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Conversion of Rice Fields to Small Tea Plantations in Bodoland Areas of Assam (India): A Sustainability Assessment

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Abstract: In the past few decades, the amount of land used for growing tea in Assam has grown a lot mainly because more small farmers have started growing tea. Small tea cultivation in Assam, which first started as a commercial garden in Golaghat in 1978, has recently revolutionized agriculture by providing sustainable income and driving social and economic change. Although small tea farms emerged relatively late in Assam's Bodoland areas, Udalguri district has become a key region due to its legacy of large tea plantations and rising awareness among the farmers about its higher returns compared to rice. The first small tea plantation (STP) in the district emerged in Amjuli in 1991, followed by Naoherua in 1993 and Darogachuba in 1997. So far Naoherua village is concerned, its area under STP expanded from 4.31 ha in 2001 to 56.82 ha in 2022, while the rice fields reduced from 203.5 ha to 54 ha during the same period. On the other hand, in Darogachuba village the STPs grew from 14 ha in 2010 to 58 ha in 2022 with rice fields decreasing from 228.48 ha to 176.84 ha. The study looks at how much money can be earned from growing small tea cultivation and rice cultivation using both data collected by the researchers and information from other sources. Accordingly, the study of income-expenditure for the period 2021-2023 shows that the benefit-cost ratio (BCR) per hectare for STP is higher (2.68 in Naoherua and 2.32 in Darogachuba) as compared to rice cultivation (1.30 and 1.50, respectively).

Keywords: Benefit Cost Ratio, Small Tea Plantation, Profitability, Net Return

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1. Introduction

The geographical background of an area has an important part in shaping how farming is done, as it is directly influenced by climate, soil, slope and topography. The geographical factors required for tea and rice cultivation are unique. Tea mostly grows in well-drained, acidic soils at higher altitudes with consistent rainfall, while rice flourishes in water-retentive soils in lowland areas with stagnant water and warmer temperatures (Dikshit & Dikshit, 2014; Barua, 1994). The geographical location of Assam is the most ideal for tea cultivation with fertile soil, abundant rainfall and humid climate (Roy, *et al*., 2019; Trewartha, 1929). The rolling terrain of Brahmaputra valley and sub-tropical climate contribute to the robust growth of tea (Kar, 2018; Roy, *et al*, 2015; Nath, 2021). On the other hand, rice has been the main food in the state and was mostly grown using rainwater. But rice, particularly winter variety can be easily affected by floods (Bhowmik, *et al*., 2005). During the colonial period, the conversion of agrarian economy into cash crops like tea, jute, mustard and opium was driven by the European investment and new land legislation aims to increase revenue and engage cultivators in commercial crops (Wary & Brahma, 2021; Deka, *et al*., 2021). Although rice cultivation has long been a part of agricultural practice in Assam, the shift to tea cultivation is being pushed by factors such as increased crop failure risk, low-income generation, seasonal unemployment problem, etc. (Sharma & Barua, 2017; Goyal & Ghosal, 2017). The conversion of rice (Autumn) and other traditional Rabi crops into tea cultivation in Assam has been taking place since 1970s which is influenced by agro-climatic, economic and social factors (De & Bodosa, 2014; Bezbaruah, 1994; Phukan, 1990; Das & Das, 2020). The globalization policies that reinforce market dominance led to significant fluctuations in pricing and demand patterns, which expose small farmers to market forces and increase risk and insecurity and pushed small farmers to convert into STP (Bose, & De Roy, 2019). In Assam, flood is a major problem which effects different varieties of rice. As a result, in certain areas, flood affected rice fields have been converted into commercial crops including tea by filling soil (Mandal, 2010; Goyari, 2005). The other advantages for small tea cultivation include tea is a perennial cash crop, growing opportunities for establishment of Bought Leaf Factories (BLFs), the tea growing areas provide a market and more regular and continuous source of income compared to rice cultivation, which is seasonal (Melvani *et al*., 2023).

While some people argue that growing cash crops can increase household income and potentially improve food security by allowing them to buy food (Hashmiu *et*

al., 2022). The tea plantations provide employment opportunities, especially for women creating a stable source of livelihood for local communities (Bhadra, 2004). The structured labour system in tea cultivation offers more consistent employment opportunity compared to the seasonal nature of rice farming (Bose & Roy, 2019). Despite the increasing importance, the growth of STP is not encouraging as this cash crop is highly capital intensive and majority of the farmers in Assam (more than 85 percent) are small and marginal with meagre savings (Sarma & Bhuyan, 2000). Although small tea farms were established relatively late in the Bodoland Areas of Assam, Udalguri district has become the core of tea cultivation in the entire Bodo region. This shift is attributed to its historical legacy of large tea plantations and the growing awareness among the Bodo and other dominant communities of this area about the higher returns from tea cultivation compared to the traditional rice-dominant farming system. Agriculture is the main economic activity in Udalguri district, including crop cultivation, fishery, dairy, poultry and sericulture. The district has 24 large tea estates owned by companies with around 10,898.56 ha area and 7,519 small tea growers covering 8,548.74 ha. (Tea Board of India, 1981-2023 & Statistical Handbook of Assam, 2000-2023). Even though the district is mostly covered by tea plantations, winter rice is still the most extensively grown crop, because only a small portion of the district is highland and suited for growing tea; the rest of the district is low lying, where winter rice is still dominant (Mandal, 2010). The total area where crops are grown once (net cropped area) and total area where crops are grown more than once (gross cropped area) in the district are 1,15,903 ha and 1,58,101 ha respectively. In 2019-20, rice was grown on 98,000 ha with a production of 247,274.88 metric tons (Statistical Handbook of Assam, 2020). Autumn rice covers 17,740 ha, winter rice 72,950 ha and summer rice 7,310 ha. (District Agriculture Office, Udalguri and Statistical Handbook, 2020). The number of STGs and the area under STPs vary across the district. The Bhergaon CD Block has the highest number of STGs (3,355) and area under STP (10,994.27 Ha), followed by Udalguri CD Block with 1,640 STGs covering 7,511.48 ha (Tea Directory of India, 1991-2020). This structural transformation highlights the paradox of agricultural production decline, even when faming remains the majority of rural livelihoods in the district (Bahuguna *et al*., 2024). The majority of its population (95%) lives in rural area and 36.2% are dependent on agriculture. Despite growth in manufacturing and services, employment opportunities are insufficient to absorb the excess rural population. Therefore, the emergence of small tea plantations offers a promising

solution to the seasonal unemployment problem faced by rice farmers. Besides, growing demographic pressure in the area has led to fragmentation of holdings and reduction in arable land. However, small and marginal farmers along with landless people who form 89% of all landholders have an average farm size of 0.57 ha. As a result, Assam's rice production system struggles for economic viability, posing challenges for local farmers and region's agricultural sustainability. The changing natural forests into tea plantations has caused big environmental problems mainly by making the soil wash away and reducing water storage in the area (Su, et. al., 2017; Zhang *et al*., 2022). However, long-term intensive tea cultivation in major tea growing areas has been linked to serious resource degradation (Goswami *et al*., 2023), decreased productivity, groundwater depletion, use of chemical fertilizers, pesticides and herbicides, labour scarcity and higher cultivation costs by raising concerns about the sustainability of agriculture (Baracskay, 1998 & Das *et al*., 2024). Therefore, in India's rapidly changing context, the future scenarios for sustainable development in villages need to consider both human and environmental needs (Deka & Goswami, 2021 & Qiao, 2016). The high cost of cultivation, coupled with relatively low rice prices and yields have contributed to the adverse profitability scenario (Abebe *et al*., 2022). With the above background, this present paper tries to understand how small tea plantations have expanded over space and conversion of rice cultivation into STP in selected villages of Udalguri district and to undertake a cost-benefit analysis between tea and rice cultivation from the perspective of economic sustainability.

2. Database and Methodology

The research problem has been formulated by identifying the problems that rice farmers encounter and how the development of small tea plantation may help to reduce these problems. The necessary data for the purpose have been collected from primary and secondary sources. By integrating primary and secondary data, the research aims to provide a comprehensive understanding about rice and tea cultivation profitability. The methodology involves a holistic analysis of both quantitative and qualitative aspects. The benefit-cost ratio (BCR) method has been used to analyse the profitability of rice versus tea cultivation by evaluating economic efficiency and feasibility. It incorporates key factors like initial investment, maintenance costs and market prices, offering a comprehensive comparison of long-term profitability. BCR helps quantify these financial aspects into a clear ratio, aiding farmers in making decisions.

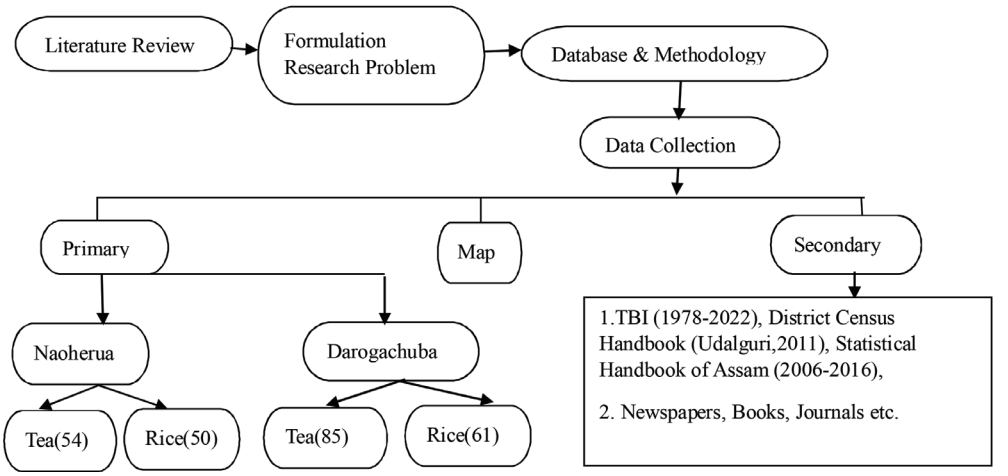


Fig. 1: Flow Diagram of study

The study is largely based on primary data concerning small tea growers and rice farmers have been collected through purposive random sampling and survey with respect to various aspects of farmers. Accordingly, two villages namely Naoherua and Darogachuba are selected, as both these villages prefer cultivation of both tea and rice. Based on cropping pattern, soil and climatic criteria, two contrasting villages were selected. Altogether 54 STGs (47.81Ha) and 50 rice farmers (40.67 Ha) have been chosen from Naoherua village and out of which 26 STGs (28.09 Ha) having both STP and rice cultivation. On the other hand, 85 STGs (55.49 Ha) and 61 rice farmers (67.1Ha) have been chosen from Darogachuba village and out of which 63 STGs (67.1 Ha) having both STP and rice cultivation. The current study employed a variety of data sources in order to enhance the analysis and to make it comprehensive. Secondary data were gathered from research articles, TBI (1978-2022), District Census Handbook (Udalguri,2011), Statistical Handbook of Assam (2006-2016). A significant challenge during primary data collection was the variability in getting responses from small scale tea growers regarding costs. Many growers could only estimate the overall cost of inputs, lacking detailed information on the quantities of fertilizers, pesticides and insecticides used. Similarly, precise labour costs for activities like weeding, soil preparation and manuring were often unknown as labour needs vary seasonally. Most growers struggled to estimate the number of labourers accurately, with fewer needed during initial flushes and more during peak seasons like pruning (December-January).

Table 1: Economic Sustainability and Indicators of farmers

Livelihood capital	*Statistics*	*STGs (N=139)*	*Rice Farmers (N=111)*
Age(Years)	Mean	44.95	45.40
	SD	8.56	8.73
Sex(Male=1,Female=0)	Mean	0.93	1.08
	SD	0.24	0.27
Education(Illiterate=0,Primary=1,High School=2,Higher Secondary=3,Graduate & Above=4)	Mean	2.12	1.77
	SD	1.63	1.60
Primary Occupation(Agriculture=0,Daily Wage=1, Service=2, Others=3)	Mean	1	0.88
	SD	0.67	0.56
Household Size(Numbers)	Mean	4.76	4.45
	SD	1.72	1.65
Experience in years	Mean	9.81	11.12
	SD	5.52	10.53
Area Cultivated(in Ha)	Mean	0.76	0.56
	SD	0.90	0.45
Yield of Tea (Kgs/Ha)	Mean	12082.11	-
	SD	7255.01	-
Yeild of Rice (Kgs/Ha)	Mean	-	2008.45
	SD	-	669.43
Total workers (Numbers/ha)	Mean	8.19	5.23
	SD	11.94	4.25
Posses heavy machineries(Yes=1No=0)	Mean	0.41	0.14
	SD	0.83	0.53
Posses farm implements(Yes=1No=0)	Mean	0.88	0.75
	SD	0.32	0.54
Posses Livestock(in Numbers)	Mean	4.51	5.66
	SD	0.85	4.58
Training/Suggestion(Yes=1No=0)	Mean	0.71	0
	SD	0.45	0
Schemes/Loan/Subsidies(Yes=1,No=0)	Mean	0.17	0.12
	SD	0.37	0.11
Mode of transportation(Bicycles=0,Bikes=1, Others=2)	Mean	1.33	2.45
	SD	1.50	1.36
Market Access(in Km)	Mean	1.68	5.69
	SD	1.35	4.56

Source: Computed from the data collected through Primary Survey, 2022

Both small tea cultivation and rice cultivation like any other types of farming are influenced by numerous factors. One important factor in this respect is the variation in farm size and the experience levels of farmers. The age, education, household size (since a larger number of domestic workers can reduce labour costs), ownership of heavy machinery (such as tractors), possession of farm implements and livestock are all important elements. Additionally, access to training and suggestion, market access, modes of transportation and availability of schemes, loans or subsidies also play major roles in both the cultivation. It has been found that the growers in the study area have been growing tea for a relatively short time with an average of about 9 years of experience while they have about 11 years of experience in rice farming. The average land holding size for tea cultivation is 0.76 hectares, while for rice cultivation it is 0.56 hectares (Table 1). Growers with more experience usually have better knowledge of how to manage their farms which helps them grow crops more efficiently and get better harvests (Goswami *et al.*, 2023).

3. General Background of Study Area

According to National Agricultural Research Project, Udalguri district of Bodoland Territorial Region (BTR) in Assam, falls under the North Bank Plain Zone covering an area of 2013.71 sq. km and lying between 26°39′45″N - 26°55′0″N latitude and 92°12′45″E - 91°57′ 30″E longitude. Udalguri district is located on the northern side of the Brahmaputra River. The climate of the area is mostly hot, humid and sometimes slightly less humid. It is bordered by Bhutan and Arunachal Pradesh to the north, the Pachnoi River to the east, Darrang district to the south and Baksa district to the west. The district is 105 meters above sea level. The annual rainfall of the district is 1972 mm largely caused by SW Monsson (June-Sep). The average temperature is 28°C. Mostly three types of soil are found in the district, viz., sandy loam, clay loam, silty clay loam and among them clay loam land coverage is highest with land area of almost 50%. With a population of 831,668 (As per 2011 Census) the district is inhabited by people of diverse ethno-linguistic and religious composition. Besides population of Bodo community (31.76%), it is largely inhabited by non-tribal Assamese, Bengali and Nepali people. The Adivasi community traditionally involved in tea plantations also forms another important segment of population in the district. Between the two selected villages, Naoherua village is located in Udalguri sub-division of Udalguri district in Assam. It is situated 30 km away from Udalguri town. The total geographical area of village is 397.79 ha with total

population of 1,136 out of which males are 547 and females are 589. Literacy rate of the village is 78.87%. There are 214 households in the village. The elevation of Naoherua village is 162 meters. On the other hand, Darogachuba village is located in Harisinga sub-division of Udalguri district in Assam. It is situated 70 km away from the district headquarters Udalguri. The total geographical area of the village is 372.57 ha. The total population is 1080 with 490 males and 590 females. Literacy rate of the village is 50.28%. There are 216 households in the village. The elevation of the village is 117 meters.

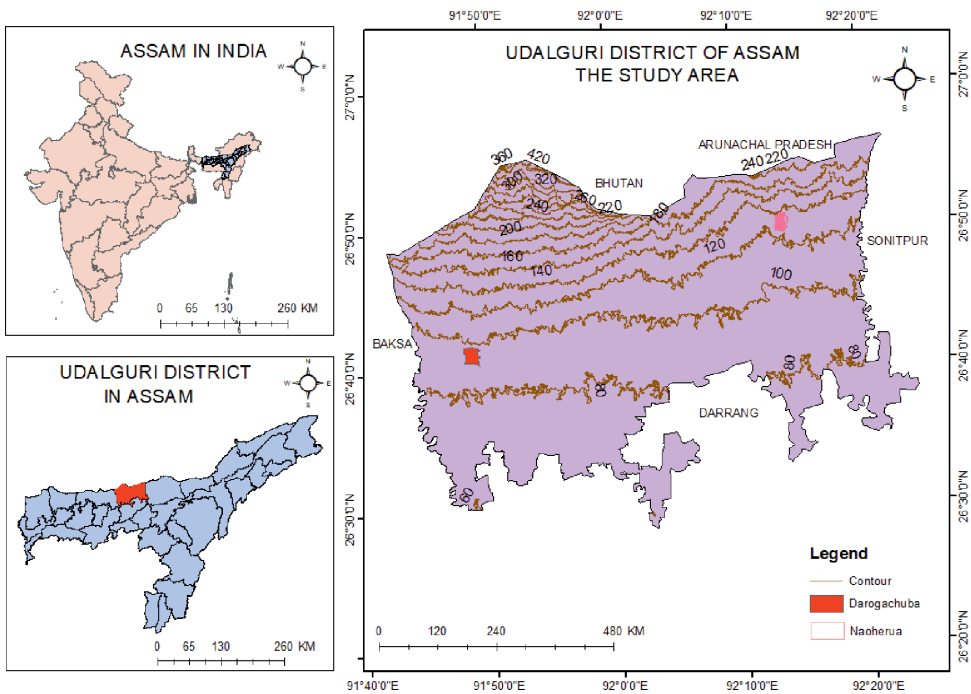


Fig. 2: Map showing the location of the study area (Udalguri District).

Source: Prepared by the first author using the Software Arc GIS 10.8 on the basis of administrative maps.

4. Results & Discussion

The main point of comparing the costs and benefits of growing rice and small tea is based on understanding the components to accurately determine farm profitability (Deka & Goswami, 2021). Additionally, estimating the cost and benefits of small tea plantation under various production scenarios gives valuable insights into long-term economic sustainability of STP.An assumptions are made to estimate the production

costs and conduct an economic comparison between STP and rice cultivation for small cale farmers. The analysis aims to extend beyond the economic advantages and considers the broader socio-economic implications of small tea growers. Since the growers typically do not have detailed records of their production costs or income, this study is primarily based on field observation. These assumptions were subsequently cross-verified with experienced tea growers.

4.1. Changing Spatial Expansion of STP in the Selected Villages (Conversion of Rice Cultivation into STP)

The changes in land use have a significant impact on farmer's livelihoods and play a crucial part in farming. There are significant ecological consequences when agricultural lands are converted into tea plantations. The north-western part of Udalguri district is rapidly changing with new opportunities growing through farming based on market needs and customer demand in rural areas. In Udalguri district, conversion of rice fields into tea gardens has become popular recently due to ongoing low yields from traditional rice farming (Fig.3).

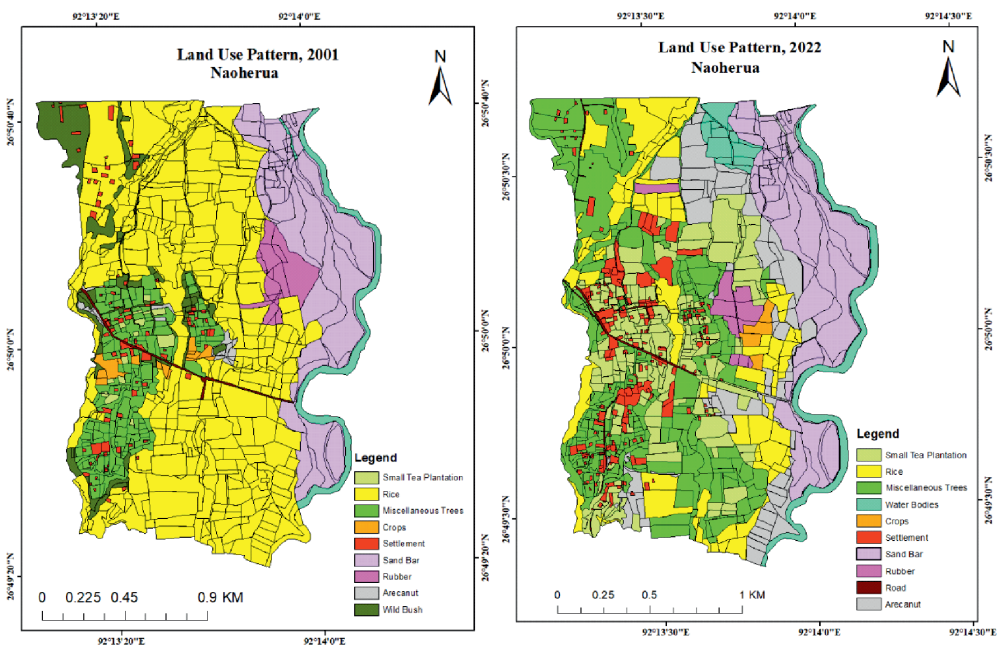


Fig. 3: Changes in land use in Naoherua, 2001 and 2022

Source: Data Extracted from Google Earth (18/10/2001) and (18/10/2022) mapping by using the Software Arc GIS 10.8 & QGIS 3.28.6.

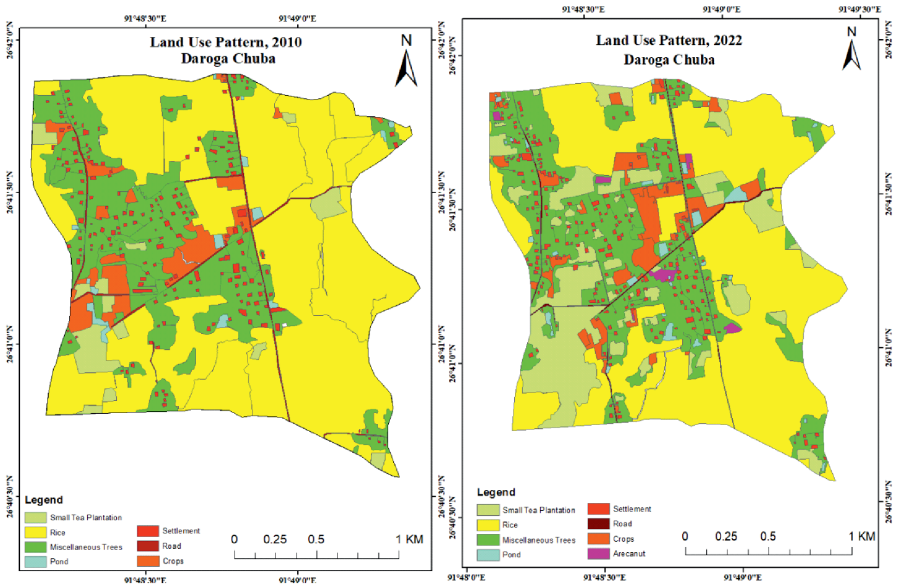


Fig. 4: Changes in land Use in Darogachuba, 2010 and 2022

Source: Data Extracted from Google Earth (25/11/2010) and (17/4/2022) mapping by using the Software Arc GIS 10.8 & QGIS 3.28.6.

Table 2: Pattern of Land Use and Land Cover Change (2010-2021)

Land use/land cover categories	*Naoherua*			*Darogachuba*		
	2001 (ha)	*2022 (ha)*	*Area Change (ha)*	*2010 (ha)*	*2022 (ha)*	*Area Change (ha)*
Smal Tea Plantation	4.31	56.82	+52.51	14	58	+44
Rice	203.5	54	-149.5	228.48	176.84	-51.64
Miscellaneous Trees (Shrubs)	34.14	86.26	+52.12	92.61	97.75	+5.14
Water Bodies	15.5	26	+10.5	-	-	-
Crops	5.33	2.74	-2.59	21.55	21.2	-0.35
Settlement	6.76	17.63	+10.87	8.6	9	+0.4
Sand Bar	92	90	-2	-	-	-
Rubber	12	7.18	-4.82	-	-	-
Road	3.52	3.52	0	4.33	4.33	0
Arecanut	4.28	53.64	+49.36	-	2.14	+2.14
Wild Bush	16.45	-	-16.45	-	-	-
Pond	-	-	-	3	4.37	+1.37
Total	397.79	397.79	0	372.57	372.57	0

Data Source: Extracted from Google Earth (2/2021) and computed using the Software Arc GIS10.8 & QGIS 3.28.6

There is a significant increase in the area of small tea plantation and miscellaneous trees (Agro-forest) in both the villages at the cost of area under rice cultivation, which has decreased substantially in both the areas. The water bodies present in the area have significantly contributed to the occurrence of recent floods in Naoherua, as a major river flowing by its side. The floods result in the rise in water level, submerging surrounding areas and creating extensive water bodies. This has brought about serious challenges before the local farmers. However, despite such challenges, the land used for STP in Naoherua village has risen to 52.51 ha in 2022 (Table 2). But the area under rice cultivation in the village fell by 149.5 ha or 37.58%. On the other hand, the area under miscellaneous trees became 52.12 ha with 13.15% increase. The area affected by water bodies has reached 10.5 ha by experiencing an increase of 2.645. the area under STP expanded to 44 ha in Darogachuba village come does to 5.14 ha with an increase of 1.38%. Thus, there has been expansion of area under STP following shrinkage in rice area largely in the highland part of the villages. The introduction and expansion of tea cultivation in both the villages were at the expense of vegetable crop, rubber plantation and wild bush. From field survey it has been found that flood is a major issue in the low-lying areas of Naoherua village and therefore such areas are converted to STP through considerable land filling.

4.2. Factors Responsible for Conversion from Traditional Rice Cultivation into STP

Farmers are increasingly switching their agricultural land from rice and other rabi crops to STPs due to the steady income and long lifespan of tea plants. The presence of numerous small and large tea factories, particularly in and around like Darogachuba and Naoherua villages with favourable agro-climatic conditions, makes STPs ecologically and economically sustainable. In fact, the productivity and economic returns of any crop depend on the factors, such as land size, production cost, harvesting cost, yield and marketing efficiency. For rice, since the land is usually small, the cost to produce it is high, the yield is average and the market price doesn't rise as much as the production cost. Conversely, the farmers who grow cash crops like tea receive necessary advice, quality plants and subsidies for machinery help from Tea Board of India (Hannan,2024). But the rice farmers do not receive similar institutional support. They often lack knowledge about the appropriate amounts and timing for applying fertilizers, pesticides and insecticides leading to crop failures

or losses. Additionally, due to absence of a well-coordinated system, rice farmers cannot fully benefit from the Minimum Support Price (MSP) and incentive schemes offered by the Government of India (GOI). The price difference between the MSP and local markets is approximately Rs 500 per quintal, which significantly impacts farmer's income (Economic Survey of Assam, 2022). As a result, farmers are often compelled to sell their produce at very low prices without any bargaining power. Such a gradual loss incurred by rice farmers has great implications towards the state's economic and ecological sustainability, as well as its food and water security. Moreover, under the scheme of infrastructure development, the reclamation of rice fields has led to rapid disappearance of wetlands.

4.3. Assumption over Cost Estimation of Small Tea Cultivation

The cost structure of STPs includes establishment/fixed costs for the initial three non-revenue years, with revenue starting from the fourth year, covering variable/operational costs. The study assumes the first three years as non-revenue years, fourth to eight as initial revenue years and ninth to 40th years as late revenue years, with tea production declining after 40 years. Traditional small tea cultivation relies on monsoon rain for irrigation, similar to rice. Tea cultivation, a perennial cash crop, requires intensive maintenance for its entire economic lifespan. Growers must maintain the plants without returns for the first three years but can practice intercropping with crops like arecanut, black pepper, betel leaf and agar wood. The year-wise establishment costs of tea cultivation in Naoherua and Darogachuba villages are presented in detail in Table 3.

In both the study villages, land preparation is crucial as a healthy tea production depends on it. So, 5-6 male workers per hectare are needed to clear the land for tea cultivation, which requires labour charge for Rs 300 per day per head. This involves clearing forest and uprooting. Although soil testing is required, farmers can get their soil tested free of charge following the planting of tea, even though majority of growers do not to test the soil. An average man-day typically consists of eight hours of labour per worker and it requires six to eight days. After this, with technological advancements, majority of growers use tractors, mostly hired to prepare land. In a period of 15-20 days, they plough land for three to four times. For the task of levelling and drainage digging, 3-4 labourers are hired, each getting Rs 300 per day. It takes farmers 90-100 days on average per hectare to settle the soil. The majority of farmers do not possess a nursery and they purchase saplings

from nearby nursery and as such a total Rs13,446 per ha of saplings is required and depending on different varieties, cost of saplings varies from Rs. 5 to Rs. 8 per saplings. It takes seven times for loading and unloading saplings and each time, it costs 500 Rs. Each pit of saplings needs to be dug and filled and each filling costs Rs 3 per saplings. Growers occasionally invest in shade trees, with approximately 60 trees to cover one hectare of tea cultivation. The tea growing areas of Assam benefit from natural irrigation, and hence additional irrigation is not necessary for small-scale tea growers. Due to advantageous topography and climate, the cost for irrigation and shade tree maintenance is minimal in both the villages. In the second year, infilling is carried out in tea gardens to replace dead bushes with healthy plants. This process involves using major nutrients such as MOP, SSP, DAP and Urea along with cow dung which is commonly used by farmers. Also, micronutrients like calcium, magnesium, copper and zinc are used to help plants grow. To control pest, weeds and diseases farmers use different pesticides and herbicides (Deka & Goswami, 2021).

From the fourth year onwards, MOP and Urea are applied three times at the beginning of each season. Each application uses 1 Bag of MOP per hectare, with each bag containing 50 kgs and costing Rs 1950. Therefore, 3 bags of MOP are required per hectare annually. Urea, which is cheaper at Rs 266 per 45 kg bag, is also applied three times a year. Pest control, herbicides, weedicides and growth promoters or nutrients are used as needed, typically on sunny days. During the initial stage, herbicides and weedicides are used more frequently, while pest control and growth promoters are applied annually. When the shoots (primaries)grow in a tea bush after pruning or skiffing, they are tipped at predetermined height parallel to ground surface. In tea cultivation, female labourers are generally required for plucking, while tasks such as drainage maintenance, manual weeding, spraying and pruning are performed by men. Drainage maintenance is carried out during December and January and manual weeding is primarily done during the rainy season, costing Rs 300 per day per labourer, with 5-6 labourers typically needed. Spraying medicines costs Rs 30 per tank. Pruning and skiffing of tea bushes are done manually, as machine pruning has not yet been adopted by growers in both study villages. Tea bushes are pruned every three to four years, with skiffing or leaving the bushes untouched in between pruning intervals. The plucking season of tea leaves begins in the fourth year, marking the start of harvesting for growers. Tea cultivation involves three plucking seasons: March-May, June-August and September- mid November with each season varying in production and price per kg of tea leaves

depending on quality of leaves. The highest quality tea leaves are characterized by one bud and two leaves. The demand for hired labourers to pluck tea leaves fluctuates with each season. The plucking structure of tea leaves is outlined in Table 3, while a few large growers exist, most STGs are marginal and subsistence farmers with less than 1 ha land. On an average, the cost of cultivating green leaves, which includes labour and fertilizer expenses, is estimated to be 10-12/Kg. However, during the peak season (June-August), the price of green leaves usually goes down. As STGs do not own their own tea processing factories, they have to rely on either large estate with factories or private tea factories dedicated to procuring leaves from the local growers. Among the factories that don't not have their own plantations and instead buy green leaves from STGs are called Bought Leaf factories (BLF).

Table 3: General Year-Wise Establishment Cost/Fixed Cost (Rs/ha) of STP

Components of fixed or establishment cost/hectare			
	Particulars	*Total cost/ha*	*Total cost/ha*
		Naoherua	*Darogachuba*
1st Year	1) Annual Land Revenue	224(0.09%)	224(0.1%)
	2) Saplings	67230(28.14%)	65000(27.65%)
	3) Land Clearing	13446(5.63%)	15000(6.38%)
	4) Tractorization	10458(4.38%)	12542(5.34%)
	5) Levelling	8964(3.75%)	9520(4.05%)
	6) Drainage Digging	8964(3.75%)	9256(3.94%)
	7) Digging & Filling pits (Planting)	40338(16.88%)	41578(17.69%)
	8) Saplings loading & unloading	3735(1.56%)	4258(1.81%)
	9) Shade Tree	2390(1%)	2325(0.99%)
	10) Non-recurring Implements	4000(1.67%)	3258(1.39%)
	11) MOP+SSP+DAP+UREA (manuring/ Fertilizers)	22410(9.38%)	21874(9.31%)
2nd Year	12) Infilling	7470(3.13%)	8547(3.64%)
	13) MOP+SSP+DAP+UREA (manuring/ Fertilizers)	22410(9.38%)	19874(8.46%)
3rd Year	14) Skiffing	17928(7.5%)	15897(6.76%)
	15)Tipping	8964(3.75%)	5899(2.51%)
Total		238931(100%)	235052(100%)

Source: Primary survey, 2022

The establishment cost is structured based on data from 2014, i.e. eight years prior to 2022. The analysis of establishment cost components for small

tea cultivation in Naoherua and Darogachuba reveals distinct difference in the allocation of costs. The annual land revenue remains constant at 224 Rs/Ha for both the villages, representing a minor share of total cost at 0.09% for Naoherua and 0.1% for Darogachuba. However, significant differences appear in other components, i.e. the proportional cost for saplings is higher in Naoherua (28.14%) as compared to Darogachuba (27.65%), indicating a slightly more initial investment on planting material.

Table 4: Components of variable cost (operational cost)/ha of sample villages

Components of variable cost (operational cost)/ha		
Particulars	*Naoherua*	*Darogachuba*
1) Manuring/Fertilizer	STP	
MOP	5,850(7.03%)	5850(5.67%)
UREA	2166(2.60%)	2166(2.10%)
2) Pest Control	4000(4.81%)	4000(3.87%)
3)Herbicide/Weedicide	3000(3.60%)	3000(2.91%)
4)Growth Promoter & Nutrient	2000(2.40%)	2000(1.94%)
5)Plucking	30000(36.04%)	40000(38.74%)
6)Tipping	2000(2.40%)	2000(1.94%)
7)Man Days		
Drainage Maintenance	3000(3.60%)	3000(2.91%)
Clearing Weed	1800(2.16%)	1800(1.74%)
Spraying	1200(1.44%)	1200(1.16%)
Pruning/Skiffing	3000(3.60%)	3000(2.91%)
Annual land Revenue	224(0.27%)	224(0.22%)
v)Carrying Cost (Rs/Ha)	15000(18.02%)	20000(19.37%)
vi)Transportation Cost (Rs/Ha)	10000(12.01%)	15000(14.53%)
Total Operating Cost/ha	83240(100%)	103240(100%)

Source: Primary survey, 2022

The variable cost structure of present study is based on cost of 2022. The variable cost components for tea cultivation in Naoherua and Darogachuba show distinct shares of total operational cost. In Naoherua, the cost of manuring and fertilization with MOP constitutes 7.03% of the total variable costs. This is followed by pest control (4.81%). Urea application accounts for 2.6% (Table 4). In Darogachuba, the share of manuring and fertilization with MOP is slightly lower (5.67%), which could imply either lower soil fertility requirements or a different fertilization. Pest control costs involve 3.87% of the total. The use of Urea is also lower (2.1%). Overall, the use of

chemical fertilizer, pest control etc is lesser in Darogachuba than Naoherua. While in terms of plucking, cost of plucking leaves is higher in Darogachuba, because owing to high production of green leaves the labour requirement is higher than Naoherua. In Darogachuba, the labour cost (Rs. 200 Rs/day for females) is higher than Naoherua (Rs. 180/ day for females). While the agricultural production in Darogachuba is much more labour intensive, requiring more human effort for activities such as manuring, fertilization and pest control but Naoherua has adopted more efficient or mechanized farming techniques, reducing more reliance on manual labour and thus lowering labour cost as a few economically better-off growers have adopted plucking machine and pruning machine. The carrying cost and transportation cost in Darogachuba is much higher than Naoherua as the growers of Darogachuba are much more dependent on middlemen. In view of this, the growers of Darogachuba have to pay a commission of Rs. 2 per kg to the middlemen, but the growers of Naoherua have a society in their own village. They supply their green tea leaves to society. As regards man days in tea cultivation, in both the villages labour cost and requirement of labourers are almost similar (Rs. 300 per day for male labourers).

Table 5: Production Structure of Small Tea Growers in Naoherua Village of Udalguri District

Naoherua	*Year*	*Production in kg/ha*	*production structure*
	up to 1 year	0	0
	2	0	0
	3	0	0
	4	1344	56kgs/Ha*2Days/week*2 weeks/months*6 months/year
	5	3429	63.5kgs/Ha*3Days/week*3 weeks/months*6 months/year
	6	3780	70kgs/Ha*3Days/week*3 weeks/months*6 months/year
	7	6526	77.7kgs/Ha*4Days/week*3 weeks/months*7 months/year
	8	14630.4	114.3kgs/Ha*4Days/week*4 weeks/months*8 months/year
	9	19600.64	153.13kgs/Ha*4Days/week*4 weeks/months*8months/year
Darogachuba	up to 1 year	0	0
	2	0	0
	3	0	0
	4	1377.84	57.41kgs/Ha*2Days/week*2 weeks/months*6 months/year
	5	4108.23	65.21kgs/Ha*3Days/week*3 weeks/months*7 months/year
	6	4571.28	72.56kgs/Ha*3Days/week*3 weeks/months*7 months/year
	7	5012.28	79.56kgs/Ha*3Days/week*3 weeks/months*7 months/year
	8	14880	116.25kgs/Ha*4Days/week*4 weeks/months*8 months/year
	9	19925.76	155.67kgs/Ha*4Days/week*4 weeks/months*8months/year

Source: Primary survey, 2022

The production is non-existent in the first three years, which is typical for tea cultivation as the plants require time to mature before can be harvested and due unproduction period of time, growers have to survived on other occupation. From years 4 to 6, the initial jump in production indicates the plants reaching maturity and the beginning of a stable harvesting cycle. The sharp increase shows a period of peak productivity due to optimal plant maturity and improved cultivation practices. In Darogachuba, the figure suggests a faster growth rate in productivity compared to Naoherua in the initial productive years and middle productive years. There are several reasons for higher productivity of tea in Darogachuba than Naoherua. In Darogachuba, there is more fertile soil and better climatic conditions conducive to tea cultivation such as optimal rainfall, temperature and humidity. Improved farming techniques such as use of fertilizers, pest control and crop management practices and more efficient labour force with better training and organization, leading to higher productivity per hectare. The use of high-yielding tea plant varieties in Darogachuba contribute to higher productivity compared to Naoherua.

4.4. Assumptions Made in the Estimation of Cost of Rice (Winter) Cultivation

In Assam, the major crop rice is cultivated mainly in June/July to November/December, relying heavily on monsoon rainfall and low-lying areas. Rice cultivation in the state is categorized into four types: Ahu, Sali, Boro and Bao. These types are based on land topography, hydrological characteristics, crop growth duration, length of season and growing conditions. They are grouped seasonally as Autumn (Ahu), Winter (Sali), Deepwater (Bao) and Summer (Boro). Autumn rice or Ahu rice is a short duration variety cultivated from March/April to June/July, typically grown in highland areas with minimal rainfall or irrigation or without irrigation. Winter rice is harvested during the winter season, more precisely cultivated during June/July to November/December. Sali and Bao are the types of rice cultivation which are grown during this season. The growing period of Sali rice concedes with the rainy monsoon season in the state. This crop is predominately grown as rainfed crop in the medium to low land with monsoon rain as the prime source of water. The varieties of this group of rice are longer in duration. Although some modern varieties are grown as Sali crop, most of the Sali varieties are still traditional long duration varieties. Bao is an extremely long duration variety only to be grown in the flood affected areas. They are particularly known as deep water rice varieties having the elongation capacity to grow with the rising flood water. The next group of rice is the

summer rice. Boro rice varieties are cultivated in this season, mostly along the bank of the swamps. Boro varieties are cultivated during November/December to May/June. Land preparation involves ploughing, harrowing and levelling, aiding to weed control and providing a suitable surface for sowing. Most growers hire tractors for land preparation, which starts in the pre-monsoon season during April-May. They generally plough land for 3-4 times within a span of 15-30 days. Adding farm Yard manure (FYM) creates a seedbed for easy seedling, uprooting and transplanting. Seed sowing in rain-fed conditions and transplanting in irrigated systems start with monsoon. 20-25 days old rice seedlings are transplanted into levelled and puddled fields. The sowing process typically requires around 5 man-days per hectare. Transplantation which on an average requires 45-50 female labourers per hectare is completed within 5-10 days. As this is labour intensive, it often involves family members on a full time or part time basis. Despite modern technologies introduced during the green revolution, Assam's rice production and productivity have witnessed little improvement. Although post-green revolution many HYV rice varieties were recommended, adoption is increasing slowly. Still the fertilizer use is minimal and far below recommended levels (40:20:20: N:P: K). In both the villages, cow dung usage is prominent and has been applied from the beginning of pre-monsoon season. Additionally, farmers use chemicals like weed killers and insecticides to protect the plants. The timing of rice harvesting varies depending on the type of rice and regional conditions but generally done when grains are fully ripe. Winter rice is usually harvested from the end of November to middle of December in Assam. The need for hired workers mostly depends on how much land is being framed (Goswami *et al*., 2023). Usually, this work needs about 50-55 labourers per hectare. Threshing of rice involves separating the grain from stalks and husks after harvesting. This process is labour intensive and typically requires a significant workforce. Traditionally it is done by bullocks or using simple tools but modern methods employ mechanical threshers to improve efficiency. In both study villages, rice markets are categorized into village, primary and secondary levels. Remote farmers often sell to moving traders from mid-October to mid-January, due to the fear of losses, financial needs, financer's pressure and inadequate storage facility. The large farmers however wait for higher prices. These unorganized markets lack facilities and government support, leading to trader-driven price fluctuations. In the study area, small to medium-scale farmers, small to medium-scale farmers have low marketable surplus, limiting them to local sales due to high distant market costs.

Poor road conditions increase transportation costs, despite availability of various modes of transport. Further, lack of suitable domestic rice markets forces farmers to sell their rice to traders at lower prices. Village and primary markets also lack price notifications, essential facilities and infrastructure.

Table 6: Components of Variable Costs (Operational Costs)/Ha in Rice farming in Sample Villages

Annual Operational Cost	*Naoherua(Rs/Ha)*	*Darogachuba(Rs/Ha)*
Utilization of labour Inputs used per hectare		
1)Land Preparation	1300	1350
2)Sowing	500	530
3)Fertilizer Application	1000	1250
4) Transplanting	13500	14000
5) Weeding	6000	3000
6) Spraying	600	650
7) Harvesting	13000	13500
8) Threshing	4000	2000
9) Winnowing	3915	4300
Utilization of Non-Labour farm Inputs per Hectare		
Nitrogen	2000	2300
Phosporous	2000	1800
Potash	2000	1700
Insecticides	1000	1300
Seeds	3000	3500
Rent of land	187	187
Cost of Jute Bags(Rs/Ha)	250	300
Carrying Cost(Rs/Ha)	100	200
Transportation Cost (Rs/Ha)	300	350
Cost of Milling (Rs/Ha)	2000	2100
Miscellaneous	3000	2500
Total Cost	59652	56817

Source: Primary survey, 2022

Naoherua village exhibits higher operational cost as compared to Darogachuba village (Table 6). Tye higher operational cost in Naoherua is largely attributed to more efficient use of labour and non-labour inputs, higher investment in quality inputs such as fertilizers and seeds and better-quality management practices. On the other hand, Darogachuba village records lower costs in weeding and harvesting, which implies more efficient labour use or mechanization. The higher costs in fertilizer

application and seeds indicate investment in better quality inputs, contributing to higher productivity.

Table 7: Annual Net Profit from per hectare of land for Tea cultivation and Rice cultivation (Winter Rice)

Items	*Tea*		*Rice*	
	Naoherua	*Darogachuba*	*Naoherua*	*Darogachuba*
i)Total Production (Kgs/Ha)	19600.64	19925.76	4182.54	4524.81
ii)Total Cost of Production (Rs/Ha)	83240	103240	59652	56817
iii)Average Revenue from Tea @INR 15.63 Rs/Kg in Naoherua and 17.21 Rs/Kg in Darogachuba Revenue from Rice @INR 31 Rs/Kg in Naoherua and 30 Rs/Kg in Darogachuba	306358	342922.33	129658.74	135744.3
iv)Revenue from Straw(Rs/Ha)	-	-	4000	3000
v)Revenue from Rice husk powder (Rs/Ha)	-	-	4000	3000
Net profit iii)-ii)	223118	239682.33	-	-
Net Profit iii)-ii)+iv)+v)	-	-	78006.74	84927.3
Benefit/Cost Ratio {Net Profit/Cost of Cultivation}	2.68	2.32	1.30	1.50

Source: Primary survey, 2022

In Naoherua, tea cultivation yields slightly less per hectare compared to Darogachuba but benefits from significantly lower production costs. Darogachuba, on the other hand, achieves higher green leaf production per hectare and better market prices, leading to increased revenue despite incurring higher production costs. The competitive pricing advantage in Darogachuba is due to the presence of multiple BLF and estate factories, allowing growers to choose where to sell their leaves based on prevailing daily prices, as they have already agreements with more than one factory. This competition encourages the sale of high-quality tea leaves, which fetch better prices. As Naoherua village does not have BLF, it relies solely on estate factories, and it limits price competition. Despite this, the lower production costs in Naoherua result in a higher Benefit-Cost Ratio (BCR) of 2.68, indicating greater cost efficiency and substantial net profit. In contrast, Darogachuba village with its higher production costs and a BCR of 2.32, shows lower cost efficiency, although it benefits from higher revenue due to better market access and quality inputs. For rice cultivation, Darogachuba again shows a slight edge with a BCR of 1.50 compared to Naoherua's 1.30 (Table 7). The higher production and revenue in Darogachuba, combined with lower production costs, contribute to better BCR. Both locations achieve similar net profits but Darogachuba's slightly lower costs improve its BCR.

Hence, both the villages almost similar net profits, but Darogachuba's slightly lower costs improve its BCR marginally. Despite a lower BCR, rice cultivation remains profitable, particularly in Darogachuba due to additional revenue from bi-products like straw and rice husk powder.

4.5. Benefit Cost ratio of Tea and Rice (Winter) Cultivation in Long-Term Perspectives

The tea production actually started from the fourth year from merely zero in the first three years (2014-16). The production which began in 2017 increased significantly each year because of gaining maturity of tea plants and effective cultivation practices. The decline in the average price of tea is attributed to market saturation and quality variation. The initial high expenditure includes significant establishment cost such as planting, labour and infrastructure. Over the years, expenditure remains substantial but more stable, reflecting ongoing maintenance, labour and operational costs. Despite high initial costs, net returns grew significantly. The higher tea production in Darogachuba village than Naoherua village is indicative of potentially more favourable growing conditions, better agriculture practices and presence of more matured plantations. The cost of production is higher in Darogachuba than Naoherua due to higher input costs, more intensive cultivation practices or investment in higher quality production (Table 8 & Table 9). Despite higher cost, the net return in Darogachuba is higher as compared to Naoherua. Rice production remains relatively stable with minor increases each year due to limited land and resources for expansion. The consistent rise in the price of rice is due to growing demand, inflation or improvement in rice quality. Rice production in Darogachuba is higher than in Naoherua, indicating better cultivation techniques and soil fertility. The average price per kg of rice is slightly lower in Darogachuba compared to Naoherua.

The STP shows higher profitability and it indicates a better financial outcome for farmers growing STP, assuming market conditions favourable. However, sometimes due to price volatility and higher expenditure costs the STPs face economic threats. Farmers need to manage these challenges carefully to sustain profitability. With a more stable price and well understood cultivation practices, rice offers lower risk, making it a reliable crop choice for farmers (Fig.5 & Fig.6). The late start and rapid production increase suggest a growing market, possibly due to increased demand and introduction of tea cultivation. As a staple food, rice benefits from established demand, contributing to its price stability and steady production increases.

Table 8: Cost-benefit Analysis of Small Tea Plantation and Rice Cultivation of Naoherua village

Year	*Year*	*STP (Naoherua)*					*Rice (Naoherua)*					
		Production (kg/Ha)	*Average Price (Rs/ Kgs)*	*Total Value (Rs/Ha)*	*Expenditure (Rs/ha)*	*Total Return (Rs/ ha)*	*Production (kg/Ha)*	*Average Price (Rs/ Kgs)*	*Total Value (Rs/Ha)*	*Expenditure (Rs/ha)*	*Revenue (Rs/ha)*	*Total Return (Rs/ha)*
1st Year	2014	0	0	0	182159	0	3409.56	20.15	68702.63	28960	2500	42242.63
2nd Year	2015	0	0	0	29880	0	3459.95	22.45	77675.88	32560	3250	48365.88
3rd Year	2016	0	0	0	26892	0	3655.15	23.54	86042.23	38520	4520	52042.23
4th Year	2017	1344	28.95	38908.8	18000	20908.8	3805.57	24.21	92132.85	40000	4630	56762.85
5th Year	2018	3429	26.78	91828.62	20478.45	71350.17	3886.56	25.11	97591.52	43250	4780	59121.52
6th Year	2019	3780	25.89	97864.2	25789.84	72074.36	4023.17	26.8	107820.96	45000	4690	67510.96
7th Year	2020	6526	20.75	135414.5	40897	94517.5	4084.38	28.11	114811.92	50147	5265	69929.92
8th Year	2021	14630.4	15.87	232184.44	82890.96	149294.44	4140.00	29.71	122999.40	56897	5630	71732.4
9th Year	2022	19600.64	15.63	306358	83240	223118	4182.54	31	129658.74	59652	8000	78006.74
Total Return (Rs/ha)						631262.32	Total Return (Rs/ha)					545715.13

Source: Primary survey, 2022

Table 9: Cost-benefit Analysis of Small Tea Plantation and Rice Cultivation of Darogachuba village

Year	*Year*	*STP (Naoherua)*					*Rice (Naoherua)*					
		Production (kg/Ha)	*Average Price (Rs/ Kgs)*	*Total Value (Rs/Ha)*	*Expenditure (Rs/ha)*	*Total Return (Rs/ ha)*	*Production (kg/Ha)*	*Average Price (Rs/ Kgs)*	*Total Value (Rs/Ha)*	*Expenditure (Rs/ha)*	*Revenue (Rs/ha)*	*Total Return (Rs/ha)*
1st Year	2014	0	0	0	184835	0	3197.93	19.47	62263.70	26116	3500	39647.7
2nd Year	2015	0	0	0	28421	0	3035.95	22.14	67215.93	28964	3050	41301.93
3rd Year	2016	0	0	0	21796	0	3022.14	25.14	75976.6	31428	4150	48698.6
4th Year	2017	1377.84	28.45	39199.55	18741	20458.55	3125.15	24.63	76972.44	36288	4478	45162.44
5th Year	2018	4108.23	25.61	105211.77	25987	79224.77	3431.96	26.17	89814.39	42440	4578	51952.39
6th Year	2019	4571.28	26.45	120910.36	32475	88435.36	3590.96	29.44	105717.86	50250	4780	60247.86
7th Year	2020	5012.28	19.66	135181.19	48971	86210.19	3599.17	30.28	108982.86	52897	5680	61765.86
8th Year	2021	14880	17.86	265756.8	68974	196782.8	3744.36	31.42	117647.79	55414	5725	67958.79
9th Year	2022	19925.76	17.21	342922.33	103240	239682.23	4524.81	30	135744.3	56817	6000	84927.3
Total Return (Rs/ha)						710793.9	Total Return (Rs/ha)					501662.9

Source: Primary survey, 2022

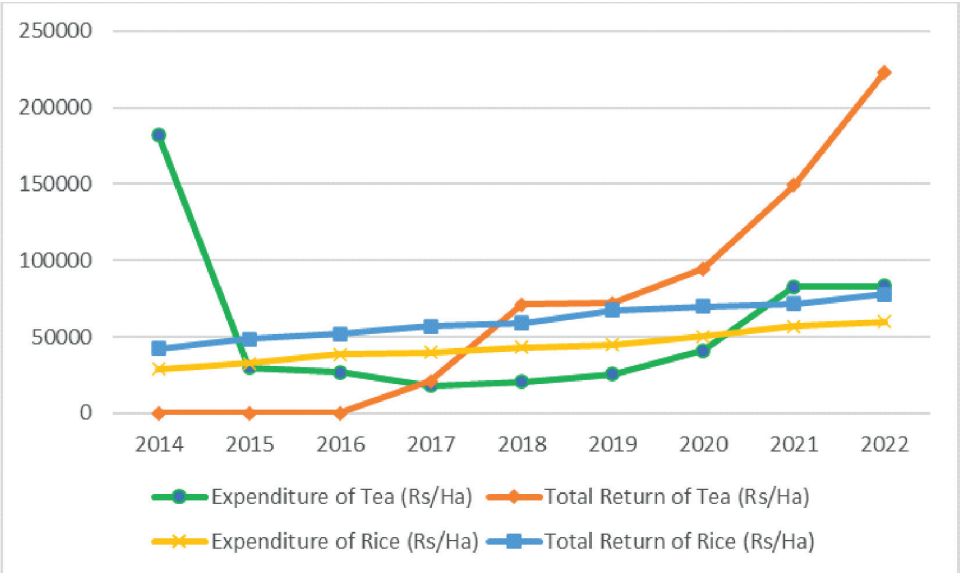
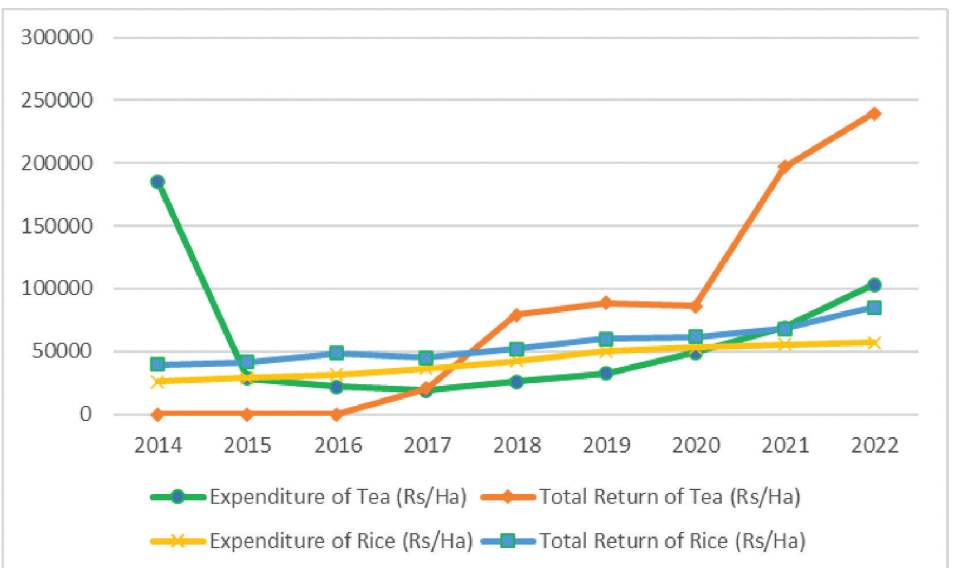


Fig. 5: Trend of Expenditure and Returns of STP and Rice in Naoherua Village



Conclusion

The present study is an attempt to understand if small tea plantation is a financially viable option for Small Tea Growers (STGs) as compared to the traditional rice farmers. The study uses cost-benefit analysis by using the indicators of NPV and B/C

ratio to assess the same. The production structure of STGs in both Naoherua and Darogachuba villages is assumed in a general perspective. The plucking structure of tea leaves increases as time period increases. The yield of production also depends upon the systematic cleaning and plucking. Hence, both male and female labourers are primarily required for plucking while man-days are for cleaning, maintaining drainage, pruning, loading, unloading and transportation. It has been found that the price of green tea leaves goes down even though both production and production cost go up. It is observed that promoting small tea cultivation in Assam is crucial since it is the largest producer of tea and it can give good job opportunities to people in rural Assam. Since the demand is high and the price is fair, small tea cultivation is also gaining attention in Udalguri district. Although Assam as an agrarian state engages more than half of its population, small tea plantations can give another way to earn money besides the income from growing rice. A comparative cost-benefit analysis of rice and tea is undertaken by considering tea as a cash crop cultivation with an economic life span of 40 years with regular pruning and plucking, while winter rice with an economic lifespan of 6-7 months. The results as of 2022 reveal that market price for winter rice is Rs 31/kg in Naoherua and Rs. 30/kg. in Darogach8uba. Under this scenario, the net return is found to be positive for both rice and tea, though it is higher for tea. Rice cultivation gives one time production in a year while tea growers get production for almost 9 months during mid-March to November after 8 years of age of tea bush. Thus, the present study concludes that farmers involved in small scale tea cultivation can earn considerably more profit than the traditional rice cultivators. The farmers must be able to cover all the expenses towards the farm production including the cost of material inputs, labour, transportation and marketing expenses. Based on the profit and income calculations growing only one crop, rice is not enough to m*eet al*l the needs of a family. Still, rice farming cannot be ignored as this is important for food at home. But to improve the overall living of farming families, it is necessary to make better use of the large unused lands and the underground for rural development. New efforts are needed to support and encourage more practical mixed farming systems like growing rice in winter or Boro season, raising animals, fish farming and planning fruits, vegetables and small tea.

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