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The potential of wet rice cultivation in Mizoram, India: A case for attaining self sufficiency in food security

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Abstract

A large number of rural people in Mizoram are fully dependent on agriculture for running their livelihoods. Paddy is the staple crop, grown both under shifting and wet rice cultivation whereas arable land under paddy is significantly low under wet rice cultivation. This paper examines the potential of wet rice cultivation to attain self-sufficiency in food security in Mizoram based on Time series data of 2009-10 and 2014-15 on area, production, and yield of wet rice cultivation. It has been suggested that if a sizeable portion of arable land is devoted to wet rice cultivation and adequate irrigation facilities are provided, then the production and yield of rice will increase multifold.

Key Words: WRC, food security, self-sufficiency, system rice intensification, Mizoram

Introduction

Half of the world's population produces and relies on the consumption of paddy (rice), a staple diet, and important food crop, mainly in the tropical and sub-tropical climate zones (Ramakrishnan, 1992a; Swift *et al.*, 1996). Wet Rice Cultivation (WRC) is irrigated and practiced in tropical countries mainly in Asia, where about 90% of the world's rice is grown because of suitable geographical and climatic conditions. The yield of WRC as well as quality of rice varies significantly depending upon the socio-ecological conditions (Ramakrishnan, 1992b; Mitchell, 1979; Nguu and Palis, 1977; Dazhong and Pimental, 1984; Leach, 1976).

Rice is the staple food in India, grown in the vast wetland of the river valleys, mainly the Ganges and the Brahmaputra, which are considered suitable for the cultivation of paddy (Raghavan, 1964). Further, the coastal regions such as the states of Tamil Nadu, Andhra Pradesh, Odisha, and West Bengal grow rice in large areas (Subbalakshmi *et al*., 2020).

The state of Mizoram, an eastern extension of the Himalaya, has a primitive economy. Agriculture is the major source of livelihoods, which is dominated by shifting cultivation with low production and yield. A huge number of rural people (>50%) are dependent on the output of traditionally grown crops. However, arable land is significantly less therefore, people of rural areas are very poor as about 19.63% of people living below the poverty line (BPL). WRC is practiced as a double-crop – both as *Kharif* and *Rabi* crops whereas few districts practice WRC only in *Rabi* season with a small proportion of arable land. WRC has a high potential to attain self-sufficiency in food grain and to reduce the number of people living in BPL. So far, no substantial studies have been carried out on WRC and literature is scanty. One of the major problems related to WRC is the identification of plots because of their tiny sizes, though there has been attempt to use Remote Sensing Data in an earlier study (Ravan *et al.,* 2004).

This study attempts to examine the potential of WRC in Mizoram. It aims to analyze the area, production, and yield of WRC compared to the potential of shifting cultivation, correlate households involved in WRC and BPL families, as well as irrigation and production of WRC. It also analyzes the change in the area, production and yield; WRC potential area and utilization of WRC potential area; district wise ranking of WRC and requirement of WRC for self-sufficiency.

Study Area

Mizoram, an eastern extension of the Himalaya, has rich subtropical and montane agro-climate. Its total geographical area is 21,027 sq km of which, 97% is hilly and undulating terrain. The economy of the state mainly depends on the output from the traditional subsistence agriculture. Total arable land in Mizoram is 51,033 ha of the total geographical area, of which, WRC area is 16,866 ha (33% of the total arable land), which is less than 0.8% of the total geographical area. Mizoram practices two types of agriculture – shifting and WRC. The arable area under WRC is low; however, its production and yield are substantial and quite higher than shifting cultivation. WRC is practiced in the flood plains, formed by the perennial river after deposition of alluvial soils, while arable patches are also found in the river valley. Mizoram receives 2,400 mm average annual rainfall and average annual temperature is 22.5^{o}C, which is quite suitable for growing crops mainly for WRC. Figure 1 shows a small patch of WRC and a WRC field in the Met river valley, the Serchhip district.

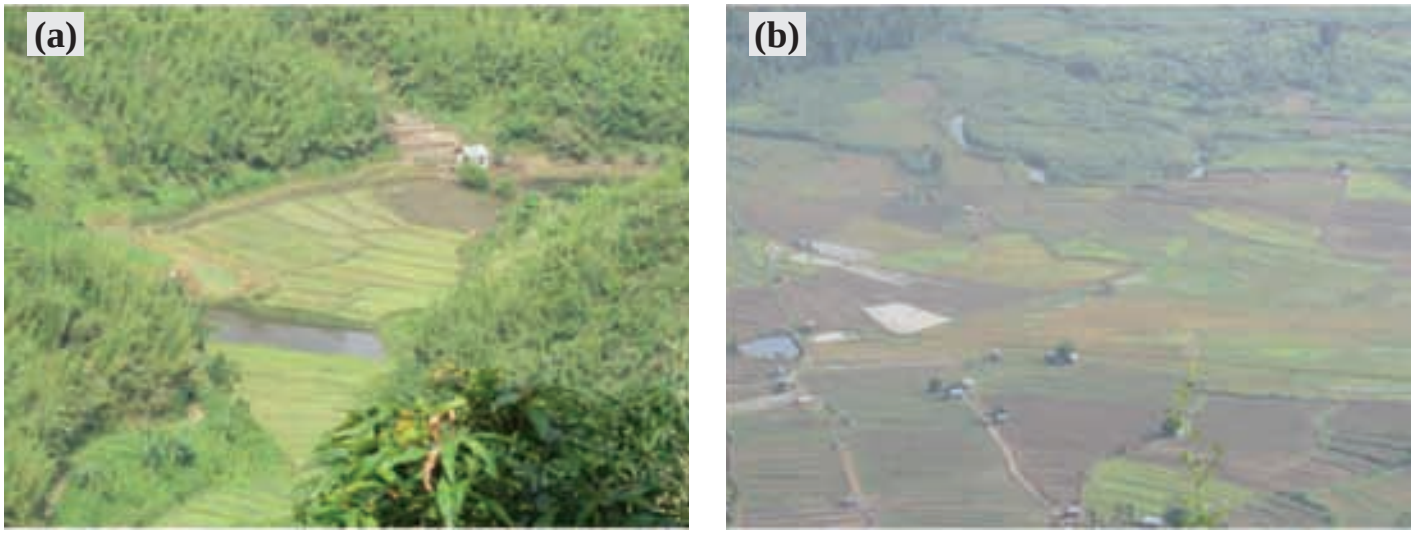

Figure 1: Wet rice fields (a) small patch of WRC (b) wide WRC fields; both in the Met river valley, Serchhip district

Methodology

A set of qualitative and quantitative methods were employed to conduct this study. Data were gathered mainly from secondary sources (Statistical abstracts – 2009-10 and 2014-15, Department of Agriculture, Aizawl) and through field observation. At the district level, the data were collected on area and production of WRC, irrigation, the number of households (HHs) involved in practicing WRC and people living below the poverty line (BPL). The collated data were subjected to analysis by SPSS using levels and indices, correlation, regression, and rank-score methods. SPSS was also used to correlate irrigation, production and HHs involved in WRC including BPL HHs. Based on the indices of area, production, and yield, WRC districts were categorized into high, medium, and low levels. The districts were ranked and scored according to their potential in WRC and the final ranking was given to districts for their future potential of WRC. Maps were digitalized showing the district point levels of WRC and the future prospective of WRC. A regression model was used to correlated WRC HHs and BPL HHs, and irrigation and production of WRC

through a linear curb. Field visits were also made to understand the WRC potential in Mizoram.

Results

Area, production, and yield of paddy under both shifting and WRC

An analysis of the area, production, and yield of paddy under both shifting and WRC in Mizoram was carried out. Firstly, the status of WRC in total crops was compared in terms of area, production, and yield followed by the comparison of WRC with shifting cultivation of paddy. The total arable land in Mizoram was 64,900 ha, and WRC shared 15.1% area (9,774 ha), while, in terms of production, its share was 19.85%. The yield of WRC was just double the average yield of total crops. In 2014-15, the total arable land decreased to 51,033 ha (21.37%), however WRC area share increased to 16,866 ha (33.04%). The production share of WRC increased by 29.71%, from 20,544 MT to 37,096 MT.

The paddy area under shifting cultivation in 2009-10 was 3.7 times higher than WRC whereas in 2014-15, WRC area increased very close to the area of paddy under shifting cultivation (Table 1). In terms of production, WRC yield which was half in 2009-10 increased to double than that of shifting cultivation in 2014-15. Hence, it was evident that the area, production, and yield of paddy increased under WRC, while shifting cultivation showed a decline.

Table 1: Area, production, and yield of paddy under shifting and WRC

Variable	2009-10		2014-15		Change (%)	
	Shifting	WRC	Shifting	WRC	Shifting	WRC
Area	36841	9774	20064	16866	-45.54	+72.56
Production	43985	20544	23583	37096	-46.38	+80.57
Yield	1.19	2.10	1.18	2.20	-0.84	+4.76

Source: Statistical Abstract, Department of Agriculture, Aizawl, Mizoram

District-wise area of WRC

Mizoram had a total WRC area of 16,866 ha with production of 37,096 MT, and a productivity level of 2.20 MT/ha in 2014-15. The District-wise area of WRC was categorized into three levels – high, medium, and low (Table 2), with three indices - >2000 ha, 1000-2000 ha, and <1000 ha in 2009-10. Champhai and Kolasib belonged to high category with an area of >2000 ha, while two districts – Serchhip and Lawngtlai were of Medium level (1000-2000 ha). Four districts – Mamit, Lunglei, Saiha, and Aizawl showed low area (<1000 ha). In 2014-15, due to the increase in the area of WRC indices, levels varied from >4000 ha (high), 2000-4000 ha (medium) and <2000 ha (low). Champhai and Kolasib maintained the first position with >4000 ha area and Lawngtlai and Serchhip continued to be under the medium category. The remaining four districts – Lunglei, Mamit, Aizawl, and Saiha maintained a low level (<2000 ha). All the districts maintained their status except Saiha and Aizawl.

Table 2: Area of WRC (ha)

Levels	Indices	Districts
Area (2009-10)		
High	>2000	Champhai and Kolasib
Medium	1000-2000	Serchhip and Lawngtlai
Low	<1000	Mamit, Lunglei, Saiha, and Aizawl
Area (2014-15)		
High	>4000	Champhai and Kolasib
Medium	2000-4000	Lawngtlai and Serchhip
Low	<2000	Lunglei, Mamit, Aizawl, and Saiha

District-wise production of WRC

Champhai and Kolasib districts showed high production under WRC (>5000 MT) in 2009-2010, whereas Lawngtlai, Mamit, and Serchhip districts had medium-level production (1000-5000 MT), and Lunglei, Aizawl, and Saiha districts recorded low level of production (<1000 MT). In 2014-15, production increased to >8000 MT in Kolasib and Champhai districts (Table 3). Kolasib district had higher production than the Champhai district. Medium level production (4000-8000 MT) was reported by Lawngtlai and Serchhip districts. Lunglei, Aizawl, and Saiha districts had low level production (<4000 MT).

Table 3: Production of WRC (MT)

Levels	Indices	Districts
Production (2009-10)		
High	>5000	Champhai and Kolasib
Medium	1000-5000	Lawngtlai, Mamit, and Serchhip
Low	<1000	Lunglei, Aizawl, and Saiha
Production (2014-15)		
High	>8000	Kolasib and Champhai
Medium	4000-8000	Lawngtlai and Serchhip
Low	<4000	Lunglei, Mamit, Aizawl, and Saiha

District-wise yield of WRC

In 2009-10, the WRC productivity was high (>2.5 MT/ha) in Champhai and Mamit districts (2009-10), followed by the districts of Aizawl, Kolasib, Lunglei, Saiha, and Lawngtlai (Table 4) with medium level of productivity (1.5-2.5 MT/ha). Only Serchhip district reported low yield (<1.5 MT/ha). In 2014-15, WRC productivity in the Lawngtlai district jumped to a high level while, the yield of WRC decreased in the Champhai district, to a low level. Serchhip district was promoted to medium level category along with other districts – Aizawl, Lunglei, Saiha, and Kolasib.

Table 4: Productivity (Yield/ha) of WRC

Levels	Indices	Districts
Yield (2009-10)		
High	>2.5	Champhai, Mamit
Medium	1.5-2.5	Aizawl, Kolasib, Lunglei, Saiha, and Lawngtlai
Low	<1.5	Serchhip
Yield (2014-15)		
High	>2.5	Lawngtlai and Mamit (equal)
Medium	1.5-2.5	Aizawl, Lunglei, Serchhip, Saiha, and Kolasib
Low	<1.5	Champhai

Change in area, production, and yield of WRC

Analysis of data on change in area, production, and yield between 2009-10 and 2014-15 (Figure 2) revealed an increase in the area under WRC in all the districts of Mizoram and it varied from 171.1% in the Aizawl district (highest) to 26.82% in the Saiha district (lowest). Two other districts *viz.*, Lunglei and Lawngtlai showed >100% increase, whereas in Kolasib and Mamit there was an escalation of 73.67% and 64.35% area, respectively. Champhai and Serchhip districts registered less than a 50% increase in the WRC area, however Mizoram as a whole registered a 62.75% expansion in WRC. In terms of production, Serchhip district ranked first showing a 320.77% increase, followed by Lawngtlai (252.38%) and Lunglei (234.44%) districts while the increase in production was up to 189.21% in Aizawl. Champhai district registered a negative change with a 11.47% decrease. Other districts – Saiha, Kolasib, and Mamit districts registered 80.76%, 63.76%, and 51.34% increase in WRC production, respectively, while overall increase of production due to WRC in Mizoram was 67.51%. There was 2.8% increase in productivity due to WRC in Mizoram.

Household level area and production of WRC

The Kolasib district had the highest area (1.46 ha) of WRC/HH in 2009-10 (Figure 3), followed by Saiha

(1.25 ha), Mamit (1.22 ha), and Champhai (1.08 ha) districts. Other districts had less than 1 ha area/HH. The state of Mizoram had an average of 1.06 ha area/HH. In 2014-15, the rice area increased to 1.28 ha/HH in Mizoram. Among the districts, Kolasib district maintained the top position with 1.97 ha area/HH, while. Lawngtlai, Champhai, Serchhip, and Lunglei districts also registered an increase in rice area/HH. There was decrease in area/HH in Mamit, Aizawl, and Saiha districts.

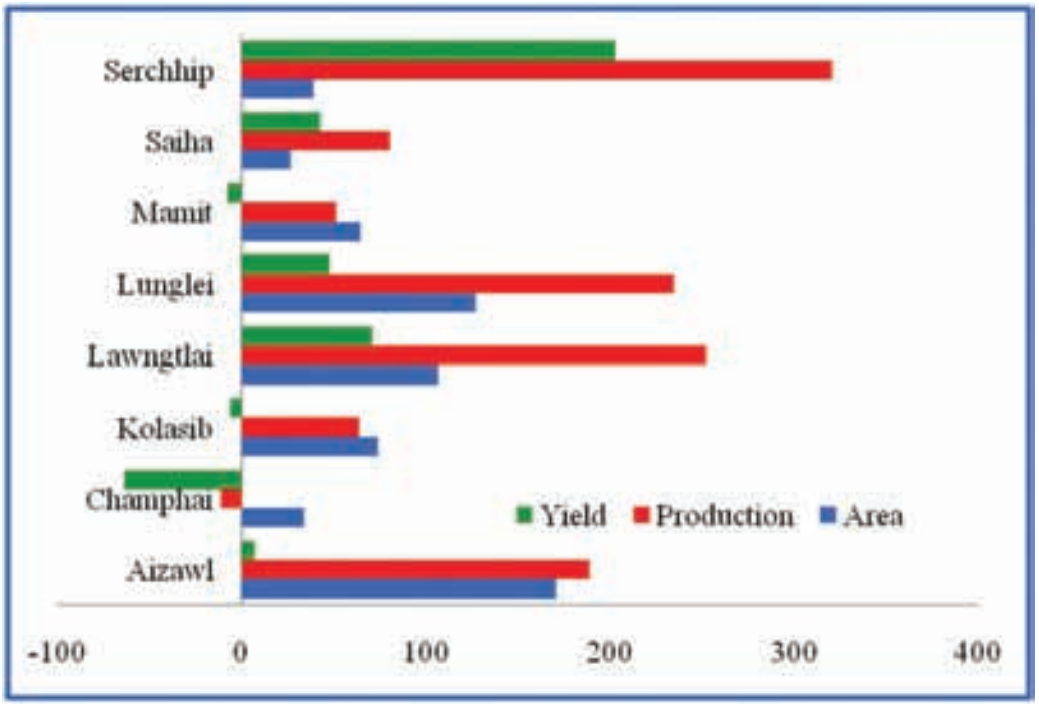

Figure 2: Change (%) in area, production, and yield of WRC 2009-10 and 2014-15

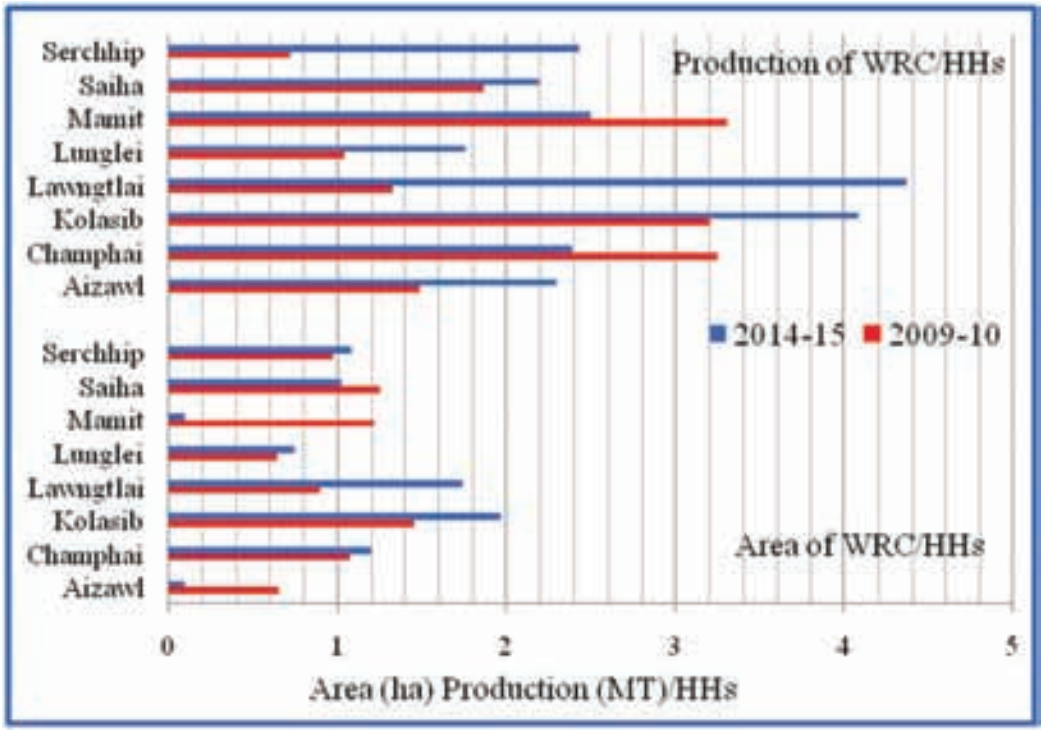

Figure 3: HHs level area and production of WRC

Mamit district topped in productivity per HH with 3.31 MT/ha/HH, followed by Champhai (3.25) and Kolasib (3.21) districts in 2009-10, while it was less than 1.5 MT/ha/HH. In 2014-15, the household productivity was the highest in Lawngtlai district (4.37 MT/ha/HH), followed by the Kolasib district (4.04). There was a decrease in two districts – Champhai (-0.86%) and Mamit (-0.81%). Overall, Mizoram state showed very little change in rice production/HH (2.80-2.81 MT/ha) during 2009-2015.

Household involved in WRC and BPL families

The total number of households involved in WRC increased from 9748 in 2008-09 to 13,182 in 2014-15 (35.23%). It was the highest in Champhai district showing a 20.35% increase, followed by Kolasib with an increase of 28.85%. The number of households involved in WRC was lowest in Saiha, Aizawl, and Serchhip districts. However, all districts registered an increase in the number of households involved in WRC during this period.

The data on BPL revealed that Mizoram had 56,584 (19.63%) people living BPL. At the district level, the highest numbers BPL was recorded in Lawngtlai district (13,126), followed by Aizawl (12,668) and Lunglei (11,437). Serchhip district had the lowest number of people living BPL (1770), followed by Champhai (2715) and Kolasib (3401). Other two districts – Saiha and Mamit had 4245 people BPL.

Correlation among irrigation, production, people living BPL and WRC HHs

There was a positive correlation between irrigation and production as evidenced by 0.725 r-value (Table 5, Figure 4), indicating that the districts with adequate irrigation resources showed a higher production. There was significantly negative correlation (r = -0.504) between irrigation and BPL, hence the districts with irrigation facilities had less people living BPL.

Data also revealed that there was high involvement of HH in districts with adequate irrigation facilities (r = +0.458). The productivity of WRC had a direct impact on people living BPL and the analysis showed less people living BPL in areas with higher WRC productivity (r= -0.377). There was a significantly positive correlation between productivity and number of people involved in WRC (r= 0.835).

Utilization of WRC potential area

Mizoram has a total WRC potential area of 74,644 ha of which only 22.60% (16,866 ha area) has been utilized so far. WRC potential area is grouped into three levels – high (>10000 ha), medium (5000-10000 ha) and low (<5000 ha). The Serchhip district, followed by Champhai and Saiha districts are high WRC potential areas with >10000 ha area. The Lunglei and Lawngtlai districts have medium WRC potential while three districts – Kolasib, Aizawl, and Mamit have a low

Table 5: Correlation among the variables related to WRC

Variables	Correlation	Irrigation	Production	People living BPL	WRC HHs
Irrigation	Pearson Correlation	1	0.727*	0-.504	0.458
	Sig. (2-tailed)		0.041	0.203	0.254
Production	Pearson Correlation	0.727*	1	0-.377	0.853**
	Sig. (2-tailed)	0.041		0.357	0.007
People living BPL	Pearson Correlation	0-.504	0-.377	1	0-.468
	Sig. (2-tailed)	0.203	0.357		0.242
WRC HHs	Pearson Correlation	0.458	0.853**	0-.468	1
	Sig. (2-tailed)	0.254	0.007	0.242	

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

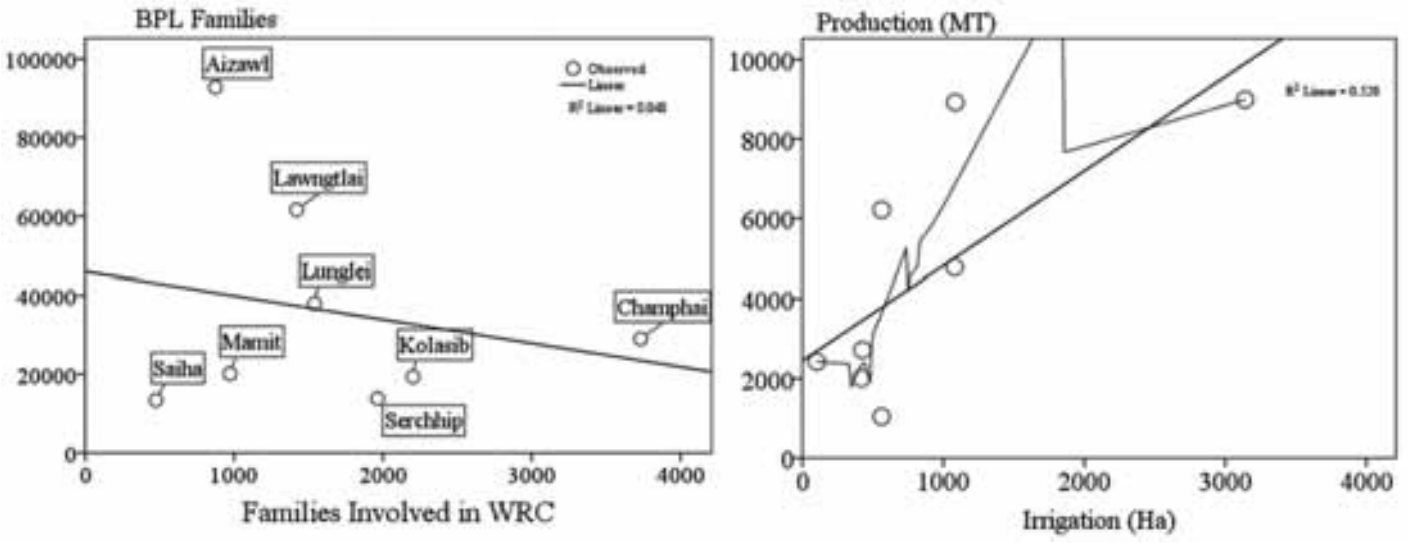

Figure 4: Correlation between families involved in WRC and BPL families and irrigation and production

potential for WRC (Table 6, Figure 5). On the other hand, the actual area under WRC at the district level is high (>2000 ha) in Champhai, followed by Lunglei, Lawngtlai, and Serchhip districts. The Kolasib district has a medium area of 1000-2000 ha, whereas Mamit, Aizawl, and Saiha districts possess low area (<2000 ha) under WRC.

The analysis of utilization of the WRC potential area revealed that Lunglei and Champhai districts were potential areas (>30%) while Lawngtlai, Kolasib, Mamit, and Aizawl districts had WRC areas of medium potential. (15-30%), Serchhip and Saiha districts showed low potential.

Table 6: Levels of WRC Potentials Area (ha), Area under WRC (ha), and Percentage of Utilization of WRC potential area

Levels	Indices	Districts
WRC potential area (ha)		
High	>10000	Serchhip, Champhai, and Saiha
Medium	5000-10000	Lunglei and Lawngtlai
Low	<5000	Kolasib, Aizawl, and Mamit
The area under WRC (ha)		
High	>2000	Champhai, Lunglei, Lawngtlai, and Serchhip
Medium	1000-2000	Kolasib
Low	<1000	Mamit, Aizawl, and Saiha
Utilization of WRC potential area (%)		
High	>30	Lunglei and Champhai
Medium	15-30	Lawngtlai, Kolasib, Mamit, and Aizawl
Low	<15	Serchhip and Saiha

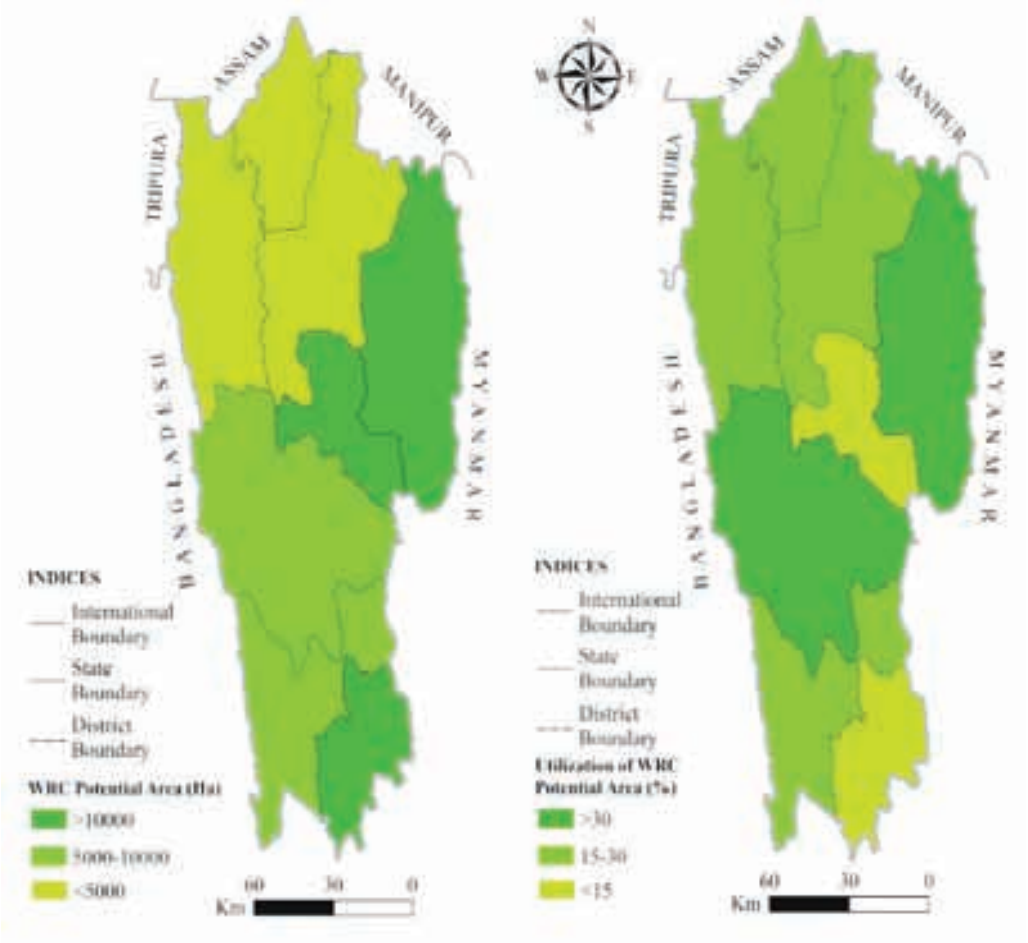

Figure 5: Change (%) in area, production, and yield of WRC from 2009-10 to 2014-15

District-wise ranking of different components of WRC

An analysis of the area, production, yield, WRC potential, and irrigated area under WRC was carried out using the ranking method (Table 7). Ranks from 1 to 8 were assigned to districts based on their performance in a different component of WRC. The districts were further categorized into four potential groups based on area, production and productivity of WRC as very high, high, moderate, and low. Champhai and Kolasib districts showed very high potential, followed by Lawngtlai and Serchhip with high potential. Lunglei and Mamit districts belonged to moderate potential, whereas Aizawl and Saiha districts had low potential in area under WRC. WRC production was the highest in Kolasib and Champhai districts (very high), followed by Lawngtlai and Serchhip districts (high). The production was moderate in Lunglei and Mamit districts and low in Aizawl and Saiha districts. Lawngtlai, Mamit, and Aizawl districts showed very high potential in productivity, followed by Lunglei and Serchhip districts (high). Saiha and Kolasib (Moderate). Champhai district had a low potential. WRC potential area was the highest in Serchhip and Champhai (very high) and the lowest in the Aizawl and Mamit districts (low). Saiha and Lunglei districts had high potential, while Lawngtlai and Kolasib had moderate potential. In terms of irrigation, 83.7% area is irrigated under WRC (2014-15). Kolasib and Champhai districts were ranked very high followed by Serchhip and Lawngtlai districts (high). Saiha and Lunglei districts showed moderate potential and Aizawl and Mamit districts had low potential.

The final ranking for future potential of WRC in Mizoram was given based on summation scores of rankings of different variables related to WRC.

Champhai district showed highest rank for future potential in WRC followed by Kolasib and Lawngtlai districts. Serchhip district was ranked next followed by Lunglei, Mamit, Saiha and Aizawl (Figure 6).

Table 7: District-wise ranking of different components of WRC (2015)

District	Area	Production	Yield	WRC Potential	Irrigated area
Aizawl					
Champhai					
Kolasib					
Lawngtlai					
Lunglei					
Mamit					
Saiha					
Serchhip					

1	2	3	4	5	6	7	8
Very high potential		High potential		Moderate potential		Low potential	

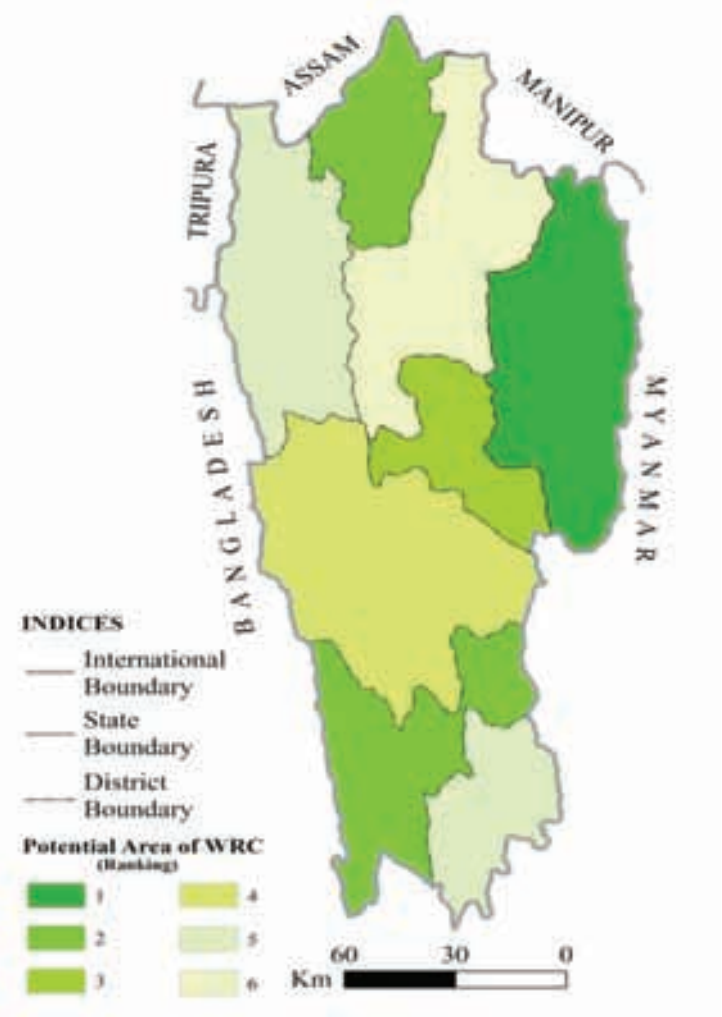

Figure 6: Final ranking for the districts based on WRC potential in different variables

A requirement of rice for self-sufficiency

The analysis of population, WRC production, and requirement of rice for self-sufficiency revealed substantial increase in self sufficiency in rice during 2009-2015 (Table 8). However, total production was only 26.82 % of total rice requirement, during this period, showing a deficiency of 73.18% in production in 2014-15. It was also estimated that an arable area of 105,876 ha was required to attain self-sufficiency in rice production.

Discussion

Mizoram has an agricultural economy with majority of rice area and production under shifting cultivation while Wet Rice Cultivation areas are significantly low. It was also evident that though the area of WRC is less than that under shifting cultivation, the production and yield are higher and have been increasing. At the district level, it has been observed that the two districts Champhai and Kolasib had high areas under WRC both in 2009-10 and 2014-15, Serchhip and Lawngtlai districts registered medium areas and the remaining four districts had low area under WRC. The trends have also indicated there has been doubling of the area under WRC with variations at the district levels and there was also substantial increase in production. However, district-wise, the status of production was almost the same in both periods with little variations. In terms of productivity of WRC, some districts showed significant increase but it was stagnant in other districts during 2009-2015. The area and production of WRC increased in all districts with changing values whereas a decrease in WRC productivity was noticed in Champhai, Kolasib, and Mamit districts though, these three districts showed high potential at HH level in WRC.

Higher production of WRC has a significant impact on attaining food security and lowering the numbers of BPL families. An analysis of levels of WRC potential area, actual area under WRC, and percent utilization of WRC has shown that Serchhip, Champhai, and Saiha districts have high potentials for WRC and the current area under WRC is also high in these districts along with Lawngtlai. Further, utilization of WRC potential area (%) is the highest in Lunglei and Champhai districts, as indicated by the rank-score analysis, however very high potential of WRC was observed in Champhai and Kolasib districts in terms of area and production. Aizawl and Mamit districts ranked highest in productivity. In the potential of WRC, Serchhip and Champhai districts had the highest rank while Champai district also has the best irrigation resources along with Kolasib. Ovearll, Champhai showed the first rank in WRC followed by

Table 8: Requirement of rice as per population need in 2009-10 and 2014-15 and change

Variables	2009-10	2014-15	Change (%)
Population (2011)	9,21,970	10,91,014	18.3
Average requirement of rice per person per year at the rate of 450 gm per day (Quintal)	1.64	1.64	Nil
Total requirement of rice for 1 year for human consumption only (Quintal)	15,12,030	17,89,263	18.3
Total annual requirement of rice for Mizoram (Quintal)	19,22,030	21,99,263	14.4
Total production of rice (Quintal)	4,62,924	5,89,940	27.4
% of the production of the total requirement	24.09	26.82	11.3
% Deficiency in production	75.91	73.18	-3.6
Land required for self-sufficiency in Mizoram (Ha)	148,888	105,876	-28.9

Source: Statistical Abstract, Department of Agriculture, Aizawl, Mizoram

Lawngtlai and Kolasib placed with second rank and Serchhip was third ranked place in practicing WRC. Other districts showed low potential.

Shifting cultivation has been reported to be economically unviable (Tawnenga *et al.*, 1997; MART 2011; Sati 2014, 2017, 2018, 2019). Therefore, the future of WRC is potentially very high. Efforts made so far by the state government to increase the area and production of WRC, have resulted in 28.4% increase in area and 10% increase in production, respectively (Zodinsanga, 2013). These efforts should be continued so that the state will attain self-sufficiency in food grain production.

Conclusions

Mizoram has a high potential to attain self-sufficiency in food grain through practicing WRC because of its higher production and productivity than that of shifting cultivation. Data between 2009-10 and 2014-15 shows that there has been a large increase in the production of rice and substantial decrease in annual requirement for rice in the region. Since Mizoram has a conducive climate to practice WRC, bringing a sizable proportion of arable land under WRC can help in efforts to attain self-sufficiency in food grain. The second important component of WRC is adequate irrigation. So, if irrigation facilities can be extended to rain-fed areas, intensive irrigation can meet the water requirements under the situation of high climate variability and change. A system of rice intensification can also be a suitable approach to increase the production under WRC. Also, more arable land can be devoted to WRC under the *Rabi* crop in all the districts. A sustainable practice of WRC will reduce the number of people living in BPL and progress towards attaining self-sufficiency in food grain and food security.

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