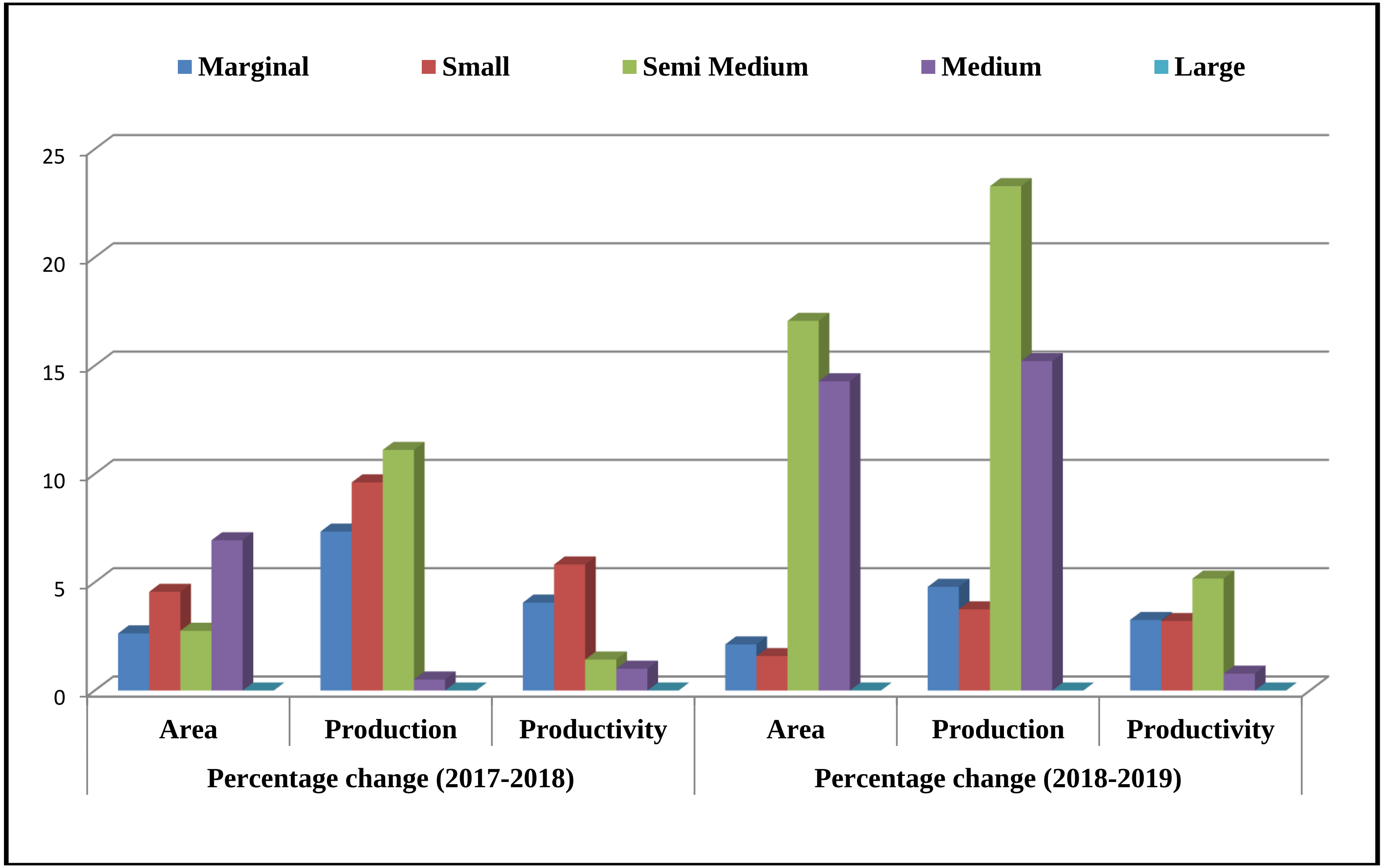

Fig 4.1.7.8: Percentage change in Area, production & productivity of Potato in Tripura (2016-2019)

5	Tripura	17.60	**-29.273****	<0.01
	Meghalaya	12.87		
6	Assam	13.46	**12.382****	<0.01
	Nagaland	11.17		

** significant at 1% level of probability

From Table 4.1.7.9, it is clear that the Productivity of potato among all the states werestatistically significant at 1% level of significance. It indicated that there was a significant difference in the potato productivityamong all the selected states.

viii. Annual income

The results presented in Table 4.1.8.1 and Fig 4.1.8.1 revealed the different sources of annual income of the potato farmersof North-eastern states. Farmers of the selected states were categorized based upon their land holding categories and their mean annual income from different sources were calculated. Potato farmers of Assam received the highest mean annual income of Rs. 2,40,645.30 in case of large farmers followed by Rs. 1,86,222.10 in case of medium farmers, Rs. 1,80,112.50 in case of semi medium farmers, Rs. 1,17,263.90 in case of small farmers and Rs. 1,10,695.20 in case of marginal farmers. In case of potato farmers of Meghalaya,large farmers hadthe highest mean annual income of Rs.3,36,435.50, followed by mean income of Rs. 2,69,388 in case of medium farmers, Rs. 1,80,112.50 for semi-medium farmers, Rs. 1,17,263.90 in case of small farmers and Rs. 1,07,245.40 for marginal farmers. Further in case of potato farmers of Nagaland, highest mean annual income of Rs. 2,80,233.50 was recorded in case of large farmers followed by Rs. 1,39,066.40 in case of medium farmers, Rs. 1,14,365 in case of semi-medium farmers, Rs. 95,349.40 in case of small farmers and Rs. 86,164.66 in case of small farmers. Similarly in case of potato farmers of Tripura, highest mean annual income of Rs. 4,44,714.20 was found in case of medium farmers followed by Rs. 4,23,409.20 in case of semi medium farmers, Rs. 2,76,751.30 in case of small farmers and Rs. 1,74,236 in case of marginal farmers. Sharma *et al*. (2014) and Akter and Akram (2020) found the similar results.

Table 4.1.8.1: Distribution of respondents based on mean annual income N=480

Sr. No.	Category of farmers	Mean annual income (Rs.)				
		Assam	Meghalaya	Nagaland	Tripura	Overall farmers
1	Marginal (< 1 ha)	110695.20	107285.40	86164.66	174236	119595.30
2	Small (1 – 2 ha)	117263.90	155530.80	95349.40	276751.30	161223.90
3	Semi Medium (2-4 ha)	180112.50	205202.80	114365	423409.20	230772.40
4	Medium (4-10 ha)	186222.10	269388	139066.40	444714.20	259847.70
5	Large (> 10 ha)	240645.30	336432.50	280233.50	0	**285770.40**

It was also revealed from the Table 4.1.8.1 that in case of the potato farmers of North-east, mean annualincome was found highest as Rs. 2,85,770.40 in case of large farmers followed by Rs. 2,59,847.70 in case of medium farmers, Rs. 2,30,772.40 in case of semi-medium farmers, Rs. 1,61,223.90 in case of small farmers and Rs. 1,19,595.30 in case of marginal farmers. These findings were similar to the findings of Kulkarni and Jahagirdar (2015).

Table 4.1.8.2: Comparative account of annual income from potato cultivation

Sr No	Name of the state	Annual income from potato(μ)	z value	Probability
1	Assam	131229	-0.959	>0.05
	Meghalaya	141309		
2	Meghalaya	141309	**3.288****	<0.01

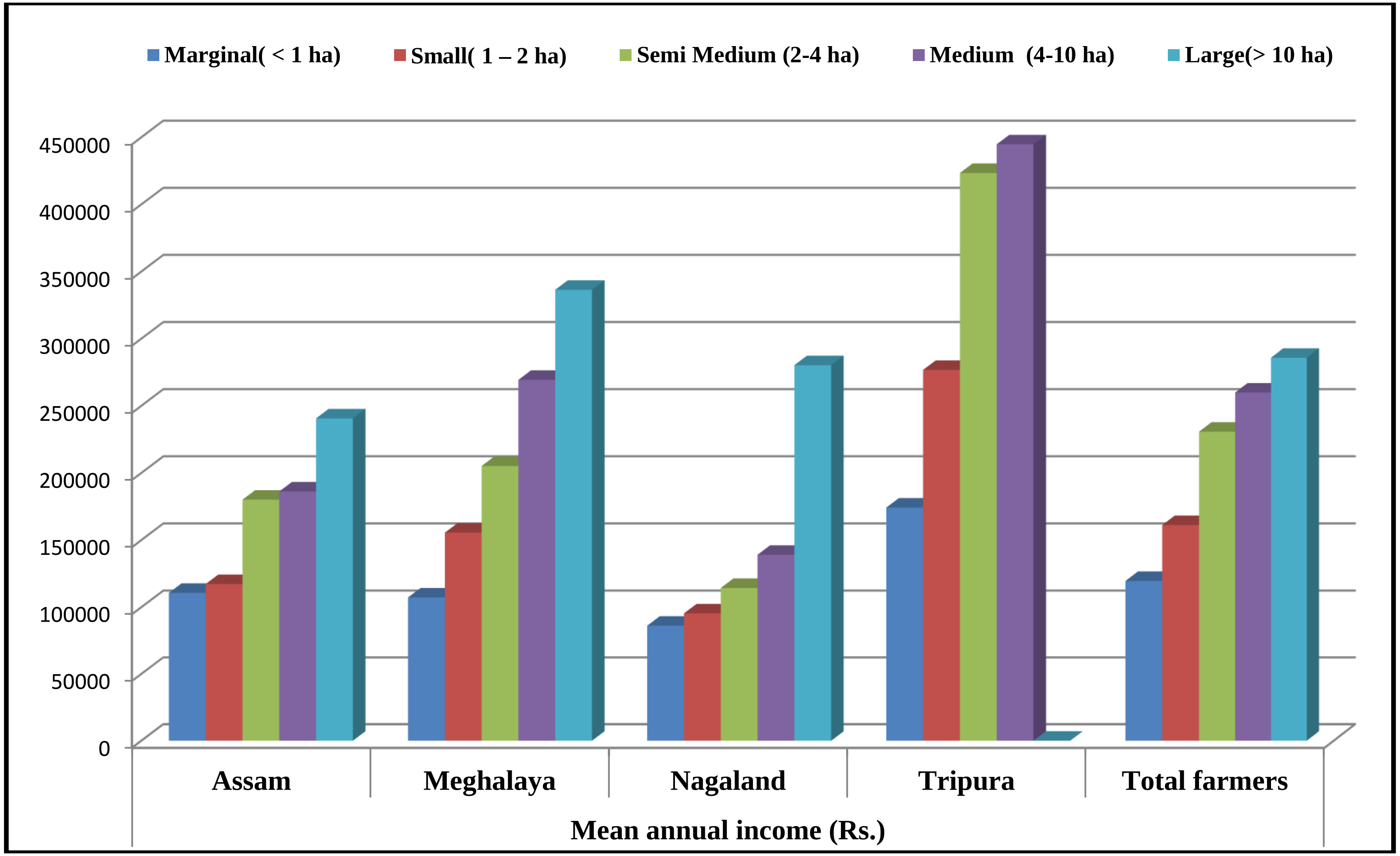

Fig 4.1.8.1: Distribution of respondents based on mean annual income

	Nagaland	122863		
3	Nagaland	122863	**-8.228****	<0.01
	Tripura	198202		
4	Tripura	198202	**-5.494****	<0.01
	Assam	131229		
5	Tripura	198202	**-5.033****	<0.01
	Meghalaya	141309		
6	Assam	131229	1.763	>0.05
	Nagaland	198202		

** significant at 1% level of probability

The annual income from the potato cultivation of the respondents were statistically significant at 1per cent level of probability as found between Meghalaya vs. Nagaland, Nagaland vs. Tripura, Tripura vs. Assam and Tripura vs. Meghalaya.

ix. Income from potato production

Table 4.1.9.1 Mean income from potato farming N=480

Sr. no.	Income groups	Assam	Meghalaya	Nagaland	Tripura	Overall Farmers
		(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)
1.	Marginal (< 1 ha)	21096.77	24435.40	18206.39	33638.91	24344.37
2.	Small (1 – 2 ha)	27503.08	33609.77	20932.74	50001.16	33011.69
3.	Semi Medium (2-4 ha)	34533.53	55702.76	26624.21	**104659.20**	**55739.92**
4.	Medium (4-10 ha)	46641.84	58761.14	33150.32	60595.20	49787.13
5.	Large (> 10 ha)	**47312**	**74995.20**	**39030.40**	0	47336.53
6.	Mean	27125	33659.17	26621.15	38230.92	31409.06
7.	Sd	16157	21757.26	9973.17	24529.58	5579.76

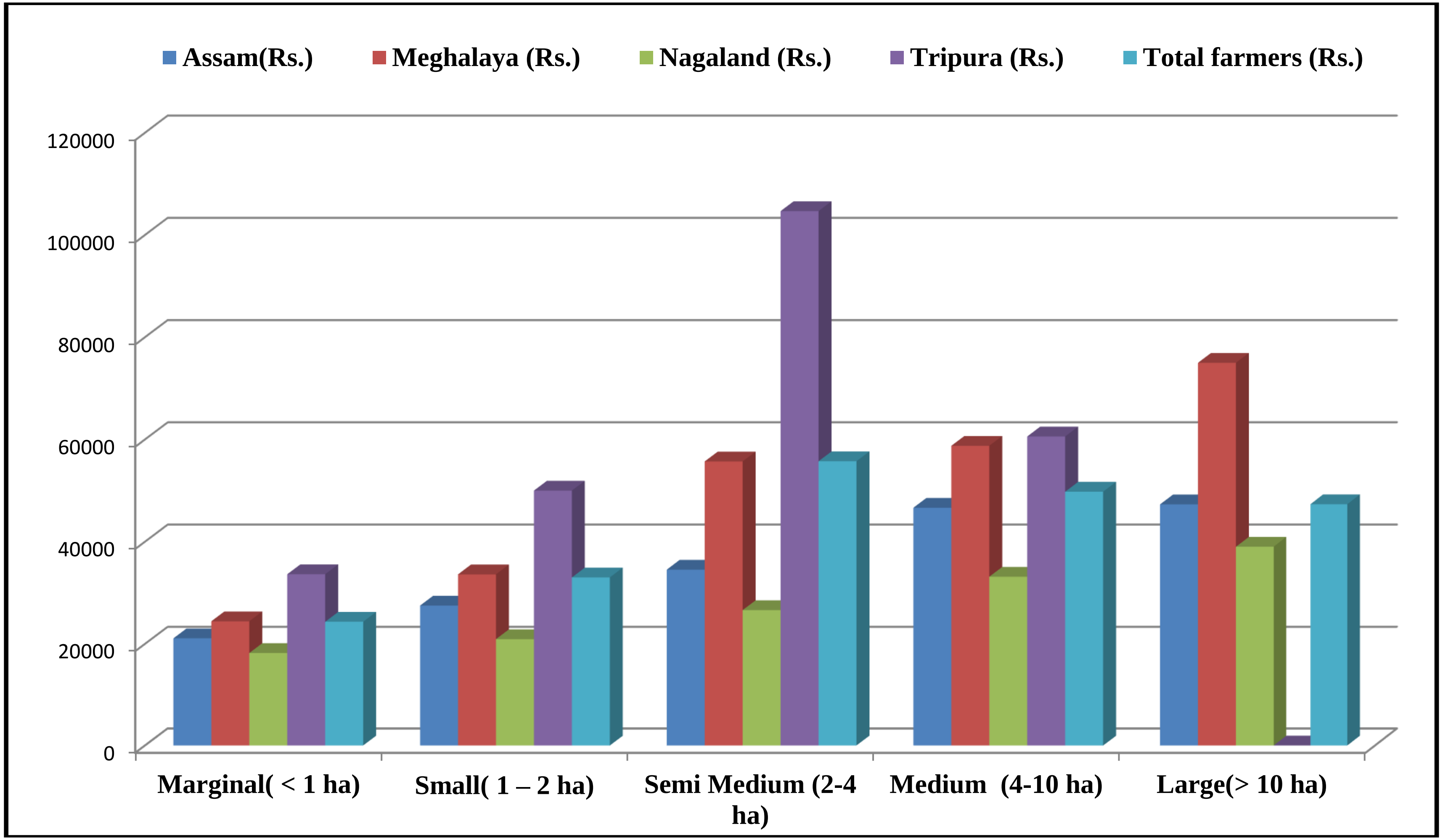

Fig 4.1.9.1 Mean income from potato farming

Table 4.1.9.1 represents the Mean income from potato farming of the respondents in North-eastern states. It was observed that highest mean income in case of large farmers for the state of Assam was Rs. 47,312.00, Meghalaya as Rs. 74995.20 and Nagaland as Rs. 39,030.40. In the state of Tripura, the highest mean income occupied by the semi-medium farmer (Rs. 104659.20). Considering all the states in North-east the highest mean income was obtained by the semi-medium farmers (Rs. 55739.92), followed by medium farmers (Rs. 49, 7787.13) followed by large farmers (Rs. 47,336.53).

Table 4.1.9.2: Comparative account of sole income from potato cultivation

Sr. No	Name of the state	Sole income from Potato(μ)	z value	Probability
1	Assam	27125	**-2.630****	<0.01
	Meghalaya	33659.17		
2	Meghalaya	33659.17	**3.208****	<0.01
	Nagaland	26621.15		
3	Nagaland	26621.15	**4.783****	<0.01
	Tripura	38230.92		
4	Tripura	38230.92	**-4.125****	<0.01
	Assam	27125		
5	Tripura	38230.92	-1.521	>0.05
	Meghalaya	33659.17		
6	Assam	27125	0.289	>0.05
	Nagaland	26621.15		

** significant at 1% level of probability

Table 4.1.9.2 represents the status of sole income of the respondents from potato among all the states of North-eastern India. It is found that Assam vs. Meghalaya, Meghalaya vs. Nagaland, Nagaland vs. Tripura and Tripura vs. Assam werestatistically significant at 1per cent level of the significance.

x. Training exposure

It was observed from Table 4.1.10.1 and Fig 4.1.10.1 that majority (58.33%) of potato growers of Tripura had training exposure between 10-20 days followed by 45.00, 44.17 per cent and 42.50 per cent of the potato growers of Nagaland, Assam and Meghalaya had training exposure between 10-20 days. Further, 23.33 per cent potato growers of Tripura, 20.00 per cent potato growers of Assam, 18.33 per cent potato growers of Meghalaya and 10.00 per cent of the potato growers of Nagaland had training below 10 days. Similarly, majority (7.50%) of the potato growers of Tripura, 5.83 per cent potato growers of Meghalaya, 5.00 per cent potato growers of Nagaland and 2.50 per cent of the potato growers of Assam had training exposure more than 20 days. Besides it, 40.00 per cent of the potato growers of Nagaland, 33.33 per cent of the potato growers of Meghalaya and Assam, 10.83 per cent of the potato growers of Tripura didn't receive any training.

Table 4.1.10.1: Distribution of respondents based on number of days of training received N=480

Sl. No.	Number of days of training received	Assam	Meghalaya	Nagaland	Tripura	Total farmers
		No (%)	No (%)	No (%)	No (%)	No (%)
1.	No training received	40(33.33)	40(33.33)	48(40.00)	13(10.83)	141(29.37)
1	<10 days	24(20.00)	22(18.33)	12 (10.00)	28(23.33)	86(17.92)
2	10-20 days	**53(44.17)**	**51(42.50)**	**54(45.00)**	**70(58.33)**	**228(47.50)**
3	>20 days	3(2.50)	7(5.83)	6(5.00)	9(7.50)	25(5.21)

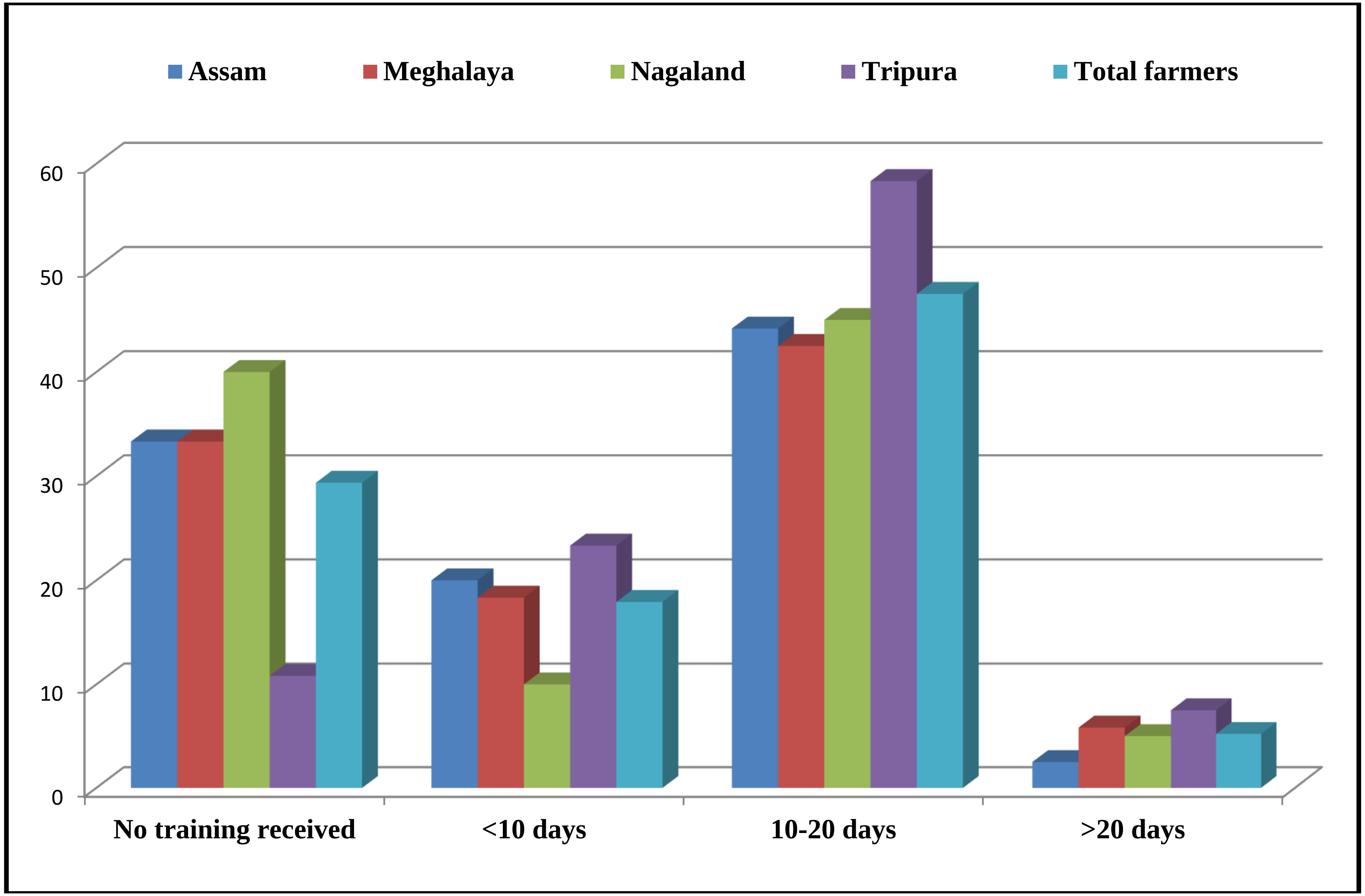

Fig 4.1.10.1: Distribution of respondents based on number of days of training received

4	Total farmers	120(100)	120(100)	120 (100)	120(100)	480(100)
5	Mean	8.07	8.38	8.36	11.36	9.04
6	Sd	6.95	7.15	7.67	6.44	7.20

It was also found that majority (47.50 %) of the potato farmers of North-east, had training exposure between 10-20 days. These might be due to the less number of trainings organized by the state horticultural department or other training agencies. These findings were similar to the findings of Kalita and Chabukdhara (2014) and Adusei (2020).

Table 4.1.10.2: Distribution of respondents based on the areas of training needs of sustainable potato cultivation in AssamN=120

Sr No	Areas of Training Needs	Most needed	Needed	Not Needed	TIS
		f (%)	f (%)	f (%)	
1	Soil Management	33(27.50)	28(23.33)	59(49.17)	39.17
2	Seed selection	45(37.50)	43(35.83)	32(26.67)	55.42
3	Seed size	**58 (48.33)**	42 (35.00)	20 (16.67)	65.83
4	Seed preparation	44 (36.67)	39 (32.50)	37 (30.83)	53.33
5	Planting time	17 (14.17)	9 (7.50)	94 (78.33)	**17.92**
6	Integrated Nutrient Management	**49 (40.83)**	59 (49.17)	12 (10.00)	65.42
7	Planting method	47 (39.17)	52 (43.33)	21 (17.50)	60.83
8	Water management	46 (38.33)	40 (33.33)	34 (28.33)	55.00
9	Intercultural operations	44 (36.67)	45 (37.50)	31 (25.83)	55.42
10	Plant protection measures	**62 (51.67)**	42 (35.00)	16 (13.33)	**69.17**
11	Harvesting	38 (31.67)	53 (44.17)	29 (24.17)	53.75
12	Seed production	35 (29.17)	54 (45.00)	31 (25.83)	51.67

Table 4.1.10.2: represents the distribution of respondents based on the areas of training needs of sustainable potato cultivation in Assam. It was revealed that majority of the farmers (51.67%) needs training in the area of Plant protection measures, followed by 48.33 per cent of the farmers need training in the area of Seed size which is also followed by 40.83 per cent of the farmers needs training in Integrated Nutrient Management. It was also observed that highest Training importance score (TIS) was in the area of Plant protection measures (69.17%) and least TIS was found in the area of planting time (17.92%).

Table 4.1.10.3: Distribution of respondents based on the areas of training needs sustainable potato cultivation in Meghalaya N=120

Sr. No.	Areas of Training Needs	MN	Needed	Not Needed	TIS
		f (%)	f (%)	f (%)	
1	Soil Management	43 (35.83)	23(19.17)	54(45.00)	45.42
2	Seed selection	**60(50.00)**	41(34.17)	19(15.83)	67.08
3	Seed size	48(30.00)	31(25.83)	41(34.17)	52.92
4	Seed preparation	45(37.50)	34(28.33)	41(34.17)	51.67
5	Planting time	3(2.50)	28(23.33)	89(74.17)	**14.67**
6	Integrated Nutrient Management	**61(50.83)**	50(41.67)	9(7.50)	71.67
7	Planting method	50(41.67)	44(36.67)	26(21.67)	60.00
8	Water management	50(41.67)	60(50.00)	10(8.33)	66.67
9	Intercultural operations	47(39.17)	41(34.17)	32(26.67)	56.25
10	Plant protection measures	**66(55.00)**	45(37.50)	9(7.50)	**73.75**
11	Harvesting	52(43.33)	45(37.50)	23(19.17)	62.08
12	Seed production	45(37.50)	61(50.83)	14(11.67)	62.92

Table 4.1.10.3 represents the distribution of respondents based on the areas of training needs of sustainable potato cultivation in Meghalaya. It was revealed that majority of the farmers (55.00%) needs training in the area of

Plant protection measures, followed by 50.83 per cent of the farmers need training in the area of integrated nutrient management which is also followed by 50 per cent of the farmers needs training in the area of selection of seed. It was also observed that highest Training important score (TIS) was in the area of Plant protection measures (73.75%) and least TIS was found in the area of planting time (14.67%).

Table 4.1.10.4: Distribution of respondents based on the areas of training needs sustainable potato cultivation in Nagaland N=480

Sr No	Areas of Training Needs	MN	Needed	Not Needed	TIS
		f (%)	**f (%)**	**f (%)**	
1	Soil Management	39(32.50)	38(31.67)	43(35.83)	48.33
2	Seed selection	54(45.00)	46(38.33)	20(16.67)	64.17
3	Seed size	45(37.50)	43(35.83)	32(26.67)	55.42
4	Seed preparation	54(45.00)	37(30.83)	29(24.17)	60.42
5	Planting time	43(35.83)	27(22.50)	50(41.67)	**47.08**
6	Integrated Nutrient Management	**69(57.50)**	46(38.33)	5(4.17)	**76.67**
7	Planting method	50(41.67)	48(40.00)	22(18.33)	61.67
8	Water management	**61(50.83)**	50(41.67)	9(7.50)	71.67
9	Intercultural operations	45(37.50)	48(40.00)	27(22.50)	57.50
10	Plant protection measures	**69(57.50)**	42(35.00)	9(7.50)	75.00
11	Harvesting	45(37.50)	42(35.00)	33(27.50)	55.00
12	Seed production	59(49.17)	52(43.33)	9(7.50)	70.83

Table 4.1.10.3 represents the distribution of respondents based on the areas of training needs of sustainable potato cultivation in Nagaland. It was revealed that majority of the farmers (57.50%) needs training in the area of Plant protection measures andintegrated nutrient management which is followed by 50.83 per cent of the farmers needs training in the area of water management. It was also observed that highest Training important score (TIS)

was in the area of integrated nutrient management (76.67%) and least TIS was found in the area of planting time (47.08%).

Table 4.1.10.5: Distribution of respondents based on the areas of sustainable potato cultivation training needs in Tripura N=480

Sr. No	Areas of Training Needs	MN	Needed	Not Needed	TIS
		f (%)	f (%)	f (%)	
1	Soil Management	24(20.00)	8(6.67)	88(73.33)	23.33
2	Seed selection	28(23.33)	44(36.67)	48(40.00)	41.67
3	Seed size	**50(41.67)**	39(32.50)	31(25.83)	57.92
4	Seed preparation	20(16.67)	24(20.00)	76(63.33)	26.67
5	Planting time	7(5.83)	6(5.00)	107(89.17)	**8.33**
6	Integrated Nutrient Management	37(30.83)	34(28.33)	49(40.83)	45.00
7	Planting method	18(15.00)	43(35.83)	59(49.17)	32.92
8	Water management	20(16.67)	36(30.00)	64(53.33)	31.67
9	Intercultural operations	**39(32.50)**	41(34.17)	40(33.33)	49.58
10	Plant protection measures	**64(53.33)**	40(33.33)	10(8.33)	**70.00**
11	Harvesting	30(25.00)	48(40.00)	42(35.00)	45.00
12	Seed production	27(22.50)	56(46.67)	37(30.83)	45.83

Table 4.1.10.5 represents the distribution of respondents based on the areas of training needs of sustainable potato cultivation in Tripura. It was revealed that majority of the farmers (53.33%) needs training in the area of Plant protection measures followed by 41.67 per cent of farmers need training in seed size which is also followed by 32.50 per cent of the farmers needs training in the area of intercultural operations. It was also observed that highest Training important score (TIS) was in the area of plant protection measures (70.00%) and least TIS was found in the area of planting time (8.33%).

Table 4.1.10.6: Comparative account of training needs in sustainable potato cultivation

Sr. No	Name of the state	TIS (μ)	Mann Whitney u test	Probability
1	Assam	53.94	-0.234	>0.05
	Meghalaya	56.42		
2	Meghalaya	56.42	**-2.333***	<0.05
	Nagaland	61.99		
3	Nagaland	61.99	**-4.944****	<0.01
	Tripura	40.42		
4	Tripura	40.42	**-2.999****	<0.01
	Assam	53.94		
5	Tripura	40.42	**-3.421****	<0.01
	Meghalaya	56.42		
6	Assam	53.94	**-2.257***	<0.05
	Nagaland	61.99		

** significant at 1%level of probability, * significant at 5% level of probability

From Table 4.1.10.6 it is clear that training needs in sustainable potato cultivation had a significant difference in case of Meghalaya vs. Nagaland and Assam vs. Nagaland which were statistically significant at 5 per cent level of significance. Whereas, Nagaland vs. Tripura, Tripura vs. Assam and Tripura vs. Meghalaya were statically significant at 1 per cent level of significance.

xi. Sources of Information

Table 4.1.11.1 Distribution of potato farmers based on their utilization of information sources in Assam N=120

Sl. No.	Mass-media information sources	Frequency of use						Mean score	Rank
		Most often		Sometimes		Never			
		f	%	f	%	f	%		

1	Radio	0	(0.00)	0	(0.00)	120	(100)		
2	Television	45	(37.50)	**71**	**(59.17)**	4	(3.33)		**II**
3	Exhibition	0	(0.00)	22	(18.33)	98	(81.67)		
4	Printed media (Poster, Folder, Leaflet etc)	0	(0.00)	21	(17.50)	99	(82.50)	**0.479**	
5	Newspaper	11	(9.17)	68	(56.67)	41	(34.17)		
6	Internet	1	(0.83)	6	(5.00)	113	(94.17)		
7	Mobile	**88**	**(73.33)**	25	(20.83)	7	(5.83)		
8	Smartphone , SMS based services	0	(0.00)	15	(12.50)	105	(87.50)		
9	Videoconferencing	0	(0.00)	0	(0.00)	120	(100)		
Sl. No.	**Formal sources of information**	**Frequency of use**						**Mean score**	**Rank**
		Most often		**Sometimes**		**Never**			
		f	**%**	**f**	**%**	**f**	**%**		
1	VLW/VEW	77	(**64.17**)	35	(29.17)	8	(0.00)		
2	Agriculture Officer	16	(13.33)	**62**	**(51.67)**	42	(35.00)		
3	SDAO	0	(0.00)	28	(23.33)	92	(76.67)	**0.408**	**III**
4	HO	0	(0.00)	7	(5.83)	103	(85.83)		
5	KVK	20	(16.67)	25	(20.83)	75	(62.50)		
6	ATMA	2	(1.67)	19	(15.83)	99	(82.50)		
7	NGOs	0	(0.00)	0	(0.00)	120	(100)		
8	ICAR	6	(5.00)	23	(19.17)	91	(75.83)		
Sl. No.	**Informal sources of information**	**Frequency of use**						**Mean score**	**Rank**
		Most often		**Sometimes**		**Never**			
		f	**%**	**f**	**%**	**f**	**%**		
1	Friends	7	(5.83)	47	(39.17)	66	(55.00)		
2	Relatives	0	(0.00)	16	(13.33)	**104**	**(86.67)**		
3	Neighbours	7	(5.83)	**64**	**(53.33)**	49	(40.83)	**0.560**	**I**
4	Progressive farmers	30	(**25.00**)	54	(45.00)	36	(30.00)		

Table 4.1.11.1 depicts the sources of information utilization by the potato farmers of Assam. It was found that among the mean score of different sources of information, informal sources of information ranked first followed by mass-media and formal sources of information. In case of using informal information sources only 25.00 per cent of the respondents made contact with progressive farmers most often followed by most (53.33%) of the farmers contact neighbours and 86.67 per cent farmers never contact relatives for their

informal sources of information needs.In case of using the different mass media sources, majority (73.33%) of the potato farmers of Assam used mobile phones most often as mass media information source. Further, majority (59.17%) of them used television sometimes, while 100.00 per cent of them never used radio and videoconferencing. In case of using formal information sources majority (64.17%) of the respondents made contact with VLW most often. Further, 51.67 per cent of them contacted Agriculture Officers sometimes while 100.00 per cent of them had never contacted with NGOs. This finding was in similar to the findings of Singh *et al*. (2004). Further, 71.25 per cent of them contacted their friends for information sometimes and 95.00 per cent of them never contacted their relatives for getting information related to crop production and management. Overall analysis revealed that mean score of using mass media sources was highest (4.44) among the other sources of information utilized by the farmers.

Table 4.1.11.2 Distribution of potato farmers based on their utilization of information sources in Meghalaya N=120

Sl. No.	**Mass-media information sources**	**Frequency of use**						**Mean score**	**Rank**
		Most often		**Sometimes**		**Never**			
		f	**%**	**f**	**%**	**f**	**%**		
1	Radio	0	(0.00)	0	(0.00)	**120**	**(100)**		
2	Television	37	(30.83)	**61**	**(50.83)**	22	(18.33)		
3	Exhibition	0	(0.00)	17	(14.17)	103	(85.83)		
4	Printed media (Poster, Folder, Leaflet etc)	0	(0.00)	14	(11.67)	106	(88.33)	**0.510**	**III**
5	Newspaper	17	(14.17)	51	(42.50)	52	(43.33)		
6	Internet	19	(15.83)	41	(34.17)	60	(50.00)		
7	Mobile	**92**	**(76.67)**	20	(16.67)	8	(6.67)		
8	Smartphone , SMS based services	0	(0.00)	17	(14.17)	103	(**85.83**)		
9	Videoconferencing	0	(0.00)	0	(0.00)	**120**	**(100)**		
Sl. No.	**Formal sources of information**	**Frequency of use**						**Mean score**	**Rank**
		Most often		**Sometimes**		**Never**			
		f	**%**	**f**	**%**	**f**	**%**		

1	VLW/VEW	32	(26.66)	44	(36.67)	44	(36.67)		
2	Agriculture Officer	9	(7.50)	**109**	**(90.83)**	2	(1.67)		
3	SDAO	0	(0.00)	25	(20.83)	95	(79.17)	**0.554**	**II**
4	HO	33	(27.50)	30	(25.00)	57	(47.50)		
5	KVK	12	(10.00)	62	(51.67)	46	(38.33)		
6	ATMA	1	(0.83)	32	(26.67)	87	(72.50)		
7	NGOs	0	(0.00)	0	(0.00)	**120**	**(100)**		
8	ICAR	**37**	**(30.83)**	48	(40.00)	35	(29.17)		
Sl. No.	**Informal sources of information**	**Frequency of use**						**Mean score**	**Rank**
		Most often		**Sometimes**		**Never**			
		f	**%**	**f**	**%**	**f**	**%**		
1	Friends	22	(18.33)	65	(54.17)	33	(27.50)		
2	Relatives	18	(15.00)	43	(35.83)	**59**	**(49.17)**		
3	Neighbours	1	(0.83)	**78**	**(65.00)**	41	(34.17)	**0.804**	**I**
4	Progressive farmers	**32**	**(26.67)**	54	(45.00)	34	(28.33)		

From the Table 4.1.11.2it was found that among the mean score of different sources of information, informal sources of information ranked first followed by formal sources of informationand mass-media. In case of using informal information sources only 26.67 per cent of the respondents made contact with progressive farmers most often followed by most (65.00%) of the farmers contacted neighbours and 49.17 per cent farmers never contacted relatives for their informal sources of information needs.In case of using formal information sources majority (30.83%) of the respondents made contact with VLW most often. Further, 90.83 per cent of them contacted Agriculture Officers sometimes while 100.00 per cent of them had never contacted with NGOs. In case of using the different mass media sources, majority (76.67%) of the potato farmers of Meghalayaused mobile phones most often as mass media information source. Further, majority (50.83%) of them used television sometimes, while 100.00 per cent of them never used radio and videoconferencing. These findings were similar to the findings of Singh *et al*. (2004). Further, 71.25 per cent of them contacted their friends for information sometimes and 95.00 per cent of them never contacted their relatives for getting information related to crop production and management. Overall analysis revealed that mean score of using mass media sources was highest (4.44) among the other sources of information utilized by the farmers.

Table 4.1.11.3 Distribution of potato farmers based on their utilization of information sources in Nagaland N=120

Sl. No.	Mass-media information sources	Frequency of use						Mean score	Rank
		Most often		Sometimes		Never			
		f	%	f	%	f	%		
1	Radio	0	(0.00)	0	(0.00)	**120**	**(100)**		
2	Television	26	(21.67)	46	(38.33)	48	(40.00)		
3	Exhibition	0	(0.00)	20	(16.67)	100	(100)		
4	Printed media (Poster, Folder, Leaflet etc)	0	(0.00)	31	(25.83)	89	(74.17)	**0.455**	**III**
5	Newspaper	17	(14.17)	51	(42.50)	52	(43.33)		
6	Internet	19	(15.83)	41	(34.17)	60	(50.00)		
7	Mobile	**47**	**(39.17)**	**53**	**(44.17)**	20	(16.67)		
8	Smartphone, SMS based services	0	(0.00)	31	(25.83)	89	(74.17)		
9	Videoconferencing	0	(0.00)	0	(0.00)	**120**	**(100)**		
Sl. No.	**Formal sources of information**	**Frequency of use**						**Mean score**	**Rank**
		Most often		**Sometimes**		**Never**			
		f	**%**	**f**	**%**	**f**	**%**		
1	VLW/VEW	**29**	**(24.17)**	37	(30.83)	54	(45.00)		
2	Agriculture Officer	4	(3.33)	**86**	**(71.67)**	30	(25.00)		
3	SDAO	0	(0.00)	25	(20.83)	95	(79.17)	**0.466**	**II**
4	HO	25	(20.83)	36	(30.00)	59	(49.17)		
5	KVK	12	(10.00)	62	(51.67)	46	(38.33)		
6	ATMA	8	(6.67)	46	(38.33)	66	(55.00)		
7	NGOs	0	(0.00)	0	(0.00)	**120**	**(100)**		
8	ICAR	2	(1.67)	41	(34.17)	67	(55.83)		
Sl. No.	**Informal sources of information**	**Frequency of use**						**Mean score**	**Rank**
		Most often		**Sometimes**		**Never**			
		f	**%**	**f**	**%**	**f**	**%**		

1	Friends	**14 (11.67)**	**57 (47.50)**	49 (40.83)		
2	Relatives	11 (9.17)	41 (34.17)	68 (56.66)		
3	Neighbours	1 (0.83)	52 (43.33)	67 (55.83)	**0.525**	**I**
4	Progressive farmers	8 (6.67)	34 (28.33)	**78 (65.00)**		

Table 4.1.11.3includes the sources of information utilization by the potato farmers of Assam. It was found that among the mean score of different sources of information utilization, informal sources of information ranked first followed by formal sources of informationand mass-media. In case of using informal information sources only 11.67and 47.50 per cent of the respondents made contact with friends most often and sometimes and 65.00 per cent farmers never contacted progressive farmers for their informal sources of information needs.In case of using formal information sources majority (24.17%) of the respondents made contact with VLW most often. Further, 71.67 per cent of them contacted Agriculture Officers sometimes while 100.00 per cent of them never contacted with NGOs. In case of using the different mass media sources, majority 39.17 per cent and 44.17 per cent of the potato farmers of Meghalaya used mobile phones most often and sometimes as their major mass media information source while 100.00 per cent of them never used radio and videoconferencing. These findings were similar to the findings of Singh *et al*. (2004). Further, 71.25 per cent of them contacted their friends for information sometimes and 95.00 per cent of them never contacted their relatives for getting information related to crop production and management. Overall analysis revealed that mean score of using mass media sources was the highest (4.44) among other sources of information utilized by the farmers.

Table 4.1.11.4 Distribution of potato farmers based on their utilization of information sources in Tripura N=120

Sl. No.	Mass-media information sources	Frequency of use						Mean score	Rank
		Most often		Sometimes		Never			
		f	%	f	%	f	%		
1	Radio	0	(0.00)	0	(0.00)	**120**	**(100)**		
2	Television	45	(37.50)	**71**	**(59.17)**	4	(3.33)		
3	Exhibition	0	(0.00)	22	(18.33)	98	(81.67)		
4	Printed media (Poster, Folder, Leaflet etc)	0	(0.00)	21	(17.50)	99	(82.50)	**0.485**	**II**
5	Newspaper	13	(10.83)	70	(58.33)	37	(30.83)		
6	Internet	1	(0.83)	6	(5.00)	113	(94.17)		
7	Mobile	**88**	**(73.33)**	25	(20.83)	7	(5.83)		
8	Smartphone , SMS based services	0	(0.00)	15	(12.50)	105	(87.50)		
9	Videoconferencing	0	(0.00)	0	(0.00)	**120**	**(100)**		
Sl. No.	**Formal sources of information**	**Frequency of use**						**Mean score**	**Rank**
		Most often		**Sometimes**		**Never**			
		f	**%**	**f**	**%**	**f**	**%**		
1	VLW/VEW	**61**	**(50.83)**	28	(23.33)	31	(25.83)		
2	Agriculture Officer	11	(9.17)	74	(61.67)	35	(29.17)		
3	SDAO	0	(0.00)	28	(23.33)	92	(76.67)	**0.420**	**III**
4	HO	0	(0.00)	7	(5.83)	113	(94.17)		
5	KVK	11	(9.17)	32	(26.67)	77	(64.17)		
6	ATMA	17	(14.17)	14	(11.67)	89	(74.17)		
7	NGOs	0	(0.00)	0	(0.00)	120	(100)		
8	ICAR	20	(16.67)	31	(25.83)	69	(57.50)		
Sl. No.	**Informal sources of information**	**Frequency of use**						**Mean score**	**Rank**
		Most often		**Sometimes**		**Never**			
		f	**%**	**f**	**%**	**f**	**%**		
1	Friends	15	(12.50)	55	(45.83)	50	(41.67)		
2	Relatives	0	(0.00)	16	(13.33)	**104**	**(86.67)**		
3	Neighbours	1	(0.83)	**71**	**(59.17)**	48	(40.00)	**0.562**	**I**
4	Progressive farmers	**25**	**(20.83)**	46	(38.33)	49	(40.83)		

From the Table 4.1.11.4it was evident that among the mean score of different sources of information utilization, informal sources of information ranked first followed by mass-media and formal sources of information. In case of using informal information sources only 20.83 per cent of the respondents made contact with progressive farmers most often followed by most (59.17%) of the farmers contact neighbours and 86.67 per cent farmers never contact relatives for their informal sources of information needs.In case of using the different mass media sources, majority (73.33%) of the potato farmers of Tripuraused mobile phones most often as mass media information source. Further, majority (59.17%) of them used television sometimes, while 100.00 per cent of them never used radio and videoconferencing. In case of using formal information sources majority (50.83%) of the respondents made contact with VLW most often. Further, 61.67 per cent of them contacted Agriculture Officers sometimes while 100.00 per cent of them had never contact with NGOs. This finding was in similar to the findings of Singh *et al*. (2004). Further, 71.25 per cent of them contacted their friends for information sometimes and 95.00 per cent of them never contacted their relatives for getting information related to crop production and management. Overall analysis revealed that mean score of using mass media sources was highest (4.44) among the other sources of information utilized by the farmers.

Table 4.1.11.5 Level of information sources utilized by the respondents N=480

Sl. No.	Respondents	Information sources utilized				
		Level	**Frequency**	**%**	**Mean**	**SD**
1	**Assam**	Low (<7.20) Medium(7.20-13.30) High (>13.30)	17 86 17	14.16 **71.68** 14.16	10.23	3.07
2	**Meghalaya**	Low (<9.50) Medium (9.50-16.10) High (>16.10)	23 82 15	19.17 **68.33** 12.50	12.79	3.34

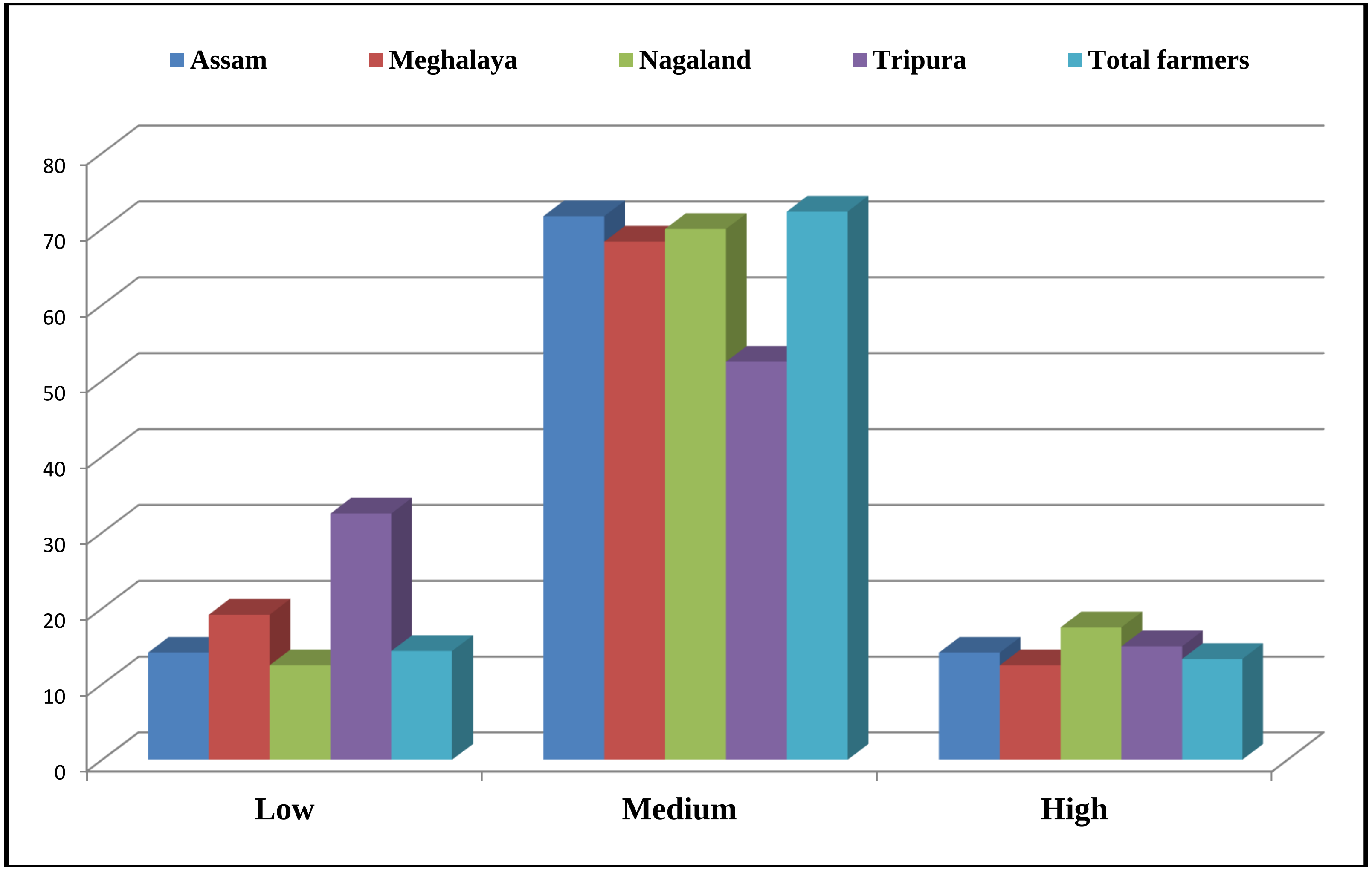

Fig 4.1.11.5 Level of information sources utilized by the respondents

3	**Nagaland**	Low (<7.30) Medium (7.30-13.30) High (>13.30)	15 84 21	12.50 **70.00** 17.50	10.38	3.04
4	**Tripura**	Low (<10) Medium(10-13.70) High (>13.70)	39 63 18	32.50 **52.50** 15.00	10.40	3.31
6	**Overall farmers**	Low (<7.50) Medium (7.50-14.30) High(>14.30)	69 347 64	14.38 **72.29** 13.33	10.95	3.37

Table 4.1.11.5 revealed that 71.68 per cent of the potato farmers of Assam had medium level of information sources utilization; followed by 14.17 per cent of them had low and high level of information sources utilization respectively. In case of potato farmers of Meghalaya, 68.33 per cent of them had medium level of information sources utilization, followed by 19.17 per cent and 12.50 per cent of them having low and high level of information sources utilization. In case of potato growers of Nagaland, majority (70.00%) of them had medium level of information sources utilization, followed by 17.50 per cent and 12.50 per cent of them having high and low information sources utilization respectively. In case of potato growers of Tripura, majority (52.50%) of the respondents had medium level of information sources utilization while 32.50 per cent of them had low and 15.00 per centof them had high information sources utilization. In case of overall potato growers of North-east, 72.29 per cent of them had medium level of information sources utilization, while 14.38 per cent and 8.33 per cent of them had low and 13.33 per cent of them had high level of information sources utilization. These findings were in accordance with the findings of Suresh (2004) and Nagesh (2006) and Shree *et al*. (2020)

Table 4.1.11.6: Comparative account of information sources utilized for sustainable potato cultivation

Sr. No	Name of the state	(μ)	z value	Probability
1	Assam	10.23	**-6.015****	<0.01
	Meghalaya	12.79		
2	Meghalaya	12.79	**5.757****	<0.01
	Nagaland	10.38		
3	Nagaland	10.38	0.090	>0.05
	Tripura	10.40		
4	Tripura	10.40	-0.338	>0.05
	Assam	10.23		
5	Tripura	10.40	**5.488****	<0.01
	Meghalaya	12.79		
6	Assam	10.23	-0.453	>0.05
	Nagaland	10.38		

** significant at 1% level of probability

Table 4.1.11.6 incorporates the status of information sources utilized by the respondents for sustainable potato cultivation. It was observed that Assam vs. Meghalaya, Meghalaya vs. Nagaland and Tripura vs. Meghalaya show a significant difference in information sources utilization at 1% level of probability.

xii. Extension contact

It was revealed from Table 4.1.12.1 that majority (57.50%) of potato growers of Assam had medium level of extension contact. Further 50.83 per cent of Meghalaya’s potato growers, 50.00per cent Nagaland’s potato and 40.00 per cent Tripura’s potato growers also had medium level of extension contact respectively.

Table 4.1.12.1: Distribution of respondents based on their extension contact in the potato farming N=480

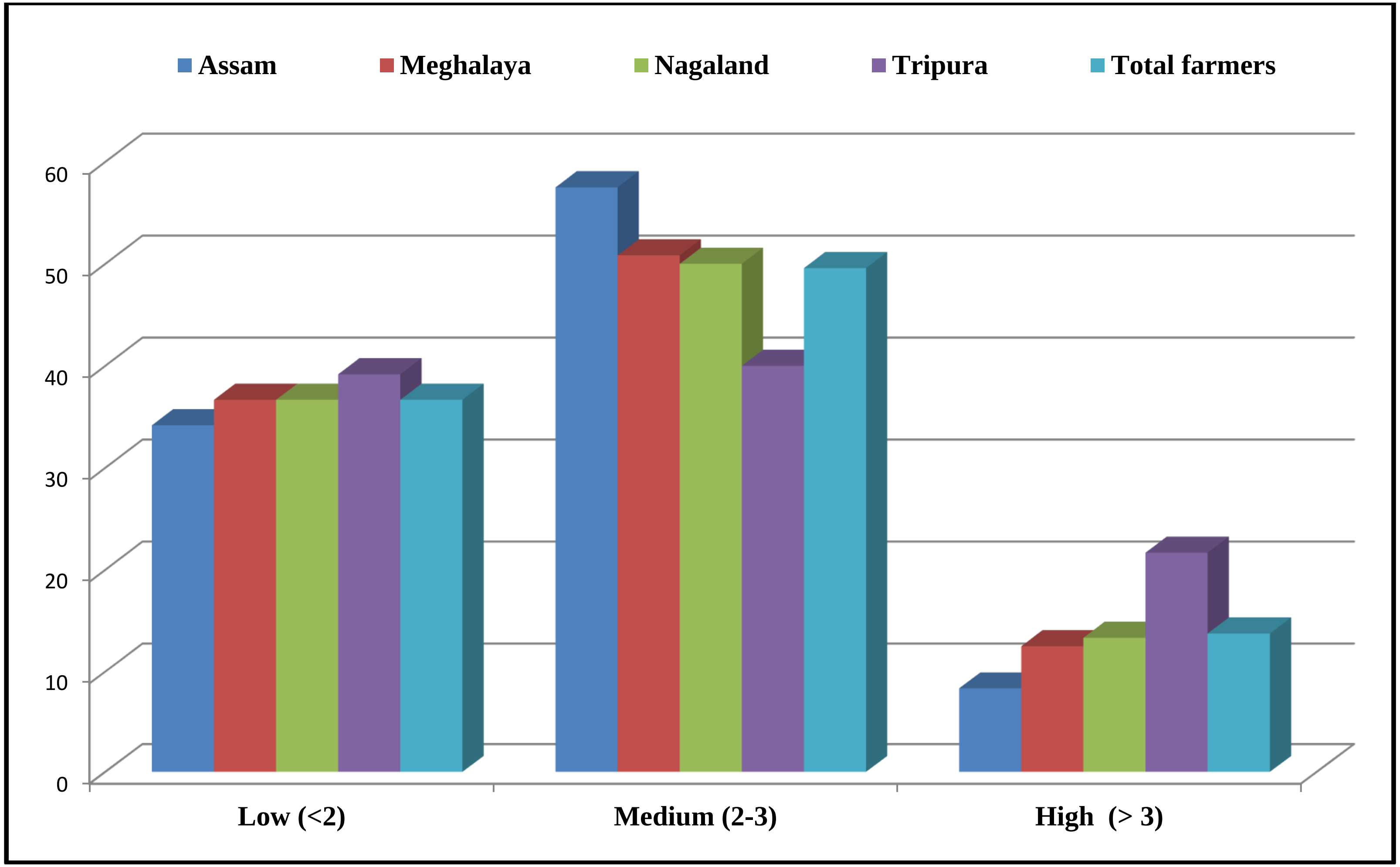

Fig 4.1.12.1: Distribution of respondents based on their extension contact in the potato farming

Sl. No.	Level of extension contact	Assam		Meghalaya		Nagaland		Tripura		Total farmers	
		f	%	f	%	f	%	f	%	f	%
1	Low (<2)	41(34.17)		44(36.67)		44(36.67)		47(39.17)		176(36.67)	
2	Medium (2-3)	69**(57.50)**		61**(50.83)**		60**(50.00)**		48**(40.00)**		238**(49.58)**	
3	High (> 3)	10(8.33)		15(12.50)		16(13.33)		25(21.67)		66(13.75)	
4	Total farmers	**120** (100)		**120** (100)		**120** (100)		**120** (100)		**480** (100)	
5	Mean Score	1.96		1.97		2.05		2.13		2.03	
6	SD	1.02		1.20		1.22		1.43		1.23	

It was also found that majority (49.58%) of the potato farmers of North-east had medium level of extension contact followed by 36.67 per cent and 13.75 per cent who had low and high level of extension contact respectively. Medium level of extension contact might be due to the less intensive extension activities in the concerned area as well as less participation of farmers in the extension activities which might have restricted their gain of required information related to their farming practices. These findings were in line with the findings of Singh (2014) and Kumar *et al*. (2021).

Table 4.1.12.2: Comparative account of extension contact for sustainable potato cultivation

Sr. No	Name of the state	(μ)	z value	Probability
1	Assam	1.96	0.500	>0.05
	Meghalaya	1.97		
2	Meghalaya	1.97	-0.683	>0.05

	Nagaland	2.05		
3	Nagaland	2.05	0.104	>0.05
	Tripura	2.13		
4	Tripura	2.13	-0.101	>0.05
	Assam	1.96		
5	Tripura	2.13	-0.517	>0.05
	Meghalaya	1.97		
6	Assam	1.96	-0.238	>0.05
	Nagaland	2.05		

** significant at 1% level of probability

Table 4.1.12.2 represents the comparative account of extension contact for potato cultivation in North-eastern India. From the table it is clear that there is no significant difference between the states in the North east over extension contact for sustainable potato cultivation.

xiii. Scientific orientation

Table 4.1.13.1: Distribution of respondents based on their scientific orientation towards sustainable potato cultivation N=480

Sl. No.	Respondents	Scientific orientation				
		Level	**Frequency**	**%**	**Mean**	**SD**
1	**Assam**	Low (<16)	27	22.50	20.39	4.39
		Medium(16-24)	79	**65.83**		
		High (>24)	14	11.67		
2	**Meghalaya**	Low (<15)	27	22.50	19.27	4.39
		Medium (15-23)	75	**62.50**		
		High (>23)	18	15.00		

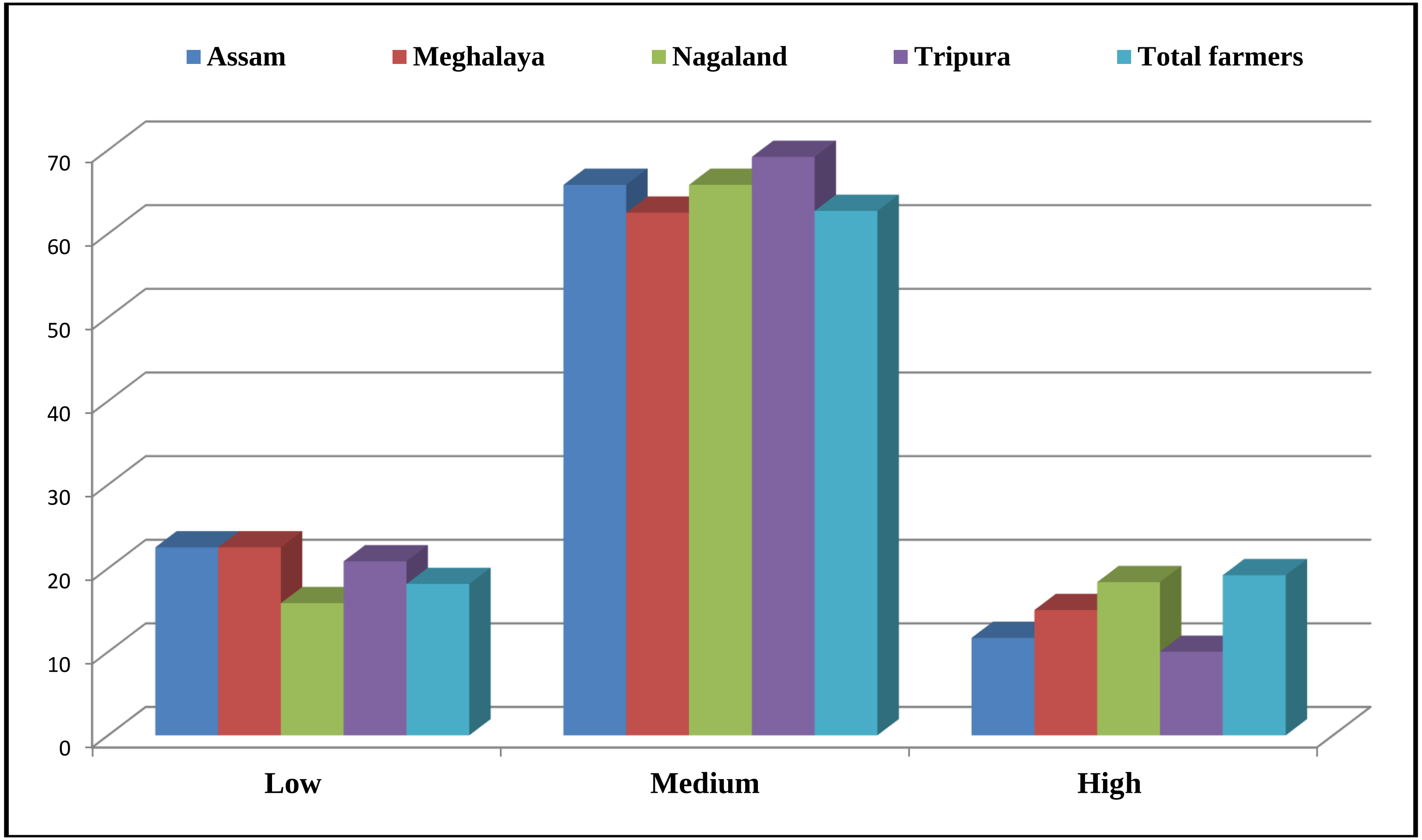

Fig 4.1.13.1: Distribution of respondents based on their scientific orientation towards potato cultivation

3	**Nagaland**	Low (<15) Medium (15-22) High (>22)	19 79 22	15.83 **65.83** 18.34	18.86	3.83
4	**Tripura**	Low (<15) Medium(15-24) High (>24)	25 83 12	20.83 **69.17** 10.00	19.65	4.69
6	**Total farmers**	Low (<15) Medium (15-23) High(>23)	87 301 92	18.12 **62.71** 19.17	19.54	4.37

Table 4.1.13.1 shows the distribution of respondents based on their scientific orientation towards sustainable potato cultivation. It was observed from the table that the respondentsfrom Assam mostly had medium level of scientific orientation (65.83%), followed by low level of scientific orientation (22.50%). In Meghalaya, it was observed that most (62.50%) of the respondents had medium level of scientific orientation followed by low level of scientific orientation (22.50%). Table also revealed that maximum percentage (65.83%) of the respondent from the state of Nagaland had medium level of scientific orientation which was followed by high level of scientific orientation (18.34%). The state Tripura also had maximum percentage of the respondents under medium level of scientific orientation (69.17%), followed by low level of scientific orientation (20.83%). But considering all the states in North-eastern India, it was found that majority of the respondents had medium level scientific orientation (62.71%) followed by high level of scientific orientation (19.17%). These findings were in accordance with the findings of Kalita and Chabukdhara (2014) and Islam *et al.* (2021).

Table 4.1.13.2: Comparative account of scientific orientation towards sustainable potato cultivation

Sr. No	Name of the state	(μ)	z value	Probability
1	Assam	20.39	**2.001***	<0.05
	Meghalaya	19.27		
2	Meghalaya	19.27	0.855	>0.05
	Nagaland	18.86		
3	Nagaland	18.86	-1.567	>0.05
	Tripura	19.65		
4	Tripura	19.65	1.219	>0.05
	Assam	20.39		
5	Tripura	19.65	-0.709	>0.05
	Meghalaya	19.27		
6	Assam	20.39	**2.976****	<0.01
	Nagaland	18.86		

** Significant at 1%level of probability, *Significant at 5% level of probability

From Table 4.1.13.2 it is clear that respondents of Assam and Meghalaya had a significant difference in their scientific orientation towards sustainable potato cultivation at 5 % level. Assam vs. Nagaland also had a statistically significant difference at 1% level of probability in the scientific orientation of farmers towards sustainable potato cultivation.

xiv. **Social participation**

From the Table 4.1.14.1 and Fig 4.1.14.1 it can be found that majority (88.34%) of the potato growers of Assam possessed low level of social participation. 78.33 per cent of potato growers of Tripura and Nagaland and 75.83 per cent of the potato growers of Meghalaya also exhibited low level of social participation.

Table 4.1.14.1: Distribution of respondents based on social participation N=480

Sl. No.	Level of social participation	Assam	Meghalaya	Nagaland	Tripura	Total farmers
		f %	f %	f %	f %	f %
1	Low (<1)	106**(88.34)**	91**(75.83)**	94**(78.33)**	94**(78.33)**	385**(80.21)**
2	Medium (1-2)	13(10.83)	24(20.00)	21(17.50)	22(18.33)	80(16.67)
3	High (>2)	1(0.83)	5(4.17)	5(4.17)	4(3.33)	15(3.12)
4	Total farmers	**120**(100)	**120**(100)	**120**(100)	**120**(100)	**480**(100)
5	Mean	0.62	0.91	0.92	0.86	0.83
6	SD	0.71	0.86	0.85	0.83	0.82

It also clear from the above table that majority (80.21%) of the potato farmers of North-east had low level of social participation, followed by 16.67 per cent and 3.12 per cent of them having medium and high social participation respectively. Restricted cosmopolite behaviour might have resulted in their low level of social participation. These findings were in accordance with the findings of Jaisawal *et al*. (2013) and Shree *et al*. (2020).

Table 4.1.14.2: Comparative account of social participation for sustainable potato cultivation

Sr. No	Name of the state	(µ)	Mann whitney U test	Probability
1	Assam	0.62	**-2.543***	<0.05
	Meghalaya	0.91		
2	Meghalaya	0.91	-.067	>0.05

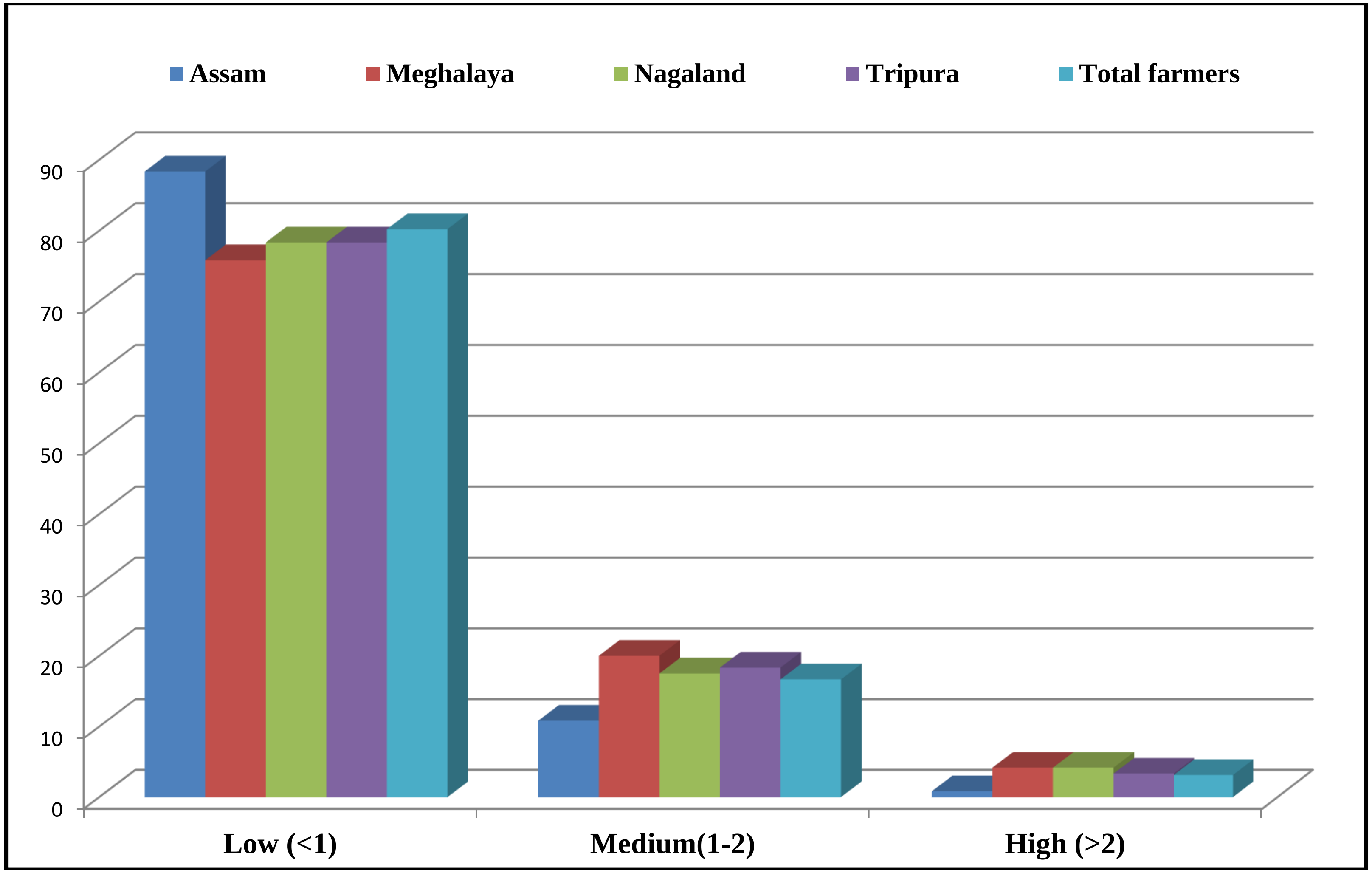

Fig 4.1.14.1: Distribution of respondents based on social participation

	Nagaland	0.92		
3	Nagaland	0.92	-.498	>0.05
	Tripura	0.86		
4	Tripura	0.86	**-2.146***	<0.05
	Assam	0.62		
5	Tripura	0.86	-.418	>0.05
	Meghalaya	0.91		
6	Assam	0.62	**-2.692****	<0.01
	Nagaland	0.92		

** significant at 1% level of probability, *significant at 5% level of probability

From table 4.1.14.2 it was clear that, social participation for potato cultivation of the respondents between Assam vs. Meghalaya and Tripura vs. Assam were statistically significant at 5% level of significance. Whereas, Assam vs. Nagaland was statistically significance at 1% level of significance with respect to social participation for sustainable potato cultivation of the respondent.

xv. Marketing channels utilized by farmers

Table 4.1.15.1: Distribution of potato farmers based on marketing channels utilized **N=480**

Sl. No.	Marketing channels	Assam	Meghalaya	Nagaland	Tripura	Total farmers utilizing marketing channels	Rank
		f (%)	f (%)	f (%)	f (%)	f (%)	
1	Farmers – Consumer	8 (6.67)	60**(50.00)**	77 **(64.17)**	46(38.33)	191**(39.79)**	I
2	Farmers – Commission agents – Wholesalers – Retailers – Consumer	**35(29.17)**	0(0.00)	0(0.00)	**55(45.83)**	90(18.75)	II
3	Farmers – Wholesalers – Consumer	14 (11.67)	19(15.83)	43 (35.83)	10(8.33)	86 (17.92)	III
4	Farmers – Wholesalers – Retailers – Consumer	**35 (29.17)**	0(0.00)	0 (0.00)	9(7.50)	44 (9.17)	IV

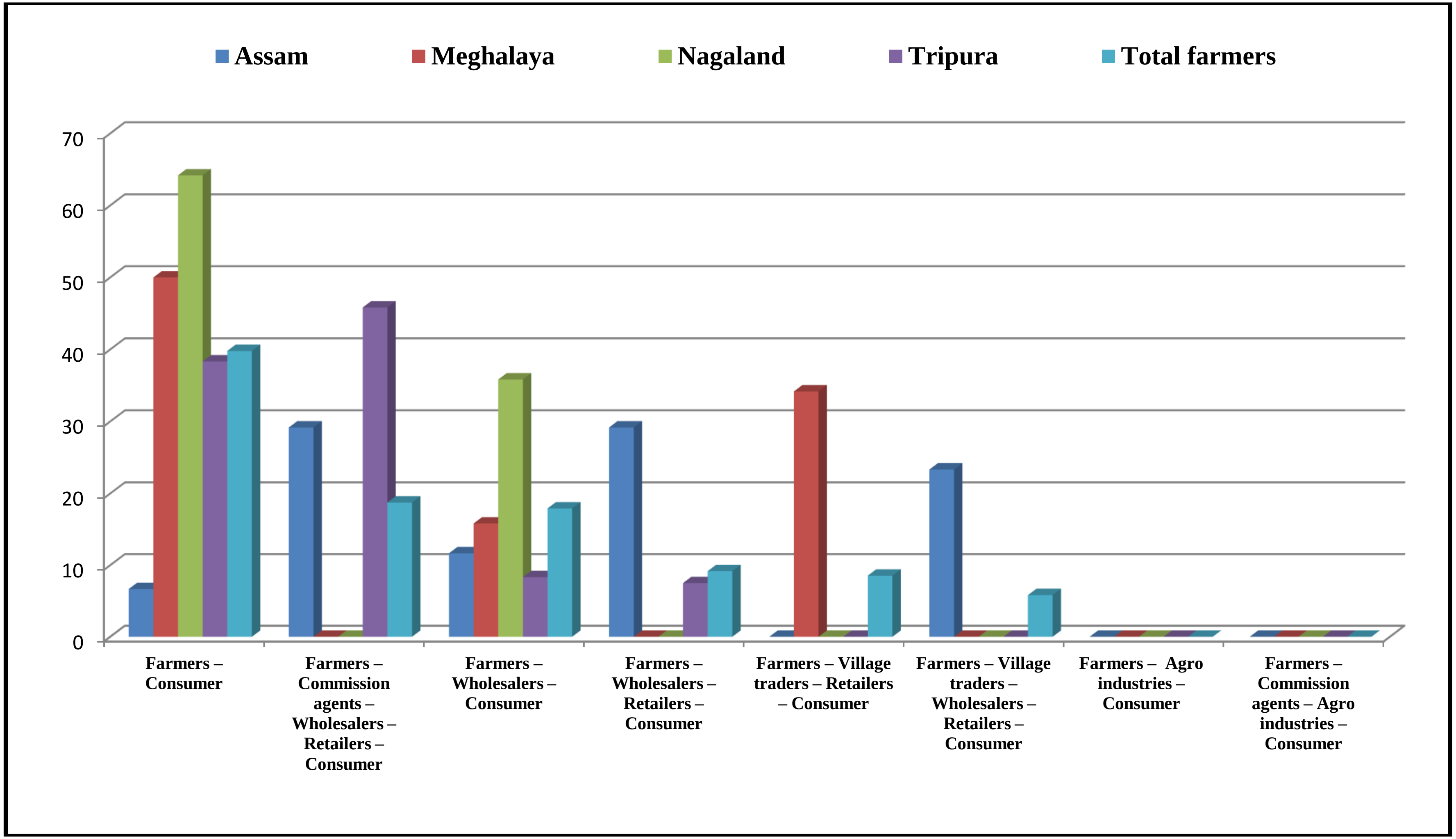

Fig 4.1.15.1 Various marketing channels utilized by farmers

5	Farmers – Village traders – Retailers – Consumer	0 (0.00)	41(34.17)	0 (0.00)	0 (0.00)	41 (8.54)	V
6	Farmers – Village traders – Wholesalers – Retailers – Consumer	28(23.33)	0(0.00)	0(0.00)	0(0.00)	28(5.83)	VI
7	Farmers – Agro industries – Consumer	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	VII-
8	Farmers – Commission agents – Agro industries – Consumer	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	VIII-

Table 4.1.15.1 displays the various marketing channels utilized by farmers in North-eastern states. It was observed that majority of the farmers (29.17%) in Assam utilized the marketing channel, Farmers – Commission agents – Wholesalers – Retailers – Consumer and Farmers – Wholesalers – Retailers – Consumer marketing channel. In Meghalaya, majority of the farmers (50%) utilized Farmers – Consumer marketing channel followed by 34.17% of the farmers utilized Farmers – Village traders – Retailers – Consumer marketing channel. In Nagaland, majority of the farmers (64.17%) utilized Farmers – Consumer marketing channel followed by 35.83% of the farmers utilized Farmers – Wholesalers – Consumer marketing channel. But, in Tripura, majority of the farmers (45.83%) utilized Farmers – Commission agents – Wholesalers – Retailers – Consumer marketing channel followed by 38.33% of the farmers utilized Farmers – Consumer marketing channel. Considering all the states in the North-eastern India, rank was allotted to various marketing channel and it was observed that majority of the farmers in the North-east utilized Farmers – Consumer marketing channel, followed by Farmers – Commission agents – Wholesalers – Retailers – Consumer marketing channel. Similar results were found by Singh *et al.* (2009) and Shree *et al*. (2020).

Table 4.1.15.2: Comparative account of marketing channels used by potato farmers

Sr. No.	Name of the state	(μ)	Mann whitney U test	Probability

1	Assam		**-8.225****	<0.01
	Meghalaya			
2	Meghalaya		**-3.974****	<0.01
	Nagaland			
3	Nagaland		**-6.556****	<0.01
	Tripura			
4	Tripura		-1.686	>0.05
	Assam			
5	Tripura		**-4.297****	<0.01
	Meghalaya			
6	Assam		**-12.017****	<0.01
	Nagaland			

** significant at 1% level of probability

From the Table 4.1.15.2 it is clear that marketing channels used by potato farmersin the North-eastern states weresignificantly different at 1% level of significance except the states of Tripura vs. Assam.

4.2 Knowledge and attitude of potato farmers towards sustainable practices of potato farming

i. Knowledge about sustainable farming practices

Table 4.2.1.1 revealed that majority 42.50 per cent and 35.83 per cent of the potato growers of Assam had very high and high knowledge on planting time, followed by 33.33 per cent of them had medium knowledge on seed production, 26.67 per cent of them had low knowledge level on integrated nutrient management and 51.67 per cent of them had no knowledge on plant protection measures. The highest mean knowledge was recorded as73.12 per cent in case of planting time.

Table 4.2.1.1 Details of Knowledge level on different dimensions of sustainable potato cultivation practices in Assam N=120

Sr. No	Dimension of potato cultivation practices	Very high Knowledge (76%- 100%)	High Knowledge (51%-75%)	Medium Knowledge (26%-50%)	Low Knowledge (1%-25%)	No Knowledge (0%)	Mean Knowledge %
		f (%)	**f (%)**	**f (%)**	**f (%)**	**f (%)**	
1	Soil Management	35(29.17)	24(20.00)	19(15.83)	9(7.50)	33(27.50)	53.96
2	Seed selection	11(9.17)	21(17.50)	31(25.83)	12(10.00)	45(37.50)	37.71
3	Seed size	2(1.67)	18(15.00)	27(22.50)	15(12.50)	58(48.33)	27.29
4	Seed preparation	14(11.67)	23(19.17)	30(25.00)	8(6.67)	45(37.50)	40.21
5	Planting time	**51(42.50)**	**43(35.83)**	9(7.50)	0(0.00)	17(14.17)	**73.12**
6	Integrated Nutrient Management	3(2.50)	9(7.50)	27(22.50)	**32(26.67)**	49(40.83)	26.04
7	Planting method	3(2.50)	18(15.00)	34(28.33)	18(15.00)	47(39.17)	31.67
8	Water management	9(7.50)	25(20.83)	30(25.00)	10(8.33)	46(38.33)	37.71
9	Intercultural operations	7(5.83)	24(20.00)	36(30.00)	9(7.50)	44(36.67)	37.71
10	Plant protection measures	0(0.00)	16(13.33)	22(18.33)	20(16.67)	**62(51.67)**	23.33
11	Harvesting	0(0.00)	29(24.17)	39(32.50)	14(11.67)	38(31.67)	37.29
12	Yield	0(0.00)	25(20.83)	31(25.83)	19(15.83)	45(37.50)	32.50
13	Seed production	0(0.00)	31(25.83)	**40(33.33)**	14(11.67)	35(29.17)	38.96

Table 4.2.1.2 revealed that majority of 24.17 per cent and 50.00 per cent of the potato growers of Meghalaya had very high and high knowledge on planting time, followed by 28.33 per cent of them had medium knowledge on

integrated nutrient management, 27.50 per cent of them had low knowledge level on water management and55.00 per cent of them had no knowledge on plant protection measures. The highest mean knowledge was recorded as 73.33 per cent in case of planting time.

Table 4.2.1.2 Details of Knowledge level of farmers on different dimensions of sustainable potato cultivation practices in Meghalaya N=120

Sr. No	Dimensions of potato cultivation practices	Very high Knowledge (76%- 100%)	High Knowledge (51%-75%)	Medium Knowledge (26%-50%)	Low Knowledge (1%-25%)	No Knowledge (0%)	Mean Knowledge %
		f (%)	**f (%)**	**f (%)**	**f (%)**	**f (%)**	
1	Soil Management	27(22.50)	27(22.50)	23(19.17)	0(0.00)	43(35.83)	48.96
2	Seed selection	0(0.00)	19(15.83)	29(24.17)	12(10.00)	60(50.00)	26.46
3	Seed size	7(5.83)	34(28.33)	30(25.00)	1(0.83)	48(40.00)	39.79
4	Seed preparation	10(8.33)	31(25.83)	24(20.00)	10(8.33)	45(37.50)	39.79
5	Planting time	**29(24.17**)	**60(50.00)**	28(23.33)	0(0.00)	3(2.50)	**73.33**
6	Integrated Nutrient Management	0(0.00)	9(7.50)	**34(28.33)**	16(13.33)	61(50.83)	23.12
7	Planting method	5(4.17)	21(17.50)	23(19.17)	21(17.50)	50(41.67)	31.25
8	Water management	0(0.00)	10(8.33)	27(22.50)	**33(27.50)**	50(41.67)	24.37
9	Intercultural operations	6(5.00)	26(21.67)	29(24.17)	12(10.00)	47(39.17)	35.83
10	Plant protection measures	0(0.00)	9(7.50)	16(13.33)	29(24.17)	**66(55.00)**	18.33
11	Harvesting	8(6.67)	15(12.50)	26(21.67)	19(15.83)	52(43.33)	30.83
12	Yield	4(3.33)	39(32.50)	21(17.50)	17(14.17)	39(32.50)	40.00
13	Seed production	0(0.00)	14(11.67)	31(25.83)	30(25.00)	45(37.50)	27.92

Table 4.2.1.3 revealed that majority 17.50 per cent of the potato growers of Nagaland had very high knowledge on soil management, followed by 21.67

per cent of them had high knowledge both in seed size and seed preparation,26.67 per cent of them had medium knowledge on intercultural operation, 24.17 per cent of them had low knowledge level on water management and57.50 per cent of them had no knowledge on integrated nutrient management. The highest mean knowledge was found to be 45.21 per cent in case of planting time.

Table 4.2.1.3 Details of Knowledge level on different dimensions of sustainable potato cultivation practices in Nagaland N=120

Sr. No	Dimension of potato cultivation practices	Very high Knowledge (76%- 100%)	High Knowledge (51%- 75%)	Medium Knowledge (26%-50%)	Low Knowledge (1%-25%)	No Knowledge (0%)	Mean Knowledge %
		f (%)	f (%)	f (%)	f (%)	f (%)	
1	Soil Management	**21(17.50)**	22(18.33)	29(24.17)	9(7.50)	39(32.50)	**45.21**
2	Seed selection	3(2.50)	17(14.17)	27(22.50)	19(15.83)	54(45.00)	28.33
3	Seed size	6(5.00)	**26(21.67)**	31(25.83)	12(10.00)	45(37.50)	36.67
4	Seed preparation	3(2.50)	**26(21.17)**	23(19.17)	14(11.67)	54(45.00)	31.25
5	Planting time	9(7.50)	41()	22(18.33)	5(4.17)	43(35.83)	43.33
6	Integrated Nutrient Management	0(0.00)	5(4.17)	24(20.00)	22(18.33)	**69(57.50)**	17.71
7	Planting method	3(2.50)	19(15.83)	25(20.83)	23(19.17)	50(41.67)	29.58
8	Water management	0(0.00)	9(7.50)	21(17.50)	**29(24.17)**	61(50.83)	20.42
9	Intercultural operations	5(4.17)	22(18.33)	**32(26.67)**	16(13.33)	45(37.50)	34.58
10	Plant protection measures	0(0.00)	9(7.50)	15(12.50)	27(22.50)	**69(57.50)**	17.50
11	Harvesting	12(10.00)	21(17.50)	24(20.00)	18(15.00)	45(37.50)	36.87
12	Yield	1(0.83)	23(19.17)	18(15.00)	25(20.83)	53(44.17)	27.92
13	Seed production	0(0.00)	9(7.50)	24(20.00)	28(23.33)	59(49.17)	21.46

Table 4.2.1.4 revealed that majority 56.67 per cent of the potato growers of Tripura had very high knowledge on planting time, followed by 39.17 per cent of them had high knowledge on planting method, 35.00 per cent of them had medium knowledge both on harvesting and seed production, 28.33 per cent of them had low knowledge level on integrated nutrient management and53.33 per cent of them had no knowledge on plant protection measures. The highest mean knowledge was recorded as83.54 per cent in case of planting time.

Table 4.2.1.4 Details of Knowledge level on dimensions of sustainable potato cultivation practices in Tripura N=120

Sr. No	Dimension of potato cultivation practices	Very high Knowledge (76%- 100%)	High Knowledge (51%-75%)	Medium Knowledge (26%-50%)	Low Knowledge (1%-25%)	No Knowledge (0%)	Mean Knowledge %
		f (%)	f (%)	f (%)	f (%)	f (%)	
1	Soil Management	66(55.00)	22(18.33)	8(6.67)	0(0.00)	24(20.00)	72.08
2	Seed selection	18(15.00)	30(25.00)	33(27.50)	11(9.17)	28(23.33)	49.79
3	Seed size	3(2.50)	28(23.33)	26(21.67)	13(10.83)	50(41.67)	33.54
4	Seed preparation	42(35.00)	34(28.33)	24(20.00)	0(0.00)	20(16.67)	66.25
5	Planting time	**68(56.67)**	39(32.50)	6(5.00)	0(0.00)	7(5.83)	**83.54**
6	Integrated Nutrient Management	4(3.33)	11(9.17)	34(28.33)	**34(28.33)**	37(30.83)	31.46
7	Planting method	12(10.00)	**47(39.17)**	40(33.33)	3(2.50)	18(17.50)	56.67
8	Water management	23(19.17)	41(34.17)	35(29.17)	1(0.83)	20(16.67)	59.58
9	Intercultural operations	11(9.17)	29(24.17)	35(29.17)	6(5.00)	39(32.50)	43.12

10	Plant protection measures	0(0.00)	16(13.33)	21(17.50)	19(15.83)	**64(53.33)**	22.71
11	Harvesting	0(0.00)	42(35.00)	**42(35.00)**	6(5.00)	30(25.00)	45.00
12	Yield	0(0.00)	35(29.17)	40(33.33)	16(13.33)	29(24.17)	41.87
13	Seed production	0(0.00)	37(30.83)	**42(35.00)**	14(11.67)	27(22.50)	43.54

Table 4.2.1.5: Distribution of respondents based on their overall knowledge level on sustainable potato farming practices N=480

Sl. No.	Respondents	Knowledge Level			Mean	SD	Knowledge Index
		Low	Medium	High			
		No %	No %	No %			
1	Assam	5(4.17)	**98(81.67)**	17(14.17)	8.83	1.60	75.71
2	Meghalaya	25(20.83)	**88 (73.33)**	7 (5.84)	8.03	1.72	68.86
3	Nagaland	29(24.17)	**89(74.17)**	2(1.67)	7.67	1.67	65.78
4	Tripura	6(5.00)	54(45.00)	**60(50.00)**	10.38	1.68	89.00
6	Total farmers	65(13.54)	**329(68.54)**	86 (17.92)	8.75	1.95	74.84

It was evident from Table 4.2.1.5 and Fig 4.2.1.5 that majority (50.00%) of the potato growers of Tripura had high knowledge level followed by 45.00 per cent of them had medium and 5.00 per cent of them had low knowledge level on sustainable potato farming. Further, 81.67 per cent of the potato growers of Assam had medium knowledge level followed by 14.17 per cent of them had high and 4.17 per of them had low knowledge level respectively. Majority (74.17%) of the potato growers of Nagaland had medium knowledge level, followed by 24.17 per cent of them had low and 1.67 per cent of them had high knowledge level respectively. In case of potato growers of Meghalaya majority (73.33%) of them had medium knowledge level followed by 20.83 per cent of them had low and 5.84per cent of them had high knowledge level respectively.

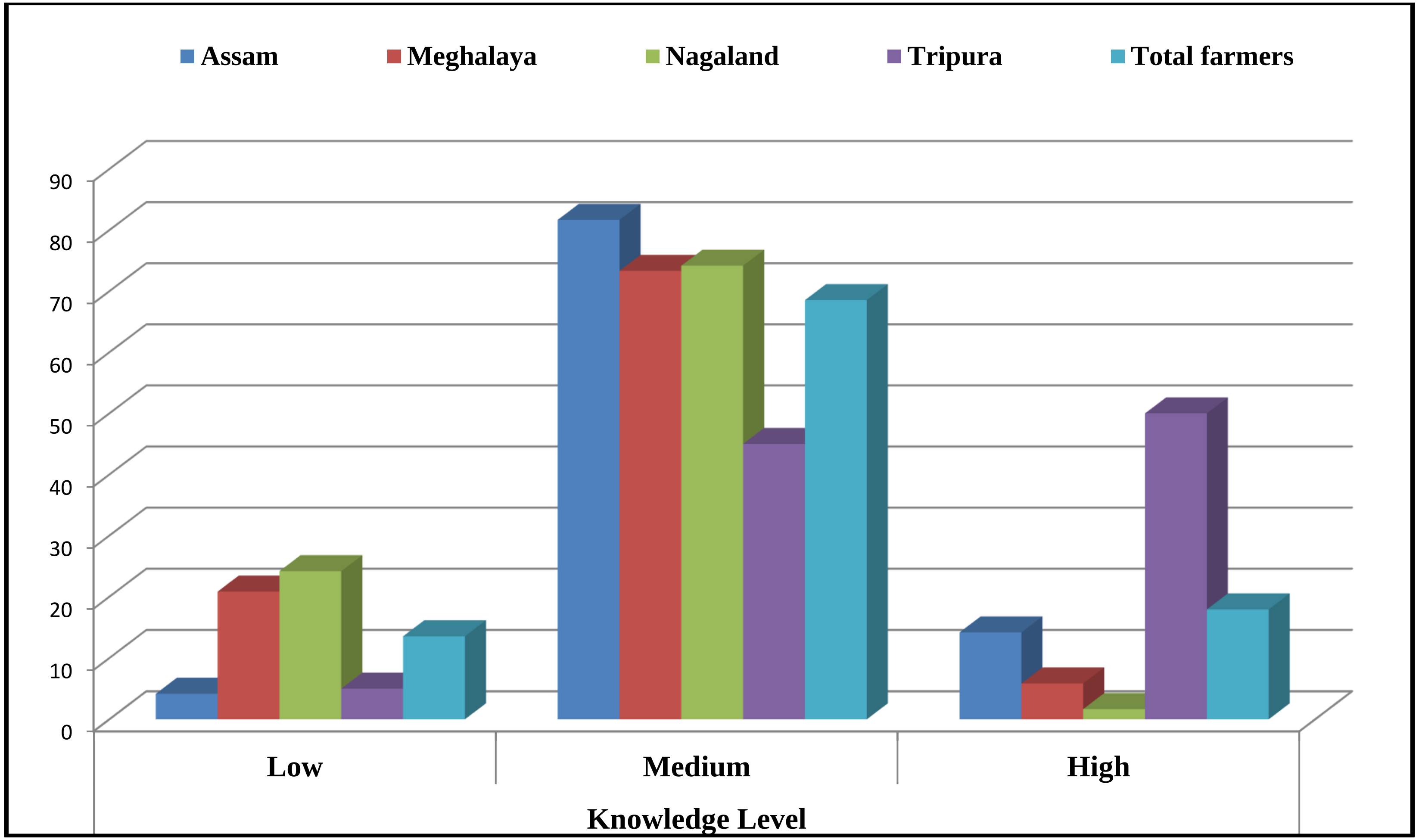

Fig 4.2.1.5 Distribution of respondents based on their knowledge level about the potato farming practices

It was also found from the Table 4.2.1.5 that majority (68.54%) of the potato growers of North-east had medium knowledge level followed by 17.92 per cent of them had high and 13.54 per cent of them had low knowledge level. This might be due to the reason that they had less contact with extension agencies and low utilization of the different information sources which might have restricted them to get updated with new technologies. These findings were in accordance with the findings of Babu*et al*. (2007), Pandy*et al*. (2011), Borua and Brahma (2012) and Jaisawal *et al*. (2013) and Yenagi *et al*. (2020).

Table 4.2.1.6: Comparative account of Knowledge on sustainable potato cultivation

Sr No	Name of the state	(μ)	z value	Probability
1	Assam	8.83	**3.738******	<0.01
	Meghalaya	8.03		
2	Meghalaya	8.03	1.644	>0.05
	Nagaland	7.67		
3	Nagaland	7.67	**-12.094******	<0.01
	Tripura	10.38		
4	Tripura	10.38	**-7.200******	<0.01
	Assam	8.83		
5	Tripura	10.38	**-10.419******	<0.01
	Meghalaya	8.03		
6	Assam	8.83	**5.500******	<0.01
	Nagaland	7.67		

** significant at 1% level of probability

Table 4.2.1.6 depicts the comparative account of knowledge on sustainable potato cultivation in North-eastern states. It was found that except the farmers belonging to the states of Meghalaya and Nagaland, farmers' knowledge on sustainable potato cultivation differed significantly at 1% level of probabilitybetween Assam and Meghalaya, Tripura and Meghalaya, Nagaland and Tripura as well as Assam and Tripura.

ii. Attitude of potato farmerstowards adoption of sustainable farming practices

Table 4.2.2.1 and Fig 4.2.2.1 depicts the attitude of farmers from selected North-eastern states towards adoption of sustainable potato farming. In case of potato farmers of Assam majority (65.83%) possessed favourable attitude towards sustainable potato farming practices followed by 18.33 per cent and 15.84 per cent of them who had highly favourable and less favourable attitude towards sustainable potato farming practices respectively. In case of potato farmers of Meghalaya, majority (69.17%) had favourable attitude towards sustainable potato farmingpractices followed by 21.66 per cent and 9.17 per cent of them possessed highly favourable and less favourable attitude towards sustainable potato farmingpractices respectively. In case of potato growers of Nagaland, majority (72.50%) of them possessed favourable attitude towards sustainable potato farmingpractices followed by 14.17 per cent, 13.33 per cent of them possessed less favourableand highly favourable attitude towards the sustainable potato farmingpractices respectively. In case of potato growers from Tripura, majority (65.83%) of them possessed favourable, followed by 24.17 per cent and 10.00 per cent had highly favourable and less favourable attitude towards the sustainable potato farmingpractices.

Table 4.2.2.1 Distribution of respondents based on their Attitude towards adoption of sustainable potato cultivation practicesN=480

Sr. No.	Respondents	Attitude of the farmers					Attitude index
		Level	Frequency	%	Mean	SD	

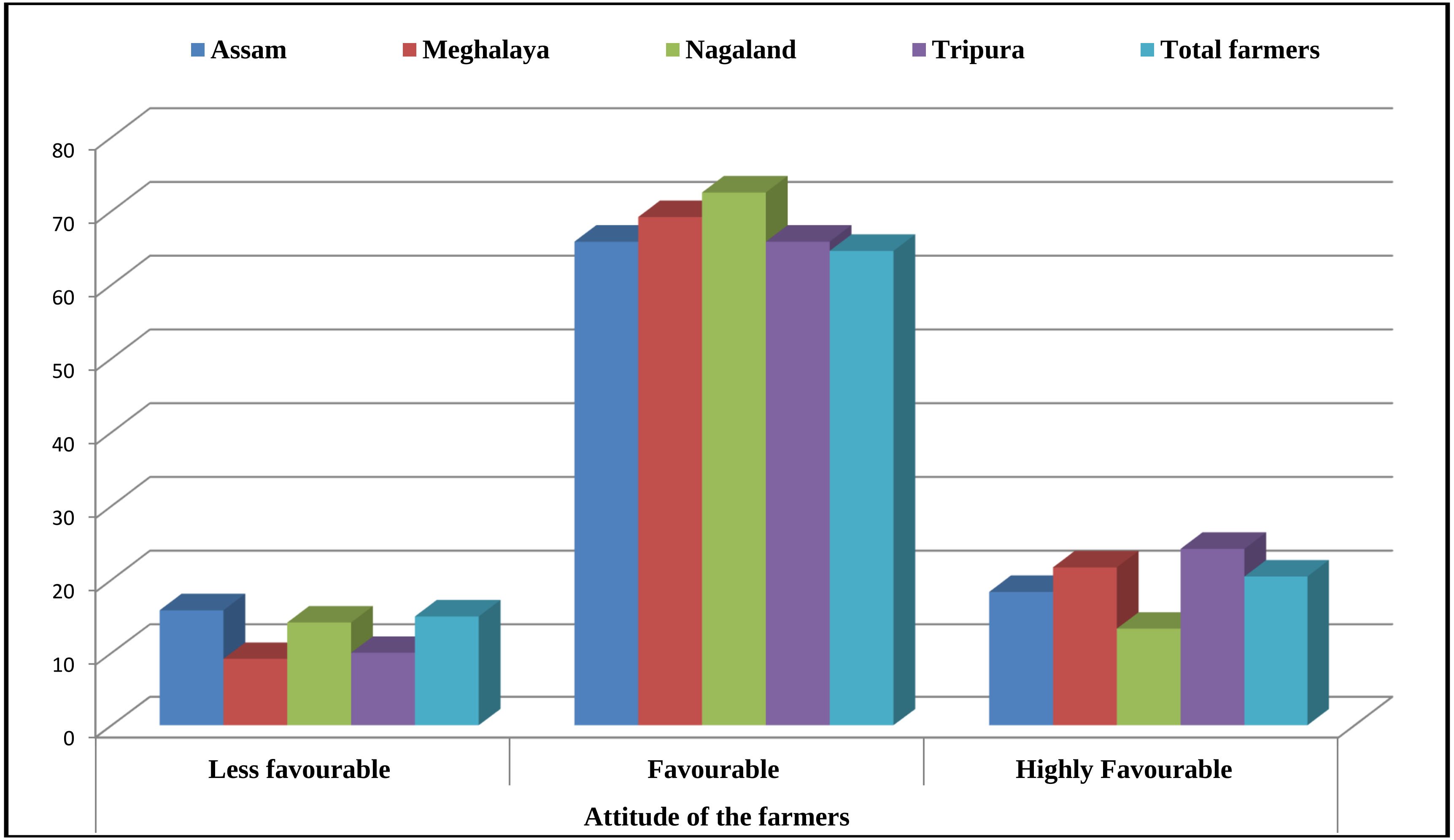

Fig 4.2.2.1 Distribution of respondents based on their Attitude towards adoption of sustainable potato cultivation practices

1	**Assam**	Less favourable (<79) Favourable (79-90) Highly Favourable (>90)	19 79 22	15.84 **65.83** 18.33	84.49	5.83	80.47
2	**Meghalaya**	Less favourable (<80) Favourable (80-93) Highly Favourable (>93)	11 83 26	9.17 **69.17** 21.66	86.84	6.48	82.71
3	**Nagaland**	Less favourable (<77) Favourable (77-88) Highly Favourable (>88)	17 87 16	14.17 **72.50** 13.33	82.69	5.37	78.75
4	**Tripura**	Less favourable (<80) Favourable (80-92) Highly Favourable (>92)	12 79 29	10.00 **65.83** 24.17	86.97	6.37	82.83
6	**Total farmers**	Less favourable (<79) Favourable (79-91) Highly Favourable (>91)	72 310 98	15.00 **64.58** 20.42	85.25	6.29	81.19

It was also found from the above Table that majority (64.58 %) of the potato farmers of North-east possessed favourable attitude while 20.42 per cent and 15.00 per cent of them possessed highly favourable and less favourable attitude towards sustainable potato cultivation respectively. Attitude index was found highest (82.83) in case of Potato growers of Tripura.

Table 4.2.2.2: Comparative account of Attitude of farmers towards sustainable potato cultivation

Sr. No	Name of the state	(μ)	Mann whitney u test	Probability
1	Assam	5.83	**-3.023****	<0.01
	Meghalaya	6.48		
2	Meghalaya	6.48	**-5.000****	<0.01
	Nagaland	5.37		

3	Nagaland	5.37	**-4.934****	<0.01
	Tripura	6.37		
4	Tripura	6.37	**-3.023****	<0.01
	Assam	5.83		
5	Tripura	6.37	-0.075	>0.05
	Meghalaya	6.48		
6	Assam	5.83	**-2.143***	<0.05
	Nagaland	5.37		

** significant at 1% level of probability, * significant at 5% level of probability

Table 4.2.2.2 revealed that 'Attitude' towards sustainable potato cultivation of the respondents in the North-eastern states was found to be statistically except among the farmers of the states between Tripura vs. Meghalaya. In Assam vs. Nagaland it was found statistically significant at 5 per cent level whereas others were found to be statistically significant at 1per cent level of significance.

4.3 Status of sustainability of potato farming practised by farmers

Table 4.3.1: Distribution of respondents based on sustainability of potato farming practised by farmers of Assam N=120

Sr. no.	Dimensions of sustainability	Level	Frequency	%	Mean score	Sd
1	Economic sustainability	Low (<3.5) Medium (3.5-5) High (>5)	22 98 0	18.33 81.67 0.00	4.3	0.88
2	Social sustainability	Low (<19) Medium (19-25) High (>25)	17 82 21	14.17 68.33 17.50	22.12	3.20
3	Environmental sustainability	Low (<14) Medium (14-18) High (>18)	14 83 23	11.67 69.17 19.16	16.67	2.13

Table 4.3.1 represents the distribution of respondents based on the sustainability of potato farming practised by farmers of Assam. It was observed that majority (81.67%) of the farmers hadmedium level of economic

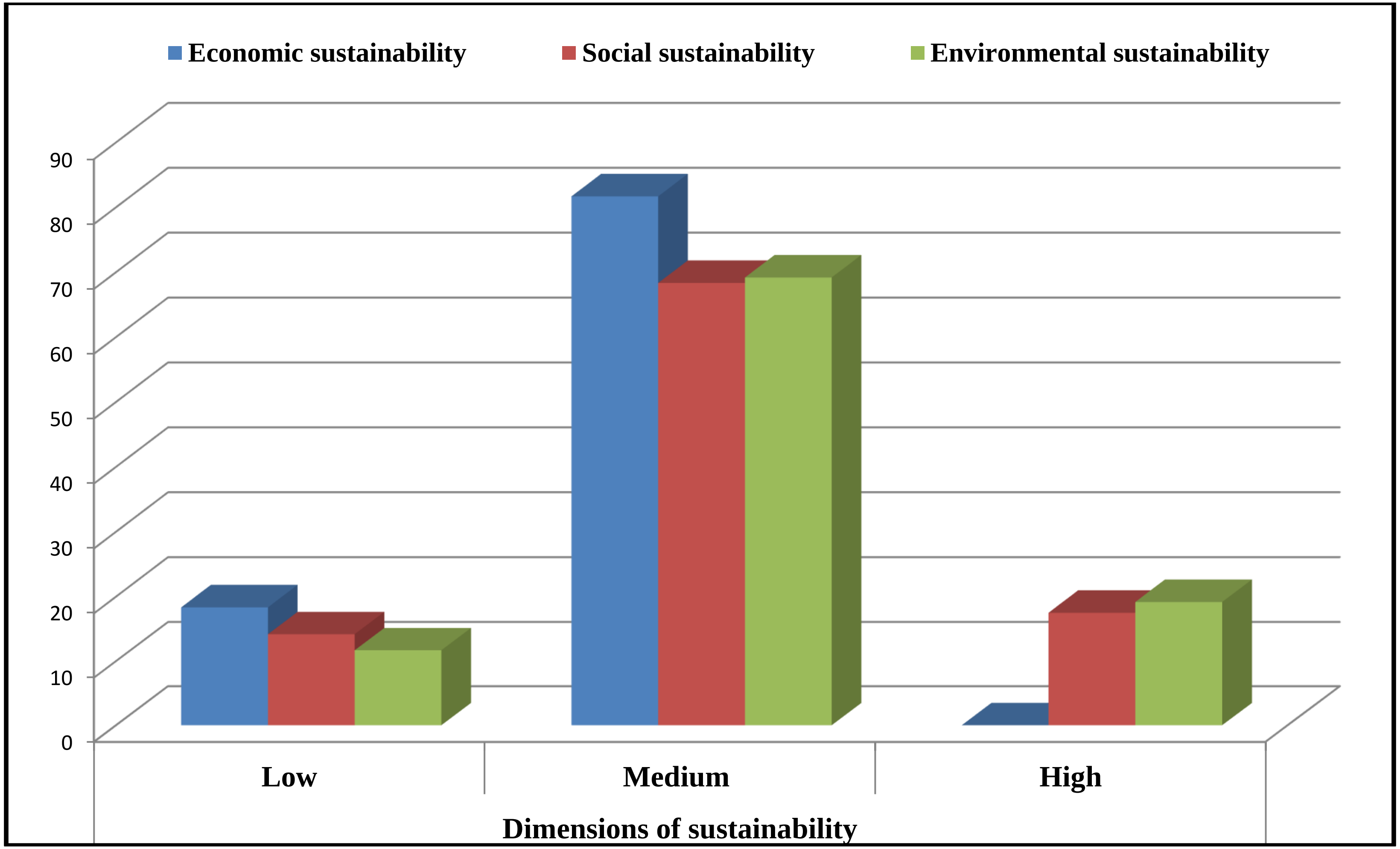

Fig 4.3.1: Distribution of respondents based on sustainability of potato farming practiced by farmers of Assam

sustainability and remaining 18.33 per cent had low level economic sustainability. Further, it was found that 68.33 per cent of the respondents had medium level social sustainability followed by 17.50 per cent of them had high and 14.17 per cent of them had low level of social sustainability. It was also found that, majority (69.17%) of the respondentshadmedium level of environmental sustainability followed by 19.16 per cent of them had high level of environmental sustainability and 11.67 per cent of the respondents had low level of environmental sustainability in the state of Assam. Among the three dimensions, the mean score (22.12) of social sustainability was the highest.

Table 4.3.2: Distribution of respondents based on sustainability of potato farming practised by farmers of Meghalaya N=120

Sr. no.	Dimensions of sustainability	Level	Frequency	%	Mean score	Sd
1	Economic sustainability	Low (<4) Medium (4-5) High (>5)	11 109 0	9.17 90.83 0.00	4.52	0.68
2	Social sustainability	Low (<25) Medium (25-30) High (>30)	12 92 16	10.00 76.67 13.33	27.73	2.50
3	Environmental sustainability	Low (<15) Medium (15-18) High (>18)	7 91 22	5.84 75.83 18.33	16.94	1.58

Table 4.3.2 represents the distribution of respondents based on sustainability of potato farming practised by farmers of Meghalaya. It was observed that 90.83 per cent of the respondent had medium level of economic sustainability and remaining 9.17 per centof them had low level economic sustainability. Further itwas observed that 76.67 per centof them had medium level of Social sustainability followed by 13.33 per cent of the respondentshad high level of social sustainability and 10.00 per cent of themhad low level of

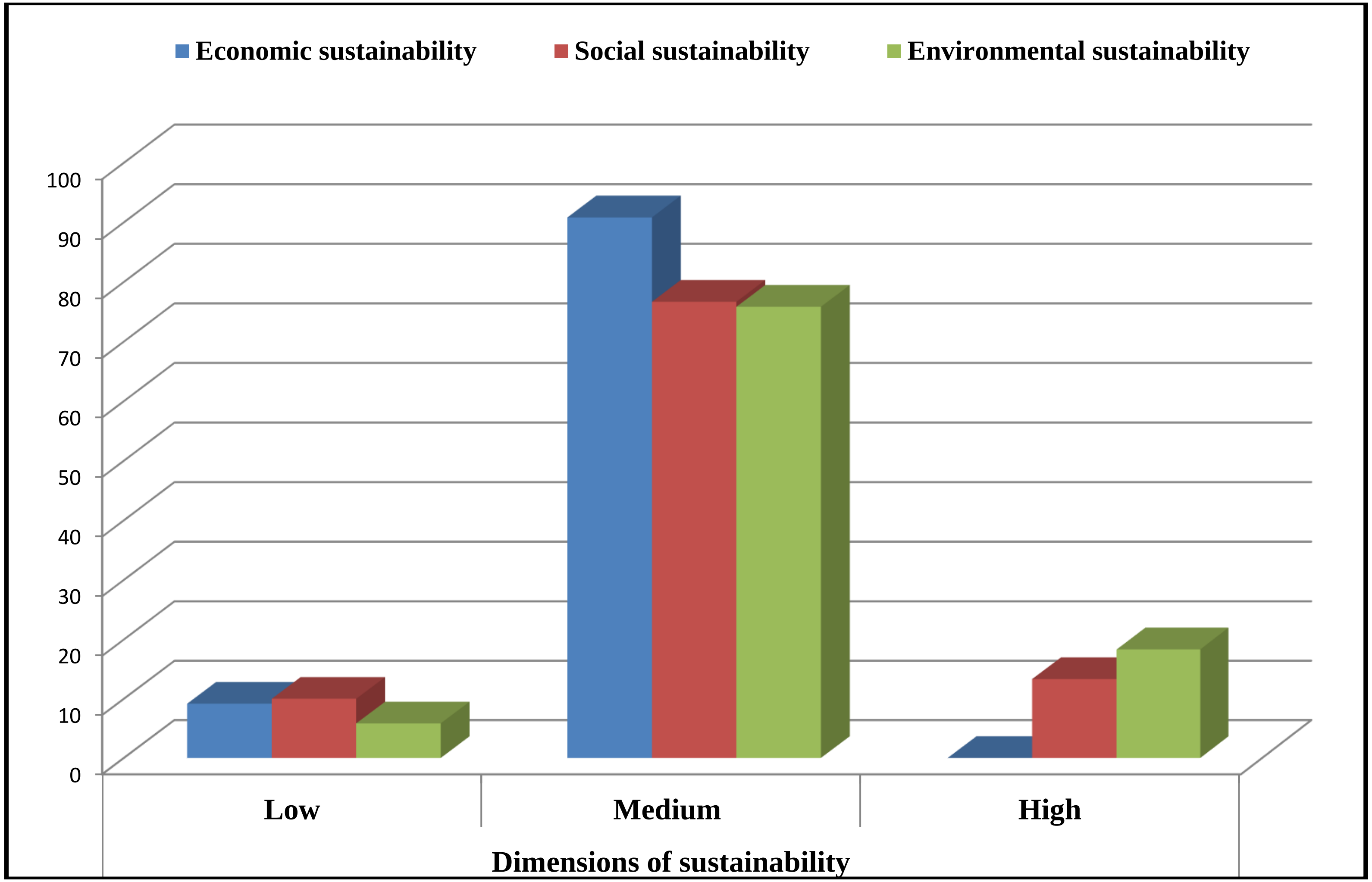

Fig 4.3.2: Distribution of respondents based on sustainability of potato farming practiced by farmers of Meghalaya

social sustainability. Apart from these, majority (75.83%) of the farmers had medium level of environmental sustainability followed by 18.33 per cent of themhaving high level of environmental sustainability and 15.84 per cent of the respondentshad low level of environmental sustainability respectively in the state of Meghalaya. Among the three dimensions, the mean score (27.73) of social sustainability was the highest.

Table 4.3.3: Distribution of respondents based on sustainability of potato farming practised by farmers of Nagaland N=120

Sr. no.	Dimensions of sustainability	Level	Frequency	%	Mean score	Sd
1	Economic sustainability	Low (<4) Medium (4-5) High (>5)	4 116 0	3.33 96.67 0.00	4.72	0.67
2	Social sustainability	Low (<23) Medium (23-28) High (>28)	7 98 15	5.84 81.66 12.50	25.89	2.61
3	Environmental sustainability	Low (<11) Medium (11-15) High (>15)	9 96 15	7.50 80.00 12.50	13.30	1.93

Table 4.3.3 represents the distribution of respondent based on sustainability of potato farming practised by farmers of Nagaland. It was observed that majority 96.67 per cent of the respondentshad medium level of Economic sustainability and remaining 3.33 per cent of them had low level economic sustainability. Further it was found that majority (81.66%) of the respondentshad medium level of Social sustainability followed by 12.50 per cent of them having high level of social sustainability and 5.84 per cent of them hadlow level of social sustainability. It was also found that majority (80.00%) of the respondentshad medium level of environmental sustainability,

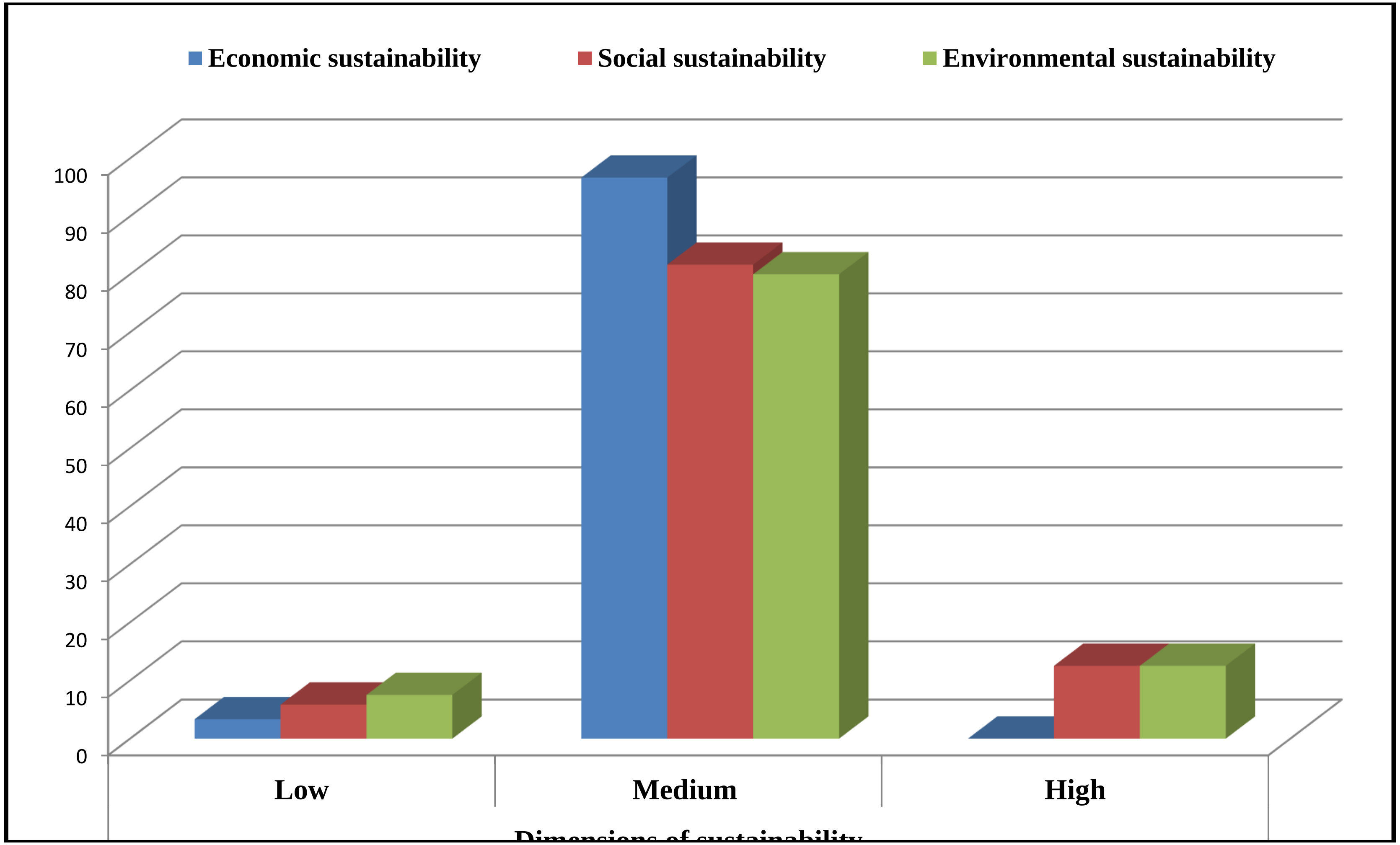

Fig 4.3.3: Distribution of respondents based on sustainability of potato farming practiced by farmers of Nagaland

followed by 12.50 per cent of the respondentswho had high level of environmental sustainability and 7.50 per cent of the respondentshaving low level of environmental sustainability respectively. Among the three dimensions, the mean score (25.89) of social sustainability was the highest.

Table 4.3.4: Distribution of respondents based on sustainability of potato farming practised by farmers of Tripura N=120

Sr. no.	Dimensions of sustainability	Level	Frequency	%	Mean score	Sd
1	Economic sustainability	Low (<3.5) Medium (3.5-5.5) High (>5.5)	16 104 0	13.33 86.67 0.00	4.46	0.80
2	Social sustainability	Low (<16) Medium (16-21) High (>21)	14 86 20	11.66 71.66 16.67	18.62	2.66
3	Environmental sustainability	Low (<17) Medium (17-20) High (>20)	4 100 16	3.34 83.33 13.33	18.79	1.44

Table 4.3.4 represents the distribution of respondents based on sustainability of potato farming practised by farmers in Tripura. It was found that most (86.67%) of the respondentshad medium level of economic sustainability and rest 13.33 per cent of them had low level of economic sustainability. It was also found that majority 71.66 per cent of the respondentshad medium level of social sustainability, followed by 16.67 per cent of them having high level of social sustainability and 11.66 per cent of the respondentshaving low level of social sustainability. Further, majority (83.33%) of the respondentshad medium level of environmental sustainability, followed by 13.33 per cent of themhaving high level of environmental sustainability and 3.34 per cent of the respondentshaving low level of environmental

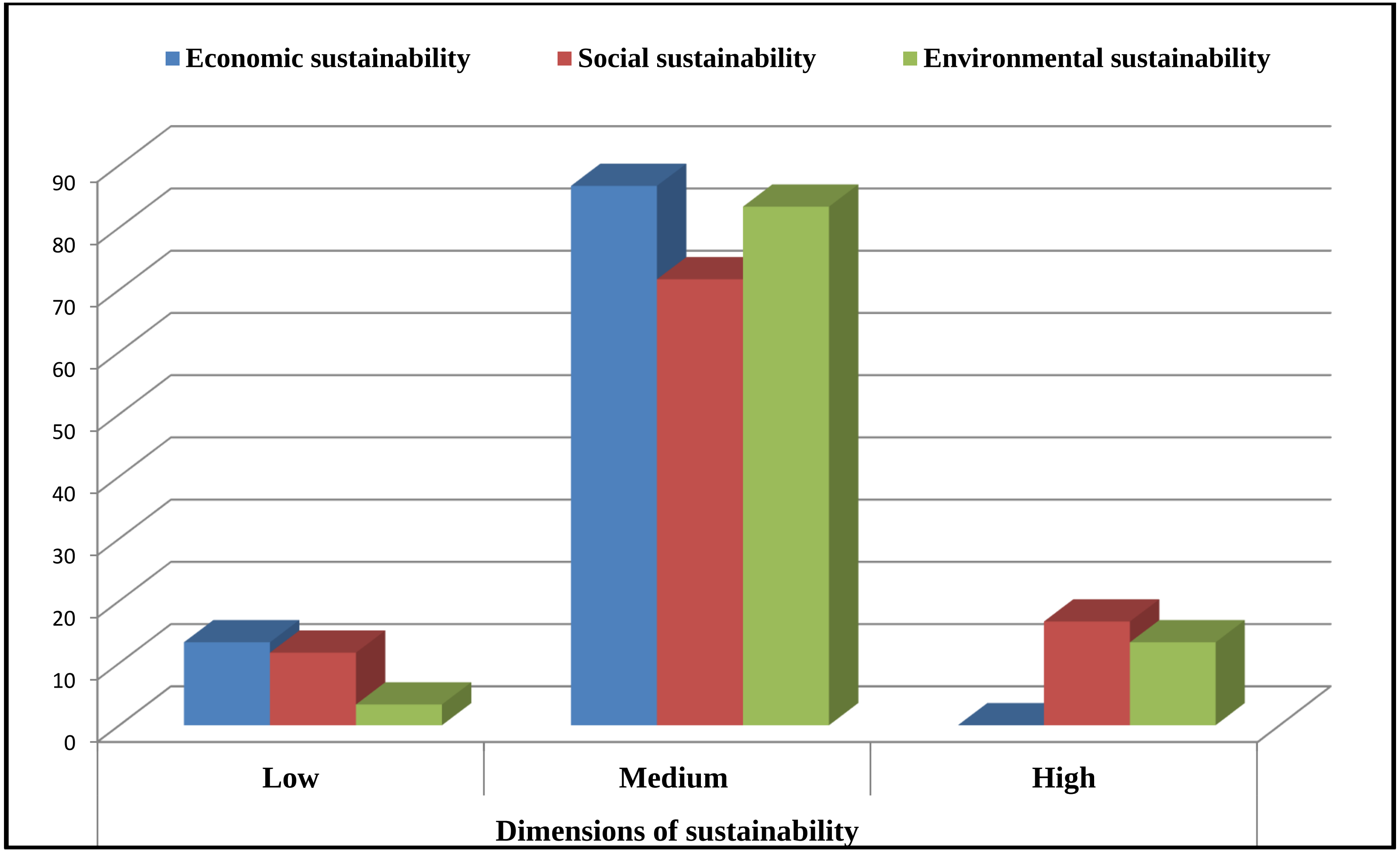

Fig 4.3.4: Distribution of respondents based on sustainability of potato farming practiced by farmers of Tripura

sustainability respectively. Among the three dimensions, the mean score (18.79) of environmental sustainability was the highest.

Table 4.3.5: Distribution of respondents based on sustainability of potato farming practised by farmers of North-east N=480

Sr. no.	Dimensions of sustainability	Level	Frequency	%	Mean Score	Sd
1	Economic sustainability	Low (<3.5) Medium (3.5-5) High (>5)	53 427 0	11.04 88.96 0.00	4.50	0.78
2	Social sustainability	Low (<19) Medium (19-28) High (>28)	78 337 65	16.25 70.21 13.54	23.59	4.46
3	Environmental sustainability	Low (<14) Medium (14-19) High (>19)	74 358 48	15.42 74.58 10.00	16.42	2.67

Table 4.3.5depicts the distribution of respondents based on sustainability of potato farming practised by farmers of North-east. It was found that majority (88.96%) of the respondentshad medium level of economic sustainability and rest 11.04 per cent of them had low level of economic sustainability. Further it wasfound that 70.21 per cent of the respondentshad medium level of social sustainability, followed by 16.25 per cent of themhavinglow level of social sustainability and 13.54per cent of them havinghigh level of social sustainability. It was further revealed that74.58 per cent of the respondentshad medium level of environmental sustainability, followed by15.42 per cent of themhaving low level of environmental sustainability and 10.00 per cent of themhavinghigh level of environmental sustainability respectively. Among the three dimensions, the mean score (23.59) of social sustainability was the highest.

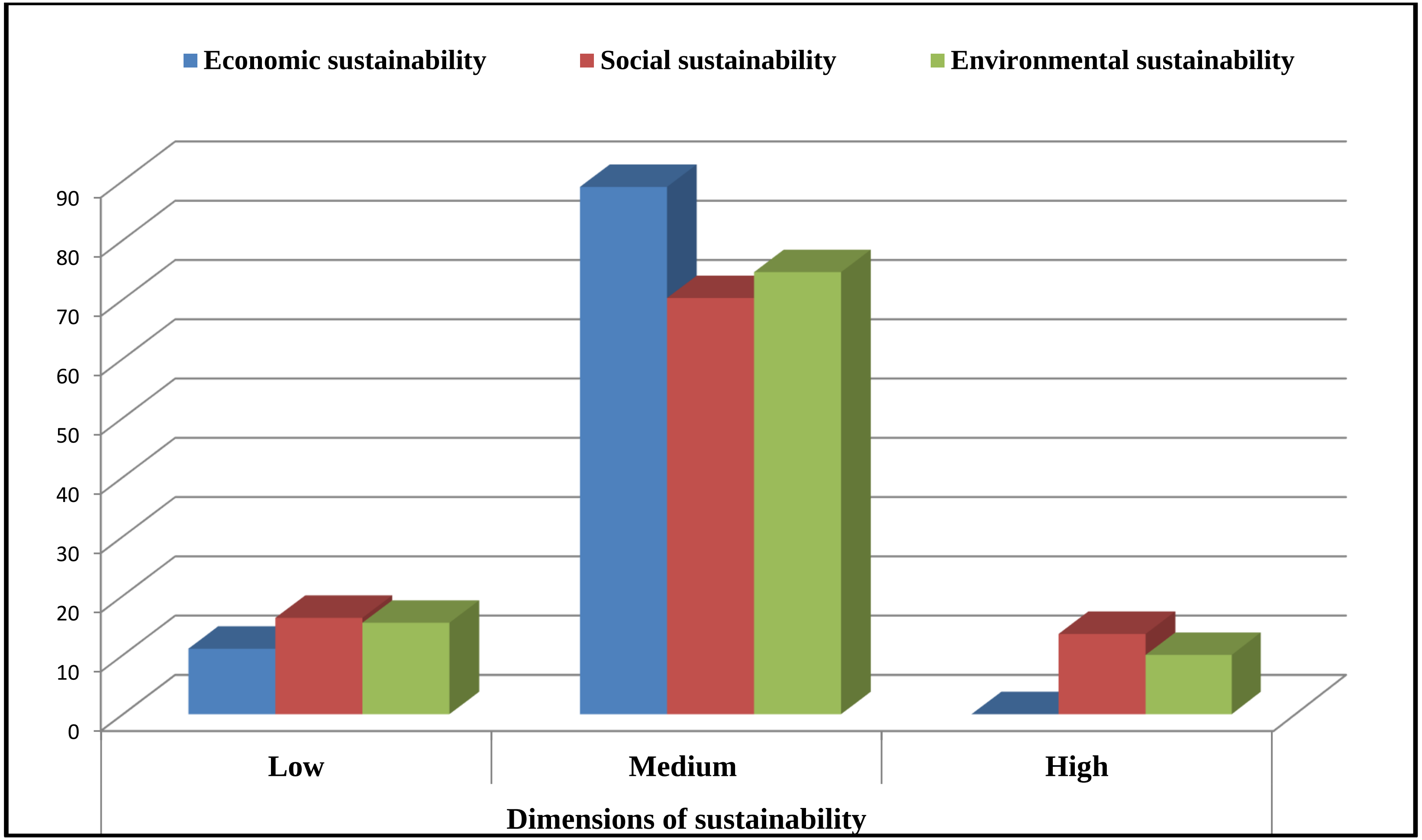

Fig 4.3.5: Distribution of respondents based on sustainability of potato farming practiced by farmers of north-east

Table 4.3.6:Sustainability indexof potato farming in the selected states

Sr. no.	State	Sustainability Index	Rank
1	Assam	50.11	III
2	Meghalaya	57.21	I
3	Nagaland	51.06	II
4	Tripura	48.68	IV
5.	**Overall**	51.76	-

Table 4.3.6 depicts the sustainability index comprising all the three dimensions namely economic sustainability, social sustainability, environmental sustainability and it was observed that potato growers of Meghalaya ranks first in sustainable cultivation of potato havingthe highest level of sustainability index (57.21), followed by Nagaland having second rank with sustainability Index of 51.06. The state of Assam ranked third having sustainability index of 50.11 followed by Tripura ranking fourth havingsustainability index of 48.68. It wasfound that overall sustainability of potato farming in North-east India was 51.76 per cent.

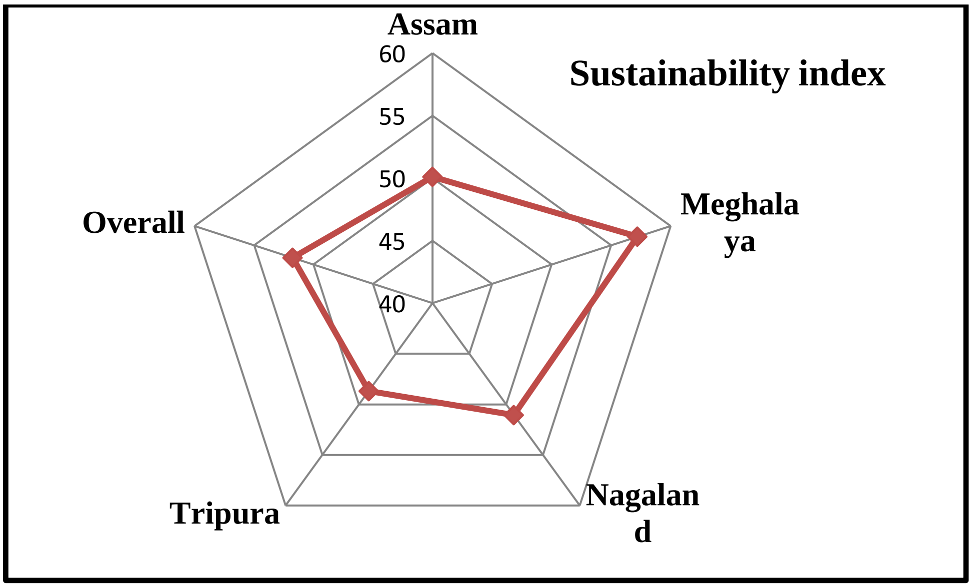

Fig 4.3.6 Overall sustainability of potato farming in North-east India

Table 4.3.7: Contribution of different dimensions of sustainability in sustainable potato farming practices N=480

Sr. No.	State	Economic sustainability	Social sustainability	Environmental sustainability
1	Assam	9.98	51.34	38.68
2	Meghalaya	9.20	56.37	34.43
3	Nagaland	10.74	58.97	30.29
4	Tripura	10.65	44.47	44.88
5.	Overall	10.14	52.79	37.07

Table 4.3.7 revealed the contribution of different dimensions of sustainability in sustainable potato farming within the North-eastern states of India. Sustainability comprises of three different dimensions namely economic, social and environmental. It was envisaged that in the state of Assam, social

sustainability contributed the highest (51.34%) in sustainability followed by 38.68 per cent by environmental sustainability and remaining 9.98 per cent by economic sustainability. In the state of Meghalaya, social sustainability contributed the highest (56.67%) in sustainability followed by 34.43 per cent by environmental sustainability and remaining 9.20 per cent by economic sustainability. In the state of Nagaland, social sustainability contributed the highest (58.97%) among the three dimensions of sustainability, followed by 30.29 per cent by environmental sustainability and remaining 10.74 per cent by economic sustainability. Further in the state of Tripura, environmental sustainability contributed the highest (44.88%), followed by 44.47 per cent by social sustainability and remaining 10.65 per cent by economic sustainability respectively. It may be interpretedthat amongthe selected potato growing states of North-east, highest (52.79%) was contributed by social sustainability, followed by environmental sustainability (37.07 %) and 10.14 per cent by economic sustainability.

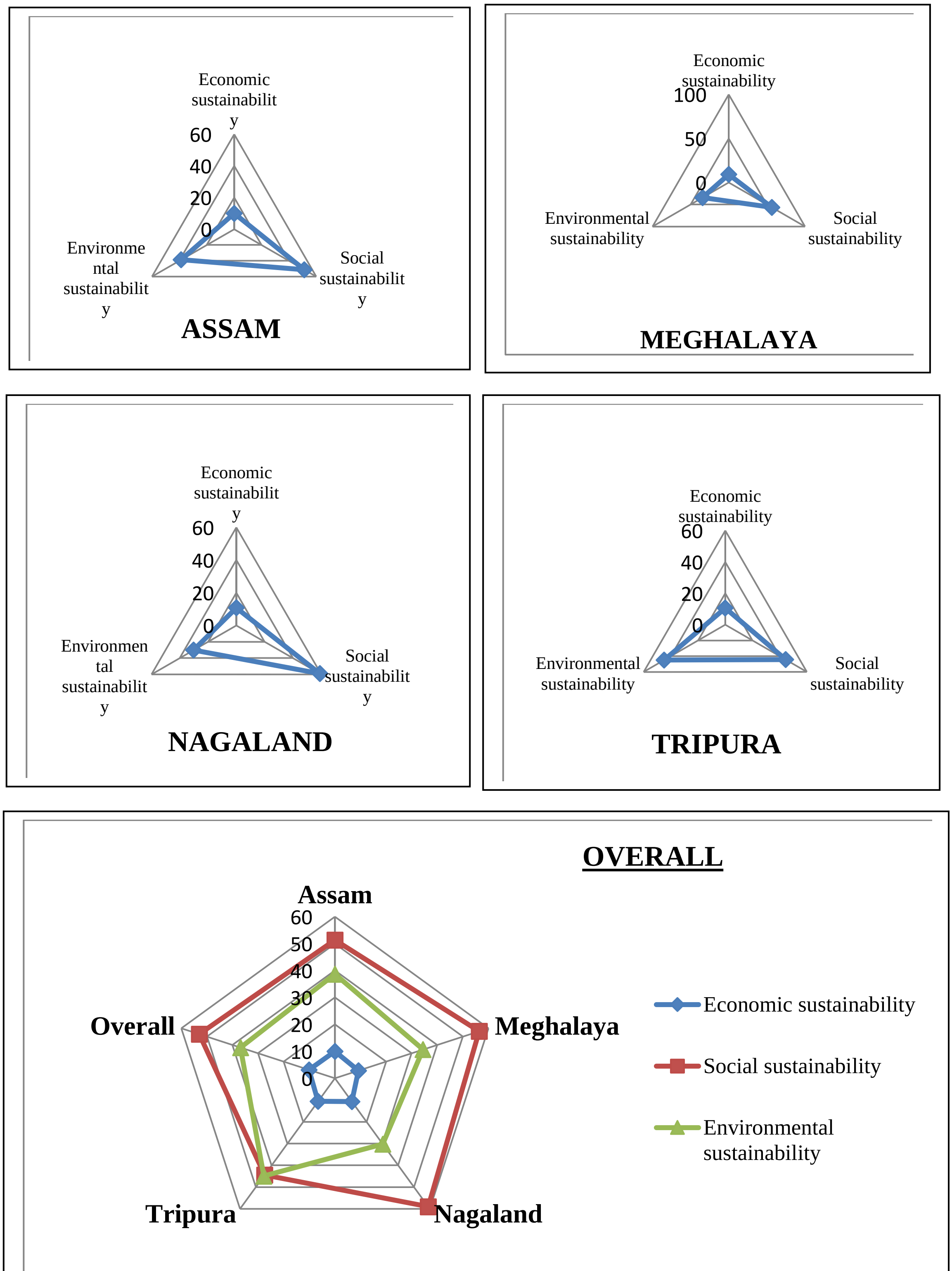

Fig 4.3.7: Contribution of different dimensions of sustainability in sustainable potato farming among the selected states of North-east.

Table 4.3.8: Correlation of personal, socio-economic and psychological characteristics of farmers with the dependent variable – 'Sustainability of potato farming practices'

Sl. No.	Independent variables	Co-efficient of correlation (r)
1.	Age	0.226**
2.	Gender	0.025
3.	Family size	0.505**
4.	Education	0.212**
5.	Size of land holding	0.236**
6.	Area under potato	0.229**
7.	Productivity	0.241**
8.	Annual income	-0.066
8.	Income from potato	0.030
10.	Training exposure	-0.107
11.	Sources of information	0.380**
12.	Extension contact	-0.021
13.	Scientific orientation	0.168**
14.	Social participation	0.242**
15.	Marketing channel	0.210**
16.	Knowledge	0.299**
17.	Attitude	-0.102

** Correlation is significant at the 0.01 level (2-tailed).

From the Table 4.3.8 it was found that variables age, family size,education, size of land holding, area under potato, productivity, sources of information, scientific orientation, social participation, marketing channel and knowledge had positive and significant association with the dependent variable "Sustainability" at 1% level of probability. Thus it may inferred that respondents who are advanced in age, have large family size, having high educational level, big size of land holding, having large area under potato, high productivity, having access to higher utilization of information sources, higher scientific orientation, high social participation, more utilization of various marketing channels and higher knowledge on sustainable farming had positive mindset towards adoption of sustainable potato farming practices. These findings were similar to the findings of Chanu *et al*. (2014) and Khan *el al*. (2020)

However, it was found that the variables sex, annual income, income from potato, training exposure, extension contact and attitude had non-significant association with the dependent variable "Sustainability".
Based upon the findings, the null hypothesis (**H_0 1a)** was rejected:

$H_0$1a: There is no association between the variables age, family size,education, size of land holding, area under potato, productivity, sources of information, scientific orientation, social participation, marketing channel and knowledge with '**Sustainability of potato farming practices'**was rejected.

The variablessex, annual income, income from potato, training exposure, extension contact and attitude were found non-significant. Therefore the following null hypothesis **H_0 1_b**was accepted:

$H_0 1_b$: There is no association between variables gender, annual income, income from potato, training exposure, extension contact and attitude with **Sustainability of potato farming practices**.

4.4 Entrepreneurial behaviour of the potato farmers

Table 4.4.1 depicts the entrepreneurial behaviour traits of the farmer's in the state of Assam. It was found that among the different entrepreneurial traits, entrepreneurial behaviour of the farmers in Assam was found to be medium level. In case of Innovativeness, most (83.00%) of the farmers had medium entrepreneurial behaviour , followed by 16.67 per cent and 0.83 per cent of them having high and low level of entrepreneurial behaviour respectively. In case of Management orientation, it was observed that majority (73.33 %) of them hadmedium level of entrepreneurial behaviour followed by 15.00 per cent and 11.67 per centof them who had high entrepreneurial behaviour and low entrepreneurial behaviour respectively. In case of Decision making ability, medium entrepreneurial behaviour was observed for most of the respondents comprising 82.50 per cent of farmers, followed by high entrepreneurial behaviour of about 11.67 per cent and low entrepreneurial behaviour of about 5.83 per cent farmers respectively. In case of economic motivation, 86.66 per cent farmers had medium level of economic motivation followed by 9.17 per cent have high and 4.17 per cent have low entrepreneurial behaviour respectively. In case of risk taking ability, majority (88.33%) of the farmers had medium entrepreneurial behaviour followed by 7.50 per cent of them had low entrepreneurial behaviour and 4.17 per cent of them had high entrepreneurial behaviour respectively. In case of Achievement Motivation, medium entrepreneurial behaviour was recorded in case of 84.17 per cent farmers, followed by high entrepreneurial behaviour as evident in case of 10.83 per cent of farmers and low entrepreneurial behaviour in case of 5.00 per cent of farmers.Further in case of scientific orientation,most (73.33%) of them had medium entrepreneurial behaviour followed by 18.33 per cent of them having high entrepreneurial behaviour and 8.34 per cent of them having low entrepreneurial behaviour respectively.

Table 4.4.1: Distribution of the potato farmers of Assam based on their entrepreneurial behaviour traits N=120

Sr. no.	Entrepreneurial behaviour traits	Level	Frequency	%	Mean score	sd
1	Innovativeness	Low (<12) Medium (12-14) High (>14)	1 99 20	0.83 82.50 16.67	13.45	1.05
2	Management Orientation	Low (<53) Medium (53-58) High (>58)	14 88 18	11.67 73.33 15.00	55.65	2.79
3	Decision making ability	Low (<12) Medium (12-16) High (>16)	7 99 14	5.83 82.50 11.67	14.36	1.81
4	Economic motivation	Low (<19) Medium (19-23) High (>23)	5 104 11	4.17 86.66 9.17	21.28	1.63
5	Risk taking ability	Low (<16) Medium (16-20) High (>20)	9 106 5	7.50 88.33 4.17	18.33	1.60
6	Achievement Motivation	Low (<15) Medium (15-18) High (>18)	6 101 13	5.00 84.17 10.83	16.86	1.50
7	Scientific Orientation	Low (<39) Medium (39-43) High (>43)	10 88 22	8.34 73.33 18.33	41.21	2.27

Table 4.4.2 exhibits the entrepreneurial behaviour traits of the farmers in the state of Meghalaya. Result obtained from different entrepreneurial traits revealed thatmost of the entrepreneurial behaviour traits of the farmers in Meghalaya state were found to be medium level. In case of Innovativeness, maximum farmers had medium level of entrepreneurial behaviour, which comprisedof nearly 88.33 per centand rest of them had high entrepreneurial behaviour (11.67 %). In case of management orientation, most (70.00 %) of them had medium entrepreneurial behaviour, followed by high entrepreneurial behaviour (17.50 %) and low entrepreneurial behaviour which was about 12.50 per cent respectively. In case of decision making ability, majority (81.66 %) of them had medium entrepreneurial behaviour, followed by 9.17 per cent of them who had both high and low level of entrepreneurial behaviour. In case of economic motivation, majority (95.83%) of the farmers had medium entrepreneurial behaviour and rest 4.17 per cent of them had low entrepreneurial behaviour. In case of risk taking ability, majority (91.66%) of them had medium entrepreneurial behaviour followed by 4.17 per cent of them having high and low entrepreneurial behaviour. In case of achievement motivation, medium entrepreneurial behaviour was recorded highestin case of 90.00 per cent of the farmers, followed by 7.50 per cent who had low entrepreneurial behaviour and 2.50 per cent of them having high entrepreneurial behaviour. Further, in case of scientific orientation, majority (77.50%) had medium level of entrepreneurial behaviour followed by 12.50 per cent and 10.00 per cent of them having high and low entrepreneurial behaviour respectively.

Table 4.4.2: Distribution of the potato farmers of Meghalaya based on their entrepreneurial behaviour traits N=120

Sr. no.	Entrepreneurial behaviour traits	Level	Frequency	%	Mean	sd
1	Innovativeness	Low (<12) Medium (12-14) High (>14)	0 106 14	0.00 88.33 11.67	13.14	0.86
2	Management Orientation	Low (<56) Medium (56-58) High (>58)	15 84 21	12.50 70.00 17.50	57.04	1.43
3	Decision making ability	Low (<10) Medium (10-14) High (>14)	11 98 11	9.17 81.66 9.17	11.93	1.89
4	Economic motivation	Low (<21) Medium (21-24) High (>24)	5 115 0	4.17 95.83 0.00	22.34	0.99
5	Risk taking ability	Low (<18) Medium (18-20) High (>20)	5 110 5	4.17 91.66 4.17	19.15	0.94
6	Achievement Motivation	Low (<18) Medium (18-20) High (>20)	9 108 3	7.50 90.00 2.50	18.92	0.98
7	Scientific Orientation	Low (<39) Medium (39-42) High (>42)	12 93 15	10.00 77.50 12.50	40.60	1.67

Table 4.4.3 revealed the entrepreneurial behaviour traits of the farmers in the state of Nagaland. Result obtained among the different entrepreneurial traits revealed that most of the entrepreneurial behaviour traits of the farmers in Meghalaya statewere medium level. In case of Innovativeness, most (82.50%) of them had medium entrepreneurial behaviour followed by 12.50 per cent

havinghigh and 5.00 per cent with low entrepreneurial behaviour. In case of management orientation, it was found that most (90.83%) of the farmers had medium entrepreneurial behaviour followed by 13.33 per cent havinglow and 5.84 per cent having high entrepreneurial behaviour. In case of decision making ability, majority (75.83%) had medium entrepreneurial behaviour followed by 13.33 per cent havinghigh and 13.33 per cent having low entrepreneurial behaviour. In case of economic motivation, 76.67 per cent of the farmers had medium entrepreneurial behaviour followed by 15.83 per cent of them having low and 7.50 per cent of them having high entrepreneurial behaviour respectively. In case of Risk taking ability, majority (92.50%) of the farmers had medium entrepreneurial behaviour followed by 5.00 per cent of them having low entrepreneurial behaviourand 2.50 per cent of them having high entrepreneurial behaviour respectively. In case of achievement motivation, majority (85.83%) of the farmers had medium entrepreneurial behaviour followed by 10.00 per cent having low entrepreneurial behaviour and 4.17 per cent having high entrepreneurial behaviour respectively.In case of scientific orientation most (78.33%) of them hadmedium entrepreneurial behaviour, followed by 11.67 per cent of them havinglow and 10.00 per cent of them having high entrepreneurial behaviour respectively.

Table 4.4.3: Distribution of the potato farmers of Nagaland based on their entrepreneurial behaviour traits N=120

Sr. no.	Entrepreneurial behaviour traits	Level	Frequency	%	Mean	sd
1	Innovativeness	Low (<12) Medium (12-15) High (>15)	6 99 15	5.00 82.50 12.50	13.69	1.46
2	Management	Low (<50)	7	5.84	54.92	4.02

	Orientation	Medium (50-59) High (>59)	109 4	90.83 3.33		
3	Decision making ability	Low (<6) Medium (6-9) High (>9)	13 91 16	10.84 75.83 13.33	7.82	1.89
4	Economic motivation	Low (<21) Medium (21-24) High (>24)	19 92 9	15.83 76.67 7.50	22.15	1.50
5	Risk taking ability	Low (<18) Medium (18-21) High (>21)	6 111 3	5.00 92.50 2.50	19.50	1.18
6	Achievement Motivation	Low (<18) Medium (18-21) High (>21)	12 103 5	10.00 85.83 4.17	19.25	1.38
7	Scientific Orientation	Low (<39) Medium (39-44) High (>44)	14 94 12	11.67 78.33 10.00	41.32	2.40

Table 4.4.4 depicted the entrepreneurial behaviour traits of the farmers in the state of Tripura. In case of innovativeness, most (89.17%) of the farmers had medium entrepreneurial behaviour and rest 10.83 per cent had high entrepreneurial behaviour. In case of Management orientation, it was found that 76.66 per cent of the farmers had medium entrepreneurial behaviour followed by 16.67 per cent havinghigh and 6.67 per cent had low entrepreneurial behaviour. In case of decision making ability, majority (60.00%) of them had medium entrepreneurial behaviour. In case of economic motivation, most (83.33 %) of the farmers had medium entrepreneurial behaviour, followed by 13.34 per cent and 3.33 per cent of them having high and low entrepreneurial behaviour respectively. Further, in case of risk taking ability, most (85.83%) of the farmers had medium entrepreneurial behaviour followed by 8.33 per cent having high and 5.83 per cent having low

entrepreneurial behaviour. In case of achievement motivation, most (91.66%) of the farmers recorded medium level of entrepreneurial behaviour followed by 6.67 per cent having low and 1.67 per cent having high entrepreneurial behaviour. In case of scientific orientation,most (75.83%) of the farmers had medium entrepreneurial behaviour,followed by 12.50 per cent having high and 11.67 per cent of them having low entrepreneurial behaviour respectively.

Table 4.4.4: Distribution of the potato farmers of Tripura based on their entrepreneurial behavioural traits N=120

Sr. no.	Entrepreneurial behaviour traits	Level	Frequency	%	Mean	sd
1	Innovativeness	Low (<12) Medium (12-14) High (>14)	0 107 13	0.00 89.17 10.83	13.11	0.84
2	Management Orientation	Low (<55) Medium (55-58) High (>58)	8 92 20	6.67 76.66 16.67	57.05	1.46
3	Decision making ability	Low (<11) Medium (11-13) High (>13)	22 72 26	18.33 60.00 21.67	12.17	1.59
4	Economic motivation	Low (<21) Medium (21-23) High (>23)	4 100 16	3.33 83.33 13.34	22.38	1.00
5	Risk taking ability	Low (<18) Medium (18-20) High (>20)	7 103 10	5.83 85.83 8.33	19.20	1.02
6	Achievement	Low (<18)	8	6.67	18.94	0.93

	Motivation	Medium (18-20) High (>20)	110 2	91.66 1.67		
7	Scientific Orientation	Low (<39) Medium (39-42) High (>42)	14 91 15	11.67 75.83 12.50	40.60	1.71

From Table 4.4.5it was evident that in case of innovativeness, most (81.67%) of the farmers had medium level of entrepreneurial behaviour and rest16.87 per cent of them had high entrepreneurial behaviour. In case of Management orientation, it was found that 82.92 per cent of the farmers had medium level of entrepreneurial behaviour followed by 13.54 per cent of them hadlowand 3.54 per cent had high entrepreneurial behaviour. Following that, in case of decision making ability, majority (67.09%) of the farmers had medium entrepreneurial behaviour followed by 18.12 per cent of them having low entrepreneurial behaviour and 14.79 per cent havinghigh entrepreneurial behaviour. In case of economic motivation, majority (72.50%) of the farmers had medium entrepreneurial behaviour followed by13.96 per cent who hadlowand 13.54 per cent having high level of entrepreneurial behaviour. In case of risk taking ability, 86.25 per cent of the farmer's hadmedium entrepreneurial behaviour followed by 9.58 per cent having high and 4.17 per cent of them having low entrepreneurial behaviour. Further in case of achievement motivation, 86.25 per cent of the farmers had medium entrepreneurial behaviour, followed by 9.58 per cent of them having highand 4.17 per cent of them havinglow entrepreneurial behaviour. In case of scientific orientation, 77.66 per cent of the farmers hadmedium entrepreneurial behaviour, followed by 12.92 per cent havinghigh and 10.42 per cent of them having low entrepreneurial behaviour respectively.

Table 4.4.5: Distribution of the potato farmers of North-east based on their entrepreneurial behaviour traits N=480

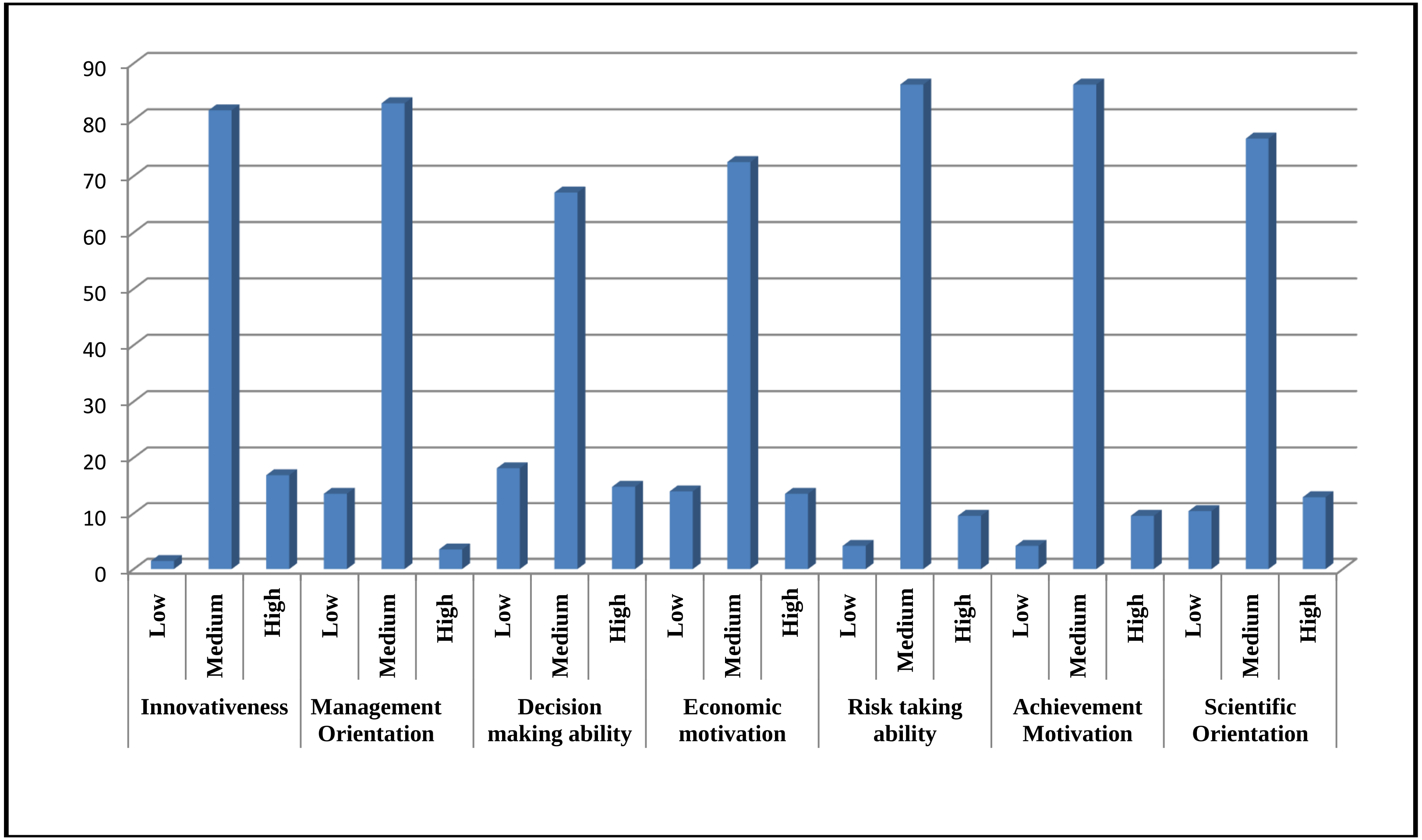

Fig 4.4.5: Distribution of the potato farmers of North-east based on their entrepreneurial behavior traits

Sr. no.	Entrepreneurial behaviour traits	Level	Frequency	%	Mean	sd
1	Innovativeness	Low (<12) Medium (12-14) High (>14)	7 392 81	1.46 81.67 16.87	13.35	1.11
2	Management Orientation	Low (<54) Medium (54-59) High (>59)	65 398 17	13.54 82.92 3.54	56.17	2.80
3	Decision making ability	Low (<09) Medium (09-14) High (>14)	87 322 71	18.12 67.09 14.79	11.57	2.97
4	Economic motivation	Low (<21) Medium (21-23) High (>23)	67 348 65	13.96 72.50 13.54	22.04	1.39
5	Risk taking ability	Low (<17) Medium (17-20) High (>20)	20 414 46	4.17 86.25 9.58	18.99	1.32
6	Achievement Motivation	Low (<17) Medium (17-20) High (>20)	20 414 46	4.17 86.25 9.58	18.49	1.55
7	Scientific Orientation	Low (<39) Medium (39-43) High (>43)	50 368 62	10.42 76.66 12.92	40.93	2.07

It was clearly observed from the Table 4.4.6 that entrepreneurial behaviour of the potato growers in the north-eastern stateswas found to be medium level. In case of Assam, 69.17 per centof farmers hadmedium entrepreneurial behaviour followed by 16.66 per cent having high entrepreneurial behaviour and 14.17 per cent having low entrepreneurial behaviour. In case of Meghalaya, majority (70.00%) of the respondentshad medium entrepreneurial behaviour followed by16.66 per cent having low and 13.34 per cent of them having high entrepreneurial behaviour respectively. In case of Nagaland, most (70.83%) of the respondents had medium entrepreneurial behaviourfollowed by 15.83 per cent of them having low and 13.34 per cent of them having high entrepreneurial behaviour. In case of Tripura, 68.33 per cent of the farmers had medium entrepreneurial behaviour followed by 18.33 per cent of them having low and 13.34 per cent of them having high entrepreneurial behaviour respectively.

Table 4.4.6: Status of entrepreneurial behaviour of potato growers in North-east states of India N=480

Sr. no.	State	Level	Frequency	%	Mean	sd
1	Assam	Low (<168) Medium (168-193) High (>193)	17 83 20	14.17 69.17 16.66	180.94	12.42
2	Meghalaya	Low (<175) Medium (175-192) High (>192)	20 84 16	16.66 70.00 13.34	183.13	8.45
3	Nagaland	Low (<165) Medium (165-192) High (>192)	19 85 16	15.83 70.83 13.34	178.66	13.26
4	Tripura	Low (<175) Medium (175-192) High (>192)	22 82 16	18.33 68.33 13.34	183.46	8.25

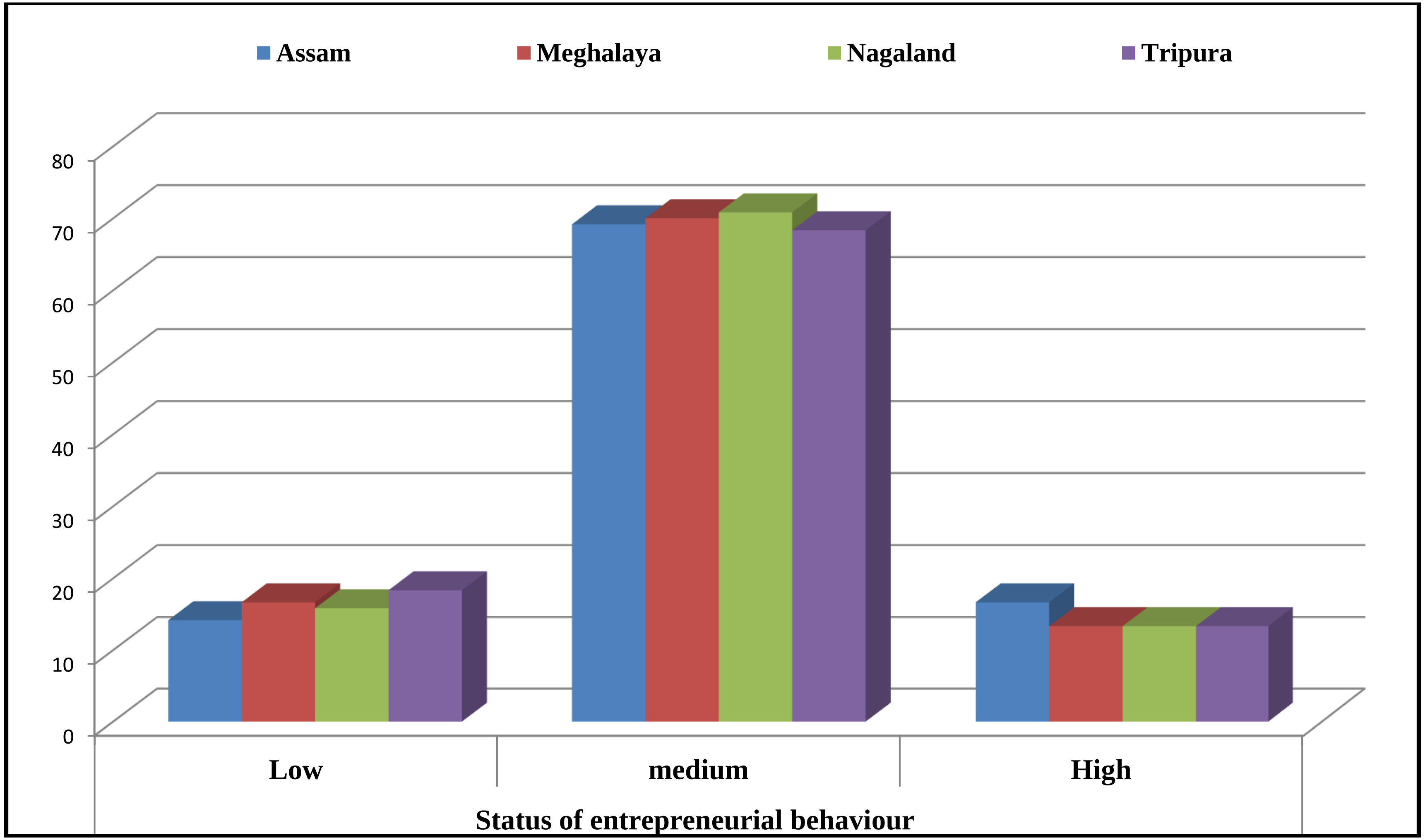

Fig 4.4.6: Status of entrepreneurial behavior of potato growers in North-east states of India

ASSAM	Achievement motivation	Age, Size of Land Holding, Area under Potato, Attitude
	Decision making ability	Family size, Productivity
	Economic motivation	Area under Potato, Extension contact
	Risk taking ability	Education level, Extension contact
	Scientific orientation	Productivity, income from potato
MEGHALAYA	Decision making ability	Scientific orientation, Marketing channel
	Economic motivation	Annual income, Extension contact
NAGALAND	Achievement motivation	Size of landholding, Marketing channel
	Decision making ability	Marketing channel, Attitude
	Risk taking ability	Knowledge
	Scientific orientation	Annual income, Income from potato, Social participation
TRIPURA	Innovativeness	Knowledge
	Risk taking ability	Knowledge

Fig 4.4.7 Significant characters of entrepreneurship based on step down multiple regressions

Fig 4.4.7 represents the frame work formulated using step down multiple regressions, which helps us to screen out the significant variables from relatively trivial ones over the entrepreneurial behaviour for the various states in North east.With context to the state of Assam, it is evidentthat size of land holding, area under potato, attitude has significant role in promoting achievement motivation. Family size, productivity has significant role in decision making ability. Area under potato, extension contact have significant role in economic motivation. Further, education level, extension contact have significant role in risk taking ability and productivity, income from potato have significant role in scientific orientation for the state of Assam. Mentioning the state Meghalaya, scientific orientation, marketing channel have significant role in decision making ability and annual income, extension contact have significant role in promoting economic motivation and entrepreneurial behaviour. Further, in case of Nagaland state, size of landholding, marketing channel have significant role in achievement motivation. Marketing channel, attitude have significant role in promoting decision making ability. Knowledge have significant role in risk taking ability and annual income, income from potato, and social participation have significant role in promoting scientific orientation and entrepreneurial behaviour. It also shows thatknowledge have a significant role towards innovativeness and promoting risk taking ability of the potato farmers in the state of Tripura.

4.4.8 Principal Component Analysis

"Principal Component Analysis, or PCA, is a dimensionality-reduction method that is often used to reduce the dimensionality of large data sets, by transforming a large set of variables into a smaller one that still contains most of the information in the large set. Reducing the number of variables of a data set naturally comes at the expense of accuracy, but the trick in dimensionality reduction is to trade a little accuracy for simplicity. Because smaller data sets are easier to explore and visualize and make analysing data much easier and faster for machine learning algorithms without extraneous variables to process" (Annonymous, 2021).

Table 4.4.8.1: Principal components analysis of entrepreneurial behaviour of farmers in Assam

Items	PC1	PC2	PC3	PC4
Innovativeness	0.44	-0.02	0.15	0.63
Management Orientation	-0.45	-0.40	-0.07	-0.09
Decision making ability	0.26	-0.43	-0.39	0.44
Economic motivation	0.23	-0.59	0.23	-0.34
Risk taking ability	-0.56	0.22	-0.06	0.43
Achievement motivation	-0.01	-0.08	-0.84	-0.13
Scientific orientation	-0.41	-0.50	0.23	0.27
Eigenvalue	1.33	1.25	1.08	1.02
Variance percent	18.97	17.86	15.46	14.53
Cumulative variance percent	18.97	36.83	52.29	66.82

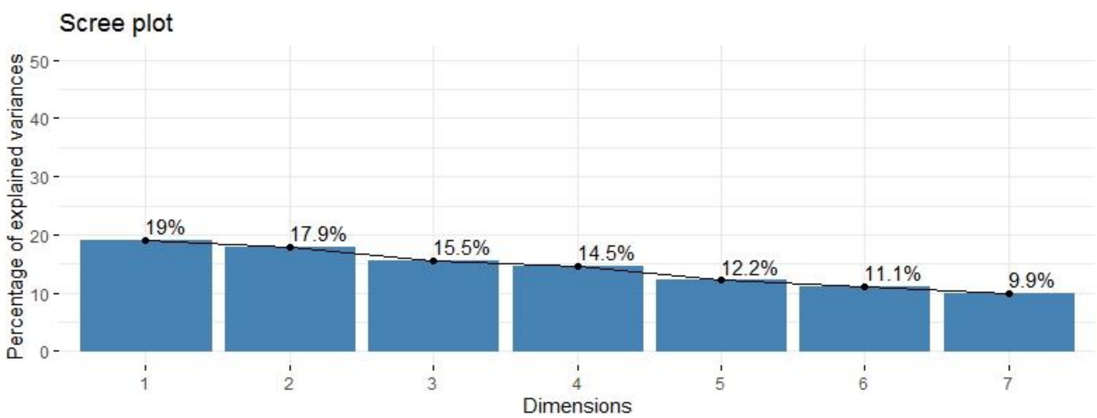

Fig 4.4.8.1.1 Percentage of explained variance of entrepreneurial behaviour of farmers in Assam

Table 4.4.8.1 and Fig 4.4.8.1.1, Fig 4.4.8.1.2 highlights the PCA, which revealed that the first four principal components (PCs) having Eigen value greater than one contributed 68.82 per cent (70.00%) of the total variation among the entrepreneurial behaviour for the state of Assam. The PC1 contributed nearly 19.00 per cent, whereas PC2, PC3 and PC4 contributed 17.86 per cent, 15.46 per cent and 14.53 per cent, respectively of the total variation.

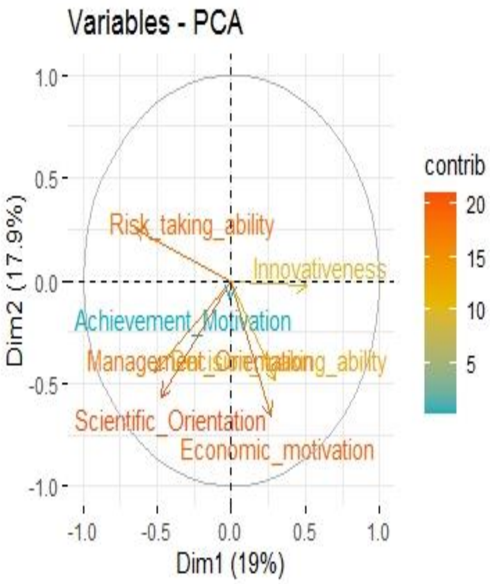

Fig 4.4.8.1.2 Entrepreneurial behaviours contribution with respect to the first two principal components for Assam

Risk taking ability (-0.56), economic motivation (-0.59) and scientific orientation (-0.50) were the top contribution in PC-1 and PC-2 (Fig 4.4.8.1.2). Whereas, achievement motivation (-0.84) and innovativeness (0.63) were the top contributor in PC-3 and PC-4. Thus, this information might be kept into consideration during sustainable potato farming to promote the entrepreneurial behaviour in the state of Assam.

Table 4.4.8.2: Principal components analysis of entrepreneurial behaviour of farmers in Meghalaya

Items	PC1	PC2	PC3
Innovativeness	-0.60	0.20	-0.01
Management Orientation	0.47	0.45	-0.16
Decision making ability	0.50	-0.06	0.37
Economic motivation	-0.19	0.42	0.42
Risk taking ability	-0.10	0.52	0.49
Achievement motivation	0.31	0.42	-0.29
Scientific orientation	-0.17	0.36	-0.58
Eigenvalue	1.29	1.25	1.05
Variance percent	18.49	17.79	15.04
Cumulative variance percent	18.49	36.27	51.31

Here in Table 4.4.8.2 and Fig 4.4.8.2.1, PCA revealed that the first three principal components (PCs) having Eigen value greater than one contributed 51.31 per cent of the total variation among the entrepreneurial behaviour for the state of Meghalaya (Table-). The PC-1 contributed 18.49 per cent, whereas PC-2 and PC-3 contributed 17.79 per cent and15.04 per centrespectively of the total variation.

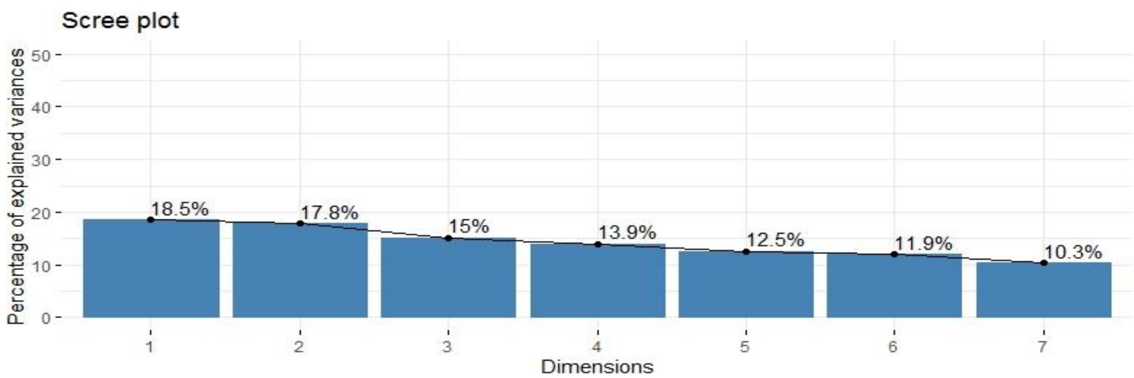

Fig 4.4.8.2.1: Percentage of explained variance of entrepreneurial behaviour of farmers in Meghalaya

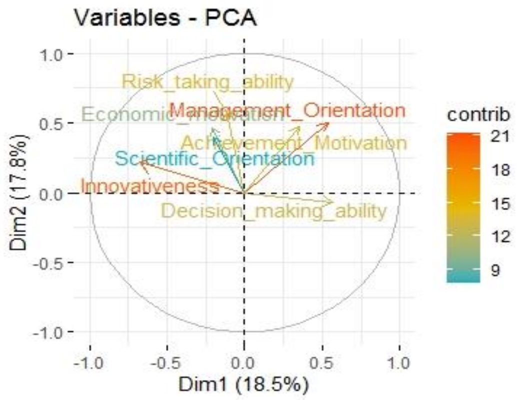

Fig 4.4.8.2.2: Entrepreneurial behaviours contribution with respect to the first two principal components for Meghalaya.

Innovativeness (-0.60), Decision making ability (0.50) and Risk taking ability (-0.52) were the top contributors in PC-1 and PC-2 (Fig 4.4.8.2.2). Management Orientation was also top contributor for both PC-1 and PC-2. Whereas, Scientific orientation (-0.58) were the top contributor in PC-3. Thus, this information might be kept into consideration during the sustainable potato farming to promote the entrepreneurial behaviour in the state of Meghalaya.

Table 4.4.8.3: Principal components analysis of entrepreneurial behaviour of farmers in Nagaland

Items	PC1	PC2	PC3
Innovativeness	-0.47	0.32	-0.14
Management Orientation	-0.21	-0.70	-0.03
Decision making ability	0.40	-0.02	-0.30
Economic motivation	-0.48	-0.45	-0.27
Risk taking ability	-0.34	-0.03	0.60
Achievement motivation	0.41	-0.41	-0.12
Scientific orientation	-0.25	0.20	-0.67
Eigenvalue	**1.33**	**1.16**	**1.08**
Variance percent	**18.97**	**16.53**	**15.43**
Cumulative variance percent	**18.97**	**35.50**	**50.93**

Table 4.4.8.3 and Fig 4.4.8.3.1, 4.4.8.3.2 represents the PCA for the state of Nagaland. It was found that the first three principal components (PCs) having Eigen value greater than one contributed 50.93 per cent of the total variation among the entrepreneurial behaviour for the state of Nagaland. The PC-1 contributed 18.97 per cent, whereas PC-2 and PC-3 contributed 16.53 per cent and 15.43 per cent respectively of the total variation.

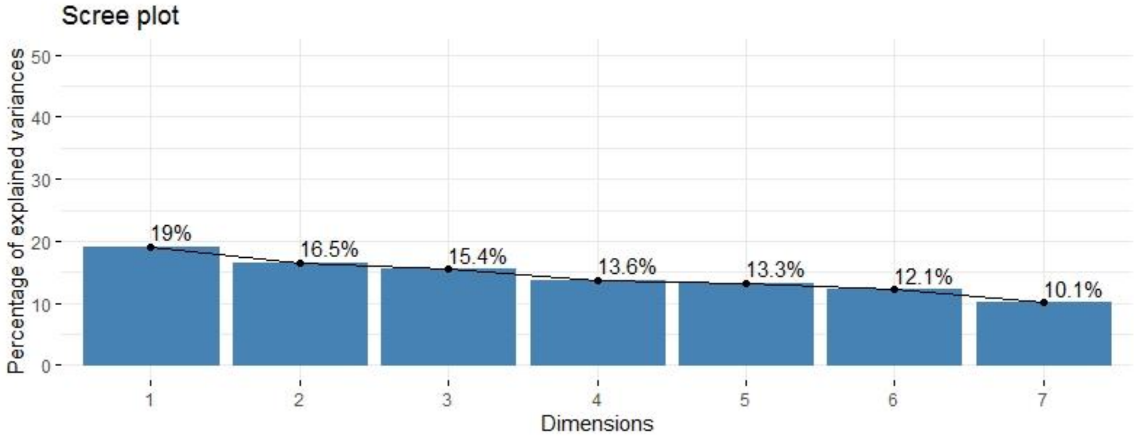

Fig 4.4.8.3.1: Percentage of explained variance of entrepreneurial behaviour of farmers in Nagaland

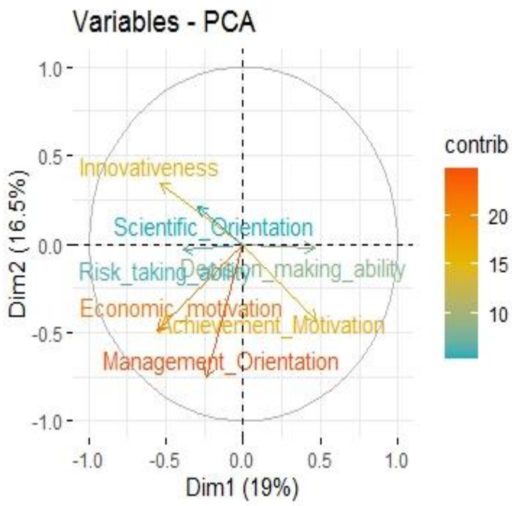

Fig 4.4.8.3.2: Entrepreneurial behaviours contribution with respect to the first two principal components for Nagaland

Economic motivation (-0.48), innovativeness (-0.47) and management orientation (-0.69) were the top contribution in PC-1 and PC-2 (Fig 4.4.8.3.2). Whereas, risk taking ability (0.59) was the top contributor in PC-3.Achievement motivation is also a high contributor for both PC-1 and PC-2. Thus, this information might be kept into consideration during the sustainable potato farming to promote the entrepreneurial behaviour in the state of Nagaland.

Table 4.4.8.4: Principal components analysis of entrepreneurial behaviour of farmers in Tripura

Items	PC1	PC2	PC3
Innovativeness	0.65	-0.11	0.06
Management Orientation	-0.53	-0.39	-0.17
Decision making ability	-0.29	-0.30	0.54
Economic motivation	0.07	0.42	-0.31
Risk taking ability	0.43	-0.43	0.21
Achievement motivation	0.02	-0.28	-0.69
Scientific orientation	0.11	-0.55	-0.24
Eigenvalue	**1.44**	**1.26**	**1.11**
Variance percent	**20.55**	**17.97**	**15.82**
Cumulative variance percent	**20.55**	**38.52**	**54.34**

Table 4.4.8.4 and Fig 4.4.8.4.1, 4.4.8.4.2 revealed the PCA for the state of Tripura. It can be concluded from the table that the first three principal components (PCs) having Eigen value greater than one contributed 54.34 per cent of the total variation among the entrepreneurial behaviour for the state of Tripura (Table-). The PC-1 contributed 20.55 per cent, whereas PC-2 and PC-3 contributed 17.97 per cent and 15.82 per cent respectively of the total variation.

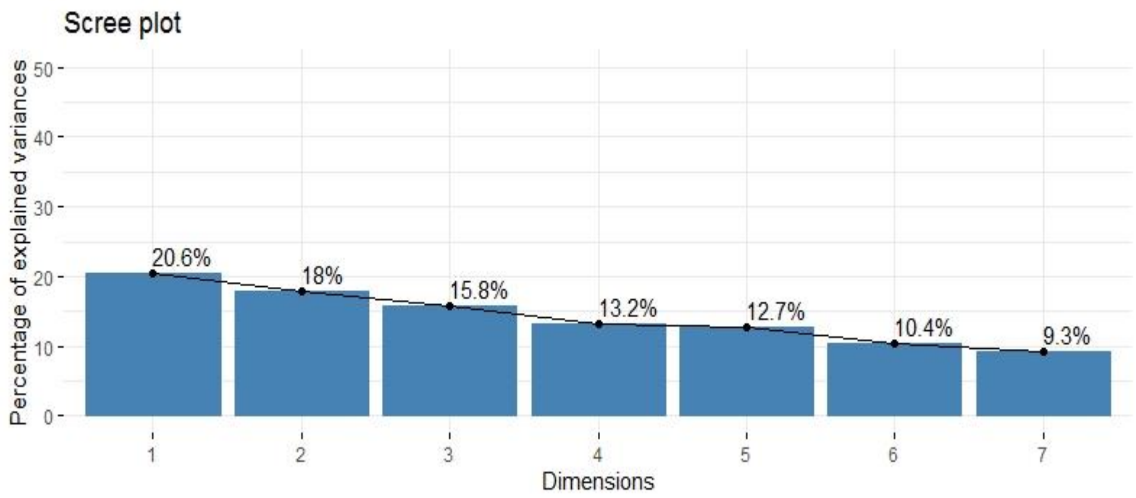

Fig 4.4.8.4.1: Percentage of explained variance of entrepreneurial behaviour of farmers in Tripura

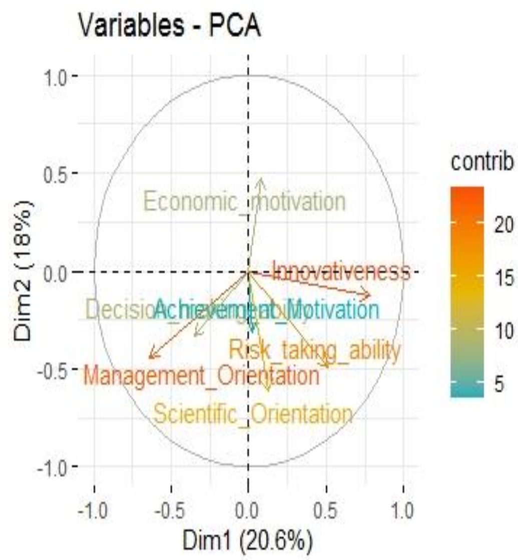

Fig 4.4.8.4.2: Entrepreneurial behaviours contribution with respect to the first two principal components for Tripura

Innovativeness (0.65) and Management Orientation (-0.53) and Scientific orientation (-0.55) were the top contribution in PC-1 and PC-2 (Fig 4.4.8.4.2). Whereas, achievement motivation (-0.69) and decision making ability (0.54) were the top contributor in PC-3. Risk taking ability is also high contributor for both PC-1 and PC-2. Thus, this information might be kept into consideration during the sustainable potato farming to promote the entrepreneurial behaviour in the state of Tripura.

Table 4.4.8.5: Principal components analysis of entrepreneurial behaviour for north-eastern states of India

Items	PC1	PC2	PC3
Innovativeness	0.09	-0.60	0.21
Management Orientation	0.01	0.65	0.36
Decision making ability	-0.58	0.23	0.11
Economic motivation	0.34	0.25	0.35
Risk taking ability	0.47	-0.03	-0.01
Achievement motivation	0.56	0.21	-0.19
Scientific orientation	0.04	-0.22	0.81
Eigenvalue	**1.67**	**1.27**	**1.04**
Variance percent	**23.79**	**18.09**	**14.84**
Cumulative variance percent	**23.79**	**41.88**	**56.71**

Table 4.4.8.5 and Fig 4.4.8.5.1, 4.4.8.5.2 included the Principal Component Analysis (PCA) of north-eastern states (***i.e.*** all four states) on entrepreneurial behaviour and it was found that the first three principal components (PCs) having greater than one Eigen value contributed 56.71 per cent of the total variation among the entrepreneurial behaviour (Table-). The PC-1 contributed 23.79%, whereas PC-2 and PC-3 contributed 18.09 per cent and 14.84 per cent respectively of the total variation.

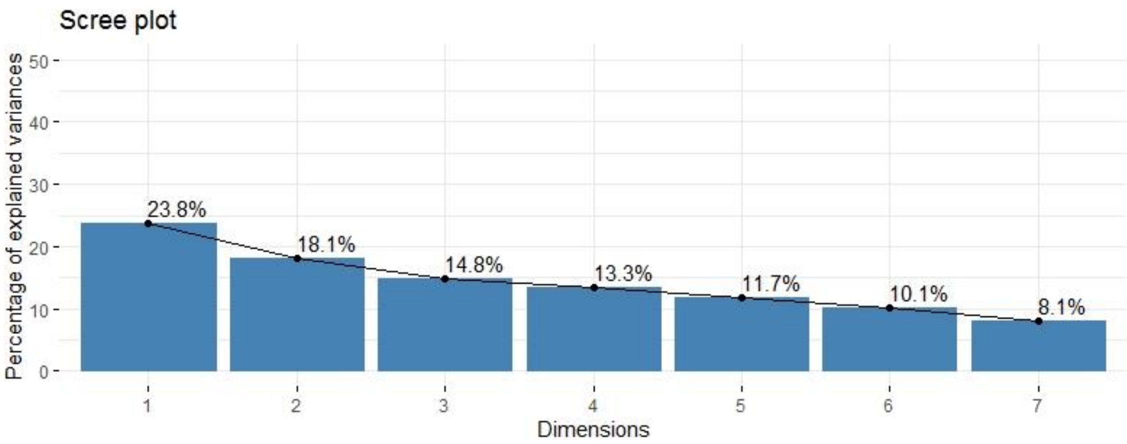

Fig 4.4.8.5.1: Percentage of explained variance of entrepreneurial behaviour of farmers in all the selected states

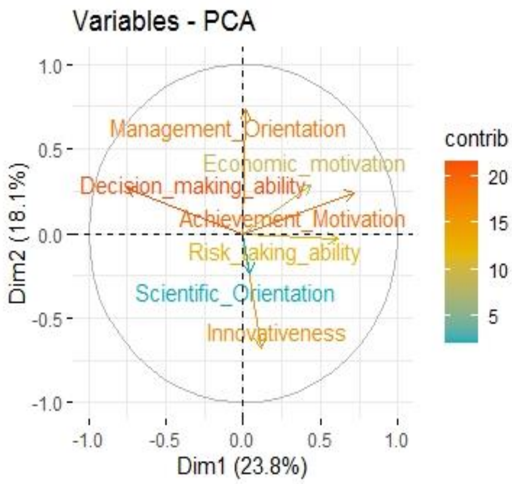

Fig 4.4.8.5.2 Entrepreneurial behaviours contribution with respect to the first two principal components for all the states

Decision making ability (-0.58) and achievement motivation (0.55) was the top contributor in PC-1. Innovativeness (-0.60) and management Orientation (0.65) was the top contributor in PC-2. Whereas, scientific orientation (0.81) was the top contributor in PC-3. Management orientation was one of the entrepreneurial behaviour which has the high contribution in PC-2 and PC-3 Thus, this information might be kept into consideration during the sustainable potato farming to promote the entrepreneurial behaviour in the north eastern state.

4.4.9 Correlation of selected personal, socio-economic and psychological characteristics of the farmers with 'entrepreneurial behaviour of potato farmers'

Table 4.4.8.5: Correlation of selected personal, socio-economic and psychological characteristics of the farmers with 'entrepreneurial behaviour of potato farmers'

Sl. No.	Independent variables	Co-efficient of correlation (r)
1.	Age	0.046
2.	Gender	-0.043
3.	Family size	0.023
4.	Education	-0.011
5.	Size of land holding	0.099*
6.	Area under potato	0.095*
7.	Productivity	0.236**
8.	Annual income	0.077*
9.	Income from potato	0.032
10.	Training exposure	-0.059
11.	Sources of information	0.111*
12.	Extension contact	0.067
13.	Scientific orientation	0.071
14.	Social participation	0.049
15.	Marketing channel	0.107*
16.	Knowledge	0.137**
17.	Attitude	0.036

** significant at the 0.01 level (2-tailed), ** significant at the 0.05 level (2-tailed)

From the Table 4.4.8.5 it was found that variables productivity and knowledge had positive and significant association with the dependent variable "Entrepreneurship" at 1% level of probability and size of land holding, area under potato, annual income, sources of information and marketing channel had positive and significant association with the dependent variable "Entrepreneurship" at 5% level of probability. Thus it may inferred that higher level of productivity, high annual income, higher knowledge level, bigger size of land holding, more area under potato cultivation, more utilization of information sources, greater use of various marketing channels may contribute positively towards promoting Entrepreneurial behaviour among the potato farmers. These findings were similar to the findings of Chanu *et al*. (2014) and Kaimal *et al.* (2020).

However, it was found that the variable age, sex, family size, education, income from potato, training exposure, extension contact, scientific orientation, social participation and attitude had non-significant association with the dependent variable "Entrepreneurship".

Based upon the findings, the null hypothesis (**H_0 2a)** was rejected:

$H_0$2a: There is no association between the variables productivity, annual income, knowledge, size of land holding, area under potato, sources of information, marketing channelwith the 'entrepreneurial behaviourof the potato farmers'was rejected.

The independent variables age, gender, family size, education, income from potato, training exposure, extension contact, scientific orientation, social participation and attitudewere found non-significant. Therefore the following null hypothesis (**H_0 2_b**)was accepted:

$H_0$$2_b$: There is no association between variablesage, gender, family size, education, income from potato, training exposure, extension contact, scientific orientation, social participation and attitudewith 'entrepreneurial behaviour of the potato farmers'.

4.5 Relationship of socio- psychological and economic characteristics of potato farmers with their Knowledge and Attitude towards sustainable potato farming

4.5.1 Step down multiple regressions

Step down multiple regressions helps us to screen out the significant variables from relatively trivial ones.Step down method is one of the variable selection techniques in multiple regressions where aim is to select only significant predictors discarding other predictions which are sharing high linear association with selected predictor (s). Only best fitted model of step down technique is displayed here.

Table 4.5.1.1: Step down multiple regression ofsocio- psychological and economic characteristics of Assam's potato farmers with their knowledge and attitude towards sustainable potato farming N=120

	Independent Variable	Unstandardized Coefficients		Standardized Coefficients	t-value	Sig.
		B	Std. Error	Beta		
KNOWLEDGE	(Constant)	5.143	3.458		1.487	0.140
	Age	0.355	0.149	1.823	2.393*	0.018
	Family size	-0.437	0.318	-0.375	-1.375	0.172
	Size of landholdings	-0.419	0.166	-0.509	-2.519*	0.013
	Sources of information	-0.354	0.227	-0.681	-1.561	0.121
	Scientific orientation	-0.183	0.157	-0.504	-1.169	0.245

	Attitude	-0.035	0.025	-0.127	-1.375	0.172
Adjusted R-sq				**0.072***		
Probability				**< 0.05**		
ATTITUDE	(Constant)	80.584	3.736		21.567**	0.000
	Knowledge	-0.420	0.319	-0.115	-1.320	0.190
	Sources of information	0.373	0.172	0.196	2.161*	0.033
	Extension contact	0.167	0.068	0.222	2.449*	0.016
Adjusted R-sq				**0.117****		
Probability				**< 0.01**		

Table 4.5.1.1 presents the result of step down multiple regression analysis of knowledge and attitude with the independent variables for the state of Assam.The step down analysis has isolated some critical causal variable in both cases, where, age and size of the land holding had significant impact on knowledge and source of information and extension contact had significant impact on attitude. The variables have explained 7.20 per cent of variance embedded with consequent variable with the dependent variable knowledge and also explained 11.70 per cent of variance embedded with consequent variable with the dependent variable attitude. It may be inferred that the variables age, size of the land holding and source of information, extension contacthave a substantial impact on the Knowledge and Attituderespectively of the farmers in relation to adoption of sustainable potato farming in Assam.

Table 4.5.1.2: Step down multiple regression ofsocio- psychological and economic characteristics of Meghalaya's potato farmers with their knowledge and attitude towards sustainable potato farming N=120

	Independent Variable	**Unstandardized Coefficients**		**Standardized Coefficients**	**t-value**	**Sig.**

		B	Std. Error	Beta		
KNOWLEDGE	(Constant)	5.456	2.114		2.580*	0.011
	Extension contact	-0.034	0.016	-0.192	-2.113*	0.037
	Attitude	0.038	0.024	0.143	1.575	0.118
Adjusted R-sq				**0.034***		
Probability				**<0.05**		
ATTITUDE	(Constant)	82.140	8.170		10.054*	0.000
	Gender	4.393	3.083	0.326	1.425	0.157
	Size of landholding	0.525	0.425	0.199	1.235	0.219
	Productivity	-0.785	0.532	-0.141	-1.475	0.143
	Income from potato	-6.992	0.000	-0.238	-2.440*	0.016
	Knowledge	0.416	0.335	0.112	1.242	0.217
	Extension contact	0.077	0.062	0.116	1.253	0.213
	Scientific orientation	0.437	0.427	0.300	1.023	0.309
	Social participation	-4.748	1.999	-0.635	-2.375*	0.019
Adjusted R-sq				**0.078***		
Probability				**< 0.05**		

Table 4.5.1.2 included the step down multiple regression of socio-psychological and economic characteristics of Meghalaya's potato farmers with their knowledge and attitude towards sustainable potato farming. The step down analysis revealed that, extension contact had significant impact on knowledge and income from potato. Social participation had significant impact towards attitude. The variables explained 3.40 per cent of variance embedded with consequent variable with the dependent variable knowledge and explained 7.80 per cent of variance with consequent variable with the dependent variable attitude. It may be inferred that use extension contact hadsignificant impact on the knowledge and income from potato, social participation had a substantive impact onattitude of the farmers inrelation to adoption of sustainable potato farming in Meghalaya.

Table 4.5.1.3: Step down multiple regression ofsocio- psychological and economic characteristics of Nagaland's potato farmers with their knowledge and attitude towards sustainable potato farming **N=120**

	Independent Variable	Unstandardized Coefficients		Standardized Coefficients	t-value	Sig.
		B	Std. Error	Beta		
KNOWLEDGE	(Constant)	9.622	1.147		8.388**	0.000
	Family size	-0.699	0.356	-0.514	-1.967	0.052
	Area under potato	28.970	12.688	0.807	2.283*	0.024
	Marketing channel	-1.097	0.660	-0.315	-1.662	0.099
Adjusted R-sq				**0.018**		
Probability				**> 0.05**		
ATTITUDE	(Constant)	70.308	9.876		7.119**	0.000
	Age	0.649	0.325	.868	1.998*	0.048
	Area under potato	51.226	34.914	.444	1.467	0.145
	Productivity	-0.812	0.645	-0.111	-1.259	0.211
	Sources of information	-1.339	1.013	-0.758	-1.321	0.189
	Social participation	-1.936	1.517	-0.308	-1.276	0.205
Adjusted R-sq				**0.094****		
Probability				**<0.01**		

Table 4.5.1.3 included step down multiple regression of socio-psychological and economic characteristics of potato farmers in Nagaland with their knowledge and attitude towards sustainable potato farming. The step down analysis revealed that, area under potato had significant impact on knowledge and age had significant impact towards the dependent variable attitude. The variables explained 1.80 per cent of variance embedded with consequent variable with the dependent variable knowledge and explained 9.40

per cent of variance with consequent variable with the dependent variable attitude. It may be inferred that independent variables like area under potato and age had substantive impact on the knowledge and attitude of the farmers in relation to adoption of sustainable potato farming Nagaland.

Table 4.5.1.4: Step down multiple regression ofsocio- psychological and economic characteristics of Tripura's potato farmers with their knowledge and attitude towards sustainable potato farming N=120

	Independent Variable	Unstandardized Coefficients		Standardized Coefficients	t-value	Sig.
		B	Std. Error	Beta		
KNOWLEDGE	(Constant)	12.821	2.575		4.980**	.000
	Education	0.499	0.342	0.409	1.460	0.147
	Area under potato	5.239	3.324	0.348	1.576	0.118
	Annual income	8.320	0.000	0.488	3.089**	0.003
	Income from potato	-3.595	0.000	-0.521	-3.239**	0.002
	Sources of information	-0.423	0.205	-0.827	-2.064*	0.041
	Scientific orientation	0.230	0.148	0.639	1.556	0.123
	Marketing channel	-0.431	0.181	-0.595	-2.386*	0.019
	Attitude	-0.050	0.023	-0.187	-2.148*	0.034
	Social participation	0.215	0.182	0.105	1.183	0.240
Adjusted R-sq				**.116**		
Probability				**<0.01**		
ATTITUDE	(Constant)	103.287	8.482		12.177**	0.000
	Knowledge	-0.789	0.338	-0.210	-2.335*	0.021
	Extension contact	0.057	0.052	0.098	1.094	0.276
	Productivity	-0.536	0.430	-0.112	-1.249	0.214

Adjusted R-sq			**0.041**		
Probability			**<0.05**		

Table 4.5.1.4 included the step down multiple regression of socio-psychological and economic characteristics of potato farmers of Tripura with their knowledge and attitude towards sustainable potato farming. The step down analysis revealed that, variables annual income, income from potato, source of information, marketing channel and attitude had significant impact on knowledge and knowledge had the significant impact on the dependent variable attitude. The variables explained 11.60 per cent of variance embedded with consequent variable with the dependent variable knowledge and explained 4.10 per cent of variance with consequent variable with the dependent variable attitude. It may be inferred that use of independent variables like annual income, income from potato, sources of information, marketing channel and attitude had substantial impact on the knowledge and knowledge had asubstantialimpact on the attitude of the farmers in relation to adoption of sustainable potato farming in Tripura.

4.5.2 Path analysis

Table 4.5.2.1: Path analysis between knowledge vs predictor variables for Assam

	Age	Family size	Size of land holding	Area under potato	Productivity	Annual income	Income from potato	Sources of information	Extension contact	Scientific orientation	Social participation	Knowledge
Age	3.599	-0.737	-0.907	0.354	-0.047	-0.005	0	-1.469	-0.038	-1.136	0.267	-0.124
Family size	3.383	-0.784	-0.851	0.35	-0.046	-0.001	-0.007	-1.365	-0.033	-1.088	0.282	-0.162
Size of landholding	2.915	-0.596	-1.119	0.35	-0.038	-0.004	0.005	-1.17	-0.031	-0.793	0.26	**-.220***
Area under potato	3.311	-0.713	-1.019	0.385	-0.045	-0.003	-0.002	-1.35	-0.035	-0.994	0.285	-0.175
Productivity	1.655	-0.353	-0.414	0.169	-0.103	0.003	0.001	-0.66	-0.004	-0.521	0.125	-0.098

Annual income	-0.252	0.008	0.067	-0.019	-0.004	0.067	-0.079	0.105	0.013	0.071	-0.006	-0.034
Income from potato	0	-0.047	0.045	0.008	0.001	0.043	-0.122	0	0.014	-0.035	0.003	-0.092
Sources of information	3.527	-0.713	-0.873	0.346	-0.045	-0.005	0	-1.499	-0.037	-1.1	0.26	-0.141
Extension contact	1.08	-0.204	-0.269	0.104	-0.003	-0.007	0.013	-0.435	-0.128	-0.343	0.082	-0.106
Scientific orientation	3.455	-0.721	-0.75	0.323	-0.045	-0.004	-0.004	-1.395	-0.037	-1.183	0.251	-0.107
Social participation	**3.059**	-0.706	-0.929	0.35	-0.041	-0.001	-0.001	-1.245	-0.033	-0.946	**0.314**	-.180*

Residual Effect^2 = 0.8124524

From the Table 4.5.2.1 it was clear that characters considered for the state of Assam are not much efficient enough to explain the variability in the dependent variable Knowledge, as it explained only 19.00 per cent variability in the dependent variable knowledge. Size of land holdings had high negative direct effect with significant and negative correlation with knowledge via age, family size, sources of information and scientific orientation. On the other hand though social participation produces a low positive direct effect, but has a significant correlation with knowledge via age, family size, size of land holding, sources of information and scientific orientation. Hence, these predictors cannot be ignored for the state of Assam.

Table 4.5.2.2: Path analysis between attitudes vs. predictor variables for Assam

	Age	Family size	Size of land holding	Area under potato	Productivity	Annual income	Income from potato	Sources of information	Extension contact	Scientific orientation	Social participation	Attitude
Age	-0.638	0.102	0.17	-0.316	0.007	0.01	0	0.55	0.074	0.154	0.156	.270**
Family size	-0.599	0.109	0.16	-0.313	0.007	0.001	0.007	0.511	0.064	0.147	0.165	.260**
Size of landholding	-0.516	0.083	0.21	-0.313	0.006	0.008	-0.005	0.438	0.059	0.107	0.152	.228*

Area under potato	-0.587	0.099	0.191	-0.344	0.007	0.007	0.002	0.505	0.067	0.135	0.167	**.251****
Productivity	-0.293	0.049	0.078	-0.151	0.016	-0.006	-0.001	0.247	0.007	0.071	0.073	0.093
Annual income	0.045	-0.001	-0.013	0.017	0.001	-0.14	0.078	-0.039	-0.025	-0.01	-0.004	-0.095
Income from potato	0	0.007	-0.008	-0.007	0	-0.091	0.12	0	-0.027	0.005	0.002	-0.003
Sources of information	-0.625	0.099	0.164	-0.31	0.007	0.01	0	0.561	0.072	0.149	0.152	**.279****
Extension contact	-0.191	0.028	0.05	-0.093	0	0.014	-0.013	0.163	0.247	0.046	0.048	**.298****
Scientific orientation	-0.612	0.1	0.141	-0.289	0.007	0.008	0.004	0.522	0.072	0.16	0.147	**.260****
Social participation	-0.542	0.098	0.174	-0.313	0.007	0.003	0.001	0.466	0.064	0.128	0.184	**.271****

Residual Effect^2 = 0.8448934

From the Table 4.5.2.2 it is clear that the attributing characters considered for the state of Assam explained only 16 per cent variability in the dependent variable Attitude. Age had high negative direct effect with positive significant correlation with attitude via sources of information and extension contact. Family size had low direct positive effect with positive significant correlation via age and sources of information. Size of land holding also had low direct positive effect with positive significant correlation via age. Area under potato also produced low direct negative effect with significant positive correlation via age and sources of information. Source of information had high positive direct effect with significant and positive correlation via age. Extension contact also had low and direct had positive significant correlation. Scientific orientation had low direct positive effect and positive significant correlation via age and sources of information. Social participation also produced low direct positive effect and positive significant correlation via age.

Table 4.5.2.3: Path analysis between knowledge vs. predictor variables for Meghalaya

	Age	Family size	Size of land holding	Area undue potato	Productivity	Annual income	Income from potato	Sources of information	Extension contact	Scientific orientation	Social participation	knowledge
Age	0.939	-0.039	-0.029	0.165	-0.024	0.001	0.003	-0.74	0.011	-0.156	-0.061	**0.068***
Family size	0.91	-0.04	-0.031	0.171	-0.02	-0.002	0.005	-0.732	0.011	-0.151	-0.061	0.059
Size of landholding	0.666	-0.03	-0.041	0.162	-0.012	-0.001	0.008	-0.544	0.009	-0.096	-0.05	0.065
Area under potato	0.845	-0.037	-0.036	0.184	-0.016	-0.003	0.007	-0.687	0.01	-0.136	-0.06	0.073
Productivity	0.291	-0.01	-0.007	0.039	-0.076	-0.012	0.012	-0.227	0.006	-0.057	-0.019	-0.058
Annual income	-0.019	-0.001	-0.001	0.007	-0.014	-0.069	0.07	0	0.002	-0.006	0.001	-0.028
Income from potato	0.028	-0.002	-0.004	0.015	-0.011	-0.056	0.086	-0.015	0.005	-0.013	-0.002	0.027
Sources of information	0.92	-0.039	-0.03	0.167	-0.023	0	0.002	-0.755	0.011	-0.153	-0.06	0.037
Extension contact	-0.188	0.008	0.007	-0.035	0.009	0.002	-0.008	0.151	-0.054	0.034	0.013	-0.057
Scientific orientation	0.901	-0.037	-0.024	0.154	-0.027	-0.003	0.007	-0.71	0.011	-0.162	-0.06	0.046
Social participation	0.854	-0.036	-0.031	0.163	-0.021	0.001	0.003	-0.68	0.01	-0.146	-0.067	0.055

Residual Effect^2 = 0.9559532

From the Table 4.5.2.3 it was clear that the knowledge attributing characters considered for the state of Meghalaya explained only 5 per cent of the variability in the dependent variable knowledge. Age had high positive direct effect producing positive correlation via source of information.

Table 4.5.2.4: Path analysis between attitudes vs. predictor variables for Meghalaya

	Age	Family size	Size of land holding	Area under potato	Productivity	Annual income	Income from potato	Sources of information	Extension contact	Scientific orientation	Social participation	attitude
Age	-0.533	0.076	0.16	-0.087	-0.032	0.003	-0.003	0.467	0.009	0.827	-0.628	**.261****
Family size	-0.517	0.079	0.171	-0.09	-0.027	-0.005	-0.007	0.462	0.009	0.801	-0.628	**.250****
Size of landholding	-0.378	0.06	0.226	-0.085	-0.016	-0.003	-0.01	0.343	0.007	0.508	-0.511	0.138
Area under potato	-0.479	0.073	0.198	-0.097	-0.021	-0.007	-0.009	0.434	0.008	0.724	-0.614	**.211***
Productivity	-0.165	0.02	0.036	-0.02	-0.102	-0.03	-0.016	0.143	0.005	0.302	-0.193	-0.017
Annual income	0.011	0.002	0.005	-0.004	-0.018	-0.165	-0.093	0	0.001	0.034	0.007	**-.217***
Income from potato	-0.016	0.005	0.02	-0.008	-0.014	-0.135	-0.114	0.01	0.004	0.069	-0.021	**-.198***
Sources of information	-0.522	0.076	0.162	-0.088	-0.031	0	-0.002	0.477	0.009	0.81	-0.621	**.266****
Extension contact	0.107	-0.017	-0.036	0.018	0.012	0.005	0.01	-0.095	-0.045	-0.181	0.131	-0.09
Scientific orientation	-0.511	0.073	0.133	-0.082	-0.036	-0.007	-0.009	0.448	0.009	0.862	-0.621	**.256****
Social participation	-0.485	0.072	0.167	-0.086	-0.029	0.002	-0.003	0.429	0.008	0.775	-0.69	0.161

Residual Effect^2 = 0.8002665

From the Table 4.5.2.4 it is clear that the attributing characters considered for the state of Meghalaya explained nearly 20.00 per cent variability in the dependent variable Attitude. Age had high negative direct effect contributing significant positive correlation via scientific orientation and social participation. Family size had low positive direct effect contributing significant positive correlation via scientific orientation. Area under potato had low negative direct effect contributing significant positive correlation via scientific orientation. Annual income had low negative direct effect contributing significant negative correlation. Income from potato had low negative direct effect contributing significant negative correlation. Sources of information had low positive direct effect contributing significant positive correlation via scientific orientation and social participation. Further scientific orientation had high positive direct effect contributing significant positive correlation via social participation and sources of information.

Table 4.5.2.5: Path analysis between knowledge vs. predictor variables for Nagaland

	Age	Family size	Size of land holding	Area undue potato	Productivity	Annual income	Income from potato	Sources of information	Extension contact	Scientific orientation	Social participation	Knowledge
Age	1.47	-0.822	0.14	0.324	0	0.003	0.008	-1.072	0.005	-0.7	0.674	0.025
Family size	1.411	-0.857	0.147	0.321	0	0.005	0.007	-1.039	0.004	-0.678	0.69	0.011
Size of landholding	1.249	-0.762	0.165	0.321	0.001	0.012	0.005	-0.974	0.004	-0.635	0.674	0.055
Area under potato	1.367	-0.788	0.151	0.348	0.001	0.011	0.004	-1.05	0.004	-0.685	0.697	0.064
Productivity	-0.015	0.009	-0.013	-0.024	-0.016	-0.004	0	0.044	-0.001	0.029	-0.008	0.005
Annual income	-0.044	0.043	-0.02	-0.038	-0.001	-0.098	0.062	0.088	0.002	0.036	-0.1	-0.074
Income from potato	0.132	-0.069	0.008	0.014	0	-0.068	0.09	-0.066	0.003	-0.036	0	0.013
Sources of information	1.44	-0.814	0.147	0.335	0.001	0.008	0.005	-1.094	0.004	-0.707	0.705	0.029
Extension contact	-0.323	0.154	-0.033	-0.063	-0.001	0.008	-0.013	0.219	-0.022	0.144	-0.13	-0.057
Scientific orientation	1.426	-0.805	0.145	0.331	0.001	0.005	0.005	-1.072	0.004	-0.722	0.713	0.032
Social participation	1.293	-0.771	0.145	0.317	0	0.013	0	-1.006	0.004	-0.671	0.766	0.093

Residual Effect^2 = 0.9100738

From the Table 4.5.2.5 it was clear that the knowledge attributing characters considered for the state of Nagaland explained nearly 9.00 per cent variability in the dependent variable knowledge. Family Size had high negative direct effect via age, scientific orientation and social participation. Sources of information had high negative direct effect via age, scientific orientation and social participation. Social orientation had high negative direct effect via age, Sources of information and Social participation

Table 4.5.2.6: Path analysis between attitude vs. predictor variables for Nagaland

	Age	Family size	Size of land holding	Area undue potato	Productivity	Annual income	Income from potato	Sources of information	Extension contact	Scientific orientation	Social participation	attitude
Age	1.756	-0.351	-0.085	0.738	0.001	0.002	0	-1.707	0.003	-0.105	0.019	.270**
Family size	1.686	-0.365	-0.089	0.73	0.001	0.003	0	-1.655	0.002	-0.102	0.019	.229*
Size of landholding	1.492	-0.325	-0.101	0.73	0.01	0.008	0	-1.551	0.003	-0.095	0.019	.185*
Area under potato	1.633	-0.336	-0.092	0.794	0.008	0.008	0	-1.673	0.002	-0.103	0.019	.260**
Productivity	-0.018	0.004	0.008	-0.056	-0.119	-0.003	0	0.07	-0.001	0.004	0	-0.108
Annual income	-0.053	0.018	0.012	-0.087	-0.005	-0.069	0	0.139	0.001	0.005	-0.003	-0.042
Income from potato	0.158	-0.029	-0.005	0.032	0	-0.047	0	-0.105	0.002	-0.005	0	0.002
Sources of information	1.721	-0.347	-0.089	0.762	0.005	0.005	0	-1.742	0.003	-0.106	0.02	.235**
Extension contact	-0.386	0.066	0.02	-0.143	-0.006	0.005	0	0.348	-0.013	0.022	-0.004	-0.09
Scientific orientation	1.703	-0.343	-0.088	0.754	0.005	0.003	0	-1.707	0.003	-0.108	0.02	.239**

Social participation	1.545	-0.329	-0.088	0.722	0.001	0.009	0	-1.603	0.002	-0.101	0.021	0.177

Residual Effect^2 = 0.8286244

From the Table 4.5.2.6 it was clear that Attitude attributing characters considered for the state of Nagaland explained nearly 17.00 per cent of variability in the dependent variable. Age had high positive direct effect and contributing significant positive correlation via sources of information and area under potato cultivation. Family size had high negative direct effect and contributing significant positive correlation via age, area under potato cultivation and sources of information. Size of land holding had low negative direct effect and contributing significant positive correlation via sources of information, area under potato cultivation and age. Area under potato had high positive direct effect contributing significant positive correlation via sources of information and age. Sources of information had high negative direct effect contributing significant positive correlation via age and area under potato cultivation. Scientific orientation had low negative direct effect contributing significant positive correlation via sources of information, area under potato cultivation and age. Hence, these predictor's variables are important.

Table 4.5.2.7: Path analysis between knowledge vs. predictor variables for Tripura

	Age	Family size	Size of land holding	Area under potato	Productivity	Annual income	Income from potato	Sources of information	Extension contact	Scientific orientation	Social participation	knowledge
Age	0.214	-0.291	-0.108	0.315	-0.003	-0.015	-0.033	-0.124	-0.002	0.011	-0.044	-0.076
Family size	0.201	-0.31	-0.097	0.301	-0.004	-0.039	0.009	-0.117	-0.003	0.011	-0.043	-0.092
Size of landholding	0.156	-0.204	-0.147	0.301	0	-0.044	0	-0.097	-0.004	0.007	-0.037	-0.071

Area under potato	0.192	-0.266	-0.127	0.35	-0.002	-0.034	-0.019	-0.115	-0.004	0.01	-0.044	-0.058
Productivity	-0.038	0.071	0.003	-0.049	0.016	0.044	-0.095	0.022	0	-0.003	0.01	-0.02
Annual income	-0.006	0.025	0.013	-0.024	0.001	0.487	-0.394	0.005	-0.001	0	0.004	0.105
Income from potato	0.015	0.006	0	0.014	0.003	0.404	-0.475	-0.006	-0.002	0.001	0	-0.038
Sources of information	0.207	-0.282	-0.112	0.315	-0.003	-0.019	-0.024	-0.128	-0.003	0.011	-0.042	-0.082
Extension contact	-0.017	0.028	0.019	-0.052	0	-0.01	0.028	0.012	0.028	0	0.005	0.041
Scientific orientation	0.207	-0.288	-0.091	0.29	-0.004	-0.005	-0.028	-0.118	-0.001	0.011	-0.044	-0.066
Social participation	0.192	-0.276	-0.112	0.315	-0.003	-0.044	0	-0.111	-0.003	0.01	-0.049	-0.081

Residual Effect^2 = 0.9132152

From the Table 4.5.2.7 it was clear that the knowledge attributing characters considered for the state of Tripura explained nearly 9.00 per cent variability in the dependent variable knowledge. Annual income had high positive direct effect, income from potato had high negative direct effect and area under potato had high positive direct effect. Hence, these predictors variables are important.

Table 4.5.2.8: Path analysis between attitude vs. predictor variables for Tripura

	Age	Family size	Size of land holding	Area under potato	Productivity	Annual income	Income from potato	Sources of information	Extension contact	Scientific orientation	Social participation	attitude
Age	0.824	0.045	-0.143	-0.058	0.02	0	-0.003	-0.037	-0.007	-0.724	0.095	0.006
Family size	0.774	0.048	-0.129	-0.055	0.026	0	0.001	-0.035	-0.008	-0.695	0.094	0.02

Size of landholding	0.601	0.031	-0.196	-0.055	0.002	0	0	-0.029	-0.012	-0.463	0.08	-0.04
Area under potato	0.741	0.041	-0.168	-0.064	0.016	0	-0.002	-0.035	-0.013	-0.62	0.095	-0.01
Productivity	-0.148	-0.011	0.004	0.009	-0.111	0	-0.01	0.007	0	0.172	-0.021	-0.106
Annual income	-0.025	-0.004	0.018	0.005	-0.01	0	-0.041	0.002	-0.002	0.007	-0.01	-0.06
Income from potato	0.058	-0.001	0	-0.003	-0.022	0	-0.05	-0.002	-0.005	-0.045	0	-0.068
Sources of information	0.799	0.043	-0.149	-0.058	0.019	0	-0.002	-0.039	-0.008	-0.687	0.092	0.008
Extension contact	-0.066	-0.004	0.025	0.01	0	0	0.003	0.003	0.089	0.03	-0.011	0.076
Scientific orientation	0.799	0.044	-0.121	-0.054	0.026	0	-0.003	-0.036	-0.004	-0.747	0.095	-0.001
Social participation	0.741	0.042	-0.149	-0.058	0.022	0	0	-0.034	-0.009	-0.672	0.106	-0.005

Residual Effect^2 = 0.9609395

From the Table 4.5.2.8 it was clear that the attributing characters considered for the state of Tripura explained nearly 4.00 per cent variability in the dependent variable knowledge. Age had high positive direct effect via scientific orientation, scientific orientation had high negative direct effect via age and size of land holding had low negative direct effect via age and scientific orientation. Hence, these predictor's variables are important.

Table 4.5.2.9: Path analysis between knowledge vs. predictor variables for all the states

	Age	Family size	Size of land holding	Area under potato	Productivity	Annual income	Income from potato	Sources of information	Extension contact	Scientific orientation	Social participation	Knowledge
Age	-0.1	-0.38	-0.01	0.079	0.012	-0.004	-0.002	-0.025	0.002	0.229	0.15	-0.049
Family size	-0.08	**-0.475**	-0.011	0.061	-0.054	-0.011	-0.001	-0.024	0.002	0.176	0.137	**-.285****

Size of landholding	-0.066	-0.318	-0.016	0.054	-0.049	-0.013	0.003	-0.017	0.003	0.137	0.123	**-.160****
Area under potato	-0.086	-0.313	-0.009	0.092	0.061	0.003	-0.006	-0.022	0.002	0.197	0.142	0.06
Productivity	-0.005	0.104	0.003	0.023	0.245	0.031	-0.015	-0.001	-0.001	0.034	0.012	**.433****
Annual income	0.005	0.057	0.002	0.003	0.086	0.088	-0.054	0.001	0.001	-0.002	-0.007	**.184****
Income from potato	-0.003	-0.005	0.001	0.007	0.054	0.068	-0.07	-0.001	0.002	0.012	0.005	0.069
Sources of information	-0.093	-0.423	-0.01	0.075	0.007	-0.004	-0.004	-0.027	0.002	0.209	0.147	**-.116***
Extension contact	0.006	0.028	0.001	-0.006	0.005	-0.003	0.005	0.002	-0.035	-0.012	-0.012	-0.018
Scientific orientation	-0.095	-0.347	-0.009	0.075	0.034	-0.001	-0.004	-0.024	0.002	0.241	0.147	0.015
Social participation	-0.087	-0.375	-0.011	0.075	0.017	-0.004	-0.002	-0.023	0.002	0.204	0.173	-0.031

Residual Effect^2 = 0.7342057

From the Table 4.5.2.9 it was clear that the knowledge attributing characters considered for all the states explained nearly 27.00 per cent of the variability in the dependent variable knowledge. Family size, size of the land holding had low positive direct effect contributing significant negative correlation with the dependant variable. Productivity and annual income had low direct positive effect but contributing significant positive correlation with the dependant variable and source of information had low negative direct effect contributing significant negative correlation with the dependant variable.

Table 4.5.2.10: Path analysis between attitude vs. predictor variables for all the states

	Age	Family size	Size of land	Area und	Productivity	Annual inco	Income from	Sources of informa	Extension contac	Scientific orientat	Social participation	Attitude

			holding	ue potato		me	potato	tion	t	ion		
Age	0.011	-0.128	0.027	0.064	0.009	0	-0.002	0.015	-0.003	0.219	-0.052	**.160****
Family size	0.009	-0.16	0.028	0.049	-0.038	0.001	-0.001	0.015	-0.003	0.168	-0.047	0.02
Size of landholding	0.007	-0.107	0.041	0.044	-0.035	0.001	0.003	0.011	-0.004	0.131	-0.043	0.049
Area under potato	0.01	-0.106	0.024	0.074	0.043	0	-0.006	0.014	-0.003	0.189	-0.049	**.187****
Productivity	0.001	0.035	-0.008	0.019	0.173	-0.002	-0.016	0	0.001	0.032	-0.004	**.235****
Annual income	-0.001	0.019	-0.006	0.002	0.06	-0.007	-0.056	-0.001	-0.001	-0.002	0.002	0.006
Income from potato	0	-0.002	-0.002	0.006	0.038	-0.005	-0.073	0.001	-0.003	0.012	-0.002	-0.026
Sources of information	0.01	-0.143	0.027	0.061	0.005	0	-0.004	0.016	-0.003	0.2	-0.051	**.125****
Extension contact	-0.001	0.01	-0.003	-0.004	0.003	0	0.005	-0.001	0.048	-0.012	0.004	0.05
Scientific orientation	0.011	-0.117	0.024	0.061	0.024	0	-0.004	0.014	-0.002	0.23	-0.051	**.186****
Social participation	0.01	-0.127	0.029	0.061	0.012	0	-0.002	0.014	-0.003	0.196	-0.060	**.126****

Residual Effect^2 = 0.9030018

From the Table 4.5.2.10 it was clear that the attributing characters considered for all the state explained nearly 10.00 per cent variability in the dependent variable Attitude. Predictor variables like age, area under potato, productivity, sources of information, scientific orientation had low positive direct effect contributing significant positive correlation with dependent variable attitude. Social participation had low direct negative effect contributing positive correlation with dependent variable attitude.

4.6 Constraints faced by farmers in potato cultivation and management

Potato farmers of Assam faced many constraints during the whole potato cultivation process. Most of the constraints were listed and categorized under different sections of problems and discussed further. All the major constraints faced by the farmers of Assam were listed under nine different sections of problems such as production constraints, financial constraints, institutional constraints, situational constraints, infrastructural constraints, technical constraints, extension constraints, marketing constraints, and storage constraints. Table 4.6.1 explains the constraints faced by potato farmers of Assam and it was found that in the production constraints, majority (65.00%) of the farmers faced problems in lack of knowledge regarding pest and disease management followed by 62.50 per cent and 45.00 per cent of the farmers who faced problem in lack of knowledge on balanced fertilizer application and high cost of input respectively. In the financial constraints, majority 20.00 per cent farmers faced problem in inadequate credit followed by 15.00 per cent and 11.67 per cent farmers who faced major problem as inadequate subsidy and high rate of interest respectively. Amongst the institutional constraints majority 20.83 per cent farmers faced problems in lack of cooperation from the various governmental or semi-governmental institutes. In situational constraints distant location of the market was one of the major constraint and about 9.17 per cent farmers faced the same problem and under infrastructural problem majority (22.50 %) of the farmers faced problem due to lack of established structure for livestock's.

Table 4.6.1: Constraints faced by the potato growers of Assam in potato cultivation and management N=120

Constraints	Major constraint	Moderate constraint	No constraints	Weighted Mean Score	Rank	Overall Mean Score	Overall Rank
	f %	f %	f %				
I. Production Constraints							
1. High cost of input	54 (45.00)	28 (23.33)	38 (31.67)	**1.13**	**III**	**1.28**	**II**
2. Lack of knowledge regarding pest and diseases	78 (65.00)	36 (30.00)	6 (5.00)	**1.6**	**I**		
3. Lack of knowledge on balanced fertilizer application	75 (62.50)	25 (20.83)	20 (16.67)	**1.45**	**II**		
4. Lack of input(seed, Fertilizer) supply	39 (32.50)	35 (29.17)	46 (38.33)	**0.94**	**IV**		
II. Financial Constraints							
1. Inadequate credit	24 (20.00)	60 (50.00)	36 (30.00)	**0.90**	**I**	**0.40**	**IX**
2. Inadequate subsidy	18 (15.00)	36 (30.00)	66 (55.00)	**0.60**	**II**		
3. High interest rate	14 (11.67)	1 (0.83)	105 (87.50)	**0.24**	**III**		
4. Insufficient repayment time	6 (5.00)	2 (1.67)	112 (93.33)	**0.12**	**V**		
5. Lack of own resource	9 (7.50)	0 (0.00)	111 (92.50)	**0.15**	**IV**		
III. Institutional constraints							
1. Lack of cooperation	25 (20.83)	0 (0.00)	95 (79.17)	**0.42**	**II**	**0.47**	**VIII**
2. Lack of support from agricultural department	3 (2.50)	89 (74.17)	28 (23.33)	**0.79**	**I**		
3. Lack of SHG	0 (0.00)	23 (19.17)	97 (80.83)	**0.19**	**III**		
IV. Situational constraints							
1. Distant location of market	1 (0.83)	63 (52.50)	56 (46.67)	**0.54**	**II**	**0.53**	**VIII**
2. Distant location of land	11 (9.17)	56 (46.67)	53 (44.17)	**0.0.65**	**I**		
3. Poor transport facility	0 (0.00)	49 (40.83)	71 (59.17)	**0.41**	**III**		
V. Infrastructural constraints							
1. Lack of availability of land	0 (0.00)	35 (29.17)	85 (70.83)	**0.29**	**IV**	**0.66**	**VI**
2. Lack of established structure for	27 (22.50)	15 (12.50)	78 (65.00)	**0.57**	**III**		

livestock							
3. Lack of tools and implements	39 (32.50)	46 (38.33)	35 (29.17)	**1.03**	**I**		
4. Lack of irrigation facility	36 (30.00)	17 (14.17)	67 (55.83)	**0.74**	**II**		
VI. Technical constraints							
1. Lack of mechanization	28 (23.33)	40 (33.33)	52 (43.33)	**0.80**	**II**	**0.71**	**V**
2. Unavailability of new technology	34 (28.33)	34 (28.33)	52 (43.33)	**0.85**	**I**		
3. Wild animal threats	20 (16.67)	20 (16.67)	80 (66.66)	**0.50**	**III**		
VII. Extension constraints							
1. Inadequate training / No training	40 (33.33)	41 (34.17)	39 (32.50)	**1.01**	**II**	**0.96**	**IV**
2. No or very few visit of extension personnel's	42 (35.00)	40 (33.33)	38 (31.67)	**1.03**	**I**		
3. No Demonstration for new practices	22 (18.33)	56 (46.67)	42 (35.00)	**0.83**	**III**		
VIII. Marketing constraints							
1. Marketing middleman	59 (49.17)	37 (30.83)	24 (20.00)	**1.29**	**I**	**1.12**	**III**
2. Surplus production	30 (25.00)	55 (45.83)	35 (29.17)	**0.96**	**II**		
IX. Storage constraints							
1. Lack of proper storage facilities	81 (67.50)	28 (23.33)	11 (9.17)	**1.58**	**I**	**1.30**	**I**
2. Storage loss	30 (25.00)	62 (51.67)	28 (23.33)	**1.02**	**II**		

Further in technical constraints category majority (28.33 %) of the farmers faced problem due to unavailability of new technologies followed by 23.33 per cent and 16.67 per cent of the farmers who faced problem due to lack of mechanization and wild animal threats respectively. In the extension constraints most (33.33 %) of the farmers faced problem because of inadequate training or no training being conducted by the government followed by 35.00 per cent and 18.33 per cent of the farmers faced problems because of limited visits by the extension personnel's and shortage of live demonstration for the new practices respectively. Among the marketing constraints marketing middleman was one of the major constraints faced by 49.17 per cent respondents and in the storage constraints 67.50 per cent faced major problem due to lack of proper storage facilities. Overall, among the different sections of constraints faced by the farmers of Assam, storage constraint was found to be as top constraint area which was ranked as 1st followed by production constraints and marketing constraints with rank 2nd and 3rd respectively.

In order to overcome the storage constraints, it is suggested to construct warehouses so as to prevent storage loss and the same time, farmers can get premium price when there is demand in the market. For minimizing the production constraints, government should organize adequate training to enhance the knowledge of farmers in managing the pest and disease problem as well as balanced use of fertilizer and integrated nutrient management. Further quality inputs may be made available timely to the farmers at a reasonable price. Marketing problem can be overcome by establishing a regulated market and providing support services to the potato farmers for timely procurement of potato. Middle man can be abolished by promoting on line marketing.

Table 4.6.2: Constraints faced by the potato growers of Meghalaya in potato cultivation and management N=120

Constraints	Major constraint	Moderate constraint	No constraints	Weighted Mean Score	Rank	Overall Mean Score	Overall Rank
	f %	**f %**	**f %**				
I. Production Constraints							
1. High cost of input	114 (95.00)	6 (5.00)	0 (0.00)	**1.95**	**I**	**1.60**	**I**
2. Lack of knowledge regarding pest and diseases	90 (75.00)	30 (25.00)	0 (0.00)	**1.75**	**III**		
3. Lack of knowledge on balanced fertilizer application	107 (89.17)	13 (10.83)	0 (0.00)	**1.89**	**II**		
4. Lack of input(seed, Fertilizer) supply	17 (14.17)	83 (69.17)	20 (16.67)	**0.97**	**IV**		
II. Financial Constraints							
1. Inadequate credit	45 (37.50)	67 (55.83)	8 (6.67)	**1.31**	**I**	**0.49**	**VII**

2. Inadequate subsidy	1 (0.83)	89 (74.17)	30 (25.00)	**0.76**	**II**		
3. High interest rate	13 (10.83)	24 (20.00)	83 (69.17)	**0.42**	**III**		
4. Insufficient repayment time	0 (0.00)	0 (0.00)	120 (100)	**0**	**IV**		
5. Lack of own resource	0 (0.00)	0 (0.00)	120 (100)	**0**	**V**		
III. Institutional constraints							
1. Lack of cooperation	0 (0.00)	0 (0.00)	120 (100)	**0**	**III**	**0.41**	**IX**
2. Lack of support from agricultural department	27 (22.50)	70 (58.33)	23 (19.17)	**1.03**	**I**		
3. Lack of SHG	0 (0.00)	23 (19.17)	97 (80.83)	**0.19**	**II**		
IV. Situational constraints							
1. Distant location of market	47 (39.17)	43 (35.83)	30 (25.00)	**1.14**	**I**	**1.00**	**IV**
2. Distant location of land	40 (33.33)	51 (42.50)	29 (24.17)	**1.09**	**II**		
3. Poor transport facility	23 (19.17)	47 (39.17)	50 (41.67)	**0.77**	**III**		
V. Infrastructural constraints							
1. Lack of availability of land	0(0.00)	36(30.00)	84(70.00)	**0.30**	**II**	**0.47**	**VIII**
2. Lack of established structure for livestock	0 (0.00)	13 (10.83)	107 (89.17)	**0.22**	**III**		
3. Lack of tools and implements	43 (35.83)	66 (55.00)	11 (9.17)	**1.27**	**I**		
4. Lack of irrigation facility	1 (0.83)	24 (20.00)	95 (79.17)	**0.22**	**IV**		
VI. Technical constraints							
1. Lack of mechanization	44 (36.67)	69 (57.50)	7 (5.83)	**1.31**	**I**	**0.69**	**VI**
2. Unavailability of new technology	11 (9.17)	68 (56.66)	41 (34.17)	**0.75**	**II**		
3. Wild animal threats	0 (0.00)	0 (0.00)	120 (100)	**0**	**III**		
VII. Extension constraints							
1. Inadequate training / No training	32 (26.67)	80 (66.67)	8 (6.67)	**1.20**	**II**	**1.21**	**III**
2. No or very few visit of extension personnel's	55 (45.83)	49 (40.83)	16 (13.33)	**1.32**	**I**		
3. No Demonstration for new practices	16 (13.33)	102 (85.00)	2 (1.67)	**1.12**	**III**		
VIII. Marketing constraints							
1. Marketing middleman	44 (36.67)	32 (26.67)	44 (36.67)	**1.00**	**I**	**0.87**	**V**

2. Surplus production	6 (5.00)	76 (63.33)	38 (31.67)	**0.73**	**II**		
IX. Storage constraints							
1. Lack of proper storage facilities	109 (90.83)	11 (9.17)	0 (0.00)	**1.91**	**I**	**1.55**	**II**
2. Storage loss	33 (27.50)	77 (64.17)	10 (8.33)	**1.43**	**II**		

Different problems faced by the potato farmers of Meghalaya were categorized under nine different sections of problems such as production constraints, financial constraints, institutional constraints, situational constraints, infrastructural constraints, technical constraints, extension constraints, marketing constraints, and storage constraints. Table 4.6.2 revealed the constraints faced by potato farmers of Meghalaya and it was found that under production constraints majority (95.00%) of the farmers faced problems because of high cost of input followed by 89.17 per cent and 75.00 per cent famers faced problem due to lack of knowledge on balanced fertilizer application and lack of knowledge regarding pest and disease management respectively. In the financial constraints, majority 37.50 per cent farmers faced problem due to inadequate credit followed by 10.83 per cent and 0.83 per cent farmers who faced major problem in high rate of interest and inadequate subsidy respectively. Amongst the institutional constraints majority 22.50 per cent farmers faced problems due to lack of support from agricultural and its allied departments. In situational constraints majority (39.17 %) of the farmers faced problem because of distant location of the market followed by 33.33 per cent and 19.17 per cent farmers faced problem because of distant location of the land and poor transport facility. In the infrastructural constraints category only 0.83 per cent farmers faced problem because of lack of irrigation facilities.

Further in the technical constraints category majority (36.67 %) of the farmers faced problem due to lack of mechanization and 9.17 per cent of farmers faced problem due to unavailability of new technologies. In the extension constraints, most (45.83 %) of the farmers faced problem because of limited visits by the extension personnel's followed by 26.67 per cent and 13.33 per cent farmers who faced problem because of inadequate training or no training being conducted by the government and shortage of live demonstrations for the new practices respectively. Among the marketing constraints 36.67 per cent farmers faced major constraint due to marketing middleman and about 5.00 per cent farmers faced problems because of surplus production. Lastly, in the storage constraints 90.83 per cent faced major problem due to lack of proper storage facilities and 27.50 per cent farmers also faced problems because of storage loss. Overall, constraints faced by the farmers of Meghalaya revealed that production constraint was recorded as top constraint area which was ranked as 1st followed by storage constraints and extension constraints as 2nd and 3rd respectively.

In order to overcome the production constraints, provision of timely quality inputs with subsidized price should be made available to the potato farmers. Further government should organize adequate training to enhance the knowledge of farmers in managing the pest and disease problem as well as balanced use of fertilizer and integrated nutrient management.

Table 4.6.3: Constraints faced by the potato growers of Nagaland in potato cultivation and management N=12

Constraints	Major constraint	Moderate constraint	No constraints	Weighted Mean Score	Rank	Overall Mean Score	Overall Rank
	f %	f %	f %				
I. Production Constraints							
1. High cost of input	81 (67.50)	39 (32.50)	0 (0.00)	**1.67**	**I**	**1.46**	**I**
2. Lack of knowledge regarding pest and diseases	83 (69.17)	30 (25.00)	7 (5.83)	**1.63**	**III**		
3. Lack of knowledge	83	31	6	**1.64**	**II**		

on balanced fertilizer application	(69.17)	(25.83)	(5.00)				
4. Lack of input(seed, Fertilizer) supply	17 (14.17)	74 (61.67)	29 (24.17)	**0.90**	**IV**		
II. Financial Constraints							
1. Inadequate credit	34 (28.33)	55 (45.83)	31 (25.83)	**1.02**	**I**	**0.39**	**VIII**
2. Inadequate subsidy	1 (0.83)	64 (53.33)	55 (45.83)	**0.55**	**III**		
3. High interest rate	5 (4.17)	35 (29.17)	80 (66.67)	**0.77**	**II**		
4. Insufficient repayment time	0 (0.00)	0 (0.00)	120 (100)	**0**	**IV**		
5. Lack of own resource	0 (0.00)	0 (0.00)	120 (100)	**0**	**V**		
III. Institutional constraints							
4. Lack of cooperation	0 (0.00)	10 (8.33)	110 (91.67)	**0.08**	**III**	**0.38**	**IX**
5. Lack of support from agricultural department	18 (15.00)	61 (50.83)	41 (34.17)	**0.81**	**I**		
6. Lack of SHG	0 (0.00)	30 (25.00)	90 (75.00)	**0.25**	**II**		
IV. Situational constraints							
1. Distant location of market	53 (44.17)	35 (29.17)	37(30.83)	**1.17**	**II**	**1.14**	**III**
2. Distant location of land	52(43.33)	39(32.50)	29(24.17)	**1.19**	**I**		
3. Poor transport facility	39(32.50)	46(38.33)	35(29.17)	**1.03**	**III**		
V. Infrastructural constraints							
1. Lack of availability of land	0 (0.00)	36 (30.00)	84 (70.00)	**0.30**	**IV**	**0.62**	**VII**
2. Lack of established structure for livestock	20 (16.67)	32 (26.67)	68 (56.66)	**0.60**	**II**		
3. Lack of tools and implements	35 (29.17)	63 (52.50)	22 (18.33)	**1.11**	**I**		
4. Lack of irrigation facility	9 (7.50)	40 (33.33)	71 (59.17)	**0.48**	**III**		
VI. Technical constraints							
1. Lack of mechanization	37 (30.83)	63 (52.50)	20 (16.67)	**1.14**	**I**	**0.75**	**VI**
2. Unavailability of new technology	20 (16.67)	53 (44.17)	47 (39.17)	**0.77**	**II**		
3. Wild animal threats	10 (8.33)	22 (18.33)	88 (73.33)	**0.35**	**III**		
VII. Extension constraints							
1. Inadequate training / No training	24 (20.00)	63 (52.50)	33 (27.50)	**0.92**	**III**	**1.02**	**IV**
2. No or very few visit of extension personnel's	47 (39.17)	49 (40.83)	24 (20.00)	**1.19**	**I**		
3. No Demonstration for new practices	15 (12.50)	84 (70.00)	21 (17.50)	**0.95**	**II**		

VIII. Marketing constraints							
1. Marketing middleman	48 (40.00)	32 (26.67)	40 (33.33)	**1.07**	**I**	**0.83**	**V**
2. Surplus production	6 (5.00)	59 (49.17)	55 (45.83)	**0.59**	**II**		
IX. Storage constraints							
1. Lack of proper storage facilities	86 (71.67)	23 (19.17)	11 (9.16)	**1.62**	**I**	**1.25**	**II**
2. Storage loss	17 (14.17)	72 (60.00)	31 (25.83)	**0.88**	**II**		

Different problems faced by the potato farmers of Nagaland were categorized under nine different sections of problems such as production constraints, financial constraints, institutional constraints, situational constraints, infrastructural constraints, technical constraints, extension constraints, marketing constraints and storage constraints. In Table 4.6.3 constraints faced by potato farmers of Nagaland were further sub-categorized as major constraints, moderate constraint and no constraint. It was observed that in the production constraints sections majority (69.17%) of the farmers faced problems because of both lack of knowledge regarding pest and diseases and also lack of knowledge about balance fertilizer application followed by 67.50 per cent and 14.17 per cent famers faced problem because of high cost of input and lack of input (seed, fertilizer) supply from various governmental agencies respectively. In the financial constraints majority 28.33 per cent farmers faced problem in inadequate credit facility followed by 4.17 per cent and 0.83 per cent farmers faced major problem in high rate of interest and inadequate subsidy from governmental agencies respectively. Amongst the institutional constraints majority 15.00 per cent farmers faced problem due to lack of support from agricultural and its allied departments. In situational constraints majority (44.17 %) of the farmers faced problem because of distant location of the market followed by 43.33 per cent and 32.50 per cent farmers faced problem because of distant location of the land and also poor transport facility respectively. In the infrastructural constraints category majority 29.17

per cent farmers faced problem because of lack of proper tools and implements followed by 16.67 per cent and 7.50 per cent farmers faced problems because of established structure for livestock's and suitable irrigation facilities respectively.

Further in the technical constraints category majority (30.83 %) of the farmers faced problem due to lack of farm mechanization followed by 16.67 per cent and 8.33 per cent of the farmers faced problem due to unavailability of new technologies and wild animal threats respectively. In the extension constraints, most (39.17 %) of the farmers faced problem because of very limited visits by the extension personnel's followed by 20.00 per cent and 12.50 per cent farmers faced problem because of inadequate training or no training being conducted from the government side and shortage of live demonstration for the new practices respectively. Among the marketing constraints, 40.00 per cent farmers faced major constraint as marketing middleman and about 5.00 per cent farmers faced problems because of surplus production. Lastly, in the storage constraints, 71.67 per cent faced major problem due to lack of proper storage facilities and 14.17 per cent farmers also faced problems because of storage loss. Overall, among the different sections of constraints faced by the farmers of Nagaland, production constraint was found as top constraint area which was ranked as 1stfollowed by storage constraints and situational constraints as ranked 2nd and 3rd respectively.

Besides the suggestions in the previous table, it is suggested that the situational constraints can be minimized by making proper marketing channel where farmers can sell their produce in their farm itself and also by improving transportation facilities to minimize cost and loss during the transportation process.

Table 4.6.4: Constraints faced by the potato growers of Tripura in potato cultivation and management N=120

Constraints	Major constraint	Moderate constraint	No constraints	Weighted Mean Score	Rank	Overall Mean Score	Overall Rank
	f %	f %	f %				
I. Production Constraints							
1. High cost of input	77 (64.17)	43 (35.83)	0 (0.00)	**1.64**	**III**	**1.60**	**I**
2. Lack of knowledge regarding pest and diseases	102 (85.00)	18 (15.00)	0 (0.00)	**1.85**	**II**		
3. Lack of knowledge on balanced fertilizer application	107 (89.17)	13 (10.83)	0 (0.00)	**1.89**	**I**		
4. Lack of input(seed, Fertilizer) supply	20 (16.67)	83 (69.17)	17 (14.17)	**1.02**	**IV**		
II. Financial Constraints							
1. Inadequate credit	18 (15.00)	87 (72.50)	15 (12.50)	**1.02**	**I**	**0.37**	**VIII**
2. Inadequate subsidy	1 (0.83)	89 (74.17)	30 (25.00)	**0.76**	**II**		
3. High interest rate	0 (0.00)	7 (5.83)	103 (85.83)	**0.06**	**III**		
4. Insufficient repayment time	0 (0.00)	0 (0.00)	120 (100)	**0**	**IV**		
5. Lack of own resource	0 (0.00)	0 (0.00)	120 (100)	**0**	**V**		
III. Institutional constraints							
1. Lack of cooperation	0 (0.00)	0 (0.00)	120 (100)	**0**	**III**	**0.33**	**IX**
2. Lack of support from agricultural department	3 (2.50)	89 (74.17)	28 (23.33)	**0.79**	**I**		
3. Lack of SHG	0 (0.00)	23 (19.17)	97 (80.83)	**0.19**	**II**		
IV. Situational constraints							
1. Distant location of market	0 (0.00)	63 (52.50)	57 (47.50)	**0.52**	**II**	**0.53**	**VI**
2. Distant location of land	11 (9.17)	53 (44.17)	56 (46.66)	**0.62**	**I**		
3. Poor transport facility	0 (0.00)	49 (40.83)	71(59.17)	**0.41**	**III**		
V. Infrastructural constraints							

1. Lack of availability of land	0 (0.00)	35 (29.17)	85 (70.83)	**0.29**	**II**	**0.42**	**VII**
2. Lack of established structure for livestock	0 (0.00)	13 (10.83)	107 (89.17)	**0.11**	**IV**		
3. Lack of tools and implements	22 (18.33)	86 (71.67)	12 (10.00)	**1.08**	**I**		
4. Lack of irrigation facility	1 (0.83)	23 (19.17)	96 (80.00)	**0.21**	**III**		
VI. Technical constraints							
1. Lack of mechanization	44 (36.67)	69 (57.50)	7 (5.83)	**1.31**	**I**	**0.70**	**V**
2. Unavailability of new technology	2 (1.67)	92 (76.67)	26 (21.66)	**0.80**	**II**		
3. Wild animal threats	0 (0.00)	0 (0.00)	120 (100)	**0**	**III**		
VII. Extension constraints							
1. Inadequate training / No training	29 (24.17)	84 (70.00)	7 (5.83)	**1.18**	**I**	**1.14**	**III**
2. No or very few visit of extension personnel's	22 (18.33)	87 (70.00)	11 (9.17)	**1.09**	**III**		
3. No Demonstration for new practices	19 (15.83)	99 (82.50)	2 (1.67)	**1.14**	**II**		
VIII. Marketing constraints							
1. Marketing middleman	109 (90.83)	11 (9.17)	0 (0.00)	**1.91**	**I**	**0.99**	**IV**
2. Surplus production	10 (8.33)	99 (82.50)	11 (9.17)	**0.99**	**II**		
IX. Storage constraints							
1. Lack of proper storage facilities	109 (90.83)	11 (9.17)	0 (0.00)	**1.91**	**I**	**1.42**	**II**
2. Storage loss	7 (5.83)	99 (82.50)	14 (11.67)	**0.94**	**II**		

Different problems faced by the potato farmers of Tripura were categorized under nine different sections of problems such as production constraints, financial constraints, institutional constraints, situational constraints, infrastructural constraints, technical constraints, extension constraints, marketing constraints and storage constraints. In Table 4.6.4 constraints faced by potato farmers of Tripura were further sub-categorized as major constraints, moderate constraint and no constraint. It was observed that in the production constraints, majority (89.17%) of the farmers faced problems because of lack of knowledge about balance fertilizer application followed by 85.00 per cent and 64.17 per cent famers faced problem because of lack of knowledge regarding pest and diseases and also high cost of input respectively. In the financial constraint most (15.00%) of the farmers faced problem in inadequate credit facility. Amongst the institutional constraints only about 2.50 per cent farmers faced problems due to lack of support from agricultural and its allied departments. In situational constraints, about 44.17 per cent of the farmers faced problem because of distant location of the market. In the infrastructural constraints, about 18.33 per cent farmers faced problem because of lack of proper tools and implements.

Further in the technical constraints category majority (36.67 %) of the farmers faced problem due to lack of farm mechanization and about 1.67 per cent of the farmers faced problem due to unavailability of new technologies. In the extension constraints, most (24.17 %) of the farmers faced problem because of inadequate training or no training being conducted from the government side followed by 18.33 per cent and 15.83 per cent farmers faced problems because of very limited visits by the extension and shortage of live demonstration for the new practices respectively. Under marketing constraints 90.83 per cent of the farmers faced major constraint due to middleman and about 8.33 per cent farmers faced problems because of surplus production. Lastly, in the storage constraints, 90.83 per cent faced major problem due to lack of proper storage facilities and 5.83 per cent of farmers faced problems because of storage loss. Overall, considering the different types of constraints faced by the farmers of Tripura, production constraint was found as the top most constraint area and ranked 1stfollowed by storage constraints and extension constraints which were ranked 2nd and 3rd respectively.

In order to overcome production constraints, government should organize adequate training to enhance the knowledge of farmers in managing the pest and disease problem as well as balanced use of fertilizer and integrated nutrient management. Further quality inputs may be made available timely to the farmers at a reasonable price. This will be helpful in developing confidence among the farmers to take sustainable cultivation of potato at a large scale. Storage constraints can be minimized by adequate provision of warehouses so as to prevent storage loss and the same time, farmers can get premium price when there is demand in the market.

CHAPTER V

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

5.1 Introduction

“Potato occupies about 21.90 per cent of the total area under vegetable cultivation and having the highest (28.90%) among production of vegetables in India. India ranked third with an area of 21, 42,000 ha, while it ranked second with 5, 13, 90,000 tonnes of production, whereas it ranked at 68th with very low productivity of 23.95 MT / ha only among the potato producing countries. Among the North eastern states, Assam has the highest production of potato followed by Meghalaya and Tripura where, Tripura has the highest productivity of 18.09 MT/ha. North East region of India covers almost 9.00 per cent of the area and 4.30 per cent of the total agricultural production of India (NHB, 2018). Majority of the population in North east region is dependent on agriculture, horticulture and allied land based activities. The agricultural production system in the region is mostly rain fed, mono-cropped, and at subsistence level. Productivity of the potato is much less in North east region (7.52 MT/ha) than the national average of 23.95 MT/ha” (NHB, 2018). Potato farmers of North East India have shown tendencies of entrepreneurial behaviour such as autonomy, risk taking, need for achievement, creativity and locus of control.

Sustainable potato farming and entrepreneurship is major limiting factor among the farming community in our country and North-east, India in particular. Keeping these points in view the present study was undertaken with the following objectives:

5.2 Objectives

5.2.1 To study socio- psychological and economic characteristics of potato farmers.

5.2.2 To examine knowledge and attitude of potato farmers towards sustainable practices of potato farming

5.2.3 To find out the status of sustainability of potato farming practised by farmers

5.2.4 To examine the entrepreneurial behaviour of the potato farmers

5.2.5 To study the relationship of socio- psychological and economic characteristics of potato farmers with their knowledge and attitude towards sustainable potato farming

5.2.6 To identify the constraints being faced by potato growers and suggest appropriate strategies to overcome them

5.3 Research Methodology

"The present study was conducted in North East India. North East India comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim covers almost 9.00 per cent of the area and 4.30 per cent of the total production of India. Although the yield level was quite low due to various reasons but the per capita availability of potato in the region is higher than at the national level" (NHB, 2018). Therefore North East India was selected purposively for the present study. North East India consists of eight states. Among the eight states four states namely Assam, Meghalaya, Nagaland and Tripura were selected on the basis of higher production and productivity of potato.

From each of the selected states one highest potato producing district was selected purposively for the study. From each of the selected districts one highest potato producing block was selected. Thus, four blocks viz., North Lakhimpur block from Lakhimpur district of Assam, Mawsynram block from East Khasi hills district, Jakhama block Kohima district and Rajnagar block from South Tripura district were selected for the present study. Further four villages were selected randomly. Thus, Amguri, Nalkatu, Balijan, Rajgarh, from NorthLakhimpur block was selected from Lakhimpur district of Assam. Similarly, Mawlyngkut, Chirakatta, Dopho, Mawpen, villages from Mawsynram block was selected from East Khasi hills district. Further Pfuchama, Phesama, Viswema, Khuzama, villages from Jakhama block was selected from Kohima district and Barapathari, Rajnagar, Chittamara, Uttar krishnapur village from Rajnagar block of South Tripura district was selected respectively. Independent variables included age, gender, family size, education, size of land holding, area under potato, productivity of potato, annual income, income from potato, training exposure, sources of information utilized, extension contact, scientific orientation, social participation, marketing channel, knowledge about sustainable potato farming, attitude towards sustainable potato farming and dependent variables included Sustainability of potato farming practices, Entrepreneurial behavior.

The primary data was collected by conducting personal interview with the help of a pre-tested structured-schedule. The secondary data and related information were collected from concerned departments, various publications, journals, magazines relevant text books, internet sources etc. The data collected from the respondents were scored, tabulated and analyzed to calculate frequency, percentage, mean, standard deviation correlation, step down regression, Z test and Path analysis for obtaining valid inferences.

5.4 Results and discussion

5.4.1 Socio psychological and economic characteristics of potato farmers

It was also observed that majority 76.25 per cent of the potato growers of in the selected states of North-east belonged to the middle age group between 35-55 years followed by 14.37 per cent and 9.37 per cent of them who belonged to the old age above 55 years and in theyoung age group below 35 years. Most 51.46 per cent of the potato farmers were male and about 48.54 per cent were female. Further majority (78.33%) of them belonged to medium family size (4-7 members), followed by 12.29 per cent of them having small family size (less than 4 members) and remaining 9.38 per cent of them had large family size having more than 7 family members. In case of education category, 27.92 per cent of the potato farmers had education up to secondary level and as well as higher secondary level followed by 13.12 per cent of them having education upto graduation, 12.50 per cent of them were illiterate, 12.08 per cent of them had education upto middle school, 5.63 per cent of them had education upto primary school and only 3.33 per cent of them had education upto Post Graduate and above respectively.

It was noteworthy to find that majority (58.54%) of the potato famers belonged to the marginal land holding category, followed by 15.84 per cent, 11.87 per cent, 9.79 per cent and 3.96 per cent of them who belonged to small, semi-medium, medium and big land holding categories respectively. Most (62.29%) of them had land under potato in the range of 0.1-0.2 ha followed by 24.79 per cent, 8.75 per cent, 2.92 per cent and 1.25 per cent of them having area under potato in the range of less than 0.1 ha, 0.3-0.4 ha, above 0.4 ha and 0.2-0.3 ha respectively and an average of 31.81 per cent of total land was utilized by the farmers under potato cultivation in the selected states. The average productivity of potato (17.6 t/ha) was found highest in the state of Tripura and lowest in Nagaland as 11.17 t/ha within the period of 2016-2019.

The mean annual income was found to be the highest as Rs. 2,85,770.40 in case of large farmers followed by Rs. 2,59,847.70 in case of medium farmers, Rs. 2,30,772.40 in case of semi-medium farmers, Rs. 1,61,223.90 in case of small farmers and Rs. 1,19,595.30 in case of marginal farmers among the various North-east states. Further the highest mean income from potato cultivation was obtained by the semi-medium farmers (Rs. 55739.92), followed by farmers having medium land holding size (Rs. 49, 7787.13) and large farmers (Rs. 47,336.53) respectively. Majority (47.50 %) of the potato farmers had training exposure between 10-20 days and 72.29 per cent of them had medium level of information sources utilization, while 14.38 per cent and 8.33 per cent of them had low and 13.33 per cent of them had high level of information sources utilization.

It was also found that majority (72.29%) of the farmers had medium level of information sources utilization and most (49.58%) of them had medium level of extension contact, Majority (62.71%) of the respondents had medium level of scientific orientation and most (80.21%) of the potato farmers had low level of social participation. Majority (39.79%) of the farmers in the selected states utilized Farmers – Consumer marketing channel, followed by Farmers – Commission agents– Wholesalers – Retailers – Consumer marketing channel as recorded in case of 18.75 per cent of them.

5.4.2 Knowledge and attitude of potato farmers towards sustainable practices of potato farming

5.4.2.1Knowledge of potato farmers about sustainable farming practices

Majority 42.50 per cent and 35.83 per cent of the potato growers of Assam had very high and high knowledge on planting time, followed by 33.33 per cent of them who had medium knowledge on seed production, 26.67 per cent of them having low knowledge level on integrated nutrient management.

Further majority (24.17%) and 50.00 per cent of the potato growers of Meghalaya had very high and high knowledge on planting time, followed by 28.33 per cent of them having medium knowledge on integrated nutrient management and 27.50 per cent of them had low knowledge level on water management. In case of potato farmers of Nagaland, majority (17.50%) of them had very high knowledge on soil management, followed by 21.67 per cent of them who had high knowledge both in seed size and seed preparation, 26.67 per cent of them had medium knowledge on intercultural operations and 24.17 per cent of them had low knowledge level on water management. Majority (56.67 %) of the potato growers of Tripura had very high knowledge on planting time, followed by 39.17 per cent of them who had high knowledge on planting method, 35.00 per cent of them had medium knowledge both on harvesting and seed production and 28.33 per cent of them had low knowledge level on integrated nutrient management. Overall analysis revealed that majority (68.54%) of the potato growers of all the four north-eastern states had medium knowledge level, followed by 17.92 per cent of them having high and 13.54 per cent of them having low knowledge level on sustainable cultivation practices. Mean knowledge on sustainable cultivation practices of potato cultivation was found highest among the farmers of Meghalaya.

5.4.2.2Attitude of potato farmers towards sustainable farming practices

Majority (64.58%) of the potato farmers in the selected states possessed favourable attitude while 20.42 per cent and 15.00 per cent of them possessed highly favourable and less favourable attitude towards sustainable potato cultivation practices. Further 72.50 per cent of farmers in Nagaland had medium level of attitude, followed by 69.17 per cent of them in case of Meghalaya and 65.83 per cent of them both in case of Assam and Tripura. The mean attitude index was highest in case of potato farmers of Tripura amongst all the four North eastern states selected for the present study.

It was found that education, marketing orientation, extension contact, sources of information utilized, farming experience, scientific orientation and knowledge had positive and significant association with the dependent variable “Attitude” at 1% level of probability. The variable age and family type had negative and significant association with the dependent variable “Attitude” at 1% level of probability.

5.4.3 Status of sustainability of potato farming practised by farmers

It was observed that in the state of Assam majority (81.67%) of the farmers had medium level of economic sustainability, followed by 18.33 per cent of them having low level economic sustainability. Further, it was found that 68.33 per cent of the respondents had medium level of social sustainability followed by 17.50 per cent of them having high and 14.17 per cent of them having low level of social sustainability. It was also found that, majority (69.17%) of the respondents had medium level of environmental sustainability, followed by 19.16 per cent of them having high level of environmental sustainability and 11.67 per cent of them having low level environmental sustainability. In case of Meghalaya, it was found that 90.83 per cent of the respondent had medium level economic sustainability and remaining 9.17 per cent of them had low level of economic sustainability. It was observed that 76.67 per cent of them had medium level of social sustainability followed by 13.33 per cent of them who had high level of social sustainability and 10.00 per cent of them had low level of social sustainability. Apart from these, majority (75.83%) of the farmers had medium level of environmental sustainability followed by 18.33 per cent of them having high level of environmental sustainability and 15.84 per cent of them having low level of environmental sustainability. It was further observed in case of farmers of Nagaland that majority (96.67%) of the respondent had medium level economic sustainability and remaining 3.33 per cent of them had low level of economic sustainability. Further it was found that majority (81.66%) of the respondents had medium level of social sustainability followed by 12.50 per cent of them having high level of social sustainability and 5.84 per cent of them having low level social sustainability. Further in case of Tripura state majority (80.00%) of the respondents had medium level of environmental sustainability, followed by 12.50 per cent of them having high level of environmental sustainability and 7.50 per cent of them having low level of environmental sustainability. It was also found that most (86.67%) of the potato growers had medium level of economic sustainability and rest 13.33 per cent of them had low level of economic sustainability. Majority (71.66%) of the respondents had medium level of social sustainability, followed by 16.67 per cent of them having high level social sustainability and 11.66 per cent of them having low level of social sustainability. It was found that majority (83.33%) of the respondents had medium level of environmental sustainability followed by 13.33 per cent of them having high level of environmental sustainability and 3.34 per cent of them having low level of environmental sustainability.

It was also found that majority (88.96%) of the potato growers of north-east had medium level of economic sustainability and rest 11.04 per cent of them had low level of economic sustainability. Further it was found that 70.21 per cent of the respondents had medium level of social sustainability followed by 16.25 per cent of them had low level of social sustainability and 13.54 per cent of the respondents had high level of social sustainability. 74.58 per cent of the respondent had medium level of environmental sustainability followed by 15.42 per cent of them having low level of environmental sustainability and 10.00 per cent of them having high level of environmental sustainability. Overview of sustainability analysis revealed that social sustainability contributed highest (52.79%), followed by environmental sustainability (37.07%) and economic sustainability (10.14%).

Correlation analysis revealed that variables age, family size, education, size of land holding, area under potato, productivity, sources of information, scientific orientation, social participation, marketing channel and knowledge had positive and significant association with the dependent variable “Sustainability” at 1% level of probability.

5.4.4 Entrepreneurial behaviour of the potato farmers

Analysis of the entrepreneurial behaviour of the farmers of north-eastern states was found to be at medium level. In case of innovativeness, most (81.67%) of the farmers had medium level of entrepreneurial behaviour and rest 16.87 per cent had high entrepreneurial behaviour. In case of management orientation, it was found that 82.92 per cent of the farmers had medium level of entrepreneurial behaviour followed by 13.54 per cent of them who had low and 3.54 per cent had high entrepreneurial behaviour. In case of decision making ability, majority (67.09%) of the farmers had medium level of entrepreneurial behaviour, followed by 18.12 per cent of them having low entrepreneurial behaviour and 14.79 per cent had high entrepreneurial behaviour. In case of economic motivation, majority (72.50%) of the farmers had medium level of entrepreneurial behaviour followed by 13.96 per cent who had low and 13.54 per cent had high level of entrepreneurial behaviour. In case of risk management ability, most (86.25%) of the farmers had medium entrepreneurial behaviour, followed by 9.58 per cent who had high and 4.17 per cent who had low entrepreneurial behaviour. Further in case of achievement motivation, 86.25 per cent of the farmers had medium entrepreneurial behaviour followed by 9.58 per cent having high and 4.17 per cent having low entrepreneurial behaviour. Lastly, in case of scientific orientation, 77.66 per cent of the farmers had medium level of entrepreneurial behaviour, followed by 12.92 per cent who had high and 10.42 per cent having low entrepreneurial behaviour respectively.

Based on Correlation analysis, it was found that variables productivity and knowledge had positive and significant association with the dependent variable “Entrepreneurship” at 1% level of probability and size of land holding, area under potato, annual income, sources of information and marketing channel had positive and significant association with the dependent variable “Entrepreneurship” at 5% level of probability.

Based on ‘step down multiple regression’ it was found in case of the state of Assam that age, size of land holding, area under potato, attitude had significant role in achievement motivation. Family size, productivity had significant role in decision making ability. Area under potato, extension contact had significant role in economic motivation. Further, education level, extension contact had significant role in risk taking ability and productivity, income from potato had significant role in scientific orientation. In the state of Meghalaya, scientific orientation, marketing channel had significant role in decision making ability and annual income, extension contact had significant role in economic motivation and entrepreneurial behaviour. Further, in case of Nagaland state, size of landholding, marketing channel had significant role in achievement motivation. Marketing channel, attitude had significant role in decision making ability. Knowledge had significant role in risk taking ability and annual income, income from potato, and social participation had significant role in scientific orientation and entrepreneurial behaviour. It also revealed that knowledge had a significant role towards innovativeness and risk taking ability of the farmers in the state of Tripura.

Based on the ‘Principal Component Analysis (PCA)’ of entrepreneurial behaviour of the potato growers of north-eastern states (***i.e.*** all four states) it was found that the first three principal components (PCs) having greater than one eigen value contributed 56.71 per cent of the total variations among the entrepreneurial behaviour. The PC-1 contributed 23.79 per cent, whereas PC-2 and PC-3 contributed 18.09 per cent and 14.84 per cent respectively of the total variations.

Decision making ability (-0.58) and achievement motivation (0.55) was the top contributor in PC-1. Innovativeness (-0.60) and Management Orientation (0.65) was the top contributor in PC-2. Whereas, Scientific orientation (0.81) contributed highest in PC-3. Management orientation was one of the entrepreneurial behavioural traits which had high contribution in PC-2 and PC-3. Thus, these variables may be considered important to influence the entrepreneurial behaviour of potato farmers.

5.4.5 Relationship of socio- psychological and economic characteristics of potato farmers with their knowledge and attitude towards sustainable potato farming

5.4.5.1 Findings based on Step down multiple regressions

It case of potato farmers of Assam it was found that variables age and size of the land holding had significant impact on knowledge and source of information and extension contact had significant impact on attitude. In Meghalaya found use of extension contact have impact on the knowledge and income from potato, social participation had a substantive impact on attitude of the farmers. Further the variables area under potato had significant impact on knowledge and age had significant impact towards attitude in case of Potato farmers of Nagaland. In Tripura, variables annual income, income from potato, source of information, marketing channel and attitude had substantive impact on the knowledge and knowledge had substantive impact on the attitude of the farmers.

5.4.5.2 Direct and indirect effect of socio- psychological and economic variables on 'Knowledge' and 'Attitude' of farmers

In Assam, size of land holding had high negative direct effect with significant and negative correlation with knowledge via age, family size, sources of information and scientific orientation. Age had high negative direct effect with positive significant correlation with attitude via sources of information and extension contact. Source of information also had high positive direct effect with significant and positive correlation with attitude via age.

In Meghalaya, Age had high positive direct effect producing positive and significant correlation with Knowledge via source of information. Age also had high negative direct effect contributing significant positive correlation with Attitude via scientific orientation and social participation. Further scientific orientation had high positive direct effect and significant positive correlation with Attitude via social participation and sources of information.

In Nagaland, Family Size had high negative direct effect via age, scientific orientation and social participation. Sources of information had high negative direct effect via age, scientific orientation and social participation. Social orientation had high negative direct effect via age, Sources of information and Social participation with respect to knowledge on sustainable potato cultivation. Further, Age had high positive direct effect and contributing significant positive correlation with Attitude via sources of information and area under potato cultivation. Family size had high negative direct effect and contributing significant positive correlation via age, area under potato cultivation and sources of information. Area under potato had high positive direct effect contributing significant positive correlation via sources of information and age. Sources of information had high negative direct effect contributing significant positive correlation via age and area under potato cultivation.

In Tripura, Annual income had high positive direct effect, income from potato had high negative direct effect and area under potato had high positive direct effect with Knowledge. Further, Age had high positive direct effect via scientific orientation, scientific orientation had high negative direct effect via age and size of land holding had low negative direct effect via age and scientific orientation with respect to the Attitude.

Knowledge attributing characters considered for all the four states explained nearly 27.00 per cent of the variability in the dependent variable ‘Knowledge’. Family size and size of the land holding had low positive direct effect contributing significant negative correlation with the dependant variable Knowledge. Productivity and annual income had low direct positive effect but contributing significant positive correlation with the dependant variable and sources of information had low negative direct effect contributing significant negative correlation with Knowledge.

Attitude attributing characters considered for all the four states explained nearly 10.00 per cent of variability in the dependent variable. Variables like age, area under potato, productivity, sources of information, scientific orientation had low positive direct effect contributing significant positive correlation with dependent variable attitude. Social participation had low direct negative effect contributing positive correlation with dependent variable attitude.

5.4.6 Constraints faced by farmers in potato cultivation and management

Constraints faced by the farmers were grouped under nine different sections such as production constraints, financial constraints, institutional constraints, situational constraints, infrastructural constraints, technical constraints, extension constraints, marketing constraints, and storage constraints. In Assam, the major constraint faced by the potato growers was found to be storage constraints which ranked I followed by production constraints which ranked II and marketing constraints which ranked III. Majority (67.50%) of the potato growers didn't have access to the storage facility of potato. Therefore they suffered a huge loss in absence of any suitable storage facility. Majority (65%) of them lacked knowledge in disease and pest management for sustainable potato cultivation and 49.17 per cent of them faced problem in marketing their produce due to interference of middlemen.

In Meghalaya, the major constraint faced by the potato growers was also found to be production constraint which was ranked I followed by storage constraints which was ranked II and extension constraints which was ranked III. Majority (95%) of them faced problem due to high input cost for sustainable potato cultivation, most (90.83%) lacked access to the storage facility of potato while 45.83 per cent of them faced problem due to lack of required extension support and timely advisory service in adopting sustainable potato cultivation practices.

In Nagaland production constraint was recorded as top constraint which was ranked I followed by storage constraints and situational constraints which was ranked as II and III respectively. Majority (69.17%) of them lacked knowledge in disease and pest management as well as judicious use of manures and fertilizers during potato cultivation. This resulted in lower yield of potato. Further, most (71.67%) of them didn't have access to the storage facility of potato which resulted in wastage due to rotting. Distant location of market created situational constraint for 44.17 per cent of the potato growers. This posed difficulty in selling off their produce for getting remunerative price.

In Tripura, the major constraint faced by the potato growers was found to be production constraint which was ranked I followed by storage constraints which was ranked II and extension constraints which was ranked III. Majority (89.17%) of them faced severe problem due to lack of knowledge for balanced use of fertilizers for sustainable potato cultivation, 82.50 percent faced inadequate access to the storage facility of potato while 70.00 per cent of them faced problem in adopting sustainable potato cultivation practices due to inadequate exposure to required training as per their need.

Based on the constraint analysis, it was revealed that production, storage, marketing and extension constraints proved to be the major bottlenecks which hindered high productivity, economic gain and posed severe limitations in adoption of sustainable potato cultivation and management practices. In order to overcome the storage constraints, it is suggested to construct warehouses so as to prevent storage loss so that farmers can get premium price when there is demand in the market. For minimizing the production constraints, quality inputs may be made available timely to the farmers at a reasonable price. Further government should organize adequate training to enhance the knowledge of farmers in managing the pest and disease problem as well as balanced use of fertilizer and integrated nutrient management. Timely visit of extension personnel and need based training may be a great help to the farmers to get needed extension support. Marketing problems can be overcome by establishing regulated market and providing support services to the potato farmers for timely procurement of potato. Interference of middle man can be abolished by promoting on line / e - marketing.

5.5 Conclusion

1. Majority of the potato growers were educated, middle aged, male, had medium knowledge level, medium level of overall utilization of

information sources with respect to entrepreneurship and sustainable potato farming practices. They belonged to medium family size had medium level of extension contact with the extension personnel were literate and had education upto secondary level. It was found that majority of them belonged to the marginal land holding category with land holdings of 0.1-0.2 ha.

2. Mean annual income was found highest of Rs. 2, 85,770.40 in case of big potato growing farmers and highest mean income from potato was obtained by semi-medium farmers (Rs. 55739.92).
3. Potato farmers from all the selected four North-east states had training exposure varying only 10-20 days which proved to be limiting factor to have updated knowledge and required skill in adopting sustainable potato cultivation practices.
4. Scientific orientation of the potato farmers was found to be medium. Social participation of the potato farmers was also found to be low. Most of the potato farmers used farmer-consumer marketing channel to sell their produce.
5. Majority of potato farmers had medium knowledge on sustainable cultivation practices. Mean knowledge on sustainable cultivation practices of potato cultivation was found highest among the farmers of Meghalaya.
6. Majority of potato farmers had favorable attitude towards sustainable potato cultivation practices. It was found that education, marketing orientation, extension contact, sources of information utilized, farming experience, scientific orientation and knowledge had positive and highly significant association with the "Attitude" whereas the variable age and family type had negative and significant association with the 'Attitude' of farmers towards adopting sustainable potato cultivation practices. The mean attitude index was highest in case of potato farmers of

Tripura amongst all the four north eastern states selected for the present study.

7. Entrepreneurial behavior of potato farmers was observed to be moderate in all the four selected North east states. In case of potato farmers of Assam showed that variables age, size of land holding, area under potato and attitude played a significant role in influencing achievement motivation. Family size, productivity had significant role in decision making ability. Area under potato, extension contact had significant role in economic motivation. Further, education level, extension contact had significant role in promoting risk taking ability and productivity, income from potato had significant role in promoting scientific orientation for the state of Assam. In the state Meghalaya, scientific orientation, use of appropriate marketing channels had significant role in decision making ability of farmers and annual income, extension contact had significant role in promoting economic motivation as an integral component of entrepreneurial behaviour. Further, in case of Nagaland state, size of landholding, marketing channels had significant role in achievement motivation. Marketing channels, attitude had significant role in decision making ability. Annual income, income from potato, and social participation had significant role in scientific orientation and promoting entrepreneurial behaviour of farmers. In Tripura, knowledge had a significant role towards promoting innovativeness and risk taking ability of the farmers. Overall analysis revealed that variables productivity and knowledge, size of land holding, area under potato, annual income, sources of information and marketing channel had positive and significant association with the variable “Entrepreneurship” .
8. In the states of Assam, Meghalaya and Nagaland majority of the farmers had medium level of economic sustainability whereas in the state of

Tripura majority of the farmers had medium level of environmental sustainability. Overview of sustainability analysis among all the potato growers revealed that social sustainability contributed highest (52.79%), followed by environmental sustainability (37.07%) and economic sustainability (10.14%). Thus, Social sustainability was found to be major factor influencing the sustainable potato farming in the North east region. Further variables age, family size, education, size of land holding, area under potato, productivity, sources of information, scientific orientation, social participation, marketing channel and knowledge had positive and significant association with the variable "Sustainability".

9. Constraint analysis included production constraints, financial constraints, institutional constraints, situational constraints, infrastructural constraints, technical constraints, extension constraints, marketing constraints, and storage constraints. Major constraints faced by the potato growers included lack of availability of quality planting materials, inadequate knowledge of insect pest and disease management as well as balanced use of fertilizers, lack of proper storage facility of potato, interference of the middlemen in marketing of produce as well as lack of needed extension support services to get updated knowledge and skill in adopting sustainable potato cultivation practices.

5.6. Policy implications and recommendations

1. The farmers were found successful in producing large quantities of potatoes and they also have entrepreneurial potentials. Therefore, it is recommended that the farmers should be motivated, encouraged and trained to develop potato based enterprises.
2. Majority of the respondents were educated and middle aged between 36-50 years. These educated groups of farmers if guided and trained

properly, can step up the productivity of potato in the NE region by adopting sustainable potato farming practices.

3. Majority of the potato farmers had medium level of social participation so it is need to involve the potato farmers in all level of social gathering to improve the social participation.
4. Majority of the potato farmers belonged to marginal land holding category. Therefore it is the need of hour to go for aggregation of products and form cooperative farming. Potato based farmer's producer's organizations may also be promoted for reaping higher levels of social and economic sustainability.
5. Most of the farmers sell their produce in nearby markets through farmer-consumer marketing channel only because they have difficulty selling in distant markets. So it is needed to create needed marketing infrastructure suitable training and providing proper marketing linkages for profit maximization.
6. Most of the respondents had medium extension contact and medium level of utilization of mass media, formal and informal sources. Therefore, it is necessary to educate the potato growers on the importance of keeping contact with the extension functionaries so that they can assist them on various problems.
7. It was found that majority of the potato farmers had medium level of training exposure related to the sustainable potato farming practices. Therefore, need based training and demonstration programmers should be organized periodically.
8. Economic and environmental sustainability contributed very less in achieving the overall sustainability of potato farming in the region. Therefore, more emphasis should be laid on enhancing measures to adopt eco friendly production measures by imparting needed knowledge

and skills as well as developing agripreneurship to improve the sustainability of potato farming in the North east region.

9. Most of the respondents faced constraints in production, storage, marketing and getting required extension support services. Provision of warehouses, quality inputs, need based training to enhance the knowledge of farmers in managing the pest and disease problem as well as balanced use of fertilizer and integrated nutrient management, needed extension support, establishing regulated market and promoting on line / e – marketing may be helpful to overcome the constraints and promoting sustainable potato cultivation and establishment of potato based entrepreneurial ventures.

5.7 Suggestions for further studies

1. This study was conducted in only four districts of four different states of North-east, India. Similar study may be extended to the entire districts of all the NE states to ascertain the findings and identify the parameters to enhance the sustainability of potato farming.
2. A separate study on potato based entrepreneurial ventures may studied for promoting the avenues of agripreneurship.
3. Participatory research on developing sustainable potato farming models may be taken into consideration.

REFERENCES

REFERENCES

Abdullah, I., Mahmood, W., Bin, M. F., Muhammad, H. F., Rahman, A. B. M., Jali, F. 2015. Sustainability in Malaysian Palm Oil: A Review on Manufacturing Perspective. *Polish Journal of Environmental Studies.* 24. 1463-1475.

Adebayo, S. A. and Oladele, O. I. 2013. Socio-economic status of organic vegetable farmers in South West Nigeria.*Journal of Food, Agriculture & Environment*. **11**(2):397-402.

Adusei, F.Y. 2020.Investigating the factors that affect the adoption of organic agriculture in Asokwa, Kumasi metropolis.*Int. J. Agric. Ext*. 8 (03):163-172.

Akter, R. and Akram, W. 2020. Economics of Potato Production: A Case Study on the Farmers of Munshiganj Area. *International Journal of Academic Multidisciplinary Research*. 4(5): 81-89.

Ali, J. 2015. Adoption of diversification for risk management in vegetable cultivation.*International Journal of Vegetable Science*.**21**(1):9-20.

Ali, J. 2011. Adoption of mass media information for decision-making among vegetable growers in Uttar Pradesh.*Indian Journal of Agricultural Economics*.**66**(2):241-254.

Anonymous. 2007. CPRI Vision, 2025. Central Potato Research Institute, Shimla, p 35.

Anonymous. 2014. Hand Book on Horticulture statistics. Department of Agriculture and Cooperation, Ministry of Agriculture; Government of India, 1-3.

Annonymous. 2020a. https://www.britannica.com/place/Assam /People accessed on 14.11.2020 at 18.00 hrs)

Annonymous . 2020b. https://www.britannica.com/place/Meghalayaaccessed on 14.11.2020 at 18.05 hrs

Annonymous . 2020c. https://www.britannica.com/place/Nagalandaccessed on 14.11.2020 at 18.20 hrs

Annonymous . 2020d. http://tripura.nic.in accessed on 15.11.2020 at 14.20 hrs.

Annonymous .2019a. Statistical Handbook Assam- 2019.Directorate of Economics and Statistics, Govt. of Assam; p 67-79.

Annonymous .2019b. Statistical Handbook Meghalaya 2019.Directorate of Economics and Statistics, Govt. of Meghalaya, p:44-47.

Annonymous .2019c. https://agri.tripura.gov.in/basic_statistics accessed on 16.08.2020 at 20.03 hrs.

Annonymous . 2020. Statistical Handbook 2020. Directorate of Economics and Statistics, Government of Nagaland, p:26-39.

Annonymous.2020e. District census handbook of lakhimpur, Assam. Directorate of Census Operations, Assam Ministry of Home Affairs, series 19, part XII-B, p 1-233

Annonymous . 2020f. https://eastkhasihills.gov.in/ accessed on 22.05.2021 at 15.20 hrs

Annonymous . 2020g. https://kohima.nic.in/about%20district/ accessed on 28.04.2021 at 20.25 hrs

Annonymous . 2020h. https://southtripura.nic.in/ accessed on 26.05.2021 at 12.00 hrs

Annonymous .2021. http://lakhimpur.nic.in/Lakhimpur/about.htm acessed on 28.05.2021 at 19.40 hrs.

Annonymous, 2021. A step by step explanation of Principal Component Analysis (PCA). https://builtin.com/data-science/ step-step-explanation-principal-component-analysis accessed on 28th September, 2020 at 20.22 hrs.

Arneja, C. S., Singh, R. and Kaur, G. 2009. Constraints in potato cultivation faced by the potato growers.*Agricultural Science* Digest.**29**(2):51-53.

Archana, K. N.2013. A study on entrepreneurial behaviour of commercial seed growers of Dharwad district of Karnataka. M.Sc (Agri.) Thesis, Department of Agricultural Extension Education, University of Agricultural Sciences, Dharwad.

Arun, S. K. 2001. A study of the technological gap and the constraints in the adoption of rapeseed/mustard crop technology among farmers in western Uttar Pradesh.Ph.D. Thesis (Un-published).C.C.S. University, Meerut.

Babu, B. K., Prabhakar, K. and Reddy, G. R. 2007.Knowledge of vegetable growers on vegetable marketing.*Journal of Research ANGRAU*.**35**(2):97-98.

Bagheri, A. 2010. Potato farmers' perceptions of sustainable agriculture: the case of Ardabil province of Iran. *Procedia Social and Behavioral Sciences*. 5:1977–1981

Bajracharya, M. and Sapkota, M. 2017. Profitability and productivity of potato (*Solanum tuberosum*) in Baglung district, Nepal. *Agric & Food Secur*. 6, 47. https://doi.org/10.1186/s40066-017-0125-5

Bakshi, S. K. and Banerjee, B. N. 1983. Economics of potato cultivation in District Burdwan (West Bengal). *Agril. Marketing*. 25(4): 29-32.

Balasaravanan, K. and Vijayadurai, J. 2012. Entrepreneurial Behaviour among Farmers – An empirical Study.*IJEMR*. 2(1):2249 – 2585

Banafar, K.N.S., Thakur, M.K. and Gauraha, A.K., 2006, Marketing of rapeseed-mustard in Surguja district of Chhattisgarh. *Agric. Mktg*., **58** (2): 15-19.

Barbeau, A., Roy, M., Bernier, G., Guiseppe, C., Paris, S.2015. Ecogenetics of Parkinson’s disease: Prevalence and environmental aspects in rural areas. *Can. J. Neurol. Sci.* **14**:35–41.

Barman S C and Islam M N. 2005.Real adoption impact measure of potato technologies on production at farmers' level in Comilla District, Bangladesh.*Indian Journal of Agricultural* Economics.**60**(4):677-685.

Baruah, R., Borua, S., Deka, C. R. and Borah, D. 2015.Entrepreneurial behaviour of tribal winter vegetable growers in Jorhat district of Assam.*Indian Research Journal of Extension Education*.**15**(1):65-69.

Basavaiah, and Chandrashekar S. K. 2020. Constraints faced in the Adoption of Technologies by Chawki rearing Centre Entrepreneurs. *Journal of Extension Education*. 32 (2):42-47.

Basavaiah and Kallimani, C.S. 2020. Knowledge and adoption of Mulberry leaf production technologies and their co-relationship with socio-economic factors of chawki rearing centre entrepreneurs in traditional sericultural districts of Karnataka. *Research Journal of Agricultural Sciences* . **11**(5) :1149-1156

Basu, D., Jana, H. and Kole, R. K. 2013. Problems faced by vegetable growers in using pesticides in Nadia district of West Bengal. *Environment and* Ecology.**31**(2C):1133-1138.

Bhatia, J. N., Chauhan, R. S. and Chahal, D. 2011.Studies on awareness pattern and communication behaviour among potato growers in relation to different diseases and their control measures.*Agriculture* Update.**6**(3/4):191-194.

Biradar, G. S., Kumar, H. M. V. and Nagaraj, G. S. B. 2013. Knowledge level of farmers about improved chilli cultivation practices in North-eastern districts of Karnataka. *Environment and* Ecology.**31**(2B):828-831.

Biswas, P. K. and Nath, D. 2013. Constraints in adoption of recommended true potato seed (TPS) production technology in Tripura. *Asian Journal of* Horticulture.**8**(1):65-67.

Bolliger, C., Rudmann, C., Halpin, D., McClelland, F.C., Jukema, L.N., Wolff, P.D., Pyysiäinen, P.J., Zmarlicki, U.K., Mara, R. and Miele, U. 2006. Developing entrepreneurial skills of farmers.*SSPE-CT-2005-006500*: 1-78.

Borua, S. and Brahma, A. K.2012. A study on the knowledge level and extent of adoption of selected technology by rural youth trained in KVKs of AAU in Assam. *J. Acad. Indus. Res.* **1**(7):374-378.

Bussan, A.J., Carter, M., Colquhoun, J., Diercks, A., Diercks, S., Groves, R., Mitchell, P., Nowak, P., Knuteson, D. and Wallendal, A. 2008. Sustainable Potato Production – A Means To An End? Common'Tater: April 2008.

Cadihon, J. J., Moustier, P., Poole, N. D., Tam, P. T. G. and Fearne, A. P. 2011. Traditional vs modern food system. *Development Policy Revire*. **24**(1):31-49

Caswell, M. 2001. The change to conservation: moving farmers towards new production practices. *Agricultural* outlook.**281**:32-34.

Chandra, S., Kumar, S. and Bairwa, K. C. 2013.An introduction to agricultural social sciences. New Vishal's publication p 610-633.

Chandramouli, P., Meti, S. K., Hirevenkangoudar, L. V. and Hanchinal, S.N. 2007. Comparative Analysis of Entrepreneurial Behaviour of Farmers in Irrigated and Dry Land Areas of Raichur District of Karnataka" *Karnataka J. Agric. Sci.* 20(2):320-222

Chanu, T. M., Baite, D. J., Singh, M. K. and Rao, D. U. M. 2014. Adoption of pineapple cultivation practices by the farmers in Manipur State. *Indian Research Journal of Extension Education*.**14**(1):17-20.

Chavai, A. M., Makar, H. B. and Barange, P. K. 2015.Adoption of potato production technology by the farmers of Maharashtra.*Journal of Agriculture Research and* Technology.**40**(1):94-97.

Chavai, A. M., Makar, H. B. and Barange, P. K. 2015.Adoption of potato production technology by the farmers of Maharashtra.*Journal of Agriculture Research and* Technology.**40**(1):94-97.

Chigadolli, M., Krishnamurthy, B. and Mallikarjuna Gowda, A. P. 2018. A study on Knowledge of turmeric growers about improved cultivation practices in Belagavi district of Karnataka. *International Journal of Agricultural Sciences*.**10**(22): 7545-7548.

Christine, D., Barbeau, Oelbermann, M., Jim, D., Karagatzides, andLeonard, J. S. T. 2015. Sustainable Agriculture and Climate Change: ProducingPotatoes (*Solanum tuberosum* L.) and Bush Beans (*Phaseolus vulgaris* L.) for Improved Food Security and Resilience in a Canadian Subarctic First Nations Community. *Sustainability*.2015(7):5664-5681.

Chouhan, M. N. 2018. Knowledge level of tribal farmers regarding okra production technology in South Gujarat.*Indian Research Journal of Extension Education*.**18**(2): 62-65.

Dannof, C. H. 1949. Observations at entrepreneurship in agriculture change and the Entrepreneur. Harvard University Press.

Goudappa, S. B., Biradar, G. S. and Bairathi, R. 2012.Technological gap in chilli cultivation perceived by farmers.*Raj. J. Extn. Edu.***20** (2):171-174.

Gupta, B., Ahmad, Q. J., Q.J.P.,and Kaur, J. 2014. Decision making ability of agri- entrepreneurs at Jammu and Kathua districts of J & K state, India.*Journal of Applied and Natural Science*.6 (2): 751 – 754

Hameed, T.S. and Sawicka, B. 2019.Farmers' knowledge of sustainable potato cultivation techniques in Poland.Agronomy Science. 74(3):82-96

Hameed, T. S. and Sawicka, B.2017.Farmers ' attitudes towards sustainable agriculture practices in Lublin Province.Advances in Sciences and Engineering. 9(1):1-6

Hayran, S., Gul, A., Ali, M. and Saridas.2018. Farmers' sustainable agriculture perception in Turkey: The case of Mersin province. NEW MEDIT N. 3/70-78 DOI: 10.30682/nm1803f

Hegde N G. 2000. Sustainable agriculture for food security. *Indian Farming* **11**(3): 5-7.

Henry, M.M., Kibwika, P., Nampala, P., Manyong, V. and Yami, M. 2020.Factors influencing implementation of bylaws on sustainable crop intensification: Evidence from potatoes in south western Uganda. *Cogent social science*. 6(1):112-118.

Hiremath, S. M. and Hilli, J. S. 2012. Yield gap analysis in chilli production technology. *Asian Journal of Horticulture*.**7**(2):347-350.

Honaryar, G. 2019. An economic analysis of production, marketing and value chain of potato in bamyan province.*International Journal of Research – Granthaalayah*.7(10):1-25.

Hrangao, R.R. B., and Sorokhaibam, R. 2015. Enterprising the Farmer Entrepreneur (A case study of Manipur, India).*International Journal of Humanities and Social Science Invention*. 4(4):28-34

Hussain, T. W., Tiyagi, B. D. and Shah, A. A.2010. Relationship of technological gap with socio-economic variables of saffron growers in Kashmir (J & K), India.*International Journal of Agricultural* Sciences.**6**(1):157-159.

Islam, W.N.U., Hakeem A. H., Dar, M. A., Khalid, R., Showkat, M. and Habib, K.R. 2021. Knowledge level about important production practices of high density apple growers of Kashmir Valley. *Indian Journal of Extension Education*. 56(3): 29- 34.

Jaisawal, D. K., Dubey, M. K. and Rajan, P. 2013. Training Need of Vegetable Growers.*TECHNOFAME- A Journal of Multidisciplinary Advance Research*.**2**(2):50- 56.

Jganathan, D., Padmanabhan,V. B., Bhaskaran, C., Chandru, A. and Johnson, B. 2009. Adoption of Organic Farming Practices by Vegetable Growers. *Indian Journal of Extension Education*.**45**(1 & 2):21-24.

Jha, K. K. 2012. Entrepreneurial behavior of pineapple growers.*Indian Research Journal of Extension Education*.**9**(3):75-77.

Jirali, B. V., Gangadharappa, N. R., Rao, L. R. and Shivamurthy, M. 2003. Cognitive domain of vegetable growers with respect to integrated pest management. *Karnataka Journal of Agricultural Sciences*.**16**(1):77-80.

Joneydi, M.S. 2012. Factors affecting in sustainability of agricultural production systems in Iran.*Annals of Biological Research*. 3 (9):4578-4583

Jugale, V. B. 2004. Horticulture Economy of Maharashtra, Shruti Publication Rajasthan, P 8.

Kafle, B. and Shah, P. 2012. Adoption of improved potato varieties in Nepal: a case of Bara district. *The Journal of Agricultural Sciences*.**7**(1): 14-22.

Kahan, D. 2012. Entrepreneurship in Farming. Rome: FAO of the UN.

Kalita, H. K. and Chabukdhara, J. 2014. Level of Modernization of Vegetable Growers of Lakhimpur District of Assam.*Journal of Academia and Industrial Research***3**(12):101-104.

Kaimal, D.S., Thomas, A. and Amritha, V.S. 2020. Entrepreneurial Potential of Apipreneurs in South Kerala.*Journal of Extension Education*. 32(2):32-37.

Karforma, J. and Banerjee, S. 2014. Adoption behaviour of improved production technology of potato among the commercial potato growers in Terai region of West Bengal.*Journal of* Interacademicia.**18**(2):302-309.

Karforma, J. and Banerjee, S. 2014. Adoption behaviour of improved production technology of potato among the commercial potato growers in Terai region of West Bengal.*Journal of* Interacademicia.**18**(2):302-309.

Khalil, M. I., Haque, M. E. and Hoque, M. Z. 2013. Adoption of BARI recommended potato (Solanum tuberosum) varieties by the potato farmers of Bangladesh. *The Agriculturists*.**11**(2):79-86.

Khan, N., Rehman, A., Salman, M.S. and Asif, K. 2020. Trends and perspectives of sustainable potato production in Aligarh district, India. *Journal of Global Resources.* 6 (02):29-36.

Kharumnuid, P., Pandey, N.K., Devarani, L., Chauhan, J.K., Singh, R., Das, B. and Marbaniang, E.K. 2021.Potato production for nutritional security and doubling farmers' income.*Journal of Pharmacognosy and Phytochemistry*. 10(1): 193-197.

Khode, N. and Palsingh, B. 2021. Entrepreneurial behavior of trained and untrained dairy animal owners: A post-facto evaluation approach. *Indian journal of Extension Education*. 56(2):57-64.

Kiran, S. T. 2003. A study on technological gap and constraints in adoption of recommended practices of mango growers. M.Sc (Agri.) Thesis, Dr. Balasaheb Sawant Konkan Krishi Visdyapeeth, Dapoli, Maharastra.

Kiranmayi, K., Vijayabhinandana, B. and Jyothi, V. 2015.Adoption of Production Technology of Chilli in Guntur District of Andhra Pradesh.*Indian Res. J. Ext. Edu*.**16** (1):107-111.

Kotnala, A. and Dubey, L. R. 2013.Cropping pattern and production problems of vegetable growers in Nainital district of Uttarakhand.*Environment and Ecology*.**31**(2):496-499.

Krishnamurthy, A. T., Kumar, V. B. S., Basavaraju, H. K. and Ahamed, B. Z. 2008. Adoption level and constraints in adoption of improved practices among vegetable growers of Chikmagalur district, Karnataka. *Environment and Ecology*.**26**(2A):888-891.

Kulkarni, N. P. and Jahagirdar, K. A.2015. Technological gap in recommended rose cultivation practices in Dharwad district, Karnataka. *Karnataka J. Agric. Sci.* **28**(3):381-384.

Kumar, A. and Poonam. 2019. Entrepreneurial attributes of vegetable growers: A study in Baloda district of Chattisgarh. *International Journal of Chemical Studies*.**6**: 22-25.

Kumar, S., Paswan, A., Rajan, A. 2021.Socio-economic profile of sugarcane growers in east Champaran district Bihar, India.*Indian Journal of Extension Education*. 56(3):144-148.

Kumar, S., Singh, D., Singh, D. K., Yadav, R. N., Sharma, V. K. and Ali, N. 2008. Study the relationship of independent variables with technological gap of potato growers. *Progressive Research*.**3**(1):67-69.

Kumar, S., Singh P. H., Gupta, V. K., Sah, U. and Pandey, S. K. 2006. Integrated development of Horticulture in North Eastern states of India (MMI), Technical bulletin no 76, Central Potato Research Institute, Shimla, Pp4.

Kumar, S. V. 2009. A study on knowledge and adoption of organic farming practices in Paddy cultivation among the tribal farmers of Kanker district. Thesis No. T-2429, submitted to JNKV.

Kumar, S., Singh, D., Yadav, R. N., Singh, V. K., Singh, R. P. and Ali, N. 2010. Assessment of adoption level of potato growers and their adoption gap in potato production technology. *Environment and Ecology*.**28**(1B):664-667.

Kumar, V. K. 2001. Entrepreneurial behaviour of floriculture farmers in Ranga Reddy district of Andhra Pradesh. M.Sc (Agri.) Thesis, Acharya N G Ranga Agricultural University, Hyderabad.

Kumaraswamy, S. 2001. Sustainability issues in agro-ecology: Socio-ecological perspective. *Agricultural Sciences* 3(2):153-169.

Lal, B., Sinha, T. K, Kumar, A., Pandit, A. and Pandey, N. K. 2011. Constraints perceived by the farmers in adoption of potato technology. *Potato Journal*.**38**(1):73-77.

Lama, M. and Bordoloi, R.2017. Potato Productivity and its Determinants: A Case Study in Sonitpur District, Assam. 14:70-81.

Likert, R. A. 1932. Technique for the measurement of attitude.The science press, New York, 140.

Mallya, G.2011. Hidden Markov Model Based Probabilistic Assessment of Droughts. Purdue University, West Lafayette, p. 47907

Marak, B. R. and Bandyopadhyay, A. K. 2015. Analysing the factors contributing towards technological gap of scientific rice cultivation in west Garo Hills district of Meghalaya. *Journal Crop and Weed.***11**(1):124-12.

Meena, R. S., Meena, V. S., Meena, S. K., Verma, J. P. 2009. The needs of healthy soils for a healthy world. Journal of Cleaner Production. 102:560-561

Meena, M. S. and Singh, K. M. 2012. Impact of Training for Efficient Water Management in Agriculture . *Munich Personal RePEc Archive*, 98115. Available at SSRN: https://ssrn.com/ abstract=3052071 or http://dx.doi.org/10.2139/ssrn.3052071

Modi , R. D., Bheemappa, A., ManjunathL, Hegde, R. V. and Havaldar, Y. N. 2013. Entrepreneurial characteristics of mango growers and their constraints in adoption of post-harvest management practices in mango.*Karnataka Journal of Agricultural Sciences.* **23** (3):384-387.

Mohapatra, A. S. and Sahu, U. N. 2012.A study of socio-economic and entrepreneurial characteristicsof tribals of Mayurbhanj district in sabai grass enterprise.*IJMIE*.**2**(5):426-438.

Nagesh, P. 2006. Study on entrepreneurial behaviour of pomegranate growers in Bagalkot district of Karnataka. M.Sc. (Agri.0 Thesis, University of Agricultural Sciences, Dharwad.

Naruka, P. S., Henry, C., Pachauri, C. P., Sarangdevot, S. S. and Kumar, S. 2010. Relationship between technological gap in the recommended soybean production technology and the selected independent variables.*Raj. J. Extn. Edu.* **17** (18):136-139.

Nath, D.and Biswas, P. K. 2011. Production Constraints of Vegetable Cultivation in West Tripura.*Journal of Community Mobilization and Sustainable Development.***6**(2):177-179.

Neisy, A., Tyari, E., Jamshidi, A. R. and Nejad, M. J. 2014.Study of sustainable soil management in potato farm in South Dezfoul Region.*Advances in Environmental Biology*.**8**(6):3121-3124.

Ngachan, S. V. 2015. Horticulture in NER- Strategies to forge ahead. National Seminar on Sustainable Horticulture VIS-A-VIS Changing Environment, February 26-28, SASRD, NU, Medziphema: 90-91.

NHB, 2018.HORTICULTURAL STATISTICS AT A GLANCE 2018.Horticulture Statistics Division, Department of Agriculture, Cooperation & Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare, Government of India:1-490

Ntawuruhunga, D**.**, Hippolyte, D. Affognon, Fiaboe, K.K.M., Abukutsa-Onyango, M.O., Turoop, L. and Muriithi, B. W. 2020. Farmers' knowledge, attitudes and practices (KAP) on production of African indigenous vegetables in Kenya. *International Journal of Tropical Insect Science*. 40(2): 337–349.

Ojo, M.A. and Jibowa, A.A. 2008. Socio-economic Characteristics Influencing Role Performance of Rural Community Power Actors in Agricultural Extension Delivery System in Osun State, Nigeria. J. Agric. Rural Dev. 2:27–40.

Onumadu, F. N., Osahon, E. E. 2014. Socio-Economic Determinants of Adoption of Improved Rice Technology by Farmers In Ayamelum local Government area of Anambra State, Nigeria. *International Journal Of Scientific & Technology Research.* **3**(1):308-314.

Pandey, S. K., Gautam, U. S., Rai, D. P. and Mustafa, M. 2011.Knowledge and Adoption of gram Production Technology.*Indian Research Journal of extension Education.* **47**(3&4):37-39.

Pandya, R.D. 1997. Entrepreneurial behaviour of inland fisherman.*Journal of Extension Education*.8: 1717.

Papang, J.S. and Tripathi, A. K. 2014. Costs and returns structure of turmeric (*Curcuma longa L*) and constraints faced by producers in Jaintia Hills district of Meghalaya, India. *Indian Journal of Agricultural Research*. 48 (3):192-198.

Paracchini, M. A., Lefebvre, M., Espinosa, M., Paloma, S. G., Piorr, A. and Zasada, I. 2011. Agricultural landscapes as multi-scale public good and the role of the Common Agricultural Policy. *Journal of Environmental Planning and Management*, 58(12):1120-1132.

Patel, D. D., Joshi, P. J. and Patel, P. P.2011.Knowledge level of rose growers about improved rose cultivation.*Gujrat Journal of Extension Education* **22**:24-25.

Patil, M., Bheemappa, A., Angadi, J. G. and Hawaldar, Y. N. 2010.Entrepreneurial characteristics of organic vegetable growers.*Karnataka Journal of Agricultural Science.***23**(3):530-532.

Patil, V.G., Mahadik, R.P. and Patil, A.S. 1999, Entrepreneurial behaviour of litter gourdgrowers. *Maharashtra Journal of Extension Education*. 18: 240-243.

Pawar, S. K. and Natikar, K. V.2015. Technological gap in pepper cultivation practices inUttar Kannada district, Karnataka. *International Journal of Farm Sciences.***5**(1):194-198.

Pawelzik, E. and Möller, K. 2014 Sustainable Potato Production Worldwide: the Challenge to Assess Conventional and Organic Production Systems. *Potato Research*.57:273–290

Peer, Q. J. A., Kumar, S., Aziz, M. A., Kaur, J., Chesti, M. H. and Bhat, A. 2014. Adoption behaviour of potato growers in sub-tropical zone of Jammu division.*African Journal of Agricultural Research*.**9**(2):202-205.

Peer, Q. J. A., Kher, S. K., Peshin, R., Ahmad, N., Kaur, J. and Bhat, F. N. 2013. Adoption of the recommended potato Production technology by the potato Growers of the Jammu division.*Potato Journal*.**40** (2): 184-186.

Peng, Z., Genshu, L., Kang, H. 2012. Entrepreneurial Intentions and Its Influencing Factors: A Survey of the University Students in Xi'an China. Creative Education. 03. 95-100. 10.4236/ce.2012.38B021.

Porchezhian, M.R., et.al. 1998, Entrepreneurial behaviour of farmers, *Journal of Extension Education*, 9: 1963-1964.

Poswal, C. S. 2004. Adoption of improved sugarcane technology in western UP.Ph.D. Thesis (Un-published).C.C.S. University, Meerut.

Raghavendra, B. N. 2007. 'A study on management practices of pineapple growers in Karnataka'. M.Sc (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Raj, R. K., Pradhan, L., Ray, P. and Behera, M. 2009. Vegetables cultivation - growers knowledge and adoption of management practices. *Journal of Interacademicia*.**13**(4):501-506.

Ram, D, Singh, M. K. and Prasad, A. 2012. Prospects of agriculture and allied entrepreneurship development in North East India. *Indian Research Journal of Extension Education Special Issue* **2**:66-72.

Rao, L. R., Shivamurthy, M., Shailaja, H. and Lakshminarayan, M. T. 2007. Knowledge of vegetable growers regarding integrated pest management practices. *Research on Crops*.**8**(1):248-251.

Ratang, W., Syauta, J. H., & Tebay, dan V. (2016). Entrepreneurship Development and Market Orientation Model as A Strategy in Food Security in Wamena, Jayawijaya. *Journal of Education and Vocational Research*, **7**(1), 37-40.

Ray, G. L. 2013. Extension Communication and management. Kalyani publishers p 154.

Ray, P. and Chowdhury, S. 2007. Knowledge-gap among vegetable growers in relation to judicious use of pesticides - a case study.*Journal of Interacademicia*.**11**(1):110-118.

Ray, P. and Chowdhury, S. 2008. Sources and pattern of utilization of information regarding judicious use of pesticides among the vegetable growers.*Agriculture Update*.**3**(1/2):192-196.

Rosouliazar, S. and Fealy, S.2013.Affective in wheat farmer's adoption of farming method of Soil management in west Azerbaijan province.*International Journal of Agricultural Management and Development*.**3**(2):73-82.

Roy, D., Bandyopadhyay, A. K. and Ghosh, A. 2013. Identification of technological gap in Pineapple cultivation in some selected areas of West Bengal. *International Journal of Science, Environment and Technology*. **2**(3): 442 – 448.

Rughoo, M. and Govinden, N. 1995.Current status of tomato production in Mauritius.*Revue Agricole et Sucriere de l'Ile Maurice.* **74**(3):14-21.

Sadati, S. A., Hosain S. F., Ali, A. and Sadati, S. A. 2010. Farmer’s Attitude on Sustainable Agriculture and its Determinants: A Case Study in Behbahan County of Iran. *Research Journal of Applied Sciences, Engineering and Technology*. 2(5): 422-427

Saikia A. 2001. Performance of Agricultural Economy of the North Eastern India: Constraints and Priorities. Presented in workshop “Prioritization of strategies for Agricultural Development in Northeastern India” organized by National Centre for Agricultural Economics and Policy Research (NCAP).

Saidaa, Abdullah, A., Novitab, E. and Ilsan, M. 2015. Sustainability Analysis of Potato Farming System at Sloping Land in Gowa; Regency, South Sulawesi.Agriculture and Agricultural Science Procedia. 9: 4-12. doi:10.1016/j.aaspro.2016.02.107

Sah, U., Dubey, S. K. and Sharma, J.P.2011. Potato Marketing in North East Region of India: A Diagnostic study. *Journal of Community Mobilization and Sustainable Development.*6(2):194-201.

Sahu, P. K. 2018. Agricultural statistics. Kalyani publishers, Vol II p 50-60

Sakharkar, V.S. 1995. A study on knowledge, fertilizer use pattern and constraints in the cultivation of soybean by farmers of Nagpur District, Maharashtra. Ph.D. Thesis, University of Agricultural Sciences, Dharwad.

Samanta, R. K. 1977. A study of some agro-economic, socio-psychological and communication variables associated with repayment behaviour of agricultural credit users of Nationalized Bank, Ph. D. Thesis, Bidhan Chandra Krishi Viswavidyalaya, West Bengal.

Sangwan, H. S. S. 2011. Knowledge and Adoption level of farmers about barley cultivation in Haryana. *Annals of Agriculture Bio-Research.* **16**(2):165-168.

Seemaprakalpa and Arora, M. 2016. Achievement motivation of women entrepreneurs. *Indian Research Journal of Extension Education*. **12**(1):23-28.

Sharma, A. 2011.Economic and constraints of king chilli growers in Dimapur district of Nagaland.*Journal of Interacademicia.***15**(4):710-719.

Sharma, A. K., Rao, D. U. M. and Singh, L. 2008.Achievement motivation in vegetable growers.*Indian Research Journal of Extension Education.***8**(1):79-82.

Sharma, A., Venyo, V. and Chauhan, J. 2014.Entrepreneurial behavior of potato growers in Kohima district of Nagaland.*Indian Research Journal of Extension Education.***14**(2):82-86.

Sharma, J. K. 2014. Technological gap in major cropping patterns of small farms under medium land conditions in Nalbari District of Assam. *J. Acad. Indus. Res.* **1**(7): 388-392.

Sharma, M. and Sidhu, K .2013. Adoption of improved potato cultivation practices. *Vegetable Science.***40** (1): 55-60.

Sharma, R. P.2000. Influence of personal characteristics in adoption of plant protection measures. *Indian Journal of Agricultural Research.***34** (2):130-133.

Sharma, R., Jadav, N.B., Chouhan, S., Singh, S.R.K. and Athare, T. 2016. Relational Analysis of Knowledge and Adoption of Organic Farming Practices in Gujarat State. *Indian Res. J. Ext. Edu*. 16 (3):66-71.

Shailesh, K., Gyanendra, S. and Yadav, V. K. 2013. Factors influencing entrepreneurial behaviour of vegetable growers.*Indian Journal of Extension Education.***13**(1): 16-19.

Shashidhara, K. K. and Manjunath, L. 2008. Adoption of eco-friendly management practices by vegetable growers of North Karnataka.*International Journal of Agricultural Sciences.***4**(2):480-484.

Shashidhara, K. K. and Manjunath, L. 2008. Influence of socio-personal, economic and psychological characteristics of vegetable growers on adoption of eco-friendly management practices.*International Journal of Agricultural Sciences.***4**(2):598-600.

Shree, D.A., Nithya, Rekha, R. and Roopa, N. 2020.Socio-economic assessment of farm women in Rice cultivation.*Indian Journal of Extension Education*. 55(4):56-60.

Singh, B. 2006.Factors influencing technological gaps in adoption of mustard (Brassica juncea L.)production technology in arid zone of Rajasthan. *Journal of Spices and Aromatic Crops.***16** (1): 50–54.

Singh, B. and Yogesh, C. J. 2016.Increased potato productivity, its consequences and sustainable Production.International Journal of Business and General Management (IJBGM). 5(3): 65-80

Singh, M., Sharma, S. K. and Kakran, M. S. 2004. Effectiveness of different communication channels on mustard growers. *Indian Research Journals of Extension Education.***4**(7):50-54.

Singh, H. P. 2015. Dynamics of Horticulture Research and Development in India with reference North-east. National Seminar on Sustainable Horticulture VIS-A-VIS Changing Environment, February 26-28, SASRD,NU, Medziphema: 6-7.

Singh, P., Choudhary, M. and Lakhera, J. P. 2014.Knowledge and attitude of farmers towards improved wheat production technology.*Indian Journal of Extension Education.***14**(2):54-9.

Singh, R. K. and Tyagi, S. K. 2014. Perception dynamics of farmers affecting sustainability in chilli production: an analytical study. *Indian Research Journal of Extension Education.***14**(1):75-77.

Singh, S. and Singh, M. K. 2014.Impact of front line demonstration on cabbage (Brassica oleracea var. capitata L.) yield improvement in South Tripura.*HortFlora Research Spectrum.***3**(2):158-161.

Sinha, A. K. and Singh, S. K. 2019.Economics of Potato Production in Northern Hills of Chhattisgarh.Economic Affairs. 64(1):01-07

Srivastava, A.K., Gupta, V.K., Lal, B., Roy, S., Yadav, S.K., Gurjar, M.S., Bag, T.K., Pandey, N.K. and Singh, B.P. 2012. Assessment of the level of knowledge and training needs of potato growing tribal farmers of Meghalaya. *Intl. J. Agric. Env. Biotech*. 5(4): 483-487

Subbanarasaiah, N. 1991. Marketing of Horticultural Crops in India, 4378/4B, Ansari Road, Darya Ganj, New Delhi. p2-4.

Supe, S. V. 1969. Factors related to different degree of rationality in decision making among farmers. Doctoral Dissertation, Indian Agricultural Research Institute, New Delhi.

Suranse, P. K., Ingle, P. O. and Thakare, U, G. 2011. Technological gap in adoption of recommended soybean cultivation practices and its correlates.*Financing Agriculture.***43**(10):24.

Suresh, S.2004. Entrepreneurial behaviour of mlk producers in Chittoor district of Andra Pradesh – a critical study. M.V.Sc Thesis, Achrya N G Ranga Agricultural University. Hyderabad.

Swaminathan, M.S. 1995. Dimension of sustainable agriculture cited by Muthuraman, P. Towards Sustainable Agriculture: Dimensions and Components. *Employment News,* **20** (34):45-60.

Tatlidil, F. F., Boz, I. and Tatlidil, H. 2009. Farmers' perception of sustainable agriculture and its determinants: a case study in Kahramanmaras province of Turkey *Environment, Development and Sustainability*. 11:1091–1106

Thorat, G., Sharma, S. K., Singh, G. and Mishra, R.2014. Knowledge, adoption and attitude of the banana growers about the banana cultivation technology.*Indian Research Journal of Genetics and Biotechnology*.**6**(4):666-669.

Verma, S. K., Rai, D. P., Tripathi, B. P. and Pandey, K. K. 2018. Study on socio-economic and psychological attributes of chilli growers in Raipur District. *International Journal of Current Microbiology and Applied Sciences*.**7**(12): 1723-1730.

Visweswaram, C. 1979. A comparative study of socio-psychological factors, knowledge and adoption of farm practices among migrant farmers from Tamil Nadu and non-migrant farmers in Kollegal taluk. M.Sc. (Ag). Thesis, University of Agricultural Sciences, Bangalore.

Waman, G. K., Wagh, B. R. and Girase, K. A.2006.Technological gap in banana production technology.*Internat. J. agric. Sci.* **2**(2):591-593.

Wani, H. T., Tiyagi, B. D. and Shah, A. A. 2010.Relationship of technological gap with socio-economic variables of saffron growers in Kashmir (J & K), India.*International Journal of Agricultural Sciences.***6**(1):157-159.

Wanyonyi, N. J. and Bwisa, H.M. 2015. Factors Influencing Entrepreneurial Behavior Among Farmers: A Case Of Cabbage Farmers In Kiminini Ward. International journal of technology enhancements and emerging engineering research. 3(9):2347-4289.

Wanole, S. N., Bande, K. D., Holkar, S. C. and Madane, R. G. 2018. Relational analysis of entrepreneurial behaviour of banana growers.*International Journal of Chemical Studies.***6**(3): 2407-2411.

Wase, R. B. 2001. Knowledge and adoption of farmers about Jayanti chilli cultivation.M.Sc (Agri.) Thesis, Dr. Punjabrao Deshmukh Krishi Vidyalaya, Akola, India.

Yadav, S. K., and Srivastava, A. K. 2015.A review on agronomical aspects of potato production in north-eastern region of India *International Journal of Applied and Pure Science and Agriculture (IJAPSA)*.01(6):44-47.

Yadav V K. 2013. Factors influencing entrepreneurial behaviour of vegetable growers. *Indian Journal of Extension Education* **13**(1): 16-19.

Yenagi, B. S., Channal, G.P. and Beli, R.B. 2020.Knowledge level of farmers about drip irrigation technology.*Indian Journal of Extension Education*. 55(4):200-202.

Zhongqi, H., Robert, L. and Honeycutt, W. 2012. Sustainable Potato production: Global Case Studies. ISBN: 978-94-007-4103-4. DOI: 10.1007/978-94-007-4104-1

APPENDICES

APPENDICES

SUSTAINABLE POTATO FARMING FOR ENTREPRENEURSHIP DEVELOPMENT: A STUDY OF POTATO GROWERS IN NORTH EAST INDIA

INTERVIEW SCHEDULE

Respondents Name: .... Date of Interview: ....
State:
Village - Block- District -

I. TO STUDY SOCIO- PSYCHOLOGICAL AND ECONOMIC CHARACTERISTICS OF POTATO FARMERS

1. **Age** ___________________ Yrs
2. **Sex**: Male/Female/Transgender
3. **Family size** : Adult : Male- Female- , Child : Male- Female- Total :_____
4. **Education** : Illiterate/Primary/ Middle/Secondary/ HS/ Graduation/ PG/ Above
5. **Size of land holding** : ________________________ Acre/ Kani / Ha/ Bigha
6. Size of land under cultivation: Agrl. crops _____________Hort. Crops _____________
7. **Area under potato**: ________________________ Acre/ Kani / Ha/ Bigha
8. **Production of potato**: _________________ Kgs/Quintals/Tonnes, Productivity: _______________
9. **Annual Income**- Salary ____________ Wages _____________ Farm _________ Livestock's ____________Other ___________ Total _____________________
10. **Income from potato** ___________
11. **Training exposure** - Have you undergone trainings related to improved potato cultivation during the last 5 years? : ………. (Y/N) If yes, pl give the following details:

Sl. No.	Name of the organization who imparted the training	Year of training	Area / Topic	No of days

Training method used :..

12. **Sources of information utilized -**

a) Mass-media sources :

Sl	Sources of information	Often	Sometimes	Never	For what type of inf do you use :
1.	Radio				
2.	Television				
3.	Exhibition				
4.	Printed media (poster,folder, leaflet, etc)				
5.	Newspaper				
6.	Internet				
7.	Mobile				
8.	Smartphone				

b) **Formal information sources:**

Sl	Sources of Info.	Often	Sometimes	Never	For what type of inf do you use :
1.	VLW/ VEW				
2.	AO				
3.	SDAO				
4.	HO				
5.	KVK				
6.	ATMA				
5.	NGOs				
6.	Any other				

c) **Informal information sources:**

Sl	Sources of info.	Often	Sometimes	Never	For what type of inf do you use :
1.	Friends				
2.	Relatives				
3.	Neighbours				
4.	Progressive farmers				

13. Extension contact: Pl state the frequency of your contact with the following ext workers:

Sl. No.	Extension personnel	Frequency of contact		
		Most often	Sometimes	Never
1	Agril officer			
2.	Horti. Officer			
3.	VDO			
4.	HDO			
5.	Agricultural scientist			
6.	SMS of KVK			

14. Scientific Orientation

Sl	Statements	SA	A	UD	DA	SDA
1.	New methods of farming give better results to a farmers then the old methods					
2.	The way farmers forefather farmed is still the best way of farming today					
3.	Even a farmer with lots of experience should use new methods in farming, it is worth the efforts					
4.	Though it takes time for a farmer to learn new methods in farming, it is worth the efforts					
5.	A good farmer experiments with new ideas in farming					
6.	Traditional methods of farming have to be changed in order to raise the level of living of a farmer					

15. Social Participation

SL	Organization	Member(Y/N)	Office bearer(Y/N)
1.	Multipurpose cooperative society		
2.	Village Panchayat		
3.	Rural youth club		
4.	Zila parishad		

5.	Religious committee		
6.	Political organization		
7.	Cooperative society		
8.	Mother dairy		
9.	Any other		

II. MARKETING CHANNEL

a. Farmers – Consumer
b. Farmers – Wholesalers – Consumer
c. Farmers – Wholesalers – Retailers – Consumer
d. Farmers – Village traders – Retailers – Consumer
e. Farmers – Village traders – Wholesalers – Retailers – Consumer
f. Farmers – Commission agents – Wholesalers – Retailers – Consumer
g. Farmers – Agro industries – Consumer
h. Farmers – Commission agents – Agro industries – Consumer
i. Others (……………………………………………………………………..)

III. TO EXAMINE KNOWLEDGE AND ATTITUDE OF POTATO FARMERS TOWARDS SUSTAINABLE PRACTICES OF POTATO FARMING

Knowledge about sustainable farming practices

SL	Particulars	Knowledge score : Yes 1, No -0	
		Score	Kn %
1.	**Soil**		
	Sandy loam, Silt loam, loam & Clay soil are suitable and well supplied with Organic matter		
2.	**Cultivars**		
	Late blight resistant varieties like Kufri Jyoti, Kufri Megha, Kufri Kanchan and Kufri Giriraj for main/autumn crops		
3.	**Seed source**		
	Seed should be procured from a reliable source, preferably from a Government agency., It IS better to replace the seed every 3-4 years,		
4.	**Seed size**		
	Best seed size for raising summer and autumn crops IS 40-50 g.		
5.	Seed' **preparation**		
	Seed from the previous year's harvest should be kept in seed trays or baskets or spread out on the floor or on racks in) a store and, exposed to natural diffused light to ensure proper sprouting. Unsprouted and rotten tubers should be sorted out periodically. The sprouted seed tubers should be taken to the fields in trays for planting to minimize sprout damage. Seed should not be kept in gunny bags up to one month before planting to avoid development of lanky, fragile and etiolated sprouts, and need to be shifted in trayson floor in diffused light.		
6.	**Planting time**		
	Planting time- Early crop- 25th sep to 10th oct, Main crop- 15th oct to 25th oct, Hills- Mar-Appril at High alt		
7.	**Manures and Fertilizer**		
	Apply 100 q/ha *farm* yard manure In furrows before planting N @ 100-120, P @ 60-80, K @ 100-120 kgs.		
8.	**Method of planting**		

	Make furrows against the slope keeping 50 cm distance between the rows. It is important to make the furrows and ridges against the slope to avoid soil erosion. Place the large size tubers in furrows in upper side of the field slope and small tubers in downward side slopes at 20-25 cm distance between, the tubers depending upon seed size. Cover the. seed tubers with soil immediately after planting, making an edges to a height of 8-10 cm.		
9.	**Water Management**		
	8-12 irrigation is necessary		
10.	**Intercultural operations,**		
	Weeding should be done as soon as the weeds appear.		
	The final earthing up should be done when the plants are 10-15 cm high.		
	While earthing up, the remaining dose of nitrogen (25 kg/ha in seed crop and 50 kg/ha in ware crop) should be applied.		
	Use herbicides like metnbuzln @ 0.7 kg/ha (1.0 kg ha) as pre emergence or paraquat @.0.5 kg/ha (2.5 litre Gramaxone) as post-emergence treatment at about 5% emergence of potato plants for effect we control of the weeds in potato crop		
11.	**Plant protection measures**		
	Potato tuber moth (PTM) damages the potato both in the field and store hence, Integrated Pest Management (I PM) schedule as under may be practiced.		
	Fields: Use healthy seed potatoes for planting		
	Deep planting (10 cm) or more with proper earthing and timely irrigation,		
	Instalation of PTM sex pheromones traps @ 20 traps/ ha for mass traping of male moths,		
	Spraying crop with microbial agent~ like *Bacillus thuringiensis* (Bt) WG @ 300 gm/ha, Granulosis Virus (GV) @ 2 larval equivalent (LE) liter of water and monocrotophos 40 WSC @ 005% cone., alternately on **PTM** appearance.',		
	If possible, inoculation release of potential parasitoids *ie. Copldosoma koehlen* or *Chelonus blackburm,* in potato fields during pest build Gp stage		
	Proper sanitation viz. removal of left over tubers, volunteer plants and alternate host' plants ;from and the vicinity of the crop		
	Sores: Provide 2·3 cm thick layers of chopped leaves of *Lantana* sp, *Eucalyptus*sp in the stored potatoes.		
	Install **PTM** sex pheromone traps @ 4 trap/100 m store area		
	Use GV formulation (to prepare 1 kg formulation, mix, 1 kg talc powder in one litre of water + 20 GV infected **PTM** larvae + 5 ml tnton in the shade to make the formulation In to dust form) 5 kg of 'GV formulated dust is sufficient for one ton of potatoes,		
	Soil pests*viz.* white grubs *Brahmma (Lachnoslema)* coriacea and *H. longlpennis;* cutworm *Agrotis segeturn* and *A'. Ipsi/on* and red ants *Dorylus onentalis* cause moderate to 'heavy damage to potato tubers. These pests are manageable by adopting following I **PM** schedule In the potato fields		
	Timely planting and harvesting of potato crop.		

	Two sprayings with chlorpyrifos 20 EC @ 2.5 liter/ha alone or alternately with bioagent *Beauvena bassiana* (1 % conc.) first after observing 2% plant curl and second on' the appearance of while grub beetles		
	Removal of alternate/collateral hosts of beetle (white grub) from potato crop		
	2-3 ploughing before planning and after harvesting to expose the immature stages of white grubs should be done for natural mortality· and for predatloi1 v. Spraying the beetle hosts and bunds with endosulfan 35 EC @ 0 05% concentration.		
	Control of fungal and bacterial diseases: In the north eastern hili region, fungal diseases such as late blight, phoma and early blight damage the potato crop severely. In North eastern hills the environmental conditions remain congenlai for late blight development throughout the crop season. It is not sufficient to use only contact fungicides like mancozeb but for the proper and effective management, following integrated steps should be taken:		
	Grow only late blight resistant varieties recommended for the region namely Kufi Giriraj, Kufi Megha, Kufi Jyoli and Kufi Kanchan (red tubers)		
	Seed potatoes should be checked thoroughly before storage		
	All blight affected tubers must be removed and buried deep In the soil. Sort out the tubers showing disease symptoms once again before planting to reduce the further crances of disease spread. As far as possible, seed 'should be taken from disease free fields		
	Ridges should be maintain high enough to cover daughter tubers and reduce chances of their infection upon exposure.		
	As soon as the weather becomes congenial for late blight appearance (temperature 10-20'C, RH>80%), the crop should be sprayed with 0,2% mancozeb (2 kg of mancozeb per ha of crop/2 g of mancozeb per liire of water) A sticker like Triton AE (0.1 %; 1 ml of ,Triton AE in one litre of water) must be mixed with the fungicide solution. Subsequent sprays depending upon the weather condition)[1s should be applied at 8 days interval till crop maturity 2nd alternatively, systemic fungicide like metalaxyl (Ridomil MZ 0.25% or 2.5 kg of Rldomll per liter or,2 5 g' of Rldomil per litre of water) may be sprayed alternating it with mancozeb, A total of four sprays (two 'each of mancozeb and Ridomil MZ) are sufficient Since the effect of Ridomilasts for two weeks, mancozeb should be applied only 15 days after the Ridomil application		
	Sprays on the resistant varieties like Kufri Glnraj, Kufri Megha and Kufri Kanchan should be need based to avoid 'misuse of chemicals		
	When 75% crop foliage is killed by late' blight, the haulms should be cut and removed from the field and buned deep in the soil		
	Harvest the crop 15-20 days after haulms cutting or when the skin has become firm, sori out' the late blight infected tubers and store the seed after treating it with 3% bonc acid (30 g per litre of water) This Will also help to check some other tuber borne diseases		
	For the effective management of early blight caused by *Alternaria solani* and leaf spots caused by Phoma spp., following integrated, management practices should be adopted, ✓ The crop must be given balanced doses of fertilizers, especially nitrogen because the incidence and seventy of these diseases are generally high in the crop receiving imbalanced doses of fertilizers, particularly low doses of nitrogen.		

	Spray of 1.0% urea (10 g per litre of water) at 45 days of crop grow1h and subsequent spray after 8-10 days may easily escape the severe onslaught of these diseases		
	Fungicidal sprays are effective in controlling early blight and other leaf spots. Mancozeb (0.2%) and Copper Oxy chloride (0.3%) recommended for· the control of late blight can take care of early blight and leaf spots.		
	Avoid cultivation of solanaceous crops like tomato, brinjal, chillies, *etc.* nearby potato fields because these crops are the collateral hosts of the pathogens causing early blight, brown rot and leaf spots.		
	Fields should be kept neat and clean, free from weeds.		
	Brown rot 'is another Important disease in North-eastern hill region. Infected seed tubers and Soil are the primary sources of infection carrying the bacterium from one season to another. For its integrated management following practices should be followed: ✓ Healthy seed free from brown rot pathogen should be used for planting		
	The seventy of the diseases can be reduced by planting the crop between the second weeks of February to first week of March and harvesting before first week of June.		
	Apply bleaching powder @ 12 kg/ha mixed with fertilizer in furrows at planting		
	The incidence of this disease can also be reduced by adopting crop rotation with maize, finger millet, cereals, garlic, onion *etc.*		
	Besides late blight, early blight, *phoma* leaf spots and brown rot, other soil and tuber borne diseases are also common in potato, though these are of minor significance for the North eastern region. They can be successfully managed by adopting the following integrated management schedule. Treat seed potato with 3% bonc acid (30' g per litre of water) for 30 minutes		
	Do not grow potato every year in the same field		
	Rotate, it with the crops like cereals, maize, millets and not solanaceous crops. Follow hot weather cultivation in plains and plateau and cold weather cultivation in the hills.		
	Avoid Injuries to the tubers during harvest, handling arid transportation.		
9.	**Harvesting**		
	Crop should be harvested soon after its maturity. Preferably, harvesting should be done on bright sunny days. All the damaged and rotted tubers' should be sorted out and marketable tubers should be graded in different size, packed in gunny bags and kept in cool place till it is marketed		
10.	**Yield**		
	300-400 quintals/ ha		
11.	**Seed Production**		
	If the seed crop is to be grown, the following extra, steps should be followed in addition to the above practices: ✓ Select such fields which are either free from brown rot pathogen or have minimum inoculum in the field.		
	Apply bleaching powder @ 12 kg/ha. at the time of land preparation to manage the Inoculum of brown rot pathogen		

	✓ Use properly sprouted seed only. Do not cut the tubers		
	✓ Adopt plant protection measures' against foliar diseases		
	✓ Apply a granular systemic insecticide such as phorate 10 G @ 10 kg/ha at the time of planting to prevent infestation of aphid vectors, Spray the crop with imldachloprid (Confldor) @ 400 g/ ha in 1000 liters water where the aphid count reaches2 aphids/1 00 compound leaves. This happens usually by the' first week of May in hills and middle of December in plains. Repeat the spray at 10-15 days interval based on the aphid population build-up in the crop and cut the haulms when its population reaches 20 aphids l100 compound 'leaves.		
	✓ During the growing season, the seed plot should be, inspected twice or thrice to remove all off-type and plants showing mottling, mosaic, crinkle, necrosis and leaf roiling symptoms. The first Inspection may be done 'when the plants 'attain' 10-15 cm height (40 days) and 'the second at flowering stage (60 days):		
	✓ During the later stages of the crop (75 days old, crop), if plants show any symptoms of purple top roll, they should ,be also removed along With the, mother and daughter tubers.,		
	✓ At the time, the' crop also starts maturing cut haulms and do not left as such in the field. Ensure that there is no regrowth of stems as tender and succulent leaves are more' attractive to the aphids.		
	✓ Harvest the crop when tile, skin of the tubers has become firm Harvesting is best' done on sunny days. Heap the produce in shade for cunning of skin and the heap is left undisturbed for 15-20 days Sort ,out the infected tubers and grade them according to their sizes, preferably into four grades-small, medium, large' and extra-large depending upon their weight, and diameter.		

IV. ATTITUDE TOWARDS SUSTAINABLE POTATO FARMING

SL	Statements	SA	A	UD	DA	SDA
1	Sustainable potato farming increase overall production without much financial burden					
2	Sustainable farming helps to increase farm income for sustainable livelihood					
3	Sustainable farming helps towards a secured occupation					
4	More and more farmers should undertake sustainable potato farming practices					
5	Potatoes produced by following sustainable potato farming practices has better keeping quality than that produced from traditional methods					
6	Sustainable potato farming is a profitable venture as compared to other farming in the longer run					
7	I go for scientific land management for sustainable potato farming					
8	I prefer to participate in soil and water conservation activities in relation to promote sustainable potato farming					
9	Green leaf manuring and green manuring in-situ are advised to enhance the soil fertility for sustainable potato farming					
10	Sustainable potato farming is better in promoting soil and water conservation measures than the traditional methods					
11	Sustainable management of potato pest and disease helps in maintaining ecological balance					

12	Sustainable nutrient management of potato farming increase the cost					
13	It is preferable to adopt sustainable potato farming practices than traditional methods					
14	Sustainable potato farming helps towards generation of farm employment					
15	Sustainable farming helps in increased economic status of farmers					
16	A farmer should practice sustainable potato farming as it is helpful in improvement of microclimate and the ecological balance					
17	Sustainable potato farming use locally available materials so management is quite easy					
18	Input requirements are high for sustainable potato farming					
19	Sustainable potato farming is difficult to practice					
20	I feel there is an important reason for judicious use of the resources like soil, water and vegetation for sustainable potato farming					
21	Incidence of pest and disease attack is considerably reduced in by following sustainable potato farming practices					

V. <u>SUSTAINABILITY OF POTATO FARMING PRACTICES – SUSTAINABILITY INDEX</u>

A. Economic sustainability

5.1 Productivity:

Can you please recall the total quantity of yield produced on your farm during the last 3 years?

Items	2016	2017	2018
Area under potato cultivation			
Production			

5.2 Dependency on external labour:

Sl. No.	Number of labour hired (Male & female)	Charge of labour/day	Total working days	Total cost (Rs.)
1				
2				
3				
4				
5				

5.3 Mandays generated

Sl. No.	Category	Mandays of employment/annum
1.	Male	
2.	Female	

1.4 Debt/Loan: Are you availing any loan from any banks for potato cultivation? Y/N

B. Social sustainability

Sl. No.	Statements	Yes	No
1.	Formation of SHG		

	a. Are you a member of any SHG?		
	b. Are you actively involved in the activities of your SHG?		
2.	Formation of Co- operative societies		
	a. Are you a part of any co-operative societies?		
	b. Are you actively involved in the activities of your society?		
3.	Formation of FPOs		
	a. Are there any FPOs in your locality?		
	b. Are you a member of the FPO?		

2. 1 Marketing linkages

a. Do you follow proper marketing linkages? Yes: _____ No: _____
b. Do you sell your produce yourself? Yes: _____ No: ______ (if yes, price per kg or per fruit__)
c. Do you sell your produce through middleman? Yes: ___ No: ___ (if yes, price per kg or per fruit: _________)
d. Do you sell your produce directly to wholesaler? Yes : ___ No: ____ (if yes, price per kg or per fruit: _________)

2. 2 Satisfaction from the crop enterprise: A-Always S-Sometimes N-Never

Sl. No.	Statements	If Yes			No
		A	S	N	
1.	Do you get economic satisfaction as a result of engaging in potato cultivation?				
2.	Do you get socially recognized as a result of engaging in potato cultivation?				

2. 3 Human Development Index/ Quality of life

Sl. No.	Statements	Yes	No
1.	Are you able to utilize the profit from potato cultivation to pay your home expenses?		
2.	Are you able to send your children to school with the profit earned from potato cultivation?		
3.	Are you able to afford food for your family whole year round?		
4.	Are you able to provide nutritious food to your family?		
5.	Are you able to provide facilities such as farm machineries, television, radio, mobile phones, etc both in the farm and at home?		

2. 4 Gender roles in farming

Participation and decision making pattern of women in sustainable potato cultivation practices

Sl. No.	Practices	Participation of women	Process of decision making					Does by consulting husband
		Yes/No	Herself	Husband alone	Husband & wife together	With relatives	Based on recommendation of Govt/KVK	Always/ ST/Never
1.	Land preparation							
2.	Selection of varieties							
3.	Selection of good sucker for planting							
4.	Sowing time							
5.	Sowing method							
6.	Seed rate/acre							
7.	Planting material treatment							
8.	Depth of seeding							
9.	Spacing							
10.	Irrigation							
11.	Mulching							
12.	Weeding							
13.	Earthing							
14.	Plant protection measures							
15.	Harvesting							
16.	Grading							
17.	Packaging							
18.	Value addition							

19.	Transportation							
20.	Marketing							
21.	Seed storage							

2. 5 Access to latest knowledge of sustainable potato cultivation practices

Sl. No.	Are you getting any information/knowledge on sustainable potato cultivation practices from	Yes	No	If yes, how many times during the last 5 years
1.	Extension agencies from Horticulture department			
2.	KVK			
3.	ATMA			
4.	CIH			
5.	Farmers' Association			
6.	Mass media (Newspaper/ Television/Magazine/ SMS/ Mobile apps			
7.	Training/ Seminar/ Workshop/ Field trip			
8.	Friends			
9.	Neighbours			

C. Environmental sustainability

3. 1 **Soil organic matter**

Do you apply organic matter in your field for sustainable potato cultivation? Yes/ No

If yes, which of the following do you use?

Sl. No.	Type of organic matter	No of times applied in a season	Total amount applied (kg/bigha)
1.	Cowdung manure		
2.	Mulches made of dried leaves and paddy straw		
3.	Poultry litter		
4.	Vermicompost		
5.	Green manure or compost		
6.	Neem oil cake		
7.	Others		

3. 2 Water conservation measures:

Do you conserve water for irrigation purposes? Yes/ No, If yes, which of the following means do you practice?

Sl. No.	Conservation measures	Yes	No
1.	Harvest rainwater		
2.	Set up well in the field		
3.	Set up bore well in the field		
4.	Source out water from nearby stream/ river		
5.	Store water in Jalkhund/pond/tank		
6.	Others		

3. 3 Drainage system

Do you maintain drainage system in your field to prevent stagnation of water? Yes/ No

3. 4 Soil erosion

Sl. No.	Statements	Yes	No
1.	Do you prepare proper trenches in your field to prevent soil erosion?		
2.	Do you construct proper trenches in your field?		
3.	Do you leave crop residues on the soil surface after harvest to conserve the soil?		
4.	Do you mulch with black polythene to prevent soil erosion?		
5.	Do you mulch with black dry leaves and grasses to prevent soil erosion?		
6.	Do you plant trees/shrubs surrounding your field to decrease the magnitude of splash erosion?		

3.5 Biodiversity in field

Sl. No.	Statements	Yes	No
1.	Do you preserve beneficial insects like ladybird, bees, spider, etc in your field?		
2.	Do you plant beetle nut trees, neem trees and other herbaceous trees surrounding your potato field?		

3.6 **Use of chemical fertilizers**

Do you apply chemical fertilizers in your field during potato cultivation? Yes/No

If yes, give the following details:

Sl. No.	**Fertilizers**	**Dosage**	**No. of times applied**
1.	Ammonium sulphate		

2.	Ammonium phosphate		
3.	Ammonium nitrate		
4.	Ammonium chloride		
5.	Any other		

3. 7 Use of pesticide/fungicide/herbicide/insecticide

Do you apply pesticide/insecticide in your field during potato cultivation? Yes/No

If yes, give the following details:

Sl. No.	Pesticide/fungicide/herbicide/insecticide	Dosage	No. of times applied
1.			
2.			
3.			
4.			

3. 8 Use of fuel/ power/energy

Total amount of money spend on purchase of fuel during potato cultivation: ____________

3. 9 Crop rotation

Do you practice crop rotation in your potato field? Yes/ No

If yes, which are the crops used in crop rotation? ____________________________

3. 10 Integrated Nutrient Management (INM)

Do you practice INM during potato cultivation? Yes/ No

If yes, which of the following are used by you in your potato field?

Sl. No.	**Nutrients**	**Dosage**	**No. of times applied**
1.	Urea		
2.	DAP		
3.	Superphosphate		
4.	Rock phosphate		
5.	Murate of potash		
6.	Farm Yard Manure		
7.	Vermicompost		
8.	Oil cakes (Neem, castor)		
9.	Green manuring (cowpea, sunhemp, etc)		

10.	Biofertilizers (azotobacter,		
11.	Azolla		
12.	Any other		

3. 11 Integrated Pest Management (IPM)

For pest management, do you practice Integrated Pest Management (IPM)? Yes/ No

If yes, do you follow the following and give details.

Sl. No.	Management	Yes	No	If yes, no of times practiced in season/ Dosage
1.	Weeding			
2.	Infected plants and plant parts removed			
3.	Cover crops are planted			
4.	Rat traps and sticky insect traps are prepared			
5.	Cowdung slurry, neem cake/ tobacco solution is prepared			
6.	Drainage system is well maintained			
7.	Suckers are treated with trichoderma			
8.	Trap crops are planted			
9.	Any others			

3. 12 Recycling of nutrients

Do you recycle the waste in your field? Yes/No

If yes, do you follow these practices?

Sl. No.	**Practice**	**Yes**	**No**	**If no, why**
1.	Setting up vermicompost pit			
2.	Setting up compost pit			
3.	Farm Yard Manure (FYM) is prepared			
4.	Potato leaves are used as mulch			
5.	Dry leaves and grasses, paddy straw, weeds are used as mulches			
6.	Poultry litter is utilized as manure			
7.	Any others			

VI. TO EXAMINE THE ENTREPRENEURIAL BEHAVIOUR OF THE POTATO FARMERS

Entrepreneurial behaviour

i. Innovativeness

Sl. No.	Statements	SA	A	UD	DA	SDA
1.	I am very much interested in adopting improved varieties of the horticultural crop.					
2.	Since I am not sure of success of new varieties of the crop, I would like to wait till others adopt.					
3.	Since new variety of the crop is not profitable, I am not interested in it.					
4.	I try to keep myself well informed about any new variety of the crop and try to adopt as soon as possible.					
5.	New varieties of the crop are not easily adoptable and hence I do not adopt.					

ii. Management Orientation

Sl.	Statements	SA	A	UD	DA	SDA
1.	Everyone should think about the income generating activity available to the local areas					
2.	The amount of inputs needed for the economic activity should be assessed well in advance.					
3.	It is not necessary to make prior decisions about the steps to be followed in taking up economic activity					
4.	It is not necessary to think ahead the total cost involved in starting income generating activity.					
5.	One should not consult experts and experience persons for planning the economic activities					
6.	It is possible to increase the returns through production plans					

iii. Decision making ability

Sl. No.	Decision criteria	Not considered	Considered after consulting others	Considered independently
1.	Selection of suitable potato variety			
2.	Land management practices			
3.	Insurance crops			
4.	Applying new practices, ideas, technologies			
5.	Nutrient and irrigation management practices			
6.	Using suitable plant protection measures			
7.	Timely harvest and marketing			
8.	Post-harvest management			

iv. Economic motivation

SL	Statements	SA	A	UD	DA	SDA

1.	A farmer should work towards larger yields and economic profits					
2.	The most successful farmers is one who makes the most profit					
3.	A farmer should try any new farming idea which may earn him more money					
4.	A farmer should grow cash crops to increase monetary profits in comparison to growing of food crops for home consumption					
5.	It is difficult for the farmers children to make good start unless he provides them with economic assistance					
6.	A farmer must earn his living but the most important thing in life cannot be defined in economic terms					

v. Risk taking ability

Sl. No.	Statements	SA	A	UD	DA	SDA
1.	A farmer should grow large number of crops to avoid greater risks involved in growing one or two crops					
2.	A farmer should rather take more of a change in making a big profit than to be content with a smaller but less risky profits					
3.	A farmer who is willing to take greater risks than the average farmer usually have better financial condition					
4.	It is better for a farmer not to try new farming methods unless most other farmers have been used them with success					
5.	Trying an entirely new method in farming by a farmer involves risk, but it is worth					

vi. Achievement Motivation

Sl. No.	Statements	SA	A	UD	DA	SDA
1.	Work should come first even if one cannot get proper rest in order to achieve ones goals					
2.	It is better to content with whatever little one has, than to be always struggling for more					
3.	No matter what I have done, I always want to do more					
4.	I would like to try at something which is really difficult even it proves that I cannot do it					
5.	The way things are now-a-days, discourage one to work hard					
6.	One should succeed in occupation even if one has to neglect his family					

vii. Scientific Orientation

Statements		Continuum			
	SA	A	UD	DA	SDA
1. Scientific methods always confuse me.					
2. Application of scientific methods is wastage of time.					
3. Scientific techniques damage the ecology.					
4. Profitable agricultural production is possible through scientific technique.					
5. I prefer scientific techniques of potato production.					
6. Scientific technique require high infrastructure.					
7. New methods of farming gives better results to a farmer than the old					

method.					
8. The way farmer’s forefathers practiced agriculture is the best way even today.					
9. Even a farmer with lots of experience should use new method in agriculture.					
10. Though it takes time for a farmer to learn new methods, it is worth the effort.					
11. A good farmer experiments with new ideas.					
12. Traditional methods in farming have to be changed in order to raise the level of living a farmer.					

VII. TO IDENTIFY THE CONSTRAINTS BEING FACED BY POTATO GROWERS AND SUGGEST APPROPRIATE STRATEGIES TO OVERCOME THEM

Constraints	**Major constraint**	**Moderate constraint**	**No constraints**	**Suggestins to overcome**
I. Production Constraints				
1. High cost of input				
2. Lack of knowledge regarding pest and diseases				
3. Lack of knowledge on balanced fertilizer application				
4. Lack of input(seed, Fertilizer) supply				
II. Financial Constraints				
1. Inadequate credit				
2. Inadequate subsidy				
3. High interest rate				
4. Insufficient repayment time				
5. Lack of own resource				
III. Institutional constraints				
1. Lack of cooperation				
2. Lack of support from agricultural department				
3. Lack of SHG				
IV. Situational constraints				
1. Distant location of market				
2. Distant location of land				
3. Poor transport facility				
V. Infrastructural constraints				
1. Lack of availability of land				
2. Lack of established structure for livestock				
3. Lack of tools and implements				
4. Lack of irrigation facilities				
VI. Technical constraints				
1. Lack of mechanization				
2. Unavailability of new				

technology				
3. Wild animal threats				
VII. Extension constraints				
1. Inadequate training / No training				
2. No or very few visit of extension personnel’s				
3. No Demonstration for new practices				
VIII. Marketing constraints				
1. Marketing middleman				
2. Surplus production				
VIII. **Storage constraints**				
1. Lack of proper storage facilities				
2. Storage loss				

PLATES

Plate 1: Potato production activities in Assam

Plate 2: Potato production activities in Meghalaya

Plate 3: Potato production activities in Nagaland

Plate 4: Potato production activities in Tripura