CHAPTER SEVEN

POSSIBLE MEASURES TO ARREST STAGNATION IN DARJEELING TEA INDUSTRY AND ITS SOCIAL IMPLICATIONS

Considering old age and vacancy as two major contributing factors in diminishing the productivity of tea bushes, let us look into some of the possible ways how to counter them. For the tea gardens of plains the following measures have been suggested and found somewhat successful to avert the ill effect of old age and vacancy.

1. Rejuvenation Pruning and Infilling

When the tea bushes become old, the multiple knots in the frame act as hindrance in the translocation of food materials from the soil to the growing parts of the plants. The aged frames also suffer from attack of Aglaospora and Poria. The frames often suffer from damages caused by borers and by scale insects. In case of rejuvenation pruning, the pruning is done in such a height so that maximum number of knots are removed along with the diseased and damaged branches. After about 2-3 months of pruning, new primaries and branches come out and which turns into healthy frame with better yield. The pruning is normally done during the month of November-December. In the next monsoon season the section is further covered by replanting new plants in the vacant places/ patches which have been created along with the death of the old bushes. This particular operation is called infilling.

2. Uprooting and Replanting

In this method, the old section in which the yield is considerably lower than the average yield of the garden, and where the vacancy rate is more than 40%, is uprooted thoroughly and then kept under a rehabilitation crop for 18 months.[1] After the soil is properly rehabilitated and becomes rich with sufficient organic matter the whole section is replanted with new high yielding seedlings or clonal plants.

While uprooting and replanting may be considered as an ultimate measure, rejuvenation and infilling are some kind of stop gap or intermediate arrangement. Because it would be unwise for any tea estate to go for uprooting for its entire

area considering the time factor involved in uprooting, rehabilitation and the period that will be required for the tea bushes to attain maturity after replanting. On said issue several scientists, experts and specialists involved in tea culture have categorically put forward their observations.

Sarkar (1974) observes, "The area with teas over 71 years old and above constitute about 70 percent of the total area under tea (in Darjeeling). A large portion of this tea is in a very bad shape. Some of this poor tea can be improved by rejuvenation pruning and heavy infilling but the remainder will have to be brought under replanting or replacement planting programme gradually and the sooner this is started the better it is."[2]

In 1976, Sarkar further suggested that, "Rejuvenation of old tea is an interim measure to increase the productivity of uneconomic areas, where replanting is not immediately possible and scope of replacement is also limited. In Darjeeling where vast majority of tea is 80 years old rejuvenation is the answer until the old bushes are uprooted and replanted."[3] Barua (1972) also suggested that rejuvenation of old tea is a must to combat the problem of old tea and the rejuvenation pruning is a answer to it.[4]

In Chapter 2 it has been observed how rejuvenation-pruning improves the productivity in other tea growing areas. Barua's (1971) study shows that by rejuvenation - pruning the yield has gone up just in the next year in some sections (see Table 2.1)[5].

In Darjeeling, the yield of a few rejuvenated sections in selected commercial gardens of different valleys and elevations were as follows :

Table 7.1 : Yield of some rejuvenated sections of Darjeeling.
Garden : G
Section No. : G11

	Pruning cycle	**Average yield in kg/ha**	**% increase of yield by rejuvenation**
Before rejuvenation	1973-1976	279	
Year of Rejuvenation	1977	277	
After Rejuvenation	1978-198	371	32.97%
	1982-1987	475	70.25%
	1988-1991	513	83.87%
	1992-1994	499	78.85%
	1995-1997	679.3	143.48%

Garden : G
Section : G12

	Pruning cycle	Average yield in kg/ha	%increase of yield by rejuvenation
Before rejuvenation	1976-1982	495	
Year of rejuvenation	1983	344	
After rejuvenation	1984-1990	533	7.68%
	1991-1996	557	12.53%

Garden : I
Section : I-1

	Pruning cycle	Average yield in kg/ha	%increase of yield by rejuvenation
Before rejuvenation	1975-1977	581	
Year of rejuvenation	1978	230	
After rejuvenation	1979-1982	914	57.31%
	1983-1987	957	64.72%
	1988-1991	1045	79.86%
	1992-1994	775	33.39%

Garden : I
Section : I-2

Pruning cycle	Average yield in kg/ha	% increase of yield by rejuvenation
Before rejuvenation	1977-1981	1338	
Year of rejuvenation	1982	784	
After rejuvenation	1983-1984	1584	18.39%
	1985-1988	1578	17.94%
	1989-1993	1313	-1.87%

Garden : J
Section : J-1

	Pruning cycle	Average yield in kg/ha	%increase of yield by rejuvenation
Before rejuvenation	1980-1983	1463	
Year of rejuvenation	1984	384	
After rejuvenation	1985-1987	1704	16.47%
	1988-1989	1681	14.90%
	1990-1994	1543	5.47%

Source : *Data Collected by the author.*

Table 7.1 shows that in Section No G11 of Garden G, the yield has gone up from 32.97% in the first pruning cycle to 143.48% in the fifth pruning cycle. For G12 of the same garden the increase in yield was continuous upto second pruning cycle. In Garden I, in section No. I-1, the increase of crop was 79.86% in the third pruning cycle, even when it came down to 33.39% in the fourth pruning cycle. In the other section of the garden, the increase scenario was more or less similar to section I-1. Thus one may advocate that in case of Darjeeling tea plantation, the rejuvenation-pruning and infilling may help to increase the productivity of an old section at least upto certain years. Therefore it can be adopted as a stop-gap-measure.

Let us see how the aforesaid technological measures are going to help the plantation labourers. In Darjeeling, for different types of pruning/skiffing operations the required mandays were as follows.

Table 7.2 : Mandays required per hectare for different pruning operations in Darjeeling

Operations	Mandays required per hectare
Rejuvenation pruning	250
Light pruning	107
Deep skiff	94
Medium skiff	80
Light skiff	10

Source : *Data Collected by the author.*

The above table makes it clear that as compared to light pruning and different types of skiffing, more employment is associated with rejuvenation-pruning operation. Because in case of rejuvenation pruning, in addition to pruning

operation, infilling is done and for which several types of extra works like raising of a nursery, carrying the plants to the field from the nursery, land preparation, preparation of planting pit, planting, etc. are involved. On the other hand, in case of light pruning, deep skiff, medium skiff and light skiff as infilling is not done, the additional works are also not required which automatically reduces the requirement of labourer. Given below a statement of manpower required for all the operations involved in infilling in the condition of vacancy at the proportion of 20%.

Table 7.3 : Mandays required per hectare for infilling a section having 20% vacancy.

Operation	Manpower required* per hectare
Carrying of plants from nursery to field	30
Preparation of planting pit	35
Planting	30
Application of pit mixture, ramming, levelling etc.	30
Total	125

*Considered that the section is having 15000 plants per hectare originally.

Uprooting and Replanting

The other recommended solution to the problem of old age and vacancy is uprooting and replanting. This process involves uprooting of the old bushes and replantation in the garden after rehabilitation of the soil. So an attempt had been made to examine the effectiveness of this method in improving the productivity of Darjeeling tea.

Table 7.4 : Details of cycle-wise yield of the replanted sections

(1) Garden	:	J	
Section No.	:	J-2	
Area	:	8.9 ha	
Spacing	:	3.5' x 2' x 2'	
Jat	:	Tukdah-78	
Elevation	:	1450 ft	
Yield before and After replanting			
Before uprooting	:	**Pruning cycle**	**Average yield in kg/ha**
		1971-1974	1381
		1975-1978	1127
		1979-1982	919
Uprooted in	:	1983	
(Kept under Guatemala till replanting year)			
Replanted in	:	June/July, 1985	
After replanting	:	1986-1988	435
		1989-1991	1290
		1992-1995	1539
(2) Garden	:	J	
Section No.	:	J-3	
Area	:	8.9 ha	
Spacing	:	3.5' x 2' x 2'	
Jat	:	AV-2	
Elevation	:	1450 ft.	
Yield before and after replanting			
Before uprooting	:	**Pruning cycle**	**Average yield in kg/ha**
		1971-1974	1273
		1975-1977	1114
		1978-1981	1055
Uprooted in	:	1982	
(Kept under Guatemala till replanting year)			
Replanted in	:	June/July 1984	
After replanting	:	1985-1987	762
		1988-1990	1142
		1991-1994	1417
3) Garden	:	J	
Section No.	:	J-4	
Area	:	4.98 ha	
Spacing	:	4' x 2' x 2'	
Jat	:	TV 14 & TV 17	
Elevation Yield status	:	1300 ft.	
Before uprooting	:	Pruning cycle	Average yield in kg/ha
		1971-1973	850
		1974-1977	868
		1978-1983	1069
Uprooted in	:	1984	
Replanted in	:	June/ july 1986	
Yield after replanting		1987-1989	510
		1990-1993	1529

Source : *Data Collected by the author.*

Above table depicts that in the third pruning cycle the sections No. J-2 and J-3 had produced the yield of 1539 kg/ha and 1417 kg/ha respectively which is more than the highest yield these sections attained before uprooting (1381 kg/ha and 1273 kg/ha respectively). The section No. J-4, in its second pruning cycle, had exceeded the highest yield it attained before uprooting (1069kgha).

Now let us examine the yearwise yield progression of some sections of other gardens where uprooting and replanting has been done.

Table 7.5 : Yearwise Yield Progression of some Uprooted and Replanted Sections.

(a) Garden	:	G
Section No.	:	G13
Area	:	2.40 ha
Year of Replanting	:	1991
Clone used	:	TV 25, TV 26
Spacing	:	105 x 60 x 60
Elevation	:	3800 to 4200 ft
Yield before uprooting	:	1985 - 711kg/ha
		1986 - 486 kg/ha
		1987 - 437 kg/ha
		1988 - 225 kg/ha
		1989 - 579 kg/ha
Year of uprooting	:	1990
Yield after replanting	:	1991 - Replanted in July-August : Not recorded
		1992 - Center out : Not recorded
		1993 - Recentering - 152 kg/ha
		1994 - UP - 533 kg/ha
		1995 - FFP - 635 kg/ha
		1996 - UP - 1270 kg/ha
		1997 -UP - 1507 kg/ha
(b) Garden	:	G
Section No.	:	G14
Area	:	2.27 ha
Year of planting	:	1993
Clone used	:	RR 17/144
Spacing	:	90 x 60 x 60 cm
Elevation	:	3400 - 3800 ft.
Yield before uprooting	:	1986 -486 kg/ha
		1987 -437 kg/ha
		1988 -225 kg/ha
		1989- 579 kg/ha
Year of uprooting	:	1990
Yield after replanting	:	1993 - Replanted in June/July : Not recorded
		1994 -Centering out : Not recorded
		1995 -UP - 218 kg/ha
		1996 -Recentering - 392 kg/ha
		1997 -UP - 716 kg/ha

UP-unprune FFP-Frame forming pruning.

Source : *Data Collected by the author.*

The above statement shows that in the case of Section No. G13 by the 6th year after uprooting, the yield rate was more than the highest yield the section had before uprooting. Similarly in the case of Section No. G14 it took only 7 years to cross the best yield record of 'before replanting' situation. Therefore, we can say that by uprooting and replanting, the productivity can be improved. And we should now see how far this improvement is going to help the plantation workers. For completion of various operations involved in uprooting, the following manpower is required :

Table 7.6 : Mandays required for uprooting

Name of operation	Mandays required/ha
Uprooting of bushes	500
Uprooting of stumps	150
Removing stones, levelling of land forking upto 6"	125
Drainage work	200
Rehabilitation crop-sowing and chopping/manuring	40
	1015

Source : *Data Collected by the author.*

The mandays required per hectare for different operations involved in replanting (for six consecutive years) is given below.

Table 7.7 : Requirement of labour (mandays) per year for replanting

Operations/Years	1	2	3	4	5	6	Total
1. Cheeling of land	150						150
2. Making roads, cleaning of drains etc.	115						115
3. Application of cowdung/ organic manure	40						40
4. Planting/infilling							
(a) Carrying of plants to the field	150						150
(b) Pitting/staking etc.	175						175
(c) Planting	150						150
(d) Application of pit. mixture ramming etc.	150						150
(e) Infilling in the subsequent years (includes everything like pitting, planting/ramming)	50	20	20	10			100
5. Planting shade permanent 100 temporary- 365	30	30					60
6. Mulching	60	60	60				180
7. Manual weeding	75	75	75	75	75	75	450
Chemical weeding	25	30	30	30	30	30	175

Operations/Years	1	2	3	4	5	6	Total
8. Applications of fertilizers	20	30	45	45	45	45	230
9. a) Plucking/tipping	10	60	100	120	260	270	820
b) Pruning	-	15	6	107	15	15	158
10. Application of pesticides	10	30	30	40	40	40	190
11. Foliar spray (urea,zinc etc.)	10	10	15	15	15	15	80
12. Maintenance of roads, fencing etc.	-	15	20	20	20	20	95
13. Maintenance of shade	15	10	20	20	20	20	105
14. Watering	30	30	30	30	30	-	150
	1265	415	451	512	550	530	3723

Source : *Data Collected by the author.*

If the uprooting and replanting is not done, the overall requirement of labourers would be lesser. Because there would be no need to deploy labourers for operations like planting, planting of infills in the subsequent year, planting of shade trees, cheeling of land, making of roads etc. On the whole the total requirement of labour (yearwise) will be as follows.

Table 7.8 : No. of mandays required for uprooting & replanting and if not uprooted

	Uprooting and replanting	No uprooting & replanting
Time of uprooting to replanting (18 months)	1015	530
Year of replanting (1st year)	1265	530
I/C - 2nd year	415	530
D.C/R.C 3rd year	451	530
C.A. - 4th year	512	530
U.P. - 5th year	550	530
U.P. - 6th year	530	530
	4738	3710

Source : *Data Collected by the author.*

I/C- Inirtial centering D.C/ R.C- Decentering / Recentering C.A- Cut across U.P- Unprune

Thus, in the case of uprooting and replanting, the number of additional workers which is required per hectare comes to 1028 within a span of seven years.

How do the tea gardens meet up the demand of additional labours? Do they employ more permanent labourers ? The obvious answer is "No". Because they employ temporary labourers as additional hands. Thus casualisation increases. However, that helps the unemployed adult members in and outside the labourers families to earn for sometime by working as a casual staff. For the families of permanent plantation labourers it augments their income.

Any upliftment in social condition of the labourers includes better education, better health and recreational facilities etc. The welfare and upliftment aspects of the labourers were taken into consideration for review in Longview T.E. where maximum area (33.27%) has been rejuvenated between 1981-95. The superintendent of the garden informed that educational status of the labourers attached to this garden is higher than any other garden of the district. Devotion to the religion is more among the labourers and which is revealed from presence of good number of temples in the garden. The superintendent further informed that in the working hours no worker is found drunk and which is not very uncommon in other gardens. Along with the improvement in economic condition the recreational and leisure time activities of the workers have also changed. Thus besides personal radio, tape recorder, television, some of them are even having dish antenna. He cited the case of a labour girl who is an award winner in most of the music competitions held in the area. The garden has made an arrangement for her special music coaching at Kurseong. Another indicator of development is that there is no labour unrest in this garden and which is otherwise very common in other gardens which are relatively backward in developmental works.

Tukvar is another garden where considerable area has been brought under Rejuvenation and infilling, and uprooting and replanting programmes. As per report of the garden executives and labour sirdars these technological measures have helped to generate more employment and income. Thus the economic condition of the labourers has improved by earnings from extra leaf price, bonus etc. In the recent years, the management has hardly faced any problem like involvement of labourers in group rivalries and clashes, drinking in working hours, leaf stealing etc.

Both the union leaders and the plantation labourers feel that out of uprooting and replanting, and rejuvenation and infilling operations the labourers are gainer in term of their employment and income. They also liked this for another reason.

Customarily the removed portion (the portion above the pruning height in case of rejuvenation pruning and the uprooted bush in case of uprooting) belong to the labourers and which can personally be used as firewood. That was in additional to the firewood they usually get from the garden.

Unfortunately, in case of majority of tea gardens in Darjeeling, the progress of both rejuvenation pruning and infilling/interplanting; and uprooting and replanting is not very encouraging. Between 1990 to 1995, only 1012.24 hectares were rejuvenated and 167.42 hectares were uprooted and replanted in whole of Darjeeling.

Why the Darjeeling tea planters are not coming forward to effectively implement the said operations ? To get its answer we have to know about the waiting period for the different types of operations as shown below :

Table 7.9 : Waiting period for harvest after different types of pruning/skiffing operations and uprooting and replanting

Type of operations	Time of operation	When plucking will start in full swing	Waiting period in weeks
RP	December	Last week of June	23
LP	December	3rd week of May	18
DS	December	4th week of April	15
MS	December	2nd week of April	13
LS/LOS/UP	December	4th week of March	11
Uprooting and replanting	December	1st week of June of 4th year	178

RP - Rejuvenation pruning; DS - Deep skiff; MS - Medium skiff, LS - Light skiff LOS - Level off skiff; UP - Unprune

Source : *Data Collected by the author.*

In Darjeeling condition when a section was uprooted in December 1990 the waiting period for the planters to get considerable harvest was as follows :

December 1990	-	Uprooted, kept under rehabilitation
June 1992	-	Replanted - harvest negligible
1993	-	Very minimum harvest so generally garde do not keep any record.
June 1994	-	Though low, recordable harvest will be there.

Since the waiting period is minimum in the case of light skiff/level off skiff, unprune the planters prefer to keep more area under such operations to have a quick

and early return. The operation like uprooting and replanting which requires relatively longer waiting period comes last in their list of choice of operations.

During the field study, several managers and proprietors were asked to identify the reasons against their aversion towards rejuvenation pruning and uprooting-replanting operations. Their observations and views in respect of rejuvenation pruning and infilling are presented below.

1. All of them were in opinion that very often instead of success they encountered with some kind of negative results. They further pointed out that unlike plains, because of the difficult terrain and odd climate, it was not possible for them to follow all the operations in detail and as pescribed.

2. A few managers believe that to increase productivity certain positive measures need to be adopted. But the rejuvenation technique adversely affect the productivity of the garden at least for certain initial years. In this situation, there is a possibility that a manager may lose his job or at least get transferred to another garden. The said apprehension is not unlikely because now-a-days change and transfer of managers has become a regular phenomenon in some gardens of Darjeeling. Therefore, a manager does not want to take any risk of adopting any long term technological measure favourable to productivity.

3. According to the planters the amount of subsidy they receive from Tea Board is very meager as compared to the investment involved to complete the operation. The Tea Board provides subsidy of Rs. 16,400/- per hectare for rejuvenation and infilling including interplanting and Rs. 12,000/- for rejuvenation and infilling. The amount is given in three instalments at the ration of 60:20:20. While the first instalment is given immediately on completion of rejuvenation, the 2nd one is given after 12 months from the date of commencement of rejuvenation. The third instalment is given after 12 months of the date of completion of infilling and/or interplanting. Considering the expenditure involved in the different stages of the operation (see Table 7.10) the amount of subsidy appears quite meager, and thus failed to motivate gardens to adopt recommended technologies.

Table 7.10 : Cost of rejuvenation and infilling per hectare

Items	Year/manday/ha						
	1 RP	2 LS	3 LS	4 LP	5 LS	6 LS	Total
1. Pruning	250	10	10	107	10	10	397
2. KCO/Repairing	38	-	-	15	-	-	53
3. Indopasting	15	-	-	-	-	-	15
4. Filling up collar regions/Thullying/ demossing	67	62	62	62	62	63	377
5. Construction/repairing of drains	50	10	5	5	5	5	80
6. Survey of drainage	2	-	-	-	-	-	2
7. Application of fertilizers	10	10	10	10	10	10	60
8. Application of pH correcting chemicals	2	-	-	-	-	-	2
9. Application of plant protection chemicals	56	56	56	56	56	56	336
10. Application of weedicides	60	45	45	45	45	45	285
11. Manual weeding	21	14	14	14	14	14	91
12. Foliar spray	21	21	21	21	21	21	126
13. Plucking	220	350	350	300	350	350	1920
14. Planting of infills @ 20% vacancy							
a) Pitting/staking/ transportation	125	-	-	-	-	-	125
b) Fertilizer application YTD	15	15	15	-	-	-	45
c) Pruning/infills/ Tipping	-	10	-	-	-	-	10
d) Weeding	30	30	30	-	-	-	90
e) Any other watering infills	-	10	-	-	-	-	10
Total	982	643	618	635	573	673	4024
15. Total labour cost[6] @ Rs.40/m.d.	39280	25720	24720	25400	22920	22920	160960
16. Material cost							
Plant protection chemicals	1200	1500	1500	120	1500	1500	8400
Manures & fertilizers	2300	2300	2300	2300	2300	2300	13800
Weedicide	900	800	800	800	800	800	4900
Cost of infills @Rs 2/-	6000	-	-	-	-	-	6000
	49680	30320	29320	29700	27520	27520	194060

RP - Rejuvenation pruning; LS - Light skiff ; LP - Light prune.

Source : *Author's estimate from field data.*

4. It has been observed that only to avail the subsidy, Head Office of the gardens

often insists to go for rejuvenation but later on does not provide the necessary financial support to complete the operation properly. As a result, in many gardens (e.g. Tomsong), after rejuvenation, the follow up operation like consolidation by infilling had not been carried out and therefore it appeared as a half hearted technological attempt to gear up productivity.

The labourers prefer the rejuvenation pruning operation primarily for getting additional employment and wage, and secondarily to have free firewood as pointed out earlier. They also feel that along with this developmental technology, when there would be better yield that will ultimately help them in getting more bonus.

Regarding uprooting and replanting measures the different views expressed by the planters are furnished below:

1. All of them agreed that a considerable investment is involved in this particular operation. The investment need is relatively more in the hills than in the gardens of the plains. It comes true when we look at the report of the working group for revision of unit cost for tea development in the Eastern and North Eastern regions of India published by NABARD in 1992. The said report has calculated the cost of development of new planting in high elevation gardens of Darjeeling as Rs. 1,15,900 per hectare. By contrast, in case of a garden in Eastern plains and Assam it comes to Rs. 84,500 and Rs. 79,606 respectively. Moreover, for uprooting and replanting operations, there is a need of supplementary fund required for uprooting and rehabilitation, in addition to planting.[7]

2. Because of the steep slopes in some tea garden areas and undulated topography, the gardeners surmise the possibility of soil erosion, followed by uprooting measures in the plantation.

3. Some are afraid of loosing the quality of the tea as a consequence of uprooting of earlier varieties. They apprehend that the 'mosquittal' flavour may not be obtained from the new bushes as they get it presently from the old chinery type of bushes.

4. As there is a rehabilitation period in the case of uprooting, naturally its pay back period would be more longer than the rejuvenation-pruning. So there is a general inclination for adopting rejuvenation pruning operation instead of uprooting and replanting.

5. The subsidy provided by Tea Board (i.e. Rs. 45,000 per hectare) is not adequate

to do uprooting and replanting operations properly. Table 7.11 shows the expenses involved in the different stages of said operations.

Table 7.11 : Cost of uprooting and replanting/ha in Darjeeling

Operations/Years	1	2	3	4	5	6	Total
1. Cheeling of land	150	-	-	-	-	-	150
2. Making roads,cleaning of drains etc.	115	-	-	-	-	-	115
3. Application of cowdung/ organic manure	40	-	-	-	-	-	40
4. Planting/Infilling							
a) Carrying of plants to the field	150	-	-	-	-	-	150
b) Pitting/staking etc.	175	-	-	-	-	-	175
c) Planting	150	-	-	-	-	-	150
d) Application of pit mixture, ramming etc.	150	-	-	-	-	-	150
e) Infilling in the subsequent years (includes everything like pitting,planting/ ramming)	50	20	20	10	-	-	100
5. Planting shade Permanent - 100 Temporary- 365	30	30	-	-	-	-	60
6. Mulching	60	60	60	-	-	-	180
7. a) Manual weeding	75	75	75	75	75	75	450
b) chemical weeding	25	30	30	30	30	30	175
8. Application of fertilizers	20	30	45	45	45	45	230
9.a) Plucking/tipping	10	60	100	120	260	270	820
b) Pruning	-	15	6	107	15	15	158
10. Application of pesticides	10	30	30	40	40	40	190
11. Foliar spray (urea,zinc etc.)	10	10	15	15	15	15	80
12. Maintenance of roads, fencing etc.	-	15	20	20	20	20	95
13. Maintenance of shade	15	10	20	20	20	20	105
14. Watering	30	30	30	30	30	-	150
	1265	415	451	512	550	530	3723
Total cost of labour @ Rs. 40/-	50600	16600	18040	20480	22000	21200	148920
15.Material cost							
Planting material @ Rs.2/- per plant	30000	2400	960	960	480	-	34800
Shade	1200	400	400	-	-	-	2000
Plant protection chemicals	1200	1200	1500	1500	1500	1500	8400
Weed control chemicals	500	600	600	600	600	600	3500
Fertilizers	2000	1800	2000	2300	2300	2300	12700
	85500	23000	23500	25840	26880	25600	210320

Source : Author's estimate from field data.

Apart from above expenses some additional costs are involved as wage payment prior to replanting (see Table 7.6). And that roughly amounts Rs. 40,600/- as payment against 1015 labour mandays @ Rs. 40/- per manday. Therefore the cost comes to Rs. 210320.00 + Rs. 40600.00 = Rs.250920.00

Since both these operations are costly enough and are dependent on some other factors like yield trend of a section, price, cost of inputs etc. it is necessary to find out the 'pay back period' for these operations. The pay back period is the number of years in which the total expenses of the particular operations and the initial loss of crop due to adoption of said operations is fully recovered. It also depends on factors like expenses incurred, yield pattern after and before the operation, the prevailing interest rate in which the loan is taken and the price trend. Since yield pattern vary from area to area, garden to garden and even section to section, and price varies from garden to garden the Pay Back Period for any operation in case of Darjeeling tea gardens will vary accordingly. However, based on the informations collected from different gardens, following heads were taken into consideration for calculating the Pay Back Period against Rejuvenation and infilling, and uprooting and replanting operations separately.

Total cost - Rs. 100 per kg
Fixed cost - Rs. 60 per kg
Variable cost - Rs. 40 per kg

Sale price - Rs. 120 per kg
Contribution - sale price - Variable cost
= Rs. 120 /- - Rs. 40/-
= Rs. 80 per kg

Rate of interest - 15% per annum

Calculated below (Table 7.12) the Pay back Period for rejuvenation and infilling for a section whose yield before rejuvenation was 512 kg/ha.

Table 7.12 : Pay Back Period for rejuvenation pruning and infilling

Yr.	Cash input/ outflow	yield	Cash inflow	Int. @ 15%	Balance	Crop loss kg/ha	Crop loss in Rs.	Final balance
0	49680	230	18400	-	-31280	282	-22560	-53840
1	30320	763	61040	4692	5252	-	-	-17308
2	29320	1204	96320	-	72252			+ 49692
3	29700	815	65200					
4	27520	872	69760					
5	27520	1008	80640					
6		1264	101120					
7		887	70960					
8		724	57920					
9		901	72080					
10		733	58640					

Above table shows that the pay back period is only 3 years from the year of rejuvenation.

The Pay Back Period for uprooting and replanting of a section of Garden J where the yield before uprooting was 919 kg per hectare is calculated below.

Table 7.13 : Pay Back period for uprooting and replanting.

Yr.	Cash outflow	Yield	Cash inflow	Interest @ 15%	Balance	Loss in crop	Cash loss	Final balance
-1	40600	-	-	-	-40600	919	73520	-114120
0	85500	-	-	6090	-132190	919	73520	-279230
1	23000	12	960	19829	-17405			-321099
2	23500	267	21360	26109	-202308			-349348
3	25840	1025	82000	30346	-176494			-323534
4	26880	693	55440	26474	-174408			-321448
5	25600	1742	139360	26161	- 86809			-233849
6		1436	14880	13021	+15050			-131990
7		959	76720					-55270
8		1433	114640					+59370
9		1824	145920					
10		1940	155200					

-1 year - Year of uprooting 0 year - Year of replanting

Yield before uprooting - 919 kg/ha

Total cost - Rs. 100 per kg Sale price - Rs. 120 per kg

Fixed cost - Rs. 60 per kg Contribution - Rs. 80 per kg

Variable cost - Rs. 40 per kg

Rate of interest - 15% per annum.

Source : *Author's estimate from field data.*

Table 7.13 depicts that the Pay Back Period for uprooting and replanting

in the given situation is 10 years from the year of uprooting. Taking this time factor into consideration, rejuvenation and infilling may be adopted as a short term measure, and uprooting and replanting as long term one. The former one can not be adopted as a long term measure and ultimate device because as it is evident from Table 7.1 except in case of Garden G though all other gardens recorded an initial increase in productivity followed by rejuvenation but afterwards the rate of increase gradually came down (e.g. Garden I and J). By contrast, in case of uprooting and replanting, the increase in productivity was incessant. Now the question comes when one should go for rejuvenation and at what stage the bushes need to be uprooted for replanting? Since it is very difficult to obtain data on age-specific yield for periods beyond 1970, time series of age specific yields for 180 sections from 5 gardens were collected. The crossection and time series data were pooled. Taking care of the missing values, we could obtain 4213 data points. At the first stage we computed age specific average yield as given in Table 7.14.

Table 7 .14 : Productivity of tea bushes by their age group

Age group in years	Average yield (kg/ha)
1-10	642.48
10-20	982-39
20-30	1021.69
30-40	973-32
40-50	974.78
50-60	1096.80
60-70	907.27
70-80	820.30
80-90	1013.73
90-100	1126.45
100-110	1018.03
110-120	979.45
120-130	851-13
130-140	651-42
140-150	676.43
150-160	674.13

Above table depicts that in the age group of 50 to 60 years, the bushes put on record the highest yield (1096.80 kg/hectare) and afterwards started declining till they reached in the age group of 80-100 years. It has been found that rejuvenation and infilling was done in the case of the bushes belonging to the age group of 60-80 years which resulted an increase in yield in the immediate age groups (80-100 years). When the bushes attained the age of 120 years and

above their yield capacity sharply dropped and was even lesser than the younger bushes of 10-20 years. While plotting these data we obtain the curves as presented in chart 7.1. We also fitted a third degree polynomial using Excel 97 (MS Office) with an R^2 of 59.37%. The curve also substantiates our observation of a long term highest level of yield obtained during the age group of 50-60 years. To go for a rigourous understanding of the age-yield relationship we regressed the average yield on age using a multinomial (cubic) equation. It is observed from the regression estimated that old age accounts for around 50% of the change in yield. (adjusted R^2 = .49207). Table 7.15 details the regression parameters.

Table 7.15. Regression parameters of the 3rd degree polynomial using yield as dependent variable.

Dependet Variable-Yield	Method-Cubic		
listwise Deletion of Missing Data			
Multiple R	.70827		
R Square	. 50165		
Adjusted R Square	. 49207		
Standard Error	141. 11741		
Analysis of Variance :			
	DF	Sum of Squares	Mean Square
Regression	3	3127212.6	1042404.2
Residuals	156	3106603.4	19914.1
F =	52.34497	Signif F = .0000	

Variables in the Equation

Variable	B	SE B	Beta	T	Sig T
AGE	13.596489	2.450141	3.181491	5.549	.0000
AGE**2	-.129980	.035303	-5.055334	-3.682	.0003
AGE**3	.000263	.000144	1.563632	1.826	.0697
(constant)	642.199084	45.691921		14.055	.0000

It appears that the co-efficients are significant. While plotting these data we obtained the curves as presented in chart 7.2. The fitted 3rd degree polynomial obtained using Excell 97 (MS Office) show an R^2 of 50.17%. The estimated curve suggests that the highest yield is obtained at the age of 65 years (estimated

CHART 7.1 AGE-YIELD RELATIOSHIP IN DARJEELING TEA INDUSTRY AS IN 1995

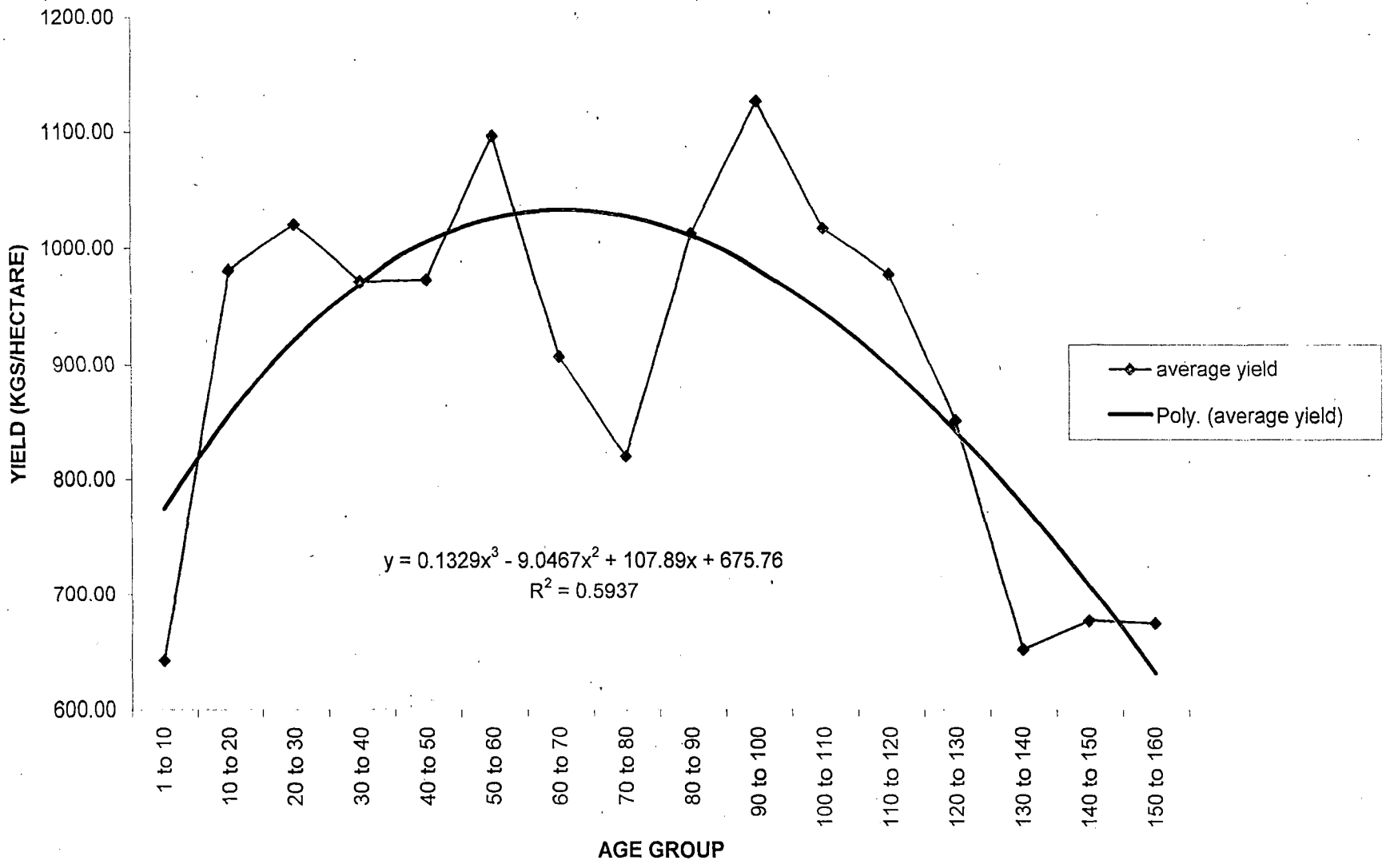
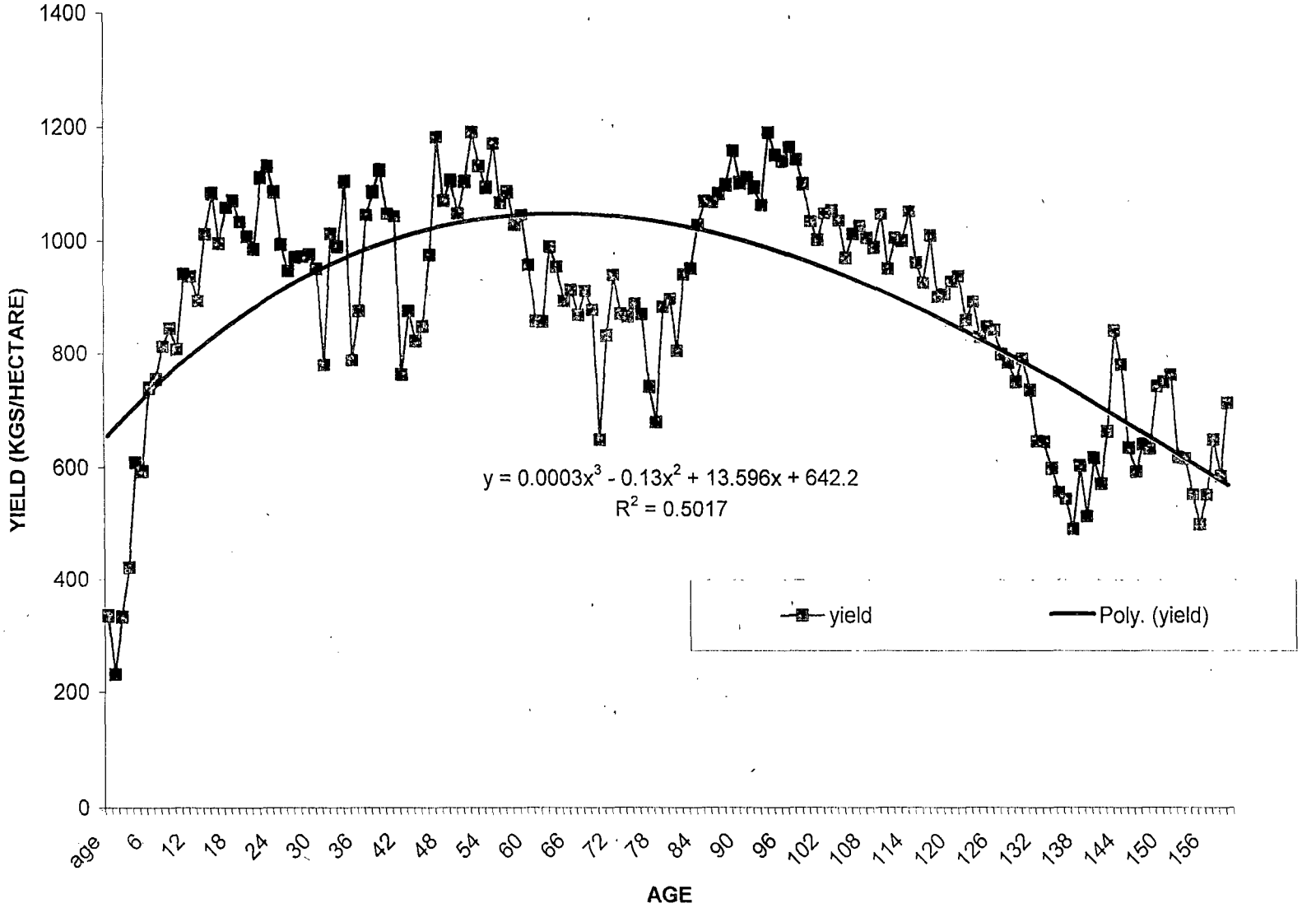


CHART 7.2 AGE-YIELD RELATIONSHIP IN DARJEELING TEA INDUSTRY AS IN 1995



1049.10kg / hectare). The estimated relationship between age and yield as described by the bold curve indicates that in the absence of any practice of rejuvenation pruning tea bushes in Darjeeling hills starts delivering declinig yield from the age of around 65 years, which is quite supportive of our observation mentioned above. It further confirms that with rejuvenation pruning the bushes show a short term tendency of increased yield as opposed to the estimated long run trend described by the bold curve. We find the actual values hovering above the estimated curve between the age group of 80-120 years. Beyond this age, the actual values tend to be lying below the trend line, baring a few esceptional shortlived peaks.

In the light of the above observation one may suggest that in Darjeeling situation rejuvenation of the bushes may be started once the bushes attain the age of 65 years. And there is need for uprooting when the bushes cross the age of 120 years.

It is important to note that frequent change of management and managers is equally responsible for the non-adoption or late adoption of these two technological measures in the tea plantation of Darjeeling, and thus ultimately contribute to the productivity stagnation. Due to persistent change in management, it is hardly possible to adopt any long term programme like uprooting and replanting, and even short term measure like rejuvenation and consolidation to revive or enhance the productivity. Moreover for a new manager, it is quite difficult to establish working rapport with the labours and to train them in favour of required operations which the garden is lacking. Therefore, to arrest the productivity stagnation, such human and management aspects need to be considered seriously.

Notes

1. To improve the fertility status and physical condition of the soil, quick growing grasses like Guatemala, Pusa giant Hybrid Napier and legumes like Mimosa invisa are grown in the uprooted area for 18 months. These crops are called rehabilitation crop as these rehabilitate the soil by adding sufficient amount of organic matter and by improving the physical condition of the soil. The rehabilitation crop is lopped from time to time and the loppings are left in situ.
2. Sarkar, S K (1974), p. 49.
3. Sarkar, S K (1976), p. 42

4. Barua, D N (1972), p.10

5. Barua, D N (1971), p.32-33

6. While computing the wage rate per manday, it is assumed that the common statutory benefits like Provident Fund, Gratuity and Bonus may be borne by the tea companies out of their revenue earnings. Benefits for Housing also has not been considered as separate financial assistance is provided for construction of labour quarters. Only towards the cost of food grain, fuel, tea etc. provided to them, 10% of the basic wage has been considered. Of course, fringe benefits like leave, holidays & medical facilities has been taken into account and the computation has been done in the following way :

Basic wage		Rs. 32.30
Leave	15 day's wage	Rs. 1.62
Holidays	12 day's wage	Rs. 1.29
Medical	5% basic wage	Rs. 1.62
Food,Fuel, Tea	10% of basic wage	Rs. 3.23

		Rs.40.06
	Round off to	Rs.40.00

7. National Bank for Agriculture and Rural Development (1992), pp.9-10.