STUDY OF AGRICULTURAL EFFICIENCY IN MIZORAM

A THESIS SUBMITTED FOR THE AWARD OF DOCTOR OF PHILOSOPHY
GEOGRAPHY AND RESOURCE MANGEMENT

Submitted by

Lalramnunmawii
Regn. No. MZU/Ph.D/203 of 12.06.2008

Under the Supervision of

Prof. Girindra Kumar

Department of Geography and Resource Management
Mizoram University
Aizawl : Mizoram

2015

DEPARTMENT OF GEOGRAPHY AND RESOURCE MANAGEMENT
MIZORAM UNIVERSITY, AIZAWL - 796004

Dr. G. Kumar
Professor & Head

Post Box No. 190
Gram : MZU

Phone : 0389-2331604(O)
: 0389-2331613(O)
Mobile : 9436151289
Email : gkumar_1951@yahoo.com

CERTIFICATE

This is to certify that the thesis entitled ***"Study of Agricultural Efficiency in Mizoram"*** by Ms. Lalramnunmawii has been written under my guidance.

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

(Prof. Girindra Kumar)

Dated Aizawl

The ________________2015

ACKNOWLEDGEMENT

First and foremost, I would like to express my deep sense of gratitude and indebtedness to my Supervisor, Professor Girindra Kumar for his guidance, invaluable advice, constant encouragement, criticisms, suggestions and unfailing interest at all stages of my research work. Without his encouragement, devotion to the work and sympathetic understanding of my limitations, this work would have been rendered in wilderness and incomplete.

My sincere thanks are due to all the Faculty Members of the Department of Geography and Resource Management, Mizoram University. Of them, whose names deserve to be put in record here for helping me in several ways are Dr.RintluangaPachuau andMr.Benjamin L.Saitluanga.

I wish to express my appreciation of the help I received from the staff of the Department of Agriculture, Directorate of Economics & Statistics Department,Directorate of Higher & Technical Education,Government of Mizoram. And I wish to extend my heartfelt thanks to the Principal and faculty members of the Department of Geography, Government Lawngtlai College for allowing me to continue my research work and given me consent to obtain leave during the study.

I am most grateful and indebted to my family, especially to my beloved parents ShriLalhriata and Shmt. Lalsangluri for their unending support, prayer and inspirations throughout my journey to complete this research work. Among my friends whose names deserve special mention for helping me in several ways are Mrs.Lalliankimi, Mr.Vanlalhmuaka, Mr.Vanlaltanpuia,Research Scholar, Department of Geography, Dr.John C. Lallawmawma,Asst. Professor KamalaNagar College andDr. R. Zonunsanga, Academic Staff College, Mizoram University.

Last but not the least; I am grateful to Almighty God for guiding me from the beginning to the end of the work.

..........May,2015

DECLARATION

I, Ms Lalramnunmawii, hereby, declare that the material embodied in the present study **'Agricultural Efficiency in Mizoram'** is based on my original research work and has not been submitted or used in part or in full for any other degree or diploma in any form in any University or Institution. My indebtedness and hearty regards to other works on the related topic have duly been acknowledged at relevant places.

(LALRAMNUNMAWII)

(PROF. G. KUMAR)
Head

(PROF. G. KUMAR)
Supervisor

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER-1

INTRODUCTION

1.1 Background:

Food is the basic need for human life and agriculture is an activity that allows meeting that demand. Man has been improving his agrarian activity by adding domestication of animals and to supplement his food supply by the flesh of animals and plants that he raises. Agriculture revolution some 10,000 years ago is still believed to be of utmost significance to mankind as it led to a new era in the use of energy. Adoption of agriculture resulted in reducing the amount of energy man had to spend in obtaining a unit of food. He began to develop better efficiency in tapping the solar energy cycle than the hunting and gathering (Cook, 1975). Hubert (1969) equates evolution of human culture with his increasing ability to control and manipulate energy of which agriculture has been the most significant development. Growth of agriculture also led to an era of higher rate of growth and increase in population density. And though it is doubtful to establish the geographical conditions in which Agriculture Revolution found its root (Saur, 1952) there is no denying the fact that it provided mankind a more sedate way of living that later flourished in the river valleys. Most of the ancient civilizations stand testimony to it and where agricultural operation could be carried out more conveniently. However, irrational and excessive use of environmental resources attributed mainly to increasing growth of population is believed to have led to the decline in the carrying capacity and demise of many old civilizations. People sought areas where there would be better productivity and better opportunities for resource use hence food security. Expansion of agricultural activities and ancient migration of people may largely be attributed to this fact.

The problem of food supply again aggravated with the Industrial Revolution set in motion since the middle of the 18th century. Industrial Revolution and Concomitant Technological Revolution are held responsible for unprecedented population growth and diverse uses of land resources. It is noteworthy that at the beginning of the 19th century when the Industrial Revolution was in its infancy, the population of the world is believed to be only around two billion. The number of people grew three fold to over six billion within a span of just 200 years in 2002. Increasing demand on resources including agricultural ones and their diverse uses have been leading to changes in the space economy as well as space organization all over the world. Increasingly faster rate of changes have been influencing the agricultural productive capacity of different regions accordingly. In this regard it is noteworthy that 80 % of the world food is obtained only from agricultural sources (crop farming, livestock rearing, and pisciculture). And though supply of food is taken as granted facet of daily consumption for most people in the advanced industrial countries of Western Europe, North America and Australia it belies the widespread realities of food scarcity and uncertainty faced by the Third World countries, Eastern Europe and even in Advanced countries of the West where it persists in pockets (Whatmore, 1995).

Agricultural activities dominated mostly by farming of crop and livestock continue to be the largest endeavor by man. And despite all the progress human beings have made in search of alternative livelihood agriculture still covers over 38 per cent of the ice free land (Foley, J.2014:54) to meet the varied demands of ever increasing global population. It is estimated that by 2050 there will be more than 9 billion people who will put claim on agricultural produces. Global demands for agricultural output then are expected to be more than double of the present. The farming communities under the guidance and supervision of their respective governments are being geared up to face the eventuality. It, as suggested by a powerful group of protagonists, may be achieved through enhancement of productivity induced by enhancement of allocation of financial resources towards capital intensive technologies.

On the other hand, there is emerging an equally powerful group of people who believe that following such a trajectory of growth in agricultural efficiency has been leading not only the planet Earth to be exposed to insurmountable environmental challenges but also adding to miseries of mankind. Larger and larger areas at the cost of regional and international ecological stability are being colonized to raise crops or to raise livestock and likes of them in the name of efficient use of land resources. It is evident from the fact that of 26.9 % usable land resource of the world under existing technological level 72.12 % of it i.e. about 19.4 million km^2 of the ice free land, is devoted to crop and livestock farming. Rest of the land of about 7.5 million km^2 under human control has either been rendered unusable due to severe erosion or is used for human habitation, afforestation, logging, mining, reservoirs as well as development of transport infrastructure like railways and roads. Farming activities, as a consequence, are found to be the largest contributor to the global warming releasing more greenhouse gases than all the modern transport systems put together. They are found to release large amounts of methane from cattle and rice farms, nitrous oxide from fertilized fields and loss of carbon dioxide sinks due to indiscriminate felling of rain forests. It has also emerged as the greatest polluter as the fertilizer and manure wash offs disrupt fragile ecosystems of the lakes, rivers and coastal areas leading to biodiversity loss and extinction of wild life. Balances in bio-geo-chemical cycle are found to have been skewed endangering human existence. In addition, farm operations have become the greatest user of precious global water supplies.

The two viewpoints – (i) meeting the demands of people – present and future, and (ii) sustaining the environmental stability in the larger interest of the humanity has set the issue of agricultural efficiency to the fore in political and economic discourses worldwide. It is emerging as one of the most debated and contested terms particularly in developing regions of the world where land for cultivation is scarce and where meeting the needs of the people may be possible only through the improvement of agricultural efficiency not only in the light of productivity and higher yield but in tune with the resilience of the environment – the very foundation of sustainable production and containment of wastage (Hayami and Ruttan,1971). This requires measurement of the existing performance of agriculture. However, no universally acceptable and satisfactory approaches to measure agricultural efficiency are available. Agricultural efficiency is considered to be a function of various factors that include the physical (e.g. climate and soil), socio-economic (e.g. size of land holding and type of farming), and technical-organizational (e.g. crop rotation, irrigation and mechanization). They together are expected to manifest in productivity and volume of production in a given area. Agricultural efficiency, thus, obviously implies maximum return from farming operations under a particular physico-cultural environment with the application of available human efforts at a given level of development (Bhatia, 1967:244) as well as capital investment available to it.

In this context, it must be noted that of the total present crop yield of the world only 55 % is directly available to the global citizenry for food calories; 36

% with about 82 % lesser calories obtained from the edible crops reach the people (who can afford it) through milk (40 cal), eggs (22 cal) and animal meats (chicken-12 cal;pork-10; beef-3 cal) and 9 % of the total crop is diverted towards the production of bio-fuels (Foley 2014:57) considered to be the an alternative to the finite hydro-carbon resources. Ironically, it is estimated under the same study that 50 % of the total food weight produced in the world is not available to the needy consumers either due to over consumption or diversion or loss in transit or wastage. It implies that the present world food production despite animal feeds and bio-fuel production is almost double the existing requirement notwithstanding the level of technology. Yet, it is now increasingly becoming clear that the practical implications of agricultural efficiency equated with enlarged production, permeate down to both at the macro and the micro economic units. Yet no significant change in food supply to a very large number of people is observed.

India, it may be said, is also not untouched with the prevalent global thinking in respect of agricultural efficiency. Agriculture as Mahatma Gandhi realized six decades ago, has been and continues to be the backbone of the Indian Economy. It is also observed that growth of Indian economy is positively correlated with the performance of agriculture sector impacting performances of industrial and other sectors of economy. This continues to be so despite the fact that agriculture's present share of 21 % against 46 % in mid fifties in national GDP has been declining. But this has not been due to declining output in agriculture. It rather has been due to substantial increase of share of service and industrial sectors in national GDP. The significance of agricultural economy in the country may be understood by the fact that despite decline, agricultural pursuits are carried on over 64 % of the total land area of the country engaging over 54.6 % of the total work force (Census, 2011). India is believed to be producing over 264.4 million tonnes (Economic Survey of India, 2013-14:175). It may also be noted that due to growth of industrial and service sectors in the country a substantial proportion of agricultural workers are believed to have changed their vocation. The number of farmers, it is estimated, has declined significantly from 127.3 million to 118.7 million between 2001 and 2011 (Census, 2011; Economic Survey of India, 2014:137).This is believed to have been caused by a shift from farm to non-farm employment. It is also suggested to have caused real farm wages to rise by over 7 per cent annually during this period. Such a Shift, however, has got no positive impact on the size and operations of land holding – a critical variable in the assessment of agricultural efficiency. Small and marginal holdings of less than 2 hectares still account for 85% of the total operational holdings and 44% of the total operated area in the country. Average holdings are found to have registered a decline to 1.16 ha in 2009-10 from 2.82 ha in 1970-71. This may, according to the estimates of Indian Council of Agricultural Research (ICAR) in 2010, may largely be attributed to the degradation of agricultural holdings of about 120.40 million ha. It is believed to have been caused mainly by soil erosion with an estimated loss of 5.3 billion tons every year. In addition, non-agricultural use of agricultural land has been rising at a very rapid rate. It, according to Agriculture Ministry report in 2010 has risen from a mere 3.3 % in 1950 to over 11 % during 2000-2010 (Mahapatra, 2014:88). Yet, there is no denying the fact that the total agricultural production in the country in post Green Revolution period has registered a remarkable growth. The same may not be applied to the productivity in terms of yield per unit area. As a matter of fact, the Green Revolution of 1970s which was believed to have ushered in an era of agricultural prosperity in the country through induction of supposedly more efficient technology is found to have boomeranged. In fact, productivity of the land in most cases, according to the 3rd advanced estimates by the Ministry of Agriculture is believed to have declined by 1.55 kg/ha for food grains (Rice-1.75 kg/ha; Wheat-1.86 kg/ha); 2.42 kg/ha for pulses; 1.63kg/ha for oil seeds worst affected being ground nut having a productivity loss of about 73.17 kg/ha (Economic Survey of India, 2014:138). Higher production of most of the agricultural products may be attributed to additional colonization of inferior lands for agriculture. It is obvious from the fact that area under different crops is reported to have been increasing. This may also be assumed that additional agricultural lands are obtained at the cost mostly of forests and wetlands – the two major agents responsible for maintenance of ecological efficiency of the regions. And it is reflected in declining productive capacity of the agricultural lands.

Agriculture, however, continues to be the backbone of the Indian Economy. Significance of agriculture (though it contributes only 21 % to India's GDP) in the country's economic, social, and political fabric goes well beyond this indicator. The rural areas are still home to some 72 % of the India's 1.25 billion people, a large number of whom are poor. Most of the rural poor depend on rain-fed agriculture and fragile forests for their livelihoods. The sharp rise in food grain production during India's Green Revolution of the 1970s enabled the country to achieve self-sufficiency in food grains and stave off the threat of famine and food shortage. Agricultural intensification in the 1970s to 1980s also saw an increased demand for rural labour that raised rural wages and, together with declining food prices, reduced rural poverty. Agricultural growth since 1990s reduced rural poverty to 26.3 % by 1999-2000. Since then, however, the slowdown in agricultural growth has become a major cause for concern. India's rice yields are one-third of China's and about half of the yield in Vietnam and Indonesia. With the exception of sugarcane, potato and tea, the same is true for most other agricultural commodities. This requires a redefinition of agricultural efficiency at least in national context.

It may also be noted that India under changing dispensations since 1970s has successfully embarked upon a course of more and more production. Initially, the objective of the so called Green Revolution had been to combat the chronic shortage of food for ever increasing population in the country. Green Revolution technology despite its capital intensive nature probably emancipated if not all but certainly a section of the farming community and resource rich regions from dependence on the vagaries of the monsoon that still determines production and the productivity for majority of the Indian farmers and who traditionally have been tied to the age old primitive technology. Still combining with new approach it freed India from dependence on International food market. After attaining self sufficiency in food and with surplus production Indian farming entered into an era of agribusiness both at national and international levels. It broke the shackles of traditionally export oriented tea, coffee, jute and cotton farming practices. The period marking the unleashing of globalization and economic liberalization under the directives of World Trade Organization and International Monetary bodies ushered in an era of surplus production at least for some selected crops. Introduction of genetically modified crops and patented seeds despite their capital intensive nature have helped India to produce more and more crops enabling the country to trade in them and meet its international obligations. This also is found to be encouraging a system of mono culture against the natural efficiency of farm lands. Under prevailing conditions, thus, a miniscule number of big and well-to do farmers are privileged and production is found to be increasing. However, the country has failed to develop corresponding infrastructure. It is reported that over 176.83 million tons of grain rot annually due to lack of storage facility and proper distribution system (Order of the Hon’ble Supreme Court on Report on the Excess Food grains in the go downs of the Food Corporation of India and the State Civil Supplies Corporations- WRIT PETITION (Civil) NO.196 of 2001: August 10,2010). It, thus, appears that the quest for better agricultural efficiency equated with enhancement of production and productivity under present circumstances at least at national level is rhetoric to please a certain politically and economically powerful group within and beyond the country and who seem to be thriving on spreading the myth of shortage of food for future population. They seem to neglect the empirical evidences that almost half of the total food produced globally is not available to the needy.

Agriculture still contributes substantially to overall economy of India. It is the largest sector of economic activity. Its contribution to the national income is approximately 42 %. It provides not only food and raw materials but also employment to a very large proportion of the population. Besides helping to earn valuable foreign exchange, increased income of agriculture also enhances demands for industrial consumer goods thereby providing stimulus to industrialisation and expansion of tertiary sector. For all these reasons, howsoever high may be the growth rates of the secondary and tertiary sectors, the importance efficient agriculture cannot be undermined in agriculturally dominant economies like that of India. Although inter- regional variations in level of agricultural development are bound to occur because of differences in geo- physical conditions, irrigation facilities and availability of agricultural inputs and infrastructure, some definite improvements in it along with a significant reduction in the regional disparities are also expected to have been achieved during seventies because of the intensive Governmental efforts taken at different levels to re- augment agricultural production and productivity. (Tewari and Singh, 1985). The Government of India places high priority on raising agricultural productivity for tackling poverty. However, bold action from policymakers is required to shift away from the existing unsustainable subsidy-based regime in order to introduce solid foundation for an optimally productive, internationally competitive and diversified agriculture in tune with the resilience of the ecosystem.

Mizoram, the land of the hill people, despite all odds and physical constraints has continued to be predominantly an agricultural state. With hardly 6 % of its land area devoted to agricultural use in 2013-14 (Agriculture Statistical Abstract,2013-14, Govt. of Mizoram) by producing 7319 metric tons over 2012-13 and despite the fact that this figure reflects an improvement of 1.19 % over 2000-01 the state has generally been experiencing a decline when compared to late 1980s (Kumar, 2012: 159). The decline in the agricultural land use though is reflected in the declining share of agriculture in the State Domestic Product, it fails to explain the dominant dependence of people on agriculture in the state. As almost 60 % of its total working force continually depends on agriculture and allied activities there is found to be a tendency to colonize more and more land on slopes not generally being considered suitable for agricultural operations. It is reflected in agricultural productivity in the state. It requires to be mentioned that despite the local authorities' attempts to discourage a less productive and supposedly environment degrading practice of shifting (Jhum) cultivation in the state through many schemes area under Jhum is found to have been increasing. It was 39342 ha in 2012-13 but only 38804 ha in 2013-14. However, it does not seem to have any positive impact on productivity of agriculture in the state. As a result, the state is hardly able to maintain a supply of food for three months for its inhabitants on its own as has been the case in the past. The question of agricultural productive efficiency becomes more glaring when it is realized that the hilly terrain of the state impedes the movement of the people and goods to meet the basic requirements of the people in its larger parts. This necessitates assessing the agricultural productive efficiency of the state on parameters that may help the people to plan for self reliance if not self sufficiency.

Present study is designed to discover the relationship amongst and efficiency of the factors in an apparently hostile terrain of Mizoram which basically depends upon the agricultural activities and production thereof. The study, therefore, implies an understanding of the variability in efficiency of agricultural production as well as potential for agricultural efficiency in the state.

1.2 Concept of Agricultural Efficiency:

Agriculture efficiency in general is associated with the productivity of crops per unit area. It may be influenced by increasing use of technology and shifting of labor away from this basic economic activity. It may reflect in an increase in productivity i.e the amount produced per unit area of land or per person employed in the activity. Efficiency of a system may also denote the ratio between the works or energy got out of it and the work or energy put into it. The more energy one gets out per unit amount one puts in the more efficient the system may be considered. In other words, agricultural efficiency is directly the agricultural production potential related to current level of agricultural performance.

Efficiency, thus, may be defined as one's ability to use the minimum resources in order to reach the organizational targets. They include output per unit area (Kendall, 1939: Weaver, 1954: Bhatia, 1967), input- output ratio (Khusro, 1964), or output per person employed in agricultural pursuits (De Vries, 1967), or input-output ratio per unit farm land and profit derived from it (Heady and Dillon, 1961; Hexem and Heady, 1978; Haedy and Bhide 1984), output in terms of grain equivalent per head of population (Buck, 1937; Shafi,1960) etc. Many a times, thus, measurement of efficiency is guided by the international comparison such as India's rice yield in comparison to China being $1/3^{rd}$, of Vietnam and Indonesia only half. None of these measures, however, take into consideration the resilience of the environment to cope up with the inducements to enhance agricultural productivity – a consideration necessary for the maintenance of sustained agricultural productivity to meet the demands of the present as well as the future Such an understanding of agricultural efficiency necessitates classification of efficiency. More recently Darkus and Malla et al. (2013) have identified three types of mutually complementary efficiency: (i) **technical efficiency** derived from available current technological and managerial practices; (ii) **allocative efficiency** referring to equivalence of price of farm products with that of customers' willingness to pay for it; and (iii) **scale efficiency referring** to guarantee of production at the minimum average cost correlated with the size of land holding. They also, however, fail to include environmental constraints in agricultural productivity

The global, national and regional experiences in agricultural productivity, thus, make it imperative to understand what makes agriculture efficient. Agricultural efficiency like in any economic system is generally made to be associated only with production. It ignores the extent to which time, effort or cost in agricultural operations is used to achieve the intended goal of production. It indirectly suggests the specific purpose of transmitting the knowledge effectively to achieve intended production targets and to contain waste and expenditure –both of monetary and human efforts. Accordingly, many measures of calculating agricultural efficiency have been suggested by the scholars. However, any measurement without taking into consideration the tolerance limit of the ecosystem and its resilience to additional input (as experienced in many parts of the world in the form of land degradation) may only give a false impression of agricultural efficiency. Thus, it is essential, as realized (though not adopted) by Farrel way back in 1957, to include environmental variables to arrive at the efficiency level of farm lands.

1.3. Scope of the study:

Agriculture efficiency is a function of different physical and social factors. It may not, however, be possible to consider all the factors independently. Therefore, it is proposed to study agricultural efficiency in respect of certain variables which reflect the combined influence of physical and social characteristics of different regions. It is in this light that following parameters are suggested to be analyzed i.e. size of holdings, land on cultivable slope, intensity of productivity (yield/unit), and irrigation intensity, cropping intensity, productivity in relation to agricultural land per unit, net sown area, total population, and agricultural workers.

In order to assess the distribution of above mentioned representatives of agricultural efficiency, it may however be necessary to evaluate the incidence of physical attributes like physiographic (especially slope categories), climate (especially moisture availability for agricultural purposes) and social factors like population, occupational structure, labour productivity and institutional arrangement with special reference to capital investments.

The above mentioned parameters are believed to represent the physical and social attributes influencing agricultural efficiency of a region. The study, in order to assess changing efficiency of areas, contemplates two time frames - 1991-92 and 2006-07. 1991 has been selected for the study as the census operation was held for the first time after Mizoram attained its statehood.

The state of Mizoram is a small hill state studded with innumerable hill ranges and criss crossing ridge and valley topography. It is also characterised by almost homogenous origin. Despite topographical adversity, thus, a very large proportion of population have been dependent on agriculture traditionally. Even at present almost 55 % (2001) of the total working population is directly dependent on farming of crops of one kind or the other. Added to this almost 6 % (2001) workers draw their sustenance as agricultural labour. This reveals that almost 61 % of the total workers are agriculture dependent wherein a very small area of only about 6 % of the state's geographical area has been available for agricultural operations (Economic Survey, 2006-2007, Govt. of Mizoram). At the same time, the demands on agricultural produces consequent upon rising population have been rising. Compounded with the local populations inability to seek alternative avenues of production there has been fragmentation of land holdings leading to growing inefficiency in agricultural pursuits. It may be noted that between 2001-02 and 2003-04 the number of agricultural holdings increased by 14.64 % from 65919 ha to 75576 ha. Kumar (2012) observes that it was not necessarily an outcome of additional colonization of land for agricultural purposes. It most likely has been caused by fragmentation of agricultural holdings wherein. 44.58 % of the holdings belong to the marginal farmers with holdings between 0.5 and 1.00 ha ;37.5% to small farmers with 1.00 – 2.00 ha; 16.58 % to medium farmer having 4 to 10 ha of holding. Holdings bigger than 10 ha are owned by meagre 0.08 % farmers in the state.

1.4. Aims and Objectives of the Study:

Assessment of **a**gricultural efficiency in spatially variable terrain of Mizoram and its delineation is believed to help the farmers and agriculture administrators to plan for crops which may be economically more appropriate and environmentally suitable to grow. As it is believed that in ecologically adverse conditions though crops may be grown but only with enhanced inputs proper strategy may be to practice agriculture in tune with the available conditions. It may help in attaining sustainability in farming as it is supposed to be within the resilience and regeneration of environmental capital. It, thus, necessitates covering the following aspects of farming in agricultural efficiency study of Mizoram where productive capacity is generally low despite high monetary input. This makes it imperative to correlate the following:

- To study the Pattern of Land use and production
- To assess Agricultural Intensity
- To assess input-output ratio in different administrative and environmental settings

- To measure Agricultural Efficiency and delineation of variable efficiency regions.

All of the above must be studied independently particularly in the light of the fact that the land and production records at the level of farmers and related administrative bodies are poorly maintained (there is no cadastral survey in the state, prevailing system of shifting operational holdings makes maintenance of land and production records difficult). Changing land use policies of the government also does not help in having sound data base in the state. Thus, collection of information on the above and related aspects and their correlation provides a measure to **delineate agricultural efficiency regions** within the state of Mizoram.

1.5. Statement of problem:

Applications of agricultural inputs at uniform rates across the field without due regard to variations in soil fertility and crop conditions does not yield desirable results in terms of crop yield. The management of in-field variability for improving the crop production and minimizing the environmental impact is the crux of efficient farming. Thus, the information on spatial variability in farming attributes is a precondition to efficient farming practices. Geomorphic characteristics influencing the slope characteristics and thereby impinging on soil fertility, ease of farming and growing period in association with the socio-economic conditions of the practicing farmers together should determine the level of agricultural efficiency. In Mizoram, the farming practices are too haphazard and non-scientific (mostly due to unavailability of desired information) and hence need some forethought before implementing any new policy and technology.

In the light of the above following pertinent questions require to be answered to meet the objectives of the present study:

1. What slope categories should be utilized to obtain optimum agricultural productions?
2. To what extent infusion of input has improved the output of farm products at different slope categories of the state?
3. To what extent the government interventions and subsidies have helped the increase in production?
4. How far the inducement to change the farming system has improved the agricultural efficiency?
5. Why some areas within the state show relatively better input- output ratio than the others?
6. Whether institutional arrangements of inputs has really enlarged the productivity in the state, and
7. At what environmental costs?

In the light of the aforesaid objectives, issues and questions the following hypotheses require to be tested.

1.6. Hypotheses

1. Farm outputs are positively correlated with the application of input
2. Slopes determine the farm input and output: lower the slope lower is the input and higher is the agricultural productivity in Mizoram and vice versa.
3. Institutional assistance has helped increasingly efficient use of land resources.

Above mentioned hypotheses require to be tested to evaluate the efficiency level of the use of inputs and corresponding output. Space technology including Global Positioning System (GPS) and Geographical Information System (GIS) holds good promise in deriving information on soil attributes and crop yield. They facilitate monitoring of seasonally variable soil and crop characteristics, namely soil moisture, crop-phenology, growth, evapo-transpiration, nutrient deficiency, crop disease, and weed and insect infestation, which, in turn, help in optimizing inputs and maximizing crop yield and income. Though widely adopted in developed countries, the adoption of ‘precision’ farming in Mizoram is yet to take a firm ground. Major handicaps are scant information on agricultural related issues. The problem is aggravated by many factors like its unique pattern of land holdings, poor infrastructure, lack of farmers’ inclination to take risk, socio-economic and demographic conditions.

The above mentioned hypotheses are proposed to be tested on the basis of samples selected at the state level and discussed elaborately in the chapter on methodology.

1.7 Review of Literature

A number of literatures are available on different dimensions of agriculture since the time it has been studied systematically. Man like Singh (1994) believe agriculture to have been an economic endeavor that utilizes the natural resources of soil and water directly to meet the basic demands of the populace. These natural resources are naturally impacted and are sensitive to the complex interactions of the atmospheric circulations, plants, animals, genes and human activities. Ecosystems where agriculture is practiced are sensitive to agricultural interventions which involves in its ambit crop raising, animal husbandry, agro- forestry and pisciculture. Besides being influenced by the physical environment it is also influenced increasingly by the human organization of space involving the number of the people, their social attitude, level of technology and the political system people adopt. Their appropriate management requires skilled individuals with the knowledge of the biophysical as well as the socio-economic background-both.

Agriculture production, it requires to be noted, uses natural resources in diverse and complex ways. The appropriate use and sustainable management of such resources form the basis of food security, poverty alleviation and environmental quality. Most of the scholars working on agricultural productivity (Equated with agricultural efficiency) though are aware of the physical limitations of the agricultural practices there has been increasingly a greater emphasis on economic growth and productivity of agriculture at least since the first quarter of the 19^{th} century. Gregor (1970) believes that descriptive regional approach as evidenced in the writings of Von Humboldt was adopted to understand location of agricultural activities and their produce. One of the first treatises in agricultural geography – the models of concentric zone and isolated estate by Von Thunen (1826) emphasized the relationship between the types of agricultural activities and the human settlements in terms only of economic distances. He appears to have belittled the limitations put by the physical constraints. And though Von Thunen introduced his model of the location of agricultural activity to explain relationship between human settlement and agricultural operations most of the studies till the first quarters of the 20th Century limited themselves to distributional aspects only. Systematic investigations in the field of agricultural geography started during the inter-war period between 1919 and 1939. Geographers undertook the responsibility of explaining causal relationships and their impact on agricultural production. Thus, Baker (1926-1933) published a series of articles on agricultural regions that clearly established a relationship between the physico-climatic factors and settlers of North America. Jonasson (1925-26), Jones (1928-30), Valkenburg (1931-36), Taylorand Shantz (1940); followed the suit and regionalized Europe, South America, Asia, Australia and Africa respectively. Though these studies provided agricultural patterns only broadly and were deterministic in approach; they helped subsequent researchers to pursue empirical analysis on agricultural land use. More detailed investigation of agricultural attributes and their complex relationship with changing institutional, infrastructural, cultural, and political patterns started in 1940's. Kendall (1939) developed a method of determining agricultural efficiency based on output per unit area and devised a system of ranking co-efficient. The best known work in this regard is that of Weaver (1954) in which he analyzed the crop combination regions of the Mid- West USA. These studies, however, were generally concerned with growing complexity of farming system and delimitation of agricultural boundaries It implied productivity of different crops to determine the dominance of one crop or the other. Use of statistical method by Weaver involving 'standard deviation' is still considered to be the most acceptable method of agricultural regionalization. Stamp (1958) attempted to correlate population with carrying capacity of the land. As a matter of fact, the studies till the first half of the 19^{th} century limited themselves mostly to distribution aspects only. The underlying assumption behind this kind of approach probably has been that different types of agriculture could be practiced under cultural leanings modeled by specific physico-climatic condition.7 Stamp (1960) later tried to improve upon his earlier study and following Kendall brought into consideration output per unit area after grading them in ranking order and deriving the 'ranking co-efficient ' for international comparisons . He used caloric value obtained from different agricultural pursuits for comparison. Enyedi (1964) developed a technique to prepare an index of productivity co-efficient. Kostrowicky (1964) and Griggs (1969) used quantitative classification to explain different types of agricultural regions and their carrying capacity. Coppock (1964) attempted to emulate the method by integrating crop, livestock, and associated enterprises to evaluate agricultural efficiency in England and Wales.

It is noteworthy that with changing understanding of the factors influencing agriculture and agricultural productivity scholars have been attempting to refine the methods of calculation of productive efficiency. Revolutionary changes in the use of statistical methods are found to have taken place particularly after 1950. During this period the Seminal work of Farrel (1957) on measurement of productive efficiency set a new trend in the evaluation of agriculture efficiency. He devised a method of input-output ratio to measure productive efficiency which replaced the index number method in vogue till then. He took into account all inputs to overcome the problem of index number method. Output, as a measure of productivity, was measured by cash receipts from adding the value of home consumption. Inputs considered included land (farms and pastures), labor (farmers, farm managers and unpaid family workers), materials (feed, livestock and seeds), and capital (farm implements and machinery). The study revealed that law of diminishing return was evident as processes which used larger holdings were more economical in terms both of capital and material due to the ease of management. It was Farrel who could not himself include inputs like climate, location and fertility though but believed that it was imperative to include them in agricultural efficiency models. It, however, underlined the extent to which time, effort or cost in agricultural operations is used to achieve the intended goal of production. It also suggests the specific purpose of transmitting the knowledge to effectively achieve intended production and containing waste and expenditure of both monetary and human efforts. The global, national and regional experiences in agricultural productivity, thus, made it imperative to understand what makes agriculture efficient. It necessitated classification of efficiency. Accordingly many measures of calculating agricultural efficiency have been suggested by the scholars. They include output per unit area (Kendall, 1939: Weaver, 1954: Bhatia, 1967), input-output ratio (Khusro, 1964), or output per person employed in agricultural pursuits (Vries, 1967), or input- output ratio per unit farm land and profit derived from it (Heady and Dillon, 1961: Hexem and Heady, 1978: Haedy and Bhide 1984): output in terms of grain equivalent per head of population (Buck, 1937: Shafi,1960) etc. Many a times, thus, measurement of efficiency has been guided by the international comparison such as India's rice yield in comparison to China being 1/3rd, of Vietnam and Indonesia only half. None of these measures, however, take into consideration the resilience of the environment to cope up with the inducements to enhance agricultural productivity – a consideration necessary for the maintenance of sustained agricultural productivity to meet the demands of the present as well as the future.

In this light, Malla *et al* (2013) divide the period between 1950 and 2011 in three distinctive phases – (i) 1950 -1990; (ii) 1990 – 2000 and (iii) 2000 – 2011 and wherein distinctive as well as increasingly more sophisticated statistical tools have been used to remove parametric biases. Hayami and Ruttan (1971) in their study having an international perspective acknowledged that agricultural growth is based on an ecologically adapted and economically viable agricultural technology involving a continuous adaptation to available resources as well as a positive response by cultural, economic and political forces. The attempt to enhance efficiency of agriculture, therefore, involves accordant technological and institutional changes through "induced development model" positively accepted by the 'cultural, economic and political forces' influencing farmers, agribusiness and administrative set ups. They accordingly are expected to take into account the changes in the supply and demand factors as well as the products. They also came to the conclusion that the technical changes promising more productive inputs take place either (a) to save labor, or (b) to save land i.e increasing or maintaining productivity with lesser input of labor or land. They, in the same study also emphasize that higher productivity in agriculture is positively correlated with the positive transmission of cheaper services and input from industrial and other non-farm sectors which are generally proportional to the level of their development. The study, however, surmises that "effective market information, research, supply and markets for factors and products" is the key to increasing productivity. It is the effective interaction between these elements that generates technical change – necessary for agricultural development in any developing country. Acknowledged by them Kawagoe and Hayami (1985) made an attempt to obtain an index to represent the ratio of the total output to the total of conventional input in order to compare agricultural efficiency across the regions as well as over time. In their study they included seeds and feed to represent gross output. They take into account five input variables represented by labor (economically active male population in agriculture), land (hectares of agricultural land), livestock (livestock units), fertilizer (nitrogen, phosphorous oxide and potassium oxide), and machinery (tractor horsepower). They assign common weights for the various inputs as 0.45 for labor, 0.10 for land, 0.20 for livestock, 0.15 for fertilizer, and 0.10 for machinery. In their studies they came to the conclusion that the productive technical efficiency was lower for the low income areas as was their labor productivity.

Gollop and Swinand (1998) in their study of Total Resource Productivity (TRP) of U.S agriculture between 1972 and 1993 attempted to provide a framework for its measurement. However, they took into account the producer based orientation of conventional productivity accounting keeping in view the concept of welfare maximization. They while analyzing the impact of selected factors of productivity found that agriculture efficiency declined between 1980 and 1993 as compared to the period between 1972 and 1979 due to the occurrence polluted water for the use in agriculture. They assign the cause of water pollution to the use of pesticides in agriculture which, according to them, increasingly polluted the water bringing down the agricultural productivity by 0.06 % as compared to the recorded productivity between 1972 and 1979. The finding suggests the adverse impact of new technology on agricultural environment. Similar trend has been found by Kumar and Mittal (2006) in the second phase of Green Revolution believed to have been started by the mid – 1980s in India. They discover that this phase has been characterized by high input-use and decelerating productivity growth in the country.

Gliessman (2001;3) equates agricultural efficiency with sustainability of agroeco system. He opines that “minimum of artificial inputs from outside the farm system, manages pests and diseases through internal regulating mechanisms, and is able to recover from the disturbances caused by cultivation and harvest”. Thus, he challenges the myth that higher inputs in agriculture results in corresponding increase in output. In fact, it may go against the tolerance limit of the agro ecosystem. Optimum efficiency in agricultural productivity obtained through generations of experience, according to him is the key to maintenance of the ecosystem hence sustainable efficiency of agriculture.

Similarly, Farshad and Zinck (2001) when they state that “a sustainable agricultural system is a system that is politically and socially acceptable, economically viable, agro technically adaptable, institutionally manageable, and environmentally sound, they essentially are providing a critique of efficiency enhancement. They, however, also believe that satisfying all these requirements and the relevant analytical criteria to assess productive efficiency of agriculture is a complex endeavour; so complex that it may be difficult to reach a comprehensive conclusion. A sustainable system equated with efficiency, according to them “has six requirements: environmental soundness, economic viability, social acceptability, institutional manageability, agro technical adaptability, and political acceptability. These requirements may be considered the foundation on which an efficient productive system may develop.

Sampaio (2013) in the light of present state of global economy feels that “sustainable economic recovery of states emerges as a priority issue of world development strategy”. She observes that efficiency is associated to sustainable development at micro-level of analysis in order to reach cost minimization, output and profit maximization. Measurement of farm efficiency represents one of the most important subjects of investigation at the microeconomic level, either in the context of developing and developed countries or within different contexts of analysis. Following Greene (2005) she also believes efficiency to be “associated with (1) technical efficiency if the goal of the analysis is to obtain maximum output given a set of inputs, (2) cost-efficiency if the aim is the minimum cost of producing that output given the input prices or (3) profit efficiency in the case where interest is in the maximum profit attainable given the inputs, outputs and price of the inputs".

Silva *et al*.(2013) have attempted to give an insight into the measures of agricultural efficiency and evaluate the support by the non-parametric, non stochastic models or econometric models in decision making processes.

Catherine *et al.* (2012) have attempted to correlate the "public goods" that farms with their primary function of agricultural production may provide. Their article reviews reports on public goods provided by agriculture on farms across a range of agriculturally relevant areas: soil management, biodiversity, landscape and heritage, water management, manure management and nutrients, energy and carbon, food security, agricultural systems diversity, social capital, farm business resilience, and animal health and welfare. These, they believe, may enhance productive efficiency of agriculture.

Sun *et al.* (2011) have studied the productivity changes of main grain crops and agricultural ecological security situations by using remote sense and Geographic Information System (GIS) technology during the period of 2004–2008. The results indicate that the Cultivated Land Instability Degree (CLID) value in Zhangjiagang city despite faster reduction of cultivated land could maintain productivity per unit area. However, they find out that the agricultural ecological deficit in Zhangjiagang city increased by 16.23 %. The Grassland ecological deficit had the largest proportion, and cultivated land ecological deficit increased slightly, but the forest ecological deficit and the hydrosphere ecological deficit remained stable. This clearly suggests that the gap between input and output in respect of agricultural production has been closing in very fast.

Such an understanding of agricultural efficiency necessitates classification of efficiency. Darkus and Malla *et al*. (2013) have identified three types of mutually complementary efficiency: They have identified three types of mutually complementary efficiency: (i) **technical efficiency** derived from available current technological and managerial practices; (ii) **allocative efficiency** referring to equivalence of price of farm products with that of customers' willingness to pay for it; and (iii) **scale efficiency referring** to guarantee of production at the minimum average cost correlated with the size of land holding.

A number of studies on the measurement of productivity have been carried out for Indian agriculture especially after 1980 though there is no dearth of literature on different aspects productivity and agricultural efficiency between then. Some notable contributions have been made by Chatterji (1952); Safi (1960, 1972, 1983); Grag (1964); Sapre and Despande (1964); Khusro (1964); Bhatia (1967); Hussain (1970, 1978); Singh and Chauhan (1977).

These studies can be classified into two groups:

1) Agriculture sector, and
2) Crop-specific analysis.

Different aspects of agriculture, therefore, have been of immense interest to the scholars from different disciplines for; they are believed to impinge on agricultural productivity hence efficiency of different regions differently. At the same time different approaches have been employed in order to assess agricultural productivity of different regions.

Prior to Industrial Revolution in Europe concern for agriculture was limited to finding out variations in agriculture from place to place (Singh and Dhillon, 1994). A new method of analyzing agricultural productivity was suggested by Singh (1979) which account not only the yield of crops but also their areal spread. Based on intensity of use, reflected in yield, and areal spread of the crops, Singh has devised nine categories by a combination of high, medium and low yield intensity with high, medium and low spread of crops. Singh (1980) published an article on the concept of agricultural development, there he mentioned that the agricultural development and its process are associated with the potential theory of production which is based on the rate of change in the agricultural production in relation to the input factors. Ahmad and Subbiah (1980) while studying agricultural productivity and development of Tamil Nadu, they paid more attention in the light of environment, technological and institutional factors. In the 19th Century, however, descriptive regional approach was adopted to understand location of agricultural activities and their produce as evidenced in the writings of Von Humboldt (Gregor, 1970).

In India, first attempt to evaluate agricultural resources and regionalization was attempted by Mukherjee (1942), Dayal (1950) attempted to correlate the distribution of cattle and fodder supply in Bihar and suggested many measures to improve the livestock resources of the state. Sapre and Despande (1964) is one of the earliest studies on agricultural efficiency in India attempted to evaluate regional variations in productivity efficiency of agriculture in Maharashtra. Due to prevailing confusion with the terms like productivity, productivity measurement, efficiency and efficiency measurement in agriculture, Sharma (1964) tried to clear the cloud from the meanings of the term and dwelt on the concept and definition. Khusro (1964) employed input- output ratio to determine agricultural efficiency in India. Bhatia (1967) studied the agricultural efficiency of 11 crops in U.P discounting livestock. He believes the agricultural efficiency to be a function of various factors that include the physical (climate and soil), socio-economic (size holding and type of farming), and technical organizational (crop rotation, irrigation and mechanization). Estimating yield efficiency of each crop in percentile terms with respect to the average yield of the specific crop he assigned weighted average taking into account the share of cropland devoted to each crop as the weight. He then classified the efficiency index as high, medium, low and very low. Shafi (1983) in his study attempted to correlate the agricultural productivity with the regional imbalances in Uttar Pradesh.

Similarly, various attempts have been made by various researchers to explain the growth in agricultural output in terms of area and yield components. The first systematic study in this regard was carried out by Minhas and Vaidyanathan in the year1965. Later, scholars like Evenson and Jha (1973),Dey and Evenson (1991), Sindhu and Byerlee (1992), Kumar and Mruthyunjaya (1992), Rosegrant and Evenson (1992), Dholakia and Dholakia (1993), Kumar and Rosegrant (1994), Evenson *et al*. (1999), Fan *et al*. (1999), Ali and Byerlee (1999), Coelli and Rao (2003), Rozelle *et al*. (2003) further refined the concept of total productivity and the analysis of growth in agricultural output. These scholars attempted to correlate the yield per unit area and productivity growth. In order to explain the dynamics of agricultural growth firstly they tried to establish a relationship between the growth in land and output growth for agriculture as a whole or for individual crops or for individual regions. They found that output growth in India before 1960 was more related with the expansion of agricultural land. With the onset of the Green Revolution in the country in late1960s technological changes and other (non-land) inputs became more important and wherein they tried to identify the sources of output growth in terms of inputs and (total) productivity. The contribution of improved technology has been measured by them as TFP growth broken into several factors that include research, extension, education, infrastructure, health of natural resources, and many like them. They realize that the input growth is influenced by several factors like input-output prices, technological innovations, institutions, infrastructure, policy initiatives, etc. (Kumar *et al*., 2004).Mandal and Dhara (2012) attempted to analyze and correlate the spatial patterns of agricultural productivity, variations in the levels of development and casual relationship between agricultural productivity and selected variables of development among the blocks of the district of South 24 Parganas of West Bengal.

Alam (2013) in his study of the trends of agricultural production attempted to correlate agricultural productivity with climatic change and its long-run impact on economic growth on the Indian economy. He finds that agricultural productivity in India has the most significant impact on the nation’s economic growth. However, being sensitive to climatic changes agricultural productivity may be impeded and so the economic growth.

The agricultural productivity, in terms of grain equivalents per head of population, was first employed by Buck (1937) in his study of land utilization in China. Buck’s method was modified and employed by Vries(1967) to obtain output of grains in the predominantly rice-growing Asian countries in terms of milled-rice equivalents per head of total population according to the local market price of each grain. Following Kendall and Stamp, Safi(1972) adopted a more sophisticated method of determining an index of productivity to assess agricultural efficiency in the Great Plains of India. The same year Singh (1972) applied a more complex statistical method and correlated the agricultural efficiency of an enumeration unit with that of the entire region. His main objective was to evaluate the carrying capacity of different parts of Haryana. Singh (1979) evolved a method by which a two dimensional picture of agricultural productivity consisting of intensity and spread could be portrayed. But it involves tedious and cumbersome calculations. Hussain (1996) attempted to measure the Agricultural Productivity in which all the crops grown in their areal unit was taken into consideration. The agricultural productivity according to him should be measured in terms of Money, minus the inputs. Conversion of production into money equivalents removes the biasness towards the crops which occupy small proportion of the gross cropped area. In other words, production in terms of money gives adequate weight to the quality and total production of all the crops. More recently Singh (2005) developed a model of 'crop- yield analysis' based on spatial and temporal characteristics in his study and demonstrated the results obtained in Assam.

In Mizoram, dominantly an agricultural state, the studies on agriculture and its productivity is found to be sparse and far between. Lalrinchhana (2004) has attempted to correlate inputs with agricultural productivity in Mizoram. In his study he tried to assess the productivity in relation to three major inputs like irrigation, fertilizer, organic manure and mechanisation. He comes to the conclusion that though proportion of fertilizer use reflected on productivity in the state, the ‘erratic growth in use of agricultural input’. However he does not seem to take into consideration the resilience factors of environment. He is more concerned about increasing productivity through institutional arrangements of farm subsidies and loans. Majumder *et al*. (2010) have made an intensive study of the agricultural practices in North East Indian state. They identify the variable nature not only of the terrain but also of the agricultural systems and their adaptability by different social groups. This, they find has led to different system of farming in the region. These system include permanent cultivation, Wet farming, Aji system (cultivation of rice and millet with fish in deep water) Jhum (shifting) farming mostly by the hill tribes, Plantation farming dominated by tea cultivation. Farmers also have cultivation systems such as home gardens and agro forestry that link their families to the forest ecosystem. They have also made an attempt to focus on agricultural practices, their productive capability and viable sustainable land use strategies for people of the region. They recognize the problem of low productivity in the region particularly in view of very rapidly growing population which has been recorded to have grown at a rate of over 31.2 % during the decade 2001-11 against the national growth rate of 21.4 %.

Lalrinmawia (2012) while evaluating the level of regional development in Mizoram has partially attempted to delineate the state on the basis of agricultural resources available to it. He has considered parameters like area under cultivation, intensity of productivity, intensity of cropping, and intensity of irrigation to arrive at productive efficiency in the state.

Chapter-II

Methodology

The methodological considerations in geographical studies have changed enormously from simple Cartographic techniques to scientific or more quantitative approaches in order to systematically hand the problem of efficiency studies and objective derivation thereof. On account of such usefulness of quantitative techniques an attempt has been made to evaluate agricultural efficiency in different parts of the hill State of Mizoram. The study is oriented towards an assessment of the spatial pattern of agricultural production.

Due to unique geographical condition and absence of Cadastral survey in the state, data either with reference to area or production available on any level of agricultural administration is neither standardized nor are they reliable. *Yet in order to start the work, the information on area and production standardized by the Govt. department from the basis of the present study. Data analysis, statistical representation, etc are done with statistical tools and software such as Statistical Package for Social Sciences (SPSS) and Excel.

**Measurement of agricultural area and production in general is carried out in terms of Tin i.e the area sown with one Tin (15 kg) of seed of any speedy denotes an area of 1 tin. Similarly, production is also measured in terms of tin notwithstanding the type of produce.*

The present study is based on the observation and experiences of the farmers and data have been collected from different sources but mostly based on primary sources where relevant and necessary information are collected through intensive field survey covering the representative District with the help of questionnaires. By adding primary sources, secondary data related to agricultural production have been collected from the Department of Agriculture and Horticulture, Aizawl, Agricultural Handbook and Statistical Abstract from Economic and Statistics Office and village level statistics have been collected by Questionnaires and from Census Office, Aizawl.

2.1 Basis of selection of villages for the study :

The present study is mostly based on primary source of data collected through field survey with the help of questionnaire prepared covering the representative villages of the three district. A comprehensive household survey in twenty seven villages of three districts of Mizoram was conducted and from every village 28 % household was taken as samples. The research is based on primary data (with secondary information). Although a total of 45 farming heads of household in every village were planned for interview.

In addition, as it would not have been possible to study the whole state for its agricultural efficiency, a simple method has been adopted to classify the districts in Mizoram (eight in all) on the basis of quantity of their agricultural production per unit area. Thus, one representative district from each category of district representing relatively high production, medium production and low production in relation to the state average has been selected for the purpose of having insight in the distribution of agricultural efficiency in the state.

Similarly, from each district three RD Blocks on the basis of average district production have been identified with the exception of Saiha district which has got only two RD blocks (one urban and the other rural) and where four villages have been selected from the singular RD block of Tuipang and five from Saiha RD Block. The selected RD Block on Aizawl District are Aibawk RD Block, Thingsulthliah RD Block and Phullen RD Block. And Ngopa RD Block, Khawzawl RD Block and Champhai RD Block are selected from Champhai District.

On other Districts, three villages each from high, medium and low production blocks have been identified. Once villages have been identified above 28 % of the household were sampled from each village to draw primary information. By stratifying on high and low values of efficiency, the accuracy of estimation is expected to increase (Ott and Longnecker; 2010: 8-12).

The data from Questionnaires was programmed and processed using Statistical Package for Social Sciences (SPSS). Slope and inputs were taken as the determining factor of efficiency.

2.2 Formula adopted for the present study :

For calculating the agricultural efficiency of the study area, the Data Envelopment Analysis (DEA) developed by Coelli (1996) has been choose to identify the agricultural efficiency region. Coelli (1996) formula has been adjusted and used by Silva.E, Arzubi.A and Berbel.J in 2004 for Dairy farms in Azores, Portugal. The applied formula for measuring dairy farm efficiency in Azores is under:

$$E_j = \frac{U_1 \text{ litres of milk} + U_2 \text{ escudos of Subsidies}}{V_1 \text{ agriculture area} + V_2 \text{ cows number} + V_3 \text{ costs}}$$

The above formula is applied for measuring agricultural efficiency which required a little adjustment according to the applicability of the present study. The adjusted formula which has been applied to the present study is :

$$E_j = \frac{U_1\ kg\ of\ production + U_2\ Subsidies}{V_1\ agriculture\ area + V_2\ No.of\ Farmers + V_3\ Costs}$$

If $E_j = 1$ which means the agricultural farms are efficient when compared with all the other farms, and when it is smaller than one, the agricultural farms are inefficient. (Silva.E, Arzubi.A and Berbel. J, 2004:pp 41). The above formula is the adjusted formula for the present study.

In the study area costs of production is counted as Rs 40/- which is taken as the average rate of all the crops. After applying the above formula, the study area is divided into three categories as Low, Medium and High. This categorization of groups is done by the process of subtracting the lowest production value recorded in the study area by the highest value which is divided by three as the study area is divided into three groups as low, medium and high category of agricultural efficiency.

In order to calculate slope as a determining factor on efficiency, Linear Regression Method of Statistical Package for Social Sciences (SPSS) has been used and the formula is

$$y = a + bX$$

Where, *y is the dependent variable*

a is the intercept (the value of ‘y’ when X= 0)

b is the slope of the line

X is the explanatory variable

By following the above formula the two variables have been entered in Statistical Package for Social Sciences (SPSS) and for analyzing the data, Linear Regression Method has been applied to get the results. After processing the data three tables have been shown which indicates the results for the variables entered.

The first table of interest is a model summary which provides us the “R” and “R^2” values. The “R” value represents the simple correlation of the two variables (the “R” Column) which indicates the exact degree of correlation. The “R^2” (the “R^2” Column) indicates how much of the total variations in the dependent variable which can be explain by the independent variable. The following table is just to show as an example on how the calculation has been interpreted.

Table. 2.1: showing Simple Correlation of Slope and Agricultural Efficiency

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.864[a]	.746	.710	.020361

The next table is the Anova table, which reports how well the regression equation fits the data (i.e. predicts the dependent variable). The table point out that the regression model predicts the dependent variables significantly well by looking at the “Regression” row and go to the “sig” column. This specifies the statistical significance of the regression model that was run. Value of the ‘F’ column denotes its significant level if the value of ‘F’ is statistically significant at a level of 0.05 or less, this suggest a linear relationship among the variable.

Table.2.2: Level of Significance between Slope and Agricultural Efficiency

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.009	1	.009	20.551	.003[a]
	Residual	.003	7	.000		
	Total	.011	8			

a. Predictors: (Constant), Slope
b. Dependent Variable: Efficiency

The last table is coefficients table which provide us with the needed information to predict the dependent variable from the independent variable as well as to settle on whether independent variable contribute statistically significantly to the model by looking at the ‘sig’ column. Furthermore, we can employ the values in the ‘B’ column under the “unstandardized coefficients” column to present the regression equation of the values which is the expected value of the dependent variable when the values of the independent variables equal 0. The values in column ‘B’ represents the extent to which the value of that independent variable contributes to the value of the dependent variable. The ‘t’ value make known the variables statistical significance. In general, A ‘t’ value of two (2) or higher indicates statistical significance.

Table.2.3 : Expected Value of the Dependent Variable

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.306	.023		13.173	.000
	Slope	-.008	.002	-.864	-4.533	.003

a. *Dependent Variable: Efficiency*

Actual value may be correlated with the expected value by calculating 0.306-0.008 = 0.298. Therefore, the value 0.298 is the expected value of the dependent variable when the independent variable equals zero.

Slope degree has been calculated by the formula :

Slope_degree = ATAN (rise_run)*57.29578

Where, rise_run = $\sqrt{([dz/dx]^2+[dz/dy]^2)}$

The values of the centre cell and its eight neighbours determine the horizontal and vertical deltas. The neighbours are identified as letters from '*a*' to '*i*', with '*e*' representing the cell for which the aspect is being calculated.

a	b	c
d	e	f
g	h	i

The rate of change in the x direction for cell '*e*' is calculated with the algorithm (for the present study 30*30 is used as the cell size) :

[dz/dx] = ((c + 2f + i) - (a + 2d + g) / (8 * x_cell_size)

The rate of change in the y direction for cell '*e*' is calculated with the following algorithm:

[dz/dy] = ((g + 2h + i) - (a + 2b + c)) / (8 * y_cell_size)

Input output ratio is another criterion to judge efficiency of farm business. It refers to the ratio of input. (Bishop, C.E & Tousent, W.D,1958). It indicates relationship of expenses with return. Therefore, to measure the efficiency of agricultural fields, the computation of input output ratio is considered meaningful for this purpose. The following formula is used:

IOR = G1 ÷ Gg

Where IOR denotes input output ratio, G1 stands for the farm expenses and Gg symbolizes the production.

When input output ratio calculation is done, the Standard Deviation Method has been applied to get the categorisation of the three groups as low, medium and high category of the study area. The lowest input/output ratio is 0.11 which is subtracted by the highest ratio i.e. 0.27, 0.27-0.11 = 0.16 which is divided by 3 as the study area is divided into three category of high, medium and low. 0.16/3= 0.05 and this value has been added to the lowest value i.e. 0.11+0.05 = 0.16, again 0.05

has been added to 0.16 i.e. 0.21….and so on. The village which having the value of upto 0.16 has been put in a low category, the value between 0.16 to 0.21 in medium category and the value above 0.21 in a high category group. The results declared that inputs do not have any influence on agricultural efficiency because when the inputs is high, automatically agricultural production is high, but that do not proved that high agricultural production with high inputs is high agricultural efficiency. Here, we have taken into consideration that less inputs with high agricultural production. All the inputs have to be included in the measurement of efficiency.

As Trosset (2001) observes “the goal of statistical inference is to draw conclusions about a population from \representative information" about it. It is in this light that the information obtained from representative sample villages have been applied to corresponding sets of population at state level. This is done to provide a basis to divide the state of Mizoram in agricultural efficiency regions wherein, it is believed, physico-cultural characteristics are more or less similar and 27 sampled villages (classified in three categories) selected from three districts may well represent the total population of villages in the state. This has been done following Kolmogorov (1933; cited in Trosset; 2001:18) who believed that collection of observed events of the sample space may assign real numbers to unobserved events with similar characteristics. In other words, A sample space outcomes for the experiment in question may be replicated to represent universe.

Chapter- III

Study Area : Environmental Setting

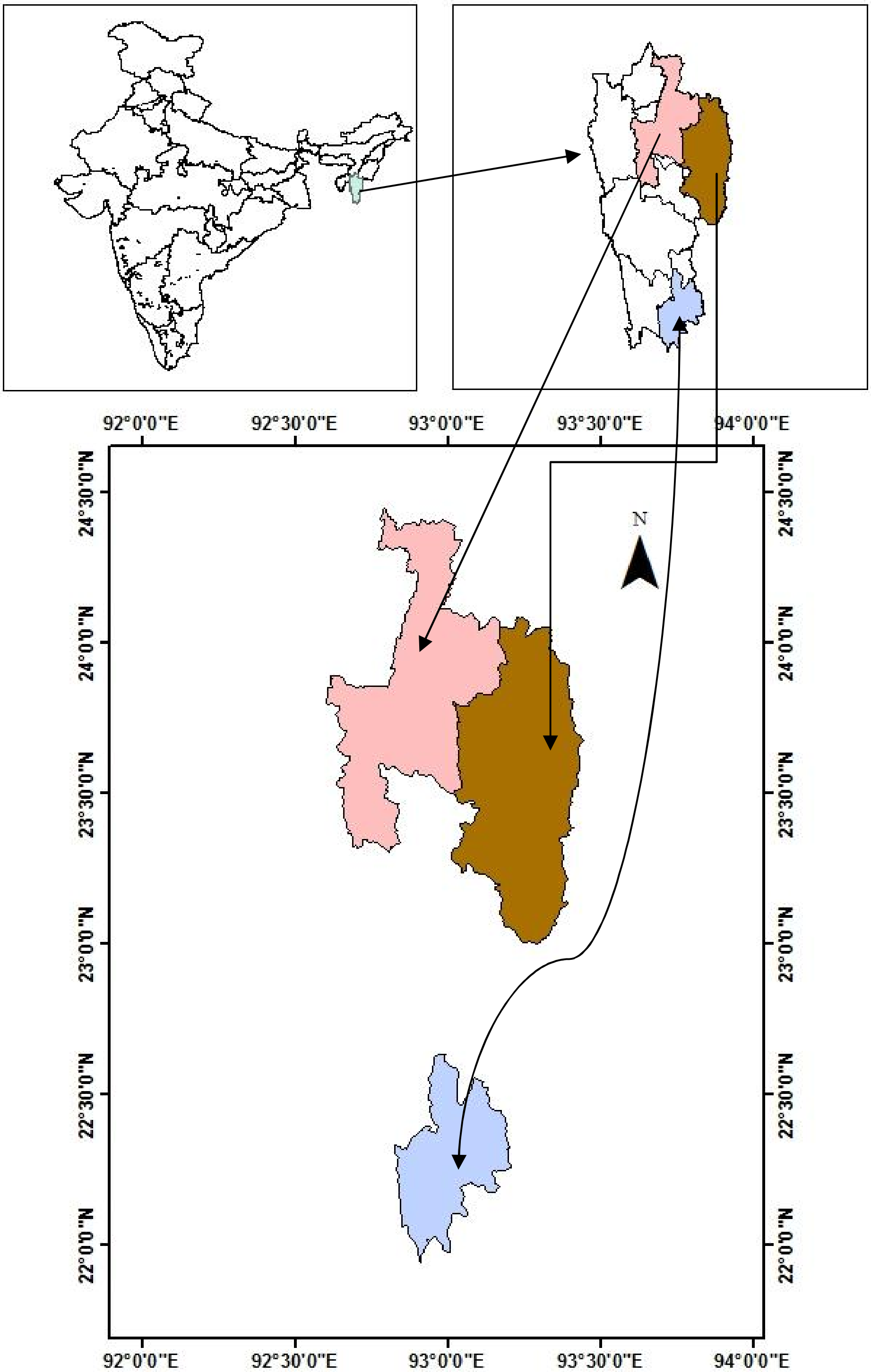
Mizoram, a district of Assam at the time of independence of India was accorded Union Territory status on 21st January in 1972 due to unique conditions in the aftermath of widespread famine (Mautam) of 1960s. Later, following the Peace Accord signed between the insurgent groups led by Mr. Laldenga in 1986 Mizoram became the 23rd full- fledged state of the Indian Union on 20th February, 1987. It commands a total geographical area of about 21081sq. Km. Initially; the state was administratively divided in three District Units of Aizawl, Lunglei, and Saiha. Later in 1998 the state was administratively reorganized to have eight districts with 22 Rural Development Blocks.

3.1.`Location and Boundary : The state of Mizoram is geographically located between 21° 58' N - 24° 35' N latitudes and 92° 15' E - 93°29'E Longitudes.** The state is bounded by Bangladesh in the West and Myanmar in the East and South. It shares a common boundary with Cachar District of Assam and the state of Manipur in the north and with the state of Tripura in North-West. It has about 722 Km International Boundary together with Myanmar and Bangladesh (404 km. with Myanmar and 318 Km. with Bangladesh).

***Dr Rintluanga Pachuau,Lecturer in Geography, Pachhunga University College, Aizawl ; Asserts that the location of Mizoram is 21° 56' N - 24° 31' N latitudes and 92° 16' E - 93°26'E longitudes; Khawiah nge Mizoram* *in Dah !, Mizoram Science Journal (1993) (In mizo language) : August, pp. 11 – 15 : Also see Geography of Mizoram (1994): Dr. Rintluanga Pachuau, R.T. Enterprise, Aizawl.*

Its maximum dimensions are 277 Km from North to south and 121 Km from East to west. The location of Mizoram is unique in the sense that similar ethnic groups are found along the International and state boundaries- Mizos along Myanmar and Manipur- Cachar borders and Chakmas along Bangladesh border. People of similar stock are also found in Tripura. Such a dispensation makes The state politically very sensitive and economically fragile.

FIG.3.1: Location Map of Study Area



Dominated by a hilly terrain Mizoram is the home of an almost homogenous tribal group known popularly as the Mizos. They constitute almost 89 % of the total population. The state though has experienced remarkable changes since the time it was a district. Under the province of Assam before 1972, administratively it acquired Union Territory states in 1972 and became a fully fledged 24th State of India in 1987 after an unabated cessionist movement for over 20 years. The socio-economic conditions of the people have undergone substantial change as the people readily embraced the opportunities offered by the Union Government of India since then. It is reflected in the fact that the state is placed at 5th rank on Human Development Index amongst the states of India. It is the 2nd most urbanized (5th including the Union Territories) state of India and has the highest literacy rate after Kerala and Lakshadweep. However, located remotely from the mainland of the country and impeded by the topographical constraints potentials of economic regeneration has not been realized so far. Despite physical constraints almost 70 % of the population still depends on agriculture and agriculture associated activities. Primitive practice of Jhum (Shifting) cultivation continues to be the mainstay of disproportionately large number of farmers. The state is hardly able to produce 1/3rd of its requirement of food grains and has to depend on supplies from outside. It is a ‘No Industry’ state where Modern industries are non- existent. Thus, agriculture and allied activities though impeded by the topographical conditions appear to be the only mainstay for larger sections of the people.

3.2 PHYSICAL CHARACTERISTICS OF THE STUDY AREA :

The hill state of Mizoram is studded with numerous ranges running generally in N- S direction. They are separated from each other by narrow synclinal river valleys. These valleys, however, open out gradually toward the Barak valley of Cachar plains of Assam in the north and Kolodyne valley of Myanmar in the south.

Physiography:

Physiography of the land emerges to carry straight control on the distribution of different phenomena through altitude, ruggedness and slope. It comprises a truly foundational resource (Glendinning and Logan, 1959). Therefore, agricultural efficiency should consist of geographical analysis of the land. On the basis of structural and relief characteristics, therefore, the state may be divided into three physiographic units –

(a) Eastern High Hills;

(b) The Western Low Hills; and

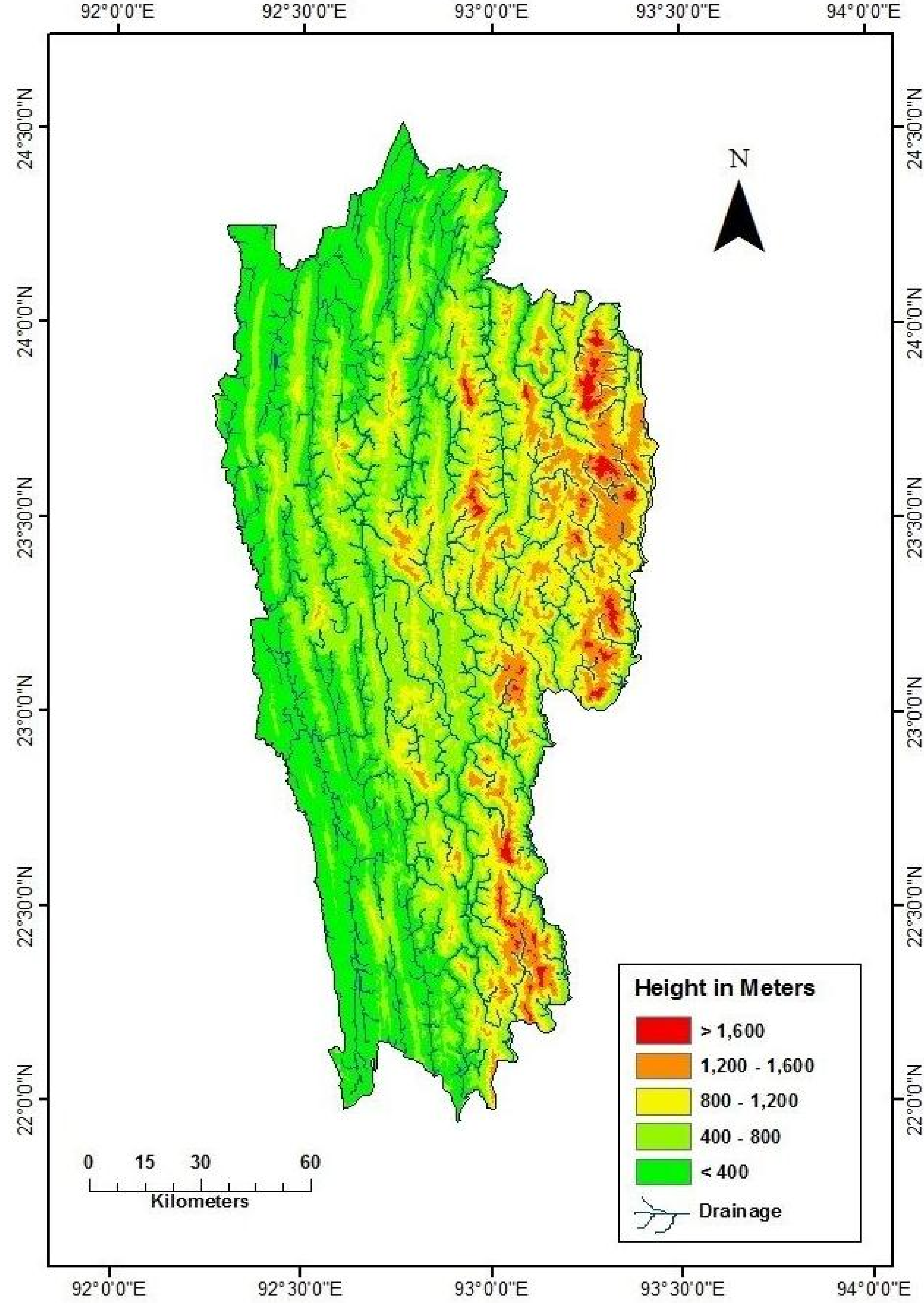
(c) Intermontane flat lands (Kumar, G. 2012)

The topography of Mizoram is fascinating. Steep and rugged, the hill ranges of Mizoram are in sharp contrast with the major mountain ranges of the country. They run North – South and tend to grow higher in the eastern side and taper off to the north and south. As many as 21 major hill ranges or peaks of various heights runs through the length and breadth of the state, leaving of course, some plains scattered occasionally here and there. The state has perhaps the most variegated topography in the North – East with the average height of the hill to the west of the state is about 1000 meters which gently rises to 1300 meters to the east. Some area however is of higher ranges which go up to the height of over 2000 meters. Phawngpui (Blue Mountain), with a height of 2157 meters (Pachuau,2009)

, situated in the south eastern part of the state is the highest peak in Mizoram. The eastern half of the state can be classified as mountainous terrain province. The altitude here varies from 400 to 2157 meters. The average elevation in this province is 1500 meters.

There are only a few patches of flat lands scattered at all places in Mizoram. They are generally located in the middle of hills and narrow valleys. These plains are believed to have been found in the beds of silted – up lakes as they are covered with rich alluvial soil. The largest plain in Mizoram is located at Champhai, which is known as ' *Rice bowl of Mizoram*'. Champhai plain is 194 kilometres east of the state capital, Aizawl, bordering Myanmar in the east has a length of only 11,27 kilometres and width is 4.83 kilometres. The whole area has been converted into permanent wet rice cultivation.

FIG: 3.1: Physical Map of Mizoram



Geology :

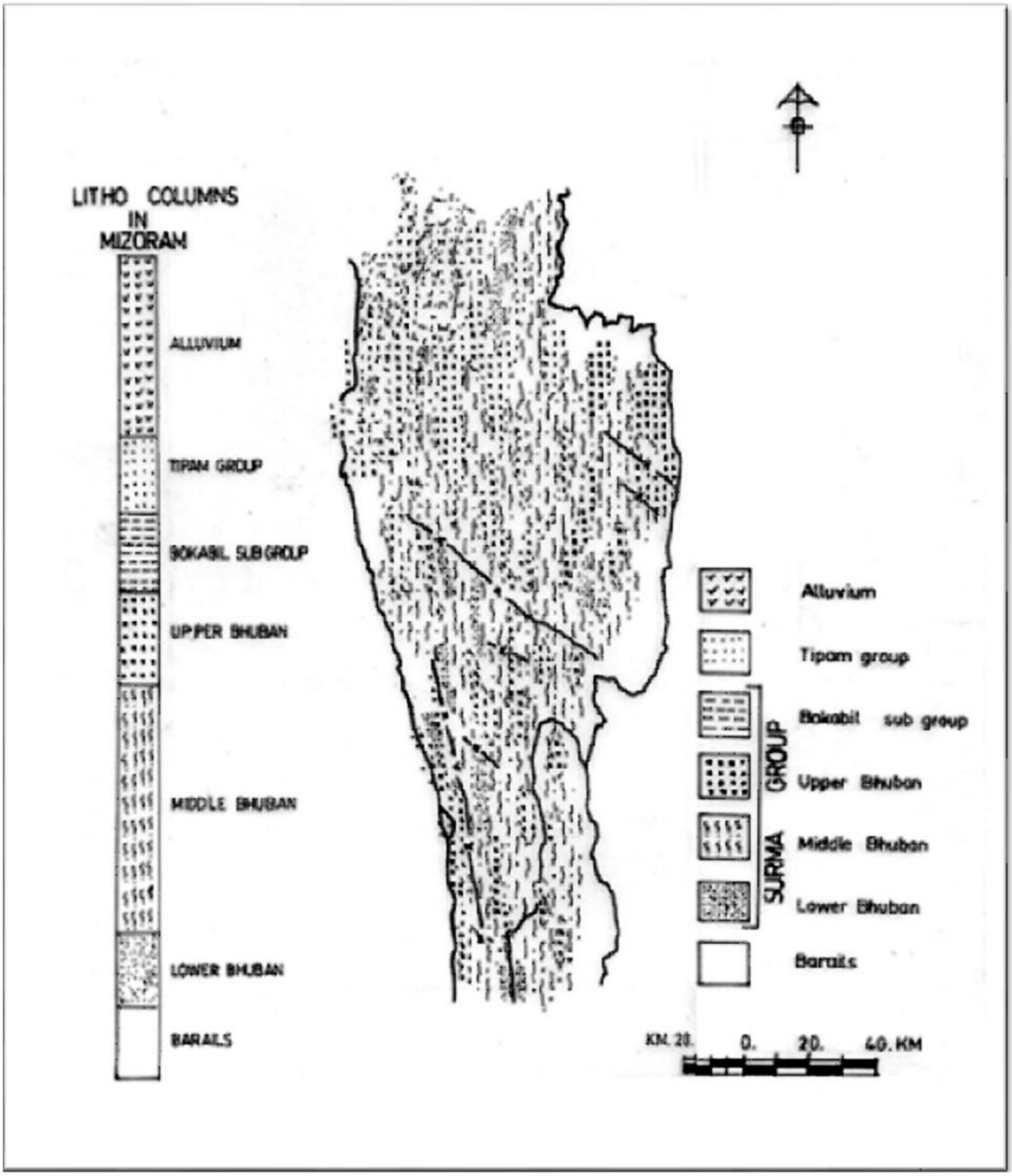
Geology is the study of rocks which made up the planet earth with different types of lithological units. The hills of Mizoram consist of sandstone and shale's of tertiary age, thrown into long folds. The rocks are the continuation of those rock forming Patkai range and Cachar hills and possibly laid down in delta or estuary of a great river discharge from Himalaya in the tertiary period. Geologically, Mizoram is highly prominent with Surma and Barail formations. Surma groups consists of Bhuban and Bokabil rock types(Kumar.G). Bhuban group has three sub divisions namely –

(1) **Upper Bhuban formation**: This rock formation is predominant arenaceous, and comprised mostly of massive, brownish, comparatively soft friable, somewhat weathered, medium grained, usually containing fragments of shale's.

(2) **Middle Bhuban formation**: The rock formation is predominantly argillaceous, and comprised mainly of shale, mudstone and siltstone.

(3) **Lower Bhuban formation**: This arrangement comprises generally of grayish, fine to very fine grained massive sandstone. The second group Barail formation is mainly composed of orenaceous rocks. The Barails comprise monotonous sequences of weathered shale, inter- bedded and interlaminated with siltstone.

Fig 3.2 : Mizoram : Geological Map



After Kumar. G in his book *Dynamics of Development and Planning: A comprehensive Regional Analysis.*

Hydrography :

Natural channels for surface flowage- the streams have been a natural source of water for human consumption, agricultural use and transportation. Running water uses, control and conservation deeply depend on the physical-climatic conditions of the regions they pass through.

Drainage :

The state of Mizoram is drained by a number of rivers and streams of different patterns and length. The southern hills are drained by Chhimtuipui on the east with a number of tributaries. Tiau river which is one of the tributary of Chhimtuipui river and Chhimtuipui river has formed a natural boundary with Myanmar in the east and south where as the northern part of the region is drained by the north flowing rivers like Tlawng, Tuivawl, Tuirial, Langkaih and Tuivai with its tributaries and fall into Barak river in Cachar plain of Assam. The major drainage systems in Mizoram are : Tlawng drainage system, Tuirial drainage system, Tuivawl drainage system, Tiau drainage system, Chhimtuipui drainage system and Khawthlangtuipui drainage system.

Ground Water :

The ground water potentiality of Mizoram has been divided into four zones depending on the structure and underlying rock formation, wherever the area having flood plains, valley fills, etc have the potential of great water recharge.

(1) **Very Good :** This zone generally covers valley fill, flood plains and low-lying areas which are located within the proximity of water bodies, where there will be continual recharge. It also includes the intersection of the

structural units, such as lineaments and faults, with valley fill and flood plains. Lithologically, this zone comprises areas where unconsolidated sediments, such as gravel, sand, silt and clayey sand are deposited.

(2) **Good :** All the remaining geological structures fall under the good potential zone. The low-lying areas including parts of flood plains and valley fills are also included in this zone. Among the rock types exposed in the study area, sandstones are generally capable of storing and transmitting water through their interstices and pore spaces present in between the grains, and are considered to be suitable aquifer.

(3) **Moderate :** This zone mainly comprises areas where the recharge condition and the water yielding capacity of the underlying materials are neither suitable nor poor. Topographically, it covers gently sloping smooth surface of the hill. The moderate zone falls within the poor water-bearing rock formation such as silty shale that are, in turn, characterized by the presence of secondary structures in them.

(4) **Poor :** The poor zone is mainly distributed in the elevated areas. It is mainly distributed along the ridges and high structural hills. This zone is predominantly high in terms of areal extend and covers large part of the state.

Table. 3.1 : Mizoram : Distribution of Ground Water Potentiality

Sl.No	Potential zones	Area(in km^2)	%
1	Very good	1889.99	8.96
2	Good	4284.41	20.32
3	Moderate	6404.47	30.37
4	Poor	8508.13	40.35
	Total	**21087.00**	**100.00**

Source : Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

Climate :

Mizoram lies within tropical region, as such it enjoys a moderate climate. It is neither too hot in summer nor too cold during winter. In general, Mizoram has a pleasant climate. As the region falls under direct influence of south – west monsoon, the state receives abundant rainfall. The climate is humid and tropical with short winter and long summer. During summer the temperature varies from 20°C to 30°C, where as it varies from 11° to 21°C in winter. The four months between November and February is winter time in Mizoram which is followed by the spring. The storms come in the middle of April to signify the beginning of summer. The mercury starts rising and the hills come under the cover of a haze. The three months from June to August are known as the rainy season. The climate is at its moderate best in the two autumnal months September and October, when the temperature moves between 19°C to 25°C.

Rainfall :

Most of the rain occurs during the months of June to September due to the influence of the Monsoon. The annual rainfall ranges from 1,969mm to 3,140.4 mm. The annual average rainfall is 2,538.4 mm (Agriculture Statistical Abstract,2012-2013). There is not much variation of rainfall in various parts of the state. Generally, it rains during May to September while July and August receives the heaviest rainfall. During rainy season, landslides are common over the road sides and hill slopes. November to February are the dry months with minimum rainfall. The abundant rainfall received in the study area supported the production in large scale. The monthly rainfall received recorded during the last five years are as under :

Table-3.2: Mizoram: Average Monthly Rainfall in the last 5 years

Sl.No	Months	2009	2010	2011	2012	2013
1	Jan	0.3	0.0	13.7	11.5	-
2	Feb	2.4	3.2	2.1	17.6	1.4
3	Mar	22.6	119.4	83.4	19.2	4.7
4	Apr	141.4	199.5	105.3	302.3	65.6
5	May	160.0	369.5	422.3	209.7	499.3
6	Jun	331.1	464.2	439.0	456.7	293.1
7	Jul	318.1	428.0	372.2	264.0	351.9
8	Aug	468.2	524.7	547.9	401.8	519.9
9	Sept	360.4	503.6	374.2	355.0	476.0
10	Oct	164.8	275.6	165.8	195.0	209.2
11	Nov	41.8	27.9	0.4	54.8	1.3
12	Dec	0.0	59.3	0.1	0.0	-
13	**Annual**	**167.8**	**247.9**	**210.5**	**190.6**	**201.9**

(Source : Meteorological Data of Mizoram,2013)

Soil:

Soil is a major resource. They are fundamental to agriculture economy of a state like Mizoram. It is the nature and quality of soils which gives direction to the cultivators in respect of the use of the land on which he practices cultivation. Geologically soils may be classified on the basis of the materials upon which soils form. The soils of Mizoram are young, immature and sandy. They have been derived mostly from Barail and Surma formations of post Oligocene periods dominated by loose sandy detritus sediments. The soils are mostly red and yellow loam. They are characterized by high organic carbon as well as high nitrogen contents. They, however, have high acidic content but are low in potash and phosphorous compounds, essential contents for most of the cultivable crops. This may be the result of heavy leaching experienced generally in areas of extended high rainfall as is found in Mizoram. However, soils in river valleys are characterized by high fertility and are heavier as they are brought down by the streams from higher altitudes**.**

Normally the soils in the state are much effected by rainfall and humidity conditions. They, thus, are classified as Udic (MIRSAC,2006) which may be sub-classified as Ultisols, Entisols and Inceptisols found at different slopes. Variants of ultisols like Udults, Ochrepts and Orthents are found accordingly at different slope categories. Ultisols are commonly found along the foothills at lower slopes. They along with its variants are fairly drained, However, they are poor in humus and content and lack fertility associated with it. Entisols occur on steep slopes and ridges or on flood plains which receive continually new detritus deposits. They occur generally along river courses and support good vegetation if it is properly managed. Inceptisols occur mainly in sub-humid regions. They are found to be suitable for differrent forest species. In the areas where steep to very steep slopes are found Hapludults soil occurs. They are found to be rich in iron but are poor in their pH value. They have a wider coverage as compared to other soil types in the study area. The following tables provides an understanding of the areal and altitudinal distribution of different types of soils in Mizoram.

Table-3.3.

Mizoram: Allocation of Soils in relation to different Slope Categories

Sl. No	Physiography	Soil Composition	Area (in km^2)	Area (in %)
1	Hill top / Hill crest	L.S. Typic Dystrochrepts L.S. Typic Udorthents F.L. Typic Hapludults	13.06	0.41
2	Hill side 10 – 25 % slope with current Jhum and	F.L .Typic Dystrochrepts Clayey Typic- Dystrochrepts	17.20	0.54

	horticulture	L.S. Typic Hapludults		
3	Hill side 10 – 25 % slope with abandoned Jhum	L.S. Typic Hapludults F.L. Typic Dystrochrepts Clayey Typic Dystrochrepts	43.01	1.35
4	Hill side 10 – 25 % slope with open forest	F.L. Umbric Dystrochrepts L.S. Typic Hapludults F.L. Humic Hapludults	23.89	0.75
5	Hill side 10- 25% with with dense forest and forest plantation	F.L. humic Hapludults Clayey Humic Hapludults F.L. Umbric Dystrochrepts	175.22	5.50
6	Hill side 25- 50% slope with current current Jhum and Horticulture	Clayey Typic Hapludults L.S. Umbric Dystrochrepts F.L Typic Hapludults	97.17	3.05
7	Hill side 25- 50% with abandoned Jhum	L.S. Umbric Dystrochrepts F.L. Typic Hapludults L.S. Typic Dystrochrepts	258.05	8.10
8	Hill side 25- 50% slope with open forest	F.L. Humic Hapludults L.S.Umbric Dystrochrepts L.S. Humic Hapludults	147.19	4.62
9	Hill side 25-50% alope with dense forest and forest plantation	Clayey Humic Hapludluts F.L.Humic Hapludults Clayey Typic Hapludults	944.92	29.66
10	More than 50% slope with current Jhum and horticulture	L.S. Humic Hapludults L.S. Umbric Dystrochrepts F.L. Humic Hapludults	76.15	2.39
11	More than 50% slope with abandoned Jhum	L.S. Typic DystrochreptsF.L. Typic HapludultsL.S. Humic Hapludults	248.81	7.81
12	More than 50% slope with open forest	L.S Typic Hapludults L.S. Humic Hapludults. F.L. Typic Dystrochrepts	126.48	3.97
13	More than 50 % slope with dense forest and forest plantation	F.L. Typic Hapludults F.L.Umbric Dystrochrepts F.L. Humic Hapludults	894.58	28.08
14	Valley/ WRC	F.L .Aquic Dystrochrepts Clayey Humic Epiaquepts F.L.Fluventic Dystrochrepts	98.44	3.09
15	Water Body		8.92	0.28
16	Built-up land		12.74	0.40
	TOTAL		**21087.00**	**100.00**

Source : Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

Even though Mizoram has a very small agriculturally appropriate area, soils in the state are usually found to be responsive to the use of fertilizers and manures. Thus, proper management and judicious use of its soil resources is expected to develop the agricultural productivity potentials hence efficiency.

Natural Vegetation:

The study area has an abundant growth of vegetation. Out of the total geographical area (21087 km^2) 15,853 km^2 areas has been covered by vegetation which accounts 75.17 % of the total geographical area (Statistical Handbook, 2012). The study area is well endowed with a vegetative cover ranging from tropical wet evergreen to montane sub- tropical alpine type. Due to the combinations and interactions vegetations reflect the environmental factors that set a limit for the range of plant species to be grown and their productivity.

3.3 POPULATION CHARACTERISTICS OF THE STUDY AREA:

Population Growth:

For every country, population enumeration is an essential activity for getting the precise statistical data of the inhabitants of the country, for making policy and programmed and implementation of the same for development. Rural – Urban classification of population is also an important instrument for the said purpose. In 2001 Census, the total population of the state was 8, 88,573 and it increased to 10, 91,014 in 2011 Census and the growth percentage is 22.78 % while the country has recorded its growth as 17.64 %. Decadal Growth of population of the state in 2001 – 2011 is lower than that of in 1991- 2001 which was 28.8 %. As much as 5, 61,977 people live in the urban areas while 5, 29,037 persons live in the rural area in the state. Among the inhabitants of urban area, 2, 81,020 are males and 2, 80,957 are females. In the rural area, the state has 2, 71,319 male population and 2, 57,718 female population.

Population Distribution:

The District wise distribution of population with density is given in the following table. Since the area is hilly, the topography is not so much suitable for comfortable and heavy concentration of population in one locality and also because the traditional system of occupation continues to be the mainstay for a large section of the society, the State has as many as 707 inhabited villages and 23 towns. The total number of households in the state is 176,134. Consequent upon the internal re-organization of the state in 1998, it now has eight districts carved out of the erstwhile three districts. The total population in the 23 notified towns is 561,977 and the rest is distributed in the 707 villages which indicate that the average population in the villages is about 748. This again indicates that the distribution of population between rural and urban areas is 48.49 % and 51.50 % respectively. This indicates that the state is highly urbanized.

Table 3.4 : Mizoram :Inter-District variation in Population Distribution

Sl. No	Name of District	Area(km^2)	Population	Density (per km^2)	%age of total population
1	Aizawl	3,576	404,054	113	37.03
2	Champhai	3,185	125,370	39	11.49
3	Kolasib	1,382	83,054	60	7.61
4	Lawngtlai	2,557	117,444	46	10.76
5	Lunglei	4,536	154,094	34	14.12
6	Mamit	3,025	85,757	28	7.86
7	Saiha	1,399	56,366	40	5.16
8	Serchhip	1421.60	64,875	46	5.94
9	**MIZORAM**	**21081.00**	**1,091,014**	**52**	**100**

Source : Statistical Handbook, Mizoram,2012

Population Density :

The study area is sparsely populated and ranks one of the lowest populated states of India. According to 2011 census, the study area accounted 1,091,014 persons which have a density of 52 persons per km^2. The population density is comparatively low due to its remote location with characteristics of mountainous landscapes, low economic level, political instability, etc.

Table 3.5 : Mizoram :Inter-District variation in Population Density

Sl.No	District	Population Density (per Km^2)
1	Mamit	28
2	Kolasib	60
3	Aizawl	113
4	Champhai	39
5	Serchhip	46
6	Lunglei	34
7	Lawngtlai	46
8	Saiha	40
TOTAL		**52**

Source : Statistical Handbook, Mizoram,2012

Population Composition :

The demographic make up of population is useful in projecting the incidence that has happen in the state.

Table 3.6 : Mizoram : Inter-District variation in Population Composition

Sl. No	District	Area (km^2)	Population			% decadal Growth rate of population (2001-11)	Sex Ratio (Females per 1000 Males
			Persons	Males	Females		
1	Mamit	3,025	85,757	44,567	41,190	36.59	924
2	Kolasib	1,382	83,054	42,456	40,598	25.92	956
3	Aizawl	3,576	404,054	201,072	202,982	24.07	1,009

4	Champhai	3,185	125,370	63,299	62,071	16.31	981
5	Serchhip	1,421	64,875	32,824	32,051	19.12	976
6	Lunglei	4,536	154,094	79,252	74,842	12.29	944
7	Lawngtlai	2,557	117,444	60,379	57,065	34.08	945
8	Saiha	1,399	56,366	28,490	27,876	19.71	978
TOTAL		**21,081**	**10,91,014**	**552,339**	**538,675**	**22.78**	**975**

Source : Statistical Handbook, Mizoram,2012

Age and Sex Composition:

In studying the population characteristics, the analysis of age and sex composition has a great importance economically and socially. The age distribution of the study area is divided into three groups where the age group of 15-64 years has been considered as the most active population age-group constituting the largest percentage which is 64.8 % of the total population followed by the age group of below 15 years which constitutes 31.4 %. The age group of above 65 years constitutes the smallest percentage of 3.8 %.

Table 3.7 : Mizoram: Age Composition

Below 15	**15-64**	**Above 65**
31.4 %	64.8 %	3.8 %

Sex composition holds an important place for demographic analysis. The overall Sex ratio in Mizoram is 975 females per 1000 males **(Table 3.6).** Based on the sex composition of Mizoram in the year 2011, four districts has been identified as areas having higher sex ratio than the state average and four district being identified as lower sex ratio than the state average. However, there is no large gap between male and female population in agricultural activities.

Occupational Structure:

The occupational structure is given in the following table which clearly show the distribution of work force among various sectors of the economy. Occupational structure means the distribution of work force in various activities or occupations. All occupation are broadly divided into three groups, viz (1) Primary or Agricultural Sector, which includes cultivation and other occupation allied to agriculture, like animal husbandry, forestry, fishery, horticulture, etc. (2) Secondary or Industrial sector which includes large, medium and small manufacturing units, constructions, etc. (3) Tertiary Sector or service sector includes trade, transport, communication, bank and other government and non – governmental services.

Table 3.8: Mizoram: Occupational Structure

Sl. No	Category	Number	Percentage
1	Total population	10,91,014	
2	Number of workers (Total work force)	4,67,158	52.6 %
3	Cultivators	2,56,332	54.9 %
4	Agricultural Labourers	26783	5.7 %
5	Household industrial workers	7100	1.5 %
6	Other workers	176944	37.9 %

Source : Mizoram at a glance; Directorate of Census Operations, Government of India, Aizawl, Mizoram.(2012)

Literacy:

Literacy level among the people is an important indicator of the quality of population of a country or state. As per the report of the National Sample Survey Organization (NSSO), Mizoram was declared as the top in literacy level among the other states in India. However, the latest survey reveals that the literacy rate has been showing a decreasing trend over the years in the state. According to the 2011 census, Kerala topped in the literacy level among other states in India with 93.91 % (followed by Lakshadweep with 92.28 %) literacy level leaving Mizoram behind at the third position with 91.58 % literate persons. District wise literacy level is shown in the following table which indicates that the overall literacy level in the state of Mizoram is 91.58 %. Serchhip District shows the highest level of literacy (98.76 %) among its population while Lawngtlai District shows the lowest level of literacy with 66.41 %. However, the literacy rate in the state is much higher as compared with the national level. While the literacy percentage in India is 74.04 %, Mizoram is having 91.58 % literacy level.

Table 3.9: Mizoram: Literacy Rate

Sl. No	**District**	**Literacy rate in %**		
		Total	**Males**	**Females**
1	Aizawl	98.50	99.01	98.00
2	Champhai	93.51	94.80	92.20
3	Kolasib	94.54	95.50	93.53
4	Lawngtlai	66.41	74.68	57.62
5	Lunglei	89.40	92.74	85.85
6	Mamit	85.96	90.15	81.37
7	Saiha	88.41	91.00	85.80
8	Serchhip	98.76	99.24	98.28
TOTAL		**91.58**	**93.72**	**89.40**

Source : Statistical Handbook of Mizoram 2012

3.4 INFRASTRUCTURE OF THE STUDY AREA:

Road:

The total length of road in Mizoram is about 6054.21 kilometers out of this 4313.11 kilometers or 71 % is surfaced roads and 1741.10 kilometers or 29 % is unsurfaced roads (Source:PWD,2010). Mizoram is connected by only one National Highway known as National Highway No.54 from Silchar (Assam State) to Tuipang in the South. It has a length of 884.78 kilometers. Road has been studied at two levels. The first level is density per 100 square kilometers which has been taken to explain the accessibility and inaccessibility of the area. The second level is density per one lakh population which help to determine the scope and bearing of economic development and how important are transport in creating new opportunities and inducement. (Youngson, 1967)

Health:

Health is an essential factor for the well being oh human. The health facilities available to a person indicate his level of living, enjoyment of health facilities has taken place among ‘Human Rights’ (Dash, 2007). A healthy population is a pre- requisite for economic growth. The no. of births recorded in the state for the year 2010 is 25,755 where as the deaths recorded is 5367.

Table 3.10: Mizoram: Birth Rate, Death Rate and Infant Mortality Rate

Sl.No	Particulars	2009	2010
1	BIRTH RATE		
	(1) Rural	27.22	27
	(2) Urban	18.98	18
	(3) Mizoram	22.88	22
2	DEATH RATE		

	(1) Rural	5.94	5.00
	(2) Urban	4.76	4.00
	(3) Mizoram	5.32	4.00
3	INFANT MORTALITY RATE		
	(1) Rural	36.40	17.00
	(2) Urban	40.03	55.00
	(3) Mizoram	37.99	33.00

Source : Statistical Handbook, 2012

Power supply:

The per capita availability of energy is high in Mizoram even though the state does not produce much of the energy**.** Village electrification is important for storing and protecting the surplus product from agriculture and any other farm outputs. 657 villages are electrified in Mizoram as on 1st April, 2012 and the per capita consumption of electricity during the year 2011-12 is 231.02 Kwh (Unit)(Statistical Handbook,2012).

Generally, agriculture in Mizoram is subsistence type and the production is for family consumption. Even if there is surplus production of crops that has to be sale, it is sale in a local market.

CHAPTER – IV

Landuse Distribution Pattern in Mizoram

4.1 Introduction

Studies on pattern of land use do not always employ similar definitions of the principal terms land, land use and land use change. Definitions and descriptions of these terms vary with the purpose of the application and context of their use. It is, thus, necessary to look at alternative definitions and descriptions of these studies, especially those offered by official sources of land and land use data.

The Food and Agriculture Organization (FAO) defines land as an area of the earth's surface (FAO, 1996). However, FAO (1995) gives more refined and holistic definition which was used also in the documentation for the Convention to Combat Desertification (FAO 1995, 6 citing UN, 1994).

"Land is a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near surface climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes and swamps) , the near surface sedimentary layers and associated groundwater reserve, the planet and animal population, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc)". (FAO 1995: 6). Wolman (1987) cites Stewart's (1968) definition of land, " the term land is used in a comprehensive, integrating sense….to refer to a wide array of natural resource attributes in a profile from the atmosphere above the surface down to some meters below the land surface. The main natural resource attributes are climate, landform, soil, vegetation, fauna and water" (Wolman, 1987, 647). It is worth noting that all definitions of land, although in general similar, differ as to the priority given to the attributes that characterized land. The natural sciences (FAO, 1995, Wolman, 1987) start from and detail the natural characteristics of land while the social sciences, more specifically economics (Hoover and Gearratani 1984, 1999) start from the more lament of space and refer more abstractly to the natural features of a segment of space.

"Land use involves both the manner in which the bio-physical attributes of the land are manipulated and the intent underlying that manipulation – the purpose for which the land is used" (Turner, *et al*. 1995:20). In a similar vein, Meyer (1995) states that "land use is the way in which, and the purpose for which, human beings employ the land and its resources (Meyer 1995:25 also cited in Moser, 1996, 247). Briefly, land use "denotes the human employment of land" (Turner and Meyer 1994:5). Skole (1994:438) expands further and states that "land use itself is the human employment of a land- cover type, the means by which human activity appropriates the results of net primary production (NPP) as determined by a complex of socio-economic factors". FAO (1995) however states that "land use concerns the function or purpose for which the land is used by the local human population and can be defined as the human activities which are directly related to land, making use of its resources or having an impact on them" (FAO 1995:21).

Foregoing definitions of land use refer mostly to larger territorial scales and not at the smaller scale e.g. urban land use which focuses on other aspects of the term. In the words of Chapin and Kaiser "at territorial scales involving large land areas, there is a strong predisposition to think of land in terms of yields of raw materials required to sustain people and their activities. At these scales, land is a resource and 'land use' means 'resource use'. In contrast, at the urban scale, instead of characterizing land in terms of the production potential of its soil and its sub- mineral content, the emphasis is more on the use potential of the land's surface for the location of various activities" (Chapin and Kaiser 1979:4). This connotation of the term "land use" is implicit in several other texts dealing with land use in the context of urban and regional analysis and planning.

The description of land use at a given spatial level and for a given area, usually involves specifying the mix of land use types, the areal extent and intensity of use associated with each type, the land tenure statute (Bourne 1982, Skole 1994). The importance and necessity of distinguishing between land use and land cover is most evident in analyses of the environmental impacts of land cover changes. However, the distinction between land use and land cover, although relatively easy to make at a conceptual level, is not so straight forward in practice as available data do not make this distinction clearly all the time, a fact that complicates the analysis of either one of them. At the global level, key sources of global data do not distinguish clearly between cover and use. (Meyer and Turner 1994 and 95). Skole (1994) provides more insight into these data problems.

The pressure on land for sustenance of livelihood has immensely increased over the past decades due to increase in population which in turn has its effect on the socio- economic condition of the population. The increase in the growth of population mark the need for proper planning of natural resource and conservation becomes a topic of much concern in the present scenario. Sustained utilization of available resources requires a scientifically approached land use planning process which incorporates integration of various data, analysis of these data, faster or précis information generation for participants in the land use planning approach. There is an urgent need for research and evaluation of proper and strategically plans and policies based on reliable and sound technologies to find new alternatives.

4.2 Land-Use Pattern in Mizoram:

Mizoram has been an area where community ownership of land has traditionally prevailed. Constrained by the physical attributes people adopted a system of Jhum (shifting) cultivation- basically a family and subsistence oriented system of cultivation (Kumar, 153-54). Recently, however, the system of land tenure ship is found to have changed significantly especially after the abolition of chieftainship in 1956. The changes are also concomitant with the administrative changes since 1972 and faster pace of urbanization in the state particularly after it attained statehood in 1987. Thus, the hold of the government over state's land resource has been increasing. It is also found to influence the land use pattern in the state.

The major land use/ land cover classes in the study area are broadly classified into settlements, agricultural land/ horticultural land, forests (dense and open), bamboo forest, forest plantation, Jhum land (current and abandoned Jhum / shifting cultivation), scrub land and water body. The following major land use types have been identified in the study area:

4.2.1 Settlements / Built-up Land: This is an area of human habitation that has a cover of buildings, transport-communications in association with water, vegetation and vacant land of the geographical area. Approximately all houses in the area are located in the middle part of the area in a number of group which is enveloped by the different physical features like rivers, lakes,, mountains, forests, etc. Most of the houses are made of brick built and planks of wood. Roofs of houses are straw, tin and concrete. It covers only 0.70 % of the total geographical area.

4.2.2 Fallow Lands: The shared of fallow land is greatly marked in the study area due to the rugged topography. The high degree of slope gradient results in more concentration of fallow land for the reason that in high degree slope area practicing of agriculture is not so much probable which result in more concentration of fallow lands in the study area. Fallow land has covered an area of about 245 Sq.km which is only 1.15 % of the total geographical area.

4.2.3 Agricultural and Horticultural Lands: The study area has a number of sites appropriate for agricultural / Horticultural lands. The existing land use and slope aspect establish the selection of suitable places for these lands. Some of the crops identified in the study area are Ginger, Rice, Turmeric, Sugarcane, Maize, Broom grass, etc which is very inadequate and does not meet the necessity of the populace. This covers an area of 162.61 Sq.km which is only 0.77% of the total geographical area.

4.2.4 Forests (open and close including Bamboo Forest) : Forests of the study area includes dense and open forests, as well as other additional reserve forests and forests plantation (Government owned and Private). Mainly the open forests are also successive secondary sequence of fallow lands (7 years and above), once used for shifting cultivation but have stay unused for a lengthy period of time. Bamboo forests are more confined to lower altitudes and are commonly found between 80 – 1400 meters MSL. The study area also has Bamboo growing stock within this altitudinal range. Forest cover an area of about 16319.23 km^2 which is 77.39 % of the total area. Out of this only 0.41 % is used for forest plantation.

Landuse/Land Cover Statistics of Mizoram for the time frame of 1991-1992, 2001-2002, 2006-2007 and 2011-2012.

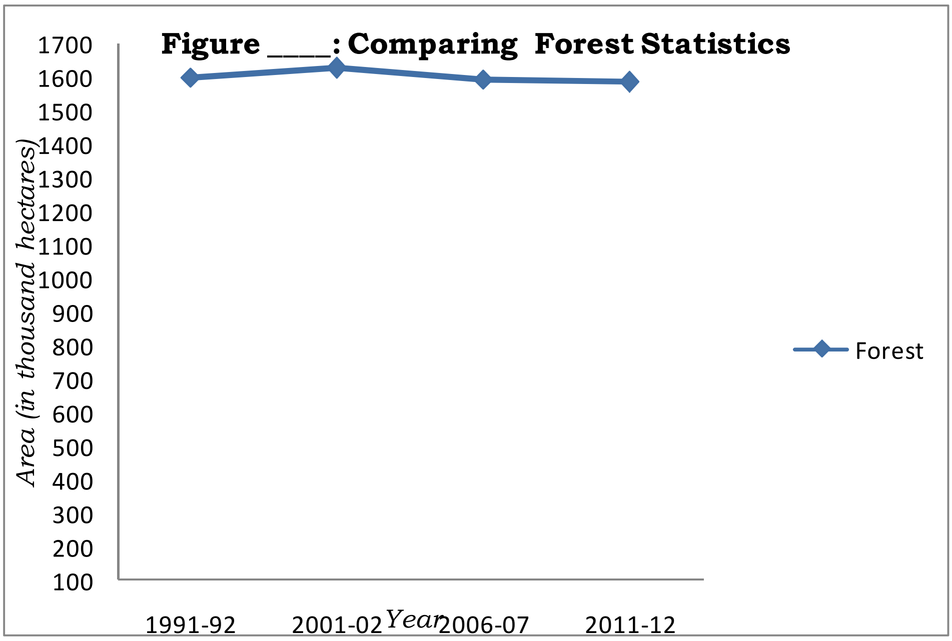
Table 4.1 : Comparing Landuse Statistics

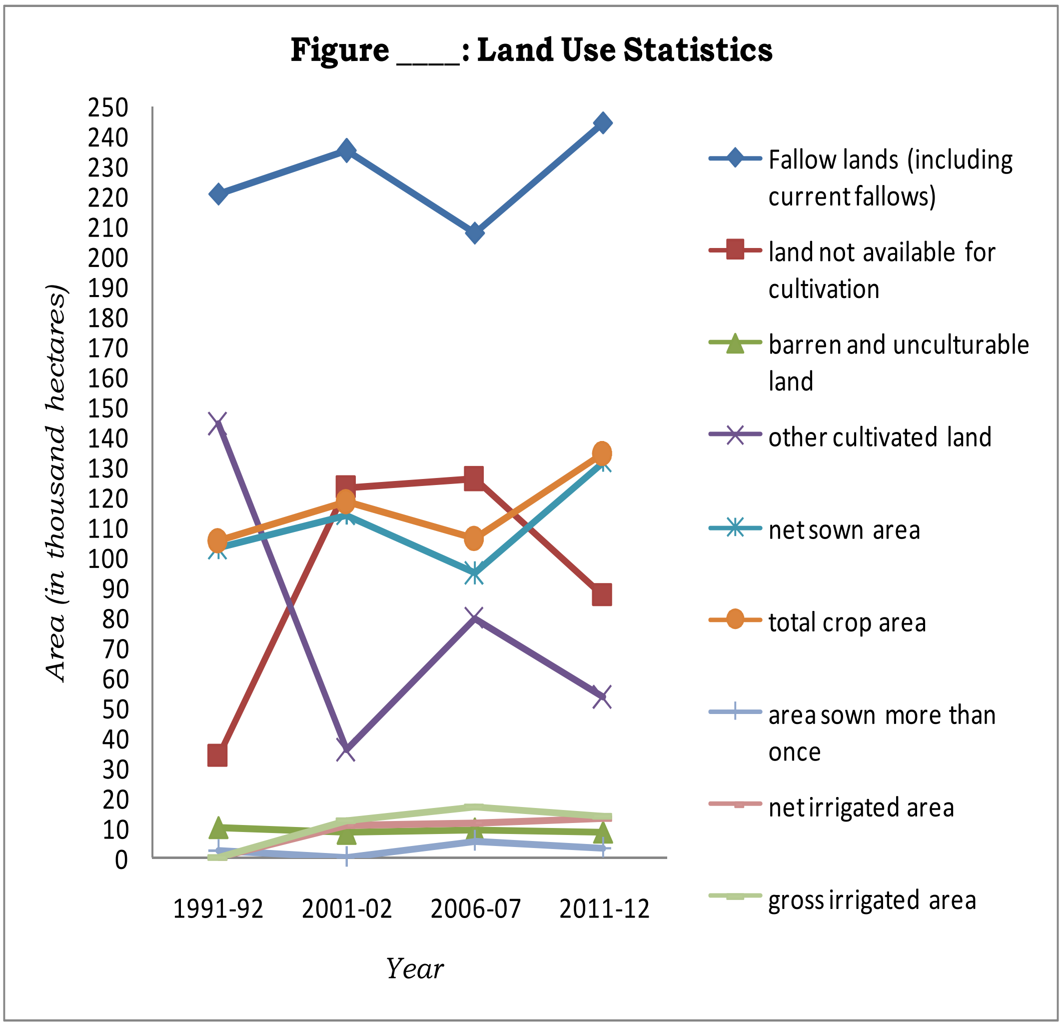
		(in thousand hectare)			
Sl.No	**Heading**	**1991-1992**	**2001-2002**	**2006-2007**	**2011-2012**
I	Geographical Area	2108.7	2108.7	2108.7	2108.7
II	Reporting Area for land utilization statistics (1-5)	2108.7	2108.7	2108.7	2108.7
1.	Forests	1598.500	1626.475	1593.700	1585.305
2.	Not available for cultivation	(a) Land put to non agriculture uses – 33.422	(a) Land put to non agriculture uses – 122.690	(a) Land put to non agriculture uses – 125.420	(a) Water logged land - Nil (b) Social forestry -46.875 (c) Land under still water-11.053 (d) Other land -28.866 **Total of (a+b+c+d) - 86.794**
3.	Barren &Unculturable land	9.500	7.800	8.630	8.25

4.	Other cultivated land including fallow land (a) Permanent pasture & other grazing land	0.180	10.600	5.235	5.25
	(b) Land under miscellaneous tree crops & groves not included in net area sown	0.140	19.603	68.765	40.868
	(c) Culturable waste	143.500	5.100	5.230	6.7
5.	(a) Fallow lands other than current fallows	212.200	199.060	166.078	183.115
	(b) Current fallows	8.500	35.798	41.465	61.188
III	Net sown area	102.598	113.921	94.187	131.23
IV	Total crop area	104.879	117.812	105.575	133.956
V	Area sown more than once	2.281	-	5.000	2.726
VI	Net irrigated area	-	10.219	11.388	12.7
VII	Gross irrigated area	-	12.162	16.360	13.15

Source: GOM Published Agriculture Statistical Abstract

Fig. 4.1: Landuse differences





Forests reporting area of 1991-1992 was 1598.500 (in thousand hectares) which increased to 1626.475 in 2001-02 is largely due to regrowth or regeneration of shifting cultivation areas in all the districts. But, the reported data in forest coverage has shown a decreasing trend in the year 2006-07 (1593.700, in '000 ha) and was only 1585.305 (in '000 ha) in 2011- 12, this is mainly due to bamboo flowering being observed by Floor Space Index (FSI) officials in association with the State Forest Department. Thus, an FSI of 2.0 indicate that the total floor area of a building is two times the gross area of the plot on which it is constructed.

Production in Mizoram:

Table 4.2: Mizoram: Agricultural Production during the given four periods

Production in metric tonnes

Sl. no	Name of crops	1991-92	2001-02	2006-07	2011-12
1	Paddy				
	1) Jhum	38,523	63,568	13,658	26,644
	2) WRC Kharif	22,677	33,845	12,131	25,304
	3) WRC Rabi	9,774	8,302	3,675	947
2	Maize	12,308	16,646	20,969	8,398
3	Wheat	NIL	18	NIL	NIL
4	Pulses	6,975	3,799	5,833	5,330
5	Topiaca	1,984	1,480	NIL	1,302
6	Oil Seed	6,799	5,499	3,757	2382
7	Cotton	489	215	150	109
8	Tobacco	765	226	342	243
9	Sugarcane	5,314	9,360	12,187	7456
10	Potato	905	1,472	1,652	2869
Total		**1,06,513**	**1,44,430**	**74,354**	**80,984**

The agricultural production shows fluctuation during the given four period of time. The continuous practice of Jhum/Shifting cultivation washes away the fertility of soil which result in the decrease on agricultural production and apart from that, the onset of bamboo flowering also result in the low production especially from the year 2006. In regards of increase in production, this is due to the regeneration of the soil fertility. If we look at the table above, it is found that the production has been increasing. It was only 1,06,513 metric tonnes in 1991-92 but rose to 1,44,430 metric tonnes in 2001-02. However, the production showed declining during 2006-07 as only 74,354 metric tonnes been produced, this is mostly due to the onset of bamboo flowering but the agricultural production in 2011-12 have been showing increasing trend due to the re-growth of shifting cultivation area.

Chapter – V

Agricultural Efficiency Regions of Mizoram

Agricultural Efficiency in view of Flichman *et al*. (2011: 3-4) is a combined result of (i) technology; (ii) farming activities (labour functions); (iii) production with cost functions; and (iv) environmental externalities. They, therefore, suggest an application of Bio-Economic model. A bio-economic model according to them is a simple link between models through an exchange of information but it is a real integration in both conceptual and technical terms. It involves bio-physical simulation models applied in agricultural systems.

Prof. M. S. Swaminathan, Emeritus Chairman, M S Swaminathan Research Foundation 2013: XV) in his foreword to the book 'Agricultural Sustainability' by Bhullar and Bhullar(2013) is of opinion that agricultural efficiency must take into account not only the economic and environmental sustainability but also the social sustainability which increasingly is becoming a vexed problem, They think that with increasing emphasis on research for private profit rather than for public good, there is a likelihood of more and more social exclusion in access to technology depending on the purchasing power of the small farmer. On global platforms the malady has been recognized. It is in this light that the year 2014 has been declared by the UN as "International Year of Family Farming" to augment sustainability against propagated concept of efficiency equated with enlargement of agricultural productivity based on sophisticated hence capital intensive technology. "The aim", according to it, "is to rekindle and sustain family farming around the world". In developing countries, they also believe that farming along with a way of life is also a means to livelihood. Agriculture, in addition to more food, therefore, should be able to generate more income and more jobs, without compromising with the environmental sustainability.

Kidd and Kidd (2006) in analyzing the practice of contemporary agriculture identify two conflicting achievements – on set of Green Revolution; and 'specification of a profound environmental hazard involving the intensive use of agricultural chemicals'. Thus, they high light the global concern about agricultural efficiency.

As the term Agriculture covers activities like horticulture, irrigation, land development, soil and water conservation, animal husbandry, dairying, poultry, piggery, fishery, handloom and other village industries, social forestry and setting up of agro-based and forest-based industries (Sundaram,2002). Agricultural development depends on combined factors of the components of environment. Agriculture as considered here encompasses arable use (the growing of the widest possible range of annual crops), agro-forestry, pisciculture (fish farming), horticulture (perennial crops in general, and fruit trees in particular), and silviculture (commercial growing of trees). An assessment of agricultural land use potential should take into account the physical aspects of geographical features such as soils, climate, slope, drainage, groundwater, geomorphology, land use, soil erosion etc. whose characteristics affect the physical and economical feasibility of agricultural productions.

It is a well-known fact that agricultural development takes place at differential rates and stages, hence disparities have been observed worldwide especially in hilly regions which exhibit higher variations in regard to physical environment (Zonunsanga, *et al.* 2012). These regional differences in development are generally attributed to disparity in technological advancement and spatial variations in the physical environment. Yadav (1975) has documented that the use of land and causes of regional imbalances in levels of agricultural production lie within the framework of physical variables. In fact, agriculture is primarily determined by physical factors such as physiography, climate and soil characteristics.

Slopes determine the physical viability and economic feasibility of various agricultural practices as certain crops require flatlands and at the same time a gently sloping surfaces proved more suitable for other particular crops. Moreover, slopes exert major influence upon soil-moisture retention capacity, soil texture and permeability as well as the rate of soil erosion through their gravitational effects. Rainfall determines agricultural development to great extent for their direct control over plants growth through moisture availability; soil is among the most important determinants of agriculture in regard to the system and development of agricultural because the properties of soil such as texture, structure, permeability and more significantly the content of organic matter and texture greatly determine the potential nutrients and moisture holding capacity and availability for growth and development of agricultural crops. Land use system manifests, to a great extent, the potentials of agricultural development. The existing land cover types, density and locations affect the moisture availability and soil properties – the rate of biological decompositions which are the sources of organic carbon and nutrients for crops and plants. Similarly, other physical factors also exert certain influences upon potentials for agricultural activities and land use.

It is in this light that an attempt has been made to study the agricultural efficiency of the sampled districts and their concomitant villages to represent the state of Mizoram.

5.1 Champhai District

Champhai district is situated in the eastern side of Mizoram, between 24°5'3.28'' and 23°0'0.47'' N latitudes and 92°59'7.7'' and 93°26'18.0'' E longitudes. The total geographical is 3185.83 km^2 and accounts for 15.11 % of the total geographical area of the state. The total population according to 2011 census is 125,370 and the literacy percentage is as high as 93.51%. Champhai is the district headquarters and it has three sub-divisions viz. Champhai, Khawzawl and Ngopa. The district is bounded on the east by Myanmar, on the west by Aizawl and Serchhip districts, on the north by Manipur state and on the south by Myanmar.

PHYSICAL CHARACTERISTICS OF CHAMPHAI DISTRICT:

Physiography :

The district is characterized by undulating rocky terrain. The hill ranges run from north to south direction and are separated by a number of rivers in between. The ridges show serrated tops, which are highly divided and separated by intervening 'V' shaped valleys. The hillside slopes are usually steep to very steep occupying maximum areas and the escarpments are frequent.

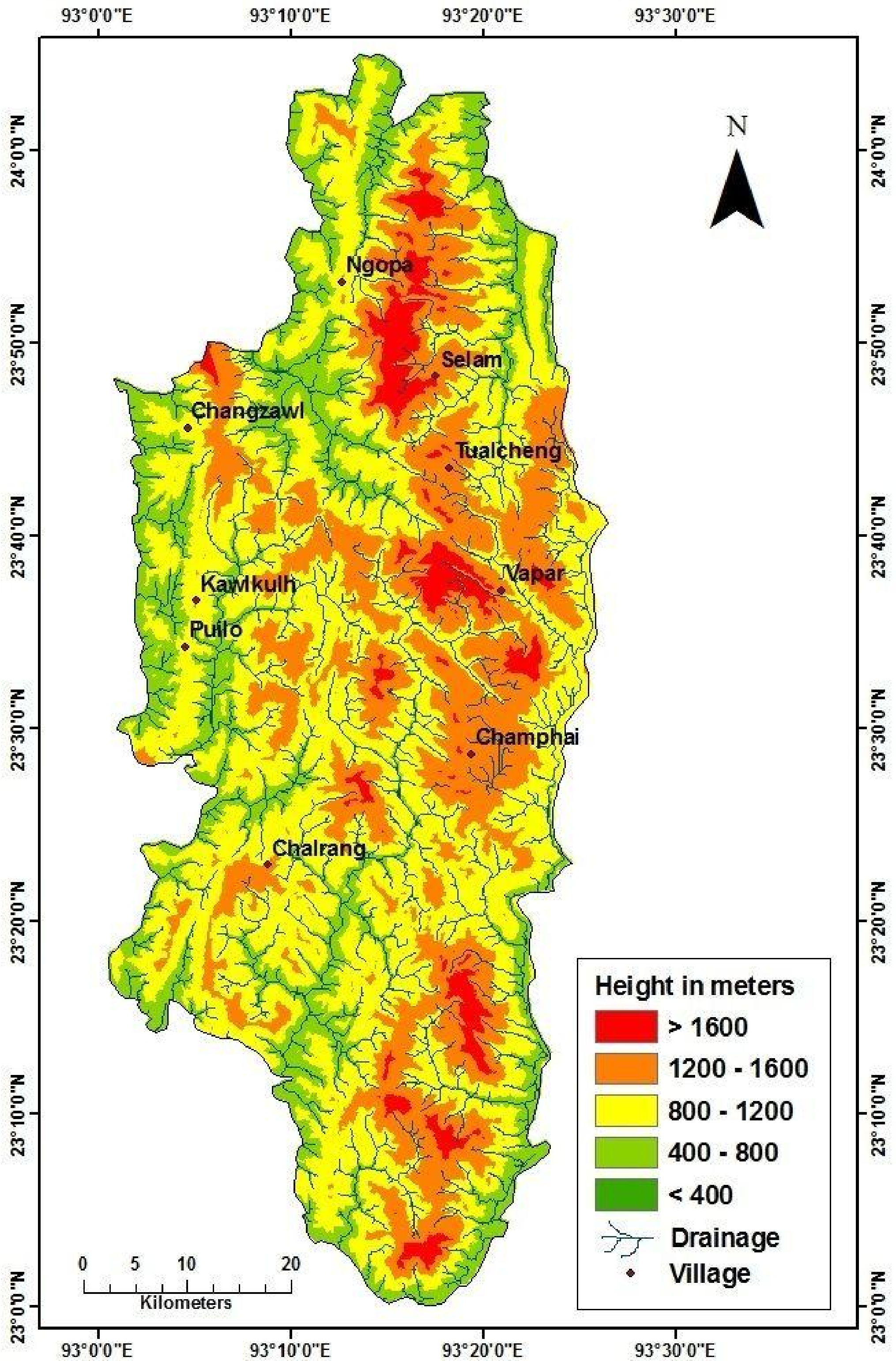
It is found that the eastern aspects are usually gentler than the western part, and also that the elevation of hills regularly increases towards the east. The highest peak in the district is Lengteng with a height of 214 meters and the biggest plain in Mizoram having 3 to 10 % slope lies adjacent to the Champhai town, the capital of the district. Geomorphologically, the district is divided into the following geomorphic groups

Table 5.1: Champhai District: Geomorphological Unit

Sl.No	**Geomorphic Unit**	**Area(in km^2)**	**%**
1	High Structured Hill	941.09	29.53
2	Medium Structured Hill	1502.02	47.15
3	Low Strucured Hill	681.65	21.40
4	Valley Fill	43.18	1.36
5	Flood Plain	17.89	0.56
Total		**3185.83**	**100.00**

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram.

FIG. 5.1 : Physical Map of Champhai District



Geology :

The district lies over middle Bhuban formation of rocks represented by sandstone, siltstone and soft shale belonging to Bhuban sub-group of Surma group of tertiary age. In several places there are evidences of facies changes. Some of the sandstone beds are massive and give dimension stones and road metal for the area and are mined in small quarries beside the main roads. The hills are approximately N-S trending, steep, mostly anticlines and the intervening valleys are generally synclinal valley. As the area occupies the eastern side of the state the hills are comparatively higher and broader as compared to the other districts on the western side of the state. The hills are of structural hills and are the most prominent units throughout the entire area. The hill ranges of Sur, Naunuarzo, Ngur and Tan are among the highest hill ranges of the state and they are at the highest of around 6000ft. The entire area is traversed by numerous lineaments in many directions. The district has been divided into the following four groups :

Table.5.2. Champhai District :Geological Features

Sl.No	Rock Types	Area(in km^2)	%
1	Sandstone	1538.50	48.29
2	Siltstone- shale	1556.63	48.86
3	Clayey sand	80.18	2.52
4	Gravel,Sand & Silt	10.52	0.33
Total		**3185.83**	**100.00**

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

Hydrography:

Water uses, its control and conservation greatly depend on the physical-climatic conditions of the regions. Hydrographical conditions in the District of

Champhai are greatly influenced by climatic variables like natural precipitation, surface drainage, and ground water.

Climate:

Champhai district enjoys a moderate climate owing to its tropical location. It is neither very hot nor too cold throughout the year. The temperature varies from $4^{o}C$ to $33^{o}C$. Among all the districts of Mizoram, Champhai district is the highest in elevation, its relief rugged in nature, enjoy a pleasant climate throughout the year. It is the district where frost is often experienced near Champhai, the capital of the district. These factors influence the evapo-transpiration, a critical factor in plant growth.

Rainfall:

Rainfall is the most important factor in Champhai district for the supply of moisture to agricultural crops. The district receives an adequate amount of rainfall during the monsoon season. Heavy rainfall starts from the second part of May and ended in the first part of October. The average annual rainfall is recorded to be about 2153mm. Precipitation is heavy during summer from south west monsoon. It makes the climate favourable for Kharif crops as well as inhabitants of the state. The temperature is considerably modified by the usual rains. Normally, July and August are the rainiest months while December and January are the driest months. The following table shows average monthly Distribution of rainfall in Champhai.

Table-5.3: Champhai District: Average Monthly Rainfall

Name of the-District	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Champhai	2009	0.0	0.0	12.2	84.3	102.6	282.2	187.5	386.1	329.5	157.2	24.2	0.0
	2010	0.0	0.0	138.1	182.8	246.7	353.8	436.9	282.9	480.0	268.3	18.3	71.3
	2011	15.9	0.0	54.9	102.2	248.9	350.6	319.9	294.1	234.3	146.3	2.9	0.8
	2012	14.3	24.3	12.0	292.2	142.0	425.5	189.5	321.7	297.9	142.2	46.2	-
	2013	-	0.5	7.3	59.4	378.3	288.1	267.4	486.5	263.2	126.5	-	-

Source: Economic & Statistic Department, Aizawl.

Drainage:

Champhai district is drained by north flowing and south flowing rivers. Among the north flowing rivers, Tuiphal, Tuisa, Tuila all of which a tributaries of Tuivai river are the notable ones. South flowing rivers are Tuichang, Tuipui and Tiau rivers. Tuivawl and Tuichang formed district boundary line Aizawl district and Serchhip district respectively. Tiau Rivers flows southwards forming an international boundary between India and Myanmar. Tuipui River and Tuiphal River flow in opposite directions dividing the entire district into two equal parts. Tuipui River provides drinking water supply as well as irrigation to agricultural lands near Champhai and forms the largest fluvial plain in the state. It is called the "Rice bowl of Mizoram".

Table 5.4 : Champhai District: Drainage System

Sl.No	Drainage System	Description
1	Tiau Drainage System	It forms an international boundary between Mizoram (India) and Myanmar for a distance of about 83 kms. Tuitho,Sihmit,Iva and Thawva lui,etc are important tributaries.
2	Tuipui Drainage System	It originates near Champhai town at a height of 1300m above sea level and flows in southward direction. Important tributaries are Tualte, Zawngtah,Arsi lui,etc.
3	Tuichang drainage System	It originates from Darngawn tlang near Khawzawl town at a height of 1449m above sea level and it flows in southward direction. Tuisen.Kharzawl,Phaisen lui,etc are important tributaries.
4	Tuivawl Drainage System	This river originates from Rullam tlang at a height of 1590m above sea level near Ruallam village and it flows in a northward direction. Its main tributaries are Tuichhiahlian lui,Tuituai lui, Siktui lui,Saichal lui,Thang lui,Puantawm lui,etc.
5	Tuivai Drainage System	It originates from Manipur state in the north east of Mizoram and it forms a state boundary line between the two states for a considerable length. First, it flows northward and takes U-turn and flows southward. Then, again take an U-turn near Daido village. Tuiphal,Rundung, Sumlung lui,etc are important tributaries.
6	Tuiphal Drainage System	Tuiphal lui originates from Zirtanzo tlang at a height of 1894m above mean sea level near Khuanglam village in the Sialkal hill ranges. It flows in north-west direction till it meets with Tuivai river. It's important tributaries are Tuimai lui, Tuiluai lui, Phalte lui and Tuithil lui.
7	Tuisa drainage System	It originates from Tlangsam tlang near Tualcheng village in the Sialkal hill ranges at a height of 1750m above mean sea level. It is a north flowing river which created quite a number of fluvial flood plains along its courses. Its main tributaries are Dimphai lui, Leiva lui, Tangkawng lui,Tuingo lui,Tuikual lui,Tuimang lui,Tuiching lui and Bak lui.

Source : Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

Ground Water:

In respect of ground water potential zone the district may be said to have better endowments when compared to other parts of the state. However, the use of ground water for agricultural purposes in the District is almost non-existent despite the fact that almost 64 % of the total area of the district has moderate to very good, good water potential. The following table gives an idea about agriculturally significant ground water potential in Champhai district.

Table-5.5: Champhai District: Distribution of Ground Water Potential

Sl.No	Potential zones	Area(in km^2)	%
1	Very good	325.71	10.22
2	Good	754.36	23.68
3	Moderate	933.53	29.30
4	Poor	1172.23	36.80
Total		**3185.83**	**100.00**

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram.

(1) **Very Good** : This zone covers valley fill, Flood plains and low lying areas which are located within immediacy of water bodies, where there will be frequent recharge. It also contains the intersection of the structural units such as lineaments and faults, with valley fill and flood plains. Lithologically, this zone cover areas where unconsolidated sediments such as gravel,silt ,sand and clayey sand are deposited. Locally, this zone covers the total valley plain of Champhai, the plain of Tuilak lui near Hnahlan village and the valley plain of major rivers,etc.

(2) **Good:** All the remaining geological structures fall under the good potential zone. It mainly covers the plains of Tlawng River, parts of Tuivai and

Tuirial synclines. Among the rock types exposed in the study area, sandstones in general are capable of storing and transmitting water through their interstices and pore spaces present among the grains and are considered to be suitable aquifer. It largely covers the major river valleys such as Tuichang, Tuivawl, Tuipui and Tiau,etc. The good zone is also found to occur in small patches within several parts of the district, mainly confined to the western part of the study area.

(3) **Moderate** : This zone mainly includes areas where the recharge condition and the water- yielding capacity of the underlying materials are neither suitable nor poor. Topographically, it covers gently sloping level surface of the hill. The moderate zone falls within the poor water bearing rock formation such as silty shale that are, in turn, characterized by the presence of secondary structures in them.

(4) **Poor**: It is mainly distributed along the ridges and high structural hills. This zone is predominantly high interms of areal extend and covers large part of the district. The poor zone is mainly confined to the eastern part of the district. It covers the elevated areas such as Tan tlang, Sur tlang, Lengteng, Sialkal, Vaikhawtlang, Mawmrang and Murlen tlang,etc.

Soil:

Soils in the river valleys of Champhai are alluvial and colluvial in origin. The soils developed on different slope categories consist of Entisols, Inceptisols and Ultisols order of soil classification. On the basis of rainfall and humidity, the soil moisture regime in the district is classified as UDIC. The crucial elements of soils have been percolated down due to heavy rainfall and become acidic in nature, the soil pH ranges from 4 to 6.5. Usually, the hill slopes are covered by soil of medium texture and when it reaches the lower slope of the valley, the texture of the soil turn out to be progressively heavier. The element of the soil is loamy skeletal on hill top and very steep slopes.

Natural Vegetation:

The primary forest in this district is mainly dominated by tropical evergreen forest. The primary tropical evergreen forests are dominated by Mesua ferrae, Protium serratum, Terminalia belerica, Adina cordifolia, Podocarpus nerifolia, Artocarpus fraxifolios, Duabanga sonneratiodes, Schima wallichii, Toona ciliata, Albizza procera,etc. There are also semi- evergreen forest and Montane sub-tropical forest consisting evergreen species like Quercus sps, Rododendron sps,Schima wallichii and decidous species like Pyrus pashia. It has been found that Pinus kesiya had been growing naturlly in Ngur, Hnahlan and Farkawn. Unlike other districts, the secondary forest and old abandoned jhum has been dominated by evergreen, semi- evergreen and decidous tree species instead of bamboos because of its position at a higher altitude. There are forest plantations in small patches that are Gmelina arborea, Gmelina oblongifolia and Pinus kesiya plantations. Forests especially the community forests owned by the village councils, by and large, supplements agricultural activities in the district.

Landuse/ Land Cover:

Landuse is the pattern of land used by human being where as land cover is the natural covering of the area where human being does not have any intrusion. The following table gives the Landuse statistics in Champhai district:

Table 5.6: Champhai District: Landuse/Land Cover

Landuse/Land cover	Area (in km^2)	%
Built-Up land	17.19	0.54
Agriculture land	37.75	1.18
Shifting Cultivation	725.92	22.78
Forest	2364.66	74.23
Scrub land	31.65	0.99
Water body	8.85	0.28
Total Geographical Area	**3185.83**	**100**

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram.

(1) **Built-Up Land**: Built-up land accounts for about 0.54 % of the total area of the District occupied mostly by its 98 villages and five towns and roads connecting them.

(2) **Agriculture and Shifting Cultivation:** They together occupy 23.96 % of the total area they also include the current fallow, culturable waste, and miscellaneous tree crops. Due to widespread practice of Jhum cultivation and estimation by tin measurement by the local residents some time it is difficult to assess the net sown area in the district.

(3) **Forest:** A large part of the district accounting for more than 74 % of the total area may be categorized as forests. They generally include natural forests, which are not disturbed by any biotic factors like shifting cultivation and other human activities.. Sub-tropical forest, evergreen and semi- evergreen forests covers major portion of the area. They may be classified as dense and open forests depending on their distances from the settlements.

(4) **Scrub Land:** Scrub lands are found in areas which are generally prone to deterioration due to erosion. Generally, they occupy features of high locations, excluding hilly/ mountainous terrain possessing sparsely vegetated thin soil cover. They account for less than 1 % of the total area and are not much significant to the agricultural economy of the district as their use for animal husbandry is almost non-existent.

(5) **Water Body:** It comprises areas with surface water, either impounded in the form of ponds, lakes or flowing as streams and rivers, etc. In the hilly terrain of the district accounting for a meager 0.28 % of the total area such water bodies are limited along the river channels.

POPULATION CHARACTERISTICS OF CHAMPHAI DISTRICT:

Population Growth:

In 2001 Census, the total population of the district was 108,392 and it increased to 125,370 in 2011 Census .Decadal Growth of population in 2001 – 2011 is 16.31 %. As much as 48,217 people live in the urban areas while 77,153 persons live in rural area in the district. Among the inhabitants of urban area, 24,109 are males and 24,108 are females. In the rural area, the district has 39,190 male populations and 37,963 female populations.

Population Distribution:

As the area is hilly, the landscape is not so much appropriate for comfortable and heavy concentration of population in one locality and also because the habitual system of occupation continues to be the basis for a large section of the society, the District has as many as 92 inhabited villages. The distribution of population between rural and urban areas is 61.5 % and 38.4 % respectively. More than half of the populations are living in rural areas mostly depending on agricultural activities.

Population Density:

The district ranks second of the highest populated district in Mizoram. According to 2011 census, the district accounted 125,370 persons which have a density of 39 persons per km^2. The population density is reasonably low due to its remote and isolated location with a characteristic of mountainous landscapes, low economic level, political instability, etc.

Population Composition:

Out of 125,370 persons in the district, the male population accounts for 63,299 which is 50.48 % where as the female population is 62,071, accounting 49.51 %.

Age and Sex Composition:

In studying the population characteristics of any area, age and sex composition examination has played a very important economically and socially. Sex ratio of the district is 981 which is higher than the state average (State average is 975).

Literacy:

Literacy level among the people is an important indicator of the quality of population of a country or state or district. Champhai district has a literacy percentage of 93.51 % which is higher than the state average and stood in 4th rank in the state. Literacy percentage of male population is 94.80 % where as percentage of female literacy is 92.20 %.

INFRASTRUCTURE OF CHAMPHAI DISTRICT:

Road:

The district has a good road network and the whole length of the district is pass through by good road networks. From Champhai town state highway runs towards the south east up to Tiau river passing through a no villages including Zokhawthar which serves for Myanmar border trade. There are a number of Agriculture/ Horticulture link roads in the district which provide transportation of the products from interior part of the district. The district capital, Champhai town is 194 kms away from the state capital, Aizawl.

Health:

For getting a good production, the workers should first be healthy enough to work and health plays an important role not only in agricultural but also in other way of activity. The no. of births recorded in the district for the year 2010 is 3147 persons (out of 25,755 births in the state) where as the deaths recorded is 703(out of 5367 deaths recorded in the state)(Statistical Abstract,2012)

Power Supply:

Out of 92 villages in the district, 85 villages have been electrified as on 1st April, 2012. Village electrification is important for storing and protecting the surplus product from agriculture and any other farm outputs.

AGRICULTURAL EFFICIENCY IN CHAMPHAI DISTRICT:

Efficiency based on Slope:

Based on the basis of sample studies of three R.D. Blocks and equally distributed nine villages of the district an attempt has been made to correlate the agricultural efficiency with slope category, by applying the Regression Method using Statistical Package for Social Sciences (SPSS) software, 74.6 % of the efficiency can be explained in order to get the relationship which match the slope of the study area. This would be considered a good fit to the data, in the sense that it would substantially improve the slope to predict the performance of the agricultural efficiency. One has the "sig" value of $p<0.003$ signifying that over all the regression model significantly predicts the outcome variable and in this light one can presume that slope plays a responsible role in agricultural efficiency. It suggests here that there is a strong relationship between slope and efficiency. The calculation shows that a high degree of correlation exists between slope and efficiency. Here,(0.306-0.008=0.298) 0.298 is the expected value of the agricultural efficiency when the values of slope equal zero. It bear out that slope and efficiency has a highly correlation with 99 % significance level.

From the above clarification, it is apparent that slope determines agricultural efficiency. If the slope degree decreases the production increases and the above explanation offer us evidence that slope impact on agricultural efficiency. The village which lies in the lower slope degree has a higher production than those lies in the higher degree of slope. We can say that the agricultural efficiency of the land depends on slope category. Table No 5.7 symbolized how slope control efficiency of the study area which later on be show in Fig 5.3 to make the picture more noticeably.

Table: 5.7 .

Champhai District: Distribution of Agricultural Land on different Slope Categories and Agricultural Efficiency of the villages

Slope in ^{0}	Tualcheng	Vapar	Selam	Puilo	Kawlkulh	Chalrang	Ngopa	Changzawl	Champhai
0-10	22	14	7	4	5	5	6	-	19
10-20	3	9	10	11	14	12	17	21	5
20-30	-	2	6	7	6	8	2	4	1
30-40	-	-	2	3	-	-	-	-	-
>40	-	-	-	-	-	-	-	-	-
Efficiency	0.22	0.25	0.21	0.16	0.21	0.19	0.18	0.16	0.27

Based on field study (2010)

It emerged from the above table that the settlements having larger proportion of agricultural lands on slopes lower than 20^0 have relatively larger efficiency than the cultivated lands above 20^0 .

Fig. 5.2: Percentile Distribution of Slopes in Champhai

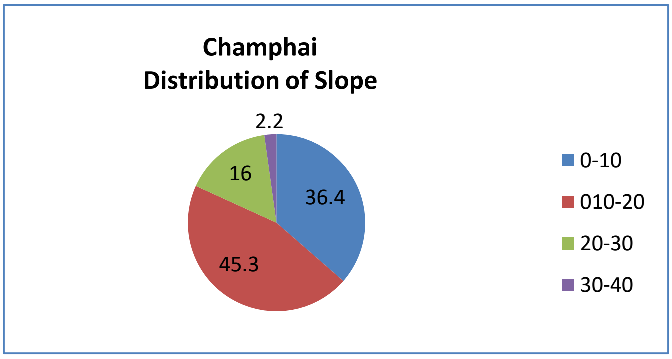
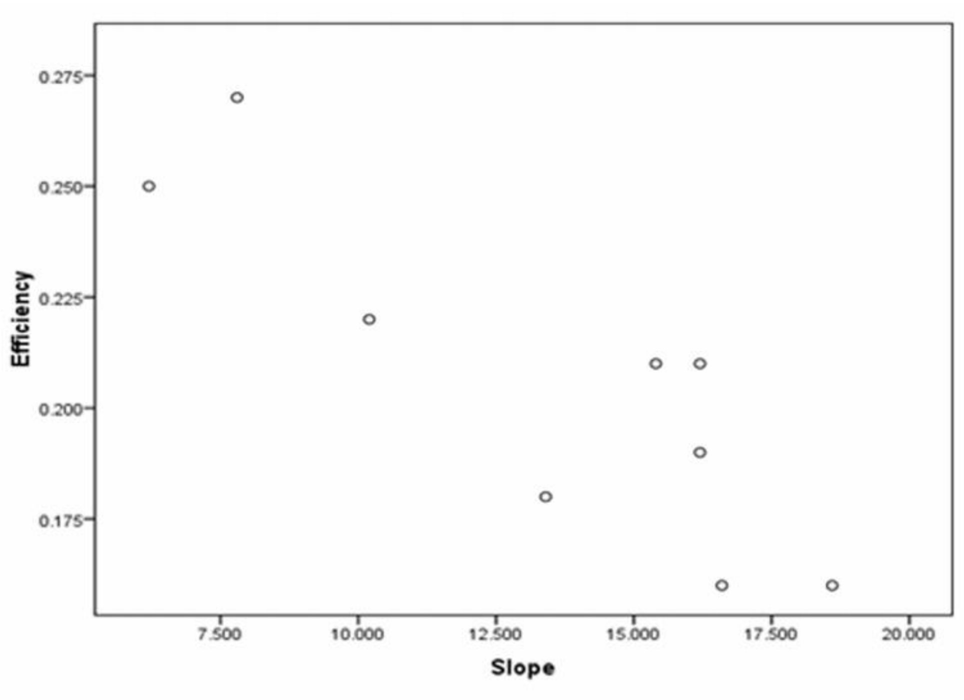


FIG.5.3: Relationship of Efficiency with Slope categories



However, there appears to be spatial productivity variations correlated with slope when it is analyzed. The following table illustrates the productivity variations in relation to the slope categories in sampled villages.

Table:5.8 : Champhai District: Agricultural Efficiency villages based on Slope

Agricultural Efficiency	Villages
High	Vapar, Champhai
Medium	Tualcheng, Selam,Kawlkulh
Low	Puilo, Changzawl, Ngopa, Chalrang

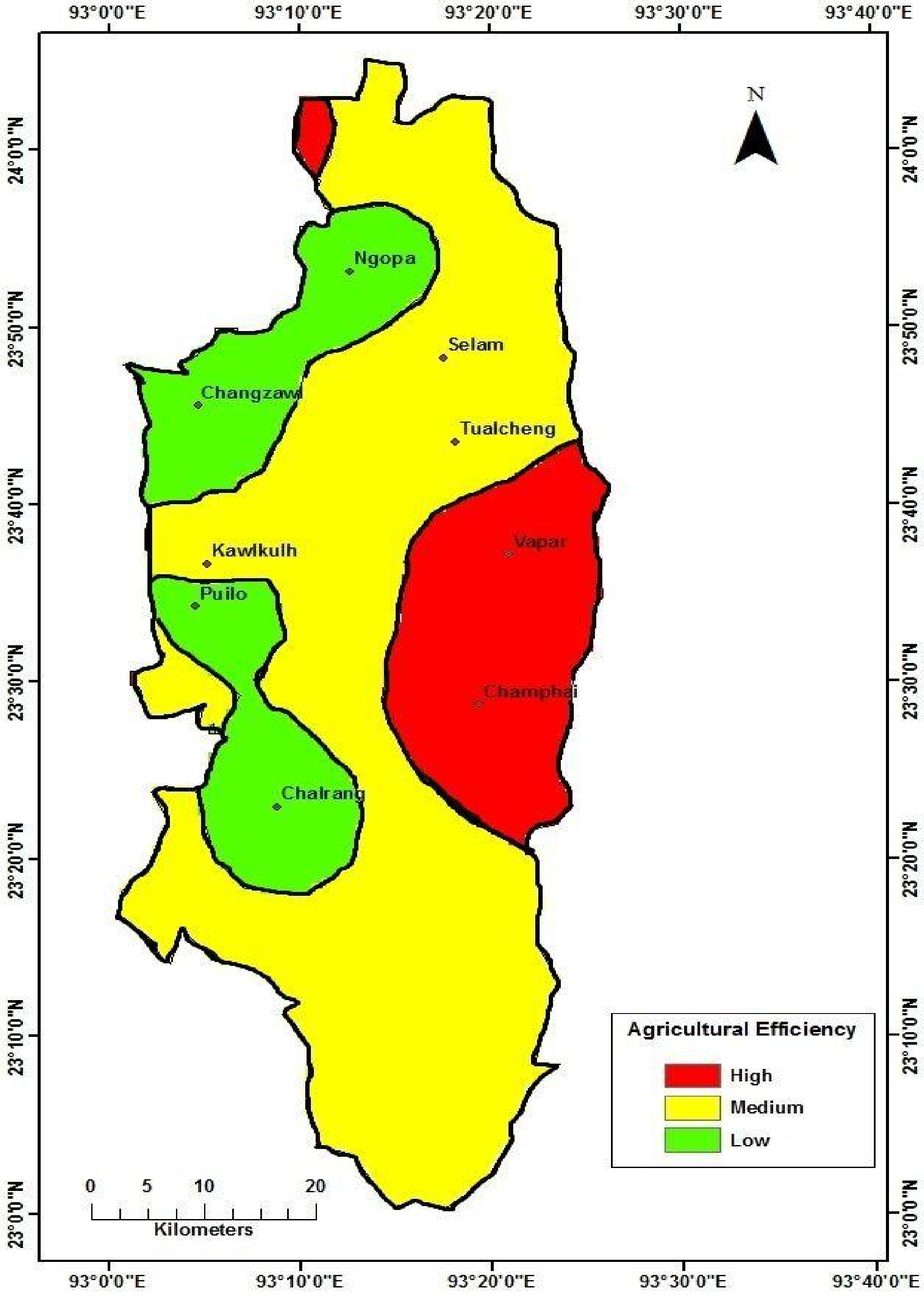
The farming activities in the District of Champhai are found to be reflecting a pattern which is generally similar to the pattern in whole of the state. Located in the eastern part of Mizoram most of the farming activities in the District are carried out on slopes below 30^0 (Table 5.7). As such relatively higher productivity in comparison to other parts of the state is obtained in the district.

The area hold by the three category of efficiency in the district

Table:5.9 : Champhai District : Area hold by Efficiency

Categories	%	Area in sq.km
High	19.53	622.52
Medium	63.15	2011.61
Low	17.30	551.13
TOTAL	**100**	**3185.26**

FIG.5.4: Agricultural Efficiency based on Slope



Efficiency based on input/output ratio.

The computation of input output ratio of an agricultural field is regarded as an helpful tool to show how the parts of a system are affected by a change in one part of that system. The following table provides us the input output ratio of Champhai district.

Table 5.10: Champhai District: Input and Output Ratio with Efficiency

Villages	Input	Output	Ratio	Efficiency
Tualcheng	201250	782840	0.25	0.22
Vapar	179530	809600	0.22	0.25
Selam	213500	911560	0.23	0.21
Puilo	291750	839200	0.34	0.16
Kawlkulh	257800	1041400	0.24	0.21
Chalrang	327250	1010080	0.32	0.19
Ngopa	309780	1068240	0.28	0.18
Changzawl	465250	1262120	0.36	0.16
Champhai	213250	999440	0.21	0.27

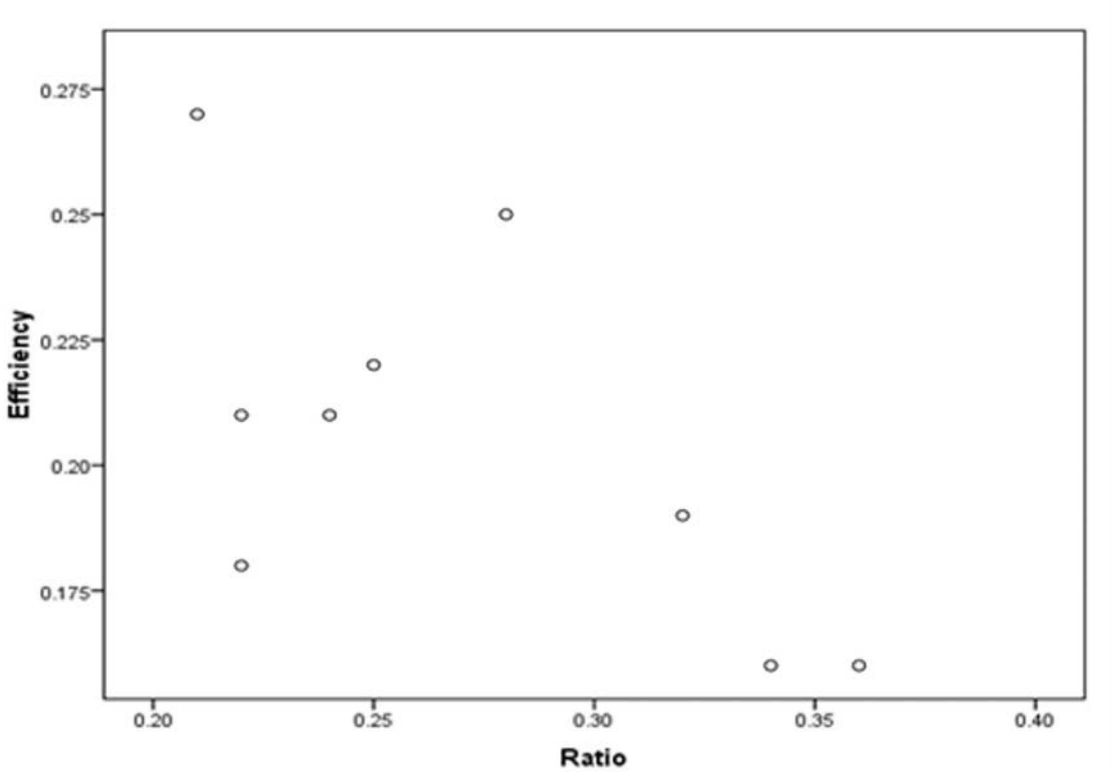
The input output ratio of agricultural field in selected villages of Champhai District, the minimum ratio is found in Champhai where as the maximum ratio was calculated to be 1:0.36 which is in Changzawl village. The agricultural field is said to be efficient when it yields a greater output per unit of input used.

An attempt has been made to correlate the agricultural efficiency with input/output ratio, the data has been processed by using SPSS software of Regression method, 40.5 % of the efficiency can be explained which is less to prove the relationship between input and agricultural efficiency of the study area.

We have the “sig” value of <0.065 indicating that which is not statistically significant and we can presume that the two variables do not have any relation.

From the above statement it is confirm that those villages having high input do not have a high efficiency. High inputs definitely give the high production but that cannot be count as a high efficiency. The villages which are grouped in high category of efficiency have lower inputs where as the villages grouped into a low category has high inputs but still having a low efficiency. When we go through to the above equation, we come up to the results that input does not have any impact on efficiency. It is not statistically significant when we acquired the result.

FIG.5.5 : Relationship of Input / Output Ratio with Efficiency



Scatter Plot of Fig 5.5 provides us that there is no relationship between efficiency and input/ output ratio which existed in the district of Champhai. Here, we came to identify that input do not have any impact on efficiency.

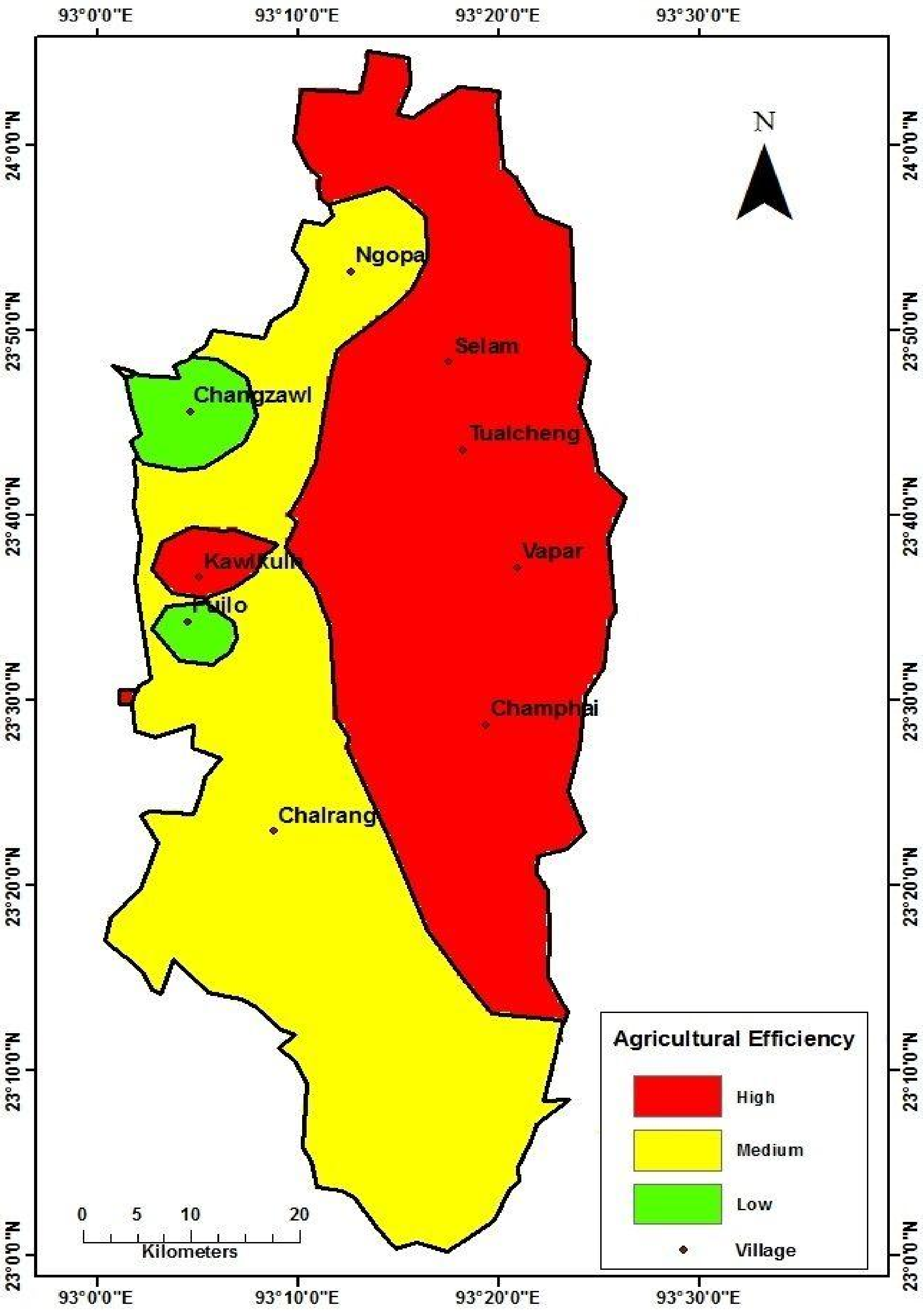
Table:5.11 : Champhai District: Agricultural Efficiency villages based on Input/Output Ratio

Agricultural Efficiency	Villages
High	Sela,Tualcheng,Vapar, champhai,Kawlkulh
Medium	Ngopa, Chalrang
Low	Puilo, Changzawl

Table. No 5.12 : Area hold by efficiency based on Input

Categories	%	Area in sq.km
High	50.70	1615.09
Medium	45.61	1452.87
Low	3.67	117.02

Fig 5.6: Agricultural Efficiency (based on Input/Output Ratio)



5.2 Aizawl District

Aizawl district is situated in the northern central part of Mizoram, between $24^{o}25'48.8''$ and $23^{o}18'27.5''$ N latitudes and $92^{o}37'31.8''$ and $93^{o}11'38.4''$ E longitudes. The total geographical area of Aizawl district is 3576.31.km^2 and accounts for 16.99 % of the total geographical area of the state. The total population of the district according to 2011 Census is 404,054 and the literacy percentage is as high as 98.50 % (2011 Census) . Aizawl is the state capital of Mizoram as well as the district headquarters. Aizawl district is bounded on the east by Champhai district and Manipur state, on the west by Mamit district and Kolasib district, on the north by Assam state and on the south by Serchhip district.

Physiography :

The district is characterized by hilly rugged terrain. The hill ranges run from north to south direction are separated by a number of rivers in between. The ridges show serrated tops, which are highly dissected and separated by intervening 'V' shaped valleys. The hillside slopes are generally steep to very steep occupying maximum areas and the escarpments are common. It is found that the eastern aspects are generally gentler than the western aspects, and also that the altitude of hills gradually increases towards the east. (Physical Map Figure 5.7). The geomorphology of the district is characterized mostly by mountain ranges, ridges running in N – S direction in parallel series. The mountain and ridges are separated from one another by narrow and deep river valleys. The flood plain constitutes the lowest coverage of 1.73 km^2 (0.05 %) of the total area which is found along the major rivers. The unavailability of plain area has created a problem for cultivation and only a small patch of land along the river is utilized for the cultivation of rice. Hills of the eastern part are larger in areal extends as well as steeper than the western and central part of the district.

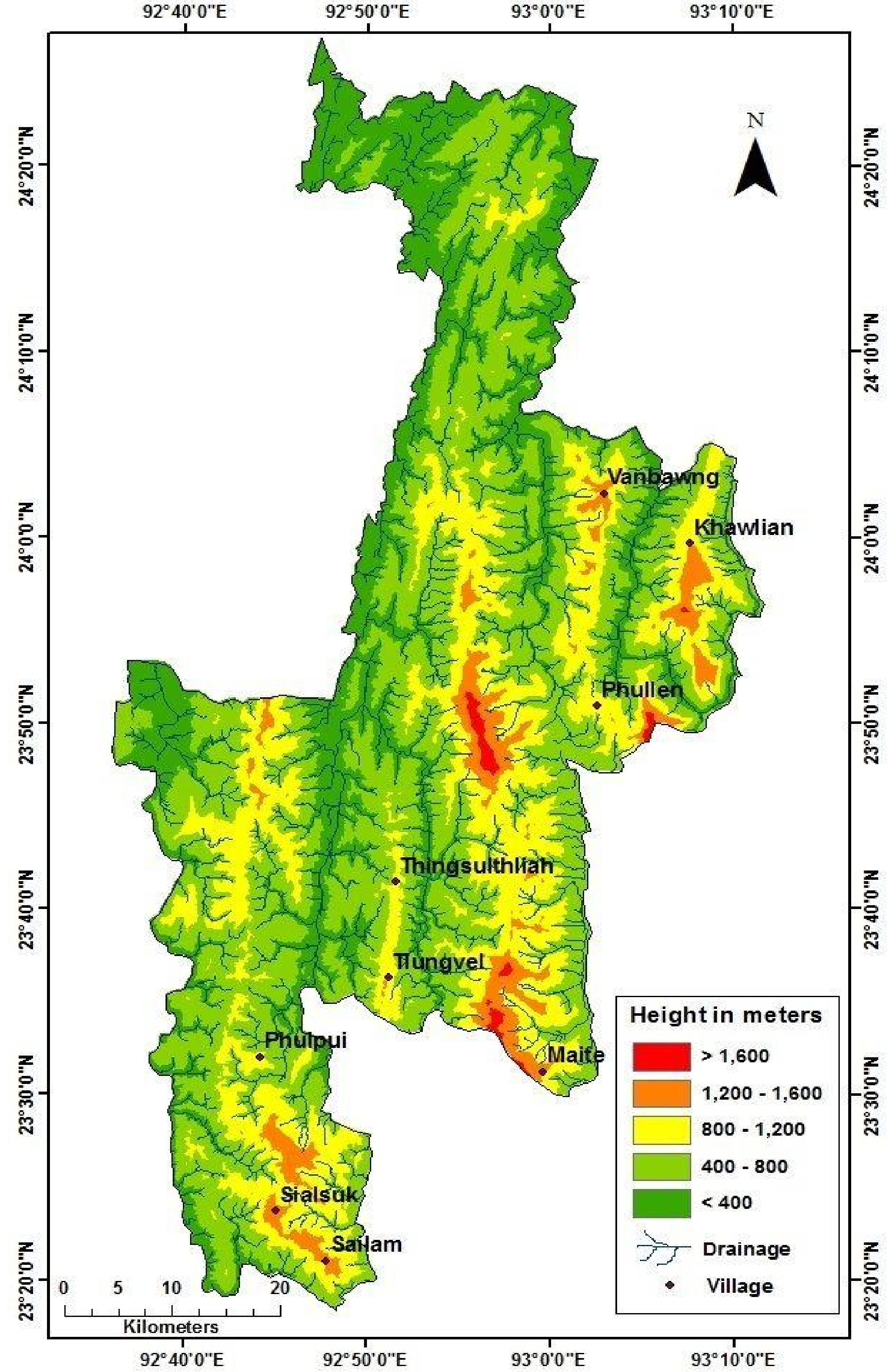
The district is divided into five major geomorphic units as under:

Table 5.13: Aizawl District: Geomorphological Unit

Sl.No	**Geomorphic Unit**	**Area(in km^2)**	**%**
1	High Structured Hill	180.21	5.04
2	Medium Structured Hill	830.37	23.22
3	Low Structured Hill	2530.93	70.77
4	Valley Fill	33.07	0.92
5	Flood Plain	1.73	0.05
Total		**3576.31**	**100.00**

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

FIG.5.7: Aizawl District Physical Map



Geology:

Two main ranges represent the district which runs almost N-S direction, one comprises of Aizawl range and the other runs from Khumtung to Darlawn. The hills are all structural hills and there is an intervening valley in the middle along Tuirial River. The North eastern area of the district is represented at places by round topped partially eroded hills and interspread with valley fills. This area is at a much lower altitude and represented by folded and faulted, weathered sandstone, shale and in some places conglomerate belonging to the tertiary , while older and younger alluvial overlie these rocks. The geological Survey of India divided the study area into two geological formations as Middle Bhuban and Upper Bhuban formations. This formation is folded into almost N – S trending anti-clines and synclines and is affected by longitudinal, oblique and transverse faults of varying magnitudes. The study area is divided into five groups as follows:

Table.5.14: Aizawl District: Geological Features

Sl.No	Rock Types	Area(in km^2)	%
1	Sandstone	1686.98	47.17
2	Siltstone-Shale	1856.97	51.92
3	Limestone	1.47	0.04
4	Clayey Sand	25.52	0.71
5	Gravel, Sand & Silt	5.36	0.15
Total		**3576.31**	**100.00**

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

Hydrography:

Natural channels for surface flowage- the streams have been a natural source of water for human consumption, agricultural use and transportation. Running water uses, control and conservation greatly depend on the physical-climatic conditions of the regions they traverse.

Climate:

The district has a pleasant climate owing to its tropical location, vegetation and its relief rugged in nature. Due to the showers of monsoon, the district is generally cool even in summer and the winter is also not very cold. The cold seasons starts from the beginning of December to the first half of February. In winter the temperature varies from 8 ^{o}C to 24 ^{o}C and in the summer it is between 18^{o}C to 32 ^{o}C. The area experienced heavy rainfall from May to September that has a direct impact on vegetation.

Rainfall:

As mentioned earlier, the entire state of Mizoram is under the influence of S – W Monsoon, Aizawl district also receives adequate amount of rainfall during monsoon season mainly from S – W monsoon. Normally, heavy rainfall starts from the second / third week of May and it ends in the early part of October. Average rainfall of Aizawl district from the year 2009 – 2013 is 2116 mm per annum, June, July and August are the rainiest months while December, January and February are the driest months.

Table5.15: Aizawl District: Average Monthly Rainfall

Name of the-District	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Aizawl	2009	0.0	1.3	26.7	152.4	169.6	219.5	279.0	426.2	223.5	168.5	9.5	0.0
	2010	0.0	6.5	134.0	247.8	286.8	409.6	280.0	500.4	388.7	151.3	7.9	39.0
	2011	13.9	0.5	80.9	109.7	294.3	297.3	257.1	335.4	293.5	86.5	0.0	0.8
	2012	15.8	25.2	42.0	345.3	242.2	437.7	255.2	473.7	407.5	135.2	86.7	-
	2013	-	2.75	8.9	84.2	423.5	225	271.7	444.5	379.5	375.7	-	-

Source: Economic & Statistic Department, Aizawl.

Drainage:

Aizawl district is drained by four major rivers, all of them are north flowing viz Tlawng, Tuirial, Tuirini, Tuivawl and Tuivai rivers. Western parts of the district are drained by Tlawng River, which is also the longest river in the state. It forms the district boundary line with Mamit district in the west.

Table.5.16: Aizawl District: Drainage System

Sl.No	Drainage System	Description
1	Tlawng Drainage System	Tlawng river is one of the most important and the longest river in Mizoram. It originates from Zopui tlang near near Lunglei town and its flows in northward direction. Important tributaries are Tut River, Lau lui,Changte lui,Serlui A,Khuang lui, Selin lui, Thingva lui, Arbawh lui, Hmawngva lui, Chite lui, Kaikuang lui, Khawiva lui, saiphai lui, Dialdawk lui, Reiek lui, Tuisen lui and Tuichhun lui,etc. The drainage system as a whole is elongated in north to south direction showing angulated;dendritic to sub-dendritic drainage patterns and even sub-parallel drainage system.
2	Tuirial Drainage System	The river originates from north Chawilung hill and flows in northward direction. Important tributaries are Tuirivung,Tuinghaleng,Chite lui, Tuirini, , Chengkawl lui,Lungdai lui and Hachhek lui,etc. The drainage patterns found in this system are Dendritic to sub-dendritic patterns.
3	Tuivawl Drainage System	This river originates from Rullam tlang at a height of 1590m above sea level near Ruallam village and it flows in a northward direction. Its main tributaries are Tuichhiahlian lui,Tuituai lui, Siktui lui,Saichal lui,Thang lui,Puantawm lui,etc. Dendritic to sub-dendritic drainage patterns are found in this system.
4	Tuivai Drainage System	It originates from Manipur state in the north east of Mizoram and it forms a state boundary line between the two states for a considerable length. First, it flows northward and take U-turn and flows southward. Then, again take an U-turn near Daido village and flows in northward direction. Tuiphal,Rundung,Sumlung lui,etc are important tributaries. These tributaries highlighted dendritic to sub- dendritic patterns.

Source : Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

Groundwater Potential:

In regards to the ground water potential zone, the district may be said to have worse endowments when compared to other parts of the state. The use of ground water for agricultural purposes in the district is almost non-existent. The district has almost 48 % of the total area of moderate to very good water potential where poor zone has cover more than 52 % of the total geographical area.

Table.5.17: Aizawl District: Distribution of Ground Water Potential

Sl.No	Potential zones	Area(in sq km)	%
1	Very good	109.14	3.05
2	Good	593.55	16.60
3	Moderate	1005.20	28.11
4	Poor	1868.42	52.24
Total		**3576.31**	**100.00**

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

(1) **Very Good** : This zone covers valley fill, Flood plains and low lying areas which are located within proximity of water bodies, where there will be continual recharge. It also includes the intersection of the structural units such as lineaments and faults, with valley fill and flood plains. Lithologically, this zone comprises areas where unconsolidated sand are deposited. Locally, this zone covers the flood plains of Tlawng, Tuirial and Barak rivers. Settlement areas such as Sairang, Zohmun, etc are included within this. This zone also covers the plains of Tuirini, Tuivawl and Tuivai rivers. It also covers the plains of minor rivers such as Changte Lui, Lau lui, Zilngai Lui and Tuimang lui.

(2) **Good:** All the remaining geological structures fall under the good potential zone. It mainly covers the plains of Tlawng River, parts of

Tuivai and Tuirial synclines. Among the rock types exposed in the study area, sandstones are generally capable of storing and transmitting water through their interstices and pore spaces present in between the grains and are considered to be suitable aquifer. It mainly covers the plains of Tlawng River, parts of Tuivai and Tuirial synclines.

(3) **Moderate**: Topographically, it covers kindly sloping flat surface of the hill. The moderate zone falls inside the poor water bearing rock formation such as silty shale that are, in turn, characterized by the presence of secondary structure in them.

(4) **Poor**: The poor zone is mainly distributed in the elevated areas. It is mainly distributed along the ridges and high structural hills. This zone is predominantly high in terms of areal extend and covers large part of the district.

Soil:

Soil is the product of interaction between parent materials, climate and biotic factors as modified by terrain conditions and the duration over which the interaction has been going on. Any variation in the intensity of any of these influencing factors results into different kinds of soil. Generally, sandstone, shale and the derived soils are mostly red and yellow loamy are found. Soils in the valley are alluvial and colluvial origin. The soils developed on different landforms consist of Entisols, Inceptisols and Ultisols order of soil classification. On the basis of rainfall and humidity, the soil moisture regime is classified as UDIC. The soils contains high amount of organic carbon and are therefore high in Nitrogen, low in Phosphorous and Potash content. As a result, most of the soils in the hill sides are suited for agro-forestry and the narrow valleys are suited for agriculture development.

Natural Vegetation:

The primary forest found in Aizawl district is mainly dominated by wet evergreen forest. Semi- evergreen forests consisting of evergreen species associated with deciduous species are also found here and there. The primary and secondary forest within this district consist of the following main species – Dipterocarpus turbinatus, Dipterocarpus retusus, Schima Wallichii, Artocarpus chaplasa, Amoor wallichii, Magnifera indica, Terminalia myriocarp, Michelia champaca, albizzia procera, Dubanga grandifolia, Aporusa octandra, Derris robusta, Erythrin arborescens, Rhus spp, Albizzia chinensis, Bauhinia variegata, sygygium cumini, Adina cordifolia, Lagerstroemia parviflora, Parkia timorian ficus sps, Bombax insigne, Toona ciliata, Callicarpa arborea, Cordia sps, Macaranga denticulate, Gmelina sps,etc. The secondary forest or old abandoned jhum in the lower altitude are mostly dominated by moist decidous bamboo forest in which the bamboo species are Melacona bambusoides, Bambusa tulda, Dendrocalamus hamiltonii,etc.

Landuse/ Land Cover:

Land use is the human use of land. Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi- natural habitats such as arable fields, pasture and managed woods. The term land use not only implies the use of land for cultivation, pastoralism, forestry, etc but it also includes the various related aspects and factors which direct and regulate the process of rich utilization in a region. The existing pattern of land used in a region is an outcome of the interplay of man's activities under a set of physical and cultural circumstances (Tiwari; 1988: 91). The study area has been divided into six major categories. Out of the total geographical area of 3576.31 km^2, forest has the largest coverage of 80.27 %, shifting cultivation has the coverage of 16.6 %, built-up land has 1.36 %, Scrub land (0.99 %), water body (0.04 %) and agriculture land consisting of plantation and kharif land is negligible (0.38 %). The landuse / land cover of the district has been classified as follows:

(1) Built-Up Land:

Built-up land is an area of human habitation, developed due to non-agricultural use and that has a cover of buildings, transport and communications, utilities in association with water, vegetation and vacant lands. Aizawl District includes one city i.e Aizawl city, three notified towns namely Sairang, Darlawn and Saitual and 98 villages. 1.36 % 48.28 km^2.

(2) Agriculture Land or Shifting Cultivation:

These are lands primarily used for farming and for production of food, fibred and other commercial horticultural crops. It includes land under crops (irrigated and un-irrigated, plantations, etc) covering 16.92 % of the total area (607.57 km^2)

(3) Forest:

This includes natural forests, which are not disturbed by any biotic factors like shifting cultivation and other human activities. The crown density of this class is very thick. Sub-tropical forest, evergreen and semi- evergreen forests covers major portion of the area which is 80.27 % (2870.79 km^2)

(4) Scrub land:

These lands are generally prone to deterioration due to erosion. They generally occupy topographically high locations, excluding hilly/ mountainous terrain. They possess sparse vegetation with thin soil cover and this land accounts for 0.99 % of the total area (35.38 km^2)

(5) Water body: This category comprises areas with surface water, either impounded in the form of ponds, lakes or flowing as streams and rivers, etc and accounting for 0.40 % of the total area (14.29 km^2).

Table.5.18: Aizawl District: Landuse/Land Cover

Landuse/Land cover	Area (in km^2)	%
Built-Up land	48.28	1.36
Agriculture land	14.16	0.32
Shifting Cultivation	593.41	16.6
Forest	2870.79	80.27
Scrub land	35.38	0.99
Water body	14.29	0.40
Total Geographical Area	**3576.31**	**100**

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram.

POPULATION CHARACTERISTISTICS OF AIZAWL DISTRICT:

Population Growth:

In 2011 Census, the district has a population of 404,054 persons which contained 201,072 male populations and 202,982 female populations. Aizawl district is the only district in Mizoram where female populations out number male populations. Decadal Growth of Population is 24.07 %. As much as 312,837 persons live in the urban area while 91,217 persons live in rural area. Among the inhabitants of urban area 154,244 are males and 158,593 are females. In the rural area, the district has 46,828 male populations and 44,389 female populations.

Population Distribution:

Knowing that the district is bounded by hilly terrain, the landscape is not so much suitable for contented and weighty concentration of population in one locality and also because the consistent system of occupation continues to be the basis for a large section of the society. The distribution of population between rural and urban areas is 22.57 % and 77.42 % respectively. More than 75 % of the populations are living in urban areas which indicate that the district is highly urbanized.

Population Density:

The district is the highest populated district in Mizoram. According to 2011 census, the district accounted 404,054 persons which has a density of 113 persons per Km^2. The population density is reasonably high due to its urbanized centre and the state capital existence in the district which offers a profession and attracted a number of populations from outside the district hoping to have a high standard of living.

Population Composition:

Out of 404054 persons in the district, the male population accounts for 201,072 which is 49.76 % where as the female population is 202,982, accounting 50.23 %.

Age and Sex Composition:

In studying the population characteristics of any area, age and sex composition examination has played a very important economically and socially. Sex ratio of the district is 1009 which is higher than the state average.

Literacy:

Literacy level among the people is an important indicator of the quality of population of a country or state or district. Aizawl district has a literacy percentage of 98.50 % which is higher than the state average and stood in 2^{th} rank in the state. Literacy percentage of male population is 99.01 % where as percentage of female literacy is 98.00 %.

INFRASTRUCTURE OF AIZAWL DISTRICT:

Road:

The district has a good road network and the whole length of the district is passing through by good road networks. The availability of good road network which pave the way for easy transportation with the neighbouring states and exchange of goods. There are a number of Agriculture/ Horticulture link roads in the district which provide transportation of the products from interior part of the district.

Health:

For getting a good production, the workers should first be healthy enough to work and health plays an important role not only in agricultural but also in other way of activity. The no. of births recorded in the district for the year 2010 is 8603 persons (out of 25,755 births in the state) where as the deaths recorded is 2107(out of 5367 deaths recorded in the state).

Power Supply:

104 villages has been electrified as on 1st April, 2012. Village electrification is important for storing and protecting the surplus product from agriculture and any other farm outputs. Accessibility of power supply is high-quality that may be because of being located in the state capital district.

AGRICULTURAL EFFICIENCY IN AIZAWL DISTRICT:

Efficiency based on Slope:

Based on the basis of sample studies of three R.D. Blocks and equally distributed nine villages of the district an attempt has been made to correlate the efficiency level of agricultural with slope categories the following equation has been done to proved slope as one of the determining factor on efficiency.

Computing the data on Statistical Package for Social Sciences (SPSS), we found 76.3 % of the efficiency can be explained which is adequate to show the relationship of the two variables in getting the concrete condition of the study area. The percentage hold for the explanations of the two variable relations is strong enough to proved slope as the determining factor on the efficiency.

The value of $p<0.002$ representing that over all the regression model statistically significantly predicts the product variable and in this light we can presume that slope has play a responsible role in efficiency. The above table suggests that there is a relationship between slope and efficiency.

It can be explained that a high degree of correlation existed between slope and efficiency. The value (0.293-0.010=0.283) 0.283 is the expected value of the efficiency when the values of slope equal zero. It is proved that slope and efficiency has a infinite relation with 99 % significance level.

By looking the above equation, we noticed that slope impact on efficiency in the study area. When the slope degree reduce at same time the agricultural production raise and this proved the slope has an impact on efficiency. The village found in the lower slope degree has produced higher production and the efficiency of the agricultural product depends on which slope category it exist. **Table No.5.17** represents how slope influence efficiency of the study area which will later be show in a Scatter plot Fig 5.8 to make the picture more clearly.

Table: 5.19.

Aizawl District : Distribution of Agricultural Land on different Slope Categories and Agricultural Efficiency of the villages

Slope in ^{0}	**Sailam**	**Vanbawng**	**Tlungvel**	**Phulpui**	**Phullen**	**Thingsulthliah**	**Sialsuk**	**Maite**	**Khawlian**
0-10	5	7	3	-	8	15	9	12	16
10-20	17	17	22	15	14	8	10	13	8
20-30	3	-	-	6	3	2	6	-	1
30-40	-	-	-	4	-	-	-	-	-
>40	-	-	-	-	-	-	-	-	-
Efficiency	0.12	0.16	0.13	0.11	0.15	0.20	0.15	0.21	0.22

Based on field study (2013)

It appears from the above table that the settlements having larger proportion of agricultural lands on slopes lower than 20^0 have relatively high efficiency than the cultivated lands above 20^0 .

Fig: 5.8 Percentile Distribution of Slope

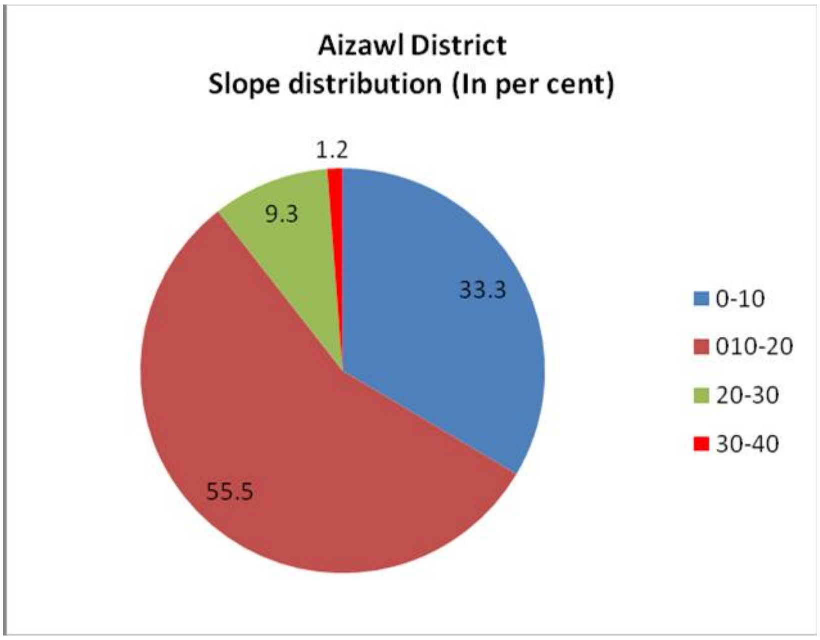


Fig 5.9: Relationship of Production with Slope Categories

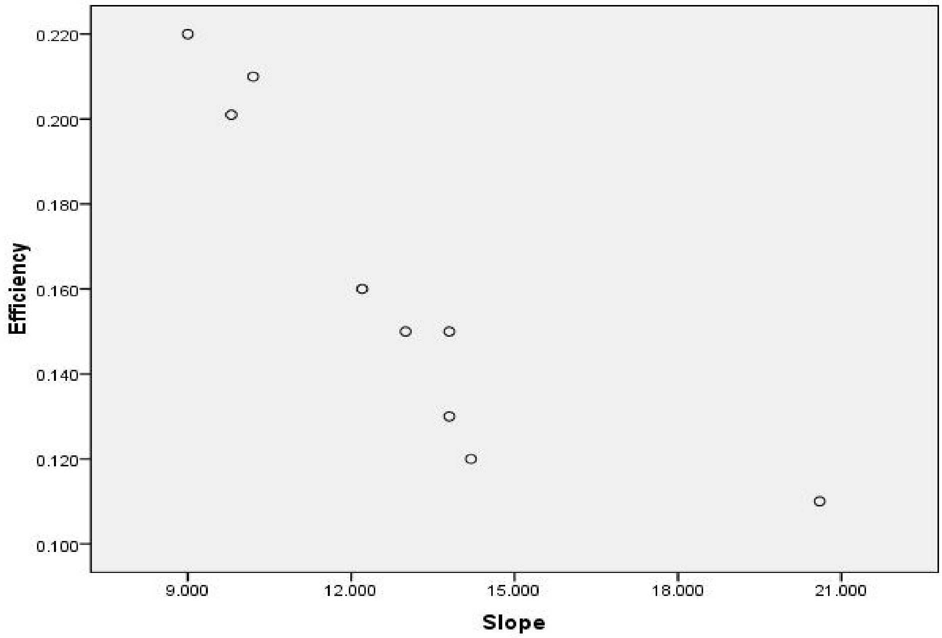


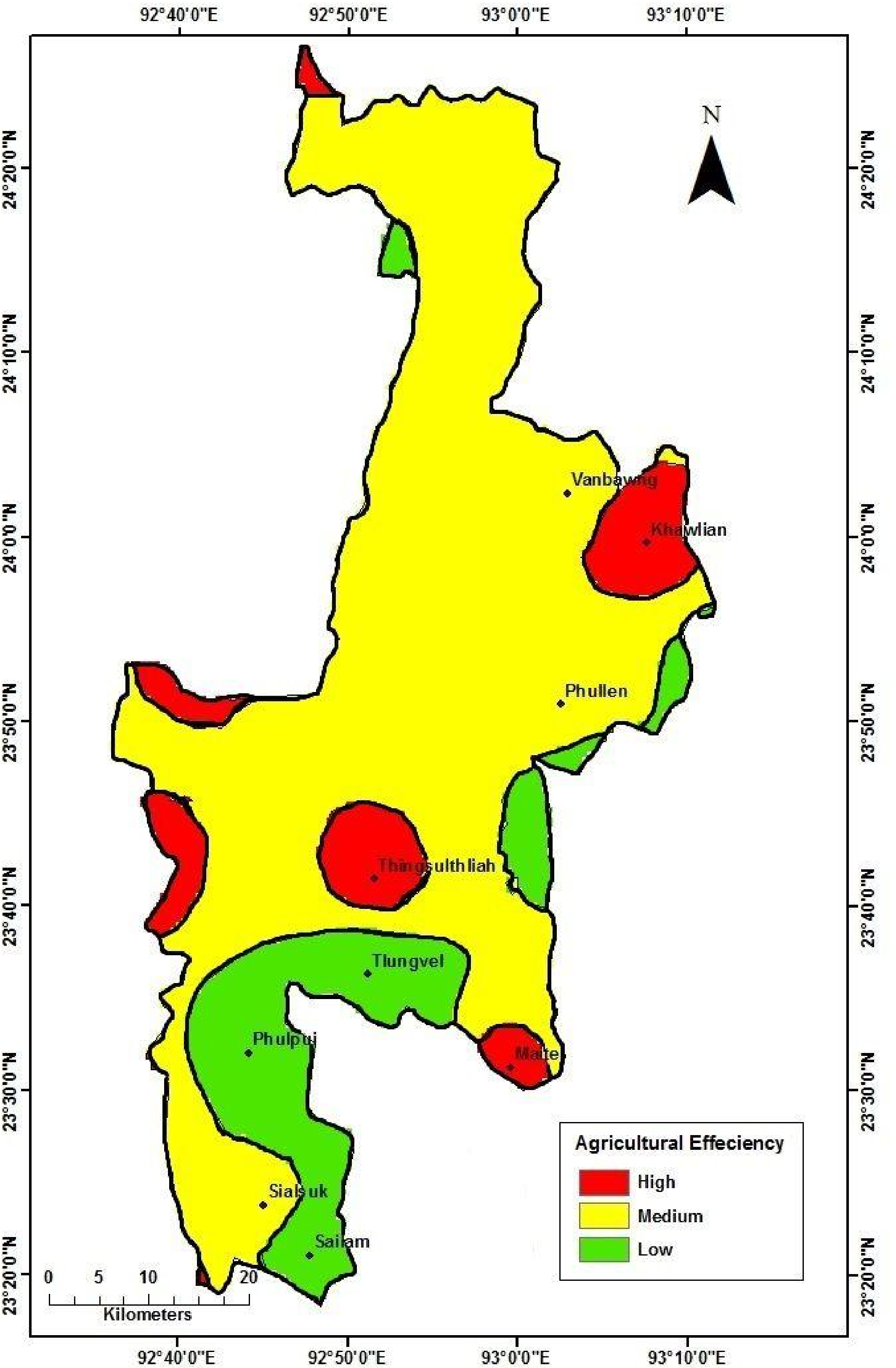
Table:5.20: Aizawl District: Agricultural Efficiency

Agricultural Efficiency	Villages
High	Thingsulthliah, Maite , Khawlian
Medium	Vanbawng, Phullen, Sialsuk
Low	Sailam, Phulpui,Tlungvel

Table:5.21: Aizawl District :Area hold by Efficiency based on Slope

Categories	**%**	**Area in km ^{2}**
High	16.29	582.78
Medium	73.66	2634.08
Low	10.04	359.13
TOTAL	**100**	**3575.99**

FIG.5.10: Agricultural Efficiency based on Slope



Efficiency Based on Input/Output Ratio. :

The input output ratio has been calculated and the minimum ratio is found in Khawlian village where as the maximum ratio is found in Sialsuk village. The village is said to be efficient when it production is large with less input. The following table show the input output ratio with agricultural efficiency of Aizawl district.

Table 5.22: Aizawl District: Input and Output Ratio with Efficiency

Villages	Input	Output	Ratio	Efficiency
Sailam	915730	1314400	0.69	0.12
Vanbawng	1467000	2069480	0.70	0.16
Tlungvel	1586537	2122280	0.74	0.13
Phulpui	932730	1324200	0.70	0.11
Phullen	1251879	1711280	0.73	0.15
Thingsulthliah	1553400	2714680	0.57	0.20
Sialsuk	1610800	2137240	0.75	0.15
Maite	855640	1498520	0.57	0.21
Khawlian	702450	1283600	0.54	0.22

From the above table it is apparent that input has nothing to do with agricultural efficiency. Here, we found the value of only 4 % which is very low to construct any explanation on the variable. This indicates that there is no relationship existed between agricultural efficiency and inputs. Here we found the “Sig” value i.e. 0.58 which proved that it is not statistically significant. High input is not high agricultural efficiency is proved by 99 % significance level.

It explains here a degree of correlation existed between input and agricultural efficiency; this equation will make it clear as 0.033 -0.189 = -0.156. The value -0.156 is the expected value of the agricultural efficiency when the value of input equal zero. This shows that input and agricultural efficiency has no connection which is statistically proved from the equation.

It appears from above equation that those villages which have a high input do not have a high efficiency. A high input definitely gives the high production but that do not count as a high efficiency. The villages which are grouped in a high category of agricultural efficiency has a lower inputs where as the villages grouped into a low category has a high inputs but still having a low agricultural efficiency. The higher input with higher production is not a higher efficiency of agricultural production. The efficiency is higher production with fewer inputs. The above equation exposed that efficiency has no relation with inputs. **Fig 5.9** will make it clear how efficiency and inputs do not have a relationship.

FIG.5.11. Relationship of Efficiency with Input/Output Ratio

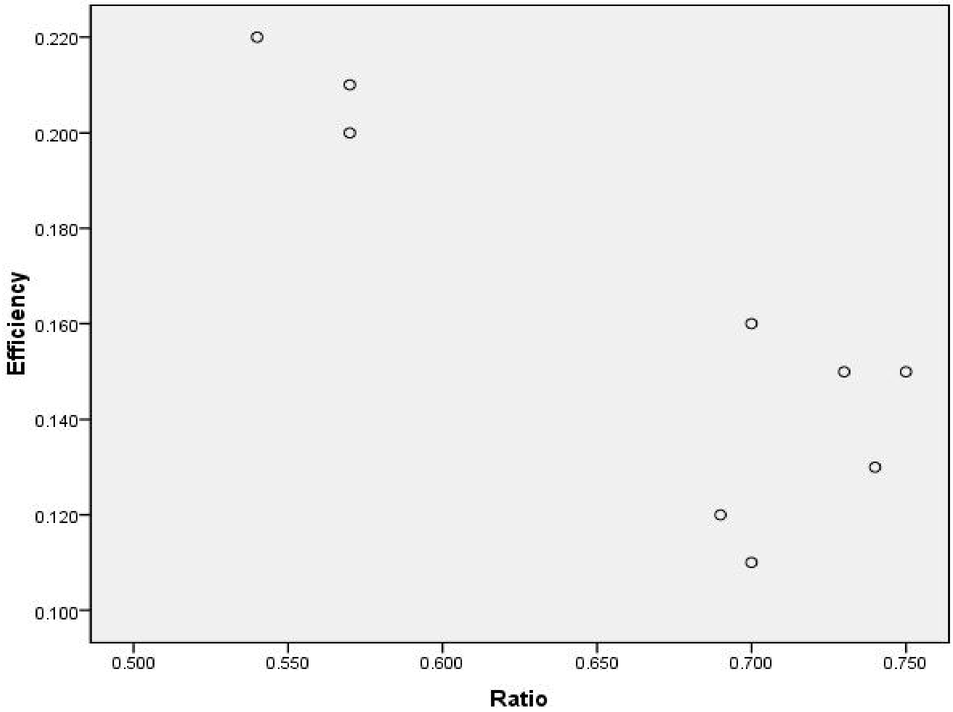


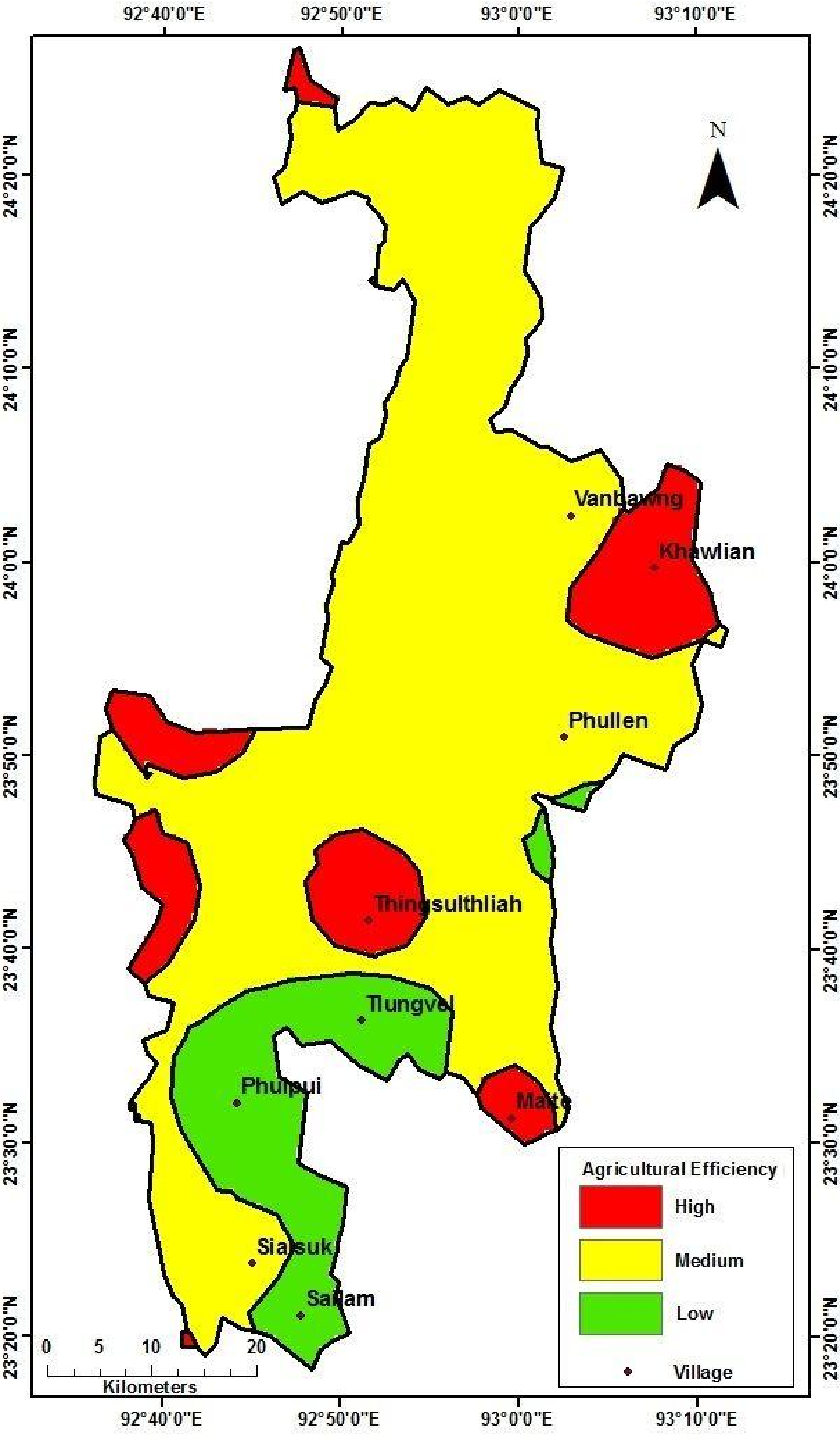
Table:5.23: Aizawl District: Agricultural Efficiency

Agricultural Efficiency	Villages
High	Thingsulthliah, Maite , Khawlian
Medium	Vanbawng, Phullen, Sialsuk
Low	Sailam, Phulpui,Tlungvel

Table. 5.24 : Aizawl District: Area hold by Efficiency based on Input

Categories	**%**	**Area in km^2**
High	13.13	469.60
Medium	71.86	2570.04
Low	14.99	536.34
TOTAL	**100**	**3575.98**

FIG.5.12: Agricultural Efficiency (based on Input / Output Ratio)



5.3 Saiha District

Saiha district is located to the south – eastern part of Mizoram between 22° 38' 01.19''N - 21° 56' 22.20'' N latitudes and 92° 49'21.37'' E - 93°12'10.55''E Longitudes (MIRSAC,2006). It is bounded to the north and west by Lawngtlai district and on the south and east by Myanmar. The total geographical area of Saiha district is 1399.90 km^2, which accounts for 6.64 % of the total geographical area of Mizoram. Agriculture is the main occupation of the district. There are 9220 cultivators, 236 agricultural labourers, 158 industrial labourers and 5204 other workers.

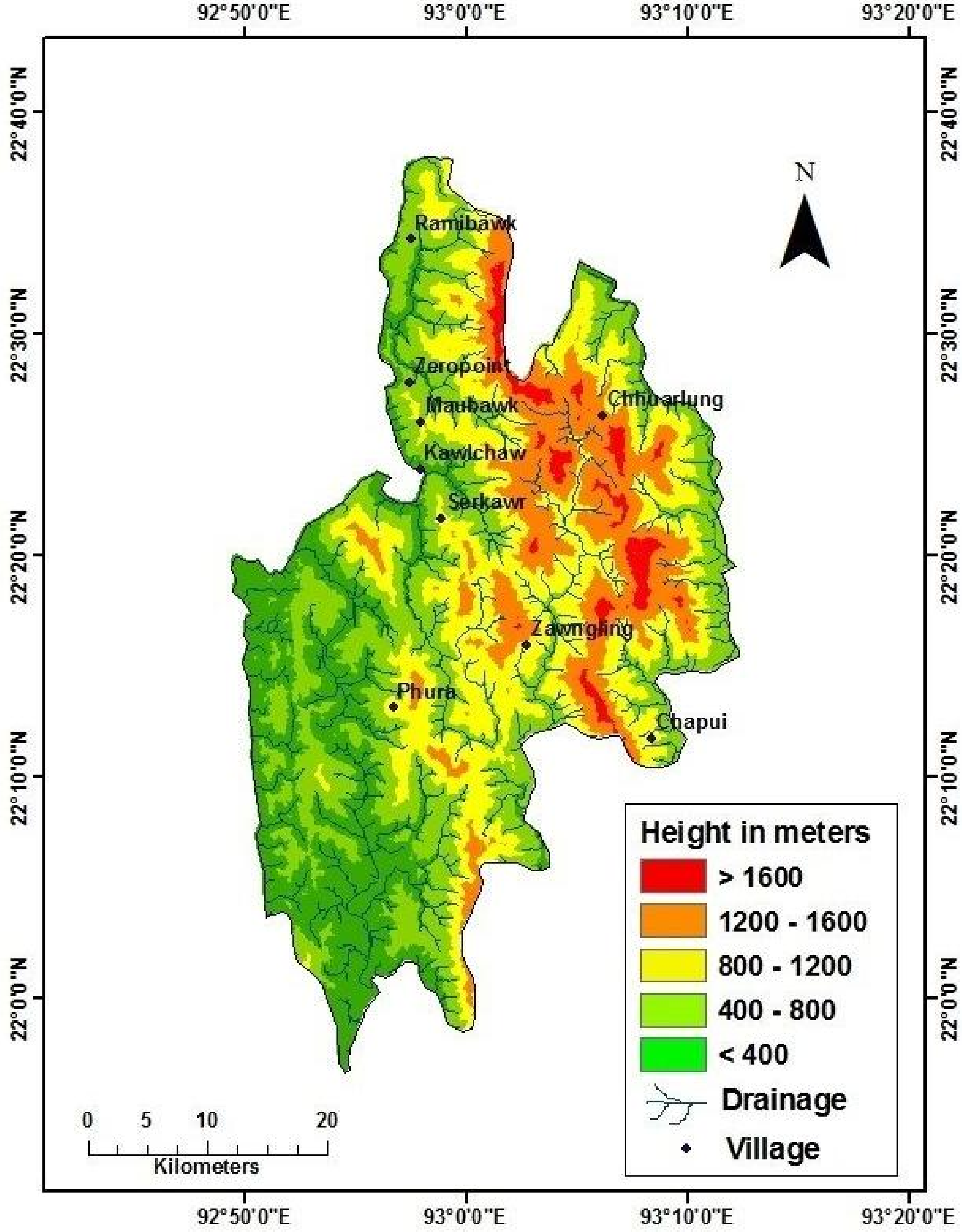
PHYSICAL CHRACTERISTICS OF SAIHA DISTRICT:

Physiography :

As the district is characterized by several prominent hill ridges running from the eastern to the northern- eastern part in addition to a few areal distribution in the central part. The District has very few flood plain accounting only 0.29 % which is found along the major rivers. They are usually found in the southern part of the district. Due to the unavailability of extensive plain area, a small patches of land along the rivers is utilized for cultivation.

The western part of the district along Chhimtuipui River is characterized by linear ridge which extends from Lawngban up to the western-southern most part of the district covering few western side of Khaikhy village. The north-eastern and the south- eastern part of the district are characterized by spectacular scarps and spur. The high structural hill are most prominent in the eastern part which covered larger areas and steeper than the western part and the central part of the district.

FIG. 5.13: Physical Map of Saiha District



An interesting feature within the district is the absence of important plain areas. Few plain areas of small dimensions are noticed along Palak lui valley around Phura and Maila villages. And a small dimension of plain area is found around Lungpuk and Khengkhawng villages. Wetland rice cultivation is not popular within the district and the few plain areas found along the rivers and between the hills are not suitable for cultivation.The geomorphology of Saiha district is divided into six (6) Geomorphic Units as under-

Table 5.25: Saiha District: Geomorphological Unit

Sl. No	**Geomorphic Unit**	**Area (in km^2)**	**%**
1	High Structural Hill	239.39	17.10
2	Medium structural hill	379.80	27.13
3	Low structural hill	598.70	42.77
4	Valley fill	19.66	1.40
5	Flood plain	4.06	0.29
6	Linear ridge	158.29	11.31
Total		**1399.90**	**100.00**

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

Geology:

By the Geological Survey of India, the study area has been classified by two major formation as Middle Bhuban and Upper Bhuban formation which represents a sequence of argillaceous and arenaceous rocks. The Middle and Upper classified formation are folded and stretching from a N – S trending anticlines and synclines and affected by a dip of an inclined rock surface, inferred and confirmed faults of varying magnitude which are mostly transverse and oblique in disposition. The structural trend stretches roughly in NNW – SSE and NNE – SSW direction.

Table.5.26: Saiha District: Geological Features

Sl.No	Rock types	Area (in km^2)	%
1	Sandstone	656.71	46.91
2	Siltstone - Shale	719.45	51.39
3	Clayey sand	19.68	1.41
4	Gravel, sand and silt	4.06	0.29
Total		**1399.90**	**100.00**

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

Hydrography:

Natural channels for surface flowage- the streams have been a natural source of water for human consumption, agricultural use and transportation. Running water uses, control and conservation greatly depend on the physical-climatic conditions of the regions they traverse.

Climate:

Climate controls man’s activities like agriculture, forestry, supply of water, industries, etc. The climatic elements which control the economic development of a region are rainfall, temperature, humidity, sunshine hours, wind and the number of rainy days. Saiha district enjoys a moderate climate owing to its tropical location; it is neither very hot nor very cold throughout the year. The district falls under the direct influence of the south west monsoon, therefore the area receives an adequate amount of rainfall which is responsible for a humid tropical climate characterized by short winter and long summer with heavy rainfall. It is observed that the mean summer temperature (June to August) is 30.86 ^{o}C and the mean winter temperature (December – february) is 24.96 ^{o}C and their difference is 5.89^{o}C which exceeds 5 ^{o}C and the soil qualifies for Hyper-themic temperature class to be used as family modifiers.

Rainfall:

Saiha district receives adequate amount of rainfall during the monsoon season. The study of the available rainfall data reveals that the heavy rainfall starts from the second part of April and ended in the first part of October. The average rainfall of Saiha district is 2606 mm per annum. Precipitation is heavy during summer. Normally June and July are the rainiest months while December and January as the driest months.

Table No. 5.27: Saiha District: Average Monthly Rainfall

Name of the-District	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Saiha	2009	0.0	0.0	21.9	109.0	292.8	641.2	545.0	765.0	604.9	167.4	119.9	0.0
	2010	0.0	0.0	204.4	165.2	581.2	528.2	718.6	661.0	995.5	653.0	86.0	129.8
	2011	0.0	0.0	148.2	109.8	538.0	693.2	604.2	1110.2	844.3	336.8	0.0	0.0
	2012	0.0	8.2	13.6	274.9	359.0	570.0	412.4	418.0	598.2	219.9	15.2	-
	2013	-	3.1	-	49.8	395.4	377.7	622.8	1077.8	1220.2	363	10.2	-

*Source: Economic & Statistic Department, Aizawl***.**

Drainage:

Saiha district is drained by two important rivers and their tributaries. These two rivers are R. Chhimtuipui and R. Tuisih. The eastern and western parts of the district are drained by R.Chhimtuipui. The south and south- eastern part of the district is drained by R. Tuisih. Besides these there are a number of perennial streams and rivulets of various patterns and length. Important perennial streams include Tuisumpui, Tuitlawkpui, Kawlchaw lui, Kawlawh lui,Palak lui and Sala lui in the western and southern part of the district where as Raki lui, Lope lui, Vaha lui and Razeipi lui are the notable ones in the eastern and central parts of the district. Most of the stream and rivulets are ephemeral in nature. Since the drainage system of the district is governed mainly by the natural drainage course and topography, the topography is young and the soils are highly erosional in character. The streams are youthful stage with deep courses and its soil does not show much diversity, they are highly erosional in character.

Table 5.28: Saiha District: Drainage System

Sl.No	Drainage System	Description
1	Chhintuipui Drainage System	It originates from the western part of Myanmar. It also forms an international boundary between India and Myanmar at a distance of 92.5km. It is the largest river in Mizoram by volume. Tiau,Mat,Kawlchaw,Tuisumpui,etc are important tributaries. The river highlighted dendritic to sub-dendritic drainage pattern.
2	Tuisih Drainage System	It originates from the north eastern part of the district between Chhuarlung and Niawhtlang villages at an altitude of 1758m above mean sea level. It flows southward till it enters Myanmar in the southern tip of the state covering a distance of about 40km. Its important tributaries are Lope lui, Vahai lui, Razeipi lui and Tlova lui.Drainage pattern of dendritic and sub- dendritic patterns are common. The fluvial flood plain located at various places are utilized for paddy farming with rainfed condition.

Source : Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

Ground Water Potential:

As the maximum area of the district fall within the poor water bearing rock formation (Slity shale) the ground water potentiality is highly attenuate. Among the four potential zone, the poor zone is predominantly high (accounting 43.16 %) interms of areal extend and covers large part of the district. Very good potential zone is found only in the western part extending from Lehry village to the western- southern part around Khaikhy village which is surrounded thinly by the good potential zone. Low availability of ground water presented in the area prohibited cultivation largely. And the area is mainly distributed in the elevated areas except for the flood plains and low lying areas found near the plains of minor rivers such as Palak lui, Tuipang lui, Sala lui, Tuisumpui lui, Tuitlawkpui lui,etc. The study area is divided into four major potential zones as under:

Table.5.29: Saiha District: Distribution of Ground Water Potential

Sl. No	Potential Zone	Area(in km^2)	%
1	Very good	110.62	8.00
2	Good	182.84	!3.06
3	Moderate	502.28	35.78
4	Poor	604.16	43.16
Total		**1399.9**	**100.00**

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram

Soil :

Soil is the product of interaction between parent materials, climate and biotic factors as modified by the terrain conditions and the duration over which the interaction has been going on. Any variation in the intensity of any of these influencing factors results into different kinds of soils. On the basis of rainfall and humidity, the soil moisture regime is classified as Udic. The soil is acidic in nature due heavry rainfall. It contains a high amount of Organic Carbon and is high in available Nitrogen, low in Phosphorous and Potassium content.

Natural Vegetation:

The primary forest of this district is mainly dominated by semi evergreen forest consisting of evergreen species associated with deciduous species and sub- tropical forest is also found at high altitude of the eastern part of the district i.e. Phawngpui range. The primary forest are mostly dominated by Mesua ferrae, Protium serratum,Terminalia belerica, Adina cordifolia, Podocarpus nerifolia, Artocarpus fraxifolios, Duabanga sonneratiodes, Schima wallichii, Toona Ciliata, Albizzia procera, Lagerstroemia parviflora, Mahonia nepalensis and different bamboo species. The sub-tropical forest is dominated by castanopsis tribuloides, Castanopsis indica, Alnus nepalensis, Betula spp, Quercus dilatata, Quercus helferiana, Prunus cerasioides, Pyrus pashia, Canrium spp. Kayea assamica, Phoebe goalparensis, Machilus spp, Bischofia javanica, Chukrassia tubularis, Michelia champaca, Salix spp, Mirica nagi, Rhododendron arboreum, Rhododendron veitchianum, Rhododendron kingianum, Rhus amherstensis, etc. The secondary forest or old abandoned jhums are mostly dominated by moist deciduous bamboo forest in the lower altitude and miscellaneous species at a higher altitude. Teak plantation is found here and there in small patches.

Land use/ Land Cover:

Land use is the human use of land. Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi- natural habitats such as arable fields, pasture and managed woods. The study area is divided into six major divisions as under:

Table.5.30: Saiha District: Landuse/Land Cover

Landuse/Land cover	**Area (in km^2)**	**%**
Total Geographical Area	**1399**	**100**
Built-Up land	6.62	0.47
Agriculture land	7.21	0.52
Shifting Cultivation	189.79	13.56
Forest	1164.62	83.19
Scrub land	19.72	1.41
Water body	11.94	0.85

Source: Natural Resources Atlas of Mizoram by MIRSAC, Science, Technology & Environment Wing Planning Department, Aizawl, Mizoram.

Built-Up Land:

Built-up land is an area of human habitation, developed due to non-agricultural use and that has a cover of buildings, transport and communications, utilities in association with water, vegetation and vacant lands. Saiha District has one town i.e. Saiha and 52 villages covering 0.47 % of the total geographical area of the district (6.62 $km^{2)}$.

Agriculture Land:

These are lands primarily used for farming and for production of food, fibred and other commercial horticultural crops. It includes land under crops (irrigated and un-irrigated, plantations, etc.) accounts 0.52 % of the total area (7.21 km^2).

Shifting Cultivation:

It is a traditional farming activities of growing crops on forested/vegetated hill slopes by slashes and burn method.. Shifting cultivation covered 13.56 % of the total area (189.79 km^2).

Forest:

Natural forests are not disturbed by any biotic factors like shifting cultivation and other human activities. The density of this class is very thick. Sub-tropical forest, evergreen and semi- evergreen forests covers major portion of this class. Forest has covered 83.19 % of the total geographical area of the district (1164.62 km^2).

Scrub Land:

These lands are generally prone to deterioration due to erosion. They generally occupy topographically high locations, excluding hilly/ mountainous terrain. They possess sparse vegetation with thin soil cover and accounts 1.41 % of the total area (19.72 km^2).

Water Body:

This category comprises areas with surface water, either impounded in the form of ponds, lakes or flowing as streams and rivers, etc. which accounts for 0.85 % of the district area (11.94 km^2).

POPULATION CHARACTERISTICS OF SAIHA DISTRICT:

Population Growth:

According to 2011 Census, the district has a population of 56,366 persons which contained 28,490 male populations and 27,876 female populations. Decadal Growth of population is 19.71 %. As much as 25,065 persons live in the urban area while 31,301 persons live in rural area. Among the inhabitants of urban area 12,715 are males and 12,350 are females. In the rural area, the district has 15,775 male populations and 15,526 female populations.

Population Distribution:

Located in a hilly terrain, the district is not so much suitable for contented and weighty concentration of population in one locality and also because the consistent system of occupation continues to be the basis for a large section of the society. The distribution of population between rural and urban areas is 55.53 % and 44.46 % respectively. Maximum concentration of population is found in the rural areas accounting for more than 55 %.

Population Density:

The district is the lowest populated district in Mizoram. According to 2011 census, the district accounted 56,366 persons having a density of 40 persons per Km^2. (Census 2011)

Population Composition:

Out of 56,366 persons in the district, the male population accounts for 28,490 which is 50.54 % where as the female population is 27,876 accounting 49.45 %.

Age and Sex Composition:

In studying the population characteristics of any area, age and sex composition examination has played a very important economically and socially. Sex ratio of the district is 978 which is higher than the state average.

Literacy:

Literacy level among the people is an important indicator of the quality of population of a country or state or district. Saiha district has a literacy percentage of 88.41 % which is lower than the state average and stood in 6th rank in the state. Literacy percentage of male population is 91.00 % where as percentage of female literacy is 85.80 %.

INFRASTRUCTURE OF SAIHA DISTRICT:

Road:

The district has a poor road network and the whole length of the district is passing through mostly by poor road networks. The unavailability of good road network which obstruct transportation with the neighbouring states and exchange of goods especially during rainy season. The existence of Agriculture and Horticulture link roads and their village roads provide transportation for the people and their products from interior part of the district.

Health:

In order to produce more from the agricultural field the people need to stay healthy and health plays an important role not only in agriculture and allied activities but also in other way of life. The no. of births recorded in the district for the year 2010 is 1,472 persons (out of 25,755 births in the state) where as the deaths recorded are 308 (out of 5367 deaths recorded in the state).

Power Supply:

57 villages have been electrified as on 1st April, 2012. Village electrification is imperative for storing and protecting the surplus product from agriculture and any other farm outputs.

AGRICULTURAL EFFICIENCY IN SAIHA DISTRICT:

Efficiency based on Slope:

Based on the basis of sample studies of three R.D. Blocks and equally distributed nine villages of the district an attempt has been made to correlate the efficiency level of agricultural with slope categories the following equation has been done to proved slope as one of the determining factor on efficiency.

Computing the data on SPSS, we found 71.8 % of the efficiency which can be explained to get the relationship between slope and efficiency of the study area. The percentage hold for the explanations of the two variable relation is strong enough to proved slope as the determining factor on the efficiency. The value of $p<0.002$ representing that over all the regression model statistically significantly predicts the product variable and in this light we can presume that slope has play a responsible role in efficiency. The degree of correlation existed between slope and efficiency, (0.312-0.007=0.305) the value 0.305 is the expected value of the efficiency when the value of slope equal zero. It is proved that slope and agricultural efficiency has a high relation with 99 % significance level.

By looking at the above description, it is observed that slope has an impact on agricultural efficiency in the present study area. When slope degree decreases the agricultural efficiency increases. The villages located in the lower slope degree have produced higher production and the agricultural efficiency also prevails.

Located in the Southern part of Mizoram most of the farming activities are carried out on slopes below 30^0. As such relatively higher productivity in comparison to other parts of the state is obtained in the district. The following Fig 5.14 gives the distribution of slope in the district.

Figure .5.14: Percentile Distribution of Slopes in Saiha

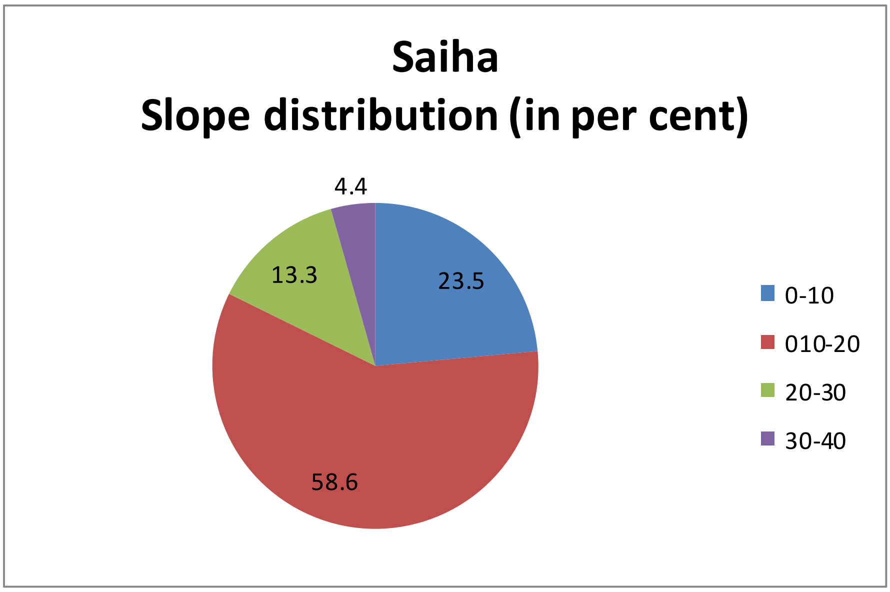
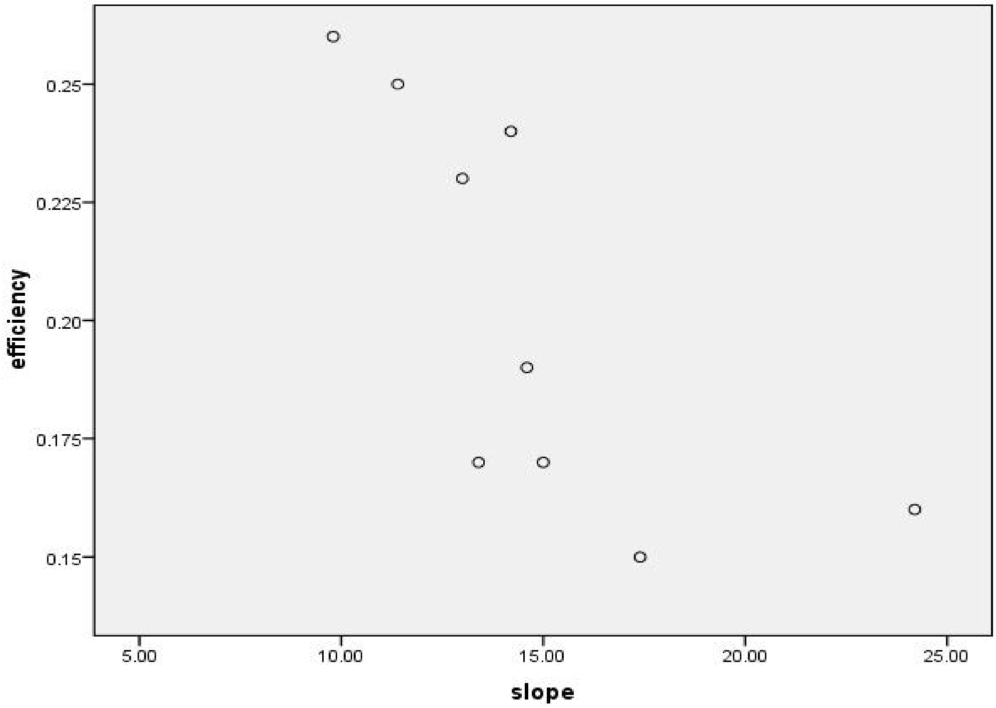


Fig.5.15: Relationship of Production with Slope



Such aberrations at village level in respect of productions, however, may be a function of additional input and variability of soil fertility. the function of production comes out more clearly when productive efficiency is calculated in terms of input-output ratio (as given in Table 5.34) on the basis of the results obtained there from settlements, thus, have been categorized as having High, Medium and Low efficiency.

However, there appears to be spatial productivity variations correlated with slope is analyzed. The following table shows the productivity variations in relation to the slope categories in sampled villages.

Table.5.31: Saiha District: Distribution of Agricultural Land on different Slope Categories and Agricultural Efficiency of the villages

Slope in ⁰	Serkawr	Rawmibawk	Kawlchaw	Chhuarlung	Phura	Zeropoint	Zawngling	Maubawk	Chapui
0-10	3	6	10	-	14	6	4	5	5
10-20	14	13	11	11	10	19	21	17	16
20-30	7	6	4	5	1	-	-	3	4
30-40	1	-	-	9	-	-	-	-	-
>40	-	-	-	-	-	-	-	-	-
Efficiency	0.15	0.24	0.23	0.16	0.26	0.25	0.17	0.20	0.19

Based on field study (2011)

It appears from the above table that the settlements having larger proportion of agricultural lands on slopes lower than 20^0 have relatively larger productivity than the cultivated lands above 20^0 despite the fact that scatter diagram for the district does not show any definite correlation of productivity with slope as reflected by the following diagram:

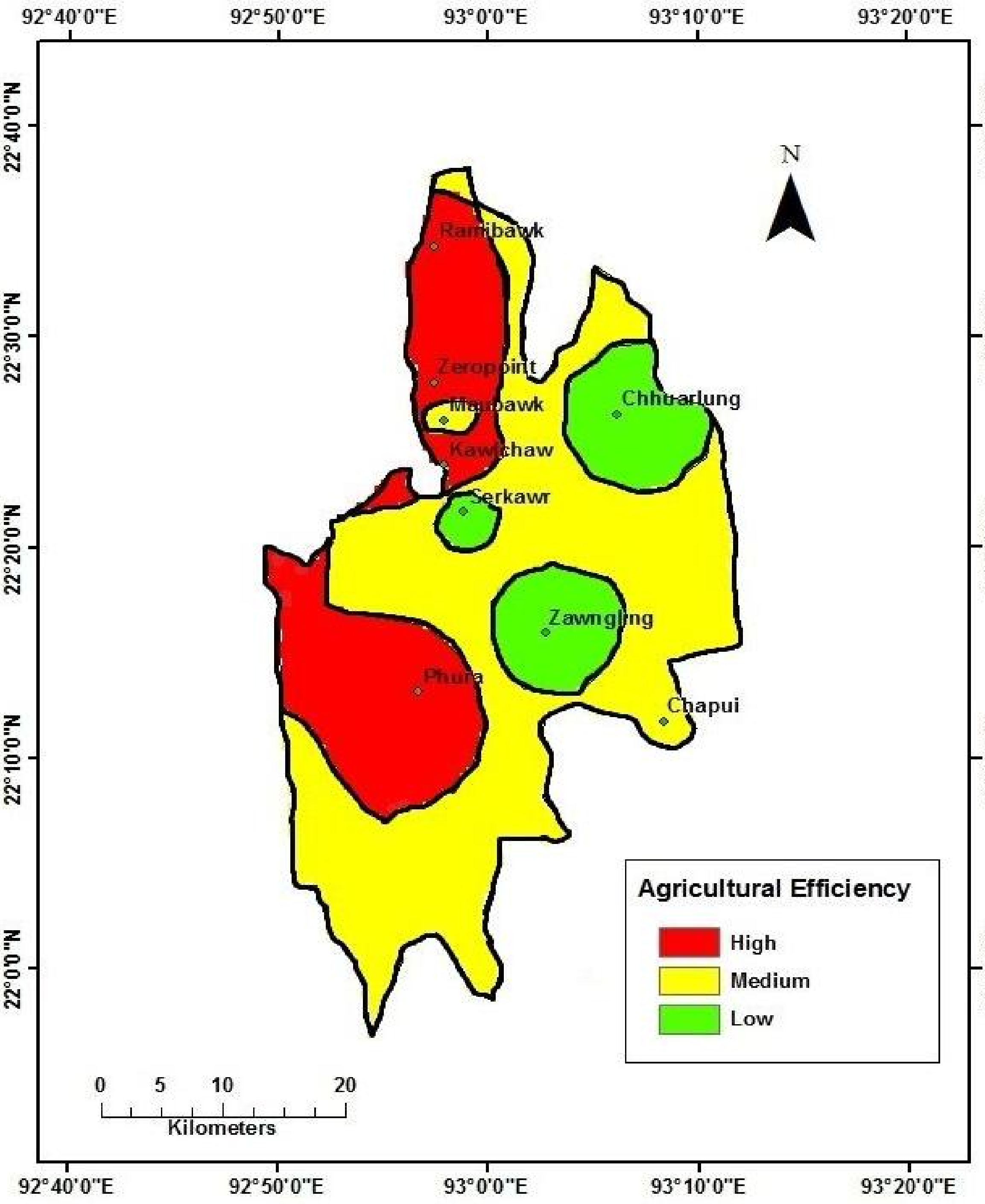
Table:5.32 : Saiha District: Agricultural Efficiency based on Slope

Agricultural Efficiency	Villages
High	Kawlchaw, Zeropoint, Phura, Rawmibawk
Medium	Chapui, Maubawk
Low	Chhuarlung, Serkawr, Zawngling

Table. 5.33 : Saiha District : Area hold by Efficiency based on Slope

Categories	%	ea in sq.km
High	14.77824	206.7476
Medium	58.42678	817.3906
Low	26.79498	374.8618
TOTAL	**100**	**1398.99**

FIG5.16: Agricultural Efficiency based on Slope



Efficiency based on input/output ratio.

Table 5.34:Saiha District: Input and Output Ratio with Efficiency

Villages	Input	Output	Ratio	Efficiency
Serkawr	205500	577280	0.35	0.15
Rawmibawk	197250	572200	0.34	0.24
Kawlchaw	294750	812000	0.36	0.23
Chhuarlung	407250	972840	0.41	0.16
Phura	252500	837200	0.30	0.26
Zeropoint	285000	849480	0.33	0.25
Zawngling	217043	518520	0.41	0.17
Maubawk	217500	917880	0.23	0.20
Chapui	419500	1010800	0.41	0.19

The calculated value of 0.640 indicates degree of correlation between input ratio and agricultural efficiency. Only 40.9 % of the agricultural efficiency can be explained which is not sufficient to show the real condition of the study area. The percentage hold for the explanation of the two variable relations is not well-built to proved input as the determining factor on the agricultural efficiency

It is proved that there is no relationship as the" sig" value is 0.064 which is not statistically significance to proved impact of input on agricultural efficiency.

It appears that those villages which have a high input do not have a high efficiency. High inputs absolutely give the high production but that do not be count as a high efficiency. The villages which are cluster in a high category of efficiency has a lower inputs where as the villages cluster in a low category has a high inputs but still having a low efficiency. The higher input with higher production is not a higher efficiency of agriculture. The efficiency is higher production with less input.

FIG.5.17: Relationship of Efficiency with Input/ Output Ratio

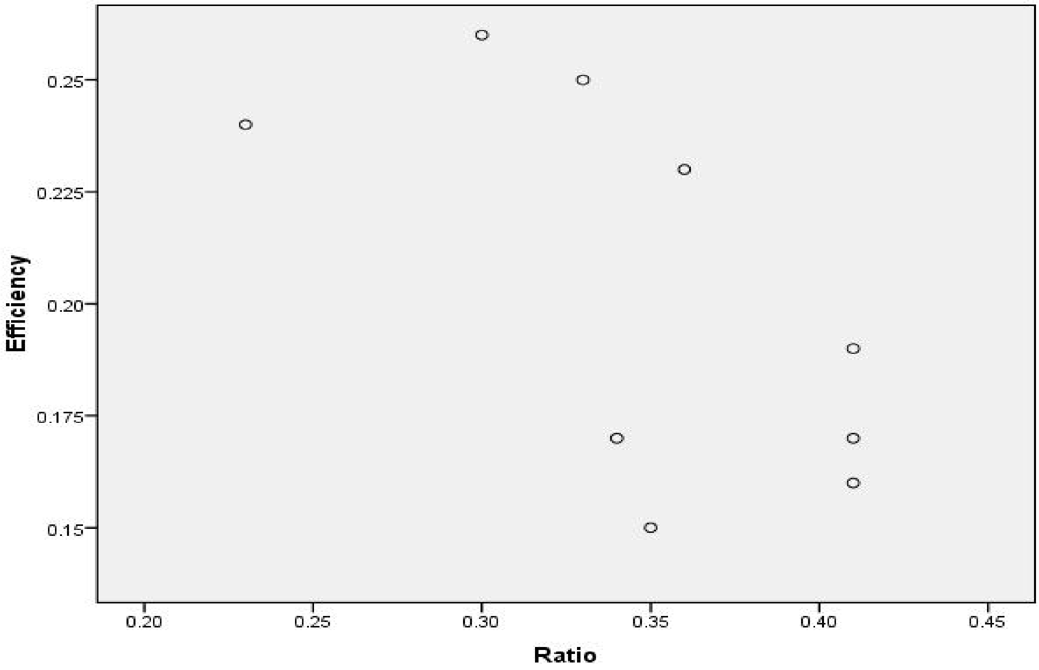


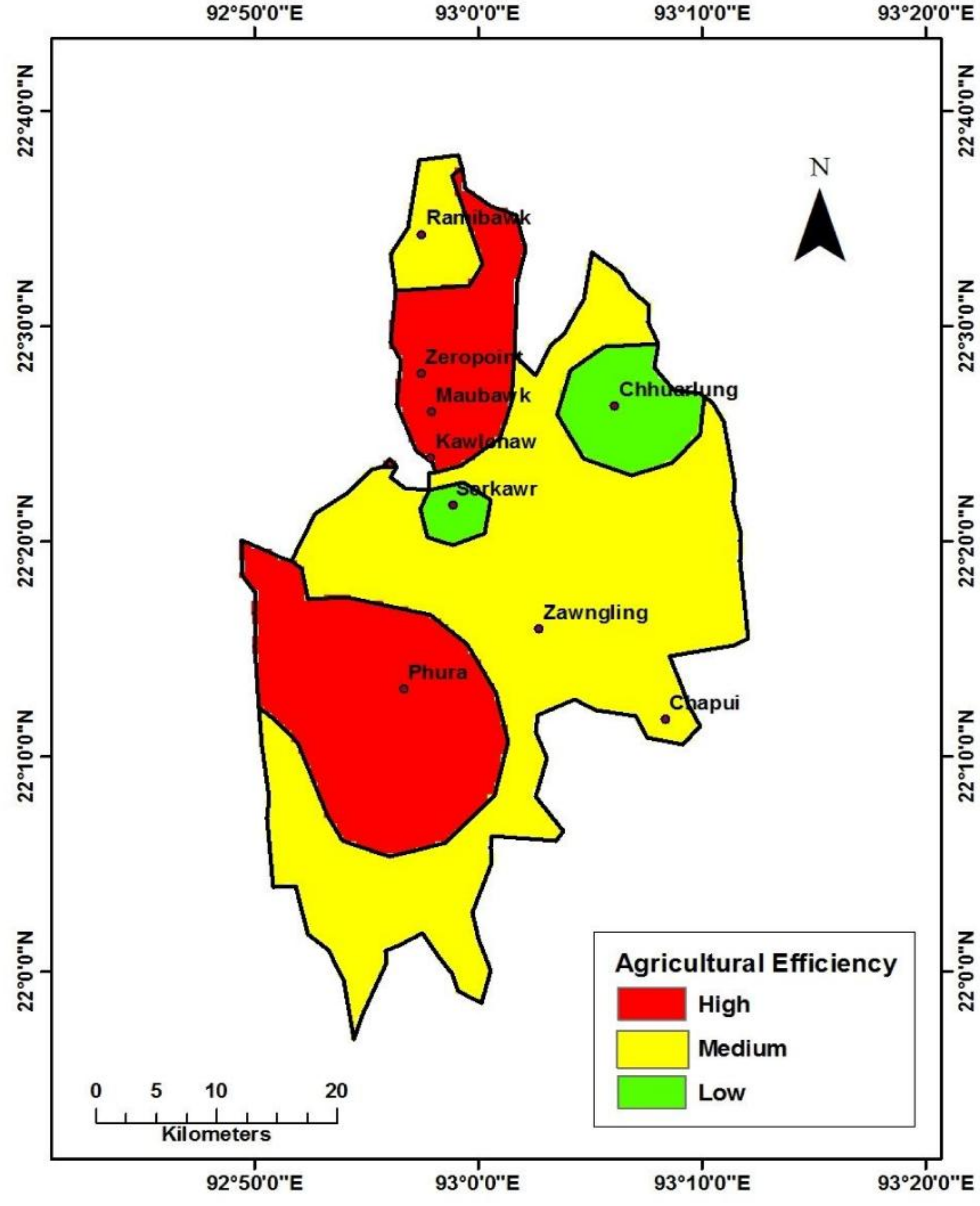
Table:5.35 : Saiha District: Agricultural Efficiency based on Input/Output Ratio

Agricultural Efficiency	Villages
High	Kawlchaw, Zeropoint, Phura, Maubawk,
Medium	Chapui, Zawngling, Rawmibawk
Low	Chhuarlung, Serkawr

Table. 5.36 : Saiha District: Area hold by Efficiency bsed on Input

Categories	**%**	**Area in km^2**
High	31.96	447.21
Medium	60.73	849.70
Low	7.29	102.08
TOTAL	**100**	**1398.99**

Fig.5.18: Saiha District: Agricultural Efficiency
(based on input/output ratio)



AGRICULTURAL EFFICIENCY IN MIZORAM:

Efficiency based on Slope:

Based on the basis of sample studies of three District an attempt has been made to compare the agricultural efficiency with slope categories. In order to obtain the best possible result we went through to the Regression Method by using Statistical Package for Social Sciences (SPSS) and the obtained result shows that slope has an impact on the agricultural efficiency. This is due to the fact that the villages having high agricultural efficiency level are more or less found in the area surrounded by low slope degree and the area bounded by high degree slope does not have high efficiency. And it is also found that overall the agricultural efficiency level is low in Mizoram due to the hilly and rugged terrain which existed in the state.

When slope is taken as the determining factor, 63.8 % of the agricultural efficiency can be explained to show the relationship of the variables for getting the concrete condition of the study area.

By looking into the "sig" column of the above table, we noticed the value of $p<0.001$ which indicates that over all the regression model statistically significantly predicts the outcome variable and in this light one came to know that slope has play a responsible role in efficiency. The above table suggested that there is a relationship between slope and efficiency. When one entered slope degree and agricultural efficiency in the software one come up to know that it is 99 % significance level proved.

The above table showed a high degree of correlation existed between slope and efficiency; (0.288 -0.007 = 0.281). And the value of 0.281 is the expected value of the dependent variable when the values of the independent variables equal zero. It is proved that slope and efficiency has a high relation with 99 % significance level.

From the above equation, it is clear that slope has a negative impact on efficiency. If the slope degree decreases the production increases. The area which lies in the lower slope degree has a higher production and the agricultural efficiency of the land also high. Table No. **5.37** represents how slope influence efficiency of the study area which will later be shown in a **Fig: 5.17** to make the picture more clearly.

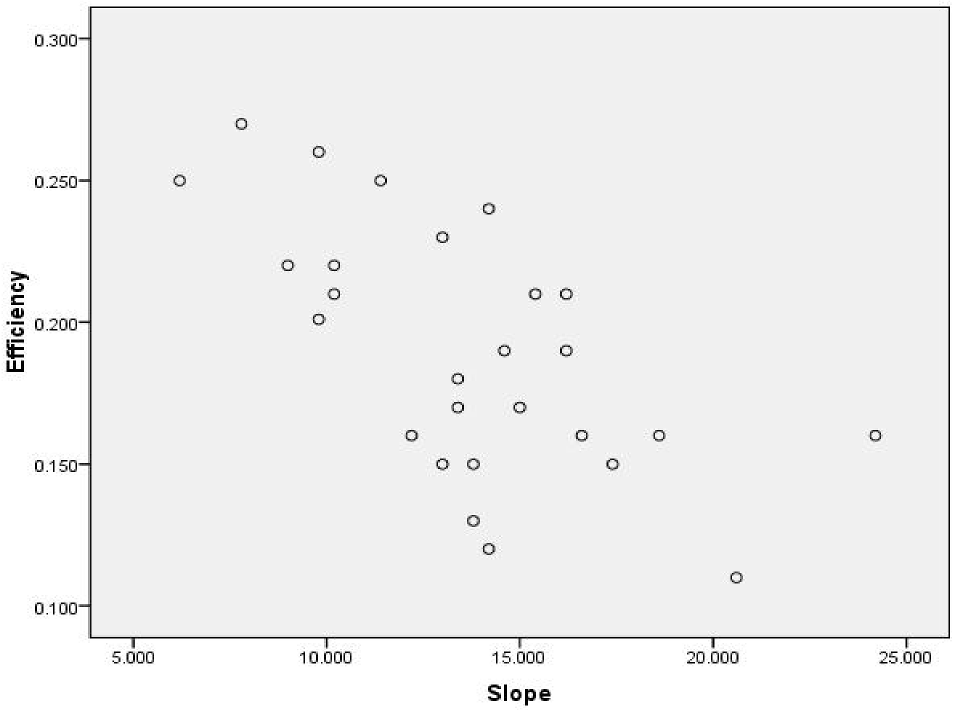
Table: 5.37:Mizoram: Distribution of Agricultural Land on different Slope Categories and Agricultural Efficiency of the villages

Villages	Slope in Degrees					Efficiency
	0-10	10-20	20-30	30-40	>40	
Tualcheng	22	3	-	-	-	0.22
Vapar	14	9	2	-	-	0.25
Selam	7	10	6	2	-	0.21
Puilo	4	11	7	3	-	0.16
Kawlkulh	5	14	6	-	-	0.21
Chalrang	5	12	8	-	-	0.19
Ngopa	6	17	2	-	-	0.18
Changzawl	-	21	4	-	-	0.16
Champhai	19	5	1	-	-	0.27
Sailam	5	17	3	-	-	0.12
Vanbawng	7	18	-	-	-	0.16
Tlungvel	3	22	-	-	-	0.13
Phulpui	-	15	6	4		0.11
Phullen	8	14	3	-	-	0.15
Thingsulthliah	15	8	2	-	-	0.20
Sialsuk	9	10	6	-	-	0.15
Maite	12	13	-	-	-	0.21
Khawlian	16	8	1	-	-	0.22
Serkawr	3	14	7	1	-	0.15
Rawmibawk	6	13	6	-	-	0.24

Kawlchaw	10	11	4	-	-	0.23
Chhuarlung	-	11	5	9		0.16
Phura	14	10	1	-	-	0.26
Zeropoint	6	19	-	-	-	0.25
Zawngling	4	21	-	-	-	0.17
Maubawk	5	17	3	-	-	0.20
Chapui	5	16	4	-	-	0.19

It appears from the above table that the settlements having larger proportion of agricultural lands on slopes lower than 20^0 have relatively larger productivity than the cultivated lands above 20^0. And thus proved that slope has an influence on agricultural efficiency.

FIG. 5.19: Relationship of Efficiency with Slope Categories

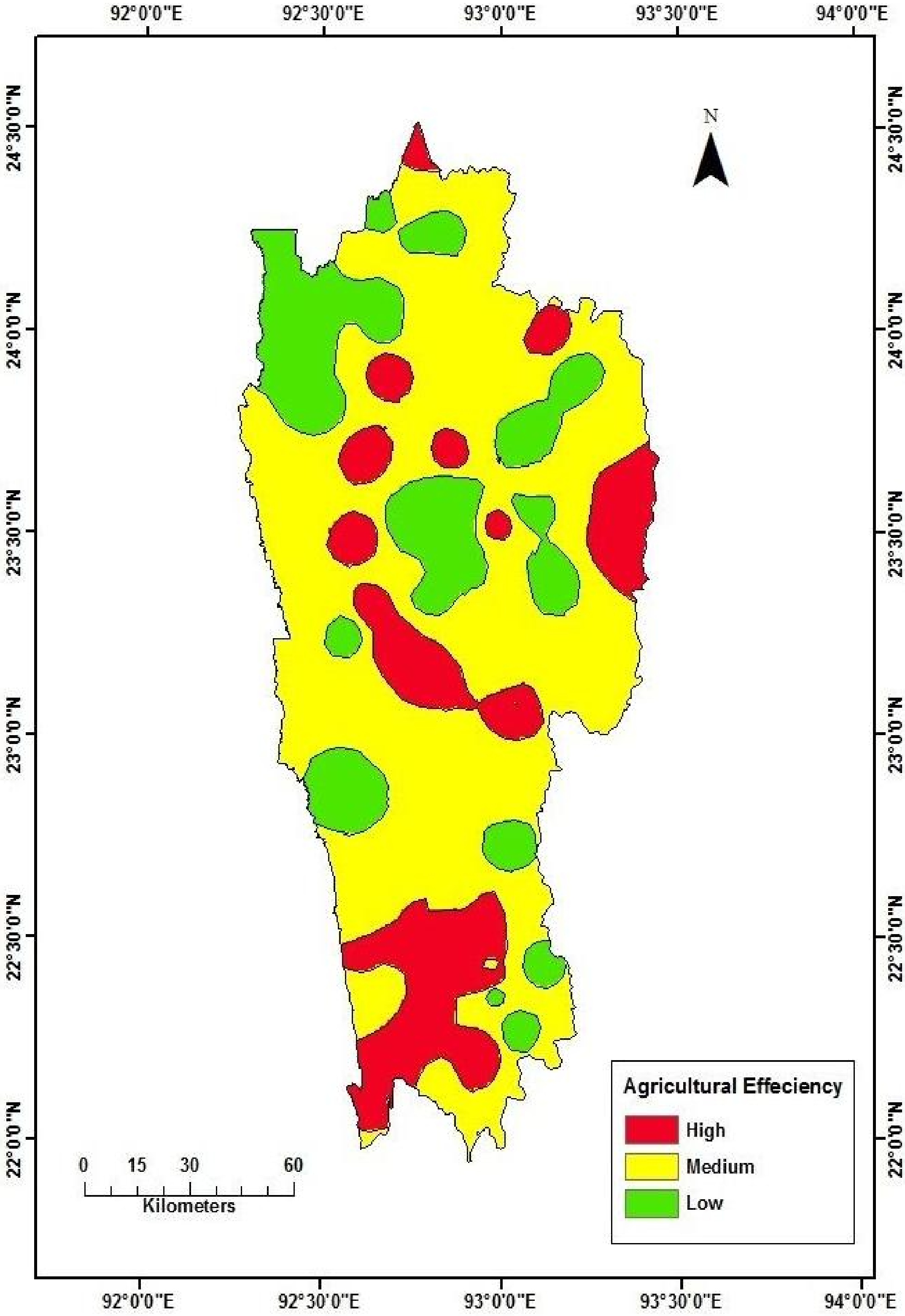


However, there appears to be spatial productivity variations correlated with slope when it is analysed. The following table shows the productivity variations in relation to the slope categories in sampled villages.

Table: 5.38: Mizoram: Agricultural Efficiency based on Slope

Agricultural Efficiency	Villages
High	Tualcheng,Vapar,Selam,Champhai, Khawlian,Rawmibawk, Kawlchaw, Phura, Zeropoint
Medium	Kawlkulh,Chalrang, Ngopa,Maite,Maubawk
Low	Puilo, Changzawl, Sailam, Vanbawng, Tlungvel, Phulpui, Phullen, Thingsulthliah, Sialsuk, serkawr, Chhuarlung, Zawngling,Chapui

Fig 5.20: MIZORAM : AGRICULTURAL EFFICIENCY (based on Slope)



Efficiency Based on Input/Output Ratio.

When input is taken as the determining factor on agricultural efficiency, following the equation it is proved that input do not have any contact on agricultural efficiency. Agricultural efficiency is basically termed as high agricultural production in the company of low inputs, however, in the study area where we find high production at the same time their inputs worth is also high and that cannot be add up as a high efficiency region. A large quantity of expenses does not grant a high efficiency.

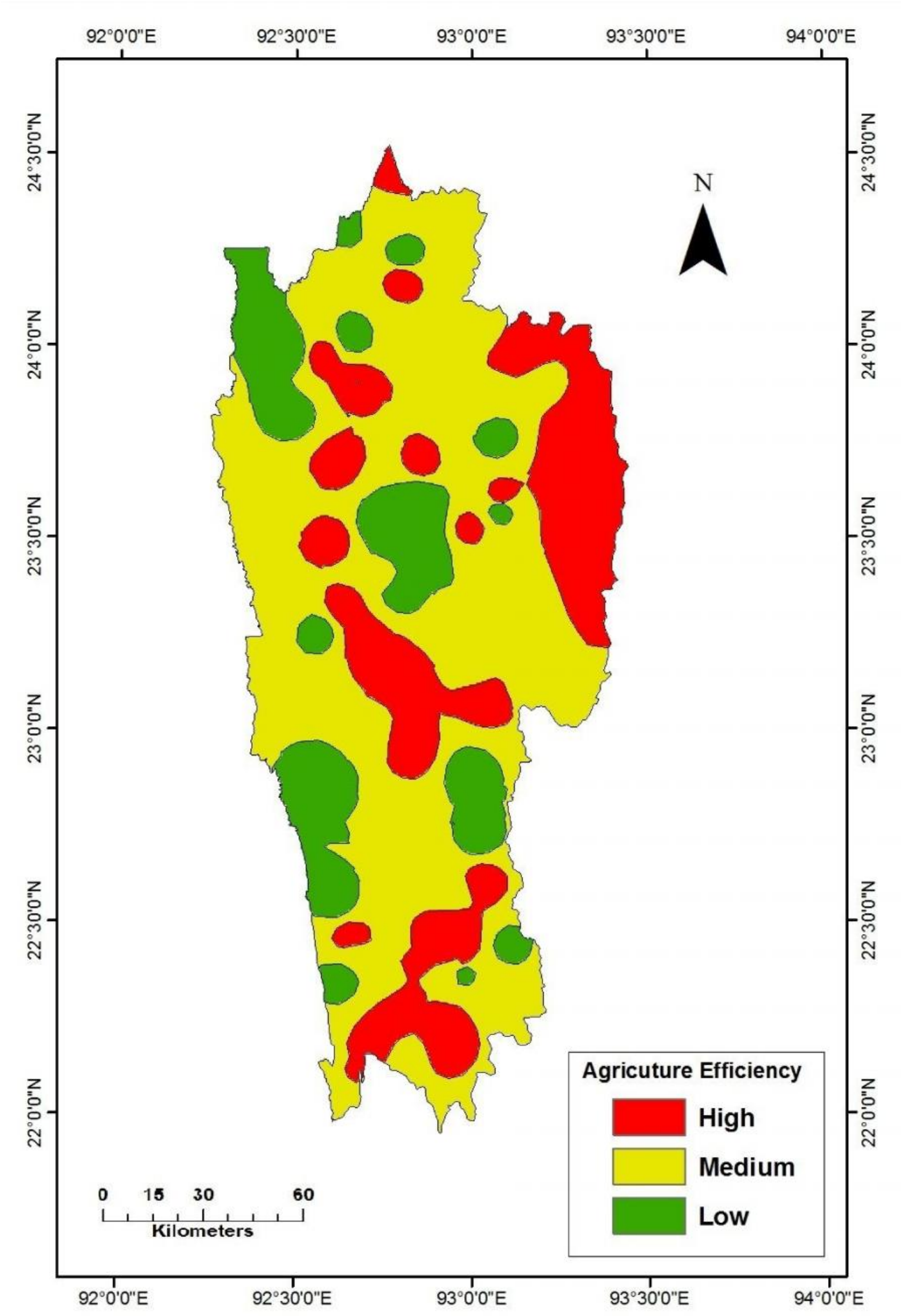
Table 5.39: Mizoram: Input and Output Ratio with Efficiency

Villages	Input	Output	Ratio	Efficiency
Tualcheng	201250	782840	0.25	**0.22**
Vapar	229530	809600	0.28	**0.25**
Selam	253500	1111560	0.22	**0.21**
Puilo	291750	839200	0.34	**0.16**
Kawlkulh	257800	1041400	0.24	**0.21**
Chalrang	327250	1010080	0.32	**0.19**
Ngopa	239780	1068240	0.22	**0.18**
Changzawl	465250	1262120	0.36	**0.16**
Champhai	213250	999440	0.21	**0.27**
Sailam	915730	1314400	0.69	**0.12**
Vanbawng	1267000	2069480	0.61	**0.16**
Tlungvel	1386537	2122280	0.65	**0.13**
Phulpui	932730	1324200	0.70	**0.11**
Phullen	1151879	1711280	0.67	**0.15**
Thingsulthliah	2053400	2714680	0.75	**0.20**
Sialsuk	1410800	2137240	0.66	**0.15**
Maite	955640	1498520	0.63	**0.21**
Khawlian	942450	1283600	0.73	**0.22**

Serkawr	205500	577280	0.35	**0.15**
Rawmibawk	197250	572200	0.34	**0.17**
Kawlchaw	294750	812000	0.36	**0.23**
Chhuarlung	407250	972840	0.41	**0.16**
Phura	252500	837200	0.30	**0.26**
Zeropoint	285000	849480	0.33	**0.25**
Zawngling	217043	518520	0.41	**0.17**
Maubawk	217500	917880	0.23	**0.24**
Chapui	419500	1010800	0.41	**0.19**

The table above provides us an initiative about those villages which have a high input automatically do not have a high agricultural efficiency. A high input undoubtedly gives the high production but that could not be add up as a high agricultural efficiency. The category of the three groups has been prepared by Standard Deviation method and the red colour on efficiency column indicates the high category, the blue colour indicates the medium category where as the black colour indicates the low category. The villages which are clustered in a high category of agricultural efficiency has a lower inputs where as the villages clustered into a low category has a high inputs but still having a low efficiency. Here, we have the result that input and efficiency do not have a relationship. Efficiency is put in simple words as high production with less input. Keeping this in mind, agricultural efficiency is less expenditure with high production. In this paper, we make a conclusion that over all the agricultural efficiency is low in the study area due to high degree of slope. Even if high inputs be happening, the efficiency level is still very low. In order to overcome this or to improve the agricultural efficiency level there are some steps which we must bring to accomplish.

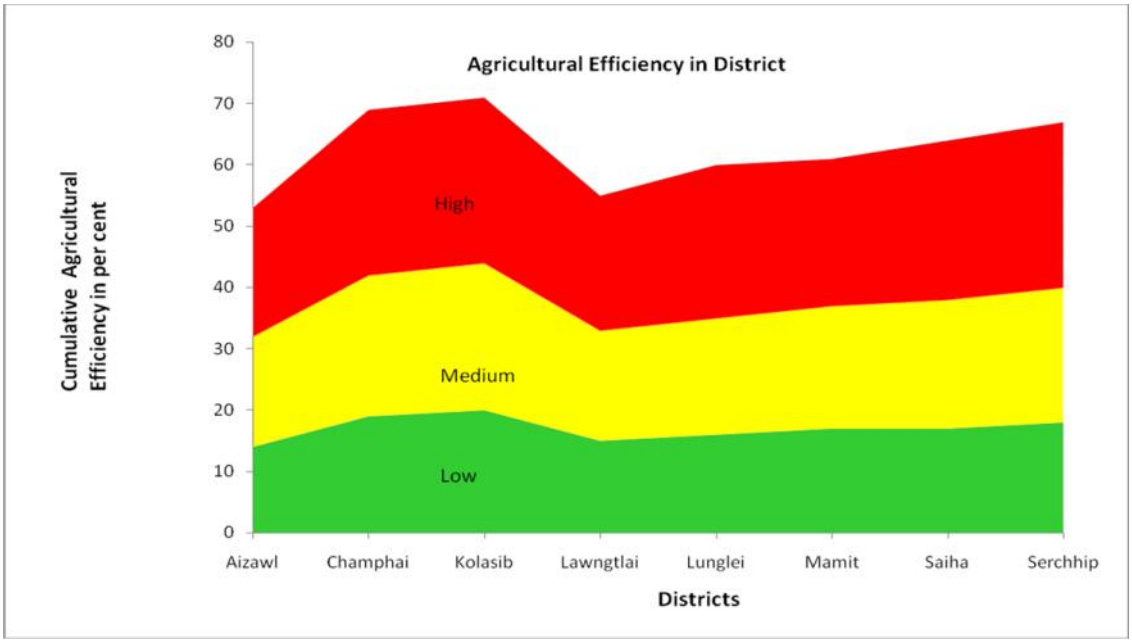
FIG.5.21:MIZORAM: Agricultural Efficiency (based on Input/Output)



The District wise distribution of agricultural efficiency occupied by the three category.

Districts	Low	Medium	High
Aizawl	14	18	21
Champhai	19	23	27
Kolasib	20	24	27
Lawngtlai	15	18	22
Lunglei	16	19	25
Mamit	17	20	24
Saiha	17	21	26
Serchhip	18	22	27

FIG 5.22 Cumulative Agricultural Efficiency in Mizoram



From the above investigation on agricultural efficiency of Mizoram, we came to realise that overall the agricultural efficiency is low this is not only due to the hilly terrain but also the low literacy among the farmers. Mostly the farmers being interviewed are illiterate and this upshot that they do not have any knowledge in selecting the field which is best for any particular crops.

Apart from that due to the lack of knowledge on how to implement a modern technology on their field in turn result in low production. And the educated youth people among the family do not make much contribution on agriculture instead they moved out to the nearby town hoping to get a better living standard. If there is the involvement of young educated people, the production may increase to some extent. By this we came to make a conclusion that the Institutional assistance has helped increasingly efficient use of land resources.

Chapter-VI

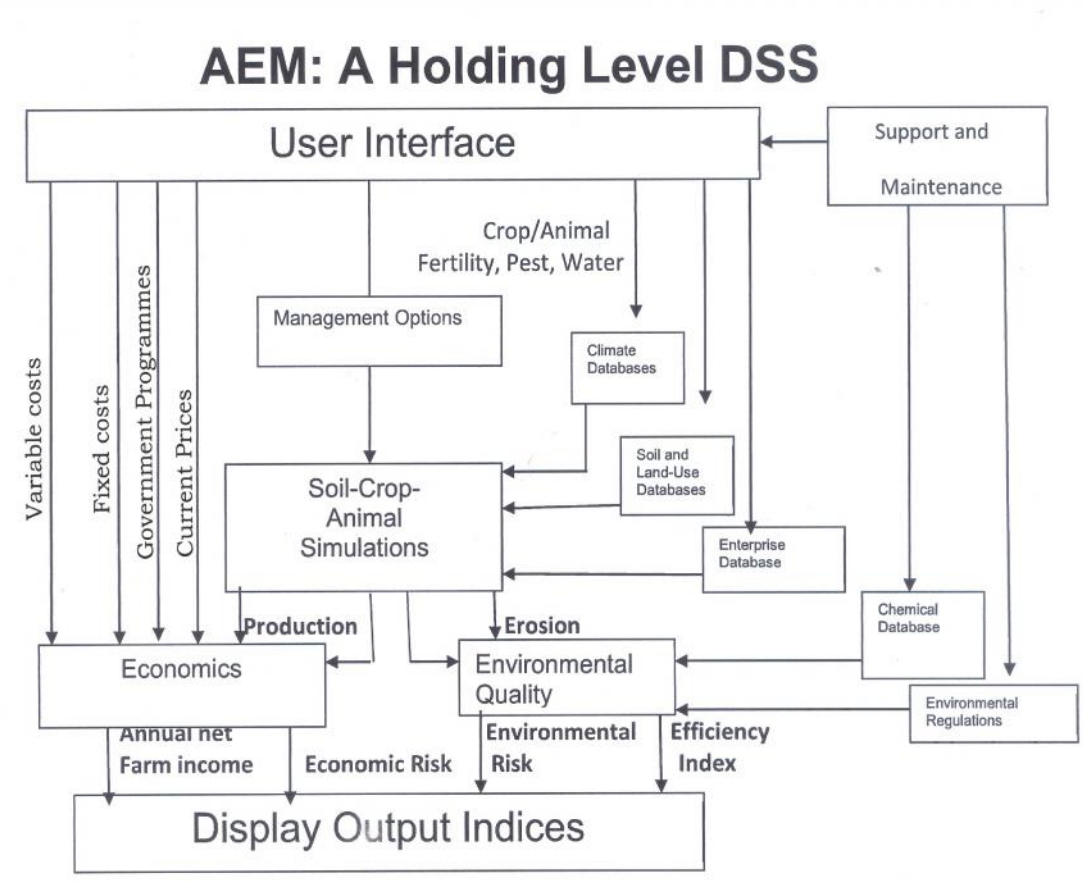
SUMMARY AND CONCLUSION

Societal issues (and agricultural efficiency is one such) observes (Lichtfouse (2009:11) cannot be resolved separately and individually in “which an individual problem is solved by an individual solution. Such an approach does not work anymore for two reasons, at least. First, all systems, mechanisms, and activities are closely intertwined. For instance, food production is closely linked to health, climate change, transportation, market, finance, and politics. Therefore, applying a remedy to only one element of this system will not work because the remedy will induce negative impacts on other elements in the end. Only solutions that consider the whole system and its connections will have a chance to succeed now”. It may well be understood by a study conducted in respect of rice cultivation in India and particularly with reference to the state of Kerala, a major rice growing state in the country. Suchitra (2015:106-109) observes that increasing use of high yielding varieties of seeds (success of which depends largely on chemical inputs (fertilizers and pesticides) supported by corresponding input of water and labour) though is believed to have increased the rice yield by leaps and bounds from 668 kg/ha in 1950 to roughly 2468 kg/ha in 2013-14 India is showing signs of exhaustion”. Bhalla (2014:6-7) also acknowledges the fact that by the early 1980s, the possibilities of extending net sown area were beginning to get exhausted. Since then Net area sown and cultivated area have been contracting because there was a substantial increase in area under non-agricultural uses which could not be compensated for by reductions in barren land, land under miscellaneous tree crops and culturable wasteland. In this process, while some good quality land was lost to non-agricultural uses, cultivation was extended, increasingly, to poorer quality land. As a result the nation, it is reported, has lost about 1.25million hectares of rice lands only between 2011-12 and 2013-14 due to monetary non-viability of the crop under relative inefficiency of land as under obtained environmental condition and pushed by government policies. It may not be out of place to refer to Radhkrishna (2009) who identified two 'dimensions' of agricultural distress - an 'agricultural development crisis, (reflected in low growth, declining profitability of agriculture), and an agrarian crisis (reflected in growing landlessness and casualisation of labour in agiculture, unchecked proliferation of small and marginal holdings, fragmentation of land holdings, and widening gap between rural and urban areas') all reflecting on the national efficiency of agriculture. A study in Kerala, a major rice growing state, suggests that about 76 % of the rice land has been diverted to different land uses in last 40 years. It is estimated that of about 875000 ha area under rice cultivation in 1970 only about 208000 ha are available for rice cultivation in the state. Major cause of depletion of rice land is attributed to mismatch between output and rising costs of input showing low or no profitability despite higher yield per unit cultivated land. Such an outcome requires a systematic study of the components that impact as well as are impacted upon by agricultural practices and ongoing quest for their enhanced efficiency. There seems to be disproportionately a deliberate attempt on the part of the propagators of enhanced productivity to emphasize the need to enhance production/productivity to meet the requirements of the ever increasing population. They seem to overlook that on global as well as national level the total food grain production is about three times more than the present requirements. The problem being cited is not about availability of food, it is about the expansion of agro-based industries and diversion of crops for meeting the energy needs as highlighted in introductory chapter. Besides, proponents equating efficiency with productivity/ production tend to deliberately overlook the environmental consequences of economically more profitable large scale mono-culture. They also seem to avoid the fact that large areas under different agro-climatic regions (an essential component in the evaluation of natural efficiency of agriculture) are being diverted for non-agricultural use year after year to meet the requirement of industries and process of urbanization. Both misleadingly advocated to be bringing about development against numerous studies and World Development Reports that such expansions have been aiding concentration of wealth and econo-political power against the expansion of common men's wellbeing.

Considering the case of Mizoram from obtained conditions, thus, raises questions about the understanding and definition of agricultural efficiency in the state.

This necessitates identifying the different significant components that may be considered to be impinging on the efficiency of agriculture in the state. It is in this light that a flow chart following Ahuja et.al.(2002) and showing the relationship amongst different significant components of agriculture in the state has been prepared as shown below.

Fig 5.19 : Relationship of Different Components of Agriculture



AEM= Agricultural Efficiency Management
DSS= Decision Support System

6.1 Thrust Areas for Future Researches:

As agricultural efficiency of different regions depends on many mutually interacting variables and information on these variables are generally not available at micro levels of agricultural operations, the present study may provide only a symbolic representation of efficiency in context of Mizoram. In the light of the problems faced during and realization of lacunae in the present study, it is felt that future studies should focus on the following areas which seem to be agriculturally, economically, socially and environmentally significant.

- Studies on diversion of agricultural land to non-agricultural uses: They may include studies emphasizing Causes; Changes in productive efficiency of land; social and economic impacts; Environmental costs – Impact on resilience of the ecosystem (land degradation; pollution addition;

- Studies on consumer behaviour of the people and its impact on agricultural land use pattern. They may include study on diversion of land from subsistence to commercial farming at regional/ local levels; diversion of food crops to animal feed and/or for production of energy.

- Quantity (as a ratio of input and output in its temporal dimension) and Quality changes (due to attempts on enlargement of productivity and corresponding changes in the quality of the land) in respect of calorie and/or nutrient values.

6.2 Suggestions:

In order to make Mizoram a viable agriculturally efficient state based on its natural and human resource endowments the following suggestions need to be implemented in the better interest of the state and its economic and environmental health.

1. Interconnection of different components in an agricultural System need to be more thoroughly established for science dependability. It is expected to vary under a variety of soil, climate, and management conditions. This will require experimental data of high resolution both in time and space.

2. Comprehensive shared experimental databases having standardized experimental protocols need to be built to measure values related to modelling variables. It is expected to experimentally verify conceptual model parameters.

3. Better compatible parameters and methods are needed for different spatial and temporal scales. It is expected to help in aggregation of simulation results from plots to fields and larger scales.

4. A mechanism need to be developed for updating the science and databases at earliest to recognize ever expanding knowledge and changing methods. A modular modelling approach with the help of public modular library is believed to help this process.

5. Better communication and coordination is needed not only among model developers in the areas of model development, parameterization and evaluation but also with different stakeholders at community and institutional levels.

6. Collaboration between model developers, field scientists and practicing farmers is needed for understanding the implication of different variables and appropriate data collection.

7. An urgent need exists for filling the most important knowledge gaps: agricultural management effects on soil–plant–atmosphere properties and processes; plant response to water, nutrient and temperature stresses; and effects of natural hazards such as hail, frost, insects, and diseases.

Conclusion:

The study therefore concludes that, several socio-economic and physical characteristics in the study area such as the remote location with the characteristics of mountainous landscape, education, low economic level including inadequate funds (low/ absence of financial assistance), absence of knowledge of new technologies, political turmoil, low density of population, etc were among the major problems faced by the farmers in the study area. Therefore, it is recommended that Public- Private Partnership (PPP) should be adopted or implemented by the Government in order to help the education of the farmers in regard to new technology and innovations. The Government should ensure better funding for the farmers in the State through proper training, seminar, workshops, etc. Financial institutions and private sector should be encouraged to establish in the study area including storage, packaging facilities in order to meet both the local and export of the product. And to enable the farmers for benefitting loom from commercial, agricultural and co-operative banks.

Labour in the study area is family labour which constitutes more than 95% (Source : field survey). This implies that hiring labour do not contribute as much as family labour in the study area. The farmers sourced their capital from their personal saving and from the sale of the previous season product. Only very few farmers sourced their capital from Banks, this indicates that, there is low or no presence of banks or any other financial assistance in the study area. A few years back, the Government has implemented NLUP (New Land-use Policy) and very few farmers have received financial assistance which still is not enough for running a field. The farmers in the study area need more financial assistance or support in order to expand the scale of their activities, expanding land holding, hiring more labour, adopting new technologies and for buying high yielding variety seeds, fertilizers, pesticides, insecticides, machines, etc. Therefore, a reliable financial assistance from the Government and the Banks is highly needed. This inadequate banking and financing facilities have failed to bring out the desired results on production.

Education also affects the productivity through effective resource use, allocation and choice of inputs for production activities. Mostly the farmers are uneducated and illiterate, only the low income families are involved in agriculture. The educated people are not interested in this sector because they thought there is only a little scope for their career in agriculture. The farmers still use the same old system and unscientific method. Absence of proper education and large scale of illiteracy are one of the important reasons for low efficiency.

Little or low input of fertilizers, pesticides and insecticides also results in low production and low efficiency in the study area. Due to the wearing away of soil fertility by erosion, the production showed decreasing year after year. To regain the soil fertility and to overcome the agricultural crisis, more input of fertilizers is highly required. And due to the invasion of pest and insects on the agricultural field, a vast area of land has been destroyed and becomes barren every year. So, it is the requirement for farmers to input more pesticides and insecticides. In this condition financial assistance again has an important part to overcome this entire crisis. And we can also say that due to poverty and ignorance of the farmers, fertilizers, pesticides, insecticides and high yielding variety seeds are unable to be success.

Deforestation due to the continuous practice of shifting agriculture badly effect on the soil fertility. Forest protects soil from massive erosion. The way agriculture been practice in Mizoram leads to a great deforestation and eat away the fertility of the soil. Apart from that, lack of crop rotation system is another factor of the low efficiency rate. To restore the soil fertility, crop rotation and regular following is very essential. Farming as the only way for earning and making a living, the cultivators have to continue their traditional cultivation uninterruptedly. So, there ought to be an improving measures on crop rotation from the Government. Low population concentration is another factor which results in the low number of workers which in turn effect on their agricultural production.

Bibliography

Aggarwal, G.C. (1995) : Fertilizer and Irrigation Management for Energy Conservation in Crop Production, *Fuel and Energy Abstracts,* Vol-36, No.5,pp. 383 (1), Elsevier Publisher

Ahmad, A. and Subbiah, S. (1980) : Determinants of Agricultural Productivity in Tamil Nadu India, *Transaction*, IIG. Vol.2, No 1 pp. 18-31

Alfred, K. and Tarway_Twalla (2013) : *Agricultural Productivity, Climate change and Small Holder Farmers Entrepreneurship: A case study of the Central and Western Regions of Liberia*.pp.1-70

Ahuja, L .R., Ma, Liwang., and Terry, A. Howell. (2002) : *Whole System Integration and Modeling — Essential to Agricultural Science and Technology in the 21st Century* in Ahuja, L. R., Ma, Liwang. Howell, Terry A.(Eds) Agricultural System Models; Lewis Publishers, NY. pp.14-20.

Ahuja, Lajpat, R., Ma, Liwang., Howell, Terry A.(Eds) (2002) : *Agricultural System Models*; Lewis Publishers, New York. pp.350

Sankhian , Anurag., and Dinesh Pratap. (2009) : Economic Evaluation and Constraints of Tea Cultivation in Kangra Valley: Himachal Pradesh. *Annals of the National Association of Geographers,India*. Vol-XXIX,No.2.pp91-99.

Ansari,Y., and Yekani , Seyed-Ali-Hosseini. (2012) : Factors Affecting the Efficiency and Effectiveness of Agricultural Financial Market: The viewpoint of Finance and Credit Expert in Kohgiluye and Boyer Ahamad Province,Iran. Journal of Basic and Applied Scientific Research. Vol-2, No.3.pp.2434-2438.

Armando, B. Mendes., Veska, Noncheva., and Emiliana, Silva. (2013) : Azorean Agriculture Efficiency by PAR in Mendes, A. B.; Silva, E.L.D.G.S.; Santos, J. M. A. (eds) *Efficiency Measures in the Agricultural Sector*; Springer; NY; pp.117-136

Asif (2009) : Levels of Agricultural and Socio-Economic Development in Rohilkhand Region of Uttar Pradesh: A micro Level Analysis. *Annals of the National Association of Geographers,India*. Vol-XXIX,No.2.pp.100-111.

Bagchi,K., (1987) : The Studies on Landuse in Selected Regions of Eastern India, *Geographical Review of India*, Vol-49,No.3,pp.1-12.

Baibhaba,B., and Sharma,P.A., (2011) : Study on Identification of Livelihood Opportunities and Challenges of Forest Dwellers in Upland Areas of North Eastern States of India. *Centre for Economic and Social Studies*, Bequmpet, Hyderabad.pp1-75

Baker, O.E. (1926) : Agricultural Region of North America, *Economic Geography*: Vol-2 pp.459-493

Baker, O.E. (1927) : Agricultural Region of North America, *Economic Geography*: Vol-3 pp.50-86, pp. 309-339,pp. 447-465

Baker, O.E. (1928) : Agricultural Region of North America,

Economic Geography : Vol-4 pp.44-73, pp.339-433

Baker, O.E. (1929) : Agricultural Region of North America : *Economic Geography*, Vol-5: pp.36-49

Baker, O.E. (1930) : Agricultural Region of North America: *Economic Geography*, Vol-6,pp. 166-190, pp. 278-308.

Baker, O.E. (1931)	:	Agricultural Region of North America, *Economic Geography*: Vol-7: pp.109-153, pp. 325-364
Baker, O.E. (1932)	:	Agricultural Region of North America: *Economic Geography*, Vol-8: pp. 325-377
Baker, O.E . (1933)	:	Agricultural Region of North America: *Economic Geography*, Vol-9: pp. 167-197.
Bhalla, S. (2014)	:	Scarce Land:Issues, Evidence and Impact; *Working paper* No. WP 02/2014, Institute for Human Development (IHD); New Delhil, p.28
Bhatia, S.S. (1967)	:	A New Measure of Agricultural Efficiency in Uttar Pradesh, India, *Economic Geography*, Vol.43 No.3; pp.244-60
Bhullar, G.S., and Bhullar, N.K. (eds : 2013)	:	Agricultural Sustainability: Progress and Prospects in Crop Research; Elsevier; London; p. 311
Bongiwe, G. Xaba., and Micah, B. Makusu. (2013)	:	Factors Affecting the Productivity and Profitability of Vegetables Production in Swaziland. *Journal of Agricultural Studies*.Vol-1, No.2. 52p.
Bottelier and Pieter. (2007)	:	Can Learn from China and Vice Versa, *China and World Economy*, Vol- 15, No. 3, May – June, pp. 52- 69 (18)
Catherine, L., Gerrard, L. G., Smith, B., Pearce, S., Padel , R., Hitchings, M. Measures, and Cooper, N (2012)	:	Public Goods and Farming in E.Lichtfouse (ed) *Sustainable Agriculture Reviews*, Vol 10; pp. 1-22

Charles, A.P.Takes. (1963) : *Socio-Economic Factors Affecting Agricultural Productivity in Nigeria* (short account of the research project). United Nations Educational, Scientific and Cultural Organization.pp1-8

Coelli, T. (1996) : *A Guide to DEAP Version 2.1, A Data Envelopment Analysis Computer Programme*. Centre for Efficiency and Productivity Analysis, Department of Econometrics, University of New England, Armidale, Australia.

Cook, Earl. (1975) : *Man, Energy, Society*: W.H. Freeman and Co. San Francisco. p.8

Coppock, J.F. (1964) : Crop, Livestock and Enterprise Combination in England and Wales: *Economic Geography:* Vol-40: pp.79-88

Darku, A. B., Malla, S., and Tran, K. C. (2013) : Historical Review of Agricultural Efficiency; CAIRN: *An ERCA Research Network Studies*; pp 1-78

Dash, L.N. (2007) : Health, Education and Human Development. *Economics of Infrastructure, Growth and Development* (ed.). L.N. Dash, Real Publication, New Delhi. p.159

Dayal, P. (1950) : The Distribution of Cattle and the Problem of Fodder Supply in Bihar, *Calcutta Geographical Review*: pp. 19-27

Endale, K. (2011) : *Fertilizer Consumption and Agricultural Productivity in Ethiopia*, Ethiopian Development Research Institute Addir Ababa, Ethiopia.pp.1-37

Edison,D. (1984) : Agricultural Productivity of India. *A spatial Analysis- Annals of Association of American Geographers*. Vol-74,pp.98-120

Enyedi, G. Y. (1964) : Geographical Types of Agriculture. *An Applied Geography: in Hungary, Budapest.*

Farshad, A., and Zinck, J. A. (2001) : Assessing Agricultural Sustainability Using the Six-Pillar Model: Iran as a Case Study in Gliessman, SR (ed) Agro ecosystem *Sustainability: Developing Practical Strategies*. CRC Press, London; pp.137-150

Fisher, James. S., and Hoy, Don. R . (1992) : More Developed and Less Developed: An Over view in Geography and Development: *A World Regional Approach*: James S.Fisher, Mc Milan Pub. Co. New York, pp.75-107.

Fischer,G., Shah, M., Tubiello, F.N., and Velhuizen,H.V. (2005) : Socio-Economic and Climate Change Impacts on Agriculture: an integrated Assessment,1990-2080. *Philosophical Transactions of the Royal Society.*

Flichman, G., Louhichi, K., and Boisson, J.M. (2011) : Modelling the Relationship Between Agriculture and the Environment Using Bio-Economic Models: Some Conceptual Issues in Flichman, G.(Ed.*) Bio-Economic Models applied to Agricultural Systems*, Springer; New York; pp.233

Foley, J. (2014) : A Five -Step Plan to Feed the World; *National Geographic Magazine*; Vol.1, Series 10; pp. 39-71

Freedma, D., Pisani,R., and Purves, R. (2009) : *Statistics*. Vinod Vaishtha for Viva Books Private Limited, Ansari Road, Daryaganj, New Delhi. 576p.

Friedland, W. (1991) : *Towards a New Political Economy of Agriculture: Introduction* : W. Friedland, L. Busch, F. Buttel and A. Rudy, Boulder, Co. west View Press, pp.1-36

Gliessman. (2001) : The Ecological Foundations of Agro Ecosystem Sustainability. Gliessman, SR (ed) *Agro Ecosystem Sustainability: Developing Practical Strategies*. CRC Press, London; pp. 3-14.

GOM (1998-2014) : *Statistical Abstract*. Department of Agriculture and Minor Irrigation, Mizoram.

GOM (2004) : *Report on Wastelands of Mizoram, Champhai District*, Mizoram Remote Sensing Centre: Science, Technology and Environment Planning Department, Aizawl, Mizoram and National Remote Sensing Agency Department of Space, Hyderabad. 10p.

GOM (2004) : *Report on Wastelands of Mizoram, Aizawl District*. Mizoram Remote Sensing Centre: Science, Technology and Environment Planning Department, Aizawl, Mizoram and National Remote Sensing Agency Department of Space, Hyderabad. 10p.

GOM (2004) : *Report on Wastelands of Mizoram, Saiha District*. Mizoram Remote Sensing Centre: Science, Technology and Environment Planning Department, Aizawl, Mizoram and National Remote Sensing Agency Department of Space, Hyderabad. 10p.

GOM (2006) : *Natural Resources Mapping of Mizoram Using Remote Sensing and G.I.S, Champhai District, Aizawl District and Saiha District*. (A project Report). State Remote Sensing Centre. Science, Technology and Environment Planning Department, Aizawl, Mizoram. Sponsored by North Eastern Council, Shillong. 71p.

GOM (2008) : *Mapping of Potential Areas for Wet Rice Cultivation in Mizoram Using Remote Sensing and G.I.S.* Mizoram Remote Sensing Centre, Science, Technology and Environment Planning Department, Aizawl. 34p.

GOM (2012) : *Statistical Handbook*, Mizoram. Directorate of Economics and Statistics Mizoram, Aizawl.

GOI (2011) : *Census of India*. Economic Survey of India

GOI (2010) : Indian Council of Agricultural Research.(ICAR)

Gregory, S. (1973) : *Statistical Methods and the Geographer*. Longman Group Ltd (formerly Longmans, Green and Co. Ltd). 271p

Greene, W. (2005) : The Econometric Approach to Efficiency Measurement. Lovell K, Fried H, Schmidt S (eds). The measurement of productive efficiency, 2nd edn. O U P, New York

Griggs, David. (1969) : The Agricultural Region of the World: Review and Reflection, *Economic Geography*: Vol-45, pp.96-120

Harvey, D.W. (1990)	:	Between Space and Time: Reflections on the Geographical Imaginations, *Annals of the Association of American Geographers*: Vol-80, pp.418 – 434
Hubert, M. King. (1969)	:	Energy Resources in Resource and Man, *National Academy of Sciences Committee on Resource and Man*: W.H. freeman & co. San Francisco. pp. 157-242.
Hulme.T.,Grosskopt,T., and Hindle,J. (2002)	:	*Agricultural Land Classification*.pp.1-15. New South Wales Agriculture. AGFACTS.
Hussain, M. (1970)	:	Pattern of Crop Combination in Uttar Pradesh: *Geographical Review of India, Kolkata*, Vol-5, No.2,pp.169-185.
Hussain, M. (1996)	:	*Systematic Agricultural Geography* : Rawat Publications, Jaipur pp. 252-253
Hussain,M. (2004)	:	Agricultural Geography. Prem Rawat for Rawat Publications, Jaipur. 430p
Jonasson, O. (1925)	:	Agricultural Regions of Europe, *Economic Geography* : Vol-1 (1925): pp.277-314
Jonasson, O. (1926)	:	Agricultural Regions of Europe, *Economic Geography* : Vol-2 (1926): pp.19-48
Jones, C.F. (1928)	:	Agricultural Regions of South America, *Economic Geography* : Vol-4 (1928): pp.1-30; pp.150-186; pp.267-294:

Jones, C.F. (1929) : Agricultural Regions of South America, *Economic Geography :*Vol-5 (1929): pp.109-140; pp.277-307; pp.390-421

Jones, C.F. (1930) : Agricultural Regions of South America, *Economic Geography :*Vol-6 (1930); pp.1-36

Joshua,Jonah Kunda., Anyanwu, Nneoma.C., Ahmed, Abubakar Jajers. (2013) : Land Suitability Analysis for Agricultural Planning Using G.I.S and Multi-Criteria Decision Analysis Approach in Greater Karu Urban Area, Nasarawa State, Nigeria. *International Journal of Applied Research and Studies (iJARS).*Vol-2,Issue 10 (Oct,2013).pp.1-16.

Kendall, M.G. (1939) : The Geographical Distribution of Crop Productivity in England, *Journal of the Royal Statistical Society*: Vol-162, pp.24-28, (quoted from *Agricultural Geography* by Jasbir Singh and S.S Dhillon, op.cit.241)

Khusro, A.M. (1964) : Returns to Scale in Indian Agriculture, *Indian Journal of Agricultural Economics:* Vol-19, pp.52-53

Kumar.,G. (2012) : *Dynamics of Development and Planning in Mizoram: A comprehensive Regional Analysis.* Kalpaz Publications, C-30, Satyawati Nagar, Delhi. 235p

Kidd, J. S., and Kidd, Renee. A. (2006) : *Agricultural Versus Environmental Science: A Green Revolution*; Chelsea; New York; pp. 208

Simwaka, Kisu., Stuart Ferrer ., and Geoff, Harris. (2011) : Analysis of Factors Affecting Technical Efficiency of Small Holder Farmers: Comparing Time- Varying and Time-Invariant Inefficiency Models. African Journal of Agricultural Research.Vol-8(29) pp.3983-3993.

Klages, K.H.W. (1953) : *Ecological Crop Geography*: Mc Milan, New York, 360 p

Kostrowicky, J. (1964) : Geographical Typology of Agriculture - Principles and Method, *Geographic Polonica*; Vol-1, pp.111- 146

Lalrinchhana. (2004) : Agricultural Inputs and Their Effect in Increasing Productivity in Mizoram with Special Reference to State Income Estimation. Unpublished *Ph.D Thesis*, Mizoram University.

Lalrinmawia. (2012) : Levels of Regional Development: A Case Study of Mizoram. Unpublished *Ph.D Thesis*, Mizoram University.

Lallianthanga, R.K., and Sailo, Robert Lalchhanhima. (2013) : Geospatial Planning for Improved Land Use System in Saiha District, Mizoram, India. Mizoram Remote Sensing Application Centre,Science and Technology,Aizawl.pp1-13

Laxmi,A. (1999) : Impact of Different Sources of Irrigation on Cropping Pattern, Yield and Farm Practices, *Geographical Review of India*, The Geographical Society of India, Calcutta, Vol-54,No.1.pp.19-30

Laxmi,A., and Fazal,S. (1992) : Changing Agricultural Pattern Due to Variation in Prices in Upper Ganga-Yamuna Doab, *The Geographer*,Vol-39,No.1,pp.19-23

Lewis. , Saweda ., and Liverpool, Tasie. (2011) : A Review of Literature on Agricultural Productivity, Social Capital and Food Security in Nigeria. *Nigeria Strategy Support Programme.(NSSP) Working paper* No.21. 53p

Lichtfouse, E. (2009) : Sustainable Agriculture as a Central Science to Solve Global Society Issues in Lichtfouse,E.(ed.) *Sustainable Agriculture Reviews* ,Vol:1, Springer, New York

Ludena,C.E. (2010) : Agricultural Productivity Growth, Efficiency Change and Technical Progress in Latin America and the Caribbean. *IDB Working Paper* Series No.IDB-WP-186.

Mahapatra, R. (2014) : State of Strife; *Down to Earth*(Annual); pp.88-92

Majumder, M., Shukla, A. K., and Arunachalam, A. (2010) : Agricultural Practices in Northeast India and Options for Sustainable Management in E.Lichtfouse (ed) *Sustainable Agriculture Reviews*, Vol 5; pp.287-315.

Misra , S. S. (2008) : Food Crunch, *Down to Earth*: April 15. pp. 22-30

Mukherjee, B.N. (1942) : Agricultural Regions of the United Provinces, *Calcutta Geography Review*: Vol-4, pp.4-16

Negi, B.S. (2007) : *Agricultural Geography*: Kedar Nath Ram Nath, Daryaganj, New Delhi. 551 p

Obasi,P.C.,Henri, Ukoha. A., Ukewihe,I.S., and Chidiebere-Mark,N.M. (2013) : Factors Affecting Agricultural Productivity Among Arable Crop Farmers in Imo State, Nigeria. *American Journal of Experimental Agriculture*. Vol-3(2): pp443-454

OECD. (1981) : The State of Environment, OECD, Paris quoted by Sarah Whatmore in 'Farming to Agri-business: *The Global Agro-Food System'; in Geographies of Global Change (eds)*R.J.Johnson, Peter J. Taylor, Michael.P J. Watts ;Blackwell Oxford (UK*) ;* p.37

Omoregbee,F., and Onemolease, E. (2013) : Empirical Analysis of Factors Affecting Productivity Among Fadama Farmers in Edo South Zone of Edo State,Nigeria. *International Journal of Advancements in research and Technology*,Vol-2,Issue-2

Ott, R. L., and Longnecker, M. (2010) : *An Introduction to Statistical Methods and Data Analysis*; Brooks/Cole; Belmount, USA; 1294p

Pachuau, Rintluanga. (2009) : *Mizoram: A study in Comprehensive Geography*, Northern Book Centre, Ansari Road, Daryaganj, New Delhi. 140p

Radhkrishna, R. (2009) : Forward, in D. Narasimha Reddy and SrijitMisra (eds) *Agrarian Crisis in India*, Oxford University Press

Rindos, D. (1984) : *The Origins of Agriculture : An Evolutionary Perspective*. Academic Press

Roy, P. (1992) : Economic Geography. A study of Resources. Central Educational Enterprises (P) Ltd 54B, Patuatola Lane, Kolkata. 624p

Sadika,H., Siegfried,B., Madan, M.D., Nazmul,H., and Puran, M. (2011) : Role of Socio-Economic Factors to Determine Technical Efficiency of Shrimp Farmers of Bangladesh. *American Journal of Agricultural Science and Engineering Technology*. pp1-10

Safi, M. (1972) : Measurement of Agricultural Productivity of the Great Plains, *the Geographer:* Vol-19, pp.4-13

Safi, M. (1974) : Perspective on Measurement of Agricultural Productivity, *the Geographer*: Vol-22, pp.628

Sampaio, A. (2013) : Review of Frontier Models and Efficiency Analysis: A Parametric Approach in Mendes, A. B.; Silva, E.L.D.G.S.; Santos, J. M. A. (Eds*) Efficiency Measures in the Agricultural Sector;* Springer; New York; pp. 13-35

Sapre, S.G., and Deshpande . (1964) : Inter-District Variation in Agricultural Efficiency in Maharashtra, India, *Journal of Agricultural Economics*: Vol-19, pp.242-252

Saur, Carl. O. (1952) : *Agricultural Origins and Dispersals*: American Geographical Society, New York; 300 p

Schuh, G. E. (2002) : Developing Country Interests in WTO Agricultural Policy, *Political economy of International trade law* : Essay in honor of Robert E. Hudec/ ed. By DLM Kennedy and J.D. Southwick, Cambridge : Cambridge University Press, P. 435 - 449.

Shafi, M. (1960) : Measurement of Agricultural Efficiency in Uttar Pradesh, *Economic Geography*, Vol-36 No.4; pp. 296-305

Shantz , H.L. (1940 - 43) : Agricultural Region of Africa, *Economic Geography*:Vol-16 (1940): pp.1-47; pp.122-161; pp.341-389

Shantz , H.L. (1941) : Agricultural Region of Africa, *Economic Geography*:Vol-17 (1941): pp.217-249; pp.353-379

Shantz , H.L. (1942) : Agricultural Region of Africa, *Economic Geography*:Vol-18 (1942): pp.229-246

Shantz , H.L. (1943) : Agricultural Region of Africa, *Economic Geography*:Vol-19 (1943): pp.77-109; pp.217 – 269

Silva,E., Arzubi, A., and Berbel, J. (2004) : *An Application of Data Envelopment Analysis (DEA) in Azores Dairy Farms*: pp.41-43

Silva, E., Mendes, A. B., and Santos, J. (2013) : Efficiency Measures in the Agricultural Sector: The Beginning in Mendes, A. B.; Silva, E.L.D.G.S.; Santos, J. M. A. (Eds) *Efficiency Measures in the Agricultural Sector;* Springer; New York; pp. 3-12

Singh, J. (1972) : A New Technique for Measuring Agricultural Productivity in Haryana (India), *the Geographer*: Vol-19, pp.15-33

Singh, J. (1979) : A New Technique of Delimiting Agricultural Production Typology in Food Crop Dominated Economy: Haryana a Case Study, *Geographic Polonica*: Vol-40, pp.19-27

Singh, J. (1994) : *India: A Comprehensive Systematic Geography:* GyarodayaPrakashan, Gorakhpur. 424 p.

Singh, J., and Dhillon, S.S. (1994) : *Agricultural Geography* :(2nd Edn.) Tata McGraw Hill Pub Co. Ltd, New Delhi. p.240

Singh, S. (2005) : *CSSM, Crop-Ecological Sustainability Simulation Model: A Spatio-Temporal Crop-Yield Analysis Tool*; Monograph No.GE/SAP-UGC/3 Department of Geography, North Eastern Hill University, Shillong; 100 p

Singh, S. (1980) : Reciprocity Model, Agricultural Development and Regional Planning – A case study of Uttar Pradesh, India, *Transactions,* IIT Geographers. Vol. 2, No. 2, July 1980. Pp.37-47

Singh, V. R. (1979) : A Method for Analysing Agricultural Productivity; *Transactions*, IIG. Vol-1, No.1,July 1979. pp 39-46.

Stamp, L.D. (1958) : The Measurement of Land Resources, *Geographical Review*: Vol-48, pp.1-9

Stamp, L.D. (1960) : *Our Developing World*: Faber and Faber, London. 280 p

Stephen , Kabwe. (2012) : Factors Affecting Efficiency of Small Holder Cotton Producers in Zambia. (a *Dissertation* submitted to the university of Zambia in Partial fulfilment of the requirements of the degree of Master of Science in Agricultural Economics.

Suchitra, M. (2015) : Rice Fatigue in State of India's Environment; *Down to Earth*; CSE, New Delhi

Sun, C. Gan. X., Sun,Z., Liu, T., Tian, T., Wang, L., and Li, J. (2014) : Land Productivity and Food Security in Zhangjiagang, China in E.Lichtfouse(ed) *Sustainable Agriculture Reviews*, Vol-13; pp 291-306.

Svobodova, E., and Vinohradsky, K. (2011) : *Variability in Development of the Landuse Intensity in Agricultural Companies.* ACTA Universitatis Agriculturae et Silviculturae Mendelianae Brunensis. Vol-LIX. No.4,2011

Taylor, G. (1930) : Agricultural Regions of Australia, *Economic Geography*: Vol-6 (1930) pp.109-134, pp.213-242

Tewari, R. T., and Singh, N. (1985) : Development and Productivity in Indian Agriculture *Indian Journal of Regional Science*, Vol- XVII, No- 1. pp 65

Trosset, Michael. W. (2001) : An Introduction to StatisticalInference and Data Analysis; *e-book*- Department of Mathematics, College of William & Mary, P.O. Box 8795,Williamsburg, VA 23187-8795.pp. 225

Trueblood,M.A., and Coggins, J. (2013) : *Inter-Country Agricultural Efficiency and Productivity*: *A malmquist Index Approach*.(Retrieved from Google)

Valkenburg, Van. S. (1931) : Agricultural Regions of Asia, *Economic Geography*:Vol-7 (1931): pp.217-237

Valkenburg, Van. S. (1932) : Agricultural Regions of Asia, *Economic Geography*: Vol-8 (1932) : pp.109-133

Valkenburg, Van. S. (1933) : Agricultural Regions of Asia, *Economic Geography*: Vol-9 (1933) :pp.1-18; pp.109-135

Valkenburg, Van. S. (1934) : Agricultural Regions of Asia, *Economic Geography*: Vol-10 (1934) : pp.14-34

Valkenburg, Van. S. (1935) : Agricultural Regions of Asia, *Economic Geography*:Vol-11 (1935) : pp.227-246; pp.325-337

Valkenburg, Van. S. (1936) : Agricultural Regions of Asia, *Economic Geography*: Vol-12(1936) : pp.27-44; pp.231-249

Weaver, John. C. (1954) : Crop Combination Regions in the Middle West, *Geographical Review*; Vol-44, pp.175-200

Whatmore, Sarah. (1995) : From Farming to Agri-business: The Global Agro-food System. *Geographies of Global Change* op.cit.pp.36-49.

Yezihalem, Tesfa. Dagnaw. (2001) : *Critical Factors Hampering Agricultural Productivity in Ethiopia: The case of Northern Ethiopian Farmers*. pp.1-15

Youngson, M.J. (1967) : *Overhead Capital, A study in Development Economics,* Edinburg University Press, Edinburg.

Yuguda, R.M., Girei. A. A., Dire. B., and Salihu, M. (2013) : Socio-Economic Factors and Constraints Influencing Productivity Among Cassava Farmers in Taraba State, Nigeria. *International Journal of Advances in Agricultural Science and Technology*. Vol-1. Issue.1.pp.1-15.

APPENDIX – I

QUESTIONAIRE

1. NAME OF THE RESPONDENT:

2. SEX OF THE RESPONDENT:

3. NO.OF FAMILY MEMBERS:

SEX		AGE
Male	Female	

4. PERIOD COVERED BY THIS QUESTIONNAIRE:

FROM	TO

5. No. of farmers involved in the farming operation who received regular salaries:

NUMBER	
Male	Female

6. No. of farmers involved in the farming operation but do not received regular salaries:

NUMBER	
Male	Female

7. Total No. of persons involved in the farming operation:

NUMBER	
Male	Female

8. Major Occupation:

NUMBER	
Service	Occupation

9. Total Income of the household:

Cultivation	Service	Business

10. Area under cultivation: ....

11. Major Crops Grown:

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

12. Area under different crops:

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

13. Production of the Crops:

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

14. Production per unit area:

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

15. Investment (Money per Crops):

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

16. Utility Pattern:

Sl.No	Crops	Consumption	Commercial
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

<u>APPENDIX-II</u>

AREA,PRODUCTION AND YIELD OF PRINCIPAL AGRICULTURAL CROPS

Sl.No	Name of Crop	2010-2011			2011-2012		
		Area(Ha.)	Production (MT)	Yield (MT/Ha.)	Area (Ha.)	Production (MT)	Yield 9MT/Ha.)
1	Paddy						
	1) Jhum	28,562	37,854	1.325	25,826	38,064	1.474
	2) WRC-Kharif	12,123	29,567	2.439	12,700	36,149	2.846
	3) WRC-Rabi	7	8	1.143	450	1,353	3.007
	Total	**40,692**	**67,429**	**1.657**	**38,976**	**75,566**	**1.939**
2	Maize	9,005	13,499	1.499	6,905	8,397	1.216
3	Pulses	3,957	6,065	1.533	3,836	5,331	1.389
4	Oilseeds	3,140	3,727	1.187	2,474	2,382	0.963
5	Sugarcane	1,418	7,900	5.571	1,463	7,456	5.096
6	Potato	431	3,666	8.582	409	2,868	7.012

APPENDIX-III

DISTRICT-WISE WRC STATISTICS

Sl.No	District	2011-2012			
		No.of WRC farmer families	Area of WRC cultivated by seasonal rain (Ha)	Area of WRC cultivated by MI (Ha)	Area still to be developed for WRC (Ha)
1	Mamit	867	729	26	554
2	Kolasib	1,344	3,464	155	694
3	Aizawl	665	407	214	670.8
4	Champhai	3,828	2,878	937	1,593
5	Serchhip	1,568	1,257	378	445
6	Lunglei	1,761	813	156	671
7	Lawngtlai	2,019	1,595	44	1,054
8	Saiha	400	403	58	2,450
Total		**12,452**	**11546**	**1968**	**8131.8**

APPENDIX-IV

FOREST AREA IN MIZORAM FOR TE YEAR 2011-2012

Sl.No	India State of Forest Report	Area (in Sq.km)
1	Very Dense Forest	134
2	Moderately Dense Forest	6,149
3	Open Forest	12,900
4	Total Forest Covered	19,183

APPENDIX-V

INSTALLED AND GENERATION OF ELECTRICITY IN MIZORAM

Year	**Diesel**		**Hydel**		**Thermal**		**Import**	**Total**	
	Installed (MW)	Generation (MU)	Installed (MW)37 .52	Generation (MU)	Installed (MW)	Generation (MU)	Generation (MU)	Installed (MW)	Generation (MU)
2010-11	0.50	0.011	17.35	37.52	22.92	1.699	390.24	40.77	429.47
2011-12	0.50	0.022	29.35	18.33	22.92	-	369.58	52.77	387.93

APPENDIX-VI

CATEGORY-WISE LENGTH OF ROADS : MIZORAM (2011-2012)

Sl.No	Type of Roads	Surfaced	Un-Surfaced	Total	Density
1	National Highways	861.12	10.00	871.12	4.13
2	State Highways	1,399.18	264.33	1,663.51	7.89
3	District Roads	1,683.83	636.72	2,320.55	11.01
4	Town Roads	674.87	284.45	959.31	4.55
5	Village Roads	412.93	632.20	1,045.13	4.96
6	Misc. Roads (Un-classified	372.85	1,232.66	1,605.52	7.62
TOTAL		**5,404.78**	**3,060.36**	**8,465.14**	**40.16**

APPENDIX-VII

NUMBER OF HOSPITALS AND HEALTH CENTRES

Sl.No	Particulars	2010-2011	2011-2012
1	**HOSPITALS**		
	Nos	12	13
	Beds	932	932
2	**COMMUNITY HEALTH CENTRES**		
	Nos	12	12
	Beds	360	270
3	**PRIMARY HEALTH CENTRES**		
	Nos	57	57
	Beds	570	570
4	**SUB-CENTRES**	370	370

APPENDIX-VIII

DISTRICT-WISE AREA AND POPULATION

Sl.no	**Name of District**	**Area in ha.**	**Population (2001 Census)**	**Population (2011 Census)**	**Difference from 2001-2011 Census**	**Percentage of increase**
1	Aizawl	357,631	325,676	400,309	74,633	22.9
2	Champhai	318,583	108,392	125,745	17,353	16
3	Kolasib	138,251	65,960	83,955	17,995	27.28
4	Lawngtlai	255,710	73,620	117,894	44,274	60.14
5	Lunglei	453,800	137,223	161,428	24,205	17.64
6	Mamit	302,575	62,785	86,364	23,579	37.56
7	Saiha	139,990	61,056	56,574	-4,482	-7.34
8	Serchhip	142,160	53,861	64,937	11,076	20.56
TOTAL		**2,108,700**	**888,573**	**1,097,206**	**208,633**	**23.47**

APPENDIX-IX

BLOCK-WISE AREA AND POPULATION

Sl.no	Name of RD Block	Area in ha	Population 2011 Census
1	Darlawn Block	103748	26048
2	Phullen Block	51515	13303
3	Aibawk Block	61688	17128
4	Tlangnuam Block	53267	317359
5	Thingsulthliah Block	87413	37897
6	Champhai Block	75867	43040
7	Ngopa Block	73326	18730
8	Khawzawl Block	98792	35931
9	Khawbung Block	70598	22137
10	Bilkhawthlir Block	55280	58487
11	North Thingdawl Block	82971	19840
12	Chawngte Block	68635	45307
13	Bungtlang ‘S’	53400	17126
14	Lawngtlai	77084	38722
15	Sangau Block	56591	16739
16	West Bunghmun Block	138926	18813
17	Lungsen Block	104629	39020
18	Lunglei Block	111706	77482
19	Hnahthial Block	98539	26113
20	Zawlnuam Block	108876	47188
21	West Phaileng Block	99957	21309
22	Reiek Block	93742	17867
23	Saiha Block	45717	35531
24	Tuipang Block	94273	21043
25	Serchhip Block	79860	44242
26	East Lungdar Block	62300	20804
TOTAL		**2108700**	**1097206**

APPENDIX-X

AREA UNDER DIFFERENT SLOPE CLASSES IN MIZORAM BASED ON ALL INDIA SOIL & LANDUSE SURVEY

Sl.no	**Name of RD Block**	**Level to gentle(0-5%)**	**Moderate slope (5-10%)**	**Strongly Sloping (10-15%)**	**Mod. To Steep slope (15-25%)**	**Steep to very Steep (25-33%)**
1	Darlawn Block	144	1,300	4,364	21,611.25	30,213.25
2	Aibawk Block	355	699	747	1,498	7,809
3	Tlangnuam Block	Nil	21.5	448.50	5,590	8,076.50
4	Thingsulthliah Block	Nil	250	999	4,998	7,725
5	Ngopa Block	1,074	268	555	4,686	16,236
6	Khawzawl Block	3,993.75	5,787.50	7,587	16,537	60,157.50
7	North Thingdawl Block	5,316	1,775	5,400	10,065	11,315
8	Chawngte Block	1,181.25	750	1,218	3,075	3,850
9	Lawngtlai	2,570	1,338	1,300	6,640	14,836
10	Sangau Block	262	188	333	661	5,057
11	West Bunghmun Block	1,550	925	925	3,393	7,533.50
12	Lungsen Block	1,825	5,587.50	8,301.25	9,299	12,683
13	Lunglei Block	315	480	852	2,342	6,105
14	Hnahthial Block	168	-	105	1,381	7,142
15	Zawlnuam Block	2,496	2,646	1,878	5,065	16,800

16	West Phaileng Block	987.5	3,175	9,781.25	14,694.75	41,068.75
17	Reiek Block	1,943	624	1,275	14,086	1,236
18	Tuipang Block	1,883	239	1,506	3,843	13,392
19	Serchhip Block	912	1,149	1,406	5,886	13,260
20	East Lungdar Block	1,619	3,346	3,231	13,691	20,216
TOTAL		**28,595**	**30,603**	**55,621**	**149,133**	**304,712**
Percentage to total area		**1.36**	**1.45**	**2.64**	**7.07**	**14.45**

Sl.no	**Name of RD Block**	**Very steep (33-50%)**	**Very very steep (>50%)**	**Ridges**	**Dissected Low Hill**	**Total area of RD Blocks**
1	Darlawn Block	19,165.50	4,974	16,470	-	98,242
2	Aibawk Block	26,835	24,272	899	-	63,114
3	Tlangnuam Block	14,895.50	23,305	2,163	-	54,500
4	Thingsulthliah Block	25,305	250	999	4,998	7,725
5	Ngopa Block	53,180	64,272	5,048	-	145,319
6	Khawzawl Block	37,340	23,897	8,493	-	163,793
7	North Thingdawl Block	12,199	70,399	5,411	3,885	125,765
8	Chawngte Block	26,602.25	23,097	2,487	5,712	67,974
9	Lawngtlai	29,374	48,684	15,263	6,512	128,317

10	Sangau Block	21,432	20,257	1,908	-	50,098
11	West Bunghmun Block	32,785.50	49,061	8,117	30,000	135,899
12	Lungsen Block	31,828	19,018	10,500	5,587	104,630
13	Lunglei Block	45,518	54,591	9,267	-	119,470
14	Hnahthial Block	60,862	19,387	4,755	-	93,800
15	Zawlnuam Block	17,866	19,622	3,157	31,272	100,793
16	West Phaileng Block	26,806.25	4,556	2,506	-	103,576
17	Reiek Block	3,024	70,072	4,527	431	97,218
18	Tuipang Block	37,900	88,004	1,840	-	148,661
19	Serchhip Block	38,547	15,893	3,199	-	80,252
20	East Lungdar Block	26,173	65,140	3,804	-	137,220
TOTAL		**587,638**	**755,331**	**113,744**	**83,400**	**21,08,078**
Percentage to total area		**27.87**	**35.80**	**5.40**	**3.96**	**14.45**

Note; There are 20 blocks during the time of survey (Deptt.of Agriculture - 2008)

APPENDIX –XI

BLOCK-WISE AREA, PRODUCTION AND YIELD OF THE PRINCIPAL AGRICULTURAL CROPS

Sl. No	Block	Total Geographical Area	Total Agricultural Area	Total Agricultural Production	Paddy		Maize		Pulses		Oilseeds		Sugarcane		Potato	
					Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield
1	Aibawk	61688	2598	10028	1748	2711	250	724	274	324	172	165	121	6050	33	54
2	Darlawn	103748	4370	16852	2938	4426	421	1218	460	542	289	323	205	10250	57	93
3	Phullen	51515	2168	8373	1458	2238	209	605	228	270	144	164	101	5050	28	46
4	Thingsulthliah	87413	3680	14194	2474	3768	354	1024	387	457	243	273	172	8600	48	78
5	Tlangnuam	53267	2242	8658	1506	2286		625	236	279	150	171	105	5250	29	47
6	Bunghmun	138926	3559	6680	2560	4849	491	1229	167	225	294	233	53	99	34	45
7	Hnahthial	98539	2553	4745	1817	3449	348	870	119	160	208	164	37	70	24	32
8	Lungsen	104629	2712	5039	1930	3660	370	926	126	170	221	174	40	76	25	33
9	Lunglei	111706	2895	5379	2059	3907	395	989	135	182	236	185	43	80	27	36

10	Ngopa	89177	3834	7834	2917	5534	574	1207	194	238	73	63	37	506	39	286
11	Khawbung	70598	3034	6201	2309	4353	454	955	153	188	58	50	29	435	30	220
12	Khawzawl	158808	6824	13933	5193	9773	1022	2149	345	423	130	112	66	970	69	506
13	E. Lungdar	62300	3322	4933	1612	3350	899	855	765	696	23	15	nil	nil	14	17
14	Serchhip	79860	4259	6320	2079	4295	1152	1095	980	889	30	19	nil	nil	18	22
15	Sangau	56591	1837	3102	1267	2300	281	539	115	162	56	50	7	10	111	41
16	Tuipang	139990	4544	7524	3134	5542	695	1330	285	401	137	124	18	26	275	101
17	Thingdawl	138251	12205	31444	8492	18068	731	1463	777	1776	1897	2236	259	7184	49	717
18	Chawngte	68635	2506	4967	1943	4083	367	717	114	112	81	50	nil	nil	1	5
19	Lawngtlai	130484	4763	9413	3695	7738	699	1364	216	211	152	95	nil	nil	1	5
20	Reiek	93742	2892	5457	1649	3542	562	873	243	295	399	277	28	403	11	67
21	W. Phaileng	99957	3083	5816	1756	3771	599	932	258	316	424	295	30	432	16	70
22	Zawlnuam	108876	3359	6335	1915	4103	653	1014	282	347	463	322	32	462	14	87

APPENDIX-XII

MIZORAM ON WAY TO SELF-SUFFICIENCY IN RICE PRODUCTION (as on 31.3.2014)

1. Population of Mizoram as on 31.3.2009 (Statistical Census,2011 Provisional)	10,91,014
2. Average reguirement of rice per person per year at the rate of 450gram per day	1.64 Qtls
3. Total requirement of rice for 1 year for human consumption only	17,89,263 Qtls
4. Misc. Consumption such as Pigs, Chicken,Dogs, Cattle and other floating population Equal to 2.5 lakhs person for 1 year	4,10,000Qtls
5. Total annual reguirement of rice for Mizoram	21,99,263 Qtls
6. Total production of rice by farmers of Mizoram during 2012-2013	5,89,940 Qtls
7. To attain self-sufficiency, rice required to be produced more 21,99,263 – 5,77,000	16,09,323 Qtls
8. % deficiency in production	73.18%
9. Area cultivated for paddy (Jhum + WRC during 2012-2013)	38,803 Ha.
10. Productivity of rice per ha.	15.20 Qtls
11. More land required to be developed for self-sufficiency in Mizoram	105,876 Ha.

APPENDIX-XIII

YEARWISE AVERAGE RAINFALL REPORT OF MIZORAM DURING LAST 20 YEARS (mm)

Sl.No	**Year**	**No.of Station**	**Total Rainfall Collected**	**Average Annual Rainfall**
1	1993	22	59,223	2.691
2	1994	13	25,605	1,969
3	1995	13	33,670	2,590
4	1996	14	35,806	2,557
5	1997	14	38,956	2,782
6	1998	14	37,371	2,669
7	1999	24	62,421	2,600
8	2000	26	74,952	2,883
9	2001	26	65,908	2,535
10	2002	26	68,842	2,648
11	2003	24	61,103	2,546
12	2004	25	68,786	2,751
13	2005	25	52,349.1	2,094
14	2006	25	58,453.8	2,338.2

15	2007	24	72,229.8	3,140.4
16	2008	23	45,173	2,174.9
17	2009	23	43,305.2	2,051.7
18	2010	22	59,877.9	2,888.5
19	2011	22	46,809.6	2,379.2
20	2012	24	56,367.9	2,532
21	2013	25	62,185.0	2,487

APPENDIX-XIV

DISTRICT-WISE NUMBER OF VILLAGES WITH HOUSEHOLD & CULTIVATOR FAMILIES DURING 2013-2014

Sl. No	District	No.of Villages (*)	Total No.of Household	Total No of Jhum Cultivator families	No. of WRC cultivator families	Total No.of cultivator families	Out of column 7. No. of families operating both Jhum& WRC
1	Aizawl	171	76103	9194	795	9989	297
2	Champhai	103	26649	8955	3968	12923	746
3	Kolasib	46	19558	4142	1377	5519	115
4	Lawngtlai	170	28245	13805	2176	15981	283
5	Lunglei	135	33421	13110	1478	14588	520
6	Mamit	91	17488	3615	943	4558	18
7	Saiha	77	11151	3341	810	4151	531
8	Serchhip	42	13147	2829	1726	4555	-
TOTAL		**835**	**225762**	**58991**	**13273**	**72264**	**2510**

*No.of villages cover all the village councils

APPENDIX-XV

ACHIEVEMENT ON POTENTIAL AREA CONNECTIVITY DURING 2013-2014

Sl. No	Districts	Constructed before 2012-2013		Constructed during 2013-2014		Total length constructed up to 2013-2014	
		Motorable (Km)	Not-Motorable (Km)	Motorable (Km)	Not-Motorable (Km)	Motorable (Km)	Not-Motorable (Km)
1	Aizawl	34	16	139	25	173	41
2	Champhai	38	5	117	-	155	5
3	Kolasib	73	-	14	4	87	4
4	Lawngtlai	19	35.5	9	-	28	35.5
5	Lunglei	55	17	86	8	141	25
6	Mamit	49.5	3	66	-	115.5	3
7	Saiha	-	-	12	-	12	-
8	Serchhip	-	-	105	-	105	-
TOTAL		**266.5**	**81.5**	**548**	**31**	**748.5**	**102.5**

APPENDIX-XVI

SELECTED DISTRICT, RD BLOCKS AND VILLAGES

DISTRICTS	RD BLOCKS	VILLAGES
SAIHA	Saiha	Rawmibawk,Chhuarlung, Zeropoint,Maubawk
	Tuipang	Serkawr, Kawlchaw, Phura, Zawngling, Chapui
AIZAWL	Aibawk	Sailam, Phulpui, Sialsuk
	Thingsulthliah	Tlungvel, Thingsulthliah, Maite
	Phullen	Vanbawng, Phullen, Khawlian
CHAMPHAI	Ngopa	Selam, Ngopa, Changzawl
	Khawzawl	Puilo, Kawlkulh, Chalrang
	Champhai	Tualcheng, Vapar, Champhai