

ECONOMICS OF INFILLING

01. As a medium and long-term development activity, infilling of vacancies in tea fields has the following attributes:

- involves no loss of crop,
- enhances yield per hectare,
- optimises land utilisation through higher bush density,
- cuts down unit cost of cultivation and maintenance,
- provides better land cover, thereby preventing soil erosion and reducing weed growth,
- increases plant population without expansion in land area, and
- accounts as revenue expenditure for vacancies up to 3000 per hectare.

02. As a pre-requisite to optimising the economic gains from infilling, it is important that the various aspects relating to identifying areas for infilling and field techniques are followed. These are enumerated in TRI Advisory Circular No E2 of May 1992.

03. Table 1 outlines the cost of infilling in the estate sector which, in keeping with the concept of partial analysis, does not include general charges. It conveys a representative clonal field situation, the elevational and other differences not being of such a magnitude as to substantially alter the estimates.

TABLE 1-Infilling Tea: Costs relevant to 2500 plants per hectare (at 1994 prices)

Operation	Labour							Material					Grand Total	%				
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total	Total	Unit	Unit	Yr 1	Yr 2	Yr 3			Yr 4	Yr 5	Total	
	(Mandays)					Mandays	Man days cost		cost	(Units)					Cost			
Uprooting Tea	20					20	1660									1660	3	
Forking	50					50	4150									4150	7	
Draining	4		3	3	3	13	1079									1079	2	
Dolomite	2					2	166	kg	0.8	400						320	486	1
Lining (Grass)	2					2	166									166	0	
Planting Grass	20					20	1660									1660	3	
Grass Fertilizer	2	2				4	332	kg	5.8	32	62					545	877	2
Lopping Grass	4	6	17			27	2241									2241	4	
Lining & Pegging			10			10	830									830	1	
Holing			33			33	2739									2739	5	
Filling Holes			8			8	664									664	1	
Planting Tea			41			41	3403	plant	3		2500					7500	10903	19
Protective Pegs			10			10	830									830	1	
Thatching			20	27	20	67	5561									5561	10	
Shading(ferns)			17			17	1411									1411	2	
Weeding			14	36	24	74	6142									6142	11	
Blistar control			3	3	3	9	747	kg	212		0.6	0.6	0.6		382	1129	2	
Manure U- 195			25	25		50	4150	kg	7.25		240	320			4060	8210	14	
Manure U-999					15	15	1245	kg	7.6					274	2082	3327	6	
Resupplying				4		4	332	plant	3			125			375	707	1	
Nursing plants			6	12	12	30	2490									2490	4	
Centring				2	3	5	415									415	1	
Total Mandays	104	8	207	112	80	511												
ANNUAL COST	8632	684	17181	9296	6840		42413			506	360	5367	2822	2210	15264			
	LABOUR AND MATERIAL COST (RS/HA)										9138	1024	26548	12118	8850		57677	100
	PER PLANT COST EACH YEAR (RS/PLANT)										4	0	11	5	4			
	LABOUR AND MATERIAL CUMULATIVE COST (RS/HA)										9138	10161	36710	48828	57677			
	CUMULATIVE PER PLANT TOTAL COST (RS/PLANT)										4	4	15	20	23			

Assumptions

1. Labour wages of Rs 83 per day inclusive of EPF and ETF
2. Per plant cost based on vacancies of 2500 per hectare
3. 20 percent of 2500 plants to be uprooted at the rate of 25 bushes per worker
4. Thatching material to be collected from estate
5. Resupplying calculated at 5% casualties in first year
6. No general charges included
7. Fertilizer application for year of planting @ 24 gm U-195 per plant per round for 4 rounds

Where a marked departure could take place is in the event of having to incur the cost of sub-soil irrigation, which may become necessary in extreme drought conditions. As will be seen, the cost of infilling per plant, relevant to 2500 plants per hectare or a 20 per cent vacancy, works out at current level to Rs 57677 or Rs 23 per plant over a 5-year period, inclusive of the recommended period for soil rehabilitation.

It is to be noted that labour accounts for 73.5 per cent of the total cost which points to the fact that where surplus labour exists, the actual cost of this operation will be of a lesser order than it might appear. Another feature is that the cost of rehabilitation could, perhaps, be by-passed in particular fields indicated in the above Circular.

4. Table 2(a) details the revenue accruing from infilling. On an estimated yield of 2250 kg/ha from the infilled plants (equated to 12500 plants per hectare), it is projected that each mature plant has a productivity of 0.18 kg of made tea (i.e., $2250/12500$) which will, of course, be lower in the interim (1300 and 1600 kg M.T/ha in 1st year and 2nd year of plucking respectively) until it reaches maturity. The cost of production of made tea from the infilled plants has been worked out. In doing so, this Table proceeds on the premise that the field productivity before infilling was 1200 kg per hectare, in which case, the overall yield thereafter would be 1650 kg, taking into account a gain of 450 kg as a result of this activity. According to an AEU study, about 82 more worker (plucker) days will be required to harvest the additional

TABLE 2(a)-Returns from infilling at 20% vacancies (2500 plants/hectare) for estate sector

Activity	year 1	year 2	year 3	year 4	year 5	year 6	year 7	-	year 25
Cost of infilling (Rs)	9138	1024	26548	12118	8850			-	
Yield Increment (Kg M.T.)					260	320	450	-	450
Plucking + Manufacturing cost (Rs)					8427	9207	12623	-	12623
Incremental Manure Cost (Rs)						471	949	-	949
Total Cost (Rs)	9138	1024	26548	12118	17277	9678	13572	-	13572
Total Returns(NSA at Rs 70/kg M.T.)					18200	22400	31500	-	31500
Net Returns (Rs)	-9138	-1024	-26548	-12118	923	12722	17928	-	17928
N P V (Rs) [at 15% Discount Rate]	5610								

crop which, at the existing wages and/or overkilos, entails an expenditure of Rs 6773. The resultant higher crop will also require more fertiliser application to the extent of the yield differential of the field before and after infilling. This, as per TRI recommendation, works out to Rs 949. The incremental cost on manufacture, transport and warehousing has been taken at Rs 13 per kg. On this basis and providing for an NSA of Rs 70 per kg, the operation involving 2500 plants per hectare breaks even in the 9th year. That this activity is financially viable is evident in that it results in a Net Present Value of Rs 5610 at a 15 per cent discount rate over a 25-year period.

As stated, the above analysis assumes a yield level of 1200 kg/ha before infilling. In practice, however, this varies markedly from field to field and the differing ranges have been incorporated and presented in Table 2(b) but the robustness of the conclusions remains substantially the same.

TABLE 2(b)-Pre-infilled field productivity and profitability changes

Pre-infilled yield (Kg M.T/ha/yr)	NPV (Rs)
1100	4298
1300	5982
1500	6516

TABLE 2(c)- Varying vacancy rates and profitability changes

Vacancy rate(%)	NPV (Rs)	Pay back period (Yrs)
10	2626	9
15	3747	9
25	6494	9
30	6643	8

A further refinement could be incorporated in that, on the assumptions made, the vacancy rates could be varied to reflect the prevailing estate level situation. However, this may require a revision in the unit cost of the plant in keeping with the number to be infilled per unit area but, in the absence of such an exercise, we have, for the present, gone by the across-the-board data in Table 1. On this basis, the resultant NPVs and pay back periods are presented in Table 2(c).

05. Reference may be made in this connection to an alternate scenario especially in the up country estate sector where, because of the weight of seedling teas, the optimum bush population would only be about 8600 per hectare. Accordingly, the number of plants that could reasonably be infilled at 20 per cent vacancy would also be lower at around 1700 per hectare. The cost to be incurred and the likely returns accruing from the operation have been separately calculated and presented in Table 3(a). It is to be noted that the cumulative cost per plant works out to about Rs 25 which is higher than in Table 1, owing to the relatively 'fixed' element involved on certain items such as forking, planting of grass, thatching, weeding etc., despite the lower number of plants infilled. Principally on this account, the NPV generated is seen to be of a lower order at Rs 3045.

In keeping with the differing vacancy rates, the NPV and pay back period too will vary. Table 3(b), which follows the pattern adopted in Table 2(c), depicts the likely trend. The higher returns associated with more vacancies are because of the spreading of the fixed cost element over a rising incremental yield. However, this argument cannot be extended to 100 per cent infilling which replanting entails since apart from the fixed cost itself undergoing a substantial change, the field proposed to be replanted is deemed to be totally uneconomic.

06. Accurate records of the cost of infilling among **small holdings** are not available. Invariably, they use family labour and while that certainly has an opportunity cost, it is seen that even where they employ hired labour, the wage rate has tended to be lower (in spite of having to provide fringe benefits like meals etc.,) than obtaining in the estate sector. Tasks also vary, with small holdings being sometimes in a position to extract higher levels of productivity from workers. All the same and pending further examination, three levels of daily wages - Rs 60, Rs 65 and Rs 70 - are taken for the purpose of this exercise. Also incorporated into the costing is an infilling subsidy of Rs 4 per plant available in two instalments (Rs 2.50 after planting and Rs 1.50 during the next year) to small holdings so much so that the effective cost to them will be lower to the extent of the wage differential and the subsidy element.

A further aspect to be noted is the marked yield difference within the small holdings, those in the low country having highly productive clonal yields whereas

TABLE 3(a)-Returns from infilling at 20% vacancies (1700 plants/hectare) for seedling fields in up country

Activity	year 1	year 2	year 3	year 4	year 5	year 6	year 7		year 25
Cost of Infilling	6295	705	18284	8342	6089			-	
Yield Increment(kg M.T)					179	220	310	-	310
Plucking+Manufacturing cost (Rs)					6043	6579	9436	-	9436
Incremental manure cost (Rs)						969	969	-	969
Total cost (Rs)	6295	705	18284	8342	12132	7548	10405	-	10405
Total Returns (Rs)					12522	15411	21672	-	21672
Net Returns (Rs)	-6295	-705	-18284	-8342	390	7863	11267	-	11267
N P V (Rs)[at 15% Discount rate]	3045								

TABLE 3(b) - Varying vacancy rates and profitability changes

Vacancy rate (%)	NPV (Rs)	Pay back period (Yrs)
10	681	8
15	2603	8
25	3486	8
30	3735	8

the mid country, with widespread vacancies and abandoned tea, being characterised by very low yields. We have, therefore, found it necessary to examine the infilling operations separately for these two elevational categories and have, in the process, taken a pre-infilled yield of 1300 kg made tea per hectare in the low country districts of Galle and Matara and 500 kg per hectare in and around Kandy. Because of the predominance of mixed cropping, the number of plants that can reasonably be expected to go into the mid country fields is also taken to be of a lower order of 1250 per hectare or 10 per cent of normal plant population, whereas the full extent of 2500 plants has been provided for in the low country. On this basis and a daily wage rate of Rs 60, Tables 4(a) and 4(b) give the financial position for the operation for the two elevational categories which, as will be seen, generates a positive NPV although of a lower order than in the estate sector. This apparent anomaly can be explained by the higher margin which accrues at the factory level on the assumed levels of NSA and variable manufacturing cost.

The likely returns on the altered assumptions are evident from Tables 5(a) and 5(b), which vary the wage rate to Rs 65 and 70 for low country and mid country respectively.

TABLE 4(a)-Returns infilling at 20% vacancies (2500 plants hectare) for small holders in low country

Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7		Year 25
Cost of Infilling (Rs)	6746	840	21811	9542	7010			-	
Yield increment (Green leaf kg)					1094	1347	1895	-	1895
Plucking cost (Rs)					3831	4715	6631	-	6631
Incremental manure cost (Rs)							949	-	949
Total cost (Rs)	4746	840	21811	9542	10841	4715	7580	-	7580
Subsidy (Rs)			6250	3750				-	
Total Returns (Rs)					10782	13270	18661	-	18661
Net Returns (Rs)	-6746	-840	15561	-5792	-59	88555	11081	-	11081
NPV (Rs)(15% Discount Rate)	2513								

Assumptions (as per Tea Small Holdings Development Authority feedback)

1. Wages at Rs 60/day
2. Plucking cost at Rs.3.5 per kg of green leaf
3. Green leaf price at Rs 9.85 per kg
4. Yield increment through infilling on par with estate sector
5. Incremental fertiliser cost calculated at 42.4 kg of U 709 per 1250 mature infilled bushes

TABLE 4(b)-Returns infilling at 10% vacancies (1250 plants hectare) for small holders in mid country

Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7		Year 25
Cost of Infilling (Rs)	3225	488	10475	3888	2800				
Yield increment (Green leaf kg)					547	674	947	-	947
Plucking cost (Rs)					1916	2358	3315	-	3315
Incremental manure cost (Rs)							285	-	285
Total cost (Rs)	3225	488	10475	3888	4716	2358	3599	-	3599
Subsidy (Rs)			3125	1875					
Total Returns (Rs)					5390	6635	9330	-	9330
Net Returns (Rs)	-3225	-488	-7350	-2013	675	4277	3731	-	5731
NPV (Rs)(15% Discount Rate)	1529								

Assumptions (as per Tea Small Holdings Development Authority feedback)

1. Wages at Rs 60/day
2. Plucking cost at Rs.3.5 per kg of green leaf
3. Green leaf price at Rs 9.85 per kg
4. Yield increment through infilling on par with estate sector
5. Incremental fertiliser cost calculated at 42.4 kg of U 709 per 1250 mature infilled bushes

TABLE 5(a)-Returns from infilling to low country small holdings

Wages (Rs/day)	60	65	70
NPV (Rs)	2513	896	448
Pay Back Period (Yrs)	10	10	11

TABLE 5(b)-Returns from infilling to mid country small holdings

Wages (Rs/day)	60	65	70
NPV (Rs)	1529	1228	1012
Pay back period (Yrs)	10	10	11

07. In the debate on estate planning, the question has been raised about the relative returns from infilling and replanting. It is to be noted that the issue is not one of infilling *versus* replanting. Both have to go hand in hand as the field selection is distinct and separate. Essentially, infilling is to be undertaken in the A category and the better B category fields and not where replanting is proposed in the foreseeable future. Given the financial resources and the appropriate land selection criteria, sections in C category and the poorer B category and those with Break Even Yield (BEY) less than the estate average will qualify for replanting. For small holdings, infilling should be an on-going activity in that, coinciding with the vacant patches coming into bearing, the old bushes could be culled and planted with grass and subsequently with the proven material, as the next and subsequent phases of infilling. Such a phased-out programme also tantamounts to an appropriate "replanting strategy" for small holdings, as suggested in the earlier paper on Replanting.

08. In all the cases examined both for the estate sector and small holdings, the returns on the investment from infilling are positive. Given the current financial constraints, infilling affords the most cost-effective option for improving the medium and long-term viability of the tea industry in Sri Lanka. Management decisions involving infilling should also be influenced by related benefits such as improving field productivity, enhancing plucking intake and keeping down the cost of production in an overall situation of escalating costs. While the activity requires to be pursued on priority, it is suggested that rather than following the usual practice of allocating a given number of plants to be infilled per field, the methodology used in this paper for estimating the returns per infilled plant, particularly taking into account the surplus labour factor, be adopted to ensure the most optimal returns.