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Comparative Impact of Climate Change on Seri Cultivation on the Rural Economy of Assam: A study with Special Concentration on the Selected Districts

Impacto das mudanças climáticas no cultivo de seda seri na economia rural de Assam: um estudo com enfoque em alguns distritos

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Abstract

The 'Queen of Textiles', that is India, which occupies the second position in the share of world silk production and first in its consumption, has ample scope in rural income and employment generation. Mulberry silk accounts for 69.16% of the total silk production in India and eri comprises of 20.87%. However, in the case of Assam, around 99% of the state's total silk production is occupied by non-Mulberry silk such as eri, tasar and muga, thereby making the sericulture sector of Assam different from the rest of India. The reports of IPCC have been stressing its concern on the issue of global climate change and the adverse impact of it on those sections of people who are mainly dependent on agriculture and allied activities. Researchers have said that the seri cultivation is not going to be free from the same. In this paper, we discuss about the scope of seri cultivation in Assam and how climate change is affecting the seri cultivating sector of the state. We have also tried to understand its resultant impact on rural income and employment.

Keywords: Rural income and Employment, Sericulture, Climate change.

JEL Codes: O13, Q12.

Resumo

A Índia, considerada a rainha dos têxteis, ocupa a segunda posição na cota de produção mundial de seda e a segunda posição no seu consumo, facto que tem importantes repercussões na economia local e na criação de emprego. A seda mulberry perfaz 69.16% da produção total do país, ao passo que a seda eri corresponde apenas a 20.87%. Todavia, no caso de Assam, cerca de 99% da produção total desta matéria-prima diz respeito a outros tipos de seda (eri, tasar e muga), o que revela a singularidade do setor de sericultura na região, face à situação vivida no resto do país. Os relatórios do IPCC têm ventilado a sua preocupação relativamente ao problema das alterações climáticas e do impacto adverso das mesmas em setores nos quais as pessoas dependem economicamente da agricultura e de atividades correlatas. Os investigadores afirmam que o cultivo de seri não está livre de ser afetado pelas mudanças climáticas. Neste artigo, discutimos o objetivo do cultivo de seda seri em Assam, bem como o modo como as mudança climáticas estão a afetar o setor na região, procurando compreender ainda o seu impacto na economia rural e no emprego.

Palavras-chave: Economia rural e emprego, Sericultura, Mudanças climáticas.

1. Introduction

The world is facing a climate crisis. Two major features of climate crisis are their regularity of rainfall and the increase in the global temperature. In its fourth assessment report of IPCC it was observed that, "warming of climate system is now unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global sea level" (Solomon et al., 2007). However, there is another matter of serious concern. The effect of

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environmental degradation is felt disproportionately by different people (Saikia & Mahanta, 2023). Rich countries have the ability to mitigate the crisis in a much better way than that of the poor countries. Even within a country, sectors which are intimately related to the environment such as agriculture, fishery, horticulture, sericulture, floriculture, etc. are expected to be severely affected. And this is especially true for the developing countries like India, with a huge population as people are closely related to these activities for their livelihood. As a result, these people, who are already poor, are expected to face the crisis first and foremost. According to FAO, in 2017, about 70 percent of the rural Indian population depended primarily on agriculture and out of them about 82 percent are small and marginalised farmers.

In the gap of 10 years, that is, between 2001 to 2011, the total rural population of Assam has increased from 2,32,16,288 to 2,68,07,034(Census, 2001, 2011). Though in percentage terms a marginal decrease is seen from 87.09 percent to 85.90 percent, there is no such decrease in the number of rural populations under the poverty line over time. The rural poverty headcount ratio has reduced from 36.4 in 2004-05 to 33.89 only in 2011-12. Of the total area of the state, about 52.11% are used for cropping in 2016-17.

In Figure 1, within twenty years from 1991 to 2011, a declining share of cultivators and agriculture is seen in the state.

Asia, with a share of about 95% of the world's total silk production, is the top-most producer of silk (Dewangan, 2013). India is known as the 'Queen of Textiles'. It has been producing silk for a very long time. Presently, India occupies the second position in the production of silk in the world out of 58 silk-producing countries of the world, only next to China. Moreover, it occupies the first position in the consumption of the same (Nagaraju, 2008; FAO, 2019). Mulberry silk occupies 69.16% of the total silk production in India and eri comprises of 20.87%.

Figure 2 presents the production of silk in different countries according to their total silk production. Figure 3 describes the distribution of different silk across the different states of India. It can be seen that while the production of Mulberry and Tasar silk captures a dominant share in the rest of the country, in the North Eastern region, the dominance of Eri and Muga silk can be seen. Assam contributes about one-tenth of India's overall silk production, and most importantly the state contributes about 97 per cent of the eri silk and 100 per cent of muga silk production in India. Though people of Assam practice four varieties of silk production, the rural Assamese people have been practicing Muga, Eri and Mulberry culture from ages and they have only recently added the Tasar silk production culture in the Sericulture economy of Assam. To grow the host plants for sericulture in Assam, the favourable temperature is between 24°C

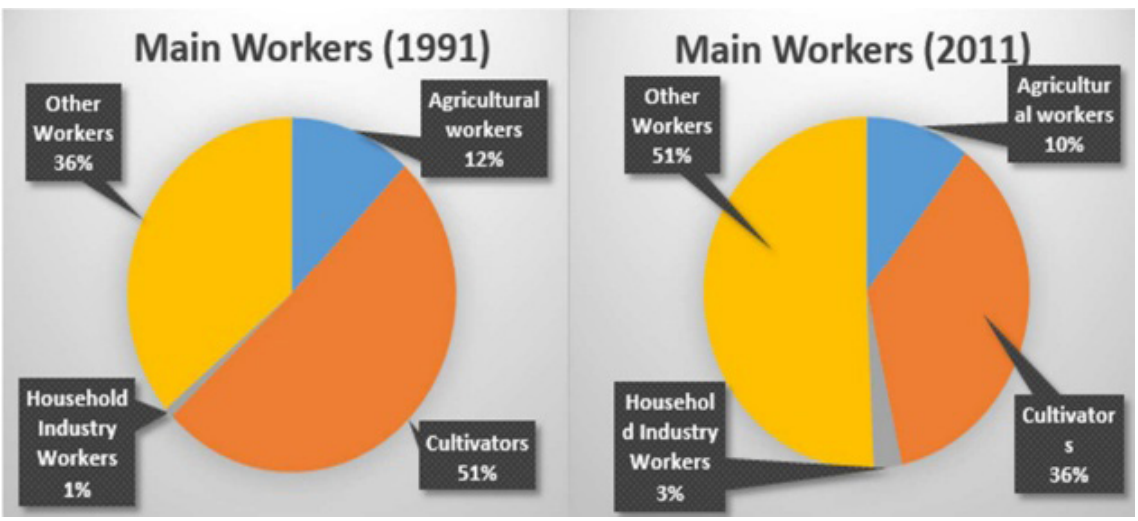

Figure 1
Distribution of Workers in Assam.
Source: Census 1991, 2011.

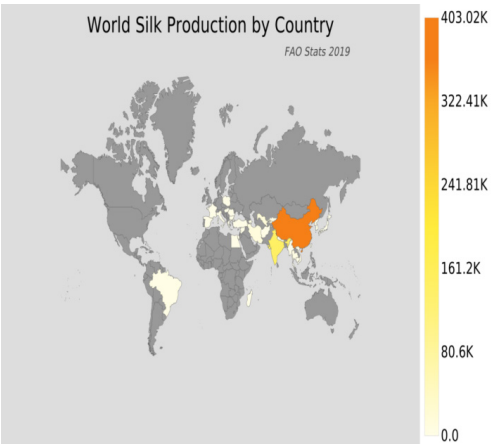

Figure 2
World silk Production by country.
Source: FAO, 2019.

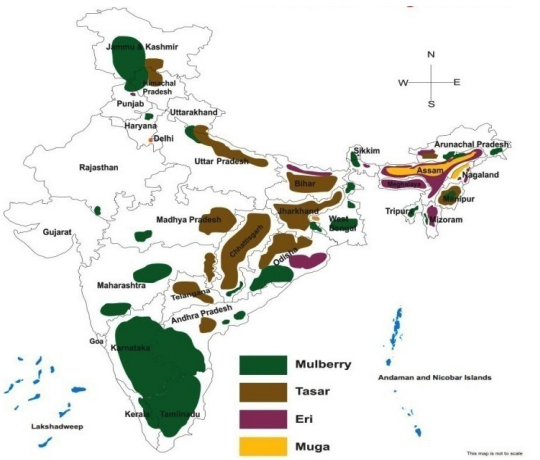

Figure 3
Distribution of Sericulture across the states of India.
Source: https://twitter.com/csbmot/status/1101343087475867648/photo/1, accessed on 2/2/2023

and 28°C and the humidity must be within 85 to 90 percent (De & Das, 2010).

Sericulture, and mostly Eri cultivation, is practiced in almost all the districts of Assam, but the cultivation is highly concentrated in Karbi Anglong, North Cachar Hills, Barpeta, Kokrajhar, Dhemaji, Sibsagar, Darrang, Lakhimpur, etc. Amongst these districts, KarbiAnglong, Jorhat, Sibsagar, Lakhimpur and Dibrugarh are the top five districts with the highest number of families engaged in Sericulture (Kakoti, 2012). Directly or indirectly, thousands of families in Assam have been engaged in various activities related to Sericulture, for example, sowing of seeds, plantation of host plants, maintenance of plants, plucking of leaves from the planted and wildly grown trees, feeding and rearing of silkworm up to cocoon stage, spinning of yarn, weaving of fabrics, marketing of cocoons and cloth, etc. The Kachari, Bodo, Karbi and Garo tribes practice ericulture activity to a large extent during their leisure time, that help in the improvement of their economic condition a lot, especially of the women.

Muga is an outdoor sericulture activity and therefore it is often influenced by changes in weather, specifically rainfall. As a result, the outcomes are found to be heavily dependent on the climatic condition. It is a costly venture and, at the same time, it involves more risk than the other sericulture activities like eri production. Looking into the net profit per unit of investment, the highest is in case of muga and it is followed by eri. In the muga cultivation, a large amount of initial investment is required for its operation and at the same time, considerably a high risk is also associated with such activities (especially of pest attack, disease, etc.) and as a result, it makes ericulture more popular among the rural poor people of Assam.

Though both male and female individuals of all sections of the rural population have been engaged in different sericulture activities, it is seen that the women of different tribal communities have been predominant in the rearing and weaving of eri raw silk and endi textiles. Along with their daily household activities, these tribal women use their leisure time and with their traditionally inherited knowledge, they produce useful and at the same time comparatively cheaper endi clothes (De & Das, 2007). Eri, tasar and mulberry variety are indoor-rearing activities, on the other hand muga is an outdoor--rearing activity. As a result, women's participation in eri and mulberry rearing is very high, whereas participation of males is comparatively higher in case of muga.

Ample literature on the sericulture sector in India and Assam is available. However, there is a dearth of literature on the impact of climate changes on the sector; more particularly only a limited literature is available using the analysis of the same specifically in Assam. Therefore, with the discussion on the possible scope of Sericulture in Assam, this paper aims to analyse the differentiated impact of climate change on Seri cultivation in Assam and to analyse the extent of impact on livelihood of Seri

cultivators due to the aforementioned effect in comparison with mulberry.

This paper is divided into five sections. Section two presents the link between sericulture and rural livelihood in the context of Assam. We present a brief description about the methodology used in the paper in section three. Results and brief summarization of findings are presented in section four. The paper finally ends with some concluding remarks.

2. Sericulture, rural livelihood and Assam

People's affection towards silk and silk fabrics has been securing a prime position among the most elegant and valued fabrics for a very long period of time (Patil et al., 2009). According to the Food and Agriculture Organization (1990), from the available evidences, it can be observed that the Sericulture activity was started about 5000 years ago. The word 'sericulture' is developed from the combination of the Greek word '*Sericos*' and the English word 'culture'; '*Sericos*' means 'silk' and 'culture' is the process of 'rearing' (Kaur & Pabba, 2021). Sericulture is an eco-friendly enterprise with high potential in reducing poverty in the rural economies. Also, by providing scope for improvement of people's quality of life, generation of employment and economic development the sector has the ability to prevent rural-urban migration (Kaur & Pabba, 2021). The effective utilization of natural resources in sericulture can lead to a considerable raise in the status of the farming community (Thapa & Shrestha, 1999; Dewangan, 2013). Low level of investment, shorter gestation period and quick and high return make the seri industry an ideal one, fitting well in the socio-economic structure of a country like India (Brahma et al., 2019). Including both industrial as well as agricultural activities, sericulture is regarded as an agro-based industry; which involve the activities such as raising the food plants for silkworm, rearing the silkworms and cocoon production from them, spinning or reeling cocoons and the production of silk at the final stage (Shrivastav, 2005; Ahmed & Rajan, 2011; Brahma et al., 2019).

Brahma et al. (2019) classified Sericulture into two broad sectors: mulberry and non-mulberry. Mulberry sector is related with mulberry silk and the non-mulberry sector is related with the rearing and production of other varieties of wild silk such as Muga *(Antheraea assama)*, Eri *(Samia ricini)* and Oak-tasar *(Antheraea proylei)*. Among these, ericulture, that is, rearing and production of the eri silk, has a leading position and popularity among the

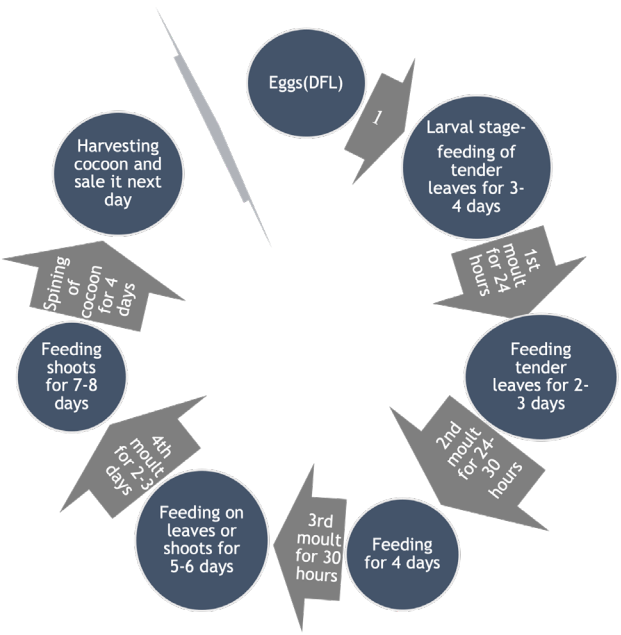

Figure 4
Silkworm rearing process.
Source: Patil et al., 2009.

poor rural population of Assam (De & Das, 2009). The process of rearing, spinning and weaving Eri silk was introduced by the *Bodos,* an indigenous community of India (Sharma, 1983). In Assam, ericulture is mainly practiced by the women of tribal communities such as *Bodos, Garos, Mishings, Karbis* and *Kacharis* and also by the *Ahoms*; which helps them to support their livelihood of their families and it is also linked with their socio-cultural and economic values (Brahma et al., 2019). In the rural economy of Assam, sericulture stands as one of the many agro-based age-old activities that provides wide scope for income and employment generation (De & Das, 2010). De and Das (2007) in their study done in Assam find that the total employment generated by the sericulture sector is almost three times larger than that of the quantity of people involved in the rearing of the same.

The trend of growth of silk production shown in Figure 5, indicates the widening of the popularity of silk for both commercial purpose and for people's regular day to day uses. Also, after 2010, the growth in eri has taken a sharp rise, reflecting a huge potentiality of the sector to support livelihood of people and income generation. Though the production of muga is not much high in the state, it is increasing over time. Even the production of mulberry is not very much impressive in the state and the trend also shows a marginal improvement in its production, which is again declining from 2020. Moreover, it is to be noted that the production of tasar is negligible in the state and the same is also reflected in Figure 3. Hence, from the trends of different silk productions, it is expected that in the coming future the silk producing sector will be able to generate huge amount of employment and can support a large number of families of Assam.

3. Materials and Methods

We are firstly interested to understand about the relation of climate change with the different Seri productions, that is Eri, Muga and Mulberry. For this purpose, we have analyzed the trend of change in rainfall in different districts of Assam and accordingly we have measured their slope coefficients. Similarly, we have also measured the trends of change in the production of Eri, Muga and Mulberry production in different districts of Assam and access their respective slope coefficients. Further we have run a correlation analysis of the derived slope coefficients of the two different series to see how the change in rainfall is linked with the changing production of different seri cultivation in Assam. Further, to achieve the desired

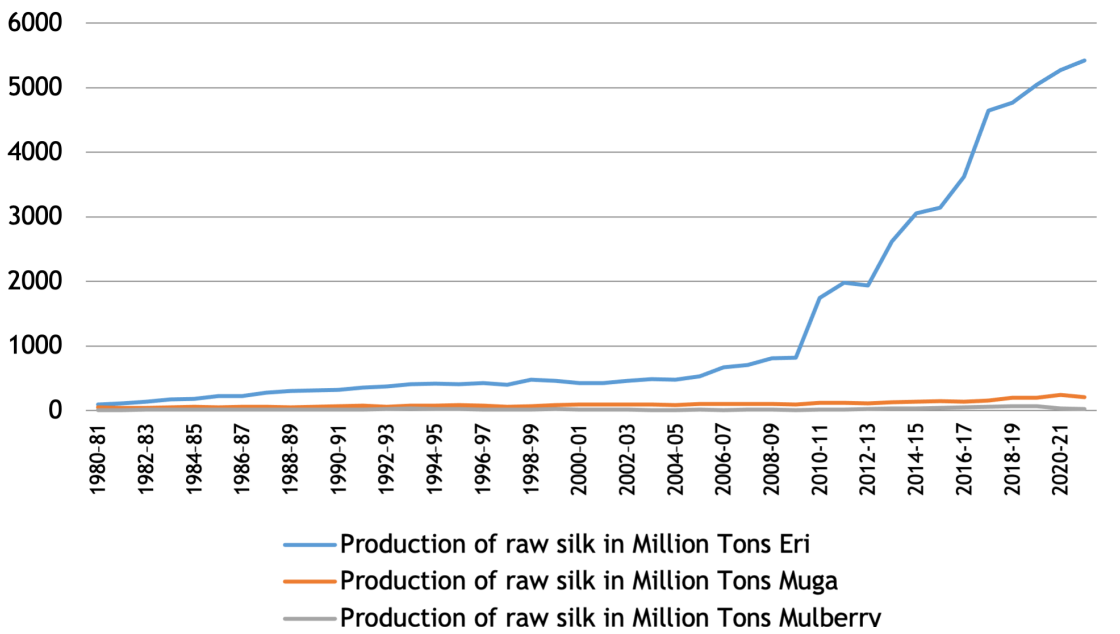

Figure 5
Trend of raw silk production in Assam.
Source: Authors' own finding from the statistical handbooks of Assam.

comparative analysis, the two leading muga silk producing districts viz. Lakhimpur and Sivsagar are considered. Similarly, Karbi Anglong and Golaghat districts are considered the leading producers of eri silk in Assam, and as leading producers of mulberry silk, we have considered Jorhat and Sonitpur districts.

Data used is secondary and collected from the reports published by the Indian Meteorological Department (GOI), Statistical Hand Books of Assam and different authentic reports and sources. For the first objective, we are using average annual temperature and rainfall to be proxies for climate change. And for the second objective, we analyse the income and employment of the Seri cultivators to understand their economic condition. Results are discussed and presented with the help of tables, and diagrams.

4. Results and Discussion

In this section, we have given an overview of the changing trend in rainfall and temperature in Assam and special discussion is done on the selected four districts. It is followed by the discussion on hoe climate change may impact the agricultural practices relating to Seri production and its probable impact on its production, nature of its relation with the changing rainfall pattern and how it may affect different sectors of the economy of Assam related to Seri culture activities.

4.1. An overview of the trend of climate change in Assam

In this subsection, an attempt is made to have an idea regarding the trend of climate change in Assam. The paper specifically concentrates on the trend of rainfall and temperature since the literature indicates that changes in temperature and rainfall may have impact on the sericulture activities.

The trend of annual rainfall of Assam from 1989 to 2017 depicted by the blue line in figure 6 was published in the report of Indian Meteorological Department, GOI, in January 2020.By the equation of the trend line of rainfall y = -6.8957x + 2241.5it can be assumed that the amount of rainfall may come down to 1889.81mm by 2040.However, it is also important to note that the change in rainfall trend is not same in all the districts. As a result, the decrease in rainfall is not uniform throughout all the districts of the state. Therefore, the trend of rainfall in different districts will give a clearer picture in this regard. Let us consider table 1 and figure 7 for a better understanding.

Looking at the trend of rainfall in the districts of Karbi Anglong and Sivsagar, the leading producers of eri and muga cocoon respectively; it is seen that both the districts have a gloomy future where rainfall is decreasing significantly. On the opposite, in case of Lakhimpur district (the lead producers of muga cocoon) rainfall is showing a decreasing trend, though it is not significant. Insignificant but increasing trend

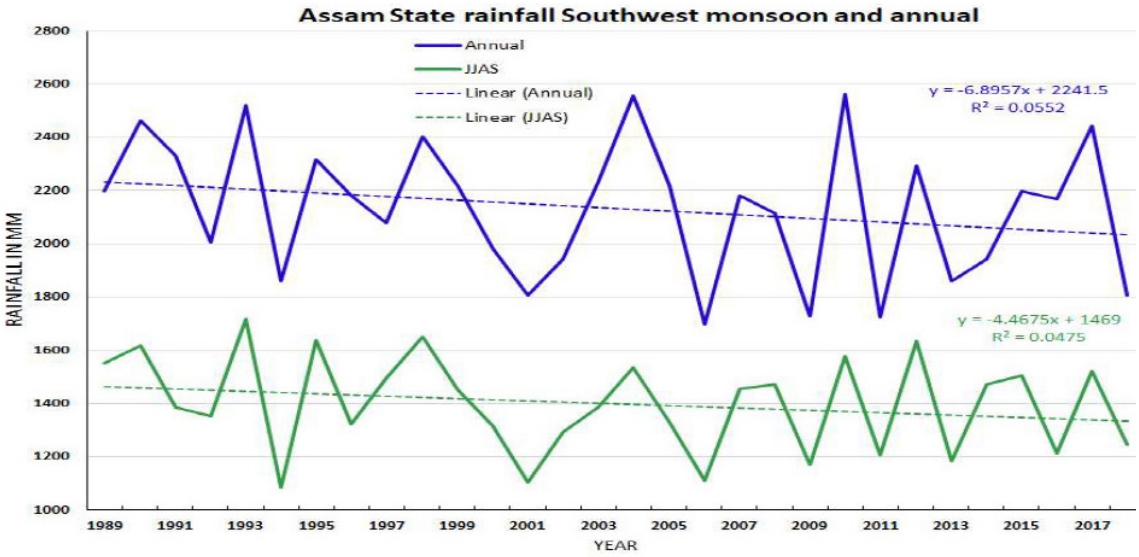

Figure 6
Trend of Rainfall in Assam.
Source: Indian Meteorological Department (GOI)

is also visible in case of rainfall for the districts Sonitpur and Golaghat and significant increase is seen in Jorhat district. In addition, table 2 presents the average annual rainfall between 1989 and 2017 in the six selected districts. Therefore, it is important to understand how these changes in rainfall may affect the production of different silk industries of Assam.

According to the Indian Meteorological Department, the mean temperature of Assam is increasing by 0.01˚c each year and if it continues, by 2050 it may increase by 1.7˚c to 2.0˚c. Additionally, post monsoon temperatures, the seasonal temperature along with winter temperatures are also rising. (ASAPCC, 2015). Table 3 presents the average annual temperature in the selected districts of Assam.

Kotia and jethua are the main commercial crops of Assam, contributing to more than 90 percent of the muga cocoon production in the state annually. Kotia is grown in the months of October and November, while Jethua is grown in the months of April and May (Padkai, V. N. et al., 2014). The average annual temperatures of the selected months in the districts have been risingover the last century. In addition, in the Golaghat district the temperature is increasing at an increasing rate (Indian Meteorological Department, GOI). From the entire discussion on rainfall and temperature conditions, it may be assumed that if the present trend continues, the Golaghat district is going to face the brunt of climate change very soon. This may especially affect the sericulture sector.

Table 1

Trend of rainfall of the districts of Assam.

Districts	Trend Equation	Slope
Barpeta	y = 204.3x + 1979.7	204.3
Bongaigaon	y = 40.856x + 3013.6	40.856
Cachar	y = 5.6509x + 2993	5.6509
Dhubri	y = 84.579x + 2083.1	84.579
Dibrugarh	y = 16.092x + 2259.8	16.092
DimaHasao	y = -109.09x + 2687.9	-109.09
Goalpara	y = 129.19x + 1756.1	129.19
Golaghat	y = 9.06x + 1626.2	9.06
Hailakandi	y = 42.349x + 2343.6	42.349
Jorhat	y = 79.017x + 1482.2	79.017
Kamrup(R+M)	y = 33.645x + 1553	33.645
KarbiAnglong	y = -33.158x + 1539.5	-33.158
Karimganj	y = 76.382x + 3194.6	76.382
Kokrajhar	y = 218.95x + 2616.6	218.95
Lakhimpur	y = -0.143x + 3161.9	-0.143
Morigaon	y = -32.126x + 1711.6	-32.126
Nagaon	y = -44.583x + 1444.3	-44.583
Nalbari	y = 122.13x + 1500.6	122.13
Sivasagar	y = -21.458x + 1948.3	-21.458
Sonitpur	y = 12.236x + 1694.7	12.236
Tinsukia	y = 30.807x + 2098	30.807

Source: Authors' own analysis using the data from statistical hand books of Assam.

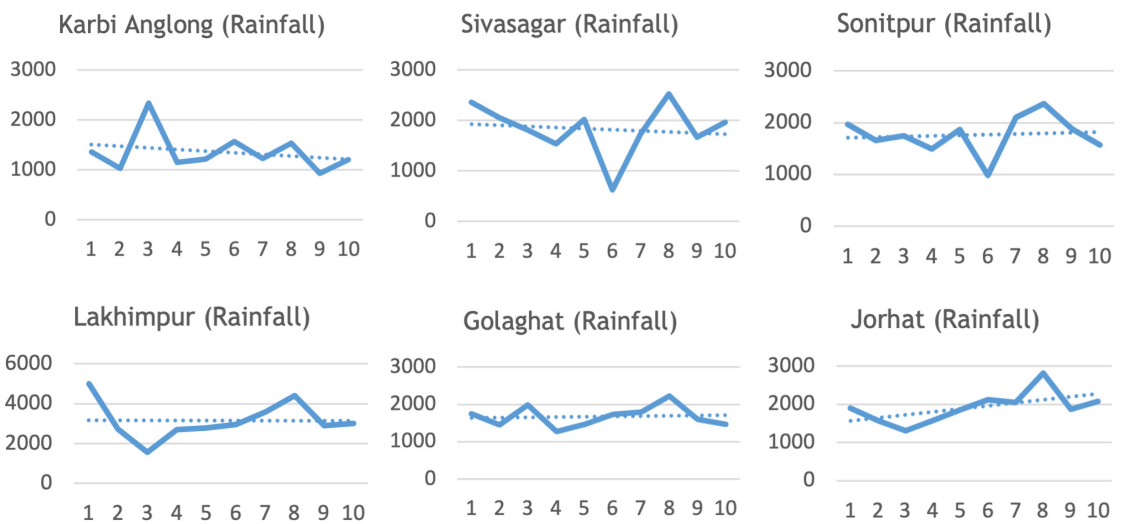

Figure 7
Trend of rainfall in the specially focused districts of Assam from 2010-2020.
Source: Authors' own analysis using the data from statistical handbooks of Assam.

Table 2

Average annual Rainfall.

Districts	Average Annual Rainfall (mm)
KarbiAnglong	1356.1
Golaghat	1624.1
Lakhimpur	2721
Sivsagar	1824.2
Sonitpur	1978.5
Jorhat	2083

Source: Indian Meteorological Department, GOI.

Table 3

Average annual temperature.

Districts	Temperature
Golaghat	23.4
Sivsagar	23.8
Lakhimpur	22.7
Sonitpur	24
Jorhat	23.7
KarbiAnglang	25

Source: Climate Data (2023).

4.2. Impact of changing trend of rainfall and temperature on sericulture

The Mulberry silkworm (*Bomby xmori L.)* aremonophagous, which feeds on the mulberry (Genus *Morus*) plant only. However, the other non-mulberry silkworms such as muga *(Antheraea assamensis* Helfer*),* eri *(Samia ricini* Donovan*),* temperate tasar *(Anther aeaproylei* Jolly*)* and tropical tasar *(Antherae mylitta* Drury*)* are polyphagous (AAU, 2023). Generally,muga silk is produced by the muga silkworms, which are fed on som (*Machilus bombycina*) and sualu (*Litsaea polyantha*) leaves, whereas, eri silk, also known as Errandi or Endi, is derived from the silkworm *Philosamia ricini* and *Samia ricini*. *Philosamia ricini* feeds on castor oil plant (*Ricinus communis*) leaves and hence known as castor silk (International Sericulture Commission, 2016) and Tasar silkworm are usually fed on the trees of Arjun *(Termanalia arjuna* Roxb. Fr. De Wright & Am.*)*, Asan *(Termanalia tomentosa,* W & A*)* and Sal *(Shorea robusta* Gaertn*)* (GOA, 2023). Therefore, the growth and development of these host trees is of vital importance for rearing silkworms (AAU, 2023).

The temperature and rainfall requirement of castor, sualu and som are given in the Table 4. Now if we compare Table 3 and 4, we can see that the growth of castor and som are not going to be affected by the rising temperature in the immediate future. But we can also see that the growth and development of sualu is bound to be hampered in all the four districts due to the rising global temperature. And since eri worm is dependent on castor trees, so the growth and development of eri is not going to get affected due to the rising temperature. However, muga worms are fed on both sualu and som tree leaves and since sualu cultivation is likely to get affected due to the rising temperature, therefore, cultivators need to reconsider their production inputs.

Again, if we compare Table 4 with Table 2, we see that castor plantation might get affected in Lakhimpur district, which again means that eri cultivation is likely to be affected in that particular district due to the changing rainfall pattern. However, rainfall pattern is going to affect muga cultivation in the districts of Karbi Anglong, Golaghat and Sivasagar. To have a clear understanding about how the rainfall is related with the different types of seri cultivation we may see the correlation between the trend of each type of seri cultivation and the trend of the change in annual rainfall across the districts. For this purpose, we can consider the table 5.

Now we shall run the correlation analysis to see how the trend of production of Eri, Muga, Mulberry cultivation and rainfall are related. Considering the Table 6, we can see that a strong

Table 4

Characteristics of Castor, Sualu and Som.

Scientific name	Common name	Temperature required (Degree Celsius)	Rainfall required (mm)
Termanalia arjuna Roxb. Fr. De Wright & Am	Arjun	20-30	750-1900
Termanalia tomentosa, W & A	Asan	21-22.5	2000-2400
Shorea robusta Gaertn	Sal	28-34	1500-3500
Genus *Morus*	Mulberry	24-28	600-2500
Ricinus communis	Castor	15-38	700-2300
Litsea polyantha	Sualu	0-20	2800-3200
Machilus bombycina	Som	23-25	2400-2800

Source: indiabiodiversity.org, worldargoforetry.org, tropical.theferns.info.

Table 5

Trend of different types of seri cultivation.

	Eri		Muga		Mulberry	
Districts	**Equation**	**Slope**	**Equation**	**Slope**	**Equation**	**Slope**
Kokrajhar	y=-0.9486x+258	-0.9486	y=0.0053x+6.454	0.0053	y=0.587x+0.6593	0.587
Dhubri	y=5.7043x+11.465	5.7043	y=0.0036x+0.1545	0.0036	y=0.0095x+0.2071	0.0095
Goalpara	y=16.607x+6.7989	16.607	y=0.4253x+9.7602	0.4253	y=0.2879x+0.3589	0.2879
Barpeta	y=8.5622x+39.442	8.5622	y=0.1112x+0.3675	0.1112	y=0.0003x+0.5096	0.0003
Morigaon	y=16.52x+11.134	16.52	y=0.0623x+0.9055	0.0623	y=0.0368x+0.3485	0.0368
Nagaon	y=16.116x+19.786	16.116	y=0.0135x+0.8929	0.0135	y=0.0199x+0.5884	0.0199
Sonitpur	y=11.441x+46.591	11.441	y=-0.2596x+5.2333	-0.2596	y=0.0632x+1.1864	0.0632
Lakhimpur	y=25.825x+10.765	25.825	y=3.2067x+3.972	3.2067	y=0.454x+1.5933	0.454
Tinsukia	y=24493x+-29.907	24,493	y=-0.1546x+5.7951	-0.1546	y=0.0757x+0.6511	0.0757
Dibrugarh	y=17.986x+0.1675	17.986	y=0.5479x+6.2062	0.5479	y=0.0899x+0.6785	0.0899
Sivasagar	y=10.489x+89.791	10.489	y=-0.1269x+15.1535	-0.1269	y=-0.0251x+1.2875	-0.0251
Jorhat	y=10.558x+38.658	10.558	y=-0.725x+9.4365	-0.725	y=0.1196x+1.4858	0.1196
Golaghat	y=12.154x+45.609	12.154	y=-0.0728x+10.084	-0.0728	y=0.0759x+0.6744	0.0759
KarbiAnglong	y=5.6765x+140.78	5.6765	y=-0.031x+0.74	-0.031	y=0.1956x+0.3535	0.1956
DimaHasao	y=18.627x+0.8587	18.627	y=-0.0331x+0.6731	-0.0331	y=0.0576x+0.086	0.0576
Cachar	y=11.085x+24.468	11.085	y=0.0767x+1.916	0.0767	y=0.1428x+-0.0802	0.1428
Karimganj	y=3.911x+12.207	3.911	y=0.2191x+-0.4545	0.2191	y=0.0127x+0.1826	0.0127
Hailakandi	y=1.0442x+18.748	1.0442	y=-0.0109x+0.4382	-0.0109	y=0.0034x+0.1665	0.0034
Bongaigaon	y=12.195x+-12.604	12.195	y=-0.0327x+0.7382	-0.0327	y=-0.0182x+0.406	-0.0182
Kamrup(R+M)	y=16.137x+44.674	16.137	y=0.4537x+9.9558	0.4537	y=-0.021x+0.6915	-0.021
Nalbari	y=6.2822x+4.4478	6.2822	y=-0.0692x+0.6796	-0.0692	y=-0.0156x+0.3222	-0.0156

Source: Authors' own analysis using the data from statistical handbooks of Assam.

positive correlation exists between eri, muga and rainfall. However, there is a very weak relation between mulberry and rainfall. This indicates that the areas where rainfall is increasing the production of the eri and muga is expected to be increased and the reduction of rainfall may lead to a great reduction in their cultivation. However, the weak relation between rainfall and mulberry cultivation indicates that rainfall will have no significant impact on the production. This specific finding has an important policy implication. It can be stated that in those areas, where the cultivation of eri and muga is suspected to be vulnerable due to the reduction of rainfall, this may be supplemented by the mulberry production to save the families and sustain their livelihood.

Cocoons are grown in some specific plants (Thangavelu et al., 1988) and these plants are affected by several climate induced diseases (Bharali, 1969; Mathieu & Kushalappa, 1993; Marthe et al., 1996; Keith et al., 2006; Das et al., 2003; Das et al., 2020; NAIP, 2023; SILKS, 2023). Therefore, it can also be assumed that climate change may have some severe impact on the plants that are hosting these cocoons (Das et al., 2010; Singh et al., 2013; Das, 2014; Borgohain, 2015).

Table 6

Correlation analysis.

	Eri	**Muga**	**Mulberry**	**Rainfall**
Eri	1			
Muga	0.9898	1		
Mulberry	-0.0138	0.1287	1	
Rainfall	0.9946	0.9992	0.0898	1

Source: Authors' own analysis using the data from statistical hand books of Assam.

4.3. Probable impact on the income and employment of seri cultivators

In the previous section we saw that climatic conditions like annual temperature and rainfall are likely to affect the plantation of castor, sualu and som trees, which are the primary sources of feed for eri and muga worms. In this section, we are going to discuss about the trend of eri, muga and mulberry

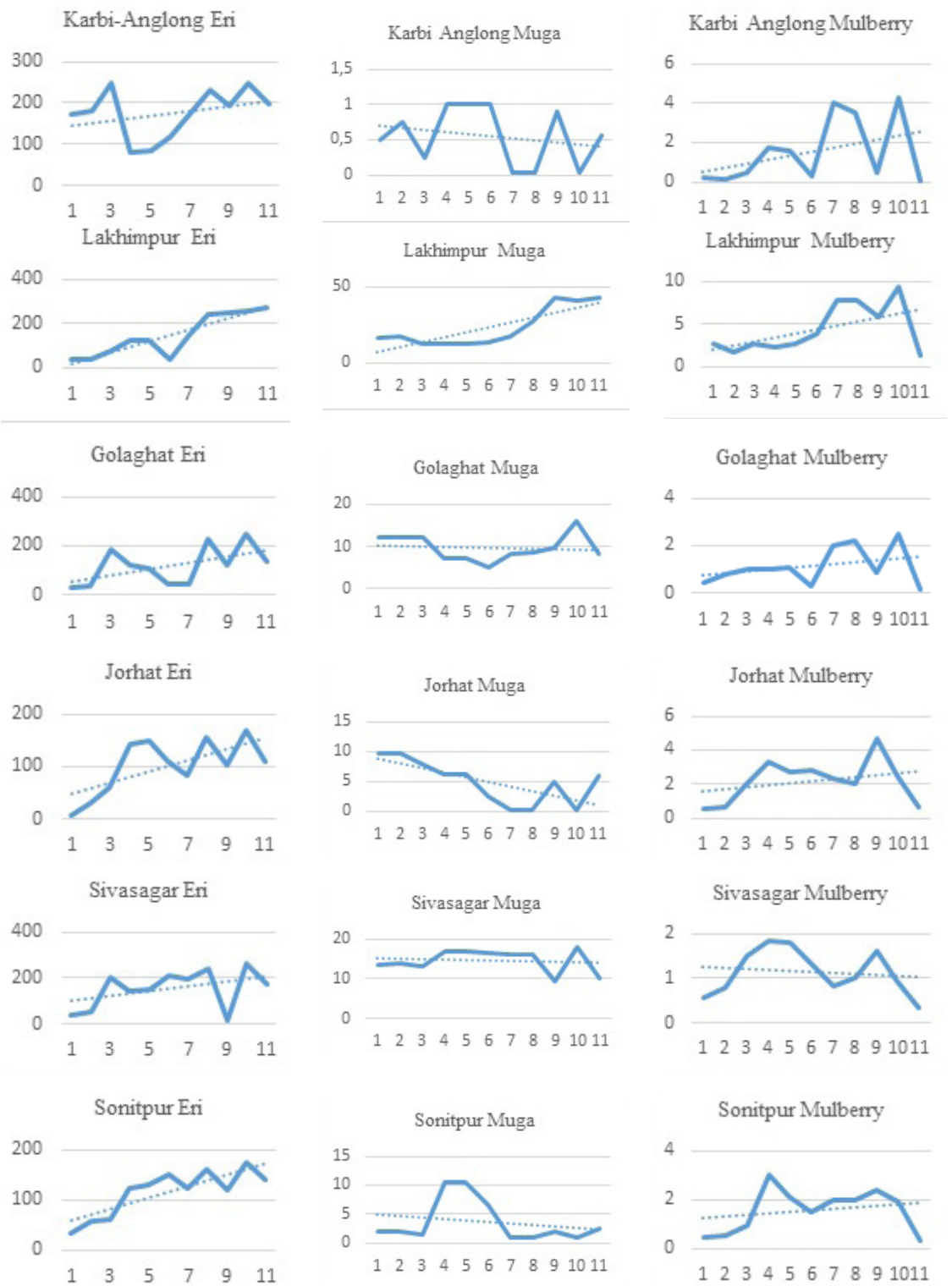

Figure 8
Trend of eri, muga and mulberry production in the selected districts.
Source: Authors' own analysis using the data from statistical handbooks of Assam.

cultivation and production with special reference to the selected districts, and thereby try to see if the predictions that were made in the context of the climatic conditions have actually materialised. The figures were constructed by the authors using data from the statistical handbooks of Assam.

In Figure 8, we can see that, different districts are showing different scenario about its trend of seri production and future possibilities in the same. The eri production is showing a growing trend in almost all the selected districts indicating a large scope for the sector irrespective of the possible adverse effect of climatic stimuli. However, the muga cultivation seems to be slightly affected by the climatic variability and as a result, in some districts their production is taking declining shape. Except the district Sivsagar, the mulberry production is also rising and it gives a clear indication that though the particular cultivation presently has small contribution towards the sector, it has a great scope for greater volume of production in the coming future.

5. Conclusion

India's rainfall pattern is deeply affected by the Indian Ocean's sea-surface temperature, sub-divisional monsoon rainfall and the El-Nino Southern Oscillation (Krishna Kumar et al., 2004). Again, the changes in rainfall and the rising temperature have severe impact on the agricultural system of India (Ortiz et al., 2008; Prasanna, 2014). The extended adverse effect of climate change may lead to a huge unexpected loss to the sericulture industry of Assam. As a result, it may adversely affect the economy of the population connected with this industry and since women are more closely related with this industry, they are expected to get more economically vulnerable (Rama Lakshmi, 2007; Chantotra et al., 2019).

From the above discussion it can be concluded that even though rainfall and temperature are becoming uncongenial for cultivation of the primary plants on which eri, muga and mulberry worms survive, their total production is increasing at a steady rate. It is also very likely that there are other forces at play like better pest control measures, intensive cultivation, advanced technologies, etc. which supplement the high levels of production. The study has also revealed that there may have very weak relation between the rainfall and mulberry raw silk production. This indicates the possibility to increase the use and popularity of mulberry silk among the poor rural masses of the state as a supplement of the other two silk industries.

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