ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue VII, July 2025

Demarcation of Agricultural Productivity Region in Champhai District: Mizoram

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DOI: https://doi.org/10.51583/IJLTEMAS.2025.1407000007

Abstract: 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. 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 dying the fact that it provided mankind a more sedate way of living that later flourished in the river valleys. Most 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.

Keywords: Food, Activity, Agrarian, human culture, population density, agriculture, revolution, civilizations, productivity.

I. Introduction:

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 sq.km 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.

Physiography: The district is characterized by hilly rugged 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 dissected and separated by intervening 'V' shaped valleys. The hillside slopes are genarally 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. The highest peak in the district is Lengteng with a height of 214 metres 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:

1. High Structured Hill: They are mainly found at the peaks of Tan, Lianchhiari lunglen tlang, Dungtlang, Sialkal tlang, Lengteng tlang, Murlen tlang, Khuanglam tlang and Mawmrang tlang. It is mainly confined to the southern, Northern & eastern part of the district.
2. Medium Structured Hill: They are found along the Chhawrtui tlang, Tinghmun tlang and Ngopa – Khawdungsei ridges. It is also found at the foorhills of Tan, Mawmrang, Sialkal, Lengteng and at the central part of the district
3. Low Structured Hill: They form the smallest area in comparision with its counter parts. They are mainly found along the major river valleys such as Tuipui, Tuivawl, Tuivai, Tiau, Tuiphal and Tuichang rivers
4. Valley Fill: They are found mainly along Tuivai, Tuipui,Tuichang,Tuiphal,Tiau and Tuirini rivers and their tributaries.
5. Flood Plain: They are formed by deposition of recent alluvium such as gravel, sand and silt.

Sl. No	Geomorphic Unit	Area (in sq km)	%
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.

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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 many places there are evidences of facies changes. The contacts of beds are often gradational. Some of the sandstone beds are massive and provide dimension stones and road metal for the area and are mined in small quarries along the main roads. The hills are approximately N-S trending,steep,mostly anticlinal and the intervening valleys are usually 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:

Sandstone: Few thick beds of sandstones are found in some areas.

Siltstone- shale: This group occupies the core of anticlines, flanked on either side by the rocks of upper Bhuban formation.

Clayey Sand: Clayey sand deposits are found scattered all over the area along small streams and valley fills between the hills.

Gravel, Sand & Silt: They are generally found along the major rivers like Tuichang, Tuivai, Tuivawl, Tuisa lui, Tiau, Tuiphal and Tuipui rivers

Sl. No	Rock Types	Area (in sq km)	%
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: 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.

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 agricultural land, near Champhai forming the largest fluvial plain in the state, which may be called " Rice bowl of Mizoram". The drainage system has been divided into the following types :

Sl. No	Drainage System	Description
1	Tiau Drainage System	The river 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. It is elongated in north to south and form tha dendritic to sub- dendritic patterns.
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. It is alongated in north to south direction showing dendritic to sub- dendritic drainage patterns.
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 inportant tributaries. It is alongated in north to south direction showing dendritic to sub- dendritic drainage patterns
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. Dendritic to sub- dendritic drainage patterns are found in this system.
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 take U-turn and flows southward. Then, again take

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		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.
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. Its 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 potential : The ground water potential zone of Champhai district are as under:

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 include the intersection of the structural units such as lineaments and faults, with valley fill and flood plains. Lithologically, this zone comprise areas where unconsolidated sediments such as gravel,silt ,sand and clayey sand are deposited. Locally, this zone covers the entire valley plain of Champhai, the plain of Tuilak lui near Hnahlan village and the valley plain of major rivers,etc. All the spring and hand pumps located within the settlement area also fall in this zone.

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 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. This zone is mainly confined to the western part of the study area.

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.

Poor : 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. 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.

Sl. No	Potential zones	Area (in sq km)	%
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.

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 4ºC to 33ºC. 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.

Rainfall : Champhai 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 rainfall is 2153mm per annum. Precipitation is heavy during summer. The occurrence of south west monsoon makes the climate favourable for inhabitants of the state as the temperature kept down to a considerable extent by the usual rains. Normally, July and August are the rainiest months while December and January are the driest months.

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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	-	-

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 abd yellow loamy are found. Soils in the valley are alluvial and colluvial origin. The soil developed on different landforms consists 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 soil types are as under :

Sl. No	Physiography	Soil composition	Area (in sq km)	%
1	Hill top/ Hill crest	L.S. Typic Dystrochrepts L.S. Typic Udorthents L.S. Typic Hapludults	13.06	0.41
2	Hill side 10-25% slope with current Jhum and horticulture	F.L. Typic Dystrochrepts Clayey Typic Dystrochrepts L.S. Typic Hapludults	17.20	0.54
3	Hill side 10- 25% slope with abandoned Jhum	F.L. Typic Dystrochrepts L.S. Typic Hapludults 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% slope with Dense forest and Forest Plantation	F.L. Humic Hapludults F.L. Umbric Dystrochrepts Clayey Humic Hapludults	175.22	5.50
6	Hill side 25-50% slope with current Jhum and horticulture	Clayey Typic Hapludults L.S. Umbric Dystrochrepts F.L. Typic Hapludults	97.17	3.05
7	Hill side 25- 50% slope with abandoned Jhum	L.S Typic Dystrochrepts L.S Umbric Dystrochrepts F.L Typic Hapludults	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% slope with dense forest and forest plantation	Clayey Humic Hapludults F.L. Humic Hapludults Clayey Typic Hapludults	944.92	29.66
10	Hill side > 50% slope with current Jhum and horticulture	L.S. Humic Hapludults L.S. Umbric Dystrochrepts F.L. Humic Hapludults	76.15	2.39
11	Hill side > 50% slope with abandoned Jhum	L.S. Typic Dystrochrepts F.L. Typic Hapludults L.S. Humic Hapludults	248.81	7.81

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12	Hill side > 50% slope with open forest	L.S. Typic Hapludults L.S. Humic Hapludults F.L. Typic dystrochrepts	126.48	3.97
13	Hill side > 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	F.L .Aquic Dystrochrepts Clayey Humic Epiaquepts F.L. Fluventic Dystrochrepts	98.44	3.09
15	Built-up land		12.74	0.40
16	Water body		8.92	0.28
	TOTAL		**3185.83**	**100.00**

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

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, Rododendronsps, 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.

Landuse/Land cover: The major landuse/land cover classes within the district can be broadly categorized into the following

Sl.No	Class	Description	Area(Sq km)	%
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. Champhai District includes five towns i.e. Champhai, Khawzawl, Ngopa, Biate, Khawhai and 98 villages	17.19	0.54
2	Agriculture land:	These are lands primarily used for farming and for production of food, fibre and other commercial horticultural crops. It includes land under crops (irrigated and un-irrigated, plantations, etc.		
	2.1 Kharif	Kharif crop land refers mainly to the wet rice cultivation areas located in the low lying plains. Unlike other districts, Champhai district has an extensive flat land near Champhai, Khawzawl and Hnahlan. The wet rice cultivation areas are usually located at the banks of rivers, streams and sometimes close to settlement areas, where soil and water supply is suitable for its establishment and growth	29.66	0.93
	2.2 Plantation	This class includes areas, which is being utilized for plantation of cash crops. They include a variety	8.09	0.25

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		of agricultural/horticultural plantations, of which the prominent ones includes Grapes, Passion fruit, Citrus Woodlands, Tea, Pineapple and Tung plantations.		
3	Forest 3.1 Dense	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.	663.99	20.84
	3.2 Medium Dense	The forests that have a crown cover neither too thick nor too thin are classed under this category The forest under this category has a thin crown cover. This type of forest includes forest, which were once disturbed and affected by biotic factors like shifting cultivation and human activities.	577.77	18.14
	3.3 Less den	These forests are characterized by those lands where shifting cultivation had been practiced and then left fallow for over a year, the resultant new vegetation of which, regenerated to form new forests	805.38	25.28
	3.4 Bamboo	Bamboo forests is not as abundant in Champhai district as compared to other districts. They are found concentrated at the western part, northern tip and along the banks of river Tiau on the eastern side of the district.	307.30	9.64
	3.5 Forest Plantation	Forest plantations are distributed throughout the district. Some has large coverage while most of them have area below the minimum mapable unit. The prominent forest plantations are Teak, Michelia, Gamari and Pine	10.22	0.33
4	Shifting Cultivation 4.1 Current shifting cultivation	It is a traditional practice of growing crops on forested/vegetated hill slopes by slash and burn method. These are associated with mountainous/hilly areas amidst forest cover and forest cleared areas.	164.48	5.16
	4.2 Abandoned shifting cultivation	These are areas that were under shifting cultivation, left idle for more than one year but less than three years thereby giving scope for the regeneration of the secondary vegetation especially bamboo or grasses	561.44	17.62

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5	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.	31.65	0.99
6	Water body	This category comprises areas with surface water, either impounded in the form of ponds, lakes or flowing as streams and rivers, etc	8.85	0.28
	Total		**3185.83**	**100.00**

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

Population characteristics of the study area: The Department of School Education and that of the Higher & Technical Education are in charge of human resource development. Like in the rest of India, a scheme for quality for all (SSA) was introduced in 2003 in Mizoram. Under this scheme, all children in the age group of 6 to 14 years are expected to attend school. In 2003, there were 8,986 out of school children from this age groups compared to 17,993 in 2002, representing a signal progress. For the age group of 15 to 35 years, a new project called 'Eradication of Residual illiteracy' (ERIP) has been introduced. With the implementation of these two projects, the State expects to achieve full literacy by 2007. Population in the study area is 1,091,014 as per 2011 census. The population density is 52 persons per Sq Km.

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 programme 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 22 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 22 notified towns is 441,006 and the rest 447,567 is distributed in the 707 villages which indicate that the average population in the villages is about 633. This again indicates that the distribution of population between rural and urban areas is 50.37 % and 49.63% respectively. This indicates that the state is highly urbanized.

Sl. No	Name of District	Area (sq/km)	Population	Density (per sq.km)	Percentage of total population
1	Aizawl	3576.31	325676	91	36.65
2	Champhai	3185.83	108392	34	12.20
3	Kolasib	1382.51	65960	47	7.42
4	Lawngtlai	2557.10	73620	28	8.29
5	Lunglei	4538.00	137233	30	15.44
6	Mamit	3025.75	62785	21	7.07
7	Saiha	1399.00	61056	43	6.87
8	Serchhip	1421.60	53861	37	6.06
9	MIZORAM	21087.00	888573	42	100

Source: Statistical Handbook, Mizoram, 2004

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 has a density of 52 persons per sq. Km. The population density is comparatively low due to its remote location with a characteristics of mountainous landscapes, low economic level, political instability, etc.

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Age & 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 interviewed family in the study area is divided into four groups where the age group of 16-50 years considered as the active population group constituted the largest percentage which is 47.41% of the total interviewed population followed by the age group of 5-15 years which constituted 24.30%. The age group of below 5 years constituted the smallest percentage of 9.56% .

Below 5	5 – 15	16 – 50	Above 50
9.56 %	24.30%	47.41%	18.72%

The sex composition of the study area clearly shows that male population has put more effort in farming activities than the females. Male workers accounts for 51.7 % while the female workers contributed 48.3%. 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 of a country 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. **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 %

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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.

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.

Sl. No	District	Literacy (in percentage)
1	Aizawl	98.50
2	Champhai	93.51
3	Kolasib	94.54
4	Lawngtlai	66.41
5	Lunglei	89.40
6	Mamit	85.96
7	Saiha	88.41
8	Serchhip	98.76
9	MIZORAM	91.58

Source: Statistical Handbook of Mizoram 2012.

Productivity 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.

Aims and Objectives of the Study: Assessment of agricultural 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.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue VII, July 2025

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 productivity regions within Champhai District.

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 productivity. 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.

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 productivity 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.

II. 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 19th 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

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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 19th 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

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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.

Gliessman (2001;3) equates agricultural efficiency with sustainability of agro eco 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.

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.

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 productivity 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.

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.

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

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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.

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.

III. 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.

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

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.

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 productive 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.

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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 productivity.

In order to calculate slope as a determining factor on productivity, 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 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 showing level of Significance between Slope and Agricultural productivity

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			
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 showing Expected Value of the Dependent Variable

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	.306	.023		13.173	.000

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	Slope	-.008	.002	-.864	-4.533	.003
Dependent Variable: E						

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 productivity.

Table: 5.7 Champhai District: Distribution of Agricultural Land on different Slope Categories and Agricultural Productivity of the villages

Slope in ^{0}	**Tual-cheng**	**Vapar**	**Selam**	**Puilo**	**Kawl-kulh**	**Chalrang**	**Ngopa**	**Chang-zawl**	**Cham-phai**
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

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue VII, July 2025

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 productivity than the cultivated lands above 20^0.

Percentile Distribution of Slopes in Champhai

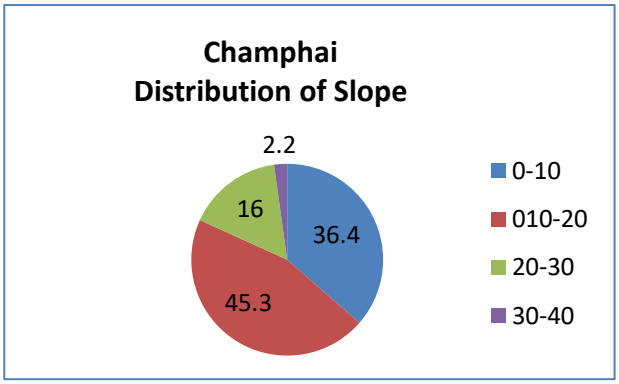
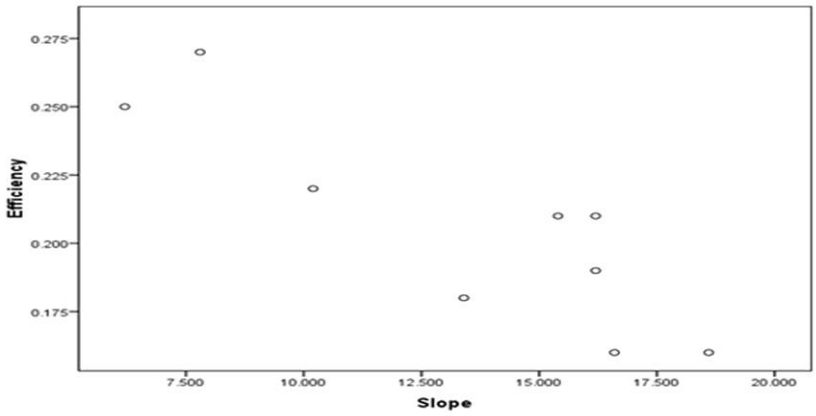


Fig Showing Relationship of Productivity with Slope categories



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 showing Champhai District: Agricultural Productivity 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 productivity in the district.

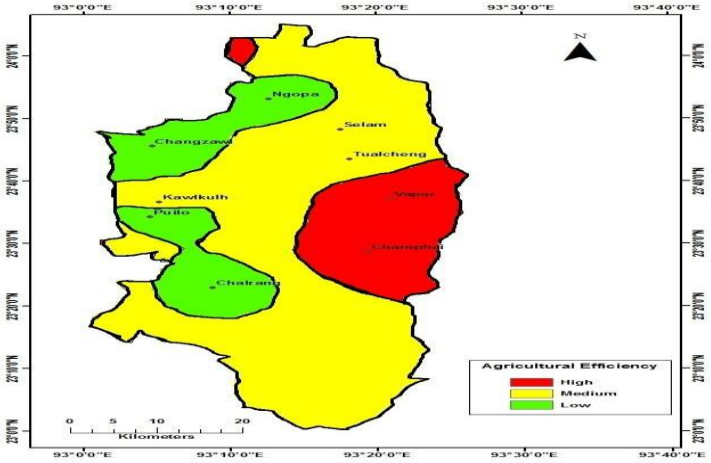
Table showing Champhai District:

Area holds by productivity

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

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Agricultural Productivity based on Slope



Productivity 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.

Champhai District: Input and Output Ratio with productivity

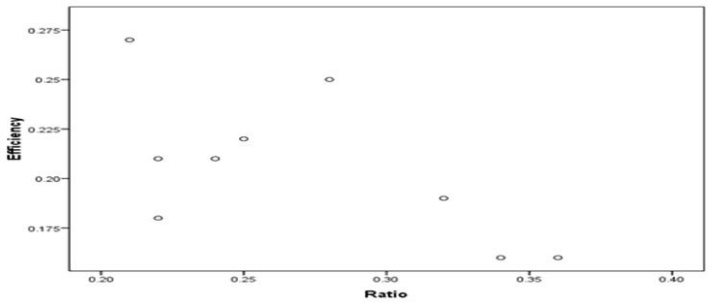
Villages	Input	Output	Ratio	Productivity
Tualcheng	201250	782840	0.25	0.22
Vapar	179530	809600	0.22	0.25
Selam	213500	911560	0.23	0.21
Puilo	291750	839200	0.34	0.16
Kawlkulh	257800	1041400	0.24	0.21
Chalrang	327250	1010080	0.32	0.19
Ngopa	309780	1068240	0.28	0.18
Changzawl	465250	1262120	0.36	0.16
Champhai	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 productivity with input/output ratio, the data has been processed by using SPSS software of Regression method, 40.5 % of the productivity can be explained which is less to prove the relationship between input and agricultural productivity 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.

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 productivity have lower inputs where as the villages grouped into a low category has high inputs which result in high production. When we go through to the above equation, we come up to the results that input does have any impact on productivity. It is not statistically significant when we acquired the result.

Relationship of Input / Output Ratio with Productivity



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Scatter Plot of Fig 5.5 provides us that there is no relationship between productivity and input/ output ratio which existed in the district of Champhai. Here, we came to identify that input do have any impact on productivity.

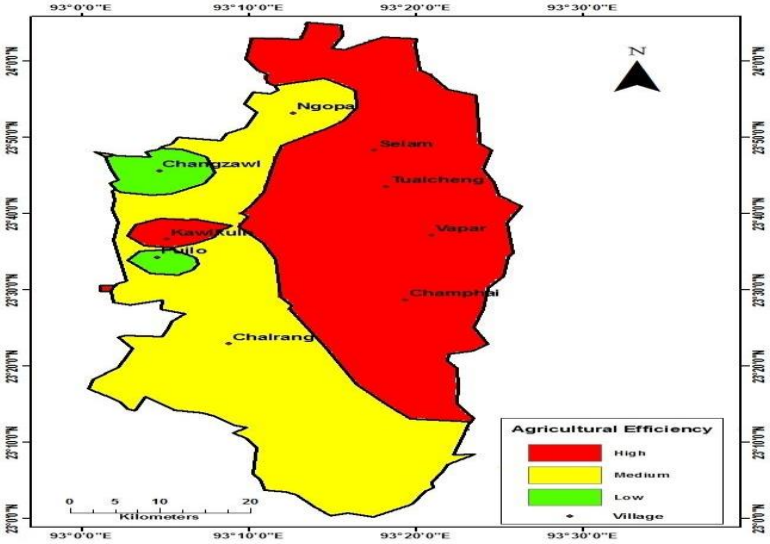
Champhai District: Agricultural Productivity villages based on Input/output Ratio

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

Area hold by productivity based on Input

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

Agricultural Productivity (based on Input/Output Ratio)



IV. 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

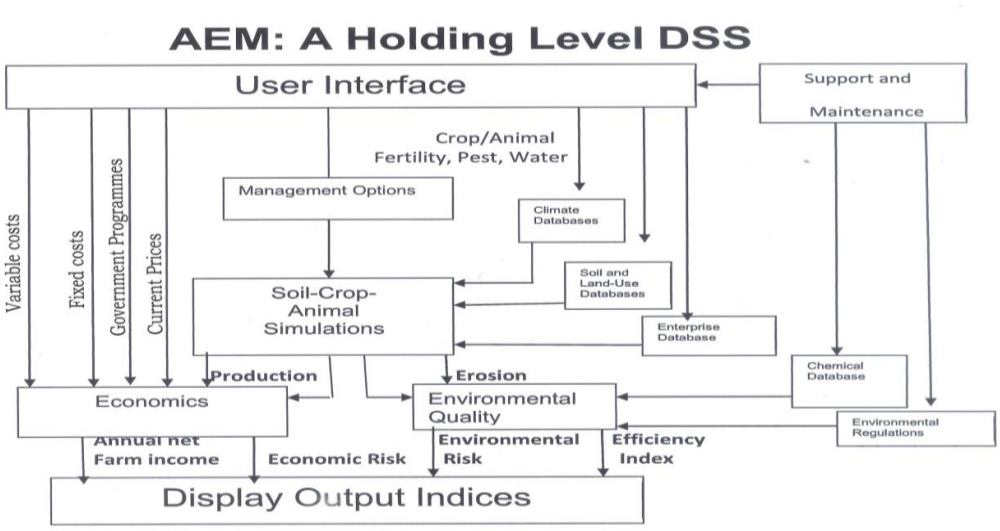
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major rice growing state, suggests that about 76 % of the rice land has been diverted to different land uses in last 40 years. It is estimated that of about 875000 ha area under rice cultivation in 1970 only about 208000 ha are available for rice cultivation 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.

Relationship of Different Components of Agriculture



AEM= Agricultural Efficiency Management DSS= Decision Support System

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.

Suggestions:

In order to make Mizoram a viable agriculturally productive district 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.

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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.

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.

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.

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.

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.

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

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.

V. 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.

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References:

1. Ahmad, A. and Subbiah, S. (1980) : Determinants of Agricultural Productivity in Tamil Nadu India, Transaction, IIG. Vol.2, No 1 pp. 18-31
2. 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
3. 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.
4. Ahuja, Lajpat, R., Ma, Liwang., Howell, Terry A.(Eds) (2002) : Agricultural System Models; Lewis Publishers, New York. pp.350
5. 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. pp.91-99.
6. 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.
7. 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
8. 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.
9. Bagchi,K., (1987) : The Studies on Landuse in Selected Regions of Eastern India, Geographical Review of India, Vol-49,No.3,pp.1-12.
10. 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
11. Baker, O.E. (1926) : Agricultural Region of North America, Economic Geography: Vol-2 pp.459-493
12. Baker, O.E. (1927) : Agricultural Region of North America, Economic Geography: Vol-3 pp.50-86, pp. 309-339,pp. 447-465
13. Baker, O.E. (1928) : Agricultural Region of North America, Economic Geography : Vol-4 pp.44-73, pp.339-433
14. Baker, O.E. (1929) : Agricultural Region of North America : Economic Geography, Vol-5: pp.36-49
15. Baker, O.E. (1930) : Agricultural Region of North America: Economic Geography, Vol-6,pp. 166-190, pp. 278-308.
16. Baker, O.E. (1931) : Agricultural Region of North America, Economic Geography: Vol-7: pp.109-153, pp. 325-364
17. Baker, O.E. (1932) : Agricultural Region of North Americ : Economic Geography, Vol-8: pp. 325-377
18. Baker, O.E . (1933) : Agricultural Region of North America : Economic Geography, Vol-9: pp. 167-197.
19. Bhullar, G.S., and Bhullar, N.K. (eds : 2013) : Agricultural Sustainability: Progress and Prospects in Crop Research; Elsevier; London; p. 311
20. 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.
21. 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
22. 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.
23. Coppock, J.F. (1964) : Crop, Livestock and Enterprise Combination in England and Wales: Economic Geography: Vol-40: pp.79-88
24. 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
25. Dayal, P. (1950) : The Distribution of Cattle and the Problem of Fodder Supply in Bihar, Calcutta Geographical Review: pp. 19-27
26. Endale, K. (2011) : Fertilizer Consumption and Agricultural Productivity in Ethiopia, Ethiopian Development Research Institute Addir Ababa, Ethiopia.pp.1-37
27. Edison,D. (1984) : Agricultural Productivity of India. A spatial Analysis- Annals of Association of American Geographers. Vol-74,pp.98-120
28. Enyedi, G. Y. (1964) : Geographical Types of Agriculture. An Applied Geography: in Hungary, Budapest.
29. 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
30. 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.
31. 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.
32. 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

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue VII, July 2025

33. Foley, J. (2014) : A Five -Step Plan to Feed the World; National Geographic Magazine; Vol.1, Series 10; pp. 39-71
34. Freedma, D., Pisani, R., and Purves, R. (2009) : Statistics. Vinod Vaishtha for Viva Books Private Limited, Ansari Road, Daryaganj, New Delhi. 576p.
35. 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
36. GOM (1998-2014) : Statistical Abstract. Department of Agriculture and Minor Irrigation, Mizoram.
37. 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.
38. 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.
39. 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.
40. 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.
41. 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.
42. GOM (2012) :Statistical Handbook, Mizoram. Directorate of Economics and Statistics Mizoram, Aizawl.
43. GOI (2011) : Census of India. Economic Survey of India
44. GOI (2010) : Indian Council of Agricultural Research.(ICAR)
45. Gregory, S. (1973) : Statistical Methods and the Geographer. Longman Group Ltd (formerly Longmans, Green and Co. Ltd). 271p
46. Griggs, David. (1969) : The Agricultural Region of the World: Review and Reflection, Economic Geography: Vol-45, pp.96-120
47. 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
48. 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.
49. Hulme.T.,Grosskopt,T., and Hindle,J. (2002) : Agricultural Land Classification.pp.1-15. New South Wales Agriculture. AGFACTS.
50. Hussain, M. (1970) : Pattern of Crop Combination in Uttar Pradesh: Geographical Review of India, Kolkata, Vol-5, No.2,pp.169-185.
51. Hussain, M. (1996) : Systematic Agricultural Geography : Rawat Publications, Jaipur pp. 252-253
52. Hussain,M. (2004) : Agricultural Geography. Prem Rawat for Rawat Publications, Jaipur. 430p
53. Jonasson, O. (1925) : Agricultural Regions of Europe, Economic Geography : Vol-1 (1925): pp.277-314
54. Jonasson, O. (1926) : Agricultural Regions of Europe, Economic Geography : Vol-2 (1926): pp.19-48
55. Jones, C.F. (1928) : Agricultural Regions of South America, Economic Geography : Vol-4 (1928): pp.1-30; pp.150-186; pp.267-294:
56. Jones, C.F. (1929) : Agricultural Regions of South America, Economic Geography :Vol-5 (1929): pp.109-140; pp.277-307; pp.390-421
57. Jones, C.F. (1930) : Agricultural Regions of South America, Economic Geography :Vol-6 (1930); pp.1-36
58. 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.
59. 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)
60. Khusro, A.M. (1964) : Returns to Scale in Indian Agriculture, Indian Journal of Agricultural Economics: Vol-19, pp.52-53
61. Kumar.,G. (2012) : Dynamics of Development and Planning in Mizoram : A comprehensive Regional Analysis. Kalpaz Publications, C-30, Satyawati Nagar, Delhi. 235p
62. Kidd, J. S., and Kidd, Renee. A. (2006) : Agricultural Versus Environmental Science: A Green Revolution; Chelsea; New York; pp. 208
63. 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.
64. Klages, K.H.W. (1953) : Ecological Crop Geography: Mc Milan, New York, 360 p
65. Kostrowicky, J. (1964) : Geographical Typology of Agriculture - Principles and Method, Geographic Polonica; Vol-1, pp.111- 146
66. 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.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue VII, July 2025

67. Lalrinmawia. (2012) : Levels of Regional Development: A Case Study of Mizoram. Unpublished Ph.D Thesis, Mizoram University.
68. 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
69. 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
70. 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
71. 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
72. 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
73. 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.
74. Mahapatra, R. (2014) : State of Strife; Down to Earth (Annual); pp.88-92
75. 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.
76. Misra, S. S. (2008) : Food Crunch, Down to Earth: April 15. pp. 22-30
77. Mukherjee, B.N. (1942) : Agricultural Regions of the United Provinces, Calcutta Geography Review: Vol-4, pp.4-16
78. Negi, B.S. (2007) : Agricultural Geography: Kedar Nath Ram Nath, Daryaganj, New Delhi. 551 p
79. 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
80. 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
81. Ott, R. L., and Longnecker, M. (2010) : An Introduction to Statistical Methods and Data Analysis; Brooks/Cole; Belmount, USA; 1294p
82. Pachuau, Rintluanga. (2009) : Mizoram: A study in Comprehensive Geography, Northern Book Centre, Ansari Road, Daryaganj, New Delhi. 140p
83. Radhkrishna, R. (2009) : Forward, in D. Narasimha Reddy and SrijitMisra (eds) Agrarian Crisis in India, Oxford University Press
84. Rindos, D. (1984) : The Origins of Agriculture : An Evolutionary Perspective. Academic Press
85. Roy, P. (1992) : Economic Geography. A study of Resources. Central Educational Enterprises (P) Ltd 54B, Patuatola Lane, Kolkata. 624p
86. Safi, M. (1972) : Measurement of Agricultural Productivity of the Great Plains, the Geographer: Vol-19, pp.4-13
87. Safi, M. (1974) : Perspective on Measurement of Agricultural Productivity, the Geographer: Vol-22, pp.628
88. 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
89. Sapre, S.G., and Deshpande. (1964): Inter-District Variation in Agricultural Efficiency in Maharashtra, India, Journal of Agricultural Economics: Vol-19, pp.242-252
90. Saur, Carl. O. (1952) : Agricultural Origins and Dispersals: American Geographical Society, New York; 300p
91. 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.
92. Shantz , H.L. (1940 - 43) : Agricultural Region of Africa, Economic Geography:Vol-16 (1940): pp.1-47; pp.122-161; pp.341-389
93. Shantz , H.L. (1941) : Agricultural Region of Africa, Economic Geography:Vol-17 (1941): pp.217-249; pp.353-379
94. Shantz , H.L. (1942) : Agricultural Region of Africa, Economic Geography:Vol-18 (1942): pp.229-246
95. Shantz , H.L. (1943) : Agricultural Region of Africa, Economic Geography:Vol-19 (1943): pp.77-109; pp.217 – 269
96. Silva,E., Arzubi, A., and Berbel, J. (2004) : An Application of Data Envelopment Analysis (DEA) in Azores Dairy Farms: pp.41-43
97. Singh, J. (1972) : A New Technique for Measuring Agricultural Productivity in Haryana (India), the Geographer: Vol-19, pp.15-33
98. 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
99. Singh, J. (1994) : India : A Comprehensive Systematic Geography: GyarodayaPrakashan, Gorakhpur. 424 p.
100. Singh, J., and Dhillon, S.S. (1994) : Agricultural Geography : (2nd Edn.) Tata McGraw Hill Pub Co. Ltd, New Delhi. p.240
101. 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

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue VII, July 2025

102. 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
103. Singh, V. R. (1979) : A Method for Analysing Agricultural Productivity; Transactions, IIG. Vol-1, No.1, July 1979. pp 39-46.
104. Stamp, L.D. (1958) : The Measurement of Land Resources, Geographical Review: Vol-48, pp.1-9
105. Stamp, L.D. (1960) : Our Developing World: Faber and Faber, London. 280 p
106. Suchitra, M. (2015) : Rice Fatigue in State of India's Environment; Down to Earth; CSE, New Delhi
107. 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.
108. Taylor, G. (1930) : Agricultural Regions of Australia, Economic Geography: Vol-6 (1930) pp.109-134, pp.213-242
109. Tewari, R. T., and Singh, N. (1985) : Development and Productivity in Indian Agriculture, Indian Journal of Regional Science, Vol- XVII, No- 1. pp 65
110. Trosset, Michael. W. (2001): An Introduction to Statistical Inference and Data Analysis; e-book- Department of Mathematics, College of William & Mary, P.O. Box 8795, Williamsburg, VA 23187-8795.pp. 225
111. Trueblood,M.A., and Coggins, J. (2013) : Inter-Country Agricultural Efficiency and Productivity: A malmquist Index Approach. (Retrieved from Google)
112. Valkenburg, Van. S. (1931,1932,1933) : Agricultural Regions of Asia, Economic Geography:Vol-7 (1931): pp.217-237 . Vol-8 (1932) : pp.109-133. Vol-9 (1933) :pp.1-18; pp.109-135
113. Valkenburg, Van. S. (1934,35,36) : Agricultural Regions of Asia, Economic Geography: Vol-10 (1934) : pp.14-34 ,Vol 11(1935):pp.227-246; pp.325-337, Vol-12(1936) : pp.27-44; pp.231-249
114. Weaver, John. C. (1954) : Crop Combination Regions in the Middle West, Geographical Review; Vol-44, pp.175-200
115. Whatmore, Sarah. (1995) : From Farming to Agri-business: The Global Agro-food System. Geographies of Global Change op.cit.pp.36-49.
116. Yezihalem, Tesfa. Dagnaw. (2001) : Critical Factors Hampering Agricultural Productivity in Ethiopia: The case of Northern Ethiopian Farmers. pp.1-15
117. 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.