Tea Bull. 14(1/2),03-17, 1994.

APPLICATION OF SLOPING AGRICULTURAL LAND TECHNOLOGY (SALT) IN TEA PLANTATIONS

P.B.Ekanayake
(Agronomist, Tea Research Institute of Sri Lanka, Talawakele, Sri Lanka)

INTRODUCTION

Most tea plantations are situated on sloping lands, The proportion of erosive rainfall ranges from as low as 4% to as high as 56% in different tea growing regions)i.e. rainfall intensity of more than 25 mm considered as erosive).

Erodibility or the susceptibility to erosion of tea soils, which belong to the great soil groups - Reddish Brown Latosols and Red Yellow Podsolic soils (erodibility of 0.17 and 0.22 respectively) are also high when compared with other great soil groups.

It was in view of such adverse factors, i.e. erosivity of rainfall in specific regions and the degree of erodibility of the soil type, that the planting of tea is now restricted to lands up to 70% slope (32°) in the up-country and only up to 55% slope (25°) in the mid-country.

Despite such practical recommendations, tea is cultivated even in lands exceeding 100% slope (45°) at present.

TRADITIONAL SOIL CONSERVATION MEASURES

Mechanical methods

(a) System of drains

Lateral and contour drains at spacings depending on the slope of the land.

(b) Terracing

Stone terraces are advocated for high rainfall areas, but the practice is limited due to non availability of stones and high cost of construction.

Agronomic and cultural practices

(a) Contour planting

(b) Thatching or mulching

(c) Establishment of cover crops

(d) Establishment of green manure crops

(e) Establishment of proper stand of shade

(f) Planting protective band of grasses on drain lips.

The benefit of agronomic and cultural practices are not fully realised as these practices are not satisfactorily implemented in most of the tea plantations.In a well managed plantation with a good cover of VP tea where recommended practices are all satisfactorily adopted there is minimum soil loss due to erosion.

PROBLEMS OF SOIL EROSION IN TEA LANDS

Tea lands are susceptible to erosion when the soil cover is inadequate. The soil cover is poor in most of the seedling tea due to various reasons viz. genetic variability, planting up and down the slope and poor soil management. Nearly 65-70 % of our total tea extent is still in seedling tea. Most of the seedling tea lands in the mid-country have degraded soils due to erosion over long periods of time.

The soil cover is also inadequate during the new clearing stage. Such fields are more vulnerable and there is considerable soil loss during the early stages until the tea canopy is fully established which takes 4-5 years from uprooting old tea or 2-3 years from planting tea. It is estimated that there is a soil loss of 250 t/ha during the first 4 years of replanted tea.

Tea lands are also exposed for a period of 3-4 months after pruning which is done every 2-5 years depending on the type of tea and elevation.

Therefore, considerable amount of soil loss is inevitable even when soil conservation measures are adopted during the new clearing stage as well as in seedling tea lands with poor soil cover.

Mechanical methods of soil conservation such as construction of terraces and drains are costly and need proper maintenance. There is no recycling of natural resources and hence there is no improvement of soil fertility with mechanical soil conservation measures. Therefore these measures are not sustainable.

The concept of Sloping Agricultural Land Technology (SALT) which is a biological method of soil conservation is an appropriate technology that could be well adopted to arrest soil loss, conserve soil and moisture and improve soil fertility in degraded tea lands.

APPLICATION OF "SALT" IN TEA LANDS

Establishment of hedgerows

The hedgerow is a double row of closely planted tree species (preferably nitrogen fixing) with good coppicing ability.

Selection of hedgerow species

In selecting a hedgerow species the following criteria are important;

(a) Adaptability to grow in a wide variety of soils

(b) Species which generate large amount of biomass

(c) Ability to tolerate regular lopping and with a good capacity to coppice.

(d) Deep rooted species that will compete less with tea for moisture and nutrients

(e) Ease in establishment so that there will be less need for infilling vacancies

(f) Multi-purpose species

Spacing between hedgerows

The spacing between hedgerows is based on two considerations. One of these is that loppings from hedgerows should adequately provide a mulch cover for the area in between two hedgerows. The other factor is that the area in between hedgerows should be able to accommodate at least 5-6 tea rows. Taking these factors into consideration the spacing between two hedgerows may vary from 7-8 m, depending on the spacing of tea.

Spacing within hedgerows

A hedgerow could be established either by sowing seeds or vegetatively propagated by planting cuttings at 15-20 cm (6-8") apart, in the row. Planting a row of vetiver grass (*Vetiveria zizanoides*) 20-25 cm below the hedgerow is recommended. The vetiver row will help to minimize soil erosion further and ensures that only water filters through leaving behind any soil particles that escapes the hedgerow.

The space within the hedgerow may be utilized to place any hard materials such as gravel, stones and logs. This will eventually help to form a natural bund.

CATEGORIES OF TEA LANDS WHERE SALT COULD BE ADOPTED

The hedgerows could be established in the following categories of tea lands;

Establishment of hedgerows in seedling tea:

(a) Fields to be replanted eventually

(b) Fields to be infilled and consolidated

Establishment of hedgerows in new clearings:

(a) With planting of rehabilitation grass

(b) With planting of VP tea

Implementing a SALT programme is easy in new clearings at the time of planting either rehabilitation grasses or VP tea compared to the establishment of hedgerows in mature seedling tea. However, adoption of this technology is of paramount importance in seedling tea lands and top priority should be given to this category. It should be mentioned that establishment of hedgerows will not be sufficient unless this is followed up by a proper programme of infilling in tea lands with vacancies.

In addition, a flexible spacing between hedgerows may be adopted in such a way that minimum number of tea bushes are lost in making way for the establishment of hedgerows.

In lands to be replanted, hedgerows should be established at least 2 years before uprooting old tea. The well established hedgerows will minimize soil loss during uprooting and land preparation stages for planting rehabilitation grass species.

SEQUENCE OF STEPS TO BE FOLLOWED IN ESTABLISHING SALT HEDGEROWS

Tracing contour lines

Contour lines could be located 7-8 m apart, using either the A-frame or the road tracer.

Land preparation

Uproot tea along the contour lines, so that a 1-1.5 m strip is cleared to establish hedgerows. It may be necessary to fork the contour strips to loosen the compacted soil, followed by liming with dolomite at the rate of 1 kg per 10 m (130-140 kg/ha).

Establishment of hedgerows

Hedgerows could be established either by sowing the seeds *in situ* or planting vegetative parts, sticks/stem cuttings. When sticks are used it is important that these should be planted deep, at least to a depth of 20-30 cm. Shallow planting results in the development of lateral roots which may compete with tea. Seeds should be sown as a continuous row, after appropriate seed treatments recommended for successful germination.

Establishment of vetiver grass row

A dense row of Vetiver grass should be established 20-25 cm down hill of the lower hedgerow.

Aftercare operations

Infilling vacancies in the hedgerow; one or two rounds of weeding within the hedgerows and one or two fertilizer applications (T.200 at 1 kg per 10 m or 130-140 kg/ha) are extremely important to boost the initial growth of hedgerow species. It is important to pay careful attention during the establishment of hedgerows.

Lopping of hedgerows

When the hedgerows are grown up to a height of 2 m, these should be lopped to a height of 1-1.5 m, or just above the plucking table in the case of a mature tea field in plucking. Loppings should be laid on either side of the hedgerows.

The first lopping could be done 6 -12 months after establishment of hedgerows, depending on the growth rate of different species. Thereafter, hedgerows may be lopped at regular intervals of 8 - 12 weeks,depending on the rate of coppicing of different species.

It is absolutely necessary that all the recommended agronomic and cultural practices are adopted when establshing SALT in new clearings.

Lateral drains should be cut according to the slope of the land. These may be necessary at the initial stages for soil conservation. However, size and depth of the drain may be reduced. Whenever possible, lateral drains may preferably be located immediately below the Vetiver row. Recommended stands of shade should also be established.

TEA STAND WITH SALT

When 1 - 1.5 m wide contour strips of land spaced every 7 - 8 m spacing is used for the establishment of hedgerows, about 15-20% of the total land become utilized for this purpose and hence a corresponding reduction in the stand of tea per ha could be anticipated. This reduction in stand per ha could be offset by adjusting the spacing of tea within the row to 45 cm instead of 60 cm

and planting of erect growing clones. However, it is not possible to reduce the spacing of clones with a spreading growth habit, such as TRI 2023 or TRI 2026.

BENEFITS AND ADVANTAGES OF SALT

(a) Minimizes soil erosion
(b) Improves soil fertility
(c) Increases efficiency of applied fertilizer
(d) Reduces in weed population and hence weeding cost
(e) Modifies the micro climate
(f) Increases productivity

DISADVANTAGES AND LIMITATIONS OF SALT

(a) Loss of 15-20% land for hedgerows
(b) Difficulty in establishment of hedgerows at the initial stages
(c) Possible competition of some hedgerow species with tea
(d) Lack of suitable species that suit all elevations
(e) Unavailability and shortages of planting materials and seeds.

HEDGEROW SPECIES

Gliricidia sepium

It is the widely used species for hedgerows at low and mid elevations. The popularity and ready acceptance of the species is based on its versatile uses, availability of planting materials and provision of large amounts of biomass through its loppings. It is estimated that 4-5 kg of dry loppings could be obtained from a meter of hedgerow per year (6-7 t/ha) under low country conditions.

Observations have shown that the initial establishment of *Gliricidia* as a hedgerow is poor. This is especially so when sticks are planted in holes made with an alavangoe. Loosening of the soil by forking up to a depth of 30 cm and incorporation of dolomite is important for better establishment. The length of the stick should be about 1 m of which the basal 20-25 cm should be buried in the soil.

Gliricidia hedgerows could also be established with seeds. These will be deep rooted compared to plants raised from cuttings; however, the initial growth with seeds is very poor and in addition seeds are not easily available. *Gliricidia* loppings decompose at a modearate rate and the ability of these loppings to smother and control weeds is partly attributed to interactions of its allelopathic compounds present in *Gliricidia* leaves.

***Erythrina lithosperma* (Dadaps)**

Dadaps as hedgerows are mostly used in up-country estates. However, this species does not seem to be a satisfactory hedgerow plant due to its poor establishment, inability to withstand drought, poor coppicing and low biomass production.

Therefore use of Dadaps as hedgerow species is strongly discouraged.

Calliandra calothyrsus

Calliandra is a recent introduction as a medium shade in tea. Observations made so far indicate that *Calliandra* is a promising hedgerow species. However, the establishment

of *Calliandra* is poor when seeds are sown *in situ*, as the plants are stunted and exhibit very poor growth rate. This may be probably due to the allelopathic effect of *Calliandra*, when sown at closer spacings. Therefore, it is necessary to raise them in a nursery and plant as hedgerows in the field. *Calliandra* forms a firm and rigid hedgerow, provide moderate biomass of 3-4 kg of dry loppings per meter hedgerow per year (4-5 t/ha). The decomposition rate of loppings are very fast, which may be due to its pinnate compound leaves.

Teckoma stans

Hedgerows of this species could be established either with seeds or stem cuttings. Establishment with seeds is very poor as in the case of *Calliandra*. Therefore, *Teckoma* hedgerows could be best established with semi-hardwood stem cuttings. *Teckoma* has a good coppicing ability. However, observations have shown that there is a high percentage of casualties during establishement and therefore it cannot be considered as a suitable species for hedgerows.

***Tithonia diversifolia* (Wild sunflower)**
Euphatorium inulifolium

These are wild species and can be easily established vegetatively through stem cuttings. Once established they grow profusely. An inherent characteristic of clump formation with multi stem shrubs, makes the management of these species difficult. It may be necessary to check the growth periodically to prevent its spread into tea. A large amount of biomass could be obtained from the loppings, giving about 4-5 kg of dry

loppings from a meter of hedgerow per year (5-6 t/ha). The loppings decompose very fast and will not remain as a mulch cover for a long period. *Tithonia diversifolia* is used in many plantations as hedgerows mainly due to its ready availability and ease in establishement. However, the other wild species, *Euphatorium inulifolium* is not a suitable species for hedgerows at all elevations, as it appears that this species is more adopted to higher elevations. Since this species is considered as an aggressive weed, most plantations do not use *Euphatorium* for hedgerows.

Cassia spectabilis

Cassia hedgerows could be established both by seeds and stem cuttings. Satisfactory establishment with stem cuttings could be achieved when very fresh cuttings are used, but a delay of even a couple of hours affects their establishment. As such this may not be a feasible proposition on a plantation scale. On the other hand, sowing seeds *in situ*, results in poor plants with stunted growth. Therefore, it is necessary to raise the plants in a nursery and transplant in the field. High biomass production was observed at mid and low elevations with as much as 7-8 kg of dry loppings from a meter hedgerow being recorded per year (9-10 t/ha). The decomposition rate of loppings is slow and hence it remains as a mulch cover for a long period. Inspite of high biomass production *Cassia* is not popular due to difficulty in its establishment.

Desmodium rensonii
Flemingia congesta

These species are introductions from the Philippines. Observations made on the

performance of these under different agro-ecological regions showed that *Flemingia congesta* is very promising in all elevations. However, the initial rate of growth is poor and takes about 5-7 months for establishing. Once established, it grows rapidly. Seed treatment by immersing in boiling water for 30 seconds and soaking in cold water for another 24 hours is important. *Flemingia* coppices very well with a biomass production of 7-8 kg of dry loppings per meter hedgerow per year (9-10 t/ha) under mid country conditions; the loppings decompose slowly and remain as a mulch cover for longer periods. Both *Desmodium* and *Flemingia* are good livestock fodder.

The performance of *Desmodium rensonii* was not satisfactory from the point of view of establishment and biomass production.

The following species have been tested as hedgerows:

Samubucus javanicus **(Elder berry)**
Adathoda vasica **(Pavatta)**
Cestrum nocternum **(Queen of the night)**

The main limitation of these species is the poor establishemt. Therefore these species cannot be considered as good hedgerow species for SALT in tea lands.

Preliminary observations have shown that *Flemingia congesta* is the best species for hedgerows at all elevations. All other species except *Tithonia diversifolia* and *Gliricidia sepium* in low and mid elevations have some limitation during establishment or in coppicing. Even *Gliricidia* does not grow well when the soil pH is low and compacted due to repeated treading.

1. EXPENDITURE ON ESTABLISHMENT OF HEDGEROWS IN SEEDLING TEA

Operation	*Cost*	
	Mandays/ha	*Rs./ha*
1.Tracing contour lines	8 - 10	640 - 800
2.Uprooting old tea	30 - 40	2400 - 3200
3.Land preparation	30 - 40	2400 - 3200
4.Planting/sowing hedgerows	20 - 30	1600 - 2400
5.Aftercare - first year	10 - 15	800 - 1200
Total	98 - 135	7840 - 10800

Cost of planting materials: (eg.*Gliricidia* & Vetiver)

1.*Gliricidia* 5000 sticks/ha at Re.1/stick	5000
2.Vetiver, 25000 sprigs/ha	1000
Total	13840 - 16800

Assumptions: 1. Labour wages = Rs.80/day
2. Length of hedgerow/ha = 1300 m

2. EXPENDITURE ON ESTABLISHMENT OF HEDGEROW IN NEW CLEARINGS

Operation	*Cost*	
	Mandays/ha	*Rs./ha*
1. Tracing contour lines	5 - 8	400 - 640
2. Planting/sowing hedgerows	20 - 30	1600 - 2400
3. After care - first year	10 - 15	800 - 1200
Total	35 - 53	2800 - 4240

Cost of planting materials (Eg.*Gliricidia* & Vetiver)

1. *Gliricidia*, 5000 sticks/ha at Re.1/stick	Rs. 5000
2. Vetiver, 25000 sprigs/ha	Rs. 1000
Total	Rs. 8800 - 10240

3. EXPENDITURE ON MAINTENANCE OF HEDGEROWS

Operation	*Mandays/ha*	*Cost Rs./ha*
1. 4 loppings at 10 LPH	40	3200
2. Aftercare	10	800
Total	50	4000

Assumptions: 1. Labour wages = Rs.80/day
2. Length of hedgerows/ha = 1300 m

4. REQUIREMENTS OF CUTTINGS/STICKS, VETIVER SPRIGS AND SEEDS

Species	*No of sticks/Qty.of seeds(kg/ha)*
Gliricidia sepium sticks(1 m)	10000 - 15000
Gliricida sepium poles (2 m)	5000 - 7500
Vetiver sprigs	25000
Desmodium rensonii seeds	6 - 8 kg
Flemingia congesta seeds	8 - 10 kg
Calliandra calothyrsus seeds	6 - 8 kg
Cassia spectabilis seeds	6 - 8 kg

5. CALCULATION OF REQUIREMENT OF CUTTINGS FOR 100 M HEDGEROW

Spacing within the row = 15 - 25 cm

$$\text{No of plants/100 m} = \frac{100 \times 100 \times 2}{15 - 25} = 800 - 1300$$

Assume total length of hedgerow per ha at 7-8 m = 1300 m

No. of plants/ha = 11000 - 17000