CHAPTER- 4

RESULTS

RESULTS

The experimental findings of the present investigation on biochemical characteristics of castor and tapioca leaves and its impact on rearing performance and cocoon and yarn quality of eri silkworms as well as its role in eri culture for the socio-economic developments of the Bodos of Kokrajhar District, BTC, Assam have been described under different sub heads:

4.1 Biochemical characterization of castor and tapioca leaves

Biochemical characterization of leaves of castor and tapioca plants in different seasons has been presented in Table 1 and Table 2. It has been observed that in both castor and tapioca, there was variation of leaf biochemical compositions among the four seasons. The leaf biochemical compositions also varied significantly between castor and tapioca.

From Table 1 it is seen that spring showed highest crude protein content among the four seasons. Although there was no significant difference of crude protein content in spring (18.99%), summer (17.88%) and autumn (17.24%), there was some significance observed in winter season. Winter showed lowest crude protein content (15.59%) among the four seasons.

In case of lipid content, spring showed significantly lowest lipid content of (10.12%) as compared to other seasons. Autumn showed highest lipid content (11.50%) although there was no significant difference with summer (11.11%) and winter (11.07%).

Spring and summer showed significantly lower crude fibre content (4.38% and 5.02% respectively) than autumn (6.38%) and winter (6.33%). Autumn showed highest crude fibre content.

Moisture is an important component of leaf biochemical constituents. Spring showed highest moisture content (86.60%). The moisture content of summer (82.49%)

and autumn (80.03%) were lower than spring and there was some correlation among them. Winter showed significantly lowest moisture content (72.83%).

Sugar content was significantly highest in autumn (5.23%) followed by winter (4.83%). Spring (4.40%) and summer (4.47%) showed low sugar content and there was no significant difference among the two seasons.

Carbohydrate content was significantly higher in spring (29.69%) than all other seasons. Among summer (26.58%), autumn (27.64%) and winter (27.78%), the summer showed lowest carbohydrate content although not significant statistically.

Phenol content was highest in spring (20.56%) followed by summer (20.34%) and winter (20.18%); there was no significant variation among these three seasons. Whereas autumn showed significantly low phenol content (15.67%).

Similarly, tannin content was highest in spring (1.74%) followed by winter (1.56%) and summer (1.53%). Autumn showed significantly low tannin content (1.00%) among the four seasons.

Free amino acid content of winter (0.98 mg/100 g) was significantly higher than other seasons. Winter was followed by autumn which showed a significant amino acid (0.83 mg/100 g). Although low in amount, summer (0.64 mg/100 g) and spring (0.63 mg/100 g) showed no significant difference of amino acid contents.

From Table 2 it is seen that spring showed highest crude protein content of (12.90%) among the four seasons. Spring was followed by summer (10.73%), autumn (10.33%) and winter (9.37%) which showed no significant variation among them.

Lipid content of spring (0.17%) was lowest among the four seasons followed by summer (0.19%). Higher lipid content was recorded in autumn (0.26%) and winter (0.25%), although they showed no significance between them.

Table 1. Bio-chemical constituents in leaf biomass of castor during different seasons

Seasons	Crude protein (%)	Lipid (%)	Crude fibre (%)	Moisture (%)	Sugar (%)	Carbohydrate (%)	Phenol (%)	Tannin (%)	Free Amino acid (mg/100 g)
Summer (Jul-Aug)	17.88 [a] (0.96)	11.11 [a] (1.53)	5.02 [a] (0.57)	82.49 [ab] (4.14)	4.47 [c] (0.07)	26.58 [b] (1.07)	20.34 [a] (0.91)	1.53 [b] (0.08)	0.64 [c] (0.08)
Autumn (Oct-Nov)	17.24 [a] (1.31)	11.50 [a] (0.65)	6.38 [b] (0.36)	80.03 [b] (1.57)	5.23 [a] (0.02)	27.64 [b] (0.91)	15.67 [b] (0.62)	1.00 [a] (0.24)	0.83 [b] (0.03)
Winter (Dec-Feb)	15.59 [b] (1.92)	11.07 [a] (0.59)	6.33 [b] (0.19)	72.83 [c] (3.93)	4.83 [b] (0.41)	27.78 [b] (0.44)	20.18 [a] (0.62)	1.56 [b] (0.13)	0.98 [a] (0.04)
Spring (May-Jun)	18.99 [a] (0.89)	10.12 [b] (0.20)	4.38 [a] (0.10)	86.60 [a] (2.90)	4.40 [c] (0.08)	29.69 [a] (0.37)	20.56 [a] (0.22)	1.74 [b] (0.29)	0.63 [c] (0.06)
Mean	17.43	10.95	5.53	80.49	4.73	27.92	19.19	1.46	0.77

Data in parenthesis are SD.

Values are the mean of three replications. Values having different superscripts differ significantly ($p < 0.05$) between samples.

Table 2. Chemical constituents in leaf biomass of tapioca during different seasons

Seasons	Crude protein (%)	Lipid (%)	Crude fibre (%)	Moisture (%)	Sugar (%)	Carbohydrate (%)	Phenol (%)	Tannin (%)	Free Amino acid (mg/100 g)
Summer (Jul-Aug)	10.73 [b] (1.50)	0.19 [b] (0.01)	1.81 [b] (0.12)	88.05 [a] (4.13)	2.90 [b] (0.02)	28.96 [b] (1.25)	9.77 [b] (0.49)	14.03 [a] (0.05)	0.19 [ab] (0.01)
Autumn (Oct-Nov)	10.33 [b] (0.86)	0.26 [a] (0.01)	2.07 [c] (0.07)	84.28 [a] (3.87)	3.09 [a] (0.11)	32.47 [a] (0.61)	9.20 [c] (0.09)	14.01 [a] (0.21)	0.18 [b] (0.01)
Winter (Dec-Feb)	9.37 [b] (0.90)	0.25 [a] (0.01)	1.78 [b] (0.02)	76.45 [b] (4.99)	2.86 [b] (0.05)	34.01 [a] (0.79)	10.10 [ab] (0.03)	14.72 [b] (0.18)	0.20 [a] (0.01)
Spring (May-Jun)	12.90 [a] (0.30)	0.17 [b] (0.01)	1.60 [a] (0.01)	89.57 [a] (1.26)	2.81 [b] (0.12)	33.12 [a] (1.10)	10.23 [a] (0.04)	15.15 [c] (0.13)	0.19 [ab] (0.01)
Mean	10.83	0.22	1.81	84.59	2.92	32.14	9.82	14.48	0.19

Data in parenthesis are SD.

Values are the mean of three replications. Values having different superscripts differ significantly ($p < 0.05$) between samples.

Spring showed significantly lowest crude fibre content (1.60%) among the four seasons. It was followed by winter (1.78%) and summer (1.81%) which did not possess any significant difference between them. Autumn showed highest crude protein content (2.07%).

Moisture was found highest in spring (89.57%) followed by summer (88.05%) and autumn (84.28%). Winter showed significantly lowest moisture content (76.45%).

Sugar content was significantly highest in autumn (3.09%). It was followed by summer (2.90%), winter (2.86%) and spring (2.81%).

Carbohydrate content was highest in winter (34.01%), although not significantly different from autumn (32.47%) and spring (33.12%). Summer showed a lowest carbohydrate content (28.96%) which was statistically significantly.

Phenol content was highest in spring (10.23%) followed by winter (10.10%) and summer (9.77%). Autumn (9.20%) had a significantly low phenol than the other seasons.

Tannin content was lowest in summer (14.03%) and autumn (14.01%) although they didn't show any significant statistical variations. It was followed by winter (14.72%) which was statistically significant in tannin content than spring (15.15%).

Free amino acid content of winter (0.20 mg/100 g) was highest followed by summer (0.19 mg/100 g) and spring (0.19 mg/100 g) which did not show any significant variations. Autumn showed a lowest amino acid content (0.18 mg/100 g) which was also not significant statistically.

There were also significant differences of biochemical constituents between castor and tapioca leaves as seen from Table 3. Large variations of important biochemical constituents were recorded in castor and tapioca leaves. Except the moisture content, castor and tapioca leaves differed significantly in crude protein content, lipid content, crude fibre content, sugar content, carbohydrate content, phenol content, tannin content and free amino acid content. Lipid and tannin content of castor and tapioca leaves varied in large ranges which may carry some other inferences.

Table 3. A comparison of biochemical constituents in leaf biomass of castor and tapioca

Bio-chemical constituents	Leaves of host plant	
	Castor	Tapioca
Crude protein (%)	17.43 [a]	10.83 [b]
Lipid (%)	10.95 [b]	0.22 [a]
Crude fibre (%)	5.53 [b]	1.81 [a]
Moisture (%)	80.49	84.59
Sugar (%)	4.73 [a]	2.92 [b]
Carbohydrate (%)	27.92 [b]	32.14 [a]
Phenol (%)	19.19 [a]	9.82 [b]
Tannin (%)	1.46 [a]	14.48 [b]
Free Amino acid (mg/100 g)	0.77 [a]	0.19 [b]

Values are the mean of three replications. Values having different superscripts differ significantly ($p < 0.05$) between samples.

4.2 Rearing performance of eri silkworm on castor and tapioca leaves during different seasons and the quality of cocoons and silk yarns produced

4.2.1 Effect of host plants on rearing performance of eri silkworm during different seasons

i) Fecundity

Fecundity (Nos.) of eri silkworm fed on castor and tapioca during different seasons as presented in Table 4 reveals that fecundity of eri silkworm varied significantly in different seasons. In the first rearing (2012-13), though the highest fecundity on castor was observed in spring season (465.33), it was found at par with summer crop. The lowest fecundity was observed during winter (366.67). Highest fecundity on tapioca was also in spring (390.33), while lowest fecundity was observed during winter (335.33).

Table 4. Effect of host plants on fecundity (Nos.) of eri silkworm in different seasons

Season	Host plants (2012-13)			Host plants (2013-14)		
	Castor	Tapioca	Mean	Castor	Tapioca	Mean
Summer (Jul-Aug)	443.33	370.67	407.00	373.00	365.00	369.00
Autumn (Oct-Nov)	413.67	369.67	391.67	466.67	362.67	414.67
Winter (Dec-Feb)	366.67	335.33	351.00	476.00	371.67	423.83
Spring (May-Jun)	465.33	394.33	429.83	489.00	390.33	439.67
Mean	422.25	367.50		451.17	372.42	

Year	2012-13		2013-14	
	S.Ed.±	$CD_{0.05}$	S.Ed.±	$CD_{0.05}$
Host plant	9.26	19.63	11.87	25.16
Season	13.09	27.76	16.78	35.58
Host plant × Season	18.52	NS	23.73	50.31

NS: Non-significant

During the second rearing (2013-14), fecundity of eri silkworm fed on castor and tapioca during different seasons reveals that fecundity of eri silkworm varied significantly in different seasons. The highest fecundity on castor was observed in spring season (489.00) and lowest during summer (373.00) while the fecundity during autumn and winter were at par. Highest fecundity on tapioca was also in spring (394.33), while the fecundity during summer, autumn and winter were at par.

However, there was no significant effect of seasons and host plants together on fecundity of eri silkworm during 2012-13 (p=0.05), while the effect of seasons and host plants together on fecundity of eri silkworm was significant during 2013-14 (p=0.05).

ii) Hatching per cent

Table 5. Effect of host plants on hatching percent of eri silkmoth eggs in different seasons

Season	Host plants (2012-13)			Host plants (2013-14)		
	Castor	Tapioca	Mean	Castor	Tapioca	Mean
Summer (Jul-Aug)	92.92	83.53	88.22	93.26	83.41	88.34
Autumn (Oct-Nov)	94.24	84.50	89.37	95.50	84.13	89.82
Winter (Dec-Feb)	85.05	82.50	83.77	93.01	86.06	89.54
Spring (May-Jun)	96.18	83.73	89.96	90.42	79.31	84.86
Mean	92.10	83.57		93.05	83.23	

Year	2012-13		2013-14	
	S.Ed.±	$CD_{0.05}$	S.Ed.±	$CD_{0.05}$
Host plant	0.71	1.51	1.18	2.51
Season	1.01	2.13	1.67	3.54
Host plant × Season	1.42	3.02	2.36	NS

NS: Non-significant

Hatching per cent of eri silkworm fed on castor and tapioca during different seasons as presented in Table 5 reveals that hatching of eri silkworm didn't vary significantly in different seasons. In the first rearing (2012-13), though the highest hatching on castor was observed in spring season (96.18%), it was found at par with autumn and summer. The lowest hatching was observed during winter (85.08%).

Hatching on tapioca was observed to be on par in all the seasons although highest percentage of hatching was observed during autumn (84.50%).

During the second rearing (2013-14), hatching of eri silkworm fed on castor and tapioca during different seasons revealed that hatching was on par during different seasons although highest hatching was observed during autumn (95.50%). Hatching on tapioca was observed to be on par in all the seasons although highest percentage of hatching was observed during winter (86.06%) and lowest during spring (79.31%).

Moreover, there was significant effect of seasons and host plants together on hatching of eri silkworm during 2012-13 ($p=0.05$). However the effect of seasons and host plants together on hatching of eri silkworm was insignificant during 2013-14 ($p=0.05$).

iii) Larval duration

Larval duration eri silkworm as presented in Table 6 reveals that larval duration varied significantly during different seasons. In the first rearing (2012-13) the larval duration on castor ranged from 17.33 days in summer to 49 days in winter while on tapioca the larval duration ranged from 19.00 days in summer to 51 days in winter.

During the second rearing (2013-14), larval duration on castor ranged from 16.33 days in summer to 49.33 days in winter while on tapioca the larval duration ranged from 18.00 days in summer to 51.67 days in winter. There was no significant difference in larval duration on castor and tapioca although larval duration was prolonged by 1 or 2 days when reared on tapioca as compared to lot fed on castor.

However, there was insignificant effect of seasons and host plants together on larval duration of eri silkworm during 2012-13 and 2013-14 ($p=0.05$).

Table 6. Effect of host plants on larval duration (days) of eri silkworm in different seasons

Season	Host plants (2012-13)			Host plants (2013-14)		
	Castor	Tapioca	Mean	Castor	Tapioca	Mean
Summer (Jul-Aug)	17.33	19.00	18.50	16.33	18.00	17.17
Autumn (Oct-Nov)	23.00	24.33	23.67	21.67	23.67	22.67
Winter (Dec-Feb)	49.00	51.00	50.00	49.33	51.67	50.50
Spring (May-Jun)	18.00	19.67	16.33	18.00	19.00	18.50
Mean	26.83	27.42		26.33	28.08	

Year	2012-13		2013-14	
	S.Ed.±	$CD_{0.05}$	S.Ed.±	$CD_{0.05}$
Host plant	1.60	NS	0.24	0.50
Season	2.27	4.81	0.33	0.71
Host plant × Season	3.21	NS	0.47	NS

NS: Non-significant

iv) Mature larval weight

Larval weight of eri silkworm as presented in Table 7 reveals that larval weight on castor was not significantly different during different seasons. In the first rearing (2012-13), the highest larval weight was observed during spring (6.56 g) and lowest during winter (5.75 g). The highest larval weight on tapioca was observed during summer (5.22 g) and lowest during spring (4.52 g).

During the second rearing (2013-14), larval weight on castor was highest during spring (6.41 g) and autumn (6.32 g), while on tapioca the highest larval weight was observed during spring (5.26 g) and winter (5.06 g) and lowest during summer (4.83 g).

Table 7. Effect of host plants on larval weight (g) of eri silkworm in different seasons

Season	Host plants (2012-13)			Host plants (2013-14)		
	Castor	Tapioca	Mean	Castor	Tapioca	Mean
Summer (Jul-Aug)	5.94	5.22	5.58	6.28	4.83	5.55
Autumn (Oct-Nov)	5.59	4.62	5.10	6.32	4.90	5.61
Winter (Dec-Feb)	5.75	5.03	5.39	5.66	5.06	5.36
Spring (May-Jun)	6.56	4.52	5.54	6.41	5.26	5.83
Mean	5.96	4.85		6.17	5.01	

Year	2012-13		2013-14	
	S.Ed.±	$CD_{0.05}$	S.Ed.±	$CD_{0.05}$
Host plant	0.16	0.34	0.11	0.24
Season	0.23	NS	0.16	NS
Host plant × Season	0.32	0.68	0.23	NS

NS: Non-significant

Moreover, there was significant effect of seasons and host plants together on larval weight of eri silkworm during 2012-13 (p=0.05). However, the effect of seasons and host plants together on larval weight of eri silkworm was insignificant during 2013-14 (p=0.05).

v) Effective rate of rearing (ERR)

Effective rate of rearing (ERR) of eri silkworm as presented in Table 8 reveals that ERR was significantly higher in the first rearing (2012-13) in spring (93.17%) and autumn (89.02) while it was at par in other seasons. ERR on tapioca was higher during spring (85.84%).

Table 8. Effect of host plants on ERR (%) of eri silkworm in different seasons

Season	Host plants (2012-13)			Host plants (2013-14)		
	Castor	Tapioca	Mean	Castor	Tapioca	Mean
Summer (Jul-Aug)	83.37	84.19	86.61	91.27	71.02	81.14
Autumn (Oct-Nov)	89.02	71.03	77.20	95.87	74.87	85.37
Winter (Dec-Feb)	86.87	73.54	80.21	92.54	76.82	84.68
Spring (May-Jun)	93.17	85.84	89.50	94.77	79.78	87.28
Mean	88.11	78.65		93.61	75.62	

Year	2012-13		2013-14	
	S.Ed.±	$CD_{0.05}$	S.Ed.±	$CD_{0.05}$
Host plant	1.47	3.12	1.22	2.58
Season	2.08	4.42	1.72	3.65
Host plant × Season	2.95	NS	2.43	NS

NS: Non-significant

During the second rearing (2013-14), ERR on castor was highest during autumn (95.87%) and spring (94.77%), while on tapioca the highest ERR was recorded during spring (79.78%) and winter (76.82%).

However, there was insignificant effect of seasons and host plants together on ERR of eri silkworm during 2012-13 and during 2013-14 (p=0.05).

vi) Single cocoon weight (male)

Cocoon weight of male of eri silkworm as presented in Table 9 reveals no significant difference. In the first rearing (2012-13), highest cocoon weight (male) was observed during spring (3.72 g) and autumn (3.27 g) and lowest during summer (3.17 g). Single cocoon weight (male) on tapioca was observed highest during summer (2.91 g) and spring (2.90 g).

Table 9. Effect of host plants on cocoon weight (g) of eri silkworm (Male) in different seasons

Season	Host plants (2012-13)			Host plants (2013-14)		
	Castor	Tapioca	Mean	Castor	Tapioca	Mean
Summer (Jul-Aug)	3.17	2.91	3.04	3.43	3.30	3.37
Autumn (Oct-Nov)	3.27	2.56	2.91	3.44	2.79	3.12
Winter (Dec-Feb)	3.22	2.49	2.86	3.11	2.65	2.88
Spring (May-Jun)	3.72	2.90	3.31	3.32	2.78	3.05
Mean	3.34	2.71		3.32	2.88	

Year	2012-13		2013-14	
	S.Ed.±	$CD_{0.05}$	S.Ed.±	$CD_{0.05}$
Host plant	0.08	0.18	0.09	0.19
Season	0.12	0.25	0.13	0.27
Host plant × Season	0.17	NS	0.18	NS

NS: Non-significant

During the second rearing (2013-14), cocoon weight of male on castor was recorded highest during autumn (3.44 g) and summer (3.43 g), while on tapioca the highest single cocoon weight was recorded during summer (3.30 g).

However, there was insignificant effect of seasons and host plants together on cocoon weight of male eri silkworm during 2012-13 and 2013-14 (p=0.05).

vii) Single cocoon weight (female)

Table 10. Effect of host plants on cocoon weight (g) of eri silkworm (Female) in different seasons

Season	Host plants (2012-13)			Host plants (2013-14)		
	Castor	Tapioca	Mean	Castor	Tapioca	Mean
Summer (Jul-Aug)	3.67	3.41	3.54	4.46	4.04	4.25
Autumn (Oct-Nov)	3.99	2.90	3.45	4.48	3.35	3.91
Winter (Dec-Feb)	4.06	2.99	3.52	4.05	3.01	3.53
Spring (May-Jun)	4.42	3.38	3.90	4.38	3.54	3.96
Mean	4.04	3.17		4.34	3.48	

Year	2012-13		2013-14	
	S.Ed.±	$CD_{0.05}$	S.Ed.±	$CD_{0.05}$
Host plant	0.11	0.23	0.12	0.25
Season	0.16	0.33	0.16	0.35
Host plant × Season	0.22	0.47	0.23	NS

NS: Non-significant

Cocoon weight of female of eri silkworm as presented in Table 10 reveals no significant difference. In the first rearing (2012-13), highest cocoon weight (female) was observed during spring (4.42 g) and lowest during summer (3.67 g). Single cocoon weight (female) on tapioca was observed highest during summer (3.41 g) and spring (3.38 g).

During the second rearing (2013-14), cocoon weight of female on castor was recorded highest during autumn (4.48 g) and summer (4.46 g), while on tapioca the highest female single cocoon weight was recorded during summer (4.04 g). Moreover, there was significant effect of seasons and host plants together on cocoon weight of female eri silkworm during 2012-13 (p=0.05). However the effect of seasons and host plants together on cocoon weight of female eri silkworm was insignificant during 2013-14 (p=0.05).

viii) Single shell weight (male)

Table 11. Effect of host plants on shell weight (g) of eri silkworm (male) in different seasons

Season	Host plants (2012-13)			Host plants (2013-14)		
	Castor	Tapioca	Mean	Castor	Tapioca	Mean
Summer (Jul-Aug)	0.48	0.41	0.45	0.52	0.45	0.48
Autumn (Oct-Nov)	0.49	0.37	0.43	0.51	0.38	0.45
Winter (Dec-Feb)	0.46	0.35	0.40	0.43	0.37	0.40
Spring (May-Jun)	0.53	0.38	0.46	0.49	0.40	0.45
Mean	0.49	0.38		0.49	0.40	

Year	2012-13		2013-14	
	S.Ed.±	$CD_{0.05}$	S.Ed.±	$CD_{0.05}$
Host plant	0.02	0.04	0.01	0.03
Season	0.02	NS	0.02	0.04
Host plant × Season	0.03	NS	0.03	NS

NS: Non-significant

Shell weight of male of eri silkworm as presented in Table 11 reveals no significant difference on castor during summer, autumn and winter though shell weight during spring was significantly higher (0.53 g) in the first rearing (2012-13). Highest shell weight on tapioca was observed during summer (0.41 g) and spring (0.38 g).

During the second rearing (2013-14), shell weight of male on castor was recorded highest during summer (0.52 g) and autumn (0.52 g), while on tapioca the highest single shell weight was recorded during summer (0.45 g) and spring (0.40 g). However, there was insignificant effect of seasons and host plants together on shell weight of male eri silkworm during 2012-13 and 2013-14 (p=0.05).

ix) Single shell weight (female)

Table 12. Effect of host plants on shell weight (g) of eri silkworm (female) in different seasons

Season	Host plants (2012-13)			Host plants (2013-14)		
	Castor	Tapioca	Mean	Castor	Tapioca	Mean
Summer (Jul-Aug)	0.47	0.44	0.45	0.55	0.50	0.53
Autumn (Oct-Nov)	0.56	0.37	0.47	0.57	0.42	0.50
Winter (Dec-Feb)	0.51	0.37	0.44	0.51	0.37	0.44
Spring (May-Jun)	0.58	0.41	0.50	0.56	0.45	0.51
Mean	0.53	0.40		0.55	0.43	

Year	2012-13		2013-14	
	S.Ed.±	$CD_{0.05}$	S.Ed.±	$CD_{0.05}$
Host plant	0.02	0.04	0.01	0.02
Season	0.03	NS	0.02	0.04
Host plant × Season	0.04	0.08	0.02	0.05

NS: Non-significant

Shell weight of female of eri silkworm (Table 12) reveals significant difference on castor. In the first rearing (2012-13), the highest shell weight was recorded spring (0.58 g) and autumn (0.56g) and lowest during summer (0.47g). Highest shell weight (female) on tapioca was observed during summer (0.44 g) and spring (0.41 g).

During the second rearing (2013-14), shell weight of female on castor was recorded highest during autumn (0.57g) and spring (0.56 g), while on tapioca the highest single shell weight was recorded during summer (0.50 g) and spring (0.45 g). Moreover, there was significant effect of seasons and host plants together on shell weight of female eri silkworm during 2012-13 and 2013-14 (p=0.05).

x) Shell ratio (male)

Table 13. Effect of host plants on shell ratio (%) of eri silkworm (male) in different seasons

Season	Host plants (2012-13)			Host plants (2013-14)		
	Castor	Tapioca	Mean	Castor	Tapioca	Mean
Summer (Jul-Aug)	15.23	14.20	14.72	15.08	13.67	14.38
Autumn (Oct-Nov)	15.05	14.56	14.81	14.78	13.73	14.26
Winter (Dec-Feb)	14.30	13.99	14.14	13.93	13.82	13.88
Spring (May-Jun)	14.36	13.74	14.05	14.84	14.52	14.68
Mean	14.74	14.12		14.66	13.94	

Year	2012-13		2013-14	
	S.Ed.±	$CD_{0.05}$	S.Ed.±	$CD_{0.05}$
Host plant	0.23	0.48	0.20	0.43
Season	0.32	NS	0.29	NS
Host plant × Season	0.45	NS	0.41	NS

NS: Non-significant

Shell ratio (SR) of male of eri silkworm as presented in Table 13 reveals significant difference on castor during summer and autumn with 15.23 and 15.05% respectively in the first rearing (2012-13). Highest shell weight (male) on tapioca was recorded during autumn (14.56%) and summer (14.20%).

During the second rearing (2013-14), SR of male on castor was recorded highest during summer (15.08%) and spring (14.84%), while on tapioca the highest shell ratio was recorded during spring (14.52%) and winter (13.82%).

However, there was insignificant effect of seasons and host plants together on SR of male eri silkworm during 2012-13 and 2013-14 (p=0.05).

xi) Shell ratio (female)

Table 14. Effect of host plants on shell ratio (%) of eri silkworm (female) in different seasons

Season	Host plants (2012-13)			Host plants (2013-14)		
	Castor	Tapioca	Mean	Castor	Tapioca	Mean
Summer (Jul-Aug)	12.79	12.79	12.79	12.54	12.47	12.51
Autumn (Oct-Nov)	13.12	12.74	12.93	12.79	12.51	12.65
Winter (Dec-Feb)	12.49	12.47	12.48	12.83	12.30	12.57
Spring (May-Jun)	12.42	12.26	12.34	12.86	12.72	12.79
Mean	12.71	12.56		12.76	12.50	

Year	2012-13		2013-14	
	S.Ed.±	$CD_{0.05}$	S.Ed.±	$CD_{0.05}$
Host plant	0.17	NS	0.32	NS
Season	0.24	NS	0.45	NS
Host plant × Season	0.34	NS	0.63	NS

NS: Non-significant

Shell ratio (SR) of female of eri silkworm as presented in Table 14 reveals no significant difference on castor during summer, winter and spring although highest SR was recorded during autumn (13.12%) in the first rearing (2012-13). Highest shell weight (female) on tapioca was recorded during summer (12.79%) and autumn (12.74%).

During the second rearing (2013-14), SR of female on castor was recorded highest during spring (12.86%) and winter (12.83) , while on tapioca the highest shell ratio was recorded during spring (12.72%) and autumn (12.51%).

However, there was insignificant effect of seasons and host plants together on SR of female eri silkworm during 2012-13 and 2013-14 ($p=0.05$).

The rearing performance also revealed the following observations-

- In case of castor fed eri silkworms, the fecundity, larval weight, ERR, cocoon weight (Male), cocoon weight (Female), shell weight (male), shell weight (female) were highest in spring season and lowest in summer and/or winter season.
- In case of tapioca fed silkworms, both spring and summer seasons showed highest recorded data for the above parameters. However, the lowest values were found mostly in winter season, along with the summer, spring and autumn seasons.
- Shell ratio (male) and shell ratio (female) were highest in summer and autumn seasons in both castor and tapioca fed leaves. The lowest values were observed in winter and spring seasons.
- Hatching of eri silk moth eggs were found highest in spring and autumn seasons whereas it was lowest in winter.
- Larval duration of eri silkworm was suitably lowest in spring and summer seasons whereas it was highest in winter.

4.2.2 Effect of host plants on count and tensile properties of eri silk yarns

Table 15 shows the count and tensile properties of silks obtained from silkworms reared on castor and tapioca leaves. The results were similar in both castor and tapioca fed silkworms; there was no significant differences in count and the important tensile properties viz. tenacity, strain, Young's modulus and toughness.

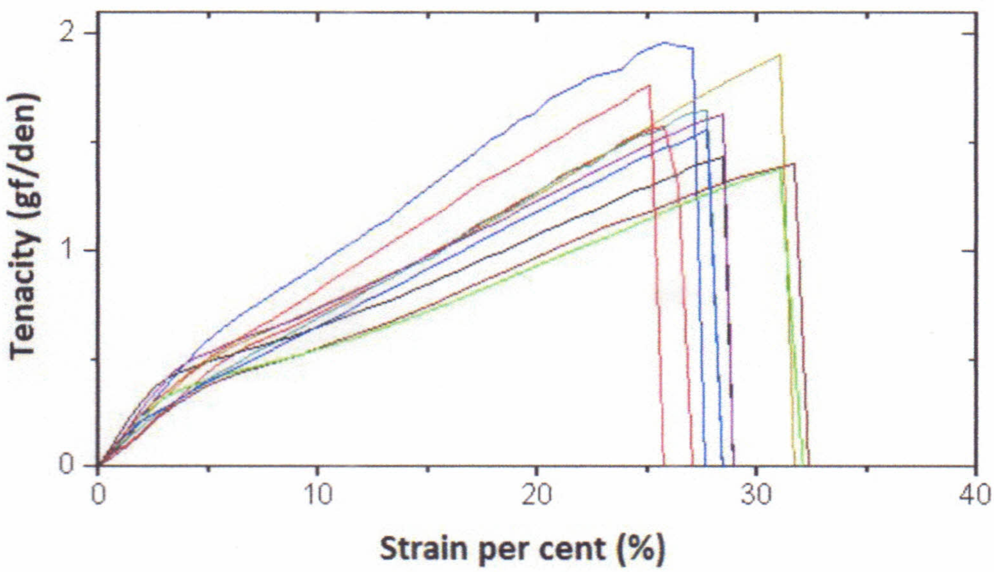
Table 15. Count and tensile properties of eri silk yarns

Types of silk yarns	Count	Tensile properties			
		Tenacity (g/den)	Strain (%)	Young's modulus (g/den)	Toughness (g/den)
Silkworms reared on castor leaves	16.22 (1.65)	1.68 (0.13)	27.58 (1.21)	77.47 (2.30)	0.3210 (0.0260)
Silkworms reared on tapioca leaves	15.67 (1.52)	1.53 (0.12)	26.61 (1.13)	79.94 (2.36)	0.3612 (0.0330)

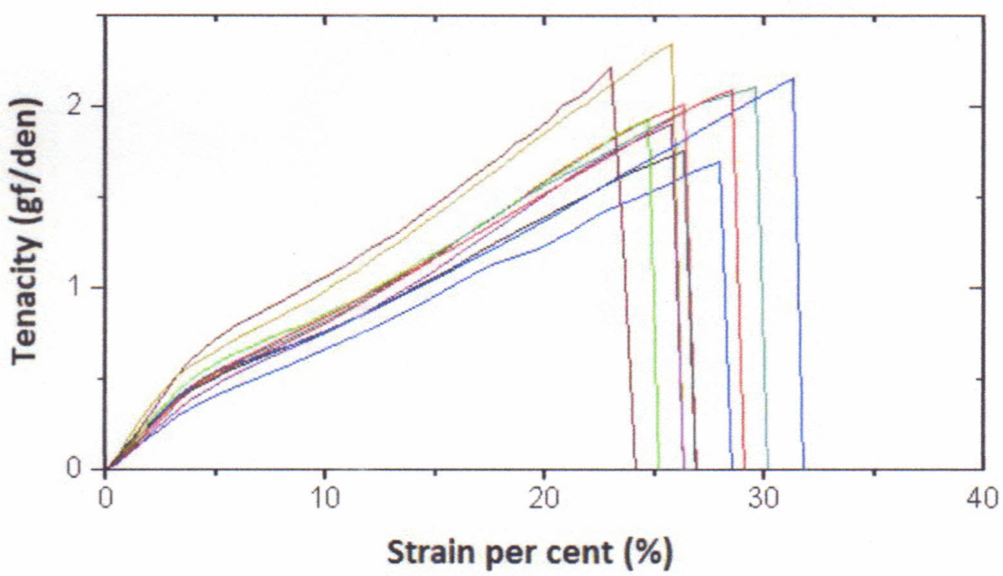
Data in parenthesis are SD.

Fig. 1 reveals the nature of stress-strain curve of the above two types of silks. There was no difference in the nature of the curve between these two types of silks.

Although there was seen some variations among the silk yarns of same type, such variations was normal for natural fibres. There were some variations of fineness of the hand spun yarns and as such it could directly affect the nature of the stress-strain curve.



(a)



(b)

Fig. 1 Stress-Strain curve of eri silk yarns
The silkworms reared on (a) castor and (b) tapioca leaves

4.3 The role of eri culture in the socio-economic development of the Bodos in Kokrajhar District

As per the work plan, a survey was carried out in selected villages of Kokrajhar District to get an account of the sericultural practices and to correlate it with the socio-economic status of the people. Meteorological data was attached here (Annexure I and Annexure II).

4.3.1 Plantation area in Kokrajhar District

It is studied from Table 16 that the total area under eri plantation was 45.6%. Muga plantation covered 48% whereas mulberry plantation covered 6.4% of the total area under plantation. Plantation for eri silkworm mostly covers castor, kesseru and tapioca plantations (Plate: 3, Plate: 4 and Plate: 5).

Table 16. Plantation area (ha) in Kokrajhar District

Eri (ha)			Muga (ha)			Mulberry (ha)			Total area (ha)
Govt.	Pvt.	Total	Govt.	Pvt.	Total	Govt.	Pvt.	Total	
45.36	372.64	418	55.1	385.9	441	25.18	32.82	58	917

As per the reports of *Silk in BTC Profile and Farmers Database, 2015-16

4.3.2 No. of sericultural villages and families in Kokrajhar District

Table 17 revealed that the majority of the families in Kokrajhar District (93.5%) were engaged in eri culture; although a few were engaged in other silkworm rearing practices like, muga (4.1%) and mulberry (2.4%) silks.

Table 17. No. of sericultural villages and families in Kokrajhar District

Seri. villages	Seri. families			
	Eri	Muga	Mulberry	Total
510	15396 (93.5%)	688 (4.1%)	381 (2.4%)	16465

****Data in the parenthesis are percentage***

Plate: 3

Castor plantations

Plate: 4

Tapioca plantations

Plate: 5

Kesseru plantations

4.3.3 Caste of farmers

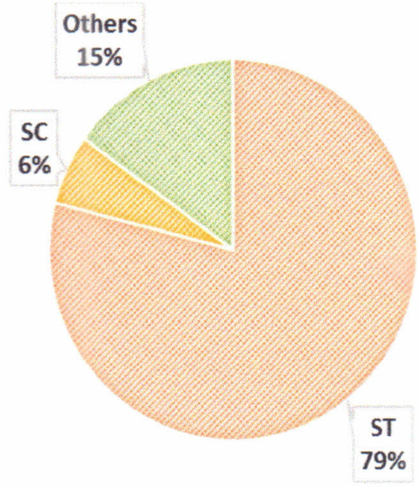


Fig. 2 Caste of farmers engaged in sericulture

Fig. 2 revealed that majority of the eri farmers were Scheduled Tribes (ST). Scheduled Castes (SC) comprised of 6% of the farmers whereas other castes covered the rest 15%.

4.3.4 Experience of farmers in sericulture

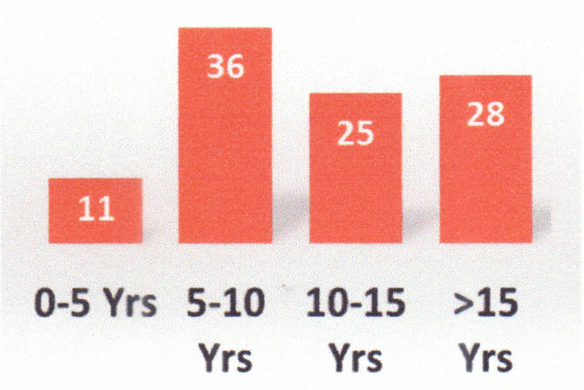


Fig. 3 Experience of farmers in sericulture

It is seen from Fig. 3 that a large number of farmers had 5-15 years of experience. Moreover, a promising number of farmers newly adopted the practice of sericulture.

4.3.5 Age of farmers and gender

Table 18. Age and gender of farmers

Age group (in years)	15-25		26-35		36-45		46-55		56-65	
Gender	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Number of farmers	9	1	27	4	20	5	19	3	8	4
Total	10		31		25		22		12	

It is observed from Table 18, which presented the age of farmers engaged in sericulture in Kokrajhar District that, maximum number of farmers was in the age group of 25- 45. Moreover, the male farmers outnumbered the female farmers. But from the point of view of involvement in eri culture, the number of females is far more than the males.

4.3.6 No. of family members of farmers

On an average, 3-4 members were present in the families of farmers in Kokrajhar District.

4.3.7 Educational Level of farmers

From Fig. 4 it is observed that the number of farmers engaged in sericulture got mostly the secondary level of education. This was followed by the farmers who were illiterate (24%) and got primary level of education (22%). Graduates comprised a small number of farmers (12%).

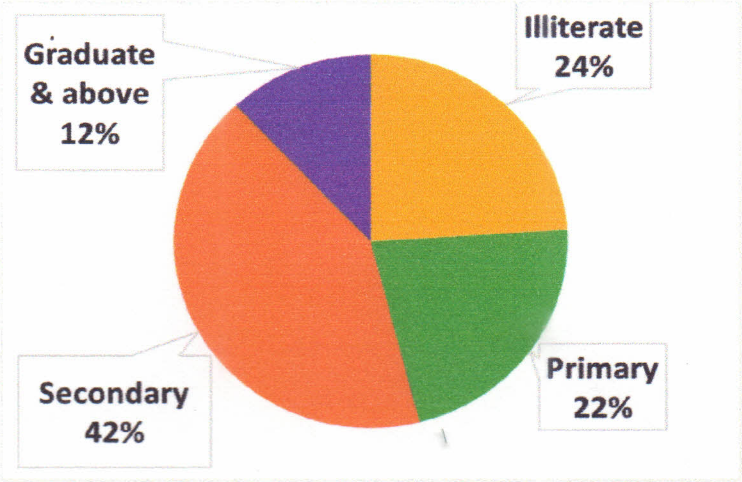


Fig. 4 Education level of farmers engaged in sericulture in Kokrajhar District

4.3.8 Type of sericulture practiced

It was observed from the survey that there were a number of sericultural facilities available in Kokrajhar District, viz. graineurs (seed), commercial silkworm rearing, spinning (manual and using automatic spinning machine), weaving, dyeing, fabric processing etc. (Plate: 6 to Plate: 12). But the majority of the farmers practiced the commercial silkworm rearing only A few farmers were employed in graineurs (production of seed) which was a very profitable business.

4.3. 9 Land holdings of farmers

Table 19. Land holdings of sericultural farmers in Kokrajhar District

Land holdings (acre)	0-1	1-2	2-3	3-4	4-5
No. of farmers	5	44	30	13	8

Table 19 revealed that most of the farmers engaged in eri culture in Kokrajhar District had an agricultural land holding of 1-3 acres. It was used in various purposes of sericulture, like plantation, rearing house etc. Besides eri culture, some farmers were also involved in growing field crops and other horticultural crops. Piggery farming, poultry farming etc. were also adopted by some farmers as a source of lateral income.

4.3.10 Constraints in eri culture in Kokrajhar District

From the survey it was seen that eri culture in Kokrajhar District faced some constrains which were required to be attended immediately. A few of them are listed below-

- More than 50% of the eri farmers were rearing less than 25 dfls per crop. This specified a scope for improvement in productivity.
- An average cut cocoon production of 10.5 kg/100 dfls indicated tremendous potential for income generation as primary activity.
- Almost a mere of 34% of the sericulture households were engaged in post-cocoon activities like reeling, spinning and weaving. Out of which, only 12% families were using improved reeling and spinning devices.
- Majority of looms in Kokrajhar District were fly shuttle frame looms without accessories required for improved designs and patterns.
- A large quantity of eri cocoons were transacted by traders/middleman and sold outside the State. Only 15% of the cocoon were utilized locally. There was ample opportunity for value addition and employment generation in post-cocoon sector.

4.3.11 Supports from organizations/departments and its impact on eri culture

Central Silk Board (CSB) and Dept. of Sericulture, Assam Govt. provided help through assistance in plantation and seeds to the farmers. They also conducted extensive hand in trainings/workshops.

It was observed that only 10% of the households had separate rearing spaces for eri silkworm rearing. Rearing houses were provided to some deserving farmers with the help of organizations like CSB, Dept. of Sericulture, Assam Govt. etc. (Plate: 13). Water motors were also provided to some selected farmers to help in the growth of the plantations.

Plate: 6

Graineurs (production of seed) of eri silkworm

Plate: 7

Rearing of eri silkworms on castor leaves

Plate: 8

Rearing of eri silkworms on tapioca leaves

Plate: 9

Rearing of eri silkworms on kesseru leaves






Plate: 10

Formation and grainage of eri cocoons

A farmer collecting castor leaves

A farmer with leaves

Ladies busy in collecting cocoons

A farmer spinning eri yarns

Plate: 11

Various activities related to eri culture

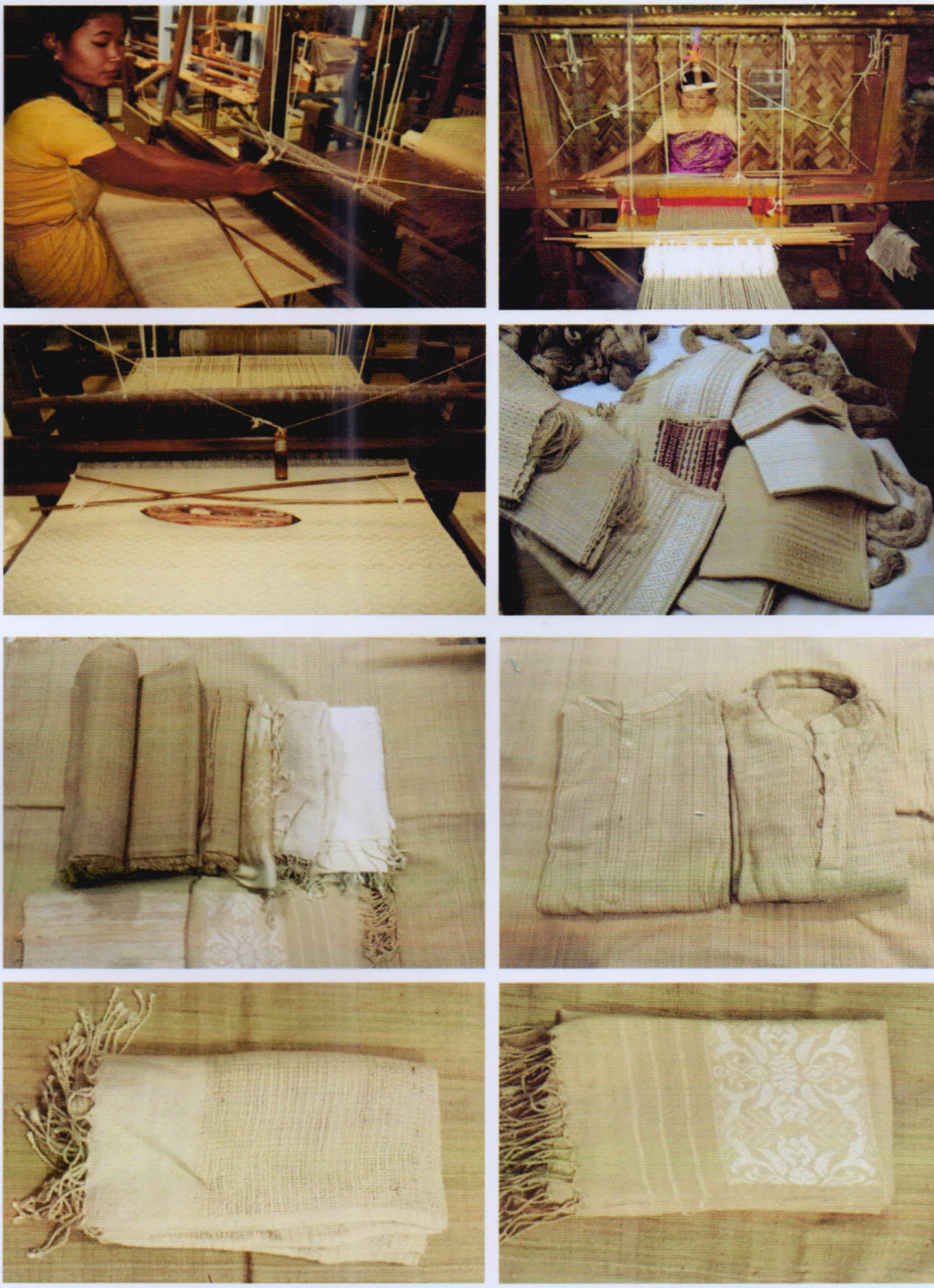


Plate: 12

Weaving facilities and finished products

Govt. funded rearing house

A farmer inside her Govt. aided rearing house

Plate: 13

Facilities provided by Dept. of Sericulture, Govt. of Assam

4.3.12 Demographic characteristics of the respondents for trainings

Table 20 presented the demographic characteristics of the 100 respondents out of which 50 farmers took trainings on skill development in eri culture, viz. systematic plantations of castor and tapioca, improved rearing practices, construction and maintenance of rearing houses, grainage, etc. the other 50 farmers did not take part in such programmes and who employed traditional eri culture methods only (list of the 100 farmers have been attached).

Table 20. Demographic characteristics of the respondents

Variables	Participant of Training	Non participant
Age (years):		
15-25	5 (10)	5 (10)
26-35	15 (30)	16 (32)
36-45	13 (26)	13 (26)
46-55	10 (20)	11 (22)
56-65	7 (14)	5 (10)
Means	34.4	35.2
Gender:		
Male	43 (86)	40 (80)
Female	7 (14)	10 (20)
Caste:		
General	7 (14)	8 (16)
SC	4 (8)	2 (4)
ST	39 (78)	40 (80)
Education level:		
Illiterate	7 (14)	16 (32)
Primary School	8 (16)	17 (34)
Secondary School	25 (50)	15 (30)
Higher Secondary	7 (14)	2 (4)
Graduates and above	3 (6)	0
Experience (years):		
<1	0	2 (2)
1-5	6 (12)	7 (14)
6-10	17 (34)	19 (38)
11-15	13 (26)	11 (22)

>15	14 (28)	11 (22)
Means	11.22	10.18
Land holding (acres):		
<1	4 (8)	2 (2)
1-2	20 (40)	23 (46)
2-3	15 (30)	13 (26)
3-4	7 (14)	8 (16)
>4	4 (8)	4 (8)
Means	2.28	2.16
No of family members:		
1	1 (2)	0
2	2 (4)	3 (6)
3	14 (28)	20 (40)
4	24 (48)	23 (46)
5	7 (14)	4 (8)
6	2 (4)	0
Types of sericulture practiced:		
Commercial silkworm rearing	43 (86)	47 (94)
Graineurs (production of seed)	7 (14)	3 (6)

The results of the study indicated that majority of respondents participated in trainings (56%) fall in the age range of 26-45 years whereas majority of non-participants (58%) fall in the range of 26-45 years.

Majority of participants (86%) were males while less percentage of males (80%) were recorded among the non-participants.

The caste of both participants and non-participants were recorded in similar numbers comprising of majority of Scheduled Tribes.

Most of the participants got education of secondary level. A good number of participants also got Higher Secondary as well as Graduation and above level qualifications. But the non-participants comprised of a large number of illiterate and Primary level educated farmers. No graduates and above qualified farmers were available among the non-participants.

The results also showed that the participants comprised of large number of farmers having more than 6-15 years of experience in sericulture. The non-participants had more farmers having 6-10 years of experience.

Participant farmers had 1-2 acres of land holding (40%) while the non-participants got majority (46%) among 1-2 acres of land holdings.

Participants contained a less share of 68% having 3-4 family members while the non-participants had an 86% share of 3-4 family members.

Although, less participants (86%) were engaged in rearing practices than the non-participants (94%), there was more than double the participants engaged in graineurs (14%) than the non-participants (6%).

4.3.13 Return from eri culture

The survey revealed that eri culture included a variety of activities which generate many primary products as well as secondary products (by-products). The primary products included the eri cut cocoons and eri silk yarns (Plate: 14). The by-products include eri pupa (used for human consumption), tapioca tubers (for human consumption), castor seeds (marketed for oil production), litters and decomposed wastes (used as manure) (Plate: 15 to Plate: 18).

i) Production cost per 100 dfls

On an average, 50 g of seed (egg) gave 100 dfls.

The present market rate of eri seed = Rs. 7 per g.

Therefore, the total production cost in 100 dfls = Rs. 7×50 = Rs. 350

(Manpower is free of cost here as the family members provided the manpower)

ii) Mean annual return of a farmer from eri culture

On an average, a farmer in Kokrajhar District was engaged in 4 crops (@100 dfls/crop) in a year. It is observed from Table 21 that there were two types of farmers available, i.e. rearers and rearers cum spinners. A rearer was engaged in producing cut cocoons and eri pupa which gave an annual return of Rs. 28000 and Rs. 60000 respectively. Thus, the total return is Rs. 88000.

Table 21. Mean annual return of a farmer from eri culture in Kokrajhar District

Types of farmers	Activities	Quantity	Rate (Rs.)	Amount (Rs.)
Rearer	**Sale proceed of cocoon (@10 kg/100 dfls)**	**40**	**700**	**28000.00**
	Sale proceed of pupa (@60 kg/100 dfls)	**240**	**250**	**60000.00**
	Total return			**88000.00**
Rearer cum spinner	**Sale proceed of yarns (@8 kg/100 dfls)**	**32**	**2000**	**64000.00**
	Sale proceed of pupa (@60 kg/100 dfls)	**240**	**250**	**60000.00**
	Total return			**124000.00**

Calculations are based on 400dfls/year/farmer

A rearer cum spinner produced eri silk yarns and eri pupa. The eri silk yarn gave an annual return of Rs. 64000, which together with the return from eri pupa gave a total return of Rs. 124000.

iii) Increase in annual return from eri culture in Kokrajhar District

Table 22 showed an increase in annual return of the eri farmers in Kokrajhar District. Return from eri silk yarns are not included in this Table. It is observed that the total return in 2015-16 was almost double of the total return in 2011-12. Returns generated from selling tapioca tubers also increased a lot in the recent years.

A number of progressive eri farmers have set up promises for other farmers (Plate: 19). The annual earning of such a progressive farmer surpassed the average annual income of a few general farmers.

Table 22. Mean increase in annual return of a farmer from eri culture in Kokrajhar District

Source		Approx. annual income (Rs.)				
		2011-12	2012-13	2013-14	2014-15	2015-16
Sericulture	Rearing (cocoon)	15,000	17,000	22,000	24,000	28,000
	Grainage	-	-	-	-	-
	Spinning	-	-	-	-	-
	Weaving	-	-	-	-	-
	Others (Pupa)	30,000	31,000	38,000	51,000	60,000
Tapioca tubers		3000	4000	6000	8000	8000
Total		48,000	52,000	66,000	83,000	96,000

4.3.14 New sericultural R&D technologies adopted in Kokrajhar District in last five years

New technologies regarding plantation, grainage, rearing, spinning, weaving etc. were provided to the farmers and weavers of Kokrajhar District.

- Platform rearing technique was introduced among some farmers.
- "C2 breed" was introduced in some pockets of Kokrajhar District.
- Wooden collapsible split type mountage was popularized/demonstrated by CSB REC Kokrajhar. Same was used as brushing tray.
- Systematic plantation of kesseru, borkesseru and castor was practiced in many villages.
- Farmers availed the community production centre, spinning, weaving, knitting, dyeing centre etc. provided by Govt. and Private farms.

- A cocoon bank was set up to channelize and organize the marketing of eri cocoons. Collection of cocoon, drying of cocoon and also grading of cocoon were systematically done in the cocoon bank.
- Various promotional events like trade fairs, exhibitions were regularly organized by Govt. and private organizations to boost the marketing of clothes and products of eri silk and silkworm.

Packaged eri cocoons

Eri yarns

Plate: 14

Eri silk yarns and cocoons ready for marketing

Plate: 15

Tubers obtained from tapioca plantation

Plate: 16

Castor seeds

Plate: 17

Product diversification of eri pupa

Plate: 18

Litters and decomposed wastes of eri culture as manure

Plate: 19
A progressive farmer