PATTERN OF AGRICULTURAL DEVELOPMENT IN MAT RIVER BASIN

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She has fulfilled all the requirements laid down in the Ph. D. regulations of the Mizoram University. The thesis is the result of her investigation into the subject. Neither the thesis as a whole nor any part of it was ever submitted to any other University for any research degree.

I also want to state here that all the experts' comments and suggestions have been incorporated in the Thesis.

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Chapter 1

Introduction

The term Agriculture has been derived from Greek words ‘Ager’ and ‘Cultura’ which means to cultivate. Agriculture has been started around one million years ago. Human has been food gatherer for time immemorial. With the help of axes, horns and other tools man killed animals and gather vegetables from nearby forest. The condition of man used to be very primitive, but the introduction of cultivation enables him to have a permanent home. Thus, Agriculture is the cultivation of plants and animals. Agriculture thus becomes the basic activity for livelihood around the globe. Agriculture has been a cornerstone of human civilization for thousands of years, providing sustenance, raw materials, and economic opportunities to communities worldwide. Scholars like Pretty (2018) have extensively studied the significance of agriculture in sustaining global food security, promoting economic development, and shaping cultural practices. Agricultural practices have evolved over time, with advancements in technology and science leading to increased productivity and efficiency. However, the modernization of agriculture has also raised concerns about environmental sustainability, resource depletion, and social equity. As the world faces challenges like population growth, climate change, and limited natural resources, the importance of promoting sustainable agriculture has become increasingly apparent. Sustainable agricultural practices, such as organic farming, agroforestry, and precision agriculture, are gaining traction as viable alternatives to conventional methods. Furthermore, the integration of modern technology, data analytics, and biotechnology in agriculture is offering promising solutions to address global food demands while minimizing environmental impacts. Overall, agriculture remains a dynamic and critical sector that requires continuous research, innovation, and policy support to ensure food security, environmental preservation, and improved livelihoods for communities worldwide.

Agriculture largely impacts the social life of the people as it influences the mind-set and controls the social life of the people therein. The schedule of Agricultural and non- agricultural countries is quite distinguishable. However, no country can sustain their economy without agriculture. Further, mineral rich countries and non-agricultural countries also need to import agriculture products to sustain their livelihood. Thus, agriculture plays a vital role in the sustenance of livelihood. One third of the available workforces engaged in agricultural activities around the globe. Agriculture is a fundamental pillar of human civilization and plays a vital role in supporting the growing global population by providing food, fibre, and other essential resources. Scholars like Tilman et al. (2011) have highlighted the paramount importance of agriculture in sustaining human livelihoods and ensuring food security. Agriculture not only fulfils basic human needs but also serves as an economic driver, contributing significantly to the GDP of many nations and providing employment for a substantial portion of the workforce. Additionally, agriculture is closely interlinked with rural development, poverty alleviation, and social stability, particularly in developing countries where a large proportion of the population depends on farming for their subsistence. Moreover, agriculture has implications for the environment, as it involves land use, water management, and biodiversity conservation. Sustainable agricultural practices are critical for safeguarding natural resources, mitigating climate change, and promoting environmental well-being. In the face of the global challenges posed by climate change, rising populations, and resource constraints, agriculture's importance has become even more pronounced as efforts are made to enhance productivity while minimizing environmental impacts.

A method of agriculture that avoids synthetic chemical inputs, genetically modified organisms, and focuses on enhancing soil health and biodiversity through practices like composting, crop rotation, and natural pest control (Lampkin & Padel 1994). The artificial application of water to crops to supplement rainfall and ensure sufficient moisture for proper plant growth, especially in arid or semi-arid regions (FAO 1992). The achievement of Green Revolution has largely improved the production of food grains adding the importance of Agriculture sector in the World’s economy. A holistic approach to managing pests and diseases that combines multiple strategies, such as biological control, cultural practices, and judicious use of pesticides, to minimize environmental impacts and maintain pest populations at acceptable levels (IPM 1996). In many places of the world part –time farming plays a major role in economic activities. The systematic planting of different crops in sequence on the same piece of land to maintain soil fertility, prevent pest and disease buildup, and improve overall crop yields. (Bongiovanni & Lowenberg-DeBoer 2004). A conservation agricultural practice that involves minimal soil disturbance by avoiding plowing and leaving crop residues on the field to protect soil structure and reduce erosion (Derpsch, Friedrich, Kassam, & Hongwen, 2010).

Agricultural development refers to the process of improving and transforming agricultural practices, technologies, and systems with the aim of increasing agricultural productivity, enhancing food security, promoting rural livelihoods, and fostering sustainable and equitable growth in the agricultural sector (World Bank 2007). It refers to the continuous process of enhancing agricultural practices, technologies, and systems with the goal of increasing agricultural productivity, sustaining the livelihoods of farmers and rural communities, and ensuring sustainable and efficient use of natural resources. Hazell, Poulton, Wiggins, & Dorward 2010). Agricultural development, in the global context, refers to the process of enhancing and transforming agricultural practices, technologies, and systems on a global scale to achieve sustainable food security, improve rural livelihoods, and address broader socio-economic and environmental challenges related to agriculture (Fan & Pandya 2012). It aims to improve agricultural productivity, increase food production and availability, alleviate poverty and hunger, enhance rural livelihoods, and promote economic growth and environmental sustainability in the agriculture sector (FAO 2018).

Agriculture has been the backbone of India's economy for centuries, employing a significant portion of the population and contributing significantly to the country's GDP. Over the years, the Indian government has implemented various policies and initiatives to promote agricultural development, enhance productivity, and improve the livelihoods of farmers. These efforts include investments in irrigation infrastructure, the promotion of modern agricultural practices, the adoption of advanced technologies, and the introduction of agricultural subsidies and financial support. The Ministry of Agriculture and Farmers' Welfare plays a crucial role in formulating and implementing these policies to support the growth of the agricultural sector. Through these measures, India aims to achieve food security, boost rural prosperity, and contribute to overall economic growth (MAFW Report 2019). Agriculture Development is a vital sector that sustains the livelihoods of a large proportion of the population and remains central to the country's economic growth. It encompasses a diverse range of crops, including rice, wheat, pulses, sugarcane, cotton, and more. This sector faces various challenges, such as fragmented landholdings, water scarcity, post-harvest losses, and dependence on monsoons. To address these issues, the government has implemented schemes and policies, focusing on irrigation, technology adoption, market access, and farmer welfare. Additionally, the Green Revolution and subsequent agricultural advancements have significantly boosted productivity. Despite its achievements, India's agriculture requires continued attention and innovation to ensure food security, enhance farmer incomes, and promote sustainable practices (Ashok & Saini 2014)

India is an agricultural country. It has a vast cultivable land. Agriculture in Northeast India is characterized by its unique agro-climatic conditions and diverse cropping patterns. The northeastern region (NER), comprising eight states, namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura, has a significant agrarian population that heavily relies on traditional farming practices. Paddy cultivation is prevalent in the low-lying areas, while horticulture and floriculture are gaining prominence in the higher altitudes. The governments at the state and central levels have been actively promoting agricultural development in the region through various policies, subsidies, and initiatives aimed at enhancing productivity, improving rural infrastructure, and encouraging sustainable farming practices. Despite the challenges posed by limited access to modern technologies, fragmented landholdings, and inadequate market linkages, the region's agriculture sector shows immense potential for growth and prosperity (Rajeshwari & Mirdha, 2013). It occupies about 45% arable fertile land. It has 39 million populations of which 75% are engaged in agriculture (Census, 2011). The NER is backward in terms of Economic development. Still agriculture activities turn out to be the major economic activity. The yield per hectare is lesser as compare to the main land. But they are still agrarian economy so development of agriculture is very important for the overall development of the region. The total geographic area of north east is 262, 230 sq. km. Agricultural land and fallow land accounts for 22.20%. The total cultivators accounts for 41.6% and agriculture labour accounts for 13.07% adding all the workforce who engage in agricultural sector, they form most of the workforce. Scholars like Lyngdoh and Bhatnagar (2017) have emphasized the need for sustainable alternatives to shift away from jhum cultivation and conserve the region's delicate ecosystem. Nevertheless, due to the socio-economic factors and traditional beliefs tied to the practice, finding viable solutions that balance ecological preservation and livelihood concerns remains a complex challenge in the North East Indian context. In Northeast India, where shifting cultivation (jhum) has been the dominant agricultural system, there is increasing interest and efforts to transition towards more sustainable and permanent farming practices. Scholars like Das et al. (2019) have highlighted the potential of permanent agriculture in the region to enhance food security, conserve natural resources, and mitigate environmental degradation. The adoption of permanent agriculture, such as terrace farming and agroforestry, can help prevent soil erosion, maintain soil fertility, and reduce the pressure on forested lands caused by shifting cultivation. However, the transition poses socio-economic challenges, as it requires addressing land tenure issues, providing alternative livelihood opportunities, and promoting awareness among farmers about the benefits of permanence. Thus, the shift towards permanent agriculture in Northeast India necessitates a multi-dimensional approach that considers the ecological, social, and economic aspects to ensure its successful implementation and sustainability.

Agriculture development in Mizoram has been a focus area for the state government, given its significance in the state's economy and livelihoods (Sati, 2018,2022). Mizoram's unique agro-climatic conditions provide opportunities for the cultivation of various crops, including rice, maize, pulses, fruits, and vegetables. The government has implemented policies and initiatives to promote sustainable farming practices, improve agricultural productivity, and enhance farmers' incomes. Efforts have been made to provide farmers with access to modern agricultural inputs, technology, and market linkages. Mizoram's agriculture is a critical component of the state's economy, providing livelihoods to a significant portion of the population and contributing to its overall growth. Scholars like Zothanpuia et al., (2020) have studied the agricultural practices in Mizoram and emphasized the importance of traditional farming systems like shifting cultivation (jhum) and terrace farming. Shifting cultivation has been a prevalent practice among indigenous communities in Mizoram, but its sustainability has been a subject of debate due to concerns about deforestation and soil degradation. In response to these challenges, there has been a growing interest in promoting sustainable agriculture, including the adoption of terrace farming and the cultivation of cash crops like oranges, bananas, and spices. The state government's initiatives to provide support and incentives for adopting modern farming techniques have played a crucial role in diversifying the agricultural landscape and improving farmers' livelihoods. However, the transition from traditional practices to sustainable modern agriculture requires careful consideration of socio-economic factors and cultural sensitivities. Therefore, further research is needed to assess the effectiveness of these initiatives and ensure the long-term sustainability of agriculture in Mizoram. Moreover, horticulture and floriculture have been encouraged to tap into the state's potential for producing high-value crops. To ensure a holistic approach, steps have been taken to address land-related issues, water management, and the conservation of natural resources. By supporting agriculture in Mizoram, the state aims to achieve food security, rural prosperity, and overall economic growth (Mizoram State Agricultural portal 2023).

The state of Mizoram practices both Shifting and permanent agriculture. The arable land is only about 5%, of which more than 50% arable land is under shifting cultivation. Shifting cultivation is rain-fed practiced in the sloppy forest areas, therefore, the production and the yield of crops is significantly low. On the other hand, permanent agriculture is practiced in the valley fills and flood plains is irrigated the thus the yield of crop is high. In the meantime, the area under permanent agriculture is less. The main crop grown under permanent agriculture is paddy/rice. On the other hand, under shifting cultivation, the crop diversity is high as many crop cultivars/races are grown together. But the consumption is domestic and even not sufficient to meet the daily food requirement. Mizoram has been characterized by steep slopes, rough and rugged topography, about 86% are forest cover (FSI 2019). Mizoram, a hilly state in Northeast India, has recognized the significance of watershed development in promoting sustainable agricultural practices and environmental conservation. Various watershed development programs have been initiated to address soil erosion, water scarcity, and land degradation. Scholars like Lalrinpuia et al. (2020) have studied the impact of watershed management interventions in Mizoram and found that such initiatives have led to improved soil and water conservation, increased agricultural productivity, and enhanced livelihood opportunities for local communities. The adoption of techniques like contour bunding, terracing, and agroforestry has been instrumental in mitigating the adverse effects of shifting cultivation (jhum) and promoting soil moisture retention. Additionally, the participatory approach involving local communities in planning and implementation has ensured the sustainability and success of watershed development projects in Mizoram. Nevertheless, challenges remain, including ensuring equitable access to resources, addressing the needs of marginalized communities, and managing external pressures on natural resources. The experiences and lessons learned from watershed development efforts in Mizoram can provide valuable insights for other regions grappling with similar environmental and agricultural challenges. Mizoram, a state known for its picturesque landscapes and hilly terrain, is blessed with abundant rivers and water bodies. River studies in Mizoram have gained importance in understanding the hydrological patterns, water availability, and environmental challenges in the region. Scholars like Lalrammawia et al. (2021) have conducted river studies in Mizoram to assess water quality, identify pollution sources, and evaluate the health of aquatic ecosystems. The state's rivers are not only crucial for water supply and agriculture but also support diverse flora and fauna. However, rapid urbanization, deforestation, and industrial activities have posed threats to river health and water quality. River studies in Mizoram have highlighted the need for sustainable water management practices and conservation efforts to safeguard these vital resources for present and future generations. The insights from river studies are essential for formulating effective policies and management strategies to ensure the ecological integrity and sustainability of Mizoram's rivers.

The Mat River is one of the prominent rivers of Mizoram flow through Aizawl, Serchhip, in the Mat River basin, agriculture plays major role in the society as it provides food and raw materials. It is the main driver for growth, development, and basic need to the present and for the next generation.

1.1. Statement of the Problems

Research problems form the foundation of any scholarly inquiry, guiding the identification and exploration of gaps in existing knowledge. Yin (2018) emphasize that well-defined research problems are essential for formulating clear research questions and objectives. By identifying specific research problems, researchers can focus their efforts on addressing relevant issues and contributing to the advancement of knowledge in their respective fields. Additionally, research problems play a crucial role in determining the study's scope, methodology, and data collection process, ensuring that the research remains focused and relevant. Moreover, a well-constructed research problem fosters critical thinking and creativity, encouraging researchers to devise innovative solutions and methodologies. Clear research problems also enhance the rigor and credibility of the study's findings, as they establish a coherent rationale for conducting the research. As a result, careful consideration and articulation of research problems are paramount to the success and impact of any research endeavor.

The Mat River Basin has rich agro-climatic conditions and fertile soil yet, the crop production and yield low. There are many drivers of low production and yield of crops, which includes, low innovation in the agricultural field, traditional method of practicing agriculture, and influence of the shifting cultivation. Meanwhile, rural livelihood mainly depends on agricultural practices, namely shifting cultivation and permanent cultivation. Since shifting cultivation is not viable – economically and environmentally therefore, alternative livelihood needs to be adopted in a sustainable manner and for sustainable agricultural development. River basin studies play a crucial role in understanding and managing the complex interactions between water resources, ecosystems, and human activities within a specific river basin. These studies involve a comprehensive assessment of hydrological, environmental, and socio-economic factors to develop sustainable management strategies for water resources. Scholars like Wohl (2017) have highlighted the importance of river basin studies in addressing issues such as water availability, water quality, flood control, and ecosystem health. By considering the entire river basin as a holistic unit, researchers can identify the interconnectedness of various components and anticipate the potential impacts of changes or interventions in one area on others. Moreover, river basin studies facilitate collaborative decision-making among multiple stakeholders, including government agencies, local communities, and environmental organizations, to ensure that water resources are utilized efficiently and equitably. With the growing challenges posed by climate change and increasing demands for water, river basin studies are becoming increasingly essential for sustainable water management and overall environmental well-being.

1.2. Research Questions

The formulation of clear and relevant research questions is essential for any study, as it lays the foundation for a focused and purposeful research process. Creswell and Creswell (2017) have emphasized that well-crafted research questions serve as a roadmap for the entire research endeavour, guiding the researcher's efforts in collecting and analysing data. Research questions act as a framework for structuring the study's objectives, methodology, and data interpretation, ensuring that the research stays on track and addresses the specific gaps in the existing knowledge. Additionally, research questions help in defining the scope of the study and narrowing down the research objectives, making the research more manageable and achievable. Moreover, a thoughtfully designed research question enhances the quality and validity of the study's findings, as it ensures that data collected are directly relevant to the research problem. It also facilitates communication with the academic community, enabling others to understand the study's purpose and significance. Overall, the importance of research questions lies in their ability to give a clear direction to the research, leading to meaningful and impactful outcomes. The following questions were raised during the study:

1. What is the impact of agricultural practices on socio-economic development of the Mat River Basin?

2. What is the impact of shifting cultivation on the environment?

3. What are the agricultural patterns in the Mat River Basin.

1.3. Objectives

The importance of research objectives lies in their role as a guiding framework for the entire research process. Kumar (2019) have emphasized that well-defined and clear research objectives provide a sense of direction to researchers, helping them focus their efforts and resources on specific goals. Research objectives not only outline the purpose of the study but also assist in formulating research questions, designing the study methodology, and interpreting the findings. They act as a roadmap, enabling researchers to stay on track and avoid wandering into unrelated areas. Additionally, research objectives enhance the credibility and rigor of the research by ensuring that the study's outcomes directly address the research problem. Moreover, transparently stating the research objectives facilitates effective communication with stakeholders, peer reviewers, and the wider academic community. Ultimately, the significance of research objectives lies in their ability to lend structure and purpose to the research endeavor, leading to meaningful and impactful outcomes.

1. To analyze the social, environmental, and economic factors influencing Agriculture Development in the study area.
2. To study the agricultural practices and their impact on socio-economic development.
3. To analyze pattern of agricultural production in relation to farm holdings.
4. To assess the pattern of agricultural development in relation to crop production and productivity.

1.4. The Study Area

The Study area, Mat River Basin is in the heart of Mizoram. It lies in the centre of Mizoram covering partially three districts – Aizawl, Serchhip, and Lunglei (Fig. 1.1). It borders with southern part of Aizawl district, Serchhip district and north Lunglei district. Mat River joins Kaladan River which is the largest river by volume near Mualthuam village from the right by 22°43’39’’ N and 92°54’46’’E. The total area of the Mat basin is 963.90 sq. km. The river basin covers partially three districts namely South Aizawl, Serchhip and North Lunglei respectively. In Topographical sheet (Survey of India) Mat River basin lies in five toposheets such as 84 A/14 , 84 A/15, 84 A/16,84 B/13 and 84 B/14. Mat river is south flowing river which stretch in North – South direction. It originates in Baktawng Tlang (1423m) and runs 102kms and joins Chhimtuipui (Koladyne) near Mualthuam Village at Lunglei district. The tributaries of Mat river are Lumtui Lui, Mangang Lui, Darnam Lui, Tuihmarlui, Nghatan Lui, Tuikhurlui, Marvate Lui, Pukpui Lui, Vanvate Lui, Saphat Lui, Thangnang Lui, Saitha Lui, Chawitui Lui, Belpui Lui, Lurhva Lui, Ngengpui Lui and other several small rivers. There are 24 villages and one town in the study area.

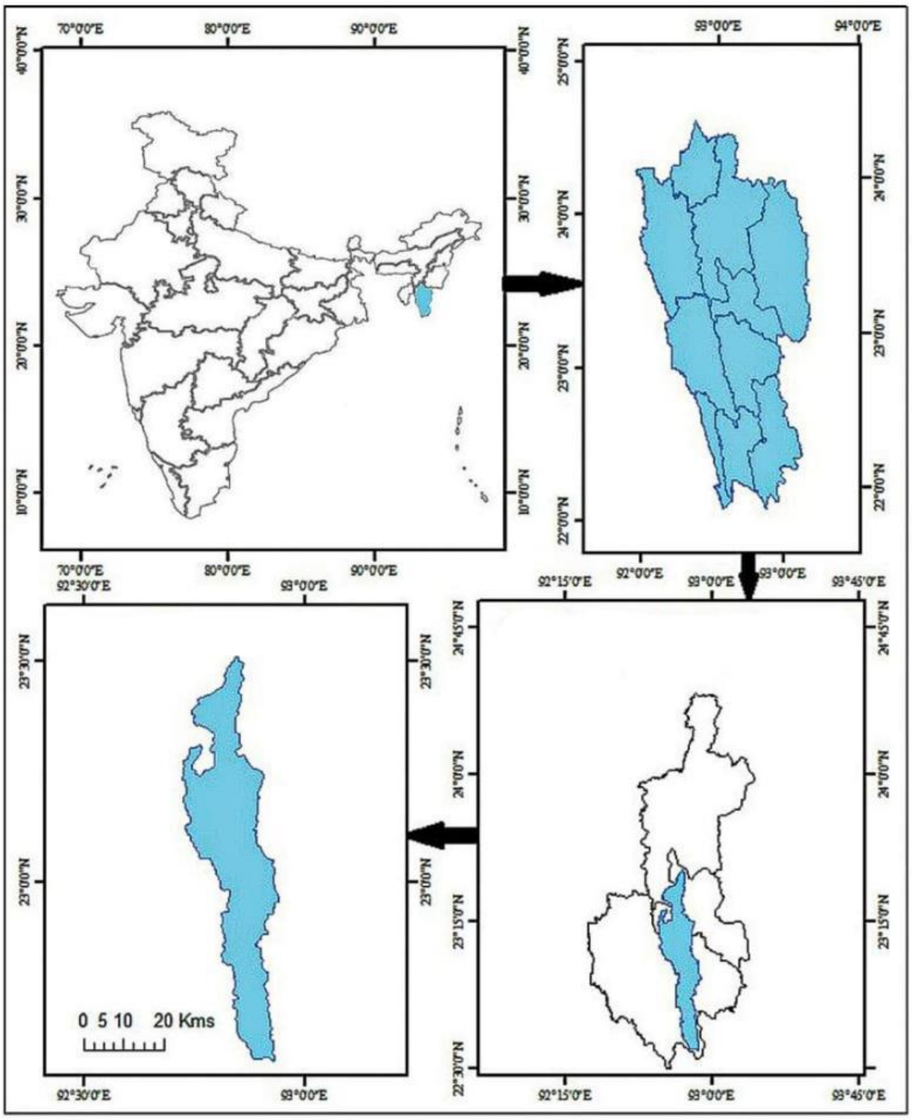

Fig. 1.1. Location Map of the Mat River Basin

1.5. Methodology

1.5.1. Primary Data Collection

The study is based on qualitative and quantitative approaches. Data are gathered both from primary and secondary sources. Field survey accomplish it. Toposheet were for collecting data on slope, land use, drainage, and settlements information. Physical data were based upon the toposheets for the preparation of base map, Global Positioning System (GPS) were used to identify elevation differences, Geographical Information System tools and techniques (GIS) were used for the integration of various data into different layers to find out the relationship and depending geographical variables. Remote Sensing (RS) Techniques were employed for identification of geomorphic features and for the preparation of land use/land cover map. Field verification of physical settings were conducted which included all the elements that influence the livelihood of the Mat River basin. Household level survey on detailed socio-economic conditions were carried out to observe the ground truth. Total 20 villages were surveyed. The total number of agriculture families were 1808. Of which, about 40% agricultural households from each village were surveyed using purposive sampling method (Table 1.1). The altitude of these villages varies from 582 m (minimum) to 1045 m (maximum) The selection of villages was based on several geographical and population indicators such as population size, elevation, and distance of villages from the nearby urban areas. Household level survey were conducted with the construction of structured questionnaire. Questionnaire covered economic, social, educational profile, historical information, agricultural population, production of paddy, horticulture products, size of land holdings, types of crops, consumption behavior, expenditure, ethnic, religion, age, sex, interest, irrigation facilities, individual preferences, size of family, occupational structure, etc.

Table 1.1: Case study villages showing altitude, total agricultural households, and surveyed households

Sl. No.	Village	Altitude(m)	Total No. of Households*	Household Surveyed	% of surveyed Households
1	Chhingchhip	1045	128	52	40.62
2	Chengpui	880	30	15	50
3	Serchhip	888	280	112	40
4	Keitum	762	80	32	40
5	East Bungtlang	654	58	24	41.37
6	Rawpui	764	98	40	40.81
7	Pangzawl	724	46	19	41.3
8	Thiltlang	856	180	72	40
9	East Rotlang	986	74	30	40.54
10	Leite	638	34	14	41.17
11	Zotuitlang	582	82	33	40.24
12	Haulawng	937	32	13	40.62
13	Chhipphir	846	46	19	41.3
14	Ramlaitui	768	120	48	40
15	S. Zote	973	160	64	40
16	Buangpui	873	66	27	40.9
17	Ralvawng	800	78	32	41.02
18	N. Mualthuam	730	52	21	40.38
19	New Dawn	768	80	32	40
20	Baktawng	1020	84	34	40.47
	Total	824	1808	733	41.037

*Agricultural households

Source: Primary survey

1.5.2. Secondary Data Collection

Data is the foundation of scientific inquiry and decision-making, serving as the raw material for research, analysis, and evidence-based conclusions. Scholars like Mayer-Schönberger and Cukier (2013) have emphasized that data is invaluable in understanding patterns, trends, and relationships, enabling researchers and policymakers to make informed choices and predictions. The importance of data lies in its ability to provide insights into complex phenomena, uncover hidden correlations, and support the development of effective strategies in various domains, including healthcare, business, economics, and social sciences. Moreover, data allows researchers to test hypotheses, validate models, and draw reliable conclusions about populations based on samples. With the advent of big data and advanced analytics, the significance of data has further expanded, as it offers unprecedented opportunities for extracting meaningful knowledge and creating value from vast and diverse datasets. Additionally, data drives innovation, facilitates continuous improvement, and empowers organizations to optimize processes and outcomes. As data-driven approaches become increasingly prevalent in the modern world, the effective collection, storage, analysis, and interpretation of data are becoming critical skills for researchers, professionals, and decision-makers.

Climatic variables play important role in Agriculture activities, keen studies on climatic variables were carried out by associating existing secondary data on rainfall, humidity, precipitation, etc. Census of India data were used to prepare the temporal analysis of socio-economic condition of the Mat River Basin.

1.5.3. Data Analysis

Statistical analysis plays a pivotal role in scientific research, enabling researchers to draw meaningful conclusions from data and make informed decisions. Scholars like Field et al. (2012) emphasize that statistical analysis provides a systematic and objective way to analyse and interpret data, allowing researchers to identify patterns, trends, and relationships within the dataset. It helps in summarizing complex information and presenting it in a concise and meaningful manner. Moreover, statistical analysis aids in testing hypotheses, determining the significance of results, and drawing generalizations about populations based on sample data. It also plays a crucial role in evaluating the reliability and validity of research findings, ensuring that the results are not due to chance or random variations. Furthermore, statistical analysis is essential for assessing the effectiveness of interventions or treatments in experimental studies. In the absence of rigorous statistical analysis, research findings may be misleading, and the reliability of the study may be questionable. Therefore, sound statistical analysis is imperative for producing robust and credible research outcomes across various fields of study.

To validate and to analyze the data, Descriptive statistics have been used, standard deviation, correlation, frequency, regression, Paired T- test and GIS software have been used.

1.6. Organization of the Study

This thesis has seven chapters and the organization of the study is as follows:

Chapter 1: Introduction

The first chapter describe the concept of agriculture. It highlights agricultural practices at different levels, followed by agricultural development at world scenario, Indian context, northeast India, Mizoram, and Mat River Basin. The chapter explains statement of the problem, hypothesis, research questions, objectives, methodology and the study area.

Chapter 2: Review of Literature

In this chapter, literature is reviewed at International level, national level, north-east level and also Mizoram state. Most of the literature review is started from the 1940's. The literature was reviewed on different types of agricultural practices worldwide and at national level. Further, the patterns and development of agriculture was reviewed. Some works have been done on agriculture development of North east India in general and Mizoram in particular. A total of more than hundred references were cited.

Chapter 3: Geographical Background and Socio-Economic Profile

This chapter deals with geographical background covering extensive geographical studies on altitude and slope, climatic variables, and forest cover within the Mat River basin. Rainfall and land use land cover data have been analyzed. In addition, socio-economic profile has been examined. Educational status, demographic profile, income profile and gender data have been studied.

Chapter 4: Patterns of Agriculture Practices and Farm Holdings

This chapter deals with agricultural practices in the Mat River basin. The area, production, productivity, and types of crops grown under shifting, permanent, and plantation cultivations are explained. Further, farm holdings are described. Two years data – 2001 and 2016 were gathered and analyzed.

Chapter 5: Changing Pattern of Agriculture

The agricultural pattern has been changing in the Mat River basin. In this chapter, changes in the area, production, and productivity have been examined. There were noticed many factors, which affected the changes in agriculture. It has been noticed that the area and production under shifting cultivation decreased. Meanwhile, it has increased under permanent agriculture but the increase is very less.

Chapter 6: The Role of Agriculture in Socio- Economic Development

In chapter 6 describe the role of shifting cultivation and permanent cultivation on the socio-economic conditions of the farmers. The factors which are affecting agriculture and economic development are elucidated. Market as a major hurdle is described.

Chapter 7: Conclusions

In conclusions, the summary of all the chapters is given. Further, the objective-wise conclusions are presented.

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Chapter 2
Review of Literature

Number of Studies have been carried out in river morphology, agriculture, and socio- economic studies around the Globe. The present study aims to correlate the physical and human dimensions. Agriculture practices, social conditions and economic activities in the developing nations have been largely determined by the existing physical endowment much larger than those of the developed nations. Thus, physical settings play major role in shaping the overall environment. Therefore, research which correlates and employ both the physical and human dimensions will be drawn to examine the relationship which will be very fruitful for better geographical understanding of the Mat River Basin. The following literature reviews are solely committed to the objectives of the study and all are reflected in reference list. They are arranged in chronological manner i.e., International, National, North East, and the Mizoram. The review of literature are as follows:

2.1. International

Agriculture development exemplified by the work of (Borlaug, 1968), underscores the transformative potential of introducing high-yielding crop varieties to boost agricultural production. Moreover, permaculture places a strong emphasis on closed-loop systems and waste reduction, permaculture emphasizes the integration of diverse plants, animals, and microorganisms within a harmonious and regenerative design. This approach is rooted in ecological principles, aiming to create self-sustaining and resilient agroecosystems that require minimal external inputs. A water basin, also known as a watershed or catchment area, is a fundamental geographic unit that plays a crucial role in the hydrological cycle and the management of water resources. It encompasses a specific land area from which all precipitation and runoff flow into a common outlet, such as a river, lake, or ocean. This concept has been extensively studied in hydrology and water management literature. As discussed by (Montgomery & Dietrich, 1988), water basins are integral to understanding erosion, sediment transport, and landscape evolution.

Mollison (1988) stressed the importance of designing systems where outputs from one element become inputs for another, minimizing waste and maximizing resource efficiency. Techniques like composting, vermiculture, and greywater recycling exemplify these principles, contributing to soil fertility and reducing environmental impact. As highlighted by him, integrating trees and perennial plants into farming systems not only conserves soil and water but also provides multiple products and services, such as fruits, timber, and shade.

Agroecological principles, as emphasized (Altieri, 1995) in "Agroecology: The Science of Sustainable Agriculture," promote the integration of ecological concepts into farming practices, fostering biodiversity, and reducing environmental impact Agricultural practices on hilly terrains present unique challenges and opportunities, often requiring specialized techniques to ensure sustainable production and mitigate soil erosion.

Agricultural practices on a global scale encompass a diverse range of methods and techniques employed to ensure food security, livelihoods, and environmental sustainability. Traditional subsistence farming coexists with modern, technology-driven approaches. Crop rotation, as highlighted in studies like "Crop Rotation and its Benefits for Sustainable Farming" by (Drinkwater et al., 1995), remains a foundational practice, helping to maintain soil fertility and prevent pest buildup Plantations often involve labour-intensive production systems, which have led to complex social and economic dynamics, including issues related to labour rights and land tenure (Bryceson, 2000). Plantation agriculture holds a prominent place in global agricultural systems, characterized by large-scale monoculture cultivation of cash crops on extensive land holdings. This practice has historical roots dating back to colonial times and has significantly shaped economies and landscapes in various regions. Plantation crops such as coffee, tea, sugarcane, and oil palm have become major contributors to export earnings and international trade (Peluso & Watts, 2001) as explored by (Altieri, 2002), emphasize the integration of ecological principles into farming systems, promoting natural pest control and reduced reliance on synthetic inputs.

At the core of permaculture lies the notion of "designing with nature," as detailed by (Holmgren, 2002), wherein agricultural landscapes are carefully planned to harness natural processes and patterns. Rather than relying on monoculture and intensive tillage, permaculture encourages polyculture, companion planting, and agroforestry to enhance biodiversity, nutrient cycling, and pest control. The management of water basins is paramount for ensuring sustainable water supply, flood prevention, and ecosystem preservation. (Gleick, 2003) highlights the interconnectedness of water within basins, underscoring the importance of integrated approaches to water resource management to address both human and environmental needs. As societies face increasing challenges related to water scarcity and climate change, a comprehensive understanding of water basins is essential for informed decision-making and the development of effective water management strategies.

Agricultural disturbances have become a growing concern in the world, encompassing a range of challenges that impact the sustainability and resilience of food systems. These disturbances include factors such as deforestation, soil degradation, and water scarcity, which disrupt the delicate balance between agricultural production and the environment. Intensive agricultural practices, often driven by the need to meet rising food demands, can lead to soil erosion, nutrient depletion, and loss of biodiversity (Foley et al., 2005)

Additionally, sustainable agricultural practices, such as crop rotation and agroforestry, promote soil health and biodiversity conservation, mitigating environmental degradation and climate change impacts (Pretty et al., 2006). In essence, agriculture's multifaceted advantages underscore its indispensable role in ensuring human well-being and the health of our planet.

Agricultural practices encompass a wide array of techniques and methods that shape the cultivation of crops and the management of livestock. These practices are essential for ensuring food security, sustainability, and rural development, adopting sustainable agricultural practices that prioritize soil health, water conservation, and biodiversity can lead to improved productivity and resilience in the face of environmental challenges.

Agricultural development plays a pivotal role in ensuring food security, poverty alleviation, and sustainable economic growth, particularly in developing countries (World Bank, 2007). a holistic approach to agricultural development involves not only increasing crop yields but also improving access to markets, credit, and education for smallholder farmers. However, the complexities of modern agricultural development extend beyond yield gains; they encompass sustainable resource management and the empowerment of marginalized farming communities (Hazell et al., 2007). Furthermore, it serves as a foundation for various industries, from agribusiness to food processing, which contribute to economic growth and stability. Agriculturally oriented communities often exhibit improved social cohesion and cultural preservation, as farming practices foster a sense of identity and tradition (Swinton et al., 2007).

While permaculture promotes local self-reliance and resilience, it also recognizes the significance of community collaboration and knowledge sharing. As discussed by (Shepard, 2008), permaculture designs often integrate social aspects, fostering community gardens, cooperative farming, and educational initiatives that empower individuals to become active stewards of their environment and food production. Permanent agriculture, or permaculture, presents a comprehensive framework that reimagines agriculture as a harmonious and regenerative partnership with nature. Drawing inspiration from ecological principles and traditional wisdom, permaculture offers a path toward sustainable food production, biodiversity conservation, and community resilience. As the world grapples with pressing challenges such as climate change and resource depletion, permaculture provides a hopeful blueprint for cultivating abundance while safeguarding the planet for future generations.

Shifting agriculture, also known as slash-and-burn or swidden farming, is a traditional land-use practice that involves clearing a portion of forest or vegetation, burning it, and then cultivating crops on the cleared land. This method has been employed by indigenous communities around the world for centuries as a means of subsistence farming. However, shifting agriculture has raised concerns due to its potential environmental impacts, particularly deforestation and loss of biodiversity. As discussed in (Mertz et al., 2009), the cycle of land clearing and burning can lead to soil degradation and reduced fertility over time, necessitating the abandonment of plots and the expansion into new areas of forest. This practice has become unsustainable as population pressures increase and forested areas diminish. To address these challenges, sustainable alternatives such as agroforestry and improved land management techniques are being explored.

This multifaceted process encompasses advancements in technology, infrastructure, policies, and practices aimed at enhancing agricultural productivity and rural livelihoods. As cited in (Dorward et al., 2009), Concurrently, precision agriculture, discussed in "Precision Agriculture: A Worldwide Overview" by (Gebbers & Adamchuk, 2010), employs advanced technologies like GPS and remote sensing to optimize resource allocation and enhance crop yields. In this context, investments in agricultural research, extension services, and value chain development have been shown to have substantial positive impacts on both food security and rural prosperity (Spielman et al., 2010: Duflo et al., 2011). Consequently, a comprehensive and inclusive approach to agricultural development remains crucial for addressing global food challenges and promoting equitable economic growth. Terrace farming has also been acknowledged for its potential to mitigate climate change impacts and improve food security, exemplifying its relevance in both historical and contemporary agricultural contexts (Food and Agriculture Organization, 2011). Additionally, the expansion of agricultural land can contribute to deforestation, causing habitat loss and contributing to climate change through increased greenhouse gas emissions (Lambin & Meyfroidt, 2011).

The study by (Van Vliet et al., 2012) underscores the importance of understanding the socio-economic and ecological contexts of shifting agriculture to develop strategies that balance food security and conservation goals. As societies strive to achieve sustainable land-use practices, it is crucial to integrate traditional knowledge with modern insights to ensure the preservation of ecosystems and the well-being of local communities. Permanent agriculture, often referred to as permaculture, represents a holistic and sustainable approach to farming that seeks to mimic natural ecosystems while meeting human needs for food, fibre, and other resources. Vegetable production is a critical component of global agriculture, contributing to food security, nutrition, and economic development. The cultivation of vegetables provides essential vitamins, minerals, and dietary fibre that are crucial for human health and well-being (Fernandez-Cornejo et al., 2012).

Agriculture plays a pivotal role in sustaining human societies by providing essential resources such as food, fibre, and fuel. Its advantages extend beyond mere sustenance, encompassing economic, social, and environmental dimensions. Agriculture contributes significantly to global economies, generating employment opportunities and fostering rural development (Barrett et al., 2012). Agricultural progress has been a driving force behind the transformation of societies, improving food security, livelihoods, and overall human well-being. Advances in agricultural technologies, practices, and policies have led to increased productivity, enabling farmers to produce more food on less land and with fewer resources. The Green Revolution, for instance, marked a significant milestone in agricultural progress, introducing high-yielding crop varieties and modern farming techniques that greatly increased food production (Pingali, 2012).

Amid concerns of climate change, studies like "Climate-Smart Agriculture: A Synthesis of Empirical Evidence" (Lipper et al., 2014) underscore the significance of adopting climate-smart techniques that improve resilience and mitigate greenhouse gas emissions. The combination of traditional wisdom and innovative approaches underscores the complexity and adaptability of agricultural practices on a global scale. Terracing, as discussed in "Terrace Farming: A Sustainable Solution for Sloped Agriculture" (Panagos et al., 2015), is a common approach that transforms steep slopes into level terraces, reducing soil runoff and facilitating water retention.

Despite its economic significance, plantation agriculture has also faced criticism for its environmental impact, including deforestation, habitat loss, and agrochemical use. Initiatives to promote sustainable plantation practices, environmental stewardship, and social responsibility are emerging as essential components of modern plantation management (Pulhin et al., 2015). The complex interplay of economic, social, and environmental factors highlights the need for balanced and responsible approaches to plantation agriculture on a global scale. For instance, conservation tillage and crop rotation, as discussed in (Lal, 2015), contribute to soil fertility and carbon sequestration, mitigating the impacts of climate change. Furthermore, agroecological approaches.

Terrace farming is a globally practiced agricultural technique that involves transforming hilly or sloped terrain into a series of flat, stepped terraces to facilitate cultivation. This method optimizes land use, reduces soil erosion, and conserves water resources, making it particularly suitable for regions with challenging topographies. In places like the Andes Mountains in South America, the Yunnan Province in China, and the Philippine Cordilleras, terrace farming has been integral to sustaining agricultural productivity for centuries (Nazarea et al., 2016) Cover cropping, as explored in "Cover Cropping for Soil Erosion Control in Sloping Lands" (Zou et al., 2016), involves planting vegetation between main crops to protect the soil from erosion and improve its structure

Vegetable production not only addresses nutritional needs but also offers economic opportunities, particularly for smallholder farmers in developing countries. It serves as a source of income and livelihood diversification, enhancing local economies and reducing poverty (Kumar & Kalita, 2017). However, the challenges of sustainable vegetable production are significant, including issues related to pest and disease management, water scarcity, and environmental degradation. Addressing these challenges through innovative and sustainable practices is crucial to ensure the continued availability of fresh and nutritious vegetables for a growing global population.

Additionally, contour farming, discussed in "Contour Farming: A Strategy to Enhance Soil Conservation in Hilly Areas" (Sharma et al., 2018), involves ploughing along the contours of the land to reduce water runoff and soil erosion. These practices collectively contribute to sustainable agricultural production on hills, emphasizing the need for context-specific approaches to address the challenges posed by hilly terrain.

Moreover, advancements in biotechnology and precision agriculture have further contributed to agricultural growth by enhancing crop resilience, pest resistance, and resource use efficiency (Parihar et al., 2019). This progress has played a pivotal role in alleviating poverty and improving nutrition, particularly in developing countries where agriculture remains a primary source of livelihood for millions of people. However, challenges such as sustainable resource management, environmental conservation, and equitable distribution of benefits remain important considerations as we continue to advance agriculture to meet the evolving needs of a growing global population. Agroforestry, highlighted in "Agroforestry Practices in Hilly Regions" (Kumar et al., 2019), integrates trees with crops, aiding in soil conservation, nutrient cycling, and diversification of products These disturbances have far-reaching implications for global food security and environmental health, highlighting the urgent need for sustainable and regenerative agricultural approaches that mitigate these negative impacts and ensure the long-term viability of agricultural systems.

The importance of incorporating traditional knowledge alongside modern innovations in agricultural practices is underscored by (Mutsaers et al., 2020), as it enhances the adaptive capacity of farming communities. In essence, the careful selection and implementation of agricultural practices play a vital role in ensuring sustainable food production while safeguarding the environment and rural livelihoods. As the world's population continues to grow, the demand for vegetables is escalating, driven by changing dietary preferences and urbanization (Reardon et al., 2020). These systems often incorporate intricate irrigation networks and soil management practices, showcasing the synergy between traditional ecological knowledge and sustainable farming (Bidogeza et al., 2020)

2.2 National

Indian agriculture is a vital sector that sustains the livelihoods of millions and contributes significantly to the country's economy. With a rich history dating back thousands of years, Indian agriculture has evolved over time to meet the needs of a growing population. According to the Food and Agriculture Organization (FAO), India is one of the world's largest producers of various agricultural commodities, including rice, wheat, sugarcane, cotton, and fruits. The Green Revolution of the 1960s, marked by the introduction of high-yielding crop varieties, irrigation systems, and modern farming techniques, played a pivotal role in boosting agricultural productivity. However, challenges such as fragmented landholdings, water scarcity, inadequate infrastructure, and fluctuations in monsoon patterns continue to impact the sector's growth. Initiatives like the Pradhan Mantri Fasal Bima Yojana (Prime Minister's Crop Insurance Scheme) and the Soil Health Card scheme have been implemented to address some of these issues and enhance farmers' resilience. The Indian government's focus on promoting sustainable and climate-resilient agriculture through measures such as organic farming and crop diversification highlights the commitment to ensure food security and rural development in the country.

Agricultural production in India plays a pivotal role in providing sustenance to its vast population and contributing substantially to its economy. According to data from the Ministry of Agriculture and Farmers' Welfare, India ranks among the top global producers of various crops, including rice, wheat, sugarcane, and cotton. The diverse agro-climatic zones across the country enable the cultivation of a wide range of crops, making India a prominent player in the global agricultural landscape. The adoption of modern farming techniques and technologies, such as the Green Revolution, has significantly boosted productivity over the years. However, challenges such as land fragmentation, water scarcity, and changing climatic patterns pose ongoing threats to agricultural production. To address these issues, the Indian government has implemented initiatives like the National Mission for Sustainable Agriculture (NMSA) and the Paramparagat Krishi Vikas Yojana (Traditional

Farming Improvement Programme) to promote sustainable agricultural practices and enhance productivity while maintaining environmental and ecological balance.

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Farming practices in India exhibit a diverse range of traditional and modern techniques that have evolved over centuries to adapt to the country's varied agro-climatic conditions. The agricultural landscape showcases practices such as subsistence farming, mixed cropping, and crop rotation, reflecting the local knowledge and wisdom of generations. According to the National Bank for Agriculture and Rural Development (NABARD), these traditional practices continue to play a crucial role in ensuring food security and sustaining rural livelihoods. However, modernization has brought about changes with the adoption of advanced technologies, such as high-yielding crop varieties, mechanization, and precision agriculture. The Government of India, through initiatives like the Rashtriya Krishi Vikas Yojana (National Agriculture Development Program), promotes a holistic approach that combines traditional wisdom with modern innovations to enhance productivity, conserve natural resources, and achieve sustainable agricultural development.

Agricultural production in India is a cornerstone of its economy, supporting the livelihoods of a significant portion of the population and contributing substantially to the country's Gross Domestic Product (GDP). According to data from the Ministry of Agriculture and Farmers' Welfare, India ranks among the world's largest producers of key crops such as rice, wheat, sugarcane, cotton, and pulses. This diverse output is made possible by the varied agro-climatic zones across the country, allowing for a wide range of crops to be cultivated. The Green Revolution, initiated in the 1960s, introduced high-yielding crop varieties, improved irrigation systems, and modern agricultural practices, leading to significant increases in productivity. However, challenges such as land fragmentation, water scarcity, and climate change impact the sector's growth. To address these issues and enhance agricultural production, the Indian government has launched various schemes and programs, such as the Pradhan Mantri Krishi Sinchai Yojana (Prime Minister's Agriculture Irrigation Scheme) and the National Food Security Mission, aimed at improving irrigation infrastructure, promoting sustainable farming practices, and ensuring food security for the nation.

Furthermore, the adoption of innovative technologies and irrigation systems has contributed to the diversification of crops, improved farm incomes, and livelihoods for millions of rural households (Joshi et al., 2007). Agriculture development is crucial as there are food scarcity found in different sections of the community, food scarcity, a pressing global concern, arises from the imbalance between the growing demand for nourishment and the limited availability of essential food resources. Factors such as population growth, changing dietary patterns, and resource constraints contribute to this challenge (Godfray et al., 2010). The sector's significance extends beyond sustenance, as it provides raw materials for various industries, including textiles, pharmaceuticals, and agro-processing, contributing to industrialization and economic growth (Gulati & Fan, 2010). Addressing food scarcity requires a multi-pronged approach that encompasses sustainable agricultural practices, investment in rural infrastructure, improved access to markets, and equitable distribution of resources. By adopting these strategies, it is possible to mitigate the impacts of food scarcity and ensure a more food-secure future for all.

The Green Revolution, initiated in the 1960s, stands as a pivotal moment that ushered in remarkable. Furthermore, it contributes to environmental services through carbon sequestration, soil conservation, and biodiversity maintenance, promoting sustainable land management and ecosystem health (Bharucha & Pretty, 2010).

It provides direct employment to millions of people, especially in rural areas, and supports various ancillary industries such as agribusiness, food processing, and textiles (Gulati & Fan, 2010). Furthermore, agriculture contributes raw materials for industrial production, ensuring a symbiotic relationship between the agricultural and industrial sectors. Despite the diversification of the economy, the significance of agriculture remains paramount, particularly in ensuring food security and stable rural incomes. As the Indian economy continues to evolve, sustainable agricultural growth becomes crucial not only for poverty reduction and equitable development but also for ensuring overall economic stability and resilience.

Agricultural progress in India has witnessed significant strides over the years, playing a crucial role in the country's economic development and food security. Inadequate infrastructure for storage and distribution, coupled with inefficient supply chains, also contribute to food wastage, exacerbating the scarcity issue (Gustavsson et al., 2011).

Advances in crop productivity through the introduction of high-yielding varieties and improved agricultural practices (Pingali, 2012). Additionally, inefficient water management and irrigation practices contribute to water scarcity, exacerbating crop yield variability and productivity constraints (Shah et al., 2013). This period saw a substantial increase in food production, particularly in wheat and rice, leading to enhanced self-sufficiency and reduced hunger (Gupta, 2014). India's rich agro-biodiversity and diverse agro-climatic zones make it conducive for the cultivation of a wide variety of crops, thereby playing a pivotal role in ensuring food security and nutrition for its growing population. Livestock farming contributes significantly to rural incomes and provides dairy, meat, and other by-products, playing a critical role in nutritional security (Thorat & Joshi, 2016). However, there is a growing emphasis on adopting sustainable and resilient farming practices, leveraging technology for precision agriculture, and enhancing market linkages to improve farmers' income and well-being. These efforts are complemented by policies aimed at doubling farmers' income and promoting agriculture-entrepreneurship (Government of India, 2016). As the sector continues to evolve, the Indian agriculture scenario reflects a dynamic landscape that requires innovative solutions to ensure food security, rural prosperity, and environmental sustainability. However, challenges such as declining soil fertility, water scarcity, and the need for sustainable resource management persist. To address these issues, there is a growing emphasis on promoting agroecological approaches, organic farming, and conservation practices to ensure a more resilient and environmentally friendly agricultural sector in India. Horticultural production in India sheds light on the significance of this sector in diversifying agriculture, enhancing nutritional security, and contributing to rural livelihoods. (Kumar et al., 2017)

Additionally, agriculture is deeply intertwined with Indian culture and traditions, influencing festivals, rituals, and social practices (Saxena, 2017). These diverse uses highlight the holistic significance of agriculture in India, reflecting its intrinsic connection to economic, social, and environmental dimensions.

According to studies such as those conducted by (Mohanty et al., 2018) have examined the impact of climate change on rice production, emphasizing the need for adaptive strategies to ensure sustained yields in the face of changing environmental conditions underscores the role of horticulture in augmenting income and generating employment opportunities, particularly for small and marginal farmers. Investigations by (Shantappa et al., 2018) emphasize the positive impact of horticulture on sustainable land use and environmental conservation. Government initiatives like the National Horticulture Mission and the Pradhan Mantri Krishi Sinchayee Yojana (Prime Minister's Agriculture Irrigation Scheme) have been assessed for their effectiveness in promoting horticultural production and improving water-use efficiency.

The National Mission for Sustainable Agriculture (NMSA), established under the National Action Plan on Climate Change, focuses on climate-resilient farming practices, soil health management, and water-use efficiency (Ministry of Agriculture & Farmers' Welfare, Government of India). The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) aims to improve irrigation infrastructure and water-use efficiency through its various components (Ministry of Agriculture & Farmers' Welfare, Government of India). The Rashtriya Krishi Vikas Yojana (RKVY) promotes agricultural development through targeted investments, innovation, and capacity-building (Ministry of Agriculture & Farmers' Welfare, Government of India). Additionally, the Paramparagat Krishi Vikas Yojana (PKVY) emphasizes organic farming and the adoption of traditional agricultural practices. These ventures underscore India's commitment to addressing agricultural challenges and fostering sustainable development in the sector.

Soil degradation due to unsustainable land use practices further compounds the problem, leading to declining fertility and reduced agricultural resilience (Lal, 2018) Small and marginal farmers, who constitute a substantial portion of the agricultural workforce, often grapple with limited resources and face difficulties in achieving profitable returns (Joshi et al., 2018). Moreover, issues like post-harvest losses, inefficiencies in supply chains, and middlemen exploitation can further impact farmers' profitability. Addressing these challenges requires a comprehensive approach that includes improving market linkages, enhancing value addition through agro-processing, promoting efficient resource management, and providing targeted support to vulnerable farming communities. By fostering an enabling environment that prioritizes sustainable and inclusive agricultural growth, India can enhance the profitability of its agriculture sector, ensuring the well-being of millions of farming households and contributing to overall economic development.

This presents an opportunity for the agriculture sector to play a pivotal role in meeting these demands while generating employment and enhancing rural livelihoods. Furthermore, advancements in technology and data-driven agriculture, such as precision farming and agtech solutions, hold the potential to revolutionize the way farming is conducted, improving productivity and resource efficiency (Krishna et al., 2019). The government's policies and initiatives, such as the National Rice Development Strategy and the Pradhan Mantri Fasal Bima Yojana (Prime Minister's Crop Insurance Scheme), have been assessed for their effectiveness in enhancing rice production and farmer resilience (NITI Aayog, 2019). Overall, the literature underscores the importance of rice production for food security, rural livelihoods, and the national economy, while also highlighting the challenges and opportunities for sustainable and resilient cultivation practices.

India's agriculture sector grapples with a multitude of pressing challenges that hinder its full potential and pose significant threats to food security and rural livelihoods.

One of the major issues is the persistent problem of small and fragmented landholdings, which limits economies of scale and access to modern agricultural practices (Birthal et al., 2019). Climate change-induced disruptions, including extreme weather events and altered precipitation patterns, further exacerbate food scarcity by affecting agricultural productivity (Ray et al., 2019).). A comprehensive approach that combines innovation, policy support, and community engagement is essential to harness the full potential of India's agriculture sector and ensure a prosperous and food-secure future.

Moreover, agriculture has deep cultural and social roots, forming an integral part of festivals, traditions, and heritage across the country. Recognizing the vital role of agriculture, there is a growing emphasis on implementing sustainable and innovative practices to enhance productivity, conserve natural resources, and promote rural prosperity, underscoring its enduring importance for India's present and future.

Forestry contributes to timber, non-timber forest products, and environmental conservation. These diverse dimensions of Indian agriculture collectively address the complex challenges of food availability, rural employment, income generation, and sustainability, forming a comprehensive foundation for the country's agrarian landscape.

While the Green Revolution brought substantial gains in food production, the sector faces persistent issues such as small and fragmented landholdings, declining soil fertility, and water scarcity (Birthal et al., 2019). Climate change impacts further compound these challenges, affecting crop yields and posing risks to food security (Ray et al., 2019). Indian agriculture is a multi-dimensional sector encompassing various aspects that collectively shape the nation's rural landscape, economy, and food security. It comprises diverse dimensions such as crop cultivation, livestock rearing, fisheries, and forestry, reflecting the country's agro-climatic diversity and cultural heritage (Kumar et al., 2019). Agriculture in India serves as a multifunctional and versatile sector with diverse uses that extend beyond mere food production. It encompasses not only the cultivation of crops and rearing of livestock but also plays a pivotal role in providing livelihoods, preserving cultural heritage, and contributing to environmental sustainability. The sector serves as a source of income for millions, particularly in rural areas, thereby supporting rural livelihoods and poverty reduction (Sharma et al., 2020). The Indian agriculture scenario is characterized by a dynamic interplay of challenges, opportunities, and transformations. The sector remains a cornerstone of the country's economy, providing employment to a significant portion of the population and contributing to rural development (Sharma et al., 2020). Fisheries and aquaculture are vital for protein intake and livelihoods in coastal and inland regions (Sinha et al., 2020).

India's agriculture sector has witnessed various ventures aimed at enhancing productivity, sustainability, and rural livelihoods. Furthermore, inadequate post-harvest infrastructure and marketing channels result in substantial food wastage and income loss for farmers (Kumar et al., 2020)

India's agriculture sector presents a dynamic landscape of opportunities and challenges, shaping the country's prospects for food security, economic growth, and sustainable development. As India continues to experience population growth and urbanization, the demand for food is expected to rise significantly (Sharma et al., 2020).

Studies such as those conducted by (Singh & Srivastava, 2020) have explored the adoption of modern practices, including improved cultivation techniques and post-harvest management, leading to increased productivity and better-quality products.

Agriculture plays a pivotal role in the Indian economy, serving as a cornerstone for rural livelihoods, employment generation, and overall economic development. The sector contributes significantly to the country's Gross Domestic Product (GDP) and remains a primary source of income for a substantial portion of the population (Sharma et al., 2020). Agriculture profitability in India is a complex and multifaceted issue influenced by various factors, including input costs, market dynamics, weather conditions, and government policies. While agriculture remains a significant contributor to the country's economy, the sector often faces challenges related to fluctuating commodity prices, inadequate market infrastructure, and lack of access to credit and technology (Birthal et al., 2020). Agriculture holds paramount importance in India, serving as the backbone of the nation's economy, culture, and livelihoods. It is a vital source of employment, employing most of the population and contributing significantly to rural development and poverty alleviation.

India is one of the world's largest producers of rice, with a significant portion of its arable land dedicated to its cultivation. Researchers have explored various aspects of rice production, including the adoption of modern cultivation practices and technologies, such as improved seed varieties and mechanization (Jat et al., 2020).

However, to fully unlock these prospects, challenges like climate change impacts, water scarcity, and soil degradation need to be addressed through sustainable and resilient agricultural practices (Narain et al., 2021). Climate change impacts, including erratic rainfall patterns and extreme weather events, add another layer of complexity, affecting crop productivity and increasing vulnerability Addressing these multifaceted challenges requires a holistic approach that integrates technological innovation, policy reforms, sustainable land management practices, and improved market access to ensure a resilient and thriving agriculture sector in India

2.3 North East India

Agriculture in North East India holds a unique significance due to the region's diverse topography, distinct climatic zones, and rich cultural heritage. Discuss the potential of horticultural crops like oranges, pineapples, and spices, which thrive in the region's diverse agro-climatic conditions. Furthermore, the implementation of agroforestry systems, as highlighted by (Sharma et al., 2014), has gained traction, aiming to balance agricultural productivity with ecological conservation.

Additionally, efforts to promote sustainable agriculture and enhance food security in the region have led to the adoption of various modern techniques and crops. (Singh

& Hazarika, 2017). Agricultural production in Northeast India is shaped by its unique agro-climatic conditions, which encompass diverse landscapes ranging from hills and mountains to valleys and plains. The region's traditional practices, including shifting cultivation, coexist with modern interventions aimed at enhancing productivity and sustainability. As highlighted by (Dev et al., 2017), shifting cultivation remains a dominant form of agricultural land use, contributing significantly to the region's food security and livelihoods. However, concerns about its environmental impacts and land degradation have spurred efforts to transition towards more sustainable practices. (Bhagawati et al., 2017). Agricultural development in North East India is a complex endeavour characterized by a blend of traditional practices and modern interventions. The region's unique agro-climatic conditions and cultural diversity present both challenges and opportunities for sustainable growth. According to (Sarma et al., 2018). The cultivation of unique indigenous crops, such as black rice and King chilli, has gained prominence not only for local consumption but also for niche markets (Pandey et al., 2019). The agricultural practices in this region are influenced by traditional knowledge and are often characterized by shifting cultivation, locally known as "jhum" or "slash-and-burn" farming. This practice, as studied by (Deka & Saikia, 2019), involves clearing small patches of forest, burning the vegetation, and cultivating crops. Additionally, research institutions such as the North Eastern Regional Institute of Water and Land Management (NERIWALM) play a vital role in developing region-specific solutions for soil erosion control, water conservation, and sustainable land use (NERIWALM, n.d.).

Collaborative efforts between various stakeholders, including governmental agencies, non-governmental organizations, and local communities, are crucial to address infrastructural limitations and promote holistic agricultural development that balances socio-economic progress with environmental sustainability. While jhum has been criticized for its environmental impacts, it remains an integral part of the cultural fabric and livelihoods of many indigenous communities the predominantly rain-fed agriculture in the region is susceptible to climatic variations, necessitating the adoption of climate-resilient practices. Government initiatives like the National

Mission for Sustainable Agriculture (NMSA) have aimed to enhance soil health, promote efficient water management, and provide training to farmers for improved agricultural practices (Government of India, 2020).

Government initiatives such as the Rashtriya Krishi Vikas Yojana (RKVY) have aimed to boost agricultural growth and livelihoods through technology dissemination, capacity building, and infrastructure development (Government of India, 2020). Collaborative efforts between research institutions, local communities, and policy-makers are essential to harness the region's agricultural potential while addressing socio-economic and environmental challenges. In recent years, policy initiatives and research endeavours, such as those described by (Kalita et al., 2020), have focused on improving agricultural productivity, post-harvest management, and market linkages in North East India. These multi-dimensional efforts are crucial for enhancing rural livelihoods, preserving local agroecosystems, and contributing to the overall development of the region

2.4 Mizoram

Agriculture in Mizoram, a northeastern state of India, holds significant importance for its economy and sustenance of livelihoods. The state's hilly terrain and abundant rainfall provide favourable conditions for diverse agricultural practices. Primarily dominated by shifting cultivation or 'jhum' cultivation, which involves rotating cultivated plots to maintain soil fertility, Mizoram's agricultural landscape has been transitioning towards more sustainable and modern practices in recent years. The state government has been promoting initiatives to promote terrace farming, organic farming, and the cultivation of high-value cash crops such as ginger, turmeric, and bamboo. According to the (Agricultural Census of India, 2015-16), Mizoram witnessed a growth in net sown area and agricultural productivity, showcasing its progress in agricultural development. However, challenges such as land scarcity, limited access to markets, and climate change impacts persist, necessitating continued efforts to enhance agricultural productivity and improve rural livelihoods in Mizoram.

The literature review on agricultural production in Mizoram reflects a multifaceted landscape shaped by a blend of traditional practices and modern interventions. Noteworthy studies such as "Changing Scenario of Agriculture in Mizoram: A Study of Aizawl District" by (Chhakchhuak et al., 2017) provide insights into the evolving agricultural patterns, highlighting shifts towards cash crops like ginger and turmeric, which have become vital contributors to the state's economy. Agricultural problems in Mizoram are characterized by a complex interplay of geographical constraints, shifting cultivation practices, and the effects of climate change. The state's hilly terrain poses challenges for large-scale mechanized agriculture, leading to fragmented landholdings and limited arable land. Traditional shifting cultivation, though ingrained in the cultural fabric, contributes to deforestation and soil degradation over time. Limited access to markets and inadequate infrastructure hinders the marketing of agricultural produce, impeding farmers' income potential (Lalnuntluanga et al., 2018). The literature review on horticulture in Mizoram showcases a growing body of research that highlights the state's potential for diverse horticultural activities and its role in economic development. Studies like "Horticultural Crop Diversity and Livelihood Options: A Study in Mizoram, India" by (Zothanpuia et al., 2018) emphasize the rich diversity of horticultural crops cultivated in Mizoram, including fruits, vegetables, spices, and floriculture products. This diversity not only contributes to local diets but also offers opportunities for income generation and market expansion.

Additionally, research such as "Sustainable Agriculture and Land Use in Mizoram" by (Lalramzauva et al., 2019) emphasize the importance of sustainable land management strategies to mitigate the adverse effects of shifting cultivation and promote long-term agricultural productivity. These studies collectively underscore the need for a comprehensive approach that integrates traditional knowledge with modern advancements to enhance agricultural production while ensuring environmental sustainability in Mizoram.

Mizoram reveals a dynamic interplay between traditional indigenous knowledge and modern agricultural approaches. Studies such as "Traditional Ecological Knowledge and Sustainable Agriculture: A Case Study in Mizoram, Northeast India" by (Ralte et al., 2019) shed light on the significance of indigenous farming practices, including 'jhum' cultivation, agroforestry, and integrated farming systems, in maintaining ecosystem balance and ensuring food security. To address these challenges, there is a growing need for sustainable agricultural practices, diversified cropping systems, and enhanced capacity-building initiatives to equip farmers with the knowledge and resources to adapt to the evolving agricultural landscape. Mizoram's plantation sector has gained significance as an alternative to shifting cultivation, offering opportunities for sustainable economic growth and environmental conservation. The state's favourable agro-climatic conditions have facilitated the cultivation of various plantation crops such as tea, rubber, and bamboo. Plantation crops, particularly tea, have shown potential for income generation and employment opportunities (Lalnuntluanga et al., 2019). On the other hand, research such as "Adoption of Modern Agricultural Practices in Mizoram: A Study of Kolasib District" by (Sailo et al., 2020) underscores the increasing adoption of modern techniques like terrace farming, improved seed varieties, and organic farming methods to enhance agricultural productivity and livelihoods. These studies collectively highlight the importance of a balanced approach that integrates traditional wisdom with contemporary techniques to address the complex challenges faced by Mizoram's agricultural sector.

Furthermore, changing precipitation patterns and increasing incidences of extreme weather events have led to erratic monsoons and crop loss, affecting food security and rural livelihoods (Hmingthanpari, 2020). Additionally, research such as "Challenges and Prospects of Horticultural Development in Mizoram" by (Lalfakzuala et al., 2021) underscores the need for improved infrastructure, technology dissemination, and market linkages to fully harness the potential of horticulture in the state. These studies collectively underline the significance of promoting sustainable horticultural practices and addressing existing challenges to enhance the contribution of horticulture to Mizoram's agricultural and economic growth. The expansion of rubber plantations has contributed to enhancing rural livelihoods, although concerns regarding land use change and biodiversity conservation have emerged (Renthlei et al., 2021). Additionally, bamboo cultivation has gained momentum due to its versatility and growing demand in various industries (Sailo et al., 2022). The Mizoram government's initiatives to promote sustainable plantation practices and value addition have aimed to boost the state's plantation sector while addressing socio-economic and environmental challenges.

The present study area 'The Mat River Basin' is in three districts of Mizoram – Aizawl, Serchhip, and Lunglei. This basin has high potential to grow different types of crops. However, the pace of agriculture development is low. Further, no work has been done on the agricultural development of the Mat River Basin. This work is the pioneer and will be useful for all stakeholders – farmers, policy makers, governmental agencies, students, scholars, and academicians.

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Chapter 3

Geographical Background and Socio –economic Profile

3.1. Geographical Background

3.1.1. Introduction

Nestled within the picturesque landscapes of Mizoram, India, lies the Mat River Basin, a geographic enclave of immense significance. Stretching across an expanse of 981 square kilometers, this vital watercourse traverses the Aizawl District, bestowing its invaluable resource upon the local populace. The Mat River, originating at an altitude of 1423 meters above mean sea level near the quaint hamlet of Baktawng, meanders through hills and valleys, intersecting lives, and fostering prosperity. Embracing a network of tributaries, locally known as 'lui,' the Mat River gains momentum and resplendent grandeur as it flows, with the Mawngping Lui and Mangang Lui being among the most prominent contributors. Its journey eventually culminates at the confluence with the Tuipui River, enhancing the river's magnificence and weaving an indelible tapestry of ecological marvel.

Despite its untapped potential for hydropower generation and irrigation, the Mat River remains a beacon of promise and prosperity for the region's inhabitants. Its uninterrupted flow serves as a lifeline for economic development, empowering communities and offering opportunities for growth. Across the three districts it traverses - Aizawl, Serchhip, and Lunglei - the river holds immense importance, sustaining approximately 20 villages that rely harmoniously on its ebbs and flows. As we embark on a comprehensive exploration of the Mat River Basin, we seek to unravel the intricate relationship between man and river and shed light on the prospects for sustainable development and preservation of this cherished natural resource. This research delves into the hidden nuances of the Mat River's influence, demonstrating its integral role in shaping the socio-economic tapestry of the region. Join us on this journey as we uncover the secrets and potential of the Mat River, an oasis of life amidst the heart of Mizoram.

3.1.2 Location and Extend

The present research endeavors to embark on a comprehensive exploration of the Mat River Basin, a vital geographic enclave ensconced within the verdant embrace of Mizoram, India. Nestled amidst the Aizawl District in Mizoram, the source of the Mat River gushes forth at an altitude of 1423 meters above mean sea level near the quaint hamlet of Baktawng. Spanning the longitudinal coordinates of 92°30′–93°00′E and the latitudinal coordinates of 22°30′–23°45′N, the Mat River Basin encompasses a total expanse of 147 square kilometers (Figure 3.1).

A perpetual watercourse, the Mat River traverses its course with a resplendent grandeur, intersecting the lives of the local populace while blessing the region with the invaluable resource it embodies. A convergence of numerous tributaries, affectionately known as 'lui' by the inhabitants, contributes to the river's voluminous flow as it meanders through the hills flanking its banks. Foremost among these tributaries are the Mawngping Lui and Mangang Lui, joining the Mat River from the right and left banks, respectively. Ultimately, the Mat River culminates its journey by merging with the Tuipui River, also known as the Chhimtuipui or Kolodyne River, at the catchment outlet, positioned at an altitude of 497. This confluence enhances the river's magnificence as it ventures forth into the broader landscape, weaving an indelible tapestry of ecological marvel.

Endowed with such abundance, the Mat River stands as a beacon of potential and prosperity, remaining untapped for hydropower generation and irrigation purposes. Its untamed vigor and uninterrupted flow serve as a natural resource for fostering the economic development of the region's inhabitants, empowering them with opportunities for growth and advancement. Intrinsically interwoven with the fate of the surrounding populace, the Mat River manifests its significance across the three districts it traverses: Aizawl, Serchhip, and Lunglei. An oasis of life amidst the heart of Mizoram, the river's course envelops approximately 20 villages, each dwelling in harmony with the ebb and flow of this aquatic lifeline (Figure 3.1). Diverse in its offerings, the Mat River caters to the varying altitudes of its surrounding villages, with Chhingchhip village in Serchhip district perched at the highest altitude, an epitome of altitude at 582 meters above sea level. Conversely, Leite Village of Lunglei District claims the distinction of being the lower village along the river's trajectory, gracefully settled at an altitude of 582 meters above sea level.

Lunglei district, adorned with 14 villages along the river's embrace, emerges as a testament to the river's integral role in shaping the region's socio-economic tapestry. With its prodigious length unfurling across the landscape, the Mat River extends its reach, spanning an awe-inspiring distance of 90.16 kilometers. As we delve into this comprehensive inquiry, the research endeavors to unearth the hidden nuances of the Mat River Basin, unraveling the symbiotic relationship between man and river, and illuminating the prospects for sustainable development and preservation of this cherished natural resource.

In this study, a total of 20 villages were case studied (Table 3.1). These villages fall in three districts. The latitude, longitude, and altitude of these villages are presented.

Table 3.1: Salient features of case study village

S. No.	Village	District	Block	Longitude	Latitude	Altitude(m)
1	Chhingchhip	Serchhip	Serchhip	92.8565	23.4709	1045
2	Chhiahtlang	Serchhip	Serchhip	92.8452	23.3774	880
3	Serchhip	Serchhip	Serchhip	92.8502	23.3417	888
4	Chengpui	Thenzawl	Serchhip	92.8209	22.977	762
5	Keitum	Sechhip	Serchhip	92.9114	23.232	654
6	East Bungtlang	Serchhip	Serchhip	92.9007	23.1823	764
7	Rawpui	Hnahthial	Lunglei	92.8989	23.1459	724
8	Pangzawl	Hnahthial	Lunglei	92.9001	23.0849	856
9	Thiltlang	Hnahthial	Lunglei	92.9213	23.0205	986
10	East Rotlang	Hnahthial	Lunglei	92.9039	22.884	638
11	Leite	Hnahthial	Lunglei	92.9114	22.9017	582
12	Zotuitlang	Hnahthial	Lunglei	92.8166	22.9986	937
13	Sekhum	Hnahthial	Lunglei	92.7095	23.1389	846

14	Kanghmun	Thenzawl	Lunglei	92.5736	23.5509	768
15	Haulawng	Lunglei	Lunglei	92.7705	23.0515	973.59
16	Chhipphir	Thenzawl	Lunglei	92.7967	23.1686	873
17	Ramlaitui	Thenzawl	Lunglei	92.7369	23.1815	800
18	S. Zote	Thenzawl	Lunglei	93.3578	23.4967	730
19	Buangpui	Thenzawl	Lunglei	92.7456	23.2364	768
20	Ralvawng	Hnahthial	Lunglei	92.8334	22.9351	1020

Source: Primary survey

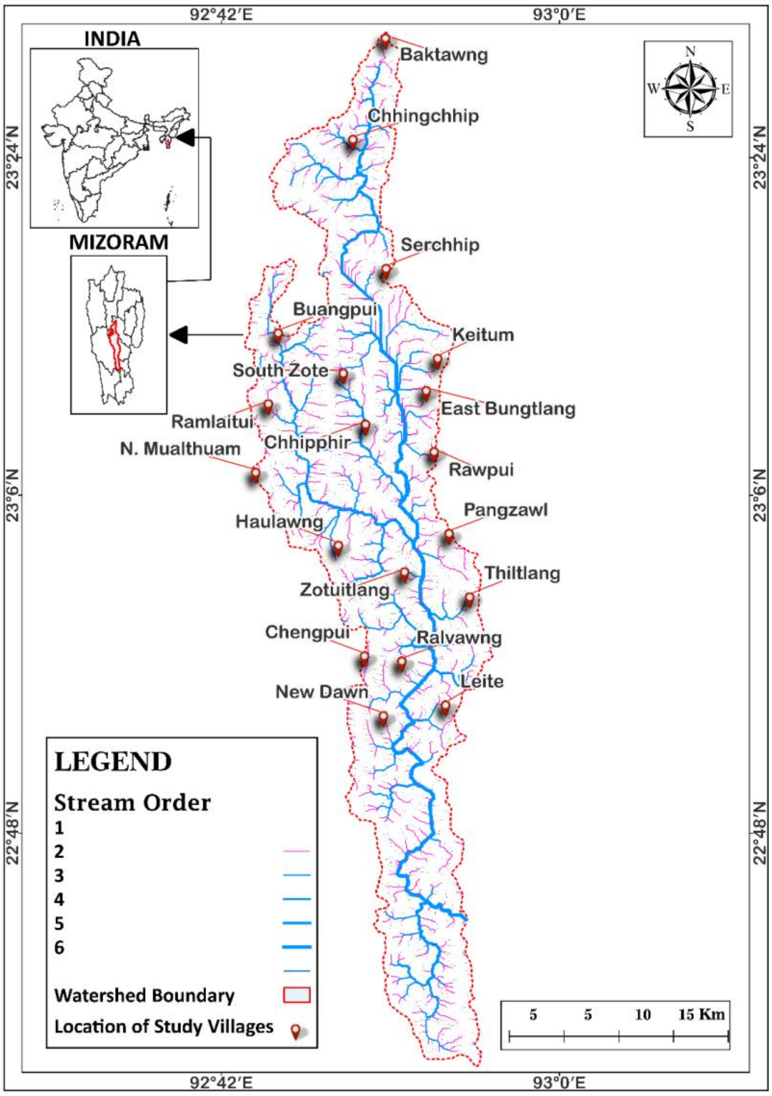

Figure 3.1. The Mat River Basin showing the study villages with rivers and streams.

3.1.3 Altitude-wise Area Coverage

Altitude, commonly referred to as the height or altitude of a point on the Earth's surface above a reference datum, is a fundamental geospatial parameter that plays a critical role in various scientific disciplines and practical applications. It is a key factor in shaping the physical and ecological characteristics of a region. Altitude data are crucial for studies related to geomorphology, hydrology, climatology, ecology, urban planning, and disaster management. In geomorphology, altitude data aid in understanding landforms' origins, evolution, and erosion patterns (Pike, 2016). Hydrological studies utilize altitude data to model water flow, simulate flooding, and estimate streamflow characteristics (Jasiewicz and Metz, 2011). Climate studies incorporate altitude to analyse temperature gradients and precipitation patterns at different altitudes (Buytaert et al., 2014). Altitude data also support habitat modelling and biodiversity assessments in ecological studies (Hortal et al., 2015). Urban planners and disaster managers use altitude information to assess flood risks and plan infrastructure (Doll and Müller, 2001). Accurate and high-resolution altitude data, acquired through technologies like remote sensing and global navigation satellite systems (GNSS), are indispensable for advancing these scientific domains and enhancing societal resilience.

The role of altitude in river basin studies is paramount, as it significantly influences the hydrological processes, geomorphology, and ecosystem dynamics within a watershed. Altitude plays a crucial role in determining the distribution of precipitation, temperature gradients, and subsequently, the spatial and temporal patterns of water flow within a river basin (Lehner and Döll, 2004). The altitudinal variations across a basin contribute to variations in precipitation regimes, which affect runoff generation, groundwater recharge, and streamflow characteristics (Dunne and Leopold, 1978). Furthermore, altitude influences the formation of landforms such as valleys, gorges, and floodplains, shaping the basin's geomorphology and sediment transport (Montgomery and Dietrich, 1992). Altitude-related changes in vegetation and land cover influence soil erosion rates and sediment delivery to rivers (Trimble, 1997). Thus, understanding the role of altitude in river basin studies is essential for comprehending the complex interactions between climate, hydrology, geology, and ecology within a watershed.

Table 3.2 and Figure 3.2 shows altitude-wise area cover in the Mat River Basin.

Table 3.2: Altitude-wise area coverage in the Mat River Basin

Landscape	Altitude (m)	Area Coverage	Percentage
Lower altitude	176-531	192.6162	19.632283
Low altitude	531.01-691	273.294	27.855317
Middle altitude	691.01-854	291.6378	29.724997
High altitude	854.01-1071	168.0057	17.123874
Higher altitude	1071.01-1551	55.566	5.6635291
	Total	981.1197	100

Source: By Author

Lower Altitude

The "Lower Altitude" category covers an area of approximately 192.62 square meters, representing the region of the Mat River Basin with the lower altitudes, ranging from 176 to 531 meters. This portion of the Mat River Basin constitutes around 19.63% of the total area. It includes areas such as valleys, plains, or low-lying regions. Lower Altitude part is the actual place of where the Mat River water flow through the study area, it found across all direction of the study area.

Low Altitude

The "Low Altitude" category covers an area of approximately 273.29 square meters, representing regions with altitudes ranging from 531.01 to 691 meters. This portion of the river basin constitutes around 27.86% of the total area. It could include gently sloping areas and foothills.

Middle Altitude

The "Middle Altitude" category covers an area of approximately 291.64 square meters, representing regions with altitudes ranging from 691.01 to 854 meters. This portion of the Mat River Basin constitutes around 29.72% of the total area. It might include hills and areas of medium altitude. Moderate altitude found alongside the range of Low altitude scattered throughout the study areas and mainly found on the northern part area.

High Altitude

The "High Altitude" category covers an area of approximately 168.01 square meters, representing regions with altitudes ranging from 854.01 to 1071 meters. This portion of the Mat River Basin constitutes around 17.12% of the total area. It could include higher mountains and elevated terrain. High altitude range are separated and dispersed throughout the study area specifically concentrated in the north area and, north west part of the study area. A small amount of area present in the south sides also.

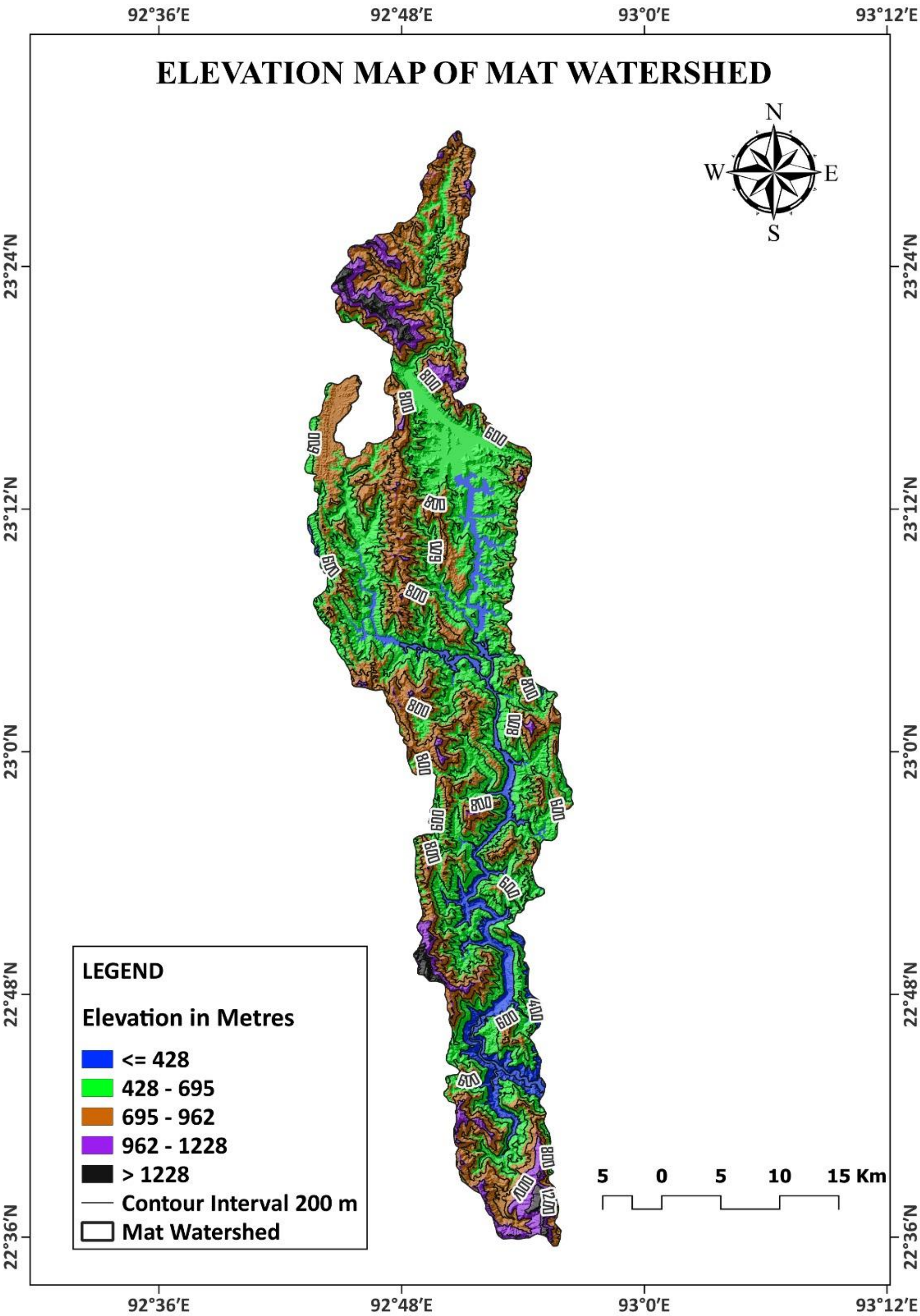

Figure 3.2. Altitude wise area cover.

Higher Altitude

The "Higher Altitude" category covers an area of approximately 55.57 square meters, representing regions with altitudes ranging from 1071.01 to 1551 meters. This portion of the river Basin constitutes around 5.66% of the total area. It might include the highest peaks and mountainous regions. Higher Altitude range are mostly present in the northern side and Southern south side, and occupying lesser areas.

Overall, the Mat River Basin has a total area coverage of 981.12 square meters, and the altitude distribution indicates that most of the area falls under the "Moderate Altitude" category, followed by the "Low Altitude" category. The higher altitudes, such as "High Altitude" and "Higher Altitude," cover a smaller proportion of the total area.

3.1.4 Slope Analysis

Lower Slope

The "Lower Slope" category represents regions in the Mat River Basin with the gentlest slopes, ranging from 0 to 12.45 degrees (Table 3.3). These areas have relatively flat terrain and are suitable for various activities, such as agriculture or settlement. It indicates the color of Dark Blue, the lower Slope areas is mainly found in the Northern part of the study areas, as in details focusing on the settled areas is North Western part and North Eastern part of the studies area.

Table 3.3: Slope Analysis of Mat River Basin

Type	Degree
Lower	0-12.45
Low	12.46-20.48
Moderate	20.49-27.67
High	27.68-35.97
Higher	35.98-70.57

Source: By Author

Low Slope

The “Low Slope” category covers regions with slopes ranging from 12.46 to 20.48 degrees. These areas have slightly steeper slopes compared to the lower slope category but are still relatively moderate (Table 3.3). They might be suitable for limited agricultural activities and some development. Low Slope range are found in along north to south across the study areas, whereas Low Slope Range: 12.46 to 20.48 degrees mostly found in end of the south point and central part of the study area.

Moderate Slope

The "Moderate Slope" category includes regions with slopes ranging from 20.49 to 27.67 degrees. These areas have moderately sloping terrain and may have some limitations for agriculture and construction.

High Slope

The "High Slope" category represents regions with slopes ranging from 27.68 to 35.97 degrees. These areas have steep slopes, making them challenging for agricultural activities and development. They may be more suitable for forestry or conservation purposes.

Higher Slope

The "Higher Slope" category covers regions with slopes ranging from 35.98 to 70.57 degrees. These areas have very steep to extremely steep terrain, likely consisting of rugged mountains or cliffs. They are generally unsuitable for agriculture or construction. Higher slope angle are found in entire area but most of the slope higher are located in the southern part of the study area.

Understanding the distribution of slope degrees in the Mat River Basinis essential for various land management and environmental planning purposes. It helps identify areas prone to erosion, potential landslide risk, and areas suitable for specific land uses.

3.1.5 Climate

Climate refers to the long-term patterns of weather conditions observed in a specific region over an extended period, typically spanning several decades or centuries. It includes parameters such as temperature, humidity, precipitation, wind patterns, and atmospheric pressure, among others. Climate plays a crucial role in shaping the ecosystems, vegetation, and overall environmental conditions in each area (Schneider 2009).

The elevated regions of the hills are reliably cold and refreshing during the summer, while the lower areas are relatively warm and humid. Storms emerge during the period of March-April, just prior to or around the summer season. The highest average temperature in the summer reaches 30 degrees Celsius, whereas the lower average temperature in winter hovers around 11 degrees Celsius.

The four months between November and February constitute the winter season in Mizoram, followed by the spring. The storms arrive in mid-April, signaling the onset of summer. As the temperature begins to rise, the hills become veiled in a haze. The three months from June to August are designated as the rainy season. The climate is at its most pleasant during the two autumnal months, September and October, with temperatures fluctuating between 19 to 24 degrees Celsius.

All things considered, Mizoram comprises wooded hills, swiftly flowing rivers, glistening streams, and serene lakes – a combination that is truly rare. It is the amalgamation of these geographical features that lends Mizoram its distinct charm and allure. The Study areas fall under climate of Moist Sub tropical climate, the Mat River Basin areas occupied three districts of Aizawl, Serchhip, Lunglei, the average annual rainfall of Aizawl district area with the past 20 years (2001 -2021) is 2367.315 mm (Table 3.4). Serchhip district area with the past 20 years (2001 -2021) is 1723.245 mm. Lunglei district area with the past 20 years (2001 -2021) is 2333.22 mm. So, with in these three district areas where the Mat River Basin situated, the areas received an average rainfall of 2141.927 mm with in the past 20 years (2001-2021).

Table 3.4. Annual rainfall in the Mat River Basin

Year	Aizawl	Serchhip	Lunglei
2015	2143.7	2164.3	3049.9
2014	1604.1	1811	2367.1
2013	2215.8	1639.6	2312.6
2012	2466.5	1752.2	2637
2011	1769.9	1969.9	2736.6
2010	2451.6	2361	3012.7
2009	1676.6	1477.3	2314
2008	1790.3	1887.3	1877.1
2007	2776.9	2942.6	3435.5
2006	1824.2	1849.5	2206.8
2005	2436.4	1370.4	1863.5
2004	3108.3	2502.5	2850
2003	2971	2561	2331
2002	2788	2270.5	2436.6
Average data	2298.99	2092.61	2561.07
Total		2317.56	

Source: GPS survey by Author

Table 3.5 shows monthly distribution of temperature. It shows that the minimum temperature in January was noticed 11.6^{o} C and in October, it was 19.55^{o} C. In other months the temperature was in between two. In terms of maximum temperature, it was 20.75^{o} in Dec and in April, it was 27.84^{o} C.

Table 3.5 Monthly distribution of temperature in 2016

Monthly distribution of temperature		
Month	Minimum	Maximum
January	11.6	22.97
February	12.63	24.5
March	14.06	23.86
April	17.56	27.84
May	18.3	26.3
June	18.85	25.3
July	19.03	25.33
August	18.77	24.53
September	18.1	25.5
October	19.55	24.05
November	18.45	22.4
December	17	20.75

Source: GPS survey by Author

Table 3.6 shows the minimum and maximum monthly relative humidity of three districts, i.e., Aizawl, Serchhip and Lunglei. Aizawl has the minimum temperature in the month of April and maximum in the month of January. While Serchhip has been so humid even in summer, it reaches 58.9 in March which was the least and highest in the month of May.

Table 3.6. Monthly humidity of the Mat River Basin

District wise monthly relative humidity (in Percentage)							
Sn	Month	Aizawl		Serchhip		Lunglei	
		Min	Max	Min	Max	Min	Max
1	2	7	8	11	12	13	14
1	January	72.9	81.5	78.9	84.1	81.4	89
2	February	67.2	77	81.3	86.3	83.3	89.5
3	March	50.7	62.8	58.9	63.7	77.3	87.6
4	April	45	55.6	83.1	89.5	82.2	89.9
5	May	51.4	61.1	82.8	89.6	84.4	90.6
6	June	58.1	72	N/A	N/A	78.7	87.9
7	July	53.7	72.9	84.5	90.9	81.4	89.9
8	August	55.8	73.1	76.6	78.2	85.1	90.7
9	September	50.2	71.1	72.2	74.3	73.4	86.1
10	October	64.8	83.1	N/A	N/A	80.1	89.1
11	November	57.9	71.6	N/A	N/A	82.5	90.1
12	December	57.5	72	N/A	N/A	86.5	89.9
13	Average	57.1	71.2	77.3	82.1	81.3	89.2

Source: GPS survey by Author

3.1.6 Land Use Pattern

Forest is the major land use in Mizoram. A forest can be defined as "a complex and diverse biological community comprising trees, shrubs, plants, and wildlife, covering extensive land areas and contributing to the global carbon cycle, biodiversity conservation, and climate regulation." Bonan (2008) The forested region encompasses over 50% of the Mat River Basin, comprising dense/close and open forest types. However, due to the prevalent practice of Jhumming (slash-and-burn) cultivation in the area, significant harm is inflicted upon the Mat River Basin ecosystem.

The study pertains to the Mat River Basin, located in the pristine region of Mizoram, where the landscape boasts a prominent combination of land cover types, namely Forest Cover, Agriculture Land, Built-up areas, and Water Bodies. This investigation aims to discern the transformation in the land use and land cover patterns that have transpired over the temporal span between 2008 and 2017. At the onset of analysis, it emerges that the Mat River Basin's ecological equilibrium has been disrupted as a result of anthropogenic interventions, particularly human settlements, and various multifaceted activities. Consequently, the domain once lush with verdant canopy has witnessed a discernible decline in its Forest Cover. The vast expanse of woodland, which measured 900.17 km square units in 2008, experienced a noteworthy reduction, contracting to 837.05 km square units in 2017. This trend alludes to the encroachment of human habitation and living requirements endeavors upon the sylvan territories, engendering ecological repercussions of profound import.

Figure 3.3. Mat River crossing forest in Lunglei district. Photo: By Author.

Paralleling this encroachment, there has been an observable upsurge in Built-up areas within the study locale. These Built-up areas signify the expansive encroachment of urbanization and developmental activities, marking the march of modernity upon the landscape. As the epoch of analysis transitioned from 2008 to 2017, the extent of Built-up areas burgeoned from a modest 11.14 km square units to a substantial 22.73 km square units. This burgeoning urbanization reflects the burgeoning needs of a growing populace and the concomitant demand for infrastructural facilities, albeit at the expense of pristine ecosystems.

In tandem with the altering land cover patterns, the water bodies in the Mat River Basin have undergone a discernible diminishment. These aquatic resources, comprising rivers, lakes, and ponds, experienced a perceptible decline from 19.16 km square units in 2008 to a meager 6.86 km square units in 2017. This decrement is ascribed to several factors, including the landscape's slope aspect, which facilitates swift surface runoff, thereby hampering the sustenance and replenishment of these water bodies. Consequently, the waning of water resources bears potential implications for the River Basin's ecological integrity, hydrological balance, and the well-being of both terrestrial and aquatic ecosystems.

Moreover, amidst these transformations, the agricultural domain has encountered a salient augmentation, indicative of a pronounced shift in occupation from primary to secondary sectors. As livelihoods veer away from traditional activities like farming and forestry towards secondary occupations like services and industries, the landscape has witnessed a significant expansion of Agricultural Land. This realm of cultivation swelled remarkably from 51.58 km square units in 2008 to 79.39 km square units in 2017, signifying the populace's shifting endeavors towards food production and agrarian pursuits (Table 3.7).

In conclusion, the Mat River Basin in Mizoram emerges as a canvas that bears the indelible imprints of human agency and developmental aspirations. The progressive decline in Forest Cover, concomitant with the burgeoning Built-up areas, highlights the inexorable march of urbanization encroaching upon the once-pristine wilderness. Additionally, the dwindling Water Bodies, influenced by the interplay of slope aspects and rapid runoff, underscores the urgency of conservation and sound hydrological management. Furthermore, the expanding Agricultural Land portends shifts in societal occupation dynamics and necessitates sustainable land use practices to foster ecological resilience and safeguard the region's natural heritage for posterity.

Table 3.7. Land Use Land Cover Data of the Mat River Basin

Land Use Land Cover data of Mat River Basin (in sq km)			
Classification	2008	2017	Change (%)
Forest Cover	900.17	837.05	
Built-up	11.14	22.73	
Water-Bodies	19.16	6.86	
Agricultural Land	51.58	79.39	
Total	982.05	982.05	

Source: From Satellite Image LISS III

3.1.7 Soil Texture

Soil texture refers to the relative proportion of different-sized mineral particles (sand, silt, and clay) present in a soil sample. It plays a crucial role in determining the soil's physical properties, such as water retention, drainage, aeration, and nutrient availability (Brady and Weil, 2016)

Mizoram is a state in the northeastern region of India, bordered by Bangladesh and Myanmar. Its soil profile exhibits unique and diverse characteristics due to variations in its topography, climate, and vegetation cover. The soil profile can be described as a vertical section of the soil displaying different layers or horizons with distinct properties.

In general, the soil in study areas is categorized as tropical rainforest soil, characterized by high rainfall, humidity, and temperature. This type of soil undergoes significant weathering, leading to increased acidity and limited nutrient content. The soil profile consists of several distinct layers or horizons discernible by their physical and chemical attributes. The topsoil layer is typically the shallower and is composed of organic Matter and mineral Materials, while the subsoil layer is denser and usually contains higher mineral content.

The topsoil layer in the Mat River Basin area exhibits a dark brown color and possesses a gravelly or sandy texture. It is rich in organic Matter, comprising decomposed plant and animal Materials. This layer plays a vital role in supporting vegetation growth and provides essential nutrients and moisture for plant sustenance. However, the region's high rainfall and humidity lead to leaching, causing nutrients in the topsoil to be easily washed away, resulting in nutrient deficiency in the soil.

The subsequent layer in the soil profile is the subsoil layer, which is often lighter in color than the topsoil and has a higher concentration of minerals. It comprises clay, silt, sand, and gravel, and is generally more compact and less porous than the topsoil layer. This layer also contains more nutrients than the topsoil; however, the lower organic Matter content makes it more challenging for plants to access these nutrients. The areas of Mat River Basin fall under three areas of Aizawl, Serchhip, Lunglei as their soil profile may also encompass specific layers or horizons, such as the A, B, and C horizons. The A horizon represents the topsoil layer and is typically the most fertile. It is rich in organic Matter and is the area where plants and organisms thrive. The B horizon represents the subsoil layer, containing higher mineral content than the topsoil, and significantly contributes to the soil's physical and chemical properties. The C horizon, being the lower layer of the soil profile, comprises unweather rock fragments

The soil is classified as tropical rainforest soil, experiencing considerable weathering and possessing limited nutrient content. The topsoil layer is dark brown, rich in organic Matter, and exhibits a gravelly or sandy texture. The subsoil layer is lighter in color, contains higher mineral content, and has reduced porosity compared to the topsoil layer. The soil profile may also comprise specific layers or horizons, such as the A, B, and C horizons, each bearing distinct physical and chemical properties. Understanding the soil profile in the Mat River Basin holds paramount importance for sustainable agriculture practices and land management.

Indeed, a comprehensive soil profile description is crucial for understanding the soil and its properties in the Mat River Basin. The presence of multiple layers or horizons with distinct compositions and textures provides valuable insights into the soil's fertility and suitability for various agricultural practices. The three major soil types in Mizoram, namely red loamy soil, lateritic soil, and hill soil, each exhibit specific characteristics also influence the regions of the Mat River Basin.

The red loamy soil, being the most common type, covers a significant portion of the study area. Its four layers, including the topsoil, subsoil, substratum, and parent Material, demonstrate varying properties and depths. The dark brown topsoil layer enriched with organic matter and minerals supports vegetation growth, while the light brown subsoil layer comprising a mix of clay and sand contributes to the soil's overall structure. The substratum and parent Material layers, containing sand, gravel, and weathered rocks, play essential roles in the long-term soil development.

Lateritic soil, accounting for a substantial portion of the Mat River Basin, area of land surface, derives from the weathering of iron and aluminum-rich rocks. Its distinct reddish-brown color and coarse texture indicate the presence of laterite in the topsoil layer, characterized by its porosity and gravelly nature. The subsoil layer, with a higher clay content, and the bedrock layer, located at the bottom of the soil profile, contribute to the soil's overall composition and stability.

Hill soil, commonly found in hilly or mountainous regions, possesses a stony texture and exhibits low fertility. The four layers of hill soil, including topsoil, subsoil, weathered parent Material, and bedrock, further illustrate the soil's complexity. The topsoil layer, composed of decomposed organic Matter, minerals, and sand, forms the initial layer for plant growth. The subsoil layer, with higher clay content, impacts water retention and nutrient availability. The weathered parent Material layer, comprising broken down rocks and boulders, influences the soil's long-term development. The bedrock layer, being a hard rock layer at the bottom, constitutes the foundation of the soil profile (Figure 3.4).

Overall, a comprehensive understanding of the soil profile in the Mat River Basin aids in preserving soil health and combating soil degradation. The unique characteristics and distribution of various soil types in the region influence agricultural practices, land use planning, and environmental conservation efforts. By recognizing the distinct layers and horizons, and the specific properties they entail, stakeholders can make informed decisions to ensure sustainable land management practices and protect the vital soil resources of the study area.

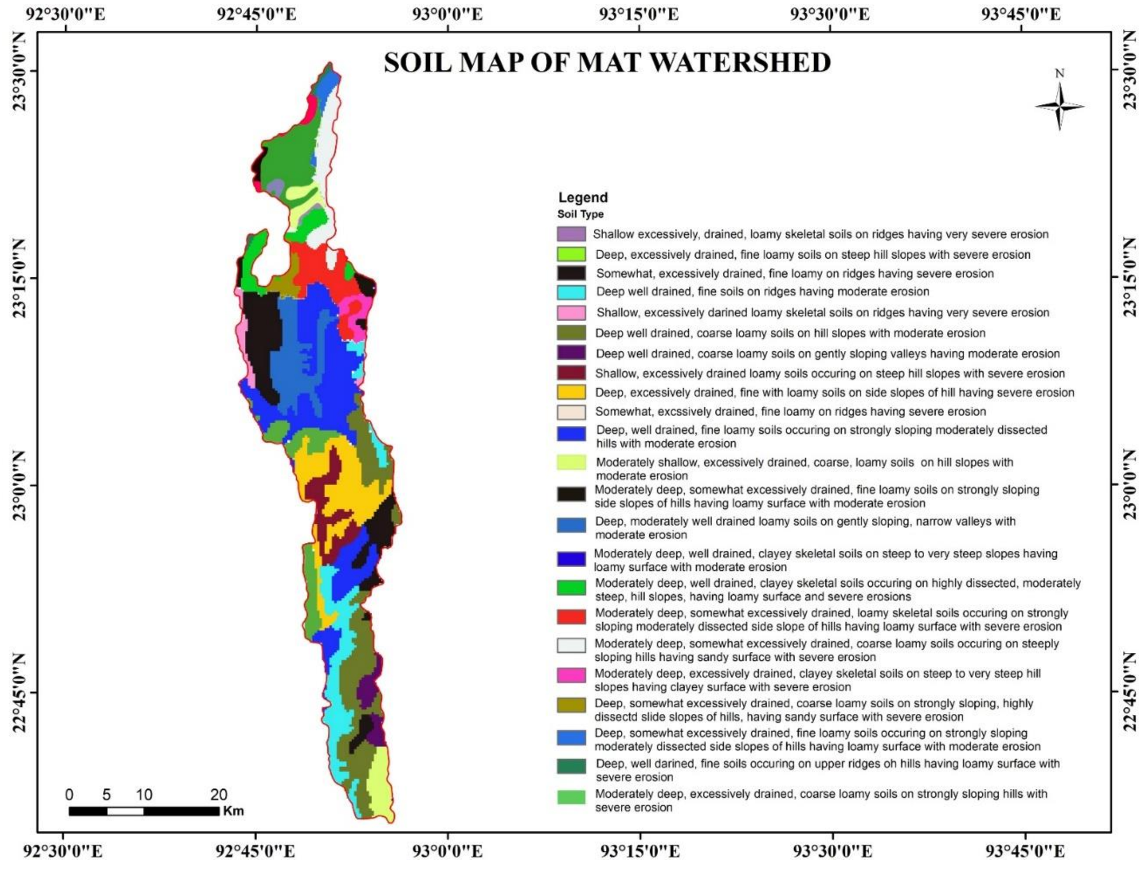

Figure 3.4. Soil Map of the Mat River Basin

3.2. Socio-economic Profile

3.2.1. Introduction

The Mat River Basin is an important geographical area located in the heart of the state of Mizoram. In order to fully comprehend the socio-economic dynamics of this region, it is essential to delve into the various aspects that contribute to its overall background. One crucial factor that characterizes the Mat River Basin is its population structure. The region is home to a diverse mix of people, belonging to different ethnicities and cultures. It is important to understand the population demographics in terms of age groups, as this can provide insights into the overall economic activity and development potential of the area.

Education plays a significant role in determining the socio-economic status of any region. In the case of the Mat River Basin, an analysis of the educational landscape reveals the level of human capital development within the community. Access to quality education can have a substantial impact on the overall well-being and economic prosperity of the population.

The sex ratio, which indicates the number of males to females in each population, is another important aspect of the socio-economic makeup of the Mat River Basin. Understanding the sex ratio can highlight any gender disparities or imbalances within the community, and shed light on the various socio-economic challenges faced by different genders.

Decadal changes in population size and composition are critical to understanding the patterns of growth or decline over a specific timeframe. By analyzing the decadal changes in the Mat River Basin, we can gain insights into the factors that have influenced the population dynamics and their subsequent impact on the socio-economic conditions of the region.

Economic development is a fundamental aspect of any socio-economic background. Examining the level of economic growth and diversification in the Mat River Basin can provide valuable insights into the overall progress and potential for further development. This can include analyzing the presence of industries, businesses, and entrepreneurial activities within the area.

Per capita income, which measures the average income earned per person in a given population, is another crucial indicator of socio-economic well-being. By studying the per capita income in the Mat River Basin, we can assess the overall standard of living and economic prosperity of its residents. This information can help inform policies and interventions aimed at improving the quality of life and reducing income disparities in the region.

Finally, an analysis of the dependence on agriculture within the Mat River Basin is essential. Many regions heavily rely on agriculture as a primary source of income and employment. Understanding the level of agricultural dependence in this area can help identify the specific challenges and opportunities faced by the local population, as well as provide insights into potential strategies for sustainable development.

3.2.2. Population Profile

In this population structure of the Mat River Basin area, the collecting data will delve into the population data of a region comprising several villages, shedding light on various aspects of demographics. The data provided includes information on the total population, male and female populations, households, and children aged 0-6 years.

By contrasting the demographics of different villages, it provides data to gain valuable insights into the diversity and unique characteristics of the region's communities.

3.2.3. The Mat River Basin

The region under examination has a total population of 66,894 individuals, making it a significant and vibrant area. Out of this population, there are 33,736 males and 33,158 females. This gender distribution reveals an almost equal proportion of males and females, contributing to the region's overall demographic balance.

Table 3.8. Population profile in the Mat River Basin.

Region	Total Population	Total Households	Males	Females	Children (0-6)	SC Population	ST Population
Chhingchhip	3,741	726	1,826	1,915	493	11	3,571
Serchhip	44,242	8,512	22,383	21,859	6,190	31	42,452
Keitum	2,022	412	1,007	1,015	320	1	2,015
Buangpui	390	84	199	191	70	0	381
South Zote	722	142	380	342	107	0	719
Ramlaitui	550	111	287	263	86	0	545
Chhipphir	1,278	265	629	649	155	0	1,274
N. Mualthuam	1,387	272	694	693	179	0	1,383
Haulawng	2,227	456	1,190	1,037	313	0	2,184
Zotuitlang	534	119	265	269	81	0	528
Chengpui	140	33	74	66	29	0	118
Ralvawng	401	90	204	197	59	0	388
New Dawn	384	91	204	180	61	0	362
Rawpui	835	172	413	422	138	0	831
Pangzawl	2,428	510	1,194	1,234	332	0	2,378
Thiltlang	1,064	236	542	522	144	3	1,047
Leite	665	173	321	344	73	2	653
E. Rotlang	664	135	338	326	45	0	654
Baktawng	3,220	551	1,586	1,634	279	1	3,188
East Bungtlang	1,966	387	984	982	279	0	1,959
Total	66,894	13477	33,736	33,158	9,433	49	66,630

Source:By Author

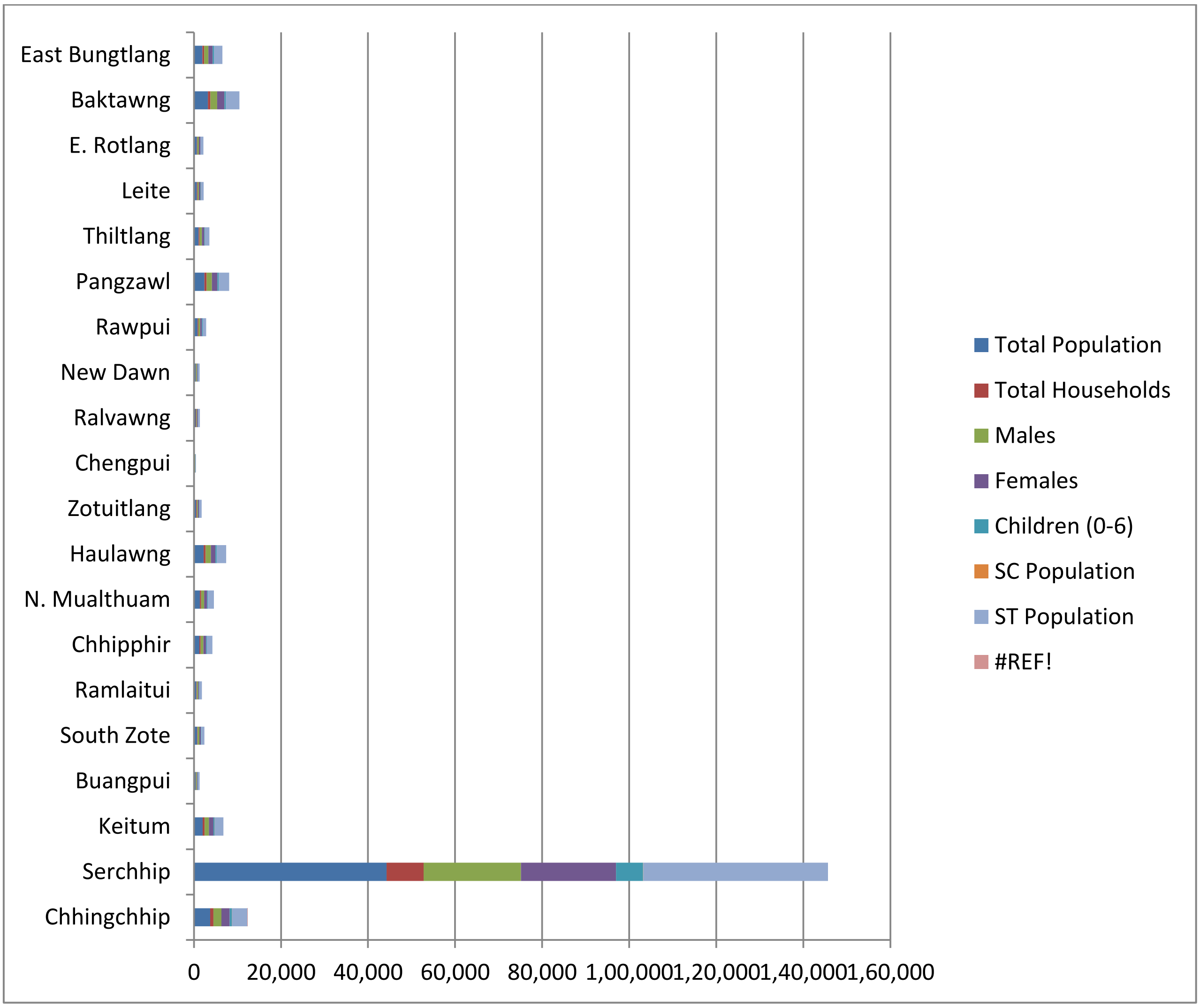

Figure 3.5. Side Bar Graph of Population file**.**

3.2.3.1 Population Distribution

As we delve into individual villages, we discover intriguing disparities in population sizes. The village with the largest population is "Serchhip," which boasts an impressive population of 44,242 residents. This village's significant population could be attributed to various factors such as economic opportunities, infrastructural development, and social amenities.

In contrast, "Chengpui" village has the smallest population in the region, housing just 140 inhabitants. The reasons for the small population in "Chengpui" could be related to factors like remoteness, limited resources, or perhaps a deliberate choice of residents to maintain a close-knit community.

By calculating the difference between the largest and smallest population villages, we find a substantial gap of 44,102 individuals. This population distribution highlights the varying sizes and dynamics of the villages within the region. Understanding these differences is crucial for policymakers to address the unique challenges and opportunities presented by each village.

3.2.3.2. Villages with the Largest Male and Female Population

Further analysis reveals that "Serchhip" is not only the village with the largest overall population but also takes the lead in both male and female populations. The village houses 22,383 males and 21,859 females, indicating a balanced gender distribution despite its large size.

3.2.3.3. Villages with the Smallest Male and Female Population

On the other end of the spectrum, "Chengpui" has the smallest male population, with only 74 males residing in the village. Correspondingly, it also has the smallest female population, with just 66 females. The closely Matched male and female numbers in "Chengpui" suggest a small, tight-knit community with potentially limited migration.

3.2.3.4. Household Statistics & Household Distribution

In addition to population data, examining household statistics provides valuable insights into family structures and living arrangements in the region. "Serchhip" stands out with the largest number of households, boasting 8,512 households. This village's larger household count could indicate a higher birth rate, a preference for larger families, or economic factors leading to joint family living.

Conversely, "Chengpui" has the smallest number of households, with only 33 households in total. The smaller household size might indicate a preference for nuclear families or a smaller population of young families in the village.

The significant contrast between the largest and smallest household villages highlights the diversity in family sizes and compositions. The difference of 8,479 households emphasizes the need for tailored approaches to address the varying requirements of each village when it comes to infrastructure, public services, and welfare programs.

3.2.3.5. Children Aged 0-6 Years

Examining the number of children aged 0-6 years across all villages provides crucial insights into the region's youthfulness and the potential demands for educational and childcare facilities. The total number of children in this age group is 9,154 Villages with the Largest and Smallest Number of Children (0-6) Years. Once again, "Serchhip" takes the lead with the highest number of children aged 0-6 years, totaling 6,190. This statistic might indicate a higher birth rate or a greater number of young families in the village, making it essential to provide adequate healthcare and educational facilities for these children's development. On the other hand, "Chengpui" has the smallest number of children aged 0-6 years, with only a modest 6 children. While this number is significantly lower, it suggests a more Mature population or potentially fewer families with young children residing in the village.

3.2.3.6. Education

This presents an analysis of literacy and illiteracy rates in various villages, with a focus on the highest and lower literacy rates, as well as populations of literate and illiterate individuals. The data is derived from a comprehensive survey conducted in the region, and the following results offer valuable insights into the educational landscape of these villages.

3.2.3.7. Village with the Highest Literacy Rate

Chhingchhip boasts the highest literacy rate among the villages, with an impressive 90.5933% of its total population being literate individuals. This village sets an example of the importance of education and highlights the effectiveness of educational initiatives in the community.

Table 3.9. Education Structure of Mat River Basin.

Village	Literacy Rate in %	Illiteracy Rate in %	Literates Total Population	Illiterates Total Population	Male Literates Population	Male Illiterates Population	Female Literates Population	Female Illiterates Population
Chhingchhip	90.59%	9.41%	3,175	566	1,577	249	1,598	317
Serchhip	88.35%	11.65%	37,342	6,900	18,916	3,467	18,426	3,433
Keitum	89.73%	10.27%	1,665	357	838	169	827	188
Buangpui	76.62%	23.38%	308	82	162	37	146	45
South Zote	86.33%	13.67%	600	122	315	65	285	57
Ramlaitui	70.02%	29.98%	423	127	221	66	202	61
Chhipphir	85.98%	14.02%	1,099	179	538	91	561	88
N.Mualthuam	85.23%	14.77%	1,204	183	605	89	599	94
Haulawng	83.06%	16.94%	1,832	395	966	224	866	171
Zotuitlang	74.68%	25.32%	419	115	216	49	203	66
Chengpui	65.38%	34.62%	104	36	55	19	49	17
Ralvawng	76.62%	23.38%	325	76	164	40	161	36
New Dawn	76.92%	23.08%	312	72	164	40	148	32
Rawpui	80.65%	19.35%	678	157	339	74	339	83
Pangzawl	80.97%	19.03%	2,014	414	984	210	1,030	204
Thiltlang	83.90%	16.10%	886	178	455	87	431	91
Leite	78.04%	21.96%	551	114	267	54	284	60
East Rotlang	77.61%	22.39%	536	128	278	60	258	68
Baktawng	80.06%	19.94%	2,624	596	1,291	295	1,333	301
East Bungtlang	84.55%	15.45%	1,663	303	821	163	842	140

Source: Census of India 2011

3.2.3.8. Village with the Lower Literacy Rate

Chengpui records the lower literacy rate among the villages, with only 65.3846% of its total population being literate (Table 3.10). This statistic emphasizes the need for targeted educational interventions to improve literacy levels in the village.

Table 3.10 Literacy & illiteracy rate showing in percentage.

Village	Total Literacy Rate (%)	Total Illiteracy Rate (%)	Male Literacy Rate (%)	Male Illiteracy Rate (%)	Female Literacy Rate (%)	Female Illiteracy Rate (%)
Chhingchhip	90.59%	9.41%	49.65%	7.85%	50.35%	10.00%
Serchhip	88.35%	11.65%	50.64%	9.28%	49.36%	9.05%
Keitum	89.73%	10.27%	50.27%	10.15%	49.73%	11.08%
Buangpui	76.62%	23.38%	52.60%	12.01%	47.40%	13.41%
South Zote	86.33%	13.67%	52.50%	10.83%	47.50%	9.50%
Ramlaitui	70.02%	29.98%	52.27%	15.63%	47.73%	18.37%
Chhipphir	85.98%	14.02%	48.68%	8.28%	51.32%	15.75%
N. Mualthuam	85.23%	14.77%	50.17%	7.39%	49.83%	15.66%
Haulawng	83.06%	16.94%	52.80%	12.21%	47.20%	9.30%
Zotuitlang	74.68%	25.32%	46.54%	11.49%	53.46%	32.73%
Chengpui	65.38%	34.62%	52.88%	33.65%	47.12%	47.22%
Ralvawng	76.62%	23.38%	50.46%	17.54%	49.54%	31.58%
New Dawn	76.92%	23.08%	52.56%	16.67%	47.44%	19.35%
Rawpui	80.65%	19.35%	49.85%	10.96%	50.15%	24.70%
Pangzawl	80.97%	19.03%	48.88%	10.42%	51.12%	24.58%
Thiltlang	83.90%	16.10%	51.34%	9.81%	48.66%	25.84%
Leite	78.04%	21.96%	48.46%	9.80%	51.54%	28.65%
East Rotlang	77.61%	22.39%	51.87%	11.19%	48.13%	20.80%
Baktawng	80.06%	19.94%	49.11%	11.24%	50.89%	16.88%
East Bungtlang	84.55%	15.45%	49.34%	9.81%	50.66%	46.20%

Source: Census of India 2011

3.2.3.9. Gender-Specific Analysis:

3.2.3.9. Village with the Highest Male Literate Population*:* Serchhip

Among male residents, Serchhip demonstrates the highest number of literate individuals, with 18,916 men possessing education. This highlights the village's emphasis on educating its male population.

Village with the Lower Male Literate Population: Chengpui

Chengpui has the lower number of literate males, with only 55 men having attained education (Table 3.10). This suggests the need for targeted efforts to improve male literacy in the village.

Village with the Highest Illiterate Male Population: Serchhip

Serchhip also reports the highest number of illiterate males, with 3,467 men lacking basic literacy skills. Addressing this distribution is crucial to promoting gender equality in education.

Village with the Lower Illiterate Male Population: Chengpui

Chengpui has the lower number of illiterate males, with only 19 men lacking basic literacy skills. These highlights positive strides in male education in the village.

Village with the Highest Female Literate Population: Serchhip

Among female residents, Serchhip has the highest number of literate individuals, with 18,426 women possessing education. This indicates the village's focus on female empowerment through education.

Village with the Lower Female Literate Population: Chengpui

Chengpui has the lower number of literate females, with only 49 women having attained education. Addressing this gender distribution in education is essential for the village's progress.

Village with the Highest Illiterate Female Population: Serchhip

Serchhip also reports the highest number of illiterate females, with 3,433 women lacking basic literacy skills. Empowering women through education is vital for the village's development.

Village with the Lower Illiterate Female Population: Chengpui

Chengpui has the lower number of illiterate females, with only 17 women lacking basic literacy skills. Efforts to further reduce female illiteracy should be recognized and supported**.**

3.2.4. Sex Ratio

The sex ratio, expressed as the number of females per 1000 males, is a demographic indicator used to measure the relative distribution of females and males within a given population. By dividing the number of females by the number of males and then multiplying the result by 1000, the sex ratio provides valuable insights into the gender composition of a community or region (Table 3.11). The total sex ratio represents an aggregate figure calculated for the entire area under consideration, encompassing all villages. It reflects the overall gender balance of the population, considering both males and females across different localities.

The highest sex ratio refers to the village where the proportion of females per 1000 males is the greatest. Such a village exhibits a notable abundance of females in relation to males, potentially stemming from specific social, cultural, or environmental factors within that community.

Table 3.11. Sex ratio of Mat River Basin

Village	Males	Females	Sex Ratio (Females per 1000 Males)
Chhingchhip	1,826	1,915	1,050.38
Serchhip	22,383	21,859	977.6
Keitum	1,007	1,015	1007.94
Buangpui	199	191	961.81
South Zote	380	342	900
Ramlaitui	287	263	916.86
Chhipphir	629	649	1031.25
N. Mualthuam	694	693	998.56
Haulawng	1,190	1,037	871.43
Zotuitlang	265	269	1015.09
Chengpui	74	66	891.89
Ralvawng	204	197	965.69

New Dawn	204	180	882.35
Rawpui	413	422	1020.58
Pangzawl	1,194	1,234	1034.57
Thiltlang	542	522	963.84
Leite	321	344	1071.65
E. Rotlang	338	326	964.5
Baktawng	1,586	1,634	1028.49
East Bungtlang	984	982	996.75
Total	33,736	33,158	997

Source: By Author

Conversely, the lower sex ratio pertains to the village with the smallest number of females per 1000 males, indicating a marked shortage of females compared to males within that area. A good sex ratio is often associated with a balanced distribution of males and females in the population. This equilibrium is generally observed when the sex ratio is close to 1000 or slightly higher, denoting a marginally greater number of females. A positive sex ratio arises when the number of females surpasses that of males within the population. This situation implies that for every 1000 males, there exist more than 1000 females, signifying a pronounced female predominance.

Furthermore, by differentiating positive and negative sex ratios, we observe that several villages, including Chhingchhip, Keitum, Buangpui, Chhipphir, N. Mualthuam, Ralvawng, New Dawn, Rawpui, Pangzawl, Leite, and Baktawng, have a sex ratio greater than 1000, signifying a positive sex ratio with an excess of females. Conversely, villages such as South Zote, Chengpui, Haulawng, Serchhip, and Thiltlang have a sex ratio lower than 1000, indicating a negative sex ratio with a surplus of males. It is crucial to recognize that imbalances in the sex ratio can have profound societal and demographic ramifications, and these imbalances may be influenced by a multitude of factors, including cultural preferences, migration patterns, and socioeconomic conditions. Striving for a balanced sex ratio is of utmost importance for the overall well-being and stability of any population.

3.2.4.1. Children 0-6 age group Sex Ratio

Showing on the table presents vital data on the sex ratio in various villages, focusing on the age group 0-6. Sex ratio, which is the number of females per thousand males, is an essential demographic indicator that reflects the balance between genders in a given population. This age group will affect the population structure of the future generation of the data, highlighting the highest and lower sex ratio villages in the 0-6 age group, and the overall total sex ratio for the entire region.

3.2.4.2. Highest Sex Ratio Village (0-6 Age Group)

Zotuitlang emerges as the village with the highest sex ratio of females per thousand males in the age group 0-6, standing at an astonishing 1314.29. This strikingly high ratio suggests that there are significantly more females than males in this particular age range in the village. A high sex ratio can indicate various factors, including a preference for having female children, socioeconomic and cultural factors, and variations in birth rates. Further investigation into the social and cultural context of Zotuitlang is necessary to better understand the factors contributing to this high sex ratio.

3.2.4.3. Lowest Sex Ratio Village (0-6 Age Group)

On the other end of the spectrum, New Dawn village displays the lowest sex ratio in the 0-6 age group, at a considerably lower 648.65. This indicates a significant imbalance between male and female populations in this age range. A low sex ratio can be attributed to several factors, such as higher mortality rates among females or a preference for male offspring. Additionally, social, and cultural norms, such as gender-based discrimination, may contribute to the disparities observed. Addressing the root causes behind the low sex ratio in New Dawn is crucial for promoting gender equality and ensuring a healthy demographic balance.

3.2.4.4. Total Sex Ratio (0-6 Age Group)

Looking at the entire region, the total sex ratio in the 0-6 age group is approximately 944.99. This figure represents the overall ratio of females per thousand males in the age range across all villages combined. A sex ratio close to 1000 indicates a relatively balanced gender distribution in this age group. However, the region's total sex ratio falls slightly below this mark, suggesting a slight preponderance of males in comparison to females. It is important to consider the implications of this overall sex ratio on social dynamics, family structures, and community development.

Table 3.12 highlights the wide disparities in sex ratios among villages in the age group 0-6. The highest sex ratio village, Zotuitlang, indicates a potential preference for female children or other cultural factors influencing gender demographics. Conversely, the lower sex ratio village, New Dawn, raises concerns about gender inequality and the need for targeted interventions to address the underlying causes. The overall total sex ratio

Table 3.12. Sex ratio 0-6 age group.

Village/town	Total Population	Population (0-6)	Males (0-6)	Females (0-6)	Sex Ratio (0-6)
Chhingchhip	3741	493	224	269	1201.79
Serchhip	44242	6190	3154	3036	961.4
Keitum	2022	320	155	165	1064.52
Buangpui	390	70	34	36	1058.82
South Zote	722	107	63	44	698.41
Ramlaitui	550	86	50	36	720
Chhipphir	1278	155	78	77	987.18
N. Mualthuam	1387	179	87	92	1057.47
Haulawng	2227	313	180	133	738.89
Zotuitlang	534	81	35	46	1314.29
Chengpui	140	29	14	15	1071.43
Ralvawng	401	59	31	28	903.23
New Dawn	384	61	37	24	648.65
Rawpui	835	138	70	68	971.43
Pangzawl	2428	332	174	158	908.05
Thiltlang	1064	144	73	71	972.6
Leite	665	92	45	47	1044.44

East Rotlang	664	120	58	62	1068.97
Baktawng	3220	547	279	268	959.85
East Bungtlang	1966	279	153	126	823.53
Total	68860	9795	4994	4801	944.99

Source: By Author

3.2.5. Decadal Changes

Apart from population changes, decadal changes can also involve shifts in land use patterns due to urbanization or changes in agricultural practices. For instance, over a decade, a rural area may see the conversion of agricultural land into urban areas, leading to changes in the landscape and demographics of that region.

As per map data presents the decadal changes in land use land cover for the MAT River Basin over the period from 2008 to 2017. It can be delved into the analysis of this data with a more sophisticated and in-depth approach.

3.2.6. Economic Development

The Mat River Basin, encompassing a vast expanse of land, is home to a diverse population of 68,860 individuals. However, despite its scenic beauty and natural resources, the region grapples with poverty, particularly in the village areas, excluding Serchhip. In this essay, we delve into the economic development of the Mat River Basin, exploring the patterns of employment, agricultural practices, shifting livelihoods, and challenges faced by the population.

3.2.6.1. Economic Structure and Workforce

Within the Mat River Basin, the workforce plays a pivotal role in shaping the region's economic landscape. Of the total population, 51.36% (35,323 individuals) are engaged in various forms of economic activities. Among these workers, agriculture remains a prominent sector, drawing 60.78% (21,474 individuals) who toil as dedicated cultivators. Additionally, 3.21% (1,132 individuals) work as laborers, contributing their skills to diverse labor-intensive tasks. A smaller yet significant proportion, 1.94% (686 individuals), are involved in home/house industries, showcasing the tenacity and resourcefulness of the local artisans and entrepreneurs.

Furthermore, the remaining 48.64% (33,537 individuals) constitute the non-working population, raising questions about the distribution of opportunities and access to livelihoods in the region.

3.2.6.2. Primary Activities and Agriculture

The village areas of the Mat River Basin are primarily characterized by a reliance on primary activities such as agriculture, cultivation, and handwork industries. A significant proportion of the cultivators engage in the production of crops like broccoli, cabbage, cowpea, carrot, cauliflower, mustard, ginger, pumpkin, watermelon, and turmeric. These crops sustain not only the livelihoods of the cultivators but also contribute to local and regional food security.

While primary activities remain a bedrock of the region's economy, there is a notable trend of shifting occupations from primary to secondary activities. This shift can be attributed to various factors, including market demands, technological advancements, and the allure of emerging economic opportunities in secondary sectors. The transition is likely to have implications for local employment patterns, rural-urban migration, and the overall socio-economic dynamics of the River Basin.

3.2.6.3. Infrastructure Challenges

The economic development of the Mat River Basin is intrinsically tied to its infrastructure, particularly the road network. The majority of roads connecting cultivation areas are seasonal jeep roads. While these roads are adequate under normal conditions, they pose significant challenges during continuous rainy days, rendering them impassable. This impedes access to remote cultivation areas and affects the transportation of agricultural produce, limiting opportunities for economic growth and trade.

The economic development of the Mat River Basin is a multifaceted process, influenced by a range of factors that interplay to shape the region's socio-economic fabric. While most of the population engages in primary activities like agriculture and cultivation, there is an observable shift towards secondary activities. This transition signals the dynamic adaptability of the population to changing economic landscapes.

Despite the potential in agriculture and the growth of secondary sectors, persistent challenges such as poverty and inadequate infrastructure need attention. Addressing these challenges requires a comprehensive approach, involving targeted policies, investments in infrastructure, skill development, and support for sustainable livelihoods. By empowering the local workforce, encouraging innovation, and promoting equitable access to resources, the Mat River Basin can progress towards inclusive economic development and improve the living conditions of its residents.

Ultimately, the path to economic prosperity in the Mat River Basin lies in harnessing the potential of its people and resources, fostering sustainable practices, and ensuring that the benefits of development reach all corners of the region. With careful planning and collaborative efforts, the Mat River Basin can embark on a journey towards a thriving and resilient economic future.

3.2.7. Per capita Income

"Per capita" is a Latin term that translates to "per person" or "per head." In the context of economics and statistics, "per capita" refers to a calculation or measurement of an economic or social indicator divided by the total population of a specific area, country, or region. It is used to provide an average value for each individual when analyzing or comparing data. For example, the term "per capita income" refers to the average income earned by each person in each area. It is calculated by dividing the total income of the area by its total population. This helps in comparing the average income levels between different regions or countries, regardless of their varying population sizes. Similarly, other indicators like "per capita GDP" (Gross Domestic Product), "per capita consumption," "per capita expenditure," "per capita healthcare spending," and so on, can be calculated to understand and compare the standard of living, economic development, or resource allocation on an individual level.

Per capita income is a vital indicator that provides valuable insights into the economic well-being of individuals living in a specific geographical area. In the context of the Mat River Basin area, understanding the per capita income offers a comprehensive understanding of the region's economic status, standard of living, and potential for growth and development. This essay explores the nuances of per capita income in the Mat River Basin area, shedding light on the challenges faced by its inhabitants and the opportunities for improving economic prosperity.

The per capita income of the Mat River Basin area is calculated by dividing the total income generated within the region by the total population. This figure reveals the average income earned by each individual and serves as a fundamental metric in assessing economic disparities and identifying avenues for equitable development.

3.2.8. Major Challenges

Poverty: One of the primary challenges faced by the Mat River Basin area is the prevalence of poverty, especially in the village regions. Despite the richness of natural resources, a significant portion of the population struggles to make ends meet, largely relying on primary activities such as agriculture and cultivation. This scenario underscores the urgency to address income disparities and uplift the economic conditions of the impoverished communities.

Limited Diversification: The region's heavy reliance on traditional agricultural practices and primary activities restricts economic diversification and hinders income generation opportunities. The lack of a robust industrial base or advanced technological sectors may contribute to stagnant per capita income growth and leave the region vulnerable to economic fluctuations.

Infrastructure Deficiency: Insufficient infrastructure, particularly the lack of all-weather road networks, impedes access to markets, impedes trade, and restricts economic activities. The limited connectivity affects transportation, hampers the flow of goods and services, and results in higher production costs, adversely impacting per capita income growth.

3.2.9. Major Opportunities

Agricultural Modernization: The Mat River Basin’s rich agricultural potential presents an opportunity for modernization and innovation. Implementing advanced farming techniques, promoting sustainable practices, and leveraging technology could enhance productivity and increase income levels for farmers.

Value Addition and Agro-Processing: Encouraging agro-processing industries within the region can add value to agricultural products, creating employment opportunities and boosting income levels. By transforming raw produce into processed goods, the Mat River Basin can tap into new markets and enhance its economic resilience.

Skill Development and Education: Investing in skill development and education can empower the local workforce with the knowledge and expertise needed to engage in higher-paying secondary and tertiary sector occupations. Equipping the population with relevant skills aligns with the shifting livelihood trends in the area and opens up opportunities for better-paying jobs.

Infrastructure Improvement: Addressing the infrastructure deficit, particularly upgrading roads and transportation networks, will not only improve accessibility but also attract investments and stimulate economic growth. Enhanced connectivity can lead to increased trade, tourism, and overall economic activities.

The per capita income of the Mat River Basin area is a crucial economic indicator that reflects the region's prosperity and the well-being of its residents. While challenges like poverty, limited diversification, and infrastructure deficiencies persist, there are numerous opportunities for economic development and income improvement.

By promoting agricultural modernization, agro-processing industries, skill development, and infrastructure improvement, the Mat River Basin can unleash its economic potential and pave the way for sustainable growth and development. An inclusive and holistic approach, driven by community engagement and collaboration with relevant stakeholders, is essential in shaping a prosperous future for the inhabitants of the Mat River Basin area. As per capita income rises, the region can strive towards a brighter and more promising economic outlook, enhancing the overall quality of life for its people.

3.2.10. Conclusions

One of the key factors characterizing the Mat River Basin is its population structure. With a diverse mix of people hailing from different ethnicities and cultures, it represents a rich tapestry of traditions and identities. A detailed analysis of population demographics, particularly in terms of age groups, can provide valuable insights into the overall economic activity and development potential of the area.

Education, being a crucial determinant of socio-economic status, plays a pivotal role in shaping the Mat 's future. Examining the educational landscape allows us to gauge the level of human capital development within the community. Access to quality education can have a transformative impact on individuals' lives, influencing their career prospects and contributing to the region's overall well-being and economic prosperity.

Another significant socio-economic indicator is the sex ratio, which denotes the number of males to females in a given population. Understanding the sex ratio in the Mat River Basin is essential to highlight any gender disparities or imbalances within the community. This information sheds light on various socio-economic challenges faced by different genders and is crucial for formulating targeted policies promoting gender equality and empowerment.

The analysis of decadal changes in population size and composition is instrumental in understanding growth or decline patterns over specific timeframes. By examining how the population has evolved over the years, we can gain valuable insights into the factors that have influenced these changes and their subsequent impact on the region's socio-economic conditions. This knowledge is crucial for policymakers to make informed decisions and plan.

Economic development is a fundamental aspect of any socio-economic background. Analyzing the level of economic growth and diversification in the Mat River Basin can provide valuable insights into its overall progress and potential for further development. This includes examining the presence of industries, businesses, and entrepreneurial activities within the area, as well as identifying key sectors that can drive economic growth and job creation.

Per capita income, which measures the average income earned per person in a given population, is a vital indicator of socio-economic well-being. By studying the per capita income in the Mat River Basin, that can assess the overall standard of living and economic prosperity of its residents. This information serves as a critical benchmark for evaluating the region's economic performance and identifying areas that require targeted interventions and support.

Finally, an in-depth analysis of the region's dependence on agriculture is essential. Many areas heavily rely on agriculture as a primary source of income and employment. Understanding the level of agricultural dependence in the Mat River Basin can help identify specific challenges and opportunities faced by the local population. It also provides insights into potential strategies for sustainable development, such as promoting agricultural modernization, diversification, and value addition.

The Mat River Basin area in Mizoram represents a diverse and economically significant region. By comprehensively examining its population structure, educational landscape, sex ratio, decadal changes, economic development, per capita income, and agricultural dependence, we can gain a holistic understanding of its socio-economic fabric. Armed with this knowledge, policymakers and stakeholders can devise well-informed strategies to promote sustainable growth, reduce inequalities, and improve the overall well-being of the Mat River Basin's residents. Through collaborative efforts and targeted interventions, the region can embark on a path of inclusive and equitable development, ensuring a prosperous and promising future for its communities.

Amidst these transformations in forest cover, built-up areas, water bodies, and agricultural land, the total extent of the Mat River Basin remained resiliently constant throughout the entire period. The totality of the River Basin's land area steadfastly maintained itself at 982.05 square kilometers, signifying a balance between the various land use changes.

The decade from 2008 to 2017 showcased a multifaceted landscape metamorphosis within the Mat River Basin. Forested regions experienced a troubling decrease, while urbanization and development surged, leading to a significant expansion of built-up areas. Concurrently, water bodies dwindled, and agricultural land substantially increased, reflecting the dynamic interplay between human activities and the natural environment. Understanding these changes is of utmost importance to formulate sustainable land use and conservation strategies, ensuring the preservation of ecological integrity for future generations.

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Chapter 4
Patterns of Agricultural Practices and Farm Holdings

4.1. Introduction

Agriculture is the primary occupation of the farmers in the Mat River Basin, contributing significantly to its economy and livelihoods. This introductory note aims to provide an overview of agricultural production in this river basin, highlighting its significance, major crops, farming practices, and challenges faced by the agricultural sector. Agricultural development in hilly regions presents unique challenges and opportunities due to the rugged terrain, limited arable land, and susceptibility to soil erosion.

Implementing sustainable agricultural practices becomes imperative to ensure both food security and environmental preservation. Studies such as Sustainable Agricultural Practices emphasize the importance of agroforestry, terrace farming, and contour cultivation to prevent soil erosion and enhance productivity (Shrestha et al., 2019). The incorporation of traditional ecological knowledge in agricultural practices in the hill regions, fosters adaptive strategies suited to the local context (Maikhuri et al., 2001). Government initiatives and participatory approaches also play a pivotal role in creating an enabling environment for agricultural development in hilly regions (Mishra et al., 2007). Balancing economic viability, social equity, and environmental stewardship remains crucial for holistic progress in hill agriculture.

Horticultural development in the Mat River basin presents unique challenges and opportunities due to the topographical constraints and ecological sensitivity of such areas. The implementation of horticulture necessitates innovative approaches that consider soil conservation, water management, and slope stabilization. Research like Horticultural Development on Sloping Land: A Review of Strategies and Technologies by (Pandey et al., 2019) underscores the importance of adopting appropriate terracing techniques, erosion control measures, and agroforestry systems to mitigate soil erosion and enhance land productivity. The promotion of high-value crops, agroecological practices, and integrated pest management, as highlighted in Sustainable Horticulture on Sloping Land (Sharma et al., 2016), can contribute to income diversification and food security. Strategic utilization of indigenous knowledge, as discussed in Hill Horticulture in Developing Countries: A Review (Shiva et al., 2018) can provide insights into traditional farming practices that are adapted to hilly terrains.

Plantation agriculture presents a unique set of challenges and opportunities due to the topographical constraints and ecological sensitivities of such terrains. Hillside plantations often focus on cash crops like tea, coffee, and spices. Sustainable management practices are crucial to prevent soil erosion, landslides, and habitat degradation. Studies such as Sustainable Land Management in Hilly Areas: Lessons from the Darjeeling Hills, India (Sharma et al., 2017) underline the significance of contour farming, agroforestry, and erosion control measures in maintaining soil integrity. Agroecological approaches, as discussed in Agroecology and the Search for a Truly Sustainable Agriculture (Altieri, 1995), emphasize harmonizing farming with the local environment to foster resilience and minimize negative impacts. The case of hillside plantation agriculture epitomizes the necessity for holistic, ecologically-sensitive practices that consider long-term environmental health alongside economic productivity.

The global demand for agricultural commodities is expected to double in the coming decades, putting enormous pressure on agriculture to produce more. Most of this increase will come from developing countries, which host most of the most bio-diverse regions on earth. Most of the biodiversity is in production areas shared with humans, where agriculture is an increasing threat, but international conservation groups continue to focus on preserving and expanding networks of protected areas, encourage large-scale, low-input farming when conservation organizations partner with farming programs. Combined with the focus on protected areas, this could exacerbate, rather than alleviate, the conflict between biodiversity conservation and agricultural production. Two models have been proposed to increase agricultural production while minimizing negative impacts on biodiversity: land conservation and land sharing. The debate is often polarizing, but both are realistic solutions and depend on local circumstances. They propose a set of criteria that can guide either choice. General principles to be considered in both land conservation and land sharing are managing spillovers, maintaining resilience and ecosystem services, considering landscape architecture, reducing loss and waste, and improving agricultural production in developing countries. Improving access and developing developed countries and their supporting markets and strategies (Baudron & Giller 2014).

The state of Mizoram practices both shifting and permanent agriculture. It has a total of about 5% arable land of which shifting cultivation covers more than 50%. The production and productivity of crops from both farming is not sufficient and therefore, the people are facing the problems of malnutrition and food insecurity. The Mat River basin has a high potential to grow varieties of crops. The arable land in the Mat River basin is not huge but most of the population engaged in agricultural activities. However, this basin could not attain food security status because of traditional methods of agriculture and inadequate infrastructural facilities. In this chapter, a detailed description of shifting and permanent agriculture is given along with area and production of crops.

4.2. Shifting Cultivation

Traditional farming practices, including shifting cultivation (jhum) and terrace cultivation, have been prevalent in the Mat River basin for centuries. Shifting cultivation involves clearing a patch of land, burning the vegetation, and cultivating crops for a few years until the soil fertility declines. Terrace cultivation, on the other hand, involves constructing terraces on hill slopes to create flat areas for cultivation, minimizing soil erosion.

In recent years, efforts have been made to promote sustainable farming practices in Mat River basin. This includes the adoption of organic farming techniques, the use of high-yielding and disease-resistant crop varieties, and the introduction of modern irrigation methods to enhance agricultural productivity and sustainability. Mat River Basin varied agro-climatic conditions support the cultivation of a wide range of crops. Some of the major crops grown in the state include. Rice is the staple crop of Mat River basin, and paddy cultivation occupies a significant portion of the agricultural land. Farmers employ both traditional methods and modern techniques for rice cultivation, including the use of improved varieties and mechanization.

4.2.1. Area, Production, and Productivity of Rice under Shifting Cultivation

Table 4.1 shows the area of rice under shifting cultivation in the case study villages. Two times data – 2001 and 2016 are shown. In 2001, the highest area of rice was obtained by Serchhip town, which was 82.2% and the lowest area was obtained by Chhipphir which was 55.5%. In 2016, the highest area of rice cultivation was obtained by Serchhip town again with 80.3%, lowest with Chhipphir which accounts for 64.8%.

Table 4.1: Area of rice under shifting cultivation.

Year		2001		2016	
Sl. No	Village	Area (ha)	%	Area (ha)	%
1	Chhingchhip	44	84.6	40	64.1
2	Chengpui	12	66.6	10	37.0
3	Serchhip	221	82.2	180	80.3
4	Keitum	28	58.3	36	93.7
5	East Bungtlang	14	72.9	19	79.1
6	Rawpui	67	79.7	64	88.8
7	Pangzawl	8	60.1	11	57.8
8	Thiltlang	98	90.7	81	86.5
9	East Rotlang	31	79.4	32	76.1
10	Leite	12	71.4	9	64.2

11	Zotuitlang	21	70.7	16	80.8
12	Haulawng	13	71.4	8	61.5
13	Chhipphir	7	55.5	7	64.8
14	Ramlaitui	62	80.7	43	74.6
15	S. Zote	97	89.1	48	75
16	Buangpui	24	63.4	26	80.2
17	Ralvawng	32	76.9	26	81.2
18	N. Mualthuam	26	77.3	18	71.4
19	New Dawn	18	70.3	14	72.9
20	Baktawng	24	78.4	18	66.1
	Total	859	79.3	706	76.9

Source: Field Survey

Table 4.2 shows the production of rice under shifting cultivation in the case study villages. Two times data in 2001 and 2016 are shown. In 2001, the highest production of rice was obtained by Thiltlang village, which was more than 90%. The lowest production falls in Chhipphir Village with 0.8%.

Table 4.2: Production of rice under shifting agriculture

Year		2001		2016	
Sl. No	Village	Production in (kg)	%	Production in (kg)	%
1	Chhingchhip	42240	5.1	38400	5.6
2	Chengpui	11520	1.3	9600	1.4
3	Serchhip	212160	25.7	172800	25.5
4	Keitum	26880	3.2	34560	5.1
5	East Bungtlang	13440	1.6	18240	2.6
6	Rawpui	64320	7.7	61440	9.06

7	Thiltlang	7680	0.9	10560	1.5
8	Pangzawl	94080	11.4	77760	11.4
9	East Rotlang	29760	3.6	30720	4.5
10	Leite	11520	1.3	8640	1.2
11	Zotuitlang	20160	2.4	15360	2.2
12	Haulawng	12480	1.5	7680	1.1
13	Chhipphir	6720	0.8	6540	0.9
14	Ramlaitui	595200	7.2	41280	6.09
P15	S. Zote	93120	11.2	46080	6.8
16	Buangpui	23040	2.7	24960	3.6
17	Ralvawng	30720	3.7	34200	5.04
18	N. Mualthuam	24960	3.02	17280	2.09
19	New Dawn	17280	2.09	13440	1.9
20	Baktawng	23040	2.7	17280	2.5

Source: Field Survey

Table 4.3 shows the productivity of the main staple crop i. e., Rice in the Mat River valley, productivity is high in 2001 as compare to 2016 as the cultivation is done under shifting cultivation, these shows the depletion of soil fertility in most villages except Pangzawl village where the fertility is 0.12 in 2001 while it grows to 0.13 in 2016. General productivity of rice under shifting cultivation ranges from 0.10 to 0.12. Productivity is highest in Serchhip town where it reach 0.32, followed by

Pangzawl village. Chengpui, Keitum, East Bungtlang, Rawpui, Thiltlang, Zotuitlang, Chhipphir and Buangpui productivity are more or less the same at 0.11.

Table 4.3: Productivity of rice under shifting cultivation

Sl. No	Village	2001	2016
		Productivity	Productivity
1	Chhingchhip	0.12	0.09
2	Chengpui	0.11	0.04
3	Serchhip	0.12	0.32
4	Keitum	0.11	0.05
5	East Bungtlang	0.11	0.03
6	Rawpui	0.11	0.10
7	Thiltlang	0.11	0.03
8	Pangzawl	0.12	0.13
9	East Rotlang	0.12	0.06
10	Leite	0.10	0.02
11	Zotuitlang	0.11	0.03
12	Haulawng	0.12	0.02
13	Chhipphir	0.11	0.01
14	Ramlaitui	0.12	0.08
15	S. Zote	0.12	0.09
16	Buangpui	0.11	0.04
17	Ralvawng	0.12	0.06

18	N. Mualthuam	0.12	0.03
19	New Dawn	0.12	0.03
20	Baktawng	0.11	0.04

Source: Field Survey

4.2.2. Area, Production, and Productivity of Fruits and Vegetables under Shifting Cultivation

Mat River basin lies in the middle of Mizoram, the temperature, humidity, and rainfall are favourable for the cultivation of various fruits and vegetables, different fruits like pineapple, mango, lemon, and guavas are the main fruits cultivated in Mat River basin Table 5.4. The diet of the Mizo's is incomplete without vegetables., breakfast and dinner consist more of vegetables, Major vegetables mostly cultivated are mustard, pumpkin leaf, east Indian glory cower, bitter berry, baby jack fruit, bitter gourd, pumpkin, sesame, capsicum, Senagalia pennate, etc. Ginger and Cabbage turn out to be the major vegetables in this area covering 50 Ha of cultivated land, while turmeric and water melon are also grown to lesser extent.

Table 4.4: Area of fruits and vegetables

		2001	2016
Sl. no.	Vegetables Production	Area in Ha	Area in Ha
1	Broccoli	10	12
2	Cabbage	20	14
3	Cow pea	15	14
4	Carrot	14	16
5	Cauliflower	18	17
6	Mustard	16	15

7	Ginger	30	21
8	Pumpkin	12	12
9	Water melon	9	2.1
10	Turmeric	4.8	2

Source: Field Survey

Table 4.5 shows the production of fruits and vegetables under shifting cultivation in the case study villages. Two times data in 2001 and 2016 are shown. In 2001, the highest production of horticultural crops was obtained by cabbage, which was more than 21%. The lowest production is turmeric at 4.3

Table 4.5: Production of fruits and vegetables under shifting cultivation

		2001		2016	
	Fruits and Vegetable Production	Total Production (kg)	%	Total Production (kg)	%
1	Broccoli	105000	4.7	138000	6.7
2	Cabbage	480000	21.6	364000	17.7
3	Cowpea	100500	4.5	95200	4.9
4	Carrot	280000	12.6	352000	17.2
5	Cauliflower	252000	11.5	272000	13.2
6	Mustard	128000	5.7	180000	8.8
7	Ginger	450000	20.2	336000	16.4
8	Pumpkin	168000	7.5	216000	10.5
9	Watermelon	162000	7.4	44100	2.19
10	Turmeric	96000	4.3	48000	2.41
		2221500	100	2045300	100

Source: Field Survey

Table 4.6 shows the productivity of fruits and vegetables in 2001 and 2016. Major vegetables which gain highest productivity is cabbage at the rate of 1.08 followed by turmeric 0.89. Lowest productivity in 2001 is mustard, while in 2016 lowest productivity broccoli at 0.56.

Table 4.6: Productivity of fruits and vegetables under shifting cultivation

Sl. No	Vegetables Production	2001	2016
		Productivity (kg/ha)	Productivity
1	Broccoli	0.47	0.56
2	Cabbage	1.08	1.26
3	Cow pea	0.3	0.33
4	Carrot	0.9	1.07
5	Cauliflower	0.63	0.78
6	Mustard	0.36	0.58
7	Ginger	0.67	0.78
8	Pumpkin	0.62	0.87
9	Water melon	0.8	1
10	Turmeric	0.89	1.15

Source: Field Survey

4.3. Permanent Cultivation

Permanent agriculture is a term often used to describe the concept of "permaculture," which is a holistic and sustainable approach to agricultural design and practice. Permaculture aims to create self-sustaining and regenerative systems that mimic natural ecosystems. It was first introduced by Bill Mollison and David Holmgren in the 1970s. The term "permanent agriculture" was later redefined as "permaculture" to reflect its broader applications beyond just agriculture. In "Permaculture: A Designers' Manual," Bill Mollison, one of the co-founders of permaculture, presents a comprehensive guide to the principles and practices of permaculture design. The book covers various aspects of permaculture, including agriculture, forestry, water management, energy systems, and community development. It serves as a fundamental resource for individuals interested in creating sustainable and regenerative systems for the long-term benefit of the environment and humanity.

Permaculture emphasizes the integration of diverse plant and animal species, the conservation and efficient use of resources, and the creation of resilient ecosystems. The design principles encourage cooperation between elements within the system and promoting synergy to achieve mutual benefits.

The core principles of permaculture include:

a. Observation: Careful observation of natural patterns and processes is essential to understand and learn from existing ecosystems.
b. Design: Permaculture encourages thoughtful and intentional design that considers the needs and interactions of all elements within the system.
c. Diversity: Biodiversity is a key feature of permaculture systems. Diverse plant and animal species enhance ecosystem resilience and productivity.
d. Integration: Different elements within the system should be integrated and complement one another to create a self-sustaining and balanced environment.
e. Energy efficiency: Permaculture designs prioritize using resources efficiently and reducing waste.
f. Stacking functions: Multiple functions are assigned to each element within the system to maximize its utility.
g. Zoning and sectors: Permaculture uses zoning to organize elements based on their frequency of use and accessibility, while sectors consider external influences like sunlight, wind, and water flow.

4.3.1. Area, Production and Productivity of Rice Under Permanent Cultivation

In this paragraph, the area, production, and productivity of rice under permanent cultivation has been elaborated. Baktawng and Chhingchhip are two important village in upper river basin. They have 18 and 40 hectares of rice cultivation on steep slopes, 5 and 12 hectares, respectively, of land is under fruits and vegetables, and 4.2 and 10 hectares of land were utilised for growing plantation crops. Serchhip is the biggest town and the district capital of Serchhip district has remarkable high are under rice cultivation i.e., 180 hectares under rice cultivation, 24 hectares under fruits and vegetables, 20 hectares under plantation crops. They marked the highest production and crop land in Mat River basin. Keitum village is a small village which lies in the middle of two rivers, namely the Mat River and Tuikum River, Tuikum River is utilised for local stone resources while the Mat River is largely utilised for agricultural purposes. Chhipphir village has the lowest total cropped area i.e., 10.8 hectares, they also have only 7 hectares of rice cultivation, 2 hectares of fruits and vegetables cultivation and 1.8 hectares of plantation of crops. Haulawng village has the second highest total cropped are accounting 13 hectares in total, 8 hectares for rice cultivation, 2.5 hectares for fruit and vegetables cultivation and 2.5 hectares for plantation of crops (Table 4.7).

Table 4.7: Area of rice under permanent cultivation

Sl. No.	Village	2001	2016
		Area (ha)	Area in Ha
1	Chhingchhip	22	36
2	Chengpui	17	25
3	Serchhip	78	179
4	Keitum	5	18

5	East Bungtlang	65	102
6	Rawpui	7	25
7	Pangzawl	56	89
8	Thiltlang	23	42
9	East Rotlang	18	38
10	Leite	9	12
11	Zotuitlang	10	26
12	Haulawng	25	68
13	Chhipphir	14	19
14	Ramlaitui	23	40
15	S. Zote	16	25
16	Buangpui	13	24
17	Ralvawng	25	51
18	N. Mualthuam	32	47
19	New Dawn	15	26
20	Baktawng	17	28

Source: Field Survey

Table 4.8 shows the production and total contribution in percentile, Rice was produced most in Serchhip, East Bungtlang and in Chengpui, contributing more than 70% of the total cultivated land. Due to development in roads and cutting of mountains in various patches and valleys, 2016 shows growing area and production of permanent agriculture, thus Serchhip, East Bungtlang and Keitum grows significantly, contributing 65-85% of land under rice production.

Table 4.8: Production of rice under permanent agriculture

Year		2001		2016	
Sl. No	Village	Production in (kg)	%	Production in (kg)	%
1	Chhingchhip	1375	62.5	1480	67.27
2	Chengpui	1190	70	1400	82.35
3	Serchhip	5850	75	6250	80.13
4	Keitum	300	60	420	84
5	East Bungtlang	4875	75	5110	78.61
6	Rawpui	490	70	540	77.14
7	Pangzawl	3780	67.5	4230	75.54
8	Thiltlang	1265	55	1350	58.69
9	East Rotlang	1080	60	1245	69.17
10	Leite	585	65	629	69.88
11	Zotuitlang	550	55	630	63
12	Haulawng	1750	70	1978	79.12
13	Chhipphir	1015	72.5	1156	82.57
14	Ramlaitui	1495	65	1570	68.26
15	S. Zote	840	52.5	954	59.62
16	Buangpui	812	62.46	1003	77.15
17	Ralvawng	1437	57.48	1560	62.4

18	N. Mualthuam	1600	50	1812	56.63
19	New Dawn	800	53.3	922	61.47
20	Baktawng	1156	68	1277	75.12

Source: Field Survey

Table 4.9 shows the productivity of rice under permanent agriculture in the Mat River basin, productivity grows drastically during 15 years. i.e., 2001 to 2016, Chhipphir, Buangpui and Baktawng are the villages with high productivity in the year 2001. Due to various irrigational and infrastructural development, productivity grows at an alarming rate, Keitum, Rawpui and Leite accounts for 16.8, 11.02 and 7.77 respectively.

Table 4.9: Productivity of rice under permanent agriculture

Sl. No	Village	2001	2016
		Productivity	Productivity
1	Chhingchhip	2.84	3.06
2	Chengpui	4.12	4.84
3	Serchhip	0.96	1.03
4	Keitum	12	16.8
5	East Bungtlang	1.15	1.21
6	Rawpui	10	11.02
7	Thiltlang	1.21	1.35
8	Pangzawl	2.39	2.5

9	East Rotlang	3.34	3.84
10	Leite	7.23	7.77
11	Zotuitlang	5.5	6.3
12	Haulawng	2.8	3.16
13	Chhipphir	5.18	5.89
14	Ramlaitui	2.83	2.97
15	S. Zote	3.28	3.73
16	Buangpui	4.80	5.94
17	Ralvawng	2.29	2.49
18	N. Mualthuam	1.56	1.77
19	New Dawn	3.56	4.09
20	Baktawng	4	4.42

Source: Field Survey

4.3.2. Plantation Under Permanent Agriculture

Table 4.10 shows the area of plantation under permanent cultivation in the Mat River Basin, East Bungtlang, Leite and Chhipphir are the top three villages accounting 27% , 16.6% and 20.6% of its arable land in 2001. Due to development in road constructions, implementation of government schemes, improved irrigation, etc, the area of plantation in the Mat River Basin developed and grow substantially in 2016. North Mualthuam, Pangzawl and Chengpui had the highest concentration of area under plantation in 2016.

Table 4.10: Area of plantation under permanent cultivation

Sl. No.	Village	2001		2016	
		Area (ha)	%	Area (ha)	%
1	Chhingchhip	3	5.7	10	16.02
2	Chengpui	2	11.11	7	25.9
3	Serchhip	17	6.3	20	8.9
4	Keitum	6	12.5	1	2.60
5	East Bungtlang	5.2	27.08	2	8.3
6	Rawpui	5	5.9	3	4.1
7	Pangzawl	2.3	17.2	4	21.0
8	Thiltlang	3	2.7	2.6	2.7
9	East Rotlang	4	10.2	4	9.5
10	Leite	2.8	16.6	2	14.2
11	Zotuitlang	3.7	12.4	1.8	9.0
12	Haulawng	3	16.4	2.5	19.2
13	Chhipphir	2.6	20.6	1.8	16.6
14	Ramlaitui	2	2.6	4.6	7.9
15	S. Zote	3.8	3.4	6	9.3
16	Buangpui	4.8	12.6	3.4	10.4
17	Ralvawng	4.6	11	2	6.2
18	N. Mualthuam	3.6	10.7	5.2	20.6
19	New Dawn	2.6	10.1	2	10.4
20	Baktawng	3	9.8	4.2	15.4

Source: Field Survey

Table 4.11. shows the production in the case study villages. Two times data in 2001 and 2016 are shown. In 2001, the highest production of rice was obtained by Ralvawng and S. Zote village, which was more than 12.9% and 12.7% respectively. The lowest production falls in Pangzawl Village with 0.6%.

Tables 4.11: Production of plantation crops under permanent agriculture.

		2001		2016	
Sl. No.	Village	Production	%	Production	%
1	Chhingchhip	8900	1.7	56000	4.5
2	Chengpui	12600	2.4	20876	1.6
3	Serchhip	21000	4.05	430000	34.8
4	Keitum	6700	1.2	32000	2.5
5	East Bungtlang	9560	1.8	21000	1.7
6	Rawpui	31000	5.9	76000	6.1
7	Pangzawl	3400	0.6	9080	0.73
8	Thiltlang	7500	1.4	120000	9.7
9	East Rotlang	8200	1.5	34000	2.7
10	Leite	25800	4.9	19500	1.5
11	Zotuitlang	59800	11.5	32000	2.5
12	Haulawng	26700	5.1	23000	1.8
13	Chhipphir	16700	3.2	8900	0.7
14	Ramlaitui	32700	6.3	78000	6.3
15	S. Zote	65790	12.7	109807	8.8
16	Buangpui	53000	10.2	45000	3.6
17	Ralvawng	67000	12.9	45000	3.6
18	N. Mualthuam	23000	4.4	34000	2.7
19	New Dawn	24000	4.6	23000	1.8
20	Baktawng	14300	2.7	17000	1.3

Source: Field Survey

Table 4.12 shows the productivity trend of plantation crop under permanent cultivation in the Mat River Basin, Ramlaitui and South Zote bags the highest production of plantation crop in 2001 while East Rotlang, Keitum and Pangzawl are the lowest productive villages in plantation crop production. Due to various development from Minor Irrigation schemes laid down by government, the average productivity rises. Serchhip, Ramlaitui and Thiltlang are the highest productivity villages in the year 2016.

Table 4.12: Productivity of plantation crop under permanent agriculture

Sl. No	Village	2001	2016
		Productivity	Productivity
1	Chhingchhip	0.56	1.5
2	Chengpui	1.2	0.8
3	Serchhip	0.24	2.05
4	Keitum	0.2	0.42
5	East Bungtlang	0.35	0.33
6	Rawpui	1.18	1.22
7	Pangzawl	0.26	0.32
8	Thiltlang	0.46	3.23
9	East Rotlang	0.375	0.675
10	Leite	1.75	0.54
11	Zotuitlang	3.11	0.67
12	Haulawng	1.7	0.6
13	Chhipphir	1.23	0.27
14	Ramlaitui	3.15	3.15
15	S. Zote	3.34	2.32
16	Buangpui	2.13	0.75
17	Ralvawng	2.80	0.78
18	N. Mualthuam	1.22	0.75
19	New Dawn	1.77	0.69
20	Baktawng	0.9	0.43

Source: Field Survey

4.4. Farm Holdings

Farm holding is an important agriculture variable. In an agrarian economy like India, land ownership has been distributed generally among three major categories, namely individual-owned, rented land, and Community land. Excessive decrease in forest cover led to an increase in farm coverage. In 2001, farmers practices farming on their own land accounts for 18% while in 2016 individual land accounts for 32.5%. This high change shows the hike of individualism in Mat River basin.

Historically, Mizoram had unique land tenure system influenced by traditional practices and community ownership. However, in the 1950s and 1960s, the government introduced land reforms to address issues of landlessness and unequal land distribution. These reforms aimed to provide land to landless farmers and limit the maximum area of land that an individual could own to promote more equitable distribution.

The size of farm holdings in Mizoram varies significantly due to the hilly terrain and limited availability of arable land. Many farmers practice subsistence agriculture on small landholdings, cultivating crops such as rice, maize, and horticultural products like oranges and bananas. Due to limited cultivable land, some farmers practice shifting cultivation, locally known as "jhum," to manage their land resources effectively. Farm holdings in Mizoram play a crucial role in shaping the state's agricultural landscape and rural livelihoods. The distribution of land holdings and trends in farm sizes are influenced by historical factors, government policies, and socio-economic dynamics. Addressing the challenges associated with fragmented land holdings and promoting sustainable agricultural practices can contribute to the overall development of Mizoram's agricultural sector and rural communities.

In India uniform categorisation of farmers is published by Press Information Bureau, Ministry of Agriculture and Farmers Welfare. All farmers are categorise based on the size of their operational land, physical features and landscape largely influence the size of operational farms. All farmers are divided into five categories namely, Marginal, Small, Semi- Medium, Medium and Large

Table 4.13. shows the different categories of famers by Ministry of Agriculture and Farmers Welfare. The marginal category accounts below a hectare of 1.00, these are farmers cultivating at the smallest hectare of land. The small category accounts for 1.00-2.00 hectare of land. The semi-medium category accounts for 2.00-4.00 hectare. The medium category accounts for 4.00-10.00 hectare and the large category accounts for 10.00 hectare and above size of land.

Table 4.13. Categorisation of farmers.

Sl. No.	**Category**	**Size-Class**
1.	Marginal	Below 1.00 hectare
2.	Small	1.00-2.00 hectare
3.	Semi- Medium	2.00-4.00 hectare
4.	Medium	4.00-10.00 hectare
5.	Large	10.00 hectare and above

Source: Ministry of Agriculture and Farmers Welfare, 2019.

There are identical changes in Farm holdings during 15 years, Mar River basin, small farms such which are less than 1 hectare rises in 10.7%, it stood 16.4% in 2001, while it rises to 27.1 % in 2016. Second category i.e., land which are in between 1- and 2-hectare accounts for 54.2 hectare in 2001 while it decreased to 44.4% in 2016. 2-4 hectares land which is quite popular among 6 villages accounts for 14.9 to 8.7 hectare in 2016. 4 to 10 hectares which is extensive for hilly agricultural households decrease from 11.8 to 7.1 hectares in 20016. So, there is negative growth in farms ranging 4 to 10 hectares in size. Lastly, the largest farms grow extensively from 4.5

to 12.7 hectare, it then gives a figure growth of 8.20% in the whole River Basin (Table 4.14).

Table 4.14. c

Sl.no	Name of the Village	Less than 1 hectare	1-2 hectare	2-4 hectare	4 to 10 hectares	More than 10 hectares
1	Chhingchhip	6	22	4	18	2
2	Chengpui	1	0	10	4	0
3	Serchhip	54	20	14	4	20
4	Keitum	10	15	6	1	0
5	East Bungtlang	0	20	4	0	0
6	Rawpui	10	12	10	8	0
7	Pangzawl	1	17	1	0	0
8	Thiltlang	7	60	2	3	0
9	East Rotlang	2	8	15	5	0
10	Leite	0	10	4	0	0
11	Zotuitlang	2	25	5	1	0
12	Haulawng	0	10	3	0	0
13	Chhipphir	2	15	1	0	0
14	Ramlaitui	5	20	3	20	0
15	S. Zote	4	50	6	3	1
16	Buangpui	7	10	0	0	10
17	Ralvawng	2	20	5	5	0
18	N. Mualthuam	2	10	5	4	0
19	New Dawn	3	20	9	0	0
20	Baktawng	2	20	2	10	0
	Total	120	384	109	86	33
	Total share (In %)	16.4	52.4	14.9	11.8	4.5

Source: Field Survey

There are identical changes in Landholdings during 15 years, Mar River basin, small farms such which are less than 1 hectare rises in 10.7%, it stood 16.4% in 2001, while it rises to 27.1 % in 2016. Second category i.e., land which are in between 1- and 2-hectare accounts for 54.2 hectare in 2001 while it decreased to 44.4% in 2016. 2-4 hectares land which is quite popular among 6 villages accounts for 14.9 to 8.7 hectare in 2016. 4 to 10 hectare which is extensive for hilly agricultural household decrease from 11.8 to 7.1hectare in 20016. So, there are negative growth in farms ranging 4 to 10 hectares size. Lastly largest farms grow extensively from 4.5 to 12.7 hectare, it then gives the figure growth of 8.20% in the whole Mat River Basin (Table 4.15).

Table 4.15: Village-wise farm holdings in 2016

	2016					
Sl.no	Name of the Village	Less than 1 hectare	1-2 Hectare	2-4 hectare	4 to 10 Hectare	More than 10 Hectare
1	Chhingchhip	10	12	6	16	8
2	Chengpui	4	10	0	0	1
3	Serchhip	82	10	12	3	5
4	Keitum	12	15	4	1	0
5	East Bungtlang	10	8	4	0	2
6	Rawpui	5	17	5	2	11
7	Pangzawl	1	15	1	0	2
8	Thiltlang	10	50	2	2	8
9	East Rotlang	5	10	5	3	7
10	Leite	4	4	1	2	3
11	Zotuitlang	8	15	5	2	3
12	Haulawng	1	10	1	0	1
13	Chhipphir	2	11	1	1	3
14	Ramlaitui	8	22	3	5	10
15	S. Zote	10	45	4	0	5
16	Buangpui	5	10	4	3	5

17	Ralvawng	8	12	2	3	7
18	N. Mualthuam	4	16	0	0	1
19	New Dawn	7	15	0	4	6
20	Baktawng	2	18	4	1	9

Source: Field Survey

4.5. Discussion and Conclusions

The Mat River Basin is renowned for its agricultural practices with rich agro-biodiversity. Agriculture plays a pivotal role in the socio-economic fabric of the Mat River Basin. Known for its diverse agroclimatic conditions and fertile soil, Mizoram boasts a vibrant agricultural sector that contributes significantly to food security, employment generation, and economic development. This section provides an overview of agricultural practices in Mat River basin, focusing on its significance, major crops, farming practices, and the challenges encountered in the sector. Significance of agricultural practices in the Mat River basin is that it provides employment opportunities, ensuring food security, and contributing to overall economic growth. The cultivation of a diverse range of crops, combined with traditional and modern farming practices, strengthens the state's agricultural resilience.

Traditional farming practices, such as shifting cultivation (jhum) and terrace farming, have been integral part of agriculture. It involves clearing small patches of land, burning the vegetation, and cultivating crops for a limited period until soil fertility diminishes. Terrace farming, on the other hand, is a sustainable technique employed on hilly terrain, where terraces are constructed to minimize soil erosion and optimize land utilization. In recent years, there has been a growing emphasis on adopting modern farming techniques, including organic farming, improved seed varieties, and efficient irrigation systems, to enhance productivity and sustainability. It has also a rich plants diversity, it is suitable for the cultivation of fruits such as oranges, pineapples, bananas, passion fruits, and various vegetables. These horticultural crops have significant market potential and contribute to both domestic consumption and export. It faces the challenge of land fragmentation; where small and fragmented landholdings limit economies of scale and mechanization in agriculture. This poses challenges to the adoption of modern agricultural practices and reduces overall productivity.

Over the years, there have been changes in farm sizes in the Mat River Basin due to various factors, including population growth, changes in land use patterns, and government policies. With the passing of time, land parcels have been further fragmented due to inheritance and land subdivisions among family members. This trend has implications for agricultural productivity and overall rural development.

The fragmented nature of farm holdings presents challenges in terms of agricultural productivity, mechanization, and efficient resource management. Additionally, it impacts farmers' access to credit and government support programs. However, there are opportunities for promoting sustainable agricultural practices, encouraging cooperative farming, and enhancing land use efficiency.

The government of Mizoram has implemented various initiatives to address land-related issues and promote sustainable agricultural practices. These include schemes for land consolidation, support for agroforestry practices, and promoting crop diversification. Proper land use planning and the adoption of modern farming techniques are essential to optimize land productivity.

Farm holdings in the Mat River Basin are intricately linked to the livelihoods of rural communities. As most farmers depend on agriculture for their income and subsistence, the distribution of land holdings has a direct impact on their economic well-being and food security. Addressing land-related challenges can significantly contribute to improving rural livelihoods.

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Chapter 5
Changing Patterns of Agriculture

5.1. Introduction

Mizoram, a picturesque state located in the northeastern region of India, has witnessed significant agricultural development in recent years. The state's unique topography, favorable climate, and abundant natural resources have contributed to the growth and diversification of agricultural activities. The government, along with various initiatives and programs, has played a crucial role in promoting sustainable agricultural practices, improving productivity, and uplifting the lives of farmers in Mizoram.

Agriculture is the main occupation and the major source of income in Mizoram. It is predominated by shifting cultivation, whereas permanent agriculture is sparsely practiced. In the recent past, there has been significant changes in the agricultural system in Mizoram. The area and production of crops under shifting cultivation are decreasing. There are several factors, which are changing shifting cultivation. Increasing population, decreasing production and productivity of crops, impact of modern cultural, and the government initiatives towards the cultivation of cash crops and implementation of new policies. However, the changes are not much effective in terms of high production and instead, the practices are decreasing.

One of the notable factors of changing agriculture in Mizoram is the implementation of the New Land Use Policy (NLUP). Launched in 2010, mainly in the Mat River basin, the NLUP aims to shift the focus from jhum (slash-and-burn) cultivation to sustainable and more productive farming practices. Under this policy, farmers are encouraged to adopt terrace cultivation, organic farming, horticulture, and cash crops. The NLUP provides financial assistance, training, and necessary infrastructure to support farmers in adopting these modern farming techniques. Terrace cultivation has gained prominence in Mizoram due to its suitability for the hilly terrain. The government has introduced various schemes to promote terrace farming, including the distribution of terrace gardening kits and the construction of irrigation channels. These efforts have resulted in increased agricultural productivity, reduced soil erosion, and improved water management.

Horticulture has emerged as a key sector in Mizoram's agricultural development. It is also a major driver for changing agricultural patterns. The state's favorable climate and rich biodiversity make it suitable for cultivating a wide variety of fruits, vegetables, flowers, and spices. Under the Horticulture Mission for Northeast and Himalayan States (HMNEH), the government provides technical support, subsidies, and market linkages to horticulture farmers. This has led to the expansion of orchards, nurseries, and floriculture units, boosting both income generation and export potential.

To promote organic farming, the government has initiated the Organic Mission in Mizoram. Organic farming practices not only ensure chemical-free produce but also contribute to environmental sustainability. The mission focuses on capacity building, training programs, and certification assistance for farmers engaged in organic cultivation. Organic products from Mizoram, such as turmeric, ginger, and pineapple, have gained popularity both within the state and in national and international markets.

In addition to crop cultivation, animal husbandry and fisheries are integral components of agricultural development in Mizoram. The state has abundant natural resources for livestock and fish production. The government provides support for breed improvement, veterinary services, feed supply, and marketing infrastructure to enhance livestock and fishery sectors. These efforts have not only increased the availability of milk, meat, and fish for local consumption but have also opened up avenues for income generation and entrepreneurship.

Furthermore, the implementation of advanced technologies and scientific practices has further propelled agricultural development in Mizoram. The government, in collaboration with research institutions and agricultural universities, conducts research and development programs to introduce high-yielding crop varieties, efficient irrigation methods, and pest management techniques. Farmers are provided with training and technical know-how to adopt these modern practices, resulting in improved yields and overall farm productivity.

The Mat River Basin has witnessed significant strides in agricultural development through various initiatives, policies, and programs. The shift from traditional jhum cultivation to sustainable practices, promotion of terrace farming, horticulture, organic farming, and livestock and fishery development has transformed the agricultural landscape. These efforts have not only improved agricultural productivity and income generation but have also contributed to environmental conservation and the overall socio-economic development of the state.

Hmar and Lalchamliana (2017) examines the evolution of agricultural policies and development strategies in Mizoram, they focus on the role of government interventions, technological advancements, etc. Ralte (2019), Lalfelpuii and Vanlalfaki (2020) investigate the impact of climate change in agriculture in Mizoram. Lalhruaitluangi and Lalbiakdiki (2018) explore the adoption and impact of sustainable agricultural practices among farmers in Mizoram. Chhakchhuak et al. (2019) examines the patternds and determinants of livelihood diversification among the farmers. Various challenges, such as land degradation, limit access to credits and lack of infrastructure hinders the agricultural development in Mizoram (Lalhlimpuia and Raman, 2019). Renthlei and Kumar (2018), Lalramzauva and Bhat (2021) investigate market dynamics and agribusiness that drives the agriculture market.

In this chapter, efforts have been made to describe the changes in agricultural patterns during the last 16 years i.e., from 2000 to 2016. The changes were noticed in terms of rice cultivation, the cultivation of fruits and vegetables, and plantation crops. The detail description is given below:

5.2. Changes in Area, Production, and productivity of Rice

Table 5.1 gave detail information on village wise rice cultivation area, production and changes during 2001 and, Chhingchhip, Baktawng and Chengpui lies on the Upper Mat basin, they have 24, 44 and 12 hectares of land under rice cultivation in Shifting Cultivation, they experience decrease in Rice production and area by 9.09% from 2001 to 2016. This shows that farmers tend to shift towards the cultivation of rice to Fruits and vegetables. However, Serchhip town the biggest in population and in production capacity shows higher shift in vegetables by 18.55% from 2001 to. Keitum village shows positive increase in rice production, the area under rice cultivation in 2001 was 28 hectares while it increased to 36 hectares, thus it literally shows 28.575 increase in rice production. Villages like East Bungtlang, Thiltlang, East Rotlang and Buangpui shows increase in productivity and area under production by 35.50 %, 3.23%, 8.33% respectively. While the remaining village namely Baktawng, New Dawn, N. Mualthuam, Ralvawng, Ramlaitui, Chhipphir, Haulawng, Zotuitlang and Leite show experienced decline in rice production and its cultivated area. New Dawn village has 18 hectares of rice cultivation in 2001 with a production of 17280 kgs while in 2001, its rice cultivated area shrink to 14 hectares and its production also decreased to 13440 kgs. The same happens to N. Mualthuam village as well, its rice cultivated area of 26 hectares in 2001 decreased to 18 hectares in. The productivity also declined to 17280 kgs from 24960 kgs in. Baktawng village has 24 hectares of rice cultivation in 2001 with a production of 23040 kgs while in, its rice cultivated area declined to 18 hectares and its production also decreased to 5760 kgs. Ralvawng village has 32 hectares of rice cultivation in 2001 with a production of 30720 kgs while in, its rice cultivated area shrink to 26 hectares and its production also decreased to 5760 kgs. Leite village has 12 hectares of rice cultivation in 2001 with a production of 11520 kgs while in, its rice cultivated area decreased 3 hectares and its production also decreased to 2880 kgs. Ramlaitui village has 62 hectares of rice cultivation in 2001 with a production of 59520 kgs while in, its rice cultivated area decreased 19 hectares and its production also decreased to 1920 kgs and the change between the years became -30.65%.

Table 5.1: Changes in area, production, and productivity of Rice (2001-2016).

Sl. No.	Villages	Change in area (ha)	Change in area (%)	Change in production (kg)	Change in production (%)	Change in productivity
1	Chhingchhip	0.2	0.320513	-3840	-9.09%	85.12821
2	Chengpui	0.6	2.222222	1920	-16.67%	133.1852
3	Serchhip	-0.4	-0.17857	39360	-18.55%	1130.357
4	Keitum	-0.3	-0.78125	7680	28.57%	273.3333
5	East Bungtlang	0.2	0.833333	4800	35.71%	258.3333
6	Rawpui	-0.3	-0.41667	2880	-4.48%	289.8413
7	Thiltlang	0.3	1.578947	2880	37.50%	-99.5489
8	Pangzawl	-0.2	-0.21368	16320	-17.35%	410.9402
9	East Rotlang	0.1	0.238095	960	3.23%	46.44689
10	Leite	-0.2	-1.42857	2880	-25.00%	957.1429
11	Zotuitlang	-0.3	-1.51515	4800	-23.81%	937.3737
12	Haulawng	-0.4	-3.07692	4800	-38.46%	1083.516
13	Chhipphir	-0.1	-0.92593	180	-2.68%	290.7407
14	Ramlaitui	-0.4	-0.69444	18240	-30.65%	579.1667
15	S. Zote	-0.7	-1.09375	47040	-50.52%	859.852
16	Buangpui	-0.2	-0.61728	1920	8.33%	779.3651
17	Ralvawng	-0.3	-0.9375	5760	-18.75%	667.7885
18	N. Mualthuam	-0.4	-1.5873	7680	-30.77%	606.3492
19	New Dawn	-0.2	-1.04167	3840	-22.22%	522.9167
20	Baktawng	-0.1	-0.36765	5760	-25.00%	-127.941

Source: Field Survey

There are 1082.4 total cropped area in 2001 in which 859 hectares are under Rice Cultivation, 148.4 hectares under fruits and vegetables, 84 hectares under plantation crops, Fruits and vegetables shows a declining trend per area of production at 15.7%, one of the important reasons is a shift from primary occupation to secondary and tertiary occupation. Meanwhile plantation crop increase in 6.07% which denotes

the increase in cash crops awareness. Rice has been imported heavily from interstate this may results to decrease in rice cultivated area, Rice has been cultivated all over Mat River basin which shows that rice is the major crop in Mat River basin. Rice is cultivated in 20 villages of Mat River basin; Production of Rice is highest at Serchhip town. Since time immemorial, Rice has been the main diet in Mizoram, in spite of its meagre value in the market 83.7% of the total cropped area is dominated by rice cultivation in 2001, which decreases to 78.5% in 2011. In typical opinion of household, if they have enough rice for a year, they are free from hungry, this leads to the birth of subsistence farming in the study area (Table 5.2).

5.3. Changes in Area, production and productivity of Fruits and Vegetables

Mat River basin lies in the middle of the Mizoram, the temperature, humidity and rainfall are favourable for cultivation of various fruits and vegetables, different fruits like pineapple, mango, lemon and guavas are the main fruits cultivated in Mat River basin Table (6.3.) The diet of the Mizo's is incomplete without vegetables., breakfast and dinner consist more of vegetables, major vegetables mostly cultivated are mustard, pumpkin leave, east Indian glory cower, bitter berry, baby jack fruit, bitter gourd, pumpkin, sesame, capsicum, Senagalia pennata, etc.

Changes in fruits and vegetables cultivated area and their changes in production has been given in Table 6.3. Several fruits and vegetables increased while few decline, Broccoli, carrot, cauliflower, and mustard showed remarkable increase in production due to high demand in the market, they increased by 31.4%, 7.94% and 40.635 accordingly. Vegetables like cabbage, cow pea and ginger shows decreasing trend of productivity. Watermelon production has been declining at 72.78% as a result of inter-state import of this particular fruit. Pumpkin has been one of the major vegetables as the pumpkin itself and its leaves are included in Mizo traditional diet, it showed rise in production by 28,57%.

Broccoli cultivation increased with an area of 11 hectares and the change is 20%, the changes in production is 33000 kgs (31.43%). Carrot cultivation increased with an area of 1 hectare and the change is 14%, the changes in production is 72000 kgs (25.71%). Pumpkin cultivation has a 0% of change in area although the production change is 48000 kgs that is 28.57%. Cabbage cultivation declined by -6 hectares i.e., -30% and the changes in production became -116000 kgs i.e., -24.17%. Cowpea cultivation declined by -1 hectares i.e., -7% and the changes in production became -5300 kgs i.e., -5.27%. Cauliflower cultivation declined by -1 hectares i.e., 6% and the changes in production became 20000 kgs i.e., 7.94%. Mustard cultivation declined by -1 hectares i.e., -6% and the changes in production became 52000 kgs i.e., 40.63%. Water melon cultivation declined by -6-9 hectares i.e., -77% and the changes in production became -117900 kgs i.e., -72.78%. Turmeric cultivation declined by -2.8 hectares i.e., -58% and the changes in production became -48000 kgs i.e., -50.00%.

Table 5.2. Changes in area, production and productivity of fruits and vegetables under Shifting Cultivation (2001-2016).

Sl. No.	Fruits and Vegetables Production	Changes in area (In Ha)	Percentage of Changes in Area	Changes in Production (in kg)	Percentage of changes in Production	Changes in productivity
1	Broccoli	11	20%	33000	31.43%	3000
2	Cabbage	-6	-30%	-116000	-24.17%	19333.33
3	Cow pea	-1	-7%	-5300	-5.27%	5300
4	Carrot	2	14%	72000	25.71%	36000
5	Cauliflower	-1	-6%	20000	7.94%	-20000
6	Mustard	-1	-6%	52000	40.63%	-52000
7	Ginger	-9	-30%	-114000	-25.33%	12666.67
8	Pumpkin	5	0%	48000	28.57%	9600
9	Water melon	-6.9	-77%	-117900	-72.78%	17086.96

10	Turmeric	-2.8	-58%	-48000	-50.00%	17142.86

Source: Field Survey

5.4. Permanent Agriculture

5.4.1. Changes of Area, Production and Productivity of Rice under Permanent Agriculture

Permanent agricultural land refers to the static land utilised for cultivation that are being harvested regularly. Mat River basin inhabits steep slopes and narrow valleys, permanent patches are generally found in river valley, where alluvial soil has been deposited each year. The Upper basin has wider valley as compare to the Lower basin, permanent agriculture is generally found in between valleys i.e., on the foothills of ranges along with Mat River. Serchhip town has major three permanent agricultural patcher which hosts number of wet rice cultivated area. Use of mechanisation like machineries and proper irrigation channels for cultivation are developed on the Upper basin of Mat River. Zawlpui permanent agricultural patch, Chamdur agricultural patch, etc are found in these areas, which made Serchhip town as the 'rice bowl' of Serchhip district.

Chhingchhip village has a total 18 hectares area of cropped land in 2001 which increased to 25 hectares in 2001, the change is 7 hectares (28%) during the given period. Chengpui village has a total 8 hectares area of cropped land in 2001 which increased to 13 hectares in 2016, the change is 5 hectares (38.5%) during the 2001 and . Serchhip has a total 78 hectares area of cropped land in 2001 which increased to 143 hectares in 2016, the change is 65 hectares (45.5%) during the given period. East Bungtlang village has a total 14 hectares area of cropped land in 2001 which increased to 19 hectares in 2016, the change is 5 hectares (26.3%) during the given period. Rawpui village has a total 25 hectares area of cropped land in 2001 which increased to 32 hectares in 2016, the change is 7 hectares (21.8%) during the given period. Pangzawl village has a total 12 hectares area of cropped land in 2001 which increased to 17 hectares in 2016, the change is 5 hectares (29%) during the given period. Thiltlang village has a total 36 hectares area of cropped land in 2001 which increased to 45 hectares in 2016, the change is 9 hectares (20%) during the given period. East

Rotlang village has a total 26 hectares area of cropped land in 2001 which increased to 32 hectares in 2016, the change is 6 hectares (18.7 %) during the given period. Leite village has a total 5 hectares area of cropped land in 2001 which increased to 9 hectares in 2016, the change is 4 hectares (44.4 %) during the given period. Zotuitlang village has a total 14 hectares area of cropped land in 2001 which increased to 16 hectares in 2016, the change is 2 hectares (12.5 %) during the given period. Haulawng village has a total 9 hectares area of cropped land in 2001 which increased to 12 hectares in 2016, the change is 3 hectares (25 %) during the given period. Chhipphir village has a total 5 hectares area of cropped land in 2001 which increased to 8 hectares in 2016, the change is 3 hectares (37.5 %) during the given period. Ramlaitui village has a total 28 hectares area of cropped land in 2001 which increased to 32 hectares in 2016, the change is 4 hectares (12.5 %) during the given period. S. Zote village has a total 38 hectares area of cropped land in 2001 which increased to 41 hectares in 2016, the change is 3 hectares (7.3 %) during the given period. Buangpui village has a total 15 hectares area of cropped land in 2001 which increased to 21 hectares in 2016, the change is 6 hectares (28.5 %) during the given period. Ralvawng village has a total 19 hectares area of cropped land in 2001 which increased to 25 hectares in 2016, the change is 6 hectares (14.3 %) during the given period. N. Mualthuam village has a total 18 hectares area of cropped land in 2001 which increased to 21 hectares in 2016, the change is 3 hectares (14.3 %) during the given period. New Dawn village has a total 12 hectares area of cropped land in 2001 which increased to 17 hectares in 2016, the change is 5 hectares (29.4 %) during the given period. Baktawng village has a total 6 hectares area of cropped land in 2001 which increased to 14 hectares in 2016, the change is 8 hectares (57.1 %) during 2001 to 2016.

Improvement in technology led to various positive changes to enlarge river valley cultivation, use of tractors, JCB, tillage, modern mechanisation, etc. widen the permanent agricultural patches. Table 6.4. shows that enlargement of permanent fields witnessed in Chhingchhip (28%), Chengpui (38.46%), enormous development of permanent patches witnessed in Serchhip town (45.45%). Narrow valleys are widened, development of road connectivity and electrification led to certain changes, low degree slopes have been cut down with the help of earthmover, etc which enlarge the valleys for cultivation extensively. Keitum, East Bungtlang, Rawpui, Pangzawl and Thiltlang permanent fields increased moderately by 33.33%, 26.31%, 21.87%, 29.41% and 20% positively. Lower Mat River basin has been surrounded by Leite, Zotuitlang, Haulawng, Ramlaitui, Ralvawng and New Dawn village. All of them shows positive changes in permanent agricultural farms, ranging from 7% to 29% increase in size of permanent agriculture.

Table 5.3. Changes in area, production, and productivity under permanent agriculture

Sl. No	Village	Changes in Cropped Area	Change in %	Changes in Production	% of changes in Production	Changes in productivity
1	Chhingchhip	7	28	47100	2.8	1745.56
2	Chengpui	5	38.5	8276	-0.8	30.8462
3	Serchhip	65	45.5	409000	30.75	2737.76
4	Keitum	7	33.3	25300	1.3	1045.24
5	East Bungtlang	5	26.3	11440	-0.1	422.406
6	Rawpui	7	21.8	45000	0.2	1135
7	Pangzawl	5	29.4	5680	0.13	250.784
8	Thiltlang	9	20	112500	8.3	2458.33
9	East Rotlang	6	18.7	25800	1.2	747.115
10	Leite	4	44.4	-6300	-3.4	-2993.3
11	Zotuitlang	2	12.5	-27800	-9	-2271.4
12	Haulawng	3	25	-3700	-3.3	-1050
13	Chhipphir	3	37.5	-7800	-2.5	-2227.5
14	Ramlaitui	4	12.5	45300	0	1269.64
15	S. Zote	3	7.3	44017	-3.9	946.904

16	Buangpui	6	28.5	-8000	-6.6	-1390.5
17	Ralvawng	6	24	-22000	-9.3	-1726.3
18	N. Mualthuam	3	14.3	11000	-1.7	341.27
19	New Dawn	5	29.4	-1000	-2.8	-647.06
20	Baktawng	8	57.1	2700	-1.4	-1169.1

(Source: Field Survey)

5.5. Changes in Landholdings

There are identical changes in Landholdings during 15 years, Mat River basin, small farms such which are less than 1 hectare rises in 10.7%, it stood 16.4% in 2001, while it raised to 27.1 % in 2016. Second category i.e., land which are in between 1- and 2-hectares accounts for 54.2 hectare in 2001 while it decreased to 44.4% in 2016. 2-4 hectares land which is quite popular among 6 villages accounts for 14.9 to 8.7 hectare in 2016. 4 to 10 hectare which is extensive for hilly agricultural household decrease from 11.8 to 7.1hectare in 2016. So, there are negative growth in farms ranging 4 to 10 hectares size. Lastly largest farms grow extensively from 4.5 to 12.7 hectare, it then gives the figure growth of 8.20% in the whole river basin.

Table 5.4: Changes in landholdings

Year	Less than 1 hectare	1-2 Hectare	2-4 hectare	4 to 10 Hectare	More than 10 Hectare
2001	16.4	52.4	14.9	11.8	4.5
	27.1	44.4	8.7	7.1	12.7
% of Changes	10.70%	9%	6.20%	-4.70%	8.20%

Source: Field Survey

5.5.1. Changes in Land Ownership

Landholding is an important agriculture variable. In agrarian economy like India, land has ownership has been distributed generally among three major categories, namely individual owned, rented land, Community land. Excessive decrease in forest cover led to increase in farm coverage. In 2001, farmers who practise farm on their own land accounts for 18% while in individual land accounts for 32.5%. This high change shows the hike of individualism in Mat River Basin.

The type of ownership of land has been divided into three types. Owned land in 2001 was 169.1 sq. Ha which accounts for 18.58% of share that rises to 32.50% in and the change during the time given became 13.92%. The rented land in 2001 in total was 63.06% with a share of 63.06% of the total land that rises to 103.08 sq. HA in 2016, having 8.50% of share and the change within the decade is 1.67%. In 2001 the total area of lands distributed by the VC was 957.8% which have 74.6% of share from the total land. In 2016, it decreases to an area of 746.6 sq. HA with 59% of shares, the change here is -15.6% (Table 5.5)

Table 5.5. Changes in Ownership of Land

Types of Ownership	Area in 2001 (in Ha)	Share in %	Area in 2016 (in Ha)	Share in %	Change in %
Owned Land	169.1	18.58%	340.32	32.50%	13.92%
Rented Land	63.06	6.83%	103.08	8.50%	1.67%
VC Distribution	957.8	74.60%	746.6	59%	-15.60%

Source: Field Survey

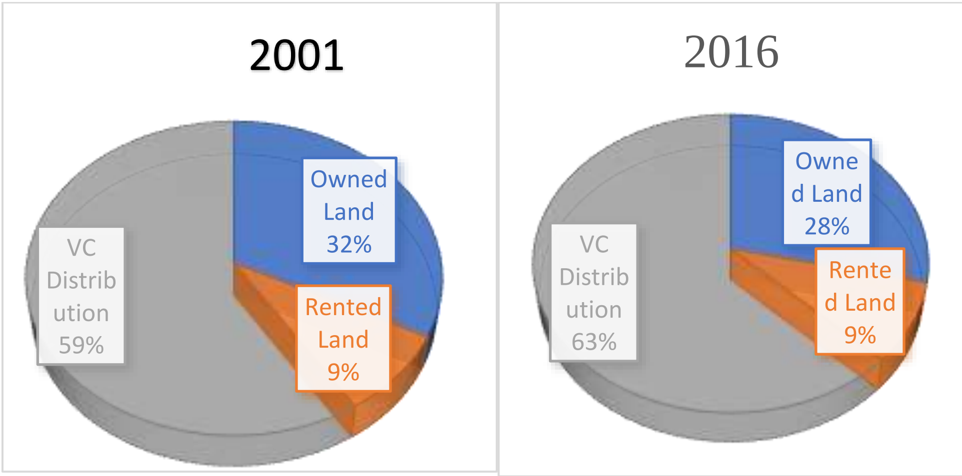

Figure 5.1. Changes in ownership of land

5.6. Statistical Analysis

Agriculture relies heavily on the application of statistical methods for informed decision-making, sustainable resource management, and improving overall productivity. The integration of statistics in agriculture is pivotal for several reasons. Firstly, it provides a scientific basis for understanding the complex interactions between production, productivity, altitude, area, etc. This empirical foundation empowers farmers, policymakers, and researchers to make data-driven choices, optimizing the use of resources, and adapting to changing climates. Statistical analysis plays a critical role in assessing and mitigating risks associated with agricultural practices, such as pest outbreaks, diseases, and extreme weather events. Through the collection and analysis of agricultural data, farmers can enhance their ability to anticipate and respond to these challenges effectively, it is underscored by a wealth of research and publications in the field. The United Nations Food and Agriculture Organization (FAO) emphasizes the role of statistics in tracking global food production, consumption, and trade patterns (FAO, 2019). Additionally, organizations like the World Bank have conducted extensive studies on the impact of agricultural statistics on economic growth and poverty reduction (World Bank, 2020). These sources highlight the indispensable role that statistics play in shaping the future of agriculture, ensuring food security, and promoting sustainable farming practices.

5.6.1. Correlation Analysis of Altitude and Productivity

The provided data includes descriptive statistics and correlation coefficients for the variables Altitude (m) and productivity. The study examined two variables, altitude, and productivity of 20 villages. The mean altitude was found to be 824.75 meters, with a standard deviation of 128.7. The mean productivity level was 710.60, with a standard deviation of 93.9 (Table 5.6).

Table 5.6. Mean and Standard Deviation of Altitude and productivity.

Variables	Mean	Std. Deviation	No. of Villages
Altitude (in m)	824.7	128.7	20
productivity	710.6	93.9	20

Source: Field Survey

5.6.2. Correlation and Regression of Productivity, Altitude and Area

Descriptive statistics were used to gain insights into the characteristics of these variables, shedding light on their central tendencies and variabilities. Table 5.7. presents descriptive statistics, correlations, and regression results for the variables of productivity (kg), altitude(m) and area(ha). For productivity, the mean value was found to be 1194.80. This indicates the average productivity level among the studied sample. The data exhibited a standard deviation of 413.044, implying that the productivity scores showed a notable dispersion around the mean. This variability suggests that the levels of productivity among 20 villages were diverse, potentially influenced by various factors.

The mean value of altitude was calculated to be 824.75 meters, altitude represents the average elevation of the study sites in the Mat River valley. The standard deviation of 128.7 signifies that the altitude values were relatively concentrated around the mean. Thus, the study area displayed more consistent altitude pattern compared to the productivity values.

The area exhibited a mean value of 45.85, it represents the average size of the Mat River basin. It displayed a relatively high standard deviation of 47.561, indicating a substantial variation in site sizes across the 20 villages. This considerable variability suggests that they were distributed widely around the mean, indicating potential differences in land use or geographical characteristics. To explore potential relationships between the variables, Pearson correlation coefficients were calculated.

Firstly, it is important to note that " productivity exhibited a perfect correlation with itself, as expected. As for the correlations with other variables, a weak negative correlation of -0.140 was observed between productivity and "Altitude(m) 2016" However, the associated p-value of 0.279 indicated that this correlation was not statistically significant at the conventional 0.05 level. Therefore, we found no compelling evidence to suggest a significant relationship between productivity levels and the altitude of the study sites.

On the other hand, a more meaningful finding emerged when examining the correlation between productivity and area. A moderate positive correlation of 0.385 was observed, and the associated p-value of 0.047 indicated statistical significance at the 0.05 level. This implies that study sites with larger areas tended to exhibit higher levels of productivity. The observed correlation may suggest potential factors or characteristics associated with larger areas that contribute to increased productivity.

Moving on to the variable altitude(m) like productivity, it showed a perfect correlation with itself. However, regarding its correlations with other variables, no statistically significant relationship was found with area. The weak positive correlation of 0.252 was not supported by a significant p-value of 0.142, indicating that altitude and area were not significantly associated in this study.

Lastly, examining the correlations of area we observed a statistically significant moderate positive correlation of 0.385 with productivity. The associated p-value of 0.047 indicated that this relationship reached statistical significance at the 0.05 level.

Consequently, the results suggest that study sites with larger areas tend to have higher levels of productivity. The correlation analysis provided valuable insights into the potential relationships between the variables productivity, altitude(m) and area. While no significant correlation was found between productivity and altitude, a significant positive correlation was observed between productivity and the area of the study sites. Similarly, no significant relationship was found between altitude and area. These findings offer a preliminary understanding of the interdependencies among these variables.

Table 5.7. Correlations of productivity, altitude and area.

Correlations				
		productivity	Altitude(m)	area
Pearson Correlation	productivity	1	-0.14	0.385
	Altitude(m)	-0.14	1	0.252
	area	0.385	0.252	1
Sig. (1-tailed)	productivity		0.279	0.047
	Altitude(m)	0.279		0.142
	area	0.047	0.142	
N	productivity	20	20	20
	Altitude(m)	20	20	20
	area	20	20	20

Source: Field Survey

5.6.3. Multiple Linear Regression

Table 5.8 shows the multiple linear regression model aimed to investigate the relationship between productivity and two predictor variables, area and altitude(m). The overall model's performance was examined through several goodness-of-fit measures. The coefficient of determination (R-squared) was 0.208, indicating that approximately 20.8% of the variance in productivity was explained by the combined influence of area and altitude. The adjusted R-squared value, which accounts for the number of predictors and sample size, was 0.115. The standard error of the estimate was 388.573, representing the average error of the model's predictions.

Table 5.8. R Square value

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.456[a]	.208	.115	388.573	.208	2.234	2	17	.138

Source: Field Survey

5.6.4. ANOVA Test

An analysis of variance (ANOVA) was performed to assess the significance of the regression model. The regression sum of squares was 674,685.674, with 2 degrees of freedom, resulting in a mean square value of 337,342.837. The F-statistic was 2.234, and the associated p-value was 0.138. These results indicate that the overall model was not statistically significant at the conventional alpha level of 0.05, suggesting that the combined influence of area and altitude(m) on productivity was not significant.

Table 5.9. Anova Test

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	674685.674	2	337342.837	2.234	.138[b]
	Residual	2566809.526	17	150988.796		
	Total	3241495.200	19			

a. Dependent Variable: productivity b. Predictors: (Constant), Area, Altitude(m)

5.6.5. Coefficient Test

The coefficients table provides information about the contributions of the predictor variables to the model. The constant term was 1684.469, with a standard error of 580.588. The coefficient for altitude was -0.810, with a standard error of 0.715. The standardized coefficient (Beta) for altitude(m) was -0.253, indicating that altitude had a negative influence on productivity. However, the t-statistic for this coefficient was -1.133, with an associated p-value of 0.273, suggesting that the effect of altitude was not statistically significant.

For the variable the coefficient was 3.898, with a standard error of 1.937. The standardized coefficient (Beta) for " area " was 0.449, indicating a positive influence on productivity. However, the t-statistic for this coefficient was 2.012, with an associated p-value of 0.060, which indicates that the effect of area on productivity was marginally non-significant. The correlation analysis and regression model provided insights into the relationships between productivity, altitude(m) and area. While a significant positive correlation was found between productivity and area, the regression analysis did not yield statistically significant results for the predictors altitude and area in explaining productivity.

Table 5.10. Coefficient (Unstardardized and Standardized)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1684.47	580.588		2.901	0.01
	Altitude(m)	-0.81	0.715	-0.253	-1.133	0.273
	area	3.898	1.937	0.449	2.012	0.06

Source: Field Survey

5.6.6. Frequency Analysis

The frequency distributions of four variables are presented altitude, area, production and productivity. The table 6.11. shows the number of observations (frequency) and the percentage of each category within the dataset.

For the variable altitude there are 20 observations in total. The values range from 582 to 1045 meters. Each value appears only once, resulting in a uniform distribution. The percentages indicate that each unique value constitutes 5% of the dataset, with no cumulative difference between them.

The variable area also consists of 20 observations. The values range from 11 to 224 square units. Most of the values appear only once, with a few values repeating (e.g., 27, 32). The percentages for each unique value are evenly distributed, with each value contributing 5% to the dataset. The cumulative percentage shows a steady increase with each additional value.

The variable production includes 20 observations as well. The values vary from 8900 to 430000 units. The frequency distribution is skewed, with some values appearing only once, and others (e.g., 20,000) repeated multiple times. The percentages for each unique value are also uniform, with each value accounting for

5% of the dataset. The cumulative percentage increases gradually as each unique value is added to the distribution.

Finally, the variable productivity also comprises 20 observations, ranging from 478 to 1389 units. Similar to production, distribution is skewed, with some values occurring once and others (e.g., 5.0) appearing multiple times. The percentages for each unique value are uniformly distributed, with each value representing 5% of the dataset. The cumulative percentage steadily rises with the addition of each unique value. The frequency distributions provide insights into the distribution patterns and concentration of values within each variable. These findings serve as a foundation for further analysis and exploration of the relationships between these variables and their impact on productivity in the context of the research objectives.

Table 5.11. Altitude, Area, Production and Productivity.

Village	Altitude (in m)	Area	Production	productivity
Chhingchhip	1045	52	42240	812.3
Chengpui	880	18	11520	640
Serchhip	888	268.8	212160	789.3
Keitum	762	48	26880	560
East Bungtlang	654	19.2	13440	700
Rawpui	764	84	64320	765.7
Pangzawl	724	13.3	7680	577.4
Thiltlang	856	108	94080	871.1
East Rotlang	986	39	29760	763.1
Leite	638	16.8	11520	685.7
Zotuitlang	582	29.7	0	678.8
Haulawng	937	18.2	12480	685.7
Chhipphir	846	12.6	6720	533.3
Ramlaitui	768	76.8	59520	775
S. Zote	973.59	108.8	93120	855.8
Buangpui	873	37.8	23040	609.5
Ralvawng	800	41.6	30720	738.5

N. Mualthuam	730	33.6	24960	742.8
New Dawn	768	25.6	17280	675
Baktawng	1020	30.6	23040	752.9

Source: Field Survey

The dataset contains vital information about various villages, including their Altitude (in meters above sea level), area (measured in some unit), Production (representing agricultural or industrial output), and productivity (calculated as production per unit area). The dataset consists of 20 observations, each corresponding to a different village.

The variables provide essential insights into the geographical and economic characteristics of these villages. Altitude indicates the elevation at which the villages are situated, providing valuable context for their environmental conditions. Area reflects the land size of each village, indicating the extent of available resources for agricultural or industrial activities.

The two key economic indicators, Production, and productivity, offer crucial information about the economic output and efficiency of each village. Production quantifies the total output, while productivity measures the efficiency of production per unit of land area, shedding light on the agricultural or industrial yield in relation to the available resources.

An initial analysis of the data reveals intriguing patterns. For instance, villages with higher altitudes seem to demonstrate varying levels of productivity, suggesting a potential relationship between elevation and economic efficiency. Similarly, different villages exhibit varying production levels, which may be influenced by factors such as natural resources, agricultural practices, or industrial activities.

Table 5.12. Altitude, area, production and productivity

Varialbles		Altitude(m)	area	Production	productivity
N	Valid	20	20	20	20
Mean		824.75	45.85	61983.2	1194.8
Std. Deviation		128.777	47.561	92032	413.044
Minimum		582	11	8900	478
Maximum		1045	224	430000	1920

Table 6.11. provide descriptive statistics for four crucial variables in our study: altitude(m), area, production and productivity.

For the variable altitude(m) which represents the elevation levels, we observe that the mean altitude is approximately 824.75 meters. The standard deviation of around 128.777 meters indicates the amount of variation present in the data points. The range of altitudes spans from a minimum of 582 meters to a maximum of 1045 meters, showing the diversity of altitude values within our dataset.

Regarding area which measures the land area, the mean area is approximately 45.85 square units. The standard deviation of approximately 47.561 square units highlights the variability in the size of the land areas under consideration. The range of areas extends from a minimum of 11 square units to a maximum of 224 square units, reflecting the wide spectrum of land sizes observed in our study.

The variable production represent the level of production. The mean production is approximately 61983.15 units. The substantial standard deviation of about 92031.981 units indicates notable dispersion among production levels. The minimum production recorded is 8900 units, while the maximum reaches 430000 units, demonstrating a significant variation in production outputs across the dataset.

The variable productivity, quantifies the productivity levels. The mean productivity is approximately 1194.80 units. The standard deviation of around 413.044 units suggests a moderate spread in productivity values. The minimum productivity observed is 478 units, while the maximum is 1920 units, underscoring the diversity of productivity levels among the observations. These descriptive statistics offer a valuable foundation for our study, providing a clear overview of the central tendencies and variability within our dataset. The diverse range of values observed in each variable illustrates the complexity of the data we are examining.

This study reveals that Mizoram is facing lots of changes in agricultural practices. Shifting cultivation is decreasing, whereas there is a small area increasing under permanent agriculture. Some area is also increasing under fruits and vegetables and also under plantation crops. However, the output from both shifting and permanent agriculture is not sufficient to feed the basic food need of the people. Therefore, many people suffering from malnutrition and food insecurity. Due to the government initiatives for agricultural development, many farming community has shifted their farmland from shifting to permanent agriculture but the rate is very slow. It has been observed that the crop diversity has been decrease from shifting to permanent. Most of the crops grown under permanent agriculture are monocropping. Whereas, under shifting cultivation, agro-biodiversity was high.

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Chapter 6

The Role of Agriculture in Socio-economic Development

6.1. Introduction

Agriculture is a crucial sector for socio-economic development in Mizoram, a state in Northeast India, various agricultural practices are implemented in Mizoram and examines their impact on the socio-economic well-being of the region. By analyzing the initiatives, challenges, and outcomes, we can understand the significance of agriculture in driving rural development and improving the livelihoods of farmers in Mizoram. Numerous procedures have been employed to examine agricultural production. Geographers from various corners of the world apply multiple ways of assessment. Each technique has its own advantages and disadvantages, so the choice belongs to the researcher to choose the best-suited technique to carry out certain studies. According to Kendall (1939) to measure the yield of crops, Ranking methods are employed in different areal units, in some countries certain crops occupy a very small proportion of the crop acreage, but was decided not to adopt any criterion of rejection on the account, a country which is good at producing one crop will, in general, be better than the average at producing any other. The starting point of this inquiry was the discovery of a similar relationship exists between county yields of the principal crops which are grown commercially.

The subject matter of land use studies in the context of geography dates back to the 1930s when L.D. Stamp, a profound agricultural scholar conducted the first Land Utilization Survey in Britain, these studies successfully carried out a new genre in agricultural studies mainly land use surveys. After successfully completing the survey L.D. Stamp has been appointed to conduct a commission to study the World Land Use Survey in 1949, initiated by the International Geographical Union (IGU). The commission was led by Valkenburg S. Van (1950), who was appointed as chairman of the commission and he put forward the concept of World Land Use Survey. A land use map was prepared at a scale of 1:1000,000 aiming to develop a regional section by using the pilot survey and satellite wages. Under this classification, there are nine categories of land such as settlements and associated non-agricultural lands (dark and light red), cropland (brown), improved permanent pasture (yellow), unimproved grazing land (orange and yellow), woodlands (different shades of green), swamps and marshes (blue) and unproductive land categories (gray). Despite regional differences, several techniques were being utilize by different scholars from different parts of the world. Stamp (1960) employed in his extensive studies at twenty countries to figure out the amount of yield in crop production. Apart from this, agricultural scholars from different parts of the world find their own unique waste off assessing agriculture production.

Agricultural practices form a set of large-scale soil cultivation by adopting specific technic based on the underlying terrain and climate (Sigh and Dhillion, 1984). Regional approaches are important in agricultural practices to bring out the most suitable technique for cultivation (Whittlesey, 1936). Agriculture practices largely impacts the social life of the people as it influences the mind-set and controls the social life of the people therein. The schedule of Agricultural and non- agricultural countries was quite distinguishable. However, no country can sustain their economy without agriculture. Further, mineral rich countries and non-agricultural countries also need to import agriculture products to sustain their livelihood. Thus, agriculture plays a vital role in the sustenance of livelihood. One third of the available workforces engaged in agricultural activities around the globe. The achievement of the Green Revolution has largely improved the production of food grains adding the importance of the Agriculture sector in the World's economy (International Labour Report 2012). Agricultural practices express the quality of the agricultural system of a region in terms of productivity, diversification, and commercialization consistent with a desired state of agrarian relations and ecological balance.

In many places of the world part–time farming plays a major role in economic activities which hinders the work force of people practising different agricultural system. India is an Agrarian economy; it has vast cultivable land with thick demographic profile to fees. It occupies about 45% arable fertile land. The North Eastern Region (NER) comprises eight states namely Sikkim, Assam, Manipur, Meghalaya, Mizoram, Arunachal Pradesh, Nagaland, and Tripura. It has 39 million populations of which 75% are engaged in agriculture (Census; 2011). NER is backward in terms of Economic development. Still agriculture activities turn out to be the major economic activity. The yield per hectare is lesser as compare to the main land. But they are still agrarian economy so development of Agriculture is very important for the overall development of North East economy. The total geographic area of north east is 262, 230 sq. km. Agricultural land and fallow land accounts for 22.20% (Patel, 2013). The total cultivators accounts for 41.6% and agriculture labour accounts for 13.07% adding all the workforce who engage in agricultural sector, they form the majority of the workforce. India is known to be second just after China in population, the necessity of food is enormous as compare to several countries, it is claimed that more than 70% rely on agriculture for living. Sustenance alone to all citizen is challenging and huge drive to the Government of India (Thenmozhi and Thilagavathi, 2014). Mizoram is characterized by steep slopes, rough and rugged topography, about 86% are forest cover (2017), however; arable land is about 4% only. In the Mat River basin, agriculture plays major role in the society as it provides food and raw materials. It is the main driver for growth, development, and basic need to the present and for the next generation.

Among several agricultural practices, the main thing that matter most is to increase productivity level, generally, it broadly depends on which type of agriculture is feasible in that area to maximise the level of production. To overcome this meagre production different types of farming system often need to adopted in certain area, there are several environment friendly systems of practices like organic farming, less utilisation of chemicals, etc. (Gupta et al., 2014; Ponisio et al., 2015). In addition to this, the quality of soil is vital for-profit maximisation, abandonment of agrochemicals, chemical fertilisers, excessive use of manure, extra tillage have decreased the productivity level. Hence, appropriate application of agricultural system led to sustainable increase in farm production (Kassam et al., 2014). The main objectives of this chapter are to examine to socio-economic impact of agriculture in the 20 case study villages of the Mat River Basin.

Husain (2014) covered almost the entire general agricultural geography starting from the origin of agriculture, nature, and scope. He analyzed the factors affecting the pattern of cultivation followed by different agricultural systems of the world accompanied by various models of agricultural geography. His keen studies on the introduction and impact of agricultural patterns of India gave the pattern of spatial changes and the nature of agriculture in India. The stagnant agricultural development during the last part of the century and found out the cropping pattern is almost mono-culture with less percentage of agricultural area under the category of cropping more than once. He found out paddy cultivation has been largely spoiled by weather condition, even after the net sown area increase to 10.0 per cent, development of agriculture remained not up to the mark (Gogoi 2006).

The author interviewed livestock growers' association and discuss with them about the economic benefits from livestock (Figure 4.1). It has been noticed that livestock cultivation has high potential in economic development of the Mat River Basin. Further livestock also helps in practicing agriculture.

Figure 6.1: Interview with Serchhip Livestock Growers Association.

Traditionally, shifting cultivation (jhum) has been a common practice in Mizoram. However, efforts are being made to transition towards more sustainable and permanent forms of agriculture. The New Land Use Policy (NLUP) aims to replace shifting cultivation with permanent farming systems. This includes promoting terrace farming, contour bunding, and agroforestry. These techniques help conserve soil, prevent erosion, and maintain soil fertility, leading to increased agricultural productivity.

Shifting cultivation popularly known as slash and burn cultivation is often claim as pollutants to the environment due to clearing of forest for farm land. Here primitive technique has been employed, mere cutting of trees, shrubs and plants, and thus cleared by burning is the most popular way of preparing land for agricultural activities (Figure 4.2 and 4.3). Due to this practice, a number of flora and fauna population has been shrinking at an alarming rate, a search for alternative way and a better environment friendly technique of cultivation in hilly areas has been a great call for agriculture Scientist across the globe.

(a) (b)

Figure 6.2: (a) Typical Mizo Cultivated area after slash and burn, Mat River Basin
(b) Visit to slash and burn cultivation area in the Mat River Basin

Figure 6.3: Shifting cultivation patch after jhum activity in the Mat River Basin.

Shifting cultivation involves clearing patches of land, burning the vegetation, and cultivating crops for a limited period before moving on to new plots. It has been practiced by indigenous communities in Northeast India as a means of subsistence agriculture. This practice allows natural forest regeneration, provides diverse food sources, and has cultural significance. However, shifting cultivation has faced criticism due to its environmental consequences and the need for increased food production to meet growing demands.

Mizoram has been transitioning from traditional shifting cultivation practices, known as jhum, towards more sustainable agricultural methods. The New Land Use Policy (NLUP) has played a significant role in this transition by encouraging farmers to adopt permanent cultivation systems, including terrace farming, contour bunding, and agroforestry. These practices have led to improved soil conservation, reduced soil erosion, and enhanced agricultural productivity, ensuring long-term food security and sustainable rural development.

The methods of cropping by configuring shifting cultivation settles or permanent cultivation and their methods of cropping in each type. He then mentioned monoculture, dual culture, polyculture, mono-cropping, multiple, triple and relay cropping. He argues continuous cropping, overlapping, and rotational cropping play a vital role in agriculture development. (Chandra 1999). Mizoram historically and culturally, he gives physical and social accounts, including the economic activity of Mizo. He claimed agriculture as the chief occupation of South East Asian Countries and is regarded as the mainstay and basic means of occupation, he gives information on workforce, land use, shifting cultivation, and permanent agriculture. He stresses crop productivity, livestock, and animal husbandry, fishery, and forestry (Pachuau 2009). Agriculture in Nigeria from a national economic perspective provides brief basic information on climate, zonal vegetation, and soils. Not only are the main crops, cattle grazing lands, and grasslands covered but also important facts about agricultural education, advisory bodies, mechanization, and modernization of Nigerian agriculture are included. The production of various crops in Nigeria and the resulting national income are compared with those of other countries. Although this and various other statistics are tabulated, there are some discrepancies. Cassava root production is shown as 7,287,000 tons in Table 1.1 and 3,470,100 tons in Table 6.1. The corresponding figures are 2,899,100 and 1,912,100 tons for millet and 318,000 and 156,500 tons for rice. However, these discrepancies are small and do not have a significant impact on the overall picture of Nigeria's agriculture and the main trends in its development. Total agricultural commodities worth £529m, of which £58m was livestock, £360m of crops grown for local consumption and £111m grown for export. The main crops grown mainly for export are oil palm, coconut, cocoa, rubber, peanuts, tobacco, and cotton. The main food crops consumed locally are roots (yam, cassava, coconut, yam), cereals (sorghum, millet, maize, rice) and legumes (mainly cowpea). Economics, Geography, Cultivation Techniques are given for each group. Crop yields in Nigeria are low compared to developed countries, but there are indications that they may increase rapidly soon as better agricultural practices are adopted. It increased from 1900 tons in 1962 to 75,461 tons in 1962. Shift cultivation remains the dominant system of agriculture, with virtually no pressure on the land except in eastern Nigeria, although the size of agricultural units is small, mainly 0.25 to 2.5 ac in eastern Nigeria and 0.5 to 2.5 ac in western Nigeria: 5ac. 1-10 ac in Nigeria and Northern Nigeria. Information about how these land units is cultivated, what the farmer does in different seasons and different climatic regions, his income, and expenses, etc. is scattered throughout the book (Oyenuga 1967).

6.2. Agriculture Development and Market Linkages under Shifting Cultivation

Agriculture has emerged as a promising sector in Mizoram, contributing to the socio-economic development of the state. The government has focused on promoting horticultural crops such as fruits, vegetables, spices, and flowers. Various initiatives, including financial support, technical assistance, and training programs, have been implemented to encourage farmers to adopt horticulture practices. These efforts have resulted in increased crop diversification, higher agricultural incomes, and improved market linkages for farmers. Farmer Producer Organizations (FPOs) have played a vital role in collective marketing, value addition, and accessing better prices for horticultural produce, thus boosting the socio-economic status of farmers.

The twenty-first-century agriculture is one of many diverse industries that will increase rural incomes and increase the long-term stability of natural resources. This can lead to a variety of activities affecting farmers, stakeholders, customers, and government industries. Information and communication technology has transmitted the most important information about agriculture in developing countries. These developing countries now connect with developed countries and receive the latest information and technology on weather, natural resources, and other relevant information. Most developing countries use a variety of technologies and other sources of information for agricultural and economic development. In this context, developing countries such as African and Asian countries are using information and communication technology for agricultural growth. However, it was pointed out that farmers did not benefit from these techniques in the workplace due to lack of knowledge and information about these techniques. In addition, farmers could not communicate directly with buyers and customers to sell their produce at fair prices, track livestock medical and pesticide costs and obtain information from other stakeholders. Information and communication technology has proven to be a new approach to communication and information exchange. The use of such technology can improve an individual's knowledge and skills. The term information and communication technology can be used for various terms such as telephone, television, video, voice information system, and fax. Information and communication technologies are a veritable source of information and knowledge for people, including farmers, and bring us closer together across different communities around the world. ICT stands for Knowledge Formation in Rural Areas of Developing Countries, which enables effective sharing of collected knowledge and information for agriculture and rural development. The use of ICT in agriculture for rural development is of great importance. Especially in African countries, which enable average access to agricultural information, farmers face many problems with communication technology connectivity. The use of information and communication technology has played a very effective role in the development of agriculture and the decision-making of agricultural communities in various countries. Information and communication technology has brought about major changes in agricultural development, transferring information and knowledge among farmers through various technologies. Information and communication technology has the potential to disseminate systematic agricultural information among smallholder farmers, just as mobile phones, television, internet and radio have the ability to transmit relevant and timely information. In the past two decades, information and communication technology (ICT) in agriculture and rural development has spread rapidly in all sectors of society and has played an important role in rural development as well. Recently, ICT has made great achievements in almost every aspect of rural life. Information and communication technologies are embedded in various devices such as computers, internet, mobile phones, television, and radios. ICT plays an important role in the agro-food sector, rapidly providing information and knowledge about agriculture around the world. Their effective dissemination of ICT can enhance the attractiveness of agriculture through production, transaction costs, increased production, efficiency and income of farmers by providing more information and added value to stakeholders. Information and communication technology in recent years has been introduced into agricultural projects, bringing fruitful results to rural development and agricultural development. For example, information and communication technology can be used in distance learning programs to help farmers learn new approaches and techniques for agricultural development in developing countries. Such technology can provide information about weather, prices, and earnings. Farmers who have used information and communication technologies in agriculture have been shown to have increased information and knowledge about their production. Similarly, those who have used e-services or e-commerce applications have increased their income. Farmers used the Internet to receive information about production from various markets in nearby cities, as well as from the country's main markets as well as information about farming, new technologies and ways to increase production. The internet has created a space for farmers to stay up to date on the market. (Chhachhar, Qureshi, Khushk, et al.2014)

(a) (b)

(c) (d)

Figure 6.4: a) Farmers waiting for community farm vehicles in Mat River Basin. b) Mizo traditional Cart used by farmers to fetch their agricultural production at Mat

River Basin. c) Construction of roads in Mat Valley. d) Farmers Union Tractor crossing road construction in Mat River Basin.

6.3. Organic Farming and Sustainable Practices under Shifting Cultivation

Mizoram has embraced organic farming as a sustainable approach to agriculture, contributing to both environmental conservation and socio-economic development. The state government, along with NGOs and agricultural institutions, has promoted organic farming through training programs, awareness campaigns, and the establishment of organic farming clusters. Organic farming practices, such as the use of organic manure, composting, and natural pest control methods, have reduced dependence on chemical inputs, protected soil health, and minimized environmental pollution. Moreover, organic farming has opened up niche markets for farmers, enabling them to access premium prices for their organic produce and enhancing their income levels. This has led to improved socio-economic conditions, increased employment opportunities, and the empowerment of rural communities.

Comparing agriculture and sustainable development, and land management, he overviewed the origin and spread of agriculture, how to manage nature resources, the prospect of agriculture baseline, he further emphasized tools for agricultural research and planning and agricultural development trends. Pathon, Humphreys, and Mitchel (1995) studied weathering and leaching, new numerical formation and their inheritance, the effect of rain wash, soil creep, soil materials of various places, and their impact on agriculture. (Chopra 2006).

6.4. Integrated Farming Systems and Livelihood Diversification under Shifting Cultivation

Integrated Farming Systems (IFS) have gained prominence in Mat River Basin, providing opportunities for livelihood diversification, and enhancing the socio-economic development of farmers. IFS involves integrating different agricultural components such as crops, livestock, fisheries, and agroforestry. This approach optimizes resource utilization, improves productivity, and provides multiple income streams for farmers. For instance, integrating livestock with crop farming allows farmers to utilize crop residues for animal feed and utilize animal waste for organic manure, thereby reducing input costs and enhancing agricultural sustainability. IFS also creates employment opportunities, promotes entrepreneurship, and strengthens rural economies by adding value to agricultural produce.

Mizoram has also embraced organic farming practices to ensure sustainability and meet the growing demand for organic produce. The state government, along with NGOs and agricultural institutions, promotes organic farming through training programs, awareness campaigns, and the establishment of organic farming clusters. These initiatives encourage farmers to adopt organic techniques such as composting, natural pest control, and avoiding synthetic inputs. Organic farming enhances soil health, minimizes environmental impacts, and opens niche markets for farmers, leading to improved economic returns and sustainable agricultural practices.

Integrated Farming Systems (IFS) are gaining popularity in Mizoram as a means to diversify income and enhance farm resilience. IFS involves integrating different agricultural components such as crops, livestock, fisheries, and agroforestry. This approach optimizes resource utilization, improves productivity, and provides multiple income streams for farmers. For instance, integrating livestock with crop farming allows farmers to utilize crop residues for animal feed and utilize animal waste for organic manure. IFS also enhances nutrient cycling and reduces dependence on external inputs.

The agricultural practices in Mizoram are undergoing a transformation towards sustainable approaches that prioritize long-term productivity, rural development, and farmer well-being. By shifting from shifting cultivation, promoting horticulture, embracing organic farming, and adopting integrated farming systems, Mizoram is fostering a resilient and prosperous agricultural sector. The Mat River Basin is dominated by two major types of agricultural practices namely, Shifting cultivation (Slash and Burn) and Permanent Agriculture. Shifting cultivation is generally practise on hills, where the specific degree of slope is high, in this situation, gravity and thin layer of top soil boost excessive soil disaster popularly known as Soil erosion. It is more prevalent where winds, rainfall and slope exhibit the agriculture environment, it then leads to huge flow of topmost fertile soils which are the lifeline of cultivation. When removal of top soil take place, plants, vegetables, fruits, trees, etc. do not get sufficient soil nutrients that are present in the uppermost layer of the soil, hence it hampers growth, taste, health, and sustenance of cultivation in a particular area. Generally, the top soil is thin on greater slopes as gravity tends to act as down puller of humus, cultivators tend to shift their cultivated areas every after 1 to 2 years in search of fertile soil. Meanwhile, permanent cultivation prevalent in river valleys and flood plains where flat land is found, here the production seems to be much higher as compare to slope cultivation, application of mechanisation, fertilisers and other advance machineries are possible in permanent agriculture.

To address the challenges associated with shifting cultivation, efforts are being made to promote sustainable agricultural practices in Northeast India. These include the adoption of agroforestry systems, terrace farming, crop rotation, and organic farming techniques. Encouraging farmers to transition to more permanent cultivation methods can improve soil fertility, increase crop productivity, and protect the region's unique biodiversity.

6.5. Contributions of Shifting Cultivation

Shifting cultivation in Northeast India has contributed to the livelihoods of indigenous communities but poses challenges to ecological sustainability and socio-economic development. Transitioning to sustainable agricultural practices can mitigate these challenges, ensuring long-term food security, environmental conservation, and improved livelihoods for the region's inhabitants.

6.5.1. Ecological Impacts

While shifting cultivation allows for forest regeneration, its extensive use can lead to deforestation, soil erosion, and loss of biodiversity (Figure 6.5) The frequent clearing of land and burning of vegetation releases significant amounts of carbon dioxide into the atmosphere, contributing to climate change. Moreover, the repeated cultivation of the same plots leads to soil nutrient depletion, reducing agricultural productivity over time. These ecological impacts necessitate a transition toward more sustainable agricultural practices.

(a) (b)

Figure 6.5: (a) Dumping site at Mat River Basin (b) Garbage burning site at Mat River Basin.

6.5.2. Socio-economic Challenges

Shifting cultivation has posed socio-economic challenges in Northeast India. The practice requires vast land areas, which can lead to land scarcity as populations increase. Additionally, shifting cultivation often involves low crop yields and limited surplus for sale, hindering economic development and livelihood improvement. The nomadic nature of shifting cultivation makes it challenging to provide essential infrastructure and public services to remote areas (Figure 4.6). Moreover, shifting cultivation's negative image has affected indigenous communities' social status and limited their access to markets and credit
Facilities.

Figure 6.6: Cabbage production at early Saturday market at Serchhip town.

6.6. Permanent Agriculture

Northeast India, comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura, is endowed with rich biodiversity and fertile land. However, traditional slash-and-burn agriculture practices have posed significant challenges to sustainable cultivation in the region. This article aims to explore the concept of permanent cultivation as a viable solution for promoting sustainable agriculture in Northeast India. By utilizing scientific techniques, agroforestry systems, and government initiatives, permanent cultivation can ensure long-term food security while preserving the unique ecological characteristics of the region.

Northeast India has long relied on traditional agriculture practices, including shifting cultivation (also known as slash-and-burn agriculture). This method involves clearing land by cutting and burning trees, followed by cultivating crops for a few years until the soil fertility declines, after which the process is repeated elsewhere. Although this practice is suitable for maintaining soil fertility in the short term, it has several adverse effects, such as deforestation, soil erosion, loss of biodiversity, and carbon emissions. These challenges necessitate a transition toward more sustainable forms of agriculture.

Permanent cultivation, also known as settled or sedentary agriculture, involves the continuous cultivation of a plot of land without frequent relocation. It employs techniques such as terracing, contour farming, crop rotation, agroforestry, and the use of organic fertilizers to enhance soil fertility and productivity. By implementing permanent cultivation practices, farmers can establish resilient agroecosystems that generate higher crop yields while minimizing negative environmental impacts.

Permanent agricultural land refers to the static land utilised for cultivation that are being harvested regularly. Mat River basin inhabits steep slopes and narrow valleys, permanent patches are generally found in river valley, where alluvial soil has been deposited each year. The Upper basin has wider valley as compare to the Lower basin, permanent agriculture is generally found in between valleys i.e., on the foothills of ranges along with Mat River. Serchhip town has major three permanent agricultural patcher which hosts number of wet rice cultivated area. Use of mechanisation like machineries and proper irrigation channels for cultivation are developed on the Upper basin of Mat River. Zawlpui permanent agricultural patch, Chamdur agricultural patch, etc are found in these areas, which made Serchhip town as the 'rice bowl' of Serchhip district.

6.6.1. Agroforestry Systems under Permanent Agriculture

Agroforestry systems, which integrate trees with crops or livestock, are particularly well-suited for permanent cultivation in Mat River Basin (Figure 4.7). These systems provide numerous benefits, such as soil conservation, nutrient cycling, improved water retention, and increased biodiversity. For instance, the traditional jhum fields have been transformed into productive agroforestry systems that combine trees, horticultural crops, and food crops. Such systems contribute to food security, income generation, and environmental sustainability.

Figure 6.7: Social Forestry area in East Bungtlang village.

6.6.2. Government Initiatives and Support under Permanent Agriculture

The Government of India, recognizing the importance of sustainable agriculture in Northeast India, has implemented several initiatives to support permanent cultivation practices. The National Mission for Sustainable Agriculture (NMSA) provides financial assistance for adopting climate-resilient agricultural practices, including the establishment of permanent cultivation systems. Furthermore, the Rashtriya Krishi Vikas Yojana (RKVY) and the National Horticulture Mission (NHM) have been instrumental in promoting agroforestry and horticultural practices across the region. These initiatives aim to enhance farmers' knowledge, provide technical support, and facilitate market linkages to ensure the success of permanent cultivation.

Permanent cultivation offers a sustainable alternative to traditional agricultural practices in Northeast India. By implementing agroforestry systems, employing scientific techniques, and benefiting from government support, farmers in the region can establish resilient agricultural systems that improve food security, protect the environment, and promote socio-economic development. However, successful adoption of permanent cultivation requires continued research, farmer training, and the active involvement of all stakeholders. The transition to permanent cultivation practices represents a significant opportunity to unlock the agricultural potential of Northeast India while ensuring the preservation of its unique ecological heritage.

6.6.3. Promotion of Horticulture under Permanent Agriculture

Horticulture is a key focus area in Mizoram's agricultural development. The state's diverse agro-climatic conditions favor the cultivation of fruits, vegetables, spices, and flowers. The government has implemented programs to encourage farmers to adopt horticulture practices. These initiatives include providing financial support, training, and technical guidance to farmers. Additionally, Farmer Producer Organizations (FPOs) have been established to facilitate collective marketing and value addition.

(a) (b)

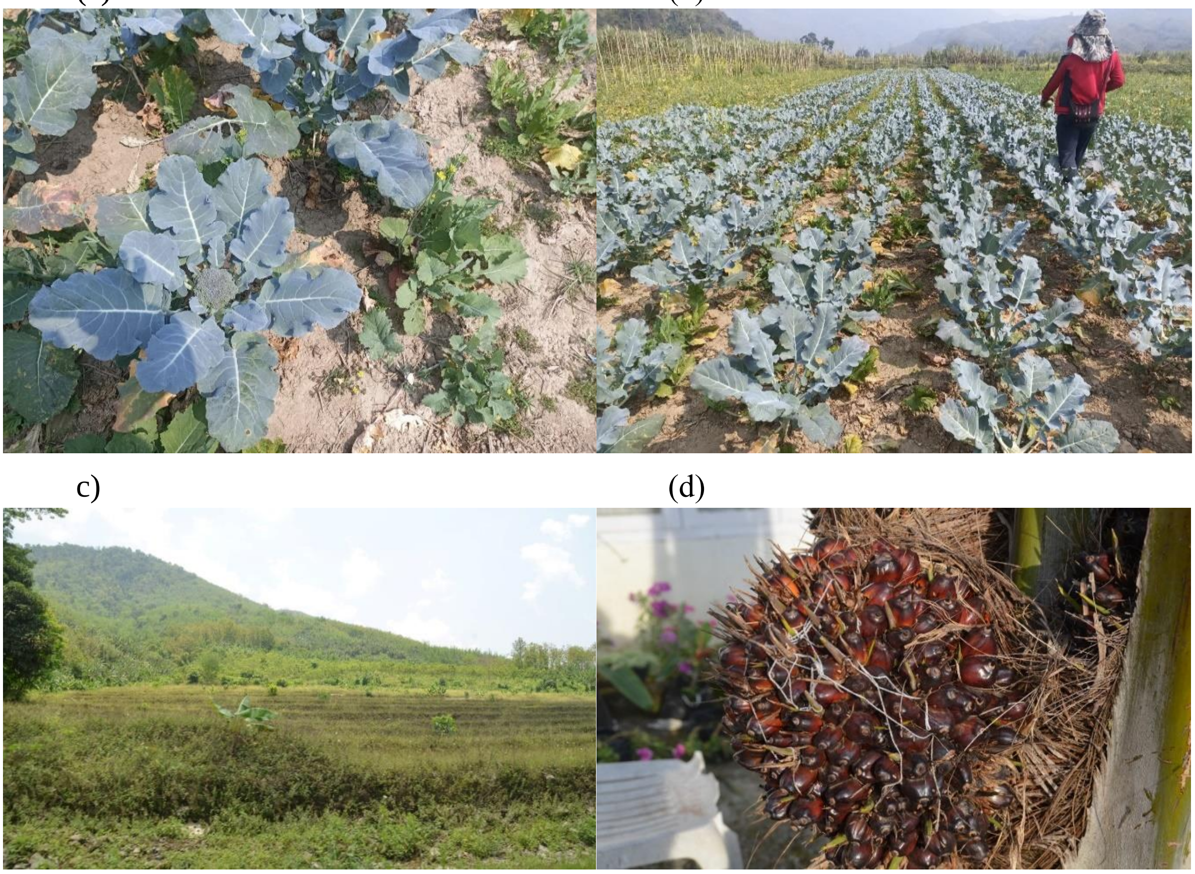

Figure 6.8: a) Broccoli plantation at Serchhip Town. b) Mustard plantation at Serchhip Town. c) Permanent plantation site at Mat River Basin. d) Oil Palm plant in Mat River Basin.

6.7. Socio-Economic Development

The total agricultural household in Mat River Basin accounts for 1808. Samples has been taken at 41.3%. The average sex ratio accounts for 977 females per 1000 males. The average family size is 6.7. Leite village has the highest sex ratio with 1072 while Haulawng village has the lowest sex ratio 871. Baktawng village has the highest family size with 5.84. Other villages like, Haulawng and East Bungtlang followed.

Table: 6.1. Households, sex ratio and family size

Village	Altitude(m)	No. of Agricultural Households	Sample Size	% of total Households	Sex Ratio (2011)	Family Size (2011)
Chhingchhip	1045	128	52	40.62	1049	5.15
Chengpuii	880	30	15	50	892	4.24
Serchhip	888	280	112	40	977	5.19
Keitum	762	80	32	40	1008	4.9
East Bungtlang	654	58	24	41.37	998	5.08
Rawpui	764	98	40	40.81	1022	4.85
Pangzawl	724	46	19	41.3	1034	4.76
Thiltlang	856	180	72	40	963	4.5
East Rotlang	986	74	30	40.54	964	4.91
Leite	638	34	14	41.17	1072	3.84
Zotuitlang	582	82	33	40.24	1015	4.48
Haulawng	937	32	13	40.62	871	4.88
Chhipphir	846	46	19	41.3	1032	4.82
Ramlaitui	768	120	48	40	916	4.95
S.Zote	973.59	160	64	40	900	5.08
Buangpui	873	66	27	40.9	960	4.64
Ralvawng	800	78	32	41.02	966	4.45
N.Mualthuam	730	52	21	40.38	999	5.09
New Dawn	768	80	32	40	882	4.21
Baktawng	1020	84	34	40.47	1030	5.84
Total	824.7295	1808	733	41.037	977.5	4.793

Source: Primary data collected by Author

The above table represents the various conditions of villages and households, sex ratio and family sizes of the sample collected from each village. Chhingchhip has the highest altitude with an altitude of 1054 m, in Chhingchhip village the number of agricultural households is 128 and the sample size is 52 that is 40.62% of the total agricultural households. According to 2011 census, the sex ratio of Chhingchhip is 1049 with a family size 0f 5.15. Next to Chhingchhip, Baktawng has the second highest altitude of 1020 m. There are 84 agricultural households in Baktawng village, and the sample size of this village is 34 that makes up to 40.47% of the total agricultural households. The sex ratio is 1030 and the average family size is 5.84 in 2011. East Rotlang has an altitude of 986 m where there are 74 agricultural households that exist in the village, a sample size of 40.54 is selected which is 30 households. The sex ratio and family size of East Rotlang is 964 respectively. S. Zote has an altitude of 973.59 m slightly lower than East Rotlang, there are 160 agricultural households where a sample size 40%, 64 households is taken into consideration. The sex ratio is 900 with a family size of 5.08. Haulawng has an altitude of 937 m, number of agricultural households is 32 and the sample size is 13 that is 40.60% of the total households. It has a sex ratio of 871 and a family size of 4.9 in average. Serchhip has an altitude of 888 m having the largest number of agricultural households compared to other villages, the number of agricultural households is 280 where a sample size of 112 (40%) is taken into consideration. The family size of Serchhip in average is 5.19that is also the highest among the villages. The sex ratio according to 2011 census is 977 in Serchhip. Chengpui has an altitude of 880 m, there are 30 agricultural households and the sample size is 15 that is 50% that is the highest sample size in per cent may be due to the scarcity of agricultural households in the village. It has a sex ratio of 892 and an average family size of 4.24. Buangpui village has an altitude of 873 m, the number of agricultural households is 66 and a sample size of 27 is taken which is 40.9% of the total agricultural households. The sex ratio and the average family size of the village according to 2011 census is 960 and 4.64 respectively. Thiltlang has an altitude of 856 m and has the second highest number of agricultural households among the represented villages by having 180 households in which a sample size of 72 (40%) is taken into consideration. The sex ratio of Thiltlang is 963 and the family size is 4.5. Chhipphir village has an altitude of 846 m and the total number of agricultural households is 46 in which the sample size is 19 (41.3%). The sex ratio is 1032 with an average family size of 4.82. Ralvawng has an altitude of 800 m, the number of agricultural households is 78 and the sample size is 32 (41.02%) households. The sex ratio is 966 and the average family size is 4.45. The altitude of Ramlaitui village is 768 m where there are 120 agricultural households. The sample size is 48 households, 40% of the total agricultural households, the sex ratio and the average family size of the village is 916 and 4.15 respectively. New Dawn village also has an altitude of 768 m while there are only 80 agricultural households in New Dawn, the sample size of the households is 34 (40.47%). The sex ratio is 882 and the family size is 4.21. Rawpui village has an altitude of 764 m with 58 agricultural households. The sample size that has been taken into consideration is 40 (40.81%) households. The sex ratio of Rawpui is 1022 and the family size is 4.9. Keitum has an altitude of 762 m, there are 80 agricultural households within the village and the sample size is 32 households. The sex ratio of Keitum is 1008 with an average family size of 4.9. N. Mualthuam has an altitude of 730 m and the total number of agricultural households is 52, the sample size is 21 (40.38%) households. The sex ratio is 999 and the average family size is 5.09. Pangzawl has an altitude of 724 m, there are 46 agricultural households and the sample size is 19. The sex ratio and the family size of Pangzawl is 1034 and 4.8 respectively. East Bungtlang has an altitude of 654 m in which 58 households are agricultural households. The sample size is 58 (24%), the sex ratio is 998 and the average family size is 5.1. Leite has an altitude of 638 m, there are 34 agricultural households and the sample size is 14, the sex ratio is 1072 and the family size is 3.9. Zotuitlang is the lowest in altitude with an altitude of 582 m only, there are 82 agricultural households and the sample size is 33 (40.24%) households. The sex ratio of Zotuitlang is 1015 and the average family size is 4.5. Overall, the given villages, the average altitude is 824 m, there are 1808 agricultural households in total and the total sample size is 733 households. The overall sex ratio is 977 and the family size is 4.8 according to 2011 census.

6.8. Intervention of NLUP

The Government of Mizoram has implemented several initiatives to promote agricultural development and improve the socio-economic conditions of farmers. The flagship program, New Land Use Policy (NLUP), aims to provide sustainable livelihood opportunities by shifting from shifting cultivation to permanent agriculture, horticulture, and allied activities. The state government provides financial assistance, training, and technical support to farmers for adopting modern agricultural practices, promoting organic farming, and developing value chains. Schemes like the Rashtriya Krishi Vikas Yojana (RKVY) and the National Mission for Sustainable Agriculture (NMSA) have also been instrumental in providing financial support and infrastructure development for agricultural activities.

6.9. Crop Diversification and Agricultural Development

Mizoram has made significant progress in crop diversification and horticulture development. Farmers have been encouraged to shift from traditional crops to high-value crops like fruits, vegetables, spices, and flowers. This shift has resulted in increased income generation and market opportunities for farmers. The state government has provided support in the form of training, subsidies, and infrastructure development for horticultural activities. The establishment of Farmer Producer Organizations (FPOs) has facilitated collective marketing, value addition, and improved access to credit and inputs for farmers.

6.10. Promotion of Organic Farming

Mizoram has made significant strides in promoting organic farming practices. The state has recognized the potential of organic agriculture in ensuring sustainable farming and better market opportunities for farmers. The Department of Agriculture, along with various NGOs and institutions, has conducted training programs to educate farmers about organic farming techniques, vermicomposting, and natural pest control methods. Organic farming clusters have been formed to encourage the adoption of organic practices and obtain organic certification. These efforts have enhanced the socio-economic status of farmers by reducing input costs, improving soil health, and enabling access to premium markets.

6.11. Challenges and Future Prospects

Despite progress, Mizoram's farmers face several challenges such as limited access to credit, inadequate market infrastructure, and the vulnerability of agriculture to climate change. Addressing these challenges requires continued government support, investment in rural infrastructure, strengthening farmer-producer linkages, and promoting agro-processing and value addition. Emphasizing sustainable agricultural practices, capacity building, and the integration of technology can further enhance the socio-economic development of farmers in Mizoram.

6.12. Conclusions

The socio-economic development in the Mat River Basin has been significantly improved through agricultural initiatives, crop diversification, horticulture development, and promotion of organic farming. Continued efforts to address challenges and explore new opportunities will pave the way for sustained prosperity and enhanced livelihoods for farmers in the state.

The implementation of sustainable agricultural practices in Mizoram has significantly contributed to the socio-economic development of the state. The transition from shifting cultivation to permanent agriculture, the promotion of horticulture and organic farming, and the adoption of integrated farming systems have improved agricultural productivity, enhanced rural livelihoods, and generated new avenues for economic growth. These efforts have led to improved food security, increased income levels, reduced dependence on external inputs, and the conservation of natural resources. By continuing to support and invest in sustainable agriculture, Mizoram can further drive socio-economic development and uplift the lives of its farming communities.

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Chapter 7

Conclusions

The present study is very comprehensive in terms of agricultural practices and its development in Mizoram in general and the Mat River basin in particular. We have noticed a large changes in agriculture practices, such as the area under shifting cultivation has decrease more thar 50% during the last 30 years. There was a scheme led by the government of Mizoram in term of the NLUP which was initiated in Mizoram in 1985, however, in the Mat River basin, it was initiated quite late. However, the NLUP was not successful because of certain political interference. The change in the ruling party in the government, the NLUP got many changes from time to time. In the meantime, the agro-ecological conditions of the Mat River basin in particular and Mizoram in general are quite suitable to grow many crops races/cultivars. The present study recommends that the shifting cultivation is neither economically viable nor ecologically suitable. Therefore, a sizable acre of land can be devoted for the cultivation of permanent agriculture. This will lead high production and productivity of crops and enhancing the income and economy of the people and government.

In this chapter, objective-wise conclusion is given below. There are a total of six main chapters described and a total of four objectives are elucidated.

7.1. Social, environmental and economic factors influencing Agricultural Development

From a social perspective, the traditional practice of shifting cultivation, commonly known as jhum, holds deep cultural significance for the indigenous communities in Mizoram. It has been a vital source of livelihood and sustenance for generations. However, over time, shifting cultivation has faced increasing environmental criticism due to its association with deforestation, soil erosion, and land degradation. As the region experiences population growth and increased agricultural demands, the need for sustainable alternatives has become apparent.

In response to these challenges, the government of Mizoram introduced the New Land Use Policy (NLUP) to promote the adoption of more permanent cultivation methods. The NLUP has been successful in encouraging farmers to transition towards terrace farming, contour bunding, and agroforestry. These sustainable practices have not only addressed environmental concerns but have also yielded substantial social benefits. By ensuring long-term food security and enhancing agricultural productivity, farmers and rural communities have experienced improved socio-economic conditions. The shift towards sustainable practices has also led to reduced labour-intensive agricultural activities, allowing for greater opportunities in education, healthcare, and other income-generating activities.

Furthermore, the promotion of horticulture crops and the establishment of Farmer Producer Organizations (FPOs) have empowered farmers by diversifying their income sources and providing improved market access. The cultivation of high-value horticultural crops such as oranges, pineapples, bananas, and passion fruits has not only contributed to domestic consumption but has also opened avenues for commercial sales, boosting rural incomes and overall economic growth.

The study also sheds light on the critical environmental factors influenced by agricultural practices in the Mat River basin. While traditional shifting cultivation has been associated with environmental challenges, the transition to sustainable practices has showcased its potential for fostering environmental conservation. Terrace farming and contour bunding have effectively reduced soil erosion and enhanced soil fertility, leading to ecological balance and the preservation of the region's rich biodiversity. Additionally, the embrace of organic farming practices has significantly mitigated the environmental impacts of chemical usage, resulting in a healthier and more sustainable agricultural ecosystem. The cultivation of horticultural crops has also been linked to increased tree cover and improved agroforestry practices, contributing to the overall restoration of the ecological landscape.

The economic impact of agricultural development in the region has been profound. The shift towards sustainable practices has facilitated crop diversification, supported by government initiatives in horticulture development. This diversification has enabled farmers to mitigate risks associated with a single crop dependency and has enhanced economic resilience. By reducing vulnerability to market fluctuations and climatic uncertainties, farmers have experienced improved socio-economic status, leading to the overall well-being of rural communities.

Moreover, the integration of livestock, fisheries, and agroforestry through Integrated Farming Systems (IFS) has proven to be a successful strategy in optimizing resource utilization, reducing input costs, and enhancing agricultural productivity. This holistic approach to farming has translated into improved farm incomes and enhanced livelihood opportunities for farming households.

It also emphasizes that sustaining and maximizing the socio-economic impacts of agricultural development in Mizoram requires a multifaceted approach. To ensure continued progress, it is essential to prioritize strengthening institutional support for farmers, investing in rural infrastructure, and promoting the adoption of cutting-edge agricultural technologies. The government, research institutions, and development agencies must collaborate to provide technical assistance, extension services, and capacity building to empower farmers with knowledge and skills.

Furthermore, an inclusive approach that addresses the specific needs of marginalized and smallholder farmers is crucial for equitable development. Gender empowerment must be at the core of agricultural policies to promote the active participation of women in the sector. Women's access to resources, training, and decision-making opportunities can play a transformative role in enhancing agricultural productivity and fostering social inclusivity.

Additionally, climate change adaptation emerges as a pressing concern in the context of agricultural development. Climate-resilient practices, drought-resistant crops, and efficient water management techniques must be integrated into agricultural strategies to ensure food security and protect farmers from climate-induced risks.

Thus, the study emphasizes that a collective effort involving policymakers, development agencies, researchers, local communities, and farmers is essential to achieving holistic and inclusive development. Sustainable agricultural practices, capacity building, and technology adoption will be instrumental in nurturing the socio-economic well-being of Mizoram's farming communities while safeguarding the region's unique environmental heritage for future generations.

Furthermore, the lessons learned from the agricultural development in the Mat River basin can serve as a model for sustainable agricultural development not only within the broader context of India but also for other regions facing similar socio-economic and environmental challenges. By capitalizing on the successes, addressing the challenges, and continuously adapting to changing circumstances, Mizoram's agricultural sector can continue its trajectory towards a resilient and prosperous future.

In conclusion, this study serves as a comprehensive and insightful exploration of the interplay between agricultural practices and their impacts on the socio-economic development of Mizoram, Northeast India. The findings and recommendations presented in this study have far-reaching implications for sustainable agricultural development, social inclusivity, environmental conservation, and economic growth in the region. By building on the achievements and addressing the challenges, Mizoram can continue its journey towards a thriving and resilient agricultural sector that upholds the welfare of its farming communities and ensures the preservation of its unique natural heritage. The successful transformation of agriculture in Mizoram will stand as a testament to the power of collective action, research, and policy support in driving sustainable and inclusive development.

7.2. Agricultural practices and their impact on Socio economic development

In the Mat River Basin, there are a total of 1,808 agricultural households, and a sample of 733 households, which represents approximately 41.3% of the total agricultural households, was taken for analysis. According to the 2011 census data, the overall sex ratio in the region is 977 females per 1000 males. The average family size in the Mat River Basin is 4.8 persons per family. The villages in the area vary in altitude, with an average altitude of 824 meters. Leite village stands out with the highest sex ratio of 1072, indicating a higher number of females compared to males, while Haulawng village has the lowest sex ratio of 871, indicating a higher number of males compared to females. Baktawng village has the highest average family size of 5.84 persons per family, while Leite village has the lowest average family size of 3.9 persons per family. These figures highlight important demographic and social characteristics of the villages in the Mat River Basin, providing valuable insights for policymaking and interventions to support agricultural development and improve the well-being of the communities in the region.

The present study delves into an extensive exploration of the pivotal role of agricultural practices in driving socio-economic development in the captivating state of Mizoram, situated in Northeast India. It sheds light on the paramount significance of agriculture in sustaining rural economies, uplifting livelihoods, and fostering overall societal well-being.

The transition from traditional shifting cultivation, known as "jhum," to sustainable agricultural practices, facilitated by the forward-thinking New Land Use Policy (NLUP), has showcased remarkable progress. The adoption of innovative techniques, such as terrace farming, contour bunding, agroforestry, and horticulture development, has not only improved agricultural productivity but also fortified the delicate balance of the region's ecological integrity. Consequently, long-term food security has been ensured, instilling a sense of confidence and stability among the farming communities.

Another noteworthy aspect is the conscious promotion of organic farming practices as a beacon of sustainable agricultural growth in Mizoram. Collaborative efforts between the government, non-governmental organizations (NGOs), and esteemed agricultural institutions have provided farmers with knowledge and training in organic farming techniques, composting, and natural pest control methods. As a result, Mizoram's farmers have embraced environmentally-friendly approaches, reducing their reliance on harmful chemicals, preserving soil health, and effectively mitigating pollution. Moreover, the adoption of organic farming practices has opened doors to lucrative niche markets, providing farmers with improved economic returns and greater empowerment within rural communities.

Moreover, the integration of various agricultural sectors through the dynamic concept of Integrated Farming Systems (IFS) has proven transformative for the region. The ingenious amalgamation of crop cultivation, livestock management, fisheries, and agroforestry has optimized resource utilization, minimized wastage, and bolstered overall productivity. This interdisciplinary approach has not only reduced input costs but also created multiple income streams, effectively fortifying the resilience of the region's rural economies.

Central to the progress witnessed in Mizoram's agricultural landscape has been the indispensable support provided by Farmer Producer Organizations (FPOs). The establishment of these collectives has led to collaborative marketing and value addition, translating into tangible benefits for the farmers. By enabling farmers to pool resources, negotiate fairer prices, and collectively access markets, FPOs have effectively bridged the gap between agricultural producers and end consumers. The resultant economic gains have trickled down to rural communities, elevating the socio-economic status of the farmers and promoting sustainable development in the region.

Despite these laudable achievements, Mizoram's farmers continue to face several challenges that warrant attention and proactive measures. Chief among these is the limited access to credit and financial services, which often impedes agricultural investments and hampers farmers' ability to adopt innovative practices. Addressing this issue necessitates enhanced financial inclusion, enabling farmers to leverage credit for sustainable agricultural endeavours.

Furthermore, strengthening market infrastructure remains paramount. An improved network of storage, transportation, and processing facilities would not only reduce post-harvest losses but also enhance market access for farmers, ensuring better price realization and greater profitability.

Another critical consideration is the escalating impact of climate change on agricultural productivity. Mizoram, like many regions across the globe, is vulnerable to the vagaries of a changing climate. To build resilience and adapt to the challenges ahead, investment in climate-smart agriculture, access to weather-related information, and the dissemination of best practices are imperative.

To chart a trajectory for sustainable agricultural development, the Government of Mizoram must continue its steadfast support for farmers through policy initiatives, incentives, and infrastructural development. Notably, the Rashtriya Krishi Vikas Yojana (RKVY) and the National Mission for Sustainable Agriculture (NMSA) have played instrumental roles in fostering agricultural growth in the state. Ensuring the continued efficacy of these programs, along with the introduction of targeted policies to address the specific needs of Mizoram's farmers, will be key in unlocking the full potential of agriculture as an engine for socio-economic development.

Furthermore, enhancing the role of women in agriculture is crucial for achieving inclusive socio-economic development in the region. Empowering women farmers with access to resources, training, and decision-making opportunities will not only improve agricultural productivity but also contribute to gender equality and women's empowerment.

To secure the future of agriculture in Mizoram, engaging the youth in the sector is essential. Education and skill development programs targeted at young individuals can cultivate a new generation of agricultural leaders and entrepreneurs. By promoting agricultural education in schools and colleges, Mizoram can instill a passion for farming and create a talent pool of young professionals interested in pursuing careers in agriculture. These programs should encompass practical training in modern farming techniques, agribusiness management, and agro-entrepreneurship, equipping young farmers with the necessary skills to innovate and drive the agricultural sector forward.

The Mat River Basin has a significant number of agricultural households, and the sample size taken for analysis represents around 41.3% of these households. The overall sex ratio is close to parity, with slightly more females than males. The average family size is 4.8 persons per family.

The government has implemented the New Land Use Policy (NLUP) to promote agricultural development and improve the socio-economic conditions of farmers. This policy encourages farmers to shift from shifting cultivation to permanent agriculture and horticulture. Various schemes like Rashtriya Krishi Vikas Yojana (RKVY) and National Mission for Sustainable Agriculture (NMSA) provide financial support and infrastructure development to enhance agricultural activities.

7.3. Patterns of agricultural production in relation to farm holdings

Between 2001 and 2016, the total production of plantation crops in the Mat River Basin declined from 824,640 kg to 677,580 kg. The production levels varied across different villages during this period, with some experiencing an increase while others witnessed a decrease. Interestingly, the altitude of the villages did not show a direct correlation with plantation crop production, as villages with higher altitudes did not necessarily have higher production levels. Notable changes in production occurred in specific villages; for example, Serchhip saw a decrease in production, while S. Zote experienced a significant increase. These trends highlight the dynamic nature of agricultural activities in the region, indicating the need for targeted interventions and strategies to support sustainable agricultural development in the Mat River Basin.

It can be observed that the total production of fruits and vegetables in the Mat River Basin was 2,221,500 kg in 2001, but this decreased to 2,045,300 kg in 2016. When analysing individual crop changes, it becomes apparent that different fruits and vegetables exhibited varying trends in production. Some crops, such as broccoli, cabbage, and ginger, saw an increase in production over the years, while others, like watermelon and turmeric, experienced a decline. These fluctuations in production levels emphasize the dynamic nature of agricultural practices and the need for tailored approaches to support the cultivation of specific crops in the region.

In response to the challenges posed by shifting cultivation, the government of Mizoram implemented the New Land Use Policy (NLUP) to encourage the adoption of more permanent cultivation methods. As a result, farmers have shifted towards terrace farming, contour bunding, and agroforestry, leading to substantial social benefits. The transition to sustainable practices has ensured long-term food security, improved agricultural productivity, and enhanced the socio-economic conditions of farmers and rural communities.

Mat River Basin has a total of 1,808 agricultural households. The sample size taken from the agricultural households is 733, which is approximately 41.3% of the total agricultural households. Sex Ratio: The overall sex ratio in the Mat River Basin is 977 females per 1000 males, according to the 2011 census data.

In 2001, the Mat River Basin's agricultural landscape revealed rice cultivation as the primary activity, yielding 859 kg, signifying its essential role as a staple crop for the communities. Additionally, fruit and vegetable cultivation played a significant part, producing 148.4 kg, highlighting agricultural diversity. Notably, certain plantation crops were cultivated, totaling 84 kg, indicating their presence in the area. The overall total cropped area of 1082.4 hectares showcased the extent of agricultural activity. Furthermore, variations in crop production among villages suggested differences in practices, climate, and soil conditions. Given the relatively low production of fruits, vegetables, and plantation crops, the region might explore opportunities for crop diversification and adopt innovative agricultural practices to enhance productivity and sustainability.

In 2016, the crop production data for the Mat River Basin indicates several key conclusions. Rice cultivation continues to be the dominant agricultural activity, with a total production of 706 kg, reaffirming its significance as a staple crop in the region. Fruit and vegetable cultivation also play a vital role, with a total production of 125.1 kg, showcasing the importance of diversifying agricultural practices. Notably, the production of plantation crops reached 89.1 kg, demonstrating their continued presence in the area. The overall total cropped area expanded to 917.6 hectares, indicating a growth in agricultural activity. Similar to 2001, variations in crop production persist among different villages, suggesting potential disparities in agricultural practices and conditions. Considering the relatively low production of certain crops like fruits, vegetables, and plantation crops, there is still scope for crop diversification and adopting innovative agricultural approaches to further enhance productivity and sustainability in the Mat River Basin.

Over the 15-year period from 2001 to 2016, the data from Tables 5.4.1 and 5.4.2 reveal significant changes in farm holdings in the Mat River Basin. Notably, there was a considerable increase in small farms, less than 1 hectare in size, rising from 16.4% to 27.1%, indicating a trend of sub-division or fragmentation of larger farms. Conversely, the category of farms ranging from 1 to 2 hectares decreased from 54.2% to 44.4%, implying a decline in medium-sized holdings, possibly converted into smaller or larger farms. The farms within the 2 to 4-hectare range, popular in six villages, also experienced a reduction from 14.9 to 8.7 hectares in 2016, highlighting shifting land distribution patterns. Furthermore, farms ranging from 4 to 10 hectares, extensive for hilly agricultural households, saw negative growth, decreasing from 11.8 to 7.1 hectares in 2016. In contrast, large farms of more than 10 hectares expanded significantly from 4.5 to 12.7 hectares, representing a growth of 8.20% in the entire Mat River Basin. These trends underscore the changing dynamics of land use and agricultural practices, warranting careful land use planning and support for smallholders to ensure sustainable and equitable agricultural development in the Mat River Basin.

Overall, these changes in farm holdings indicate a shift towards smaller landholdings and an expansion of larger farms, suggesting changes in land use patterns and possibly an increasing trend towards land concentration in certain areas. It also indicates the need for careful land use planning and support for smallholders to ensure sustainable and equitable agricultural development in the Mat River Basin. It has a significant number of agricultural households, and the sample size taken for analysis represents around 41.3% of these households. The overall sex ratio is close to parity, with slightly more females than males. The average family size is 4.8 persons per family.

The government has implemented the New Land Use Policy (NLUP) to promote agricultural development and improve the socio-economic conditions of farmers. This policy encourages farmers to shift from shifting cultivation to permanent agriculture and horticulture. Various schemes like Rashtriya Krishi Vikas Yojana (RKVY) and National Mission for Sustainable Agriculture (NMSA) provide financial support and infrastructure development to enhance agricultural activities.

By capitalizing on the successes, addressing the challenges, and continuously adapting to changing circumstances, Mizoram can continue its journey towards a resilient and prosperous agricultural sector that upholds the welfare of its farming communities and ensures the preservation of its unique natural heritage. The successful transformation of agriculture in Mizoram will stand as a testament to the power of collective action, research, and policy support in driving sustainable and inclusive development.

It is through such collaborative efforts that the Mat River basin can serve as a model for sustainable agricultural development, not only within the broader context of India but also for other regions facing similar socio-economic and environmental challenges. By learning from the experiences and applying the lessons to new contexts, sustainable agricultural development can become a driving force for positive change in the lives of farmers and the well-being of the environment.

7.4. Patterns of agricultural development in relation to crop production and crop productivity

Over the 15-year period from 2001 to 2016, there were notable changes in the area of cultivation for various crops in the Mat River Basin. The total cropped area decreased significantly, from 1082.4 hectares in 2001 to 917.6 hectares in 2016, reflecting a reduction of 165.4 hectares or a negative change of -15.24%. Rice cultivation experienced a considerable decline, with the area decreasing from 859 hectares to 706 hectares, amounting to a drop of 153 hectares or -17.8%. Similarly, the area dedicated to fruits and vegetables cultivation saw a decrease from 148.4 hectares in 2001 to 125.1 hectares in 2016, showing a reduction of 23.3 hectares or -

15.7%. In contrast, the area under plantation crops showed a slight increase, rising from 84 hectares to 89.1 hectares, indicating a small growth of 5.1 hectares or 6.07%. These changes in crop areas highlight shifts in agricultural practices and possibly changing market demands or land-use decisions made by farmers in response to various economic and environmental factors during the specified period.

There have been mixed trends in rice cultivation during this period. While some villages experienced significant increases in production, others faced declines, resulting in varied changes in the overall production levels. Villages like Keitum, East Bungtlang, and Thiltlang witnessed notable growth in rice production, with increases of 28.57%, 35.71%, and 37.50% respectively. On the other hand, villages like Haulawng and S. Zote faced substantial reductions in production, with a decline of -38.46% and -50.52% respectively. It is essential to recognize that these changes in rice production could be influenced by factors such as changes in agricultural practices, weather conditions, and land-use decisions. The data underscores the need for sustainable and adaptive agricultural strategies to mitigate the challenges faced by shifting cultivation and support the overall food security and livelihoods of the communities in the Mat River Basin.

There has been a significant increase in the total cropped area, with a growth of 163 hectares or 28.9%. This indicates an expansion of agricultural activities in the region during the 15-year period. Among the villages, Baktawng experienced the most substantial increase in cropped area, with a significant growth of 57.1%, followed by Chengpui and Pangzawl, which witnessed growth rates of 38.5% and 29.4%, respectively. On the other hand, some villages, like S. Zote, Ramlaitui, and Chhipphir, saw relatively modest increases in cropped area, indicating more stable agricultural practices in these areas. These changes may be influenced by factors such as population growth, changes in land-use patterns, and agricultural policies. The expansion of permanent agricultural land highlights the importance of sustainable and efficient land management practices to ensure the long-term environmental and economic viability of agriculture in the Mat River Basin.

The rise in individual land ownership emerges as a crucial factor driving agricultural development in the Mat River basin. Farmers' growing interest in securing their land holdings and investing in sustainable farming practices fosters a sense of ownership and enhances their decision-making power, encouraging long-term investments in land improvement and agricultural productivity.

The correlation analysis between altitude, area, production, and productivity of plantation crops reveals insightful connections between environmental factors and agricultural outcomes. This analysis forms the foundation for targeted agro-ecological zoning and crop planning, enabling farmers to optimize crop selection based on their land's unique characteristics and improve resource efficiency.

Despite the progress achieved, the study highlights several challenges that require immediate attention. Robust market infrastructure and linkages are crucial for farmers to access fair prices for their produce and capitalize on emerging market opportunities. The promotion of technology adoption and extension services is essential to empower farmers with knowledge and skills, allowing them to harness the full potential of modern agricultural practices.

To realize the vision of sustainable agricultural development in the Mat River basin, research, innovation, and consistent policy support are paramount. Collaborative efforts involving various stakeholders, including the government, research institutions, non-governmental organizations, and local communities, will be essential to co-create transformative agricultural initiatives that align with the unique needs and aspirations of the farming population.

In conclusion, this study contributes significantly to our understanding of the pattern of agricultural development in relation to crop production and crop productivity in the Mat River basin. The research emphasizes the importance of dynamic and adaptive agricultural practices that foster economic growth, enhance rural livelihoods, and ensure food security amid ever-changing challenges.

By embracing sustainable farming practices, promoting gender-inclusive policies, and addressing emerging issues related to climate change and market access, Mizoram's agricultural sector can continue its trajectory of growth and transformation. The region's agricultural potential, combined with continuous dedication, strategic planning, and collective action, can lead to a thriving and sustainable agricultural sector, preserving the region's unique natural heritage. By prioritizing sustainability, resilience, and inclusivity, Mizoram's agricultural sector can serve as a model for socio-economic development, locally and globally.

To achieve this, investment in research and innovation is critical, empowering farmers with knowledge and technologies to optimize their farming practices. Additionally, strong institutional support and policy frameworks prioritizing sustainable agriculture, environmental conservation, and gender empowerment will be instrumental in fostering long-term growth and resilience in the agricultural sector.

Moreover, collaboration among multiple stakeholders will be essential to create an enabling environment that supports sustainable agricultural development. By aligning efforts and resources, stakeholders can collectively work towards common goals, such as enhancing market access, improving agricultural infrastructure, and promoting climate-smart agricultural practices.

Sustainable agricultural development in the Mat River basin requires a holistic approach that considers the social, economic, and environmental dimensions of agriculture. Ensuring equitable access to resources and opportunities for smallholder farmers, investing in rural infrastructure, and promoting sustainable land use practices will be crucial components of such an approach.

Furthermore, capacity-building programs and extension services that equip farmers with necessary skills and knowledge will play a vital role in enhancing agricultural productivity and ensuring the adoption of sustainable practices. Additionally, research and data-driven decision-making will be essential to monitor progress, identify challenges, and adapt strategies to changing circumstances.

Agriculture in the Mat River basin possesses immense potential, it faces several challenges that hinder its growth and development. One of the major obstacles is land fragmentation, with small and fragmented landholdings limiting economies of scale and mechanization. This situation impedes the adoption of advanced agricultural practices and reduces overall productivity. Inadequate market access and infrastructure, such as storage and transportation facilities, pose challenges in connecting farmers with markets, leading to post-harvest losses and reduced profitability. Furthermore, climate change-induced events, including erratic rainfall patterns, increased temperatures, and the emergence of new pests and diseases, disrupt traditional cropping patterns and necessitate the adoption of resilient farming practices.

Mat River basin, like other regions, is experiencing the impacts of climate change, including erratic rainfall patterns, extreme weather events, and changing pest and disease dynamics. These climatic changes pose challenges to agricultural production, requiring farmers to adapt to new growing conditions and implement climate-resilient farming practices.

Limited access to markets, inadequate transportation facilities, and inadequate storage and processing infrastructure hinder the growth of the agricultural sector in Mat River basin. These challenges affect farmers' ability to fetch fair prices for their produce and hinder value addition and market integration.

Addressing challenges related to land fragmentation, market access, infrastructure development, and climate change adaptation is vital for the sustainable growth of the agricultural sector in Mizoram. Through targeted policies, investments in infrastructure, technology dissemination, and capacity building, Mat River basin can unlock its agricultural potential and improve the livelihoods of its farming communities while fostering overall economic prosperity.

Collaborative efforts involving government agencies, NGOs, and local communities are essential for fostering sustainable horticultural development in hill regions. Such holistic approaches can ensure both socio-economic progress and environmental conservation

Illustrations from the Mat River Basin

Plate No. 1: Clearing of forest in Shifting Cultivation in the Mat River basin

Plate No. 2: Slash and Burn Cultivation in the Mat River Basin


Plate No. 3: East Bungtlang village on quiet Sunday morning

Plate No. 4: Rice production at Rawpui village in the Mat River basin

Plate No. 5: Typical Mizo Cultivated area after slash and burn, Mat River Basin

Plate No. 6: Calm view of Pangzawl shifting cultivated area

Plate No. 7: Meeting with Pangzawl Village Council members

Plate No. 8: Meeting with East Bungtlang Village Council members

Plate No. 9: Traditional Cone preservation at East Bungtlang village

Plate No. 10: Social Forestry movement in East Bungtlang village

Plate No. 11: Fresh log for domestic cooking at East Bungtlang roadside, nearby the house

Plate No. 12: Ginger production in the Mat River basin

Plate No. 13: Meeting with Keitum village local leaders

Plate No. 14: Birds eye view of Wet rice cultivated area in the Mat River basin

Plate No. 15: Visit to slash and burn cultivation area in the Mat River basin

Plate No. 16: Plantation area in hill slopes of the Mat River basin

Plate No. 17: Solid waste management; Dumping area in the Mat River basin

Plate No. 18: Conducting household Survey to farmers household

Plate No. 19: Cabbage production at early Saturday market at Serchhip town

Plate No. 20: Oil extract from Oil palm plantation area in the Mat River basin

Plate No. 21: Interview with Serchhip Livestock Growers Association

Plate No. 22: Papaya production in the Mat River basin

BRIEF BIO-DATA OF THE CANDIDATE

NAME : Ramengmawii
DEPARTMENT : Geography

A. PERSONAL DETAILS:

Date of Birth	19th November, 1994
Father's Name	C Rozuala
Marital Status	Single
Address	Y-42, Bawngkawn South, Aizawl

B. ACADEMIC RECORDS

Degree	**Institution/Board/University**	**Year of Passing/Award**
HSLC	Mizoram Board of School Education	2008
HSSLC /Pre Univ	Mizoram Board of School Education	2010
UG	Mizoram University	2013
PG	Mizoram University	2015
Ph.D	Persuing	2016
Others	Diploma in Elementary Education (D.El.Ed)	2020
Others Specialization	Bachelor of Education (B. Ed)	2020
	Master of Arts in Rural Development (MARD)	2022
	Teacher Eligibility Test - MTET, CTET, NET	2016-2019
	Post Graduate Diploma in Rural Development	2021
	Diploma in Entrepreneurship	2020
	Certificate course in Remote Sensing and GIS (NESAC)	2016
	Master of Education (M.Ed)	2024

D. SEMINAR/CONFERENCE/TRAINING ATTENDED:

Sl. No.	**Name of Programme Attended/ Participated**
1	Participated in National Seminar on Management of Natural Resource for Sustainable Development Challenges and Opportunities, organized by Department of Geography and Resource Mangement, Mizoram University.
2	Rapporteur in,'Third National Seminar on Natural Resources Management for Sustainable Development, organized by Department of Geography and Resource Management, MZU
3	Paper presented on, 'International Seminar on Insurgency in South East Asia" organized by Department History and Ethnography, Mizoram University
4	Poster Presentation on Second national seminar on, "Climate change and Socio- ecological transformation" organized by Department of Geography and Resource Management, Mizoram University
5	Participated in International Women's Day Celebration. Organised by Women Study Centre, Mizoram University
6	Participated in Sustainable Management of Indegenious Knowledge
7	Participated in discussion on Geography and its Importance, organized by Geographical Research Forum, Mizoram University.
8	Participated in National Seminar on Management of Natural Resource for Sustainable Development Challenges and Opportunities, organized by Department of Geography and Resource Mangement, Mizoram University
9	Participated in National Seminar on Protection of Human Rights and Assuring the unity and Integrity of the nation.
10	Participated in 10 days Research Methodology Workshop organized by Department of Mass Communication Mizoram University
11	Paper Presented on the topic of "Evaluation of Crop Productivity in Serchhip District, Mizoram North East India on," International Conference on Natural Resource Management for Sustainable Development and Rural Livelihood.
12	Participated on National Workshop cum Training programme on Research Ethics, plagiarism and reference management, organized by Department of Library and Information Science, Mizoram University.
13	Participated on UGC Sponsored Short Term Course, 'Research Methodology for Research Scholars held from 20th to 26th, June 2016. Organized by human Resource Development Centre, Mizoram University.
14	Presented paper on the topic of Assessment of Women Participation in Agricultural development of Serchhip town, Mizoram, on National Seminar on Social Work and Rural Development in North East India, organized by Department of Social Work Mizoram University.
15	Presented paper on, 'Entrepreneurial Endeavors for Industrial Growth in North East India and Mizoram in particular", organized by Department of Commerce, Govt Hrangbana College in collaboration with Dept. of Commerce Mizoram University,
16	Presented paper on,' Shifting Cultivation and its Impact Environmental Impact in NE India, organized by Department of Geography, PUC.
17	Participated in International Workshop and Training on hydro-Meteorological Monitoring and Watershed Management, organized by,

	University of Minnesota and Mississippi Watershed Management Organization.
18	Participated in International Conference on Library Service in Knowledge Society Innovative, Value-Added Services and Best Practices, organized by the Dept of Library and Information Science, MZU.
19	Rapporteur in, ’Third National Seminar on Natural Resources Management for Sustainable Development, organized by Department of Geography and Resource Management, MZU.
20	Participated in, ‘Mechanism of Cancer induced cachexia’, organized by Department of Biotechnology, 2020, Mizoram University.
21	Participated in International Webinar on “Mahatma Gandhi’s Conception of the Power of Non-violence in the Light of Patanjali’s Yoga- sutra’, 13th, August, 2020, organized by Mizoram University.
22	Participated in the webinar on, ‘Earthquake versus Landslide with special reference to Mizoram’, conducted by Mizoram University on 13th, August, 2020.
23	Participated in National Webinar on, ‘Futuristic Hard Disk Drive: Progress and Challenges from Media Development, organized by Mizoram University.
24	Participated in National Webinar on. ‘Microwave Propagation Related to Satellite Communications’, conducted by Mizoram University, 12th, August, 2020.
25	Participated on, ‘Understanding Rivers of Hilly Region and its Conservation’, conducted by Mizoram University on 14th August 2020.
26	Participated on, ‘Opportunities in cognitive neuro-medicine: A cell to society continuum’, conducted by Dept Biotechnology, Mizoram University, 11th August 2020.
27	Participated on the webinar, ‘Covid19 Essentials information’s from Clinician’s point of view’, conducted by Dept of Biotechnology, Mizoram University, 4th August 2020.
28	Participated in the webinar, ‘Towards Inclusive Innovations and Network – based Entrepreneurship’, organized by Department of Management, Mizoram University, 10th August 2020.
29	Participated in, ‘The Importance of Corporate Governance studies for Management during Covid 19 Pandemic’, organized by Department of Management, Mizoram University on 6th August 2020.
30	Participated in, ‘Unexpected tough time in this pandemic time will have to adapt to deal with it since it is what it is’, organized by Mizoram University on 21st July 2020.
31	Participated on the webinar, ‘Evolution of Digital Banking and the way forward’. organized by Department of Commerce, Mizoram University on 28th July 2020.
32	Participated on National webinar on. ‘Novel Methods of Teaching and Learning’, organized by KLE Science Association on 25th July 2020.
33	Participated in One Week International webinar on Natural Disaster with Special Emphasis to Earthquake and its Implications’, organized by Government Champhai College on 20-24th July, 2020.
34	Participated in One-week international webinar on advances of science in

	education (ASE- 2021) during 8th to 13th march 2021.
35	Presented Paper on One Day National Seminar, “Mizoram: Environment, Development, and Climate Change” on 25th March, 2021, on the topic of Land use Land Cover Changes, organized by Dept. of Geography, Mizoram University.
36	Participated on the webinar, ‘’Using Mathematical Models to understand Epidemics”, organized by Department of Zoology, Mizoram University, on 19th May 2021.
37	Participated in the One Day State Level Webinar on ‘’Challenges of Urbanization in Developing Countries” jointly organized by Department of Geography, Govt. Hrangbana College and IQAC, Govt. Hrangbana College on the 21st of May 2021.
38	Participated on the webinar of ‘Economic Research” organized by Department of Economics, MZU on 26th May, 2020.
39	Participated on the webinar of ‘Exploration and Development for Hydrocarbons with special reference to North East India’, organized by Dept. of Geology, Mizoram University on 2nd June, 2021.
40	Participated on the webinar of ‘Relevance of Corporate Social Responsibility’ organized by Dept. of Management, Mizoram University on 28th, May, 2021.
41	Participated on the webinar of ‘the science of Learning’ organized by Dept of Electronics and Comm, Mizoram University on 25th May 2021
42	Participated on the webinar of Forest Conservation and Watershed Management’ jointly organized by MZUSC and Department of Geography and Resource Management, Mizoram University on 5th, June, 2021
43	Participated on International webinar of Re-reading the Dynamics of Mizo Literature: The Past, Present and Future, on 18th June, 2021.
44	Participated on UGC STRIDE WEBINAR on “The Role of Hypothalamic Neurokinin 3 antagonism as a Novel Treatment for Menopausal hot flushes” held on 8th June, 2021 at the Mizoram University, Aizawl, Mizoram.
45	Participated on the webinar, “COVID-Human Brain Challenges” organized by Mizoram University and INDICASAT-AIP, Republic of Panama on 30 July 2021.
46	Participated on the webinar, “Key Issues for Social Security’, organized by Faith College, Mizoram, on 17th July 2021.
47	Participated on the webinar,” People, Resource & Innovations: Building New Frontiers”, 23rd July 2021 Organized by Mizoram University BioNEST, Faith College, Aizawl & Tharthilthlentu TiLi Centre.
48	Participated on International Webinar on "Student Evaluation in Digital Education: A Perspective from Higher Education" Organized by the Department of Education, Mizoram University on 7th July 2021.
49	Participated on National Webinar on “Universal Values and Ethics” Organized by the Department of Education, Mizoram University, Aizawl, Mizoram held on 19th July 2021.
50	Participated on the webinar, “Water resource management in North East India” organized by Mizoram University and NMHS, on 5th August, 2021.
51	Participated in the Three Days Webinar on ‘Geography: Issues, Challenges and Relevance’ organized by Geography Association of Mizoram (GAM)

	during 9th -11th August, 2021.

E. SEMINAR/CONFERENCE/TRAINING/PROGRAMME CONDUCTED

Name of Programme	Date/Month/Year(2018-2023)
1. Coordinator at National Seminar on Environment Pollution organised by Dept of Geog, Govt. Hrangbana College	7th July, 2023

F. PROFESSIONAL SOCIETY MEMBERSHIP

ACADEMIC ACHIEVEMENTS, AWARDS, DISTINCTIONS: (2018-2023)

Hrangbana Award (2013) for excellence in Academic	Govt. Hrangbana College
Rank Holder in Under Graduation	Mizoram University (Central University)
Rank Holder in Post Graduation	Mizoram University (Central University)

G. ENGAGEMENTS IN VARIOUS COMMITTEES

Type of engagement	Name of Committee/ Cell	Date /Year (2018-2023)
Programme Officer (NSS)	National Service Scheme	2022-2023
Club Mentor	Weber Club	2022-2023
Secretary	Project Committee	2022 ongoing
Member	Information &Communication Technology (ICT)	2022 ongoing
Member	Intellectual Property Right Cell (IPR Cell)	2022 ongoing
Member	Internal Quality Assurance Cell (IQAC)	2022 ongoing

H. PUBLICATIONS (2018-2023)

Publications
1. Assessment of Mizoram Agriculture Production Ramengmawii and F Vanlalhmangaihsangi Dogo Rangsang Research Journal, Volume 13 Issue No. 08, Jnne 2023, Year 2023, Pages 77 to 83
2. Pattern of Migration in Western Mizoram: Impacts and Causes Ramengmawii, B. Lalrawngbawla, Lianchhingpuii, Marie Zodinpuii, Dr. Malsawmi Pachuau Dr. B. Lalfakawmi, H. Lalengzuali, and Dr. H. Lalzuithangi Dogo Rangsang, Volume Volume-13 No.4, 2023, Year 2023, Pages
3. Relationship between Self Concept and Reading Comprehension in English of VIII Class Students Ramengmawii Relationship between Self Concept and Reading Comprehension in English of VIII Class Students, Year 2023, Pages
4. A Geographical Analysis of Pharmacist Distribution and Health care facilities of western

Mizoram Ramengmawii and Dr. H. Lalzuithangi Journal of Pharmaceutical, Volume 13 Special Issue (2022), Year 2022, Pages 4194-4200
5. ANALYSIS OF RURAL DEMOGRAPHY IN REIEK RD BLOCK, MIZORAM" Ramengmawii ANALYSIS OF RURAL DEMOGRAPHY IN REIEK RD BLOCK, MIZORAM", Volume , Year 2022.
6. EVALUATION OF RURAL INFRASTRUCTURE IN REIEK RURAL DEVELOPMENT BLOCK, MIZORAM" Ramengmawii EVALUATION OF RURAL INFRASTRUCTURE IN REIEK RURAL DEVELOPMENT BLOCK, MIZORAM", Volume , Year 2022.
7. Social and Cultural Transformation (Conversion) in Post-Colonial Mizoram: Non-indigenous community Ramengmawii, Thelma Lalhmingthangi and C. Lalrinchhani : International Journal of All Research Education and Scientific Methods (IJARESM), Volume Volume 9, Issue 5, May -2021, Year 2021.
8. A keen analysis of gender dimensions in agriculture: A case study of Mizoram Ramengmawii International Journal of Current Research , Volume Vol. 13, Issue, 04, April, 2021 , Year 2021.
9. Paradigm of Insurgency in North East India: A keen analysis of the causes and consequences in the Contemporary world. Ramengmawii International Journal of Creative Research Thought, Volume | Volume 9, Issue 5 May 2021 , Year 2021.
10. Impact of Education on Agricultural Productivity: A Case Study of East Bungtlang Wet Rice Cultivation(WRC), Mizoram Ramengmawii Hermony with nature: Illusions from Geographers Perspective in the 21st Century, Volume Series II, 2018., Year 2018, Pages 369-377
11. Analysis of Agricultural Employment in Serchhip Town, Mizoram Ramengmawii Natural Resource Management for Sustainable Development and Rural Livelihoods, Volume Vol. 2(2017), Year 2017, Pages 435-441
12. Issues and Challenges of Indigenous Agricultural practices in Upper Mat Watershed, Mizoram Ramengmawii Shifting Cultivation and its impact on Environment in Northeast India, Volume , Pages 50-56

I. PROJECT UNDERTAKEN

Project title	**Minor/ Major**	**Sponsoring agency**
Qualitative Research Consultant in Life Skills Collaborative	Major	International Council for Research on Women (ICRW)
Junior Project Fellow in Problems and Status of Rural Education, Mizoram	Minor	Mizoram Rural Bank (MRB)

J. CHAPTERS CONTRIBUTED TO EDITED BOOK (2018-2023)

1. Mawii, Rameng 2017. **Analysis of Agricultural Employment in Serchhip Town, Mizoram**. Natural Resource Management for Sustainable Development and Rural Livelihoods,Vol. 2(2017), ISBN:81-7019-584-1 pp 435-441, Today andTommorow's Printers and Publishers, New Delhi, India.
2. Mawii, Rameng. 2018. **Impact of Education on Agricultural Productivity: A Case Study of East Bungtlang Wet Rice Cultivation(WRC), Mizoram.** Hermony with nature: Illusions from Geographers Perspective in the 21st Century,ISBN: 978- 81-933142-1-0 pp. 369-377, Bhatter College Publication Series II, 2018
3. Mawii, Rameng 2018**. Issues and Challenges of Indigenous Agricultural practices in Upper Mat Watershed, Mizoram**. Shifting Cultivation and its impact on Environment in Northeast India, ISBN 978-81-935083-5-0 pp 50-56, Pachhunga University College, KL Offset Printers, Aizawl, Mizoram.

K. OTHERS /Addl Information(2018-2023)

1. Basic Course on **Remote Sensing and Geographical Information System-Technology & Applications** at North Eastern Space Applications Centre(NESAC). Department ofSPACE, Govt. of India, Umiam, Meghalaya
2. Three Months **Course on Computer Concepts (CCC),** NIELIT, Government of India.
3. Six Months Course on Certificate course on **Basics Course on Remote Sensing and GIS, Indian Institute of Remote Sensing (IIRS**), Dehradun, India.
4. Online Certificate Programme on **"Applied Statistical Data Analysis Using SPSS"** conducted online by ASBM University, Bhubaneswar from 26th July to 30th July 2021.
5. **Special Summer School** equivalent to Orientation/Refresher Course held from 20th July to 2nd August, 2021 and obtained Grade A+, organized by HRDC, Mizoram University, Aizawl.
6. Short Term Course on **Research and Publication Ethics** organized by UGC- Human Resource Development Centre, Mizoram University, Aizawl during 1st – 7th October 2021.
7. Short Term Course (Online) on, **"Ph. D Scholars and Post- Doctoral Fellow Interaction Programme"** held from 14th – 20th October, 2021

PARTICULARS OF THE CANDIDATE

NAME OF THE CANDIDATE:	RAMENGMAWII
DEGREE:	DOCTOR OF PHILOSOPHY
DEPARTMENT:	DEPARTMENT OF GEOGRAPHY AND RESOURCE MANAGEMENT
TITLE OF THE THESIS:	PATTERN OF AGRICULTURAL DEVELOPMENT IN MAT RIVER BASIN
DATE OF ADMISSION:	12.09.2015

APPROVAL OF RESEARCH PROPOSAL

1.	DRC:	23.03.2016
2.	BOS:	09.04.2016
3.	SCHOOL BOARD:	13.04.2016

MZU REGISTRATION NO:	2085 OF 2010-11
Ph.D. REGISTRATION NO: & DATE:	MZU/Ph.D./855 of 13.04.2016
EXTENSION:	No.17 1/MZU(Acad)/20/14 of April 2021

HEAD
DEPARTMENT OF GEOGRAPHY
AND RESOURCE MANAGEMENT

ABSTRACT

PATTERN OF AGRICULTURAL DEVELOPMENT IN MAT RIVER BASIN

AN ABSTRACT SUBMITTED IN PARTIAL FULFILMENT OF THEREQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

RAMENGMAWII

MZU REGISTRATION NO: 2085 of 2010-11

Ph.D. REGISTRATION NO: MZU/Ph.D./855 of 13.04.2016

DEPARTMENT OF GEOGRAPHY AND RESOURCE MANAGEMENT

SCHOOL OF EARTH SCIENCES AND NATURAL RESOURCES MANAGEMENT

OCTOBER, 2023

PATTERN OF AGRICULTURAL DEVELOPMENT IN MATRIVER BASIN

BY
RAMENGMAWII

DEPARTMENT OF GEOGRAPHY AND RESOURCE MANAGEMENT

Under the Supervision of
Prof. Vishwambhar Prasad Sati

Submitted

In partial fulfillment of the requirement of the Degree of Doctor of Philosophy in Geography and Resource Management of Mizoram University, Aizawl.

Abstract

Agriculture, derived from the Greek words 'Ager' and 'Cultura', signifies the cultivation of plants and animals. It began roughly a million years ago, transitioning humans from food gatherers to settled cultivators. This fundamental activity has underpinned human civilization, providing sustenance, economic opportunities, and shaping cultural practices. Although agricultural practices have evolved over time, spurred by technological advancements, concerns about environmental sustainability and social equity have emerged.

Agriculture significantly impacts the global social fabric, sustaining economies worldwide. Despite distinctions between agricultural and non-agricultural nations, no country can thrive without agricultural products. Globally, one-third of the workforce is involved in agricultural activities. This sector not only meets basic needs but also drives economies, particularly in developing nations. Moreover, sustainable agricultural practices are essential to address environmental challenges and promote overall well-being.

Several agricultural techniques and achievements were mentioned, from organic farming and the Green Revolution to Integrated Pest Management and no-till farming. Agricultural development focuses on enhancing practices and systems to increase productivity, foster rural livelihoods, and ensure sustainability.

India, with its vast agrarian landscape, relies heavily on agriculture. The country's government has taken steps to support this sector through policies, infrastructure, and subsidies. However, challenges like fragmented landholdings, water scarcity, and reliance on monsoons persist. The Northeastern region, comprising states like Mizoram, relies on both shifting cultivation and permanent farming practices. While shifting cultivation offers crop diversity, its sustainability iResearch Questions & Objectives:

The chapter stresses the importance of clear research questions, outlining their role in guiding the research process. It then presents three key research questions focusing on the socio-economic impact of agricultural practices and the agricultural patterns in the Mat River Basin. The objectives section further delves into the significance of research objectives as a foundation for studies. Four primary objectives, ranging from analysing factors influencing agricultural development to studying patterns of crop production, are listed.

The Mat River Basin, located in Mizoram, partially spans three districts. It merges with the Kaladan River and covers an area of 963.90 sq. km. The basin encompasses 24 villages and one town. This section also provides a detailed geographical breakdown of the region.

This part of the chapter distinguishes between primary and secondary data collection. Primary data sources include field surveys, toposheets, and GPS, with the aim of gathering information on various aspects, such as slope, drainage, settlements, and socio-economic conditions. Secondary data involves leveraging existing climatic variables, including rainfall and humidity, and Census of India data. Statistical tools, including descriptive statistics, standard deviation, regression, and GIS software, will be used to analyze and validate the data.

A comprehensive overview of agriculture's significance, examining its practices at different levels — global, national, regional (North East India), and local (Mizoram, Mat River Basin). It also sets the stage with the problem statement, hypotheses, research questions, objectives, methodology, and study area. An in-depth literature review starting from the 1940s, discussing various agricultural practices and developments, both globally and within India. Over a hundred references are cited. A detailed look at the Mat River basin's geography, climate, and socio-economic factors. Examines agricultural practices in the Mat River Basin, including area, production, productivity, and types of crops under different cultivation types. Also, farm holdings are explored with data from 2001 and 2016. Investigates the shift in agricultural patterns, noting the decline in shifting cultivation and a slight rise in permanent agriculture. The Role of Agriculture in Socio-Economic Development: Discusses the impact of different cultivation methods on socio-economic conditions and factors influencing agricultural and economic development. Summarizes the findings of all chapters and provides conclusions based on the set objectives.

The Mat River in Mizoram plays a pivotal role in the region's agriculture. Despite its fertile conditions, the river basin faces challenges like traditional farming practices and influences from shifting cultivation. River basin studies are essential to understand and manage these complexities, ensuring sustainable water management and environmental health. Lastly, the significance of well-defined research problems in scholarly work was underscored, emphasizing their role in shaping research direction and outcomes. The literature review delves into various studies on river morphology, agriculture, and socio-economic developments globally, emphasizing the correlation between physical and human dimensions. The review is organized chronologically, covering international and national literature, with a focus on the Mat River Basin and its geographical understandings.

Indian agriculture, with its rich history, is integral to the country's economy, providing livelihoods to millions and being a major global producer of various commodities. The Green Revolution in the 1960s marked a critical phase, introducing modern farming techniques and high-yield varieties. Despite the advancements, challenges persist in Indian agriculture, such as water scarcity, land fragmentation, and changing climatic patterns. Various governmental initiatives, like Pradhan Mantri Fasal Bima Yojana and Soil Health Card scheme, aim to address these challenges and enhance resilience.

In essence, the literature underscores the significance of agriculture in both global and national contexts, emphasizing the role of traditional knowledge, modern techniques, and sustainable practices in shaping the future of agriculture. India's agricultural progress has significantly impacted its economic development and food security. Challenges include inadequate storage infrastructure, inefficient supply chains, food wastage, water mismanagement, and climate change effects. Advances include high-yielding crop varieties and improved practices. Livestock farming plays a key role in nutrition and rural income. India boasts rich agro-biodiversity, suitable for cultivating diverse crops. This ensures food and nutritional security for its growing population. Efforts are underway to incorporate sustainable farming practices, technology-driven precision agriculture, and enhance market linkages for farmer welfare. Horticulture is vital for nutrition, rural livelihoods, and land conservation. Agriculture is deeply linked with India's culture and traditions. Various government initiatives address challenges and promote sustainable development in agriculture. Climate change, soil degradation, water scarcity, post-harvest losses, and supply chain inefficiencies persist as challenges, but technology and policies offer solutions

Northeast India's agriculture is distinct due to its topography, climate, and culture. Horticultural crops like oranges, pineapples, and spices thrive in the region. Traditional practices, like shifting cultivation, are under scrutiny for environmental impacts. Efforts to transition to sustainable practices are ongoing. Indigenous crops like black rice and King chilli cater to local and niche markets. Rain-fed agriculture is prevalent but climate-sensitive. Government initiatives are fostering sustainable agriculture and better water management. Agriculture in Mizoram is shaped by its hilly terrain, rainfall patterns, and cultural practices like 'jhum' cultivation. There's a shift towards sustainable farming methods, with a focus on cash crops such as ginger, turmeric, and bamboo. Challenges include land scarcity, climate change, limited market access, and the impacts of shifting cultivation. Research underscores a blend of indigenous knowledge and modern farming practices. Plantation crops like tea, rubber, and bamboo offer economic growth prospects, with bamboo especially seen as a versatile, high-demand crop. Changing climate patterns pose risks, but horticultural development and sustainable plantation practices are seen as potential solutions. The Mat River Basin in Mizoram has vast crop-growing potential, but its agricultural development is slow. This work serves as an initial exploration into the basin's agricultural prospects, benefiting various stakeholders.

In essence, India's agricultural landscape is evolving, blending traditional practices with modern techniques and technologies. While challenges persist, collaborative efforts between government, communities, and research institutions offer promising solutions for sustainable growth.

The Mat River Basin, located in the scenic state of Mizoram, India, spans 981 square kilometers and holds tremendous significance due to its vast expanse and influence on local communities. Originating near Baktawng at 1423 meters above sea level, the Mat River, with its myriad tributaries, winds through diverse terrains, impacting countless lives and fostering economic growth. This river, which converges with the Tuipui River, has untapped potential for hydropower generation and irrigation. Covering three districts - Aizawl, Serchhip, and Lunglei, the Mat River is a vital water source for about 20 villages. The Mat River Basin's location, enveloped in Mizoram's lush greenery, is demarcated by specific longitudinal and latitudinal coordinates, and its topography is shaped by varying altitudes, contributing to its ecological diversity. Detailed data showcases the altitude variations, from the lowest "Lower Altitude" areas to the towering "Higher Altitude" regions. Such altitude distinctions play a pivotal role in the hydrological, geomorphological, and ecological dynamics of the basin. A slope analysis further categorizes the river basin based on terrain steepness, from the gentlest "Lower Slope" to the extremely steep "Higher Slope", aiding in land management and environmental planning. Furthermore, the region experiences a moist subtropical climate, with temperature variations throughout the year and average annual rainfall varying across the three afore mentioned districts, based on data from the past two decades. Overall, the Mat River Basin is not just a geographical entity but also a lifeline that intertwines nature with human existence, shaping socio-economic landscapes and holding prospects for sustainable development and conservation.

The Mat River Basin, located in Mizoram, India, covers 981 square kilometers. Originating near Baktawng, the river flows through various districts and supports about 20 villages, highlighting its socio-economic importance. The research aims to explore the relationship between the river and its inhabitants, along with its potential for sustainable development. The Mat River starts near Baktawng in the Aizawl District, Mizoram. It traverses through a vast area, nourished by tributaries like Mawngping Lui and Mangang Lui, before joining the Tuipui River. The river holds promise for hydropower and irrigation. The basin includes 20 villages spread across three districts: Aizawl, Serchhip, and Lunglei. Altitude, which influences a region's physical and ecological characteristics, is crucial in various scientific disciplines. Within the Mat River Basin, the area distribution based on altitude indicates that the majority lies in the "Moderate Altitude" category, followed by the "Low Altitude." The high and higher altitudes cover lesser areas.

The Mat River Basin's slope is categorized from lower to higher. Understanding the slopes is vital for land management, pinpointing areas for agriculture, development, and identifying erosion-prone zones. Mizoram's climate is defined by distinct seasons. The hilly regions remain cool during summers, while the lower parts are warmer and more humid. Winter spans from November to February, followed by spring, summer, and the rainy season. Over the past two decades, the average rainfall across the three districts of the Mat River Basin is approximately 2141.927 mm. Over 50% of the Mat River Basin is forested, but Jhumming cultivation practices have adversely affected the ecosystem. There has been a noticeable reduction in the forest cover over the years, with human settlements and activities increasingly encroaching upon previously forested areas. Land Use and Land Cover Changes:

The Mat River Basin in Mizoram has experienced significant changes over time. Built-up areas, indicative of urbanization, increased from 11.14 km^2 in 2008 to 22.73 km^2 in 2017. Water bodies decreased from 19.16 km^2 in 2008 to 6.86 km^2 in 2017, influenced by factors like landscape slope. Agricultural land expanded from 51.58 km^2 in 2008 to 79.39 km^2 in 2017 due to shifts from primary to secondary occupations. In conclusion, the Basin reflects human developmental aspirations, with declining forests, dwindling water bodies, and expanding agricultural lands.

Mizoram has a diverse soil profile influenced by its topography, climate, and vegetation. The dominant soil in study areas is tropical rainforest soil, undergoing substantial weathering and having limited nutrients. Soil profiles reveal a topsoil rich in organic matter and a subsoil dense in minerals. Different horizons like A, B, and C have been identified, each with unique properties. The soil classification further distinguishes between red loamy soil, lateritic soil, and hill soil. The Mat River Basin hosts a diverse population. Factors like population structure, education, sex ratio, and economic development are essential in understanding its socio-economic dynamics. Population data suggests diversity across villages, with Serchhip having the most substantial population and Chengpui the smallest. The area's educational landscape reveals varying literacy rates across villages. Sex ratio statistics provide insights into gender distributions, with Zotuitlang having the highest sex ratio for the 0-6 age group, and New Dawn the lowest. This summary offers an overview of the Mat River Basin's ecological and socio-economic aspects, shedding light on the region's growth, challenges, and characteristics.

The Mat River Basin's village areas mainly rely on primary activities like agriculture, producing crops such as broccoli, carrot, and ginger. While agriculture is fundamental to the economy, there's a trend of shifting from primary to secondary activities due to market demands, technology, and emerging opportunities. This shift impacts employment, rural-urban migration, and overall socio-economic dynamics. Economic development in the Mat River Basin is tied to its infrastructure, especially roads. Seasonal roads can become impassable during prolonged rain, hindering access to farming areas and transportation of produce. Addressing challenges like poverty and infrastructure is vital, requiring comprehensive solutions, investments, and supportive policies.

"Per capita" means "per person" and, in this context, refers to average income per individual. Understanding the Mat River Basin's per capita income gives insight into its economic status and growth potential. Calculating this metric reveals economic disparities and areas for growth. Prevalent poverty, especially in villages. Heavy reliance on traditional agriculture limits economic diversification. Insufficient infrastructure, especially roads, affects trade and raises production costs. Modernizing agriculture with technology can boost productivity. Promoting agro-processing industries can add value and boost the economy. Investments in skill development and education align with the shift in occupations. Infrastructure improvement can stimulate economic growth and trade.

The Mat River Basin has a diverse population with different ethnicities and cultures. Education plays a significant role in socio-economic development. Sex ratio is essential for understanding gender disparities. Analysis of decadal population changes provides growth or decline patterns. Economic growth, industries, businesses, and per capita income are vital indicators of socio-economic well-being. The Basin heavily depends on agriculture, suggesting a need for modernization and diversification strategies. Despite changes in land use, the Mat River Basin's total area remained constant at 982.05 square kilometers. From 2008-2017, the Basin saw a decline in forested areas and an increase in urbanization and agricultural land. It's crucial to understand these changes to ensure sustainable land use and ecological preservation.

The Mat River Basin, primarily dominated by agricultural practices, holds significant economic and livelihood importance. The challenging terrain of the hilly regions in the basin means farmers face difficulties like soil erosion, despite the limited arable land available. The solution, as proposed by various studies, is the implementation of sustainable agricultural practices. Techniques like agroforestry, terrace farming, and contour cultivation can prevent soil erosion and boost productivity. The application of traditional ecological knowledge in agriculture promotes adaptive strategies suitable for the hilly environment. Governmental initiatives play a critical role in supporting these endeavors.

Horticultural activities in the Mat River Basin also face challenges due to the area's topography and ecological sensitivity. Adapting innovative techniques that consider soil conservation and slope stabilization is crucial. Various studies highlight the importance of terracing, erosion control, and agroforestry in ensuring productivity in horticulture. Promotion of high-value crops and integrated pest management can further aid in achieving food security.

Plantation agriculture, focused on cash crops like tea, coffee, and spices, requires a distinct approach in hilly terrains. Sustainable management practices, like contour farming, agroforestry, and erosion control, are vital for maintaining the ecological balance. The global demand for agricultural commodities is soaring, especially from biodiversity-rich developing countries. This places immense pressure on agriculture, leading to potential conflicts between biodiversity conservation and agricultural expansion. Two primary models, land conservation and land sharing, have been suggested to reconcile this. The criteria for these models emphasize managing spillovers, maintaining resilience, and improving production, especially in developing countries.

Mizoram's agricultural landscape is marked by both shifting (like jhum and terrace farming) and permanent agriculture, with the Mat River Basin at its heart. Although the basin has potential, traditional agricultural methods and infrastructural constraints have hindered it from achieving food security. In recent years, sustainable farming practices have been promoted, with the basin’s varied agro-climatic conditions supporting a diverse range of crops. Rice is a primary staple, and its cultivation practices have evolved, combining traditional methods with modern techniques. Data from various villages in the basin reveals changing patterns in rice cultivation, with certain areas like Serchhip showing substantial growth. The basin also supports the cultivation of various fruits and vegetables, making it integral to the dietary habits of the local Mizo population. Permanent agriculture, or permaculture, presents a holistic approach to agriculture that focuses on self-sustaining, regenerative systems. Introduced in the 1970s, permaculture emphasizes biodiversity, resource conservation, and ecosystem resilience. Serchhip, East Bungtlang, and Keitum are significant contributors to rice production under permanent cultivation in the basin. As infrastructure develops, there's hope for more sustainable and productive agricultural practices in the Mat River Basin.

The Mat River Basin in Mizoram, India, stands out for its vibrant agricultural activities, which plays a critical role in the state's socio-economic landscape. According to Table 4.8, rice production between the years 2001 and 2016 showcased significant growth in several villages. For instance, in Chhingchhip, rice production grew from 1375kg in 2001 to 1480kg in 2016. Furthermore, Table 4.9 indicates a substantial increase in rice productivity during the same period. Notably, villages like Chhipphir, Buangpui, and Baktawng showed impressive productivity in 2001, and there was marked growth in villages like Keitum, Rawpui, and Leite due to improved irrigation and infrastructural developments. Table 4.10 reveals the area of plantation under permanent agriculture. While East Bungtlang, Leite, and Chhipphir were the top villages in terms of arable land percentage in 2001, by 2016, North Mualthuam, Pangzawl, and Chengpui led the pack due to advancements like road construction and improved irrigation. Meanwhile, Table 4.11 highlights a substantial production surge in villages over 15 years. Ralvawng and S. Zote notably had the highest rice production in 2001. Productivity trends of plantation crops also changed between 2001 and 2016, as seen in Table 4.12. Government-initiated minor irrigation schemes played a crucial role in this productivity boost, with Serchhip, Ramlaitui, and Thiltlang emerging as the highest productivity villages in 2016. Farm holdings provide a keen insight into an agrarian economy. In India, where agriculture is paramount, land ownership varies across categories such as individually owned, rented land, and community land. The distribution of land holdings has historical roots. Traditionally, Mizoram had a unique land tenure system influenced by community ownership. However, the 1950s and 1960s saw government-driven land reforms aimed at equitable land distribution. Many farmers in Mizoram engage in subsistence agriculture on fragmented plots. Due to the hilly terrain, "jhum" or shifting cultivation is a common practice.

The Ministry of Agriculture and Farmers Welfare classifies farmers based on their operational land size into categories ranging from marginal (below 1 hectare) to large (10 hectares and above), as shown in Table 4.13. A notable trend within the Mat River Basin between 2001 and 2016 was the shift in farm sizes. As per Tables 4.14 and 4.15, smaller farms, those less than 1 hectare, saw a rise from 16.4% in 2001 to 27.1% in 2016. Conversely, farms spanning 4 to 10 hectares showed a decline, underscoring a trend towards smaller farm holdings.

Agriculture is the backbone of the Mat River Basin, with a rich diversity of crops and practices. However, the region faces challenges, including fragmented land holdings, which pose barriers to modern agricultural practices and overall productivity. Yet, the government's initiatives, such as land consolidation and crop diversification, signal a hopeful future. Proper land use planning and the integration of modern farming techniques are paramount to ensure optimized land productivity, subsequently enriching the livelihoods of the communities within the Mat River Basin.

Mizoram, situated in northeastern India, has experienced remarkable agricultural growth due to its natural attributes and government initiatives. The majority of Mizoram's agriculture is through shifting cultivation, but recently, there's a shift towards more permanent forms of agriculture, largely influenced by government policies like the New Land Use Policy (NLUP) introduced in 2010. This policy encourages terrace farming, organic practices, horticulture, and cash crops, providing financial assistance, training, and infrastructure to the farmers.

Agriculture remains the primary occupation and a significant income source for Mizoram. However, the traditional jhum (slash-and-burn) cultivation method is being replaced by sustainable practices under the NLUP. Terrace cultivation has become particularly popular because of its suitability for the region's hilly terrain, leading to increased agricultural output, reduced soil erosion, and better water management.

Horticulture plays a pivotal role in Mizoram's agricultural landscape. The state's climate and biodiversity support a diverse range of fruits, vegetables, flowers, and spices. The government, through the Horticulture Mission for Northeast and Himalayan States (HMNEH), offers technical support and market connections to horticultural farmers, resulting in the expansion of orchards and increased exports. The Organic Mission in Mizoram focuses on promoting organic farming, which is not only environmentally sustainable but also has economic benefits. Notable organic products from Mizoram that have gained popularity include turmeric, ginger, and pineapple. Apart from crop cultivation, livestock rearing and fisheries play a crucial role in Mizoram's agricultural sector. The state's rich natural resources facilitate livestock and fish production. Government interventions in this sector include support for breed enhancement, veterinary services, and infrastructure development.

Technological advancements have further boosted Mizoram's agricultural progress. Collaborations between the government, research institutions, and universities have introduced improved crop varieties, efficient irrigation, and pest management techniques. The Mat River Basin, in particular, has seen a transformation in agricultural practices, contributing to the overall development of the state. This research also provides detailed statistics on the shifts in agricultural patterns from 2000 to 2016. These changes are evident in the cultivation of staple crops like rice and in horticultural practices. The data shows that rice cultivation has seen a mixed trend across different villages, with some experiencing growth and others a decline. Similarly, the cultivation of fruits and vegetables has seen shifts, with specific crops like broccoli and carrot experiencing growth due to market demand. On the other hand, some crops like watermelon have seen a decline, possibly due to increased imports. Permanent agriculture, typically found in river valleys, has been growing in areas like Serchhip, thanks to technological improvements. Over the span of 15 years in the Mar River basin, significant alterations in landholdings were evident. Small farms, with an area less than 1 hectare, increased by 10.7%, moving from 16.4% in 2001 to 27.1% in 2016. Conversely, farms between 1 to 2 hectares saw a decrease from 54.2% in 2001 to 44.4% in 2016. Landholdings spanning 2-4 hectares, popular among 6 villages, shrunk from 14.9% to 8.7% by 2016. Farmlands of size 4 to 10 hectares, which are generally preferred for hilly agricultural practices, also experienced a decline, dropping from 11.8% to 7.1% in 2016. Interestingly, the largest farms witnessed a significant growth, from 4.5% to 12.7%, accounting for an overall 8.20% growth across the basin.

Landholding is a pivotal agricultural metric, especially in agrarian economies like India. The categories of land ownership predominantly include individually owned, rented, and community land. A notable shift has been observed in the Mar River Basin towards individual ownership, from 18% in 2001 to 32.5% later on. The data reveals that owned land expanded from 18.58% in 2001 to 32.50% later, while rented lands grew from 63.06% to 103.08 sq. HA, even though its share decreased. In contrast, lands distributed by the VC reduced from 957.8% to 746.6 sq. HA.

Statistical methods are indispensable in agriculture for informed decisions and sustainable resource management. The integration of statistics enables a comprehensive understanding of the dynamics between factors like production, productivity, altitude, and area. It aids in predicting and mitigating agricultural risks, such as disease outbreaks, pests, and weather anomalies. Global organizations like the FAO and the World Bank have highlighted the importance of agricultural statistics in understanding global food patterns and assessing the impact on economic growth and poverty alleviation.

Data analysis revealed that the average altitude for 20 villages was 824.75 meters and the mean productivity level was 710.60. Descriptive statistics highlighted the variability and tendencies of productivity, altitude, and area. A significant positive correlation was identified between productivity and area, while no significant correlation was established between productivity and altitude, or between altitude and area. A regression model was developed to explore the relationship between productivity and two predictive variables: area and altitude. However, the model suggested that only about 20.8% of the variance in productivity could be attributed to these factors. The results from the ANOVA test indicated that the collective influence of area and altitude on productivity wasn't statistically significant. The coefficients table offered insights into the influence of predictor variables. While altitude had a negative impact on productivity, the effect was statistically insignificant. Area had a positive influence on productivity but was marginally non-significant.

The frequency distributions highlighted the variability and distribution patterns of altitude, area, production, and productivity across 20 villages, emphasizing the diversity and complexity of the dataset. Lastly, the study revealed that Mizoram is undergoing substantial agricultural changes. Shifting cultivation is dwindling, with a rise in permanent agriculture. A slight increase in the areas for fruits, vegetables, and plantation crops is also noticeable. However, the produce from both shifting and permanent agriculture remains inadequate to meet the population's basic food needs. This inadequacy has led to widespread malnutrition and food insecurity. Government initiatives have encouraged the transition from shifting to permanent agriculture, but the pace is slow. A decline in crop diversity has been noted in the shift from shifting to permanent agriculture, with most permanent agricultural practices resorting to monocropping. Conversely, shifting cultivation had previously boasted high agro-biodiversity.

The studies delves into the significance of agriculture, particularly in the state of Mizoram located in Northeast India. The region's agricultural practices have profound implications for its socio-economic growth. Historically, various techniques have been employed to measure agricultural yields and assess land use. The mention of L.D. Stamp points to the extensive land utilization studies conducted in the 1930s. Northeast India, while rich in agriculture, lags in economic development. Mizoram, despite its topographical challenges, remains reliant on agriculture. A shift is noted from the traditional "jhum" or shifting cultivation towards more sustainable farming techniques, such as terrace farming, under the New Land Use Policy (NLUP). Despite its historical and cultural significance, shifting cultivation faces scrutiny for its environmental implications. The text also briefly touches on the agricultural scenario in Nigeria, emphasizing its importance in the national economy and the potential for improved practices. Agriculture's Role in Mizoram: Agriculture is not just an economic activity in Mizoram; it's intricately tied to the socio-economic fabric of the state. The emphasis on its role in driving rural development and improving farmers' livelihoods underlines this connection.

Techniques for Agricultural Assessment: The reference to various methodologies for agricultural assessment, such as the Ranking method, emphasizes the complexity and importance of accurately gauging agricultural performance. The mention of scholars like L.D. Stamp situates the discussion in a historical context, illustrating the long-standing importance of land use and agricultural studies. While this method has cultural significance and has been a historical practice, its environmental impact, especially deforestation and loss of biodiversity, has led to calls for more sustainable farming practices. The New Land Use Policy (NLUP) and the push towards techniques like terrace farming and contour bunding show a proactive approach to addressing the challenges posed by shifting cultivation.

Mizoram's challenges stem from shifting cultivation and topography, Nigeria faces challenges related to agricultural productivity and the adaptation of modern practices. The text reiterates how agriculture, socio-economic development, and even culture are intertwined, especially in regions like Mizoram. The studies paint a comprehensive picture of the agricultural landscape in Mizoram, highlighting its challenges, historical practices, and the ongoing transition towards sustainability. The comparative elements provide Agriculture Development and Technological Advancements in Mizoram

Mizoram has positioned agriculture as a pivotal sector, emphasizing horticultural crops for socio-economic development. Financial and technical support is provided to encourage farmers towards horticulture.

The 21st-century sees agriculture intertwined with technology, particularly information and communication technology (ICT). This aids in transmitting vital information about agricultural practices, weather, and resources to developing countries, enhancing their agricultural output. Farmer Producer Organizations (FPOs) play a critical role in marketing, ensuring better prices for produce and promoting socio-economic upliftment.

Mizoram has adopted organic farming to promote sustainable agriculture, enhancing environmental conservation, and socio-economic benefits. Government and NGOs have propelled organic farming through training, awareness, and infrastructure support. Integrated Farming Systems (IFS) in the Mat River Basin focuses on integrating various agricultural components, optimizing resource utilization, increasing productivity, and diversifying income streams. This approach also promotes sustainability by reducing external inputs. Shifting cultivation, though traditional, has ecological and socio-economic challenges, including deforestation and soil erosion. The move towards sustainable practices seeks to address these issues.

Permanent agriculture in Northeast India offers a sustainable alternative to shifting cultivation. Emphasizing on permanent cultivation, with support from government initiatives, is being viewed as the key to achieving food security, environmental conservation, and socio-economic growth. Particular attention is given to horticulture and organic farming practices, maximizing yield and minimizing ecological impact.

Several government programs, like New Land Use Policy (NLUP), Rashtriya Krishi Vikas Yojana (RKVY), and the National Mission for Sustainable Agriculture (NMSA), have been launched to bolster agricultural development in Mizoram. Despite the progress, challenges remain, including limited access to credit, market infrastructure deficits, and climate change impacts on agriculture. Future prospects hinge on continued support, infrastructural investments, technological integration, and sustainable agricultural practices. This studies captures the main themes surrounding agriculture development, technological advancements, and challenges in Mizoram broader insights into global agricultural challenges and solutions

This studies provides an in-depth study of agricultural practices and their evolution in Mizoram, with a specific focus on the Mat River basin. There have been significant changes in agricultural practices over the last 30 years, including a substantial decrease in the area under shifting cultivation. Over the past three decades, the area under shifting cultivation (jhum) has seen a decrease of more than 50%. The Mizoram government introduced the New Land Use Policy (NLUP) in 1985 to promote more permanent forms of cultivation. However, this policy saw multiple changes due to political interference. Mizoram, and particularly the Mat River basin, possesses agro-ecological conditions conducive for cultivating a variety of crops. The study suggests that shifting cultivation is neither economically nor ecologically viable. Transitioning a considerable land area to permanent agriculture would increase crop productivity and improve the economic standing of the people. Influence on Agricultural Development: Shifting cultivation (jhum) has deep cultural significance but has environmental concerns. The New Land Use Policy (NLUP) encouraged transition to sustainable practices like terrace farming, which improved socio-economic conditions and environmental sustainability.

Agricultural Practices' Socio-Economic Impact: The shift towards sustainable agricultural practices has diversified income sources, improved market access, reduced environmental impact, and enhanced the socio-economic status of farmers. Patterns of Agricultural Production: Between 2001 and 2016, there was a decline in plantation crop production in the Mat River Basin. However, specific crops like broccoli and cabbage saw increased production, while others like watermelon decreased.

Demographic and Social Details:

There are 1,808 agricultural households in the Mat River Basin, with the chapter analyzing 41.3% of them. The 2011 census indicated a near-parity sex ratio with 977 females per 1,000 males. The average family size is approximately 4.8 persons. For continued agricultural development, strengthening institutional support, investing in rural infrastructure, and promoting cutting-edge agricultural technologies are essential. Policies should focus on financial inclusion, enhancing market infrastructure, addressing climate change, engaging the youth, and emphasizing the role of women in agriculture.

Variations in Production: Differences in crop production among villages might be attributed to variations in agricultural practices, climate, and soil conditions. There's potential for crop diversification and the integration of innovative practices to boost sustainability and productivity. Rice remains the primary crop, with fruit and vegetable cultivation also playing a crucial role. The data underscores an ongoing disparity in production among villages. Between 2001 and 2016, there was a marked shift towards smaller landholdings, possibly due to land fragmentation, and an expansion in larger farms. This indicates changing land use patterns and potential land concentration in some areas. The total cropped area decreased over the studied period. While rice cultivation saw a decline, plantation crops had a slight increase, hinting at shifting agricultural preferences. Despite the progress, the region faces challenges like limited market access, insufficient infrastructure, and climate change effects. Land fragmentation has hindered the broad adoption of advanced agricultural practices, reducing productivity.

The New Land Use Policy (NLUP) and other schemes like RKVY and NMSA are aiding in agricultural development and socio-economic improvement of farmers. Sustainable agricultural development in the Mat River Basin requires a comprehensive approach addressing socio-economic and environmental dimensions. Investments in research, innovation, infrastructure, and a concerted effort from government agencies, NGOs, and local communities are crucial. In essence, while Mizoram's Mat River basin holds immense agricultural potential, several challenges like climate change, land fragmentation, and limited market access exist. Addressing these through collaborative efforts can lead to sustainable agricultural growth, ensuring both socio-economic upliftment and environmental conservation. This study focuses on the agricultural development and practices in the Mat River Basin of Mizoram over a 15-year period from 2001 to 2016.