Tea harvesting equipment is disclosed herein wherein the equipment is solely supported on the tea bush canopy without any ground contact, the equipment comprising a framework (16) carrying either belts (11, 12) or wheels/rollers (23, 25) which are located at least partially below the framework (16) and engage the tea bush canopy, the belts or wheels/rollers enabling movement of the equipment over the canopy, a cutter assembly (59) carried by the framework (16) extending forwardly of and transversely across the movement direction of the harvester, and a collection duct (64) to receive cut leaves from the cutter assembly (59) and deposit same into collection bins or bags carried by the harvester.
TEA HARVESTER

The present invention relates to apparatus adapted to improve the mechanisation of tea growing activities including but not limited to harvesting, pruning, spraying and fertilising.

Tea is normally grown in rows of bushes and when plucked by hand forms a hedge.

Traditionally tea has been plucked by hand and therefore the bushes have to be pruned to a height that enables the person plucking the leaf to reach over the top of the bush and to the centre of the bush, this necessitates the tea bush being pruned at intervals to maintain the plucking height. It is also necessary to have tracks or rows in between the tea bushes. These tracks allow the entry of sunlight which in turn generates weed growth which then must be controlled by herbicides or by hand weeding at high cost.

There have been developed various methods of harvesting the tea crops by mechanised means, the first levels of mechanisation being hand held clippers with a collection device attached to one of the blades. This is all operated by hand and of course supported from the ground by the individual holding the hand clippers. The second generation of harvesters being simple reciprocating blades with two handles on the machine with a leaf collection bag which is generally carried by two people with a further two persons to carry the sack of tea, a four man crew.

This unit is still supported by the individuals holding the machinery and the collection device with the operators standing on the ground in every instance. This has required the clearing of paths through the tea, maintaining of the height of the tea and the building of bridges or pathways across drains. Further developments have been made in mechanised tea harvesting by the use of wheeled machines, half tracked machines and tracked machines in an effort to spread the weight across a greater area and reduce the ground pressure.

Tea traditionally grows at high altitude close to the equator in the tropics and therefore is subject to frequent tropical rain and the ground condition to grow tea ideally is generally moist and damp and the soils often soft. The combination of the environment and the canopy coverage of the leaves means that the site can deteriorate and over a period of time compaction can take place which can substantially further reduce yields. In every instance it is necessary to keep tracks open in the area between rows of bushes for operators and machines to pass along and substantial civil works are necessary (e.g. construction of bridges over the drains which must be at frequent intervals throughout the tea estate to enable the passage of the machines through the tea to be harvested). In addition, there needs to be sufficient width of head land at the end of the tea rows to allow the machine to be turned and re-enter the crop.

if the tea leaf is to be of value it must be harvested at the correct length therefore, it has been a continual problem to maintain a precise even depth when determining the fresh growth to be plucked. With mechanised means it has been achieved by using the ground as a constant height source and thereby having the picking means attached at a controllable point from the ground, with wheeled machines this has been impracticable where site irregularities and soft patches of ground occur. The tracked machines have been more successful but such machines are substantially more expensive and require substantial civil works carried out to enable the support of these machines.

The hand carried methods means the plucking device has to be supported by individuals from the ground, with the result that the accuracy of height, control from the ground while the person is walking along is extremely difficult to maintain, this allows the cutting means to be raised and lowered unintentionally causing loss of crop or scalping into the bush which gives poor quality harvested leaf, scalping into the maintenance foliage also reduces the yields.
It is an objective of the present invention to provide a work platform capable of use in mechanising tea plantation maintenance and harvesting activities which will solve all or some of the foregoing problems. Preferably, the present invention aims at providing a low capital cost machine that is capable of mechanized tea harvesting.

According to a first aspect, the present invention provides a work platform for use with a plurality of tea bushes growing adjacent one another, said apparatus comprising support frame means which, in use, is adapted to extend above and generally parallel to a top zone of said tea bushes, transport means carried by said support frame means and located at least partially below said support frame means adapted to contact and be supported on the top zone of said tea bushes, said transport means being movable whereby said support frame means is moved over said top zone of the tea bushes while being solely supported thereby.

By ensuring that the work platform does not have any ground support, the traditional problems discussed above with uneven or boggy ground conditions are avoided.

Moreover, access spaces between tea bushes are no longer required thereby allowing closer planting of bushes with greater yields per unit area of planting. Furthermore, problems of ground compaction around bushes are avoided as ground contact by machine or operator adjacent the bushes is largely avoided. Conveniently, the work platform of the present invention is used to carry work implements as desired. Commonly the work implement might be harvesting equipment but other equipment such as pruning, spraying, fertilising devices and the like could also be carried.

Preferably, the transport means may include one or more moving surfaces in contact with said top zone of said tea bushes, the or each said moving surface having a surface velocity equal to and in an opposite direction to a translational velocity of said platform. In one embodiment, the transport means may comprise a plurality of rollers with a peripheral surface of each said roller forming a said moving surface. In a possible alternative embodiment, the transport means may include at least one endless belt with a lower run of the or each said belt forming a said moving surface.

In a further embodiment, the or each said endless belt, together with side skirting provides a substantially enclosed chamber, means being provided to pressurise air within the or each said chamber to support said support frame means above said tea bushes. Alternatively, a plurality of transverse support rollers may be provided carried by and at least partially below said support frame means to engage against an upper surface of a lower run of the or each said endless belt.

Preferably, drive means is provided adapted to move said transport means. The drive means may be at least partially carried by said work platform. In one preferred embodiment, the drive means may comprise a drive motor and drive transmission means carried by said support frame means. In an alternative preferred embodiment, the drive means may comprise a winch arrangement adapted to pull the work platform over a desired path. The winch may be mounted on the work platform or mounted externally thereof. The externally mounted portion of the winch mechanism may be arranged to be moved to vary the path of movement of the work platform as may be desired.

Preferably, the support frame means may comprise two articulated frame members, each having independent transport means whereby the drive means is capable of moving said independent transport means at the same speed or at differing speeds as may be desired. Advantageously, the support frame means is steerable by selectably varying the relative speed (or direction) of the independent transport means.
The present invention aims also at providing tea harvesting equipment employing a work platform as described above, the harvesting equipment including a cutter assembly to cut new growth leaves from the top zone of the tea bushes and tea leaf collection means to collect said cut new growth leaves.

In accordance with a further aspect, the present invention provides a tea harvester for use in harvesting tea leaves from a plurality of tea bushes growing adjacent one another, said tea harvester comprising a support frame means which, in use, is adapted to extend above and generally parallel to a top zone of said tea bushes, transport means carried by said support frame means and located at least partially below said support frame means adapted to contact and be supported on the top zone of said tea bushes, said transport means in use having one or more moving surfaces in contact with the top zone of said tea bushes whereby the or each said moving surface has a surface velocity equal to and in an opposite direction to a translational velocity of said tea harvester, a tea leaf cutter assembly connected to said support frame extending transversely relative to a forward translational direction of said harvester forwardly of said transport means, and collection means adapted to collect tea leaves cut by said cutter assembly.

The present invention, according to a still further aspect, provides a tea harvester for use in harvesting tea leaves from a plurality of tea bushes growing adjacent one another, said tea harvester comprising a support frame means when, in use, is adapted to extend above and generally parallel to a top zone of said tea bushes, transport means carried by said support frame means adapted to contact and be supported on the top zone of said tea bushes whereby said transport means permits movement of said harvester over the top zone of said tea bushes in a predetermined translational direction, a tea leaf cutter assembly carried by said support frame extending transversely relative to said predetermined translational direction and located forwardly of said transport means, collection means adapted to collect tea leaves cut by said cutter assembly, engagement means supported from said harvester extending transversely to said translational direction and located forwardly of said cutter assembly, said engagement means being adapted in use to engage said top zone of the tea bushes forwardly of the cutter assembly, and adjustment means to vary the height of said engagement means relative to said cutter assembly.

Several preferred embodiments of the present invention will hereinafter be described with reference to the accompanying drawings, in which

Figure 1 shows a schematic perspective view of a first preferred embodiment of a work platform;
Figure 2 shows a front elevation view of the platform of Figure 1 in a position of use;
Figures 3, 4, 5, 5A, 6 and 6A show schematic views of further preferred embodiments of work platforms according to the present invention;
Figure 7 shows a perspective view of a work platform according to a further preferred embodiment incorporating tea-harvesting devices;
Figure 8 shows a perspective view of a still further embodiment of the present invention incorporating tea-harvesting devices;
Figure 9 shows a perspective view of a work platform according to the present invention incorporating devices for applying fertiliser,
Figures 10 and 11 show perspective views of a work platform according to the present invention incorporating alternative tea bush pruning devices;
Figures 12 and 12A show respectively in perspective view and in front elevation view, work platforms according to the present invention adapted for the transport of harvested tea leaf;
Figure 13 shows a still further embodiment of the present invention incorporating tea leaf harvesting devices;
The present invention aims also at providing tea harvesting equipment employing a work platform as described above, the harvesting equipment including a cutter assembly to cut new growth leaves from the top zone of the tea bushes and tea leaf collection means to collect said cut new growth leaves.

In accordance with a further aspect, the present invention provides a tea harvester for use in harvesting tea leaves from a plurality of tea bushes growing adjacent one another, said tea harvester comprising a support frame means which, in use, is adapted to extend above and generally parallel to a top zone of said tea bushes, transport means carried by said support frame means and located at least partially below said support frame means adapted to contact and be supported on the top zone of said tea bushes, said transport means in use having one or more moving surfaces in contact with the top zone of said tea bushes whereby the or each said moving surface has a surface velocity equal to and in an opposite direction to a translational velocity of said tea harvester, a tea leaf cutter assembly connected to said support frame extending transversely relative to a forward translational direction of said harvester forwardly of said transport means, and collection means adapted to collect tea leaves cut by said cutter assembly.

The present invention, according to a still further aspect, provides a tea harvester for use in harvesting tea leaves from a plurality of tea bushes growing adjacent one another, said tea harvester comprising a support frame means when, in use, is adapted to extend above and generally parallel to a top zone of said tea bushes, transport means carried by said support frame means adapted to contact and be supported on the top zone of said tea bushes whereby said transport means permits movement of said harvester over the top zone of said tea bushes in a predetermined translational direction, a tea leaf cutter assembly carried by said support frame extending transversely relative to said predetermined translational direction and located forwardly of said transport means, collection means adapted to collect tea leaves cut by said cutter assembly, engagement means supported from said harvester extending transversely to said translational direction and located forwardly of said cutter assembly, said engagement means being adapted in use to engage said top zone of the tea bushes forwardly of the cutter assembly, and adjustment means to vary the height of said engagement means relative to said cutter assembly.

Several preferred embodiments of the present invention will hereinafter be described with reference to the accompanying drawings, in which

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Figure 2 shows a front elevation view of the platform of Figure 1 in a position of use;
Figures 3, 4, 5, 5A, 6 and 6A show schematic views of further preferred embodiments of work platforms according to the present invention;
Figure 7 shows a perspective view of a work platform according to a further preferred embodiment incorporating tea-harvesting devices;
Figure 8 shows a perspective view of a still further embodiment of the present invention incorporating tea-harvesting devices;
Figure 9 shows a perspective view of a work platform according to the present invention incorporating devices for applying fertiliser;
Figures 10 and 11 show perspective views of a work platform according to the present invention incorporating alternative tea bush pruning devices;
Figures 12 and 12A show respectively in perspective view and in front elevation view, work platforms according to the present invention adapted for the transport of harvested tea leaf;
Figure 13 shows a still further embodiment of the present invention incorporating tea leaf harvesting devices;
Figures 14 and 14A illustrate schematically one possible form of drive transmission for effecting movement of the work platforms according to the present invention;

Figure 15 illustrates schematically one preferred form of cutter bar mechanism as part of tea harvesting equipment illustrated in Figures 7, 8 and 13;

Figure 16 is a cross sectional view taken transversely through a blower system for transmitting cut leaf from the cutter bar to collection means; and

Figures 17, 17A, 18, 18A, 19 and 19A are schematic views showing alternative preferred forms of belt constructions for use in apparatus according to the present invention.

Figure 1 illustrates a first form of work platform 10 comprising twin variable speed belts 11, 12. The speed variation may be controlled by any suitable means; for example, a simple belt jockey pulley (not shown) intermittently engaged in either forward, neutral or reverse. The same device can be powered by being pushed or pulled by external means or by the use of hydrostatic drives or by friction drives or such means. Variation of speed between the parallel belts is used for manoeuvring or turning the machine. One suitable form of drive transmission is illustrated and described hereinafter with reference to Figures 14 and 14A. The belts 11, 12 frictionally engage with a roller 13 driven by the drive transmission and are supported by a plurality of idler rollers 14 carried by a support frame 16. A forward main return idler roller 15 is also provided carried by the frame 16. Suitable guide strips or the like to prevent misalignment of the belts 11, 12 may be provided and can be as described hereinafter with reference to Figures 18 to 20. Figure 2 of the drawings shows the work platform of Figure 1 supported solely on an array of tea bushes 17.

Figure 3 shows a second embodiment of a work platform 10 using air turbines 18 to increase air pressure within the belts 11, 12, the belting 11, 12 acting as a seal over the top of the tea bushes 17.

The belts 11, 12 together with side skirting 19, provides an internal enclosed chamber that can be pressurised by the air turbines 18 so that a form of hover track is created without any support rollers (such as rollers 14 of Figure 1) on the base of the track other than the end rollers 13, 15 (not seen in Figure 3). It will of course be apparent that any desired form of super structure can be built onto the frame 16 (subject of course to weight considerations) to carry out any desired function some of which are described hereinafter.

Other configurations to the side-by-side belt configurations of Figures 1 to 3 may be employed. For example, a single belt arrangement might be used if steerability was not a requirement of the machine.

Figure 4 illustrates a still further arrangement comprising two full width work platforms 10, each constructed similarly to the platforms of Figure 1 except that the belts 11, 12 are not side by side but rather are in line with each platform 10 hinged or articulated to the other at 20. Steerability in this case is achieved by control of a pair of actuating cylinders 21, 22.

Figures 5 and 5A illustrate schematically a still further possible form of work platform 10. In this case, the support frame 16 is supported by a series of rollers 23 to spread the load without the use of any external belting. The rollers 23 may be formed of a lightweight material and be foam filled with at least one roller on the side by side sections being driven independently of the driven roller on the other section so that the device may be skid steered in a manner similar to the platforms of Figures 1 to 3. A drive mechanism 24 is schematically illustrated. Figure 5A shows an alternative version where the two sections are articulated in a manner similar to the arrangement of Figure 4. Figures 6 and 6A illustrate arrangements similar to Figures 5 and 5A except that in this instance, the rollers 23 are replaced by wheels 25 of a suitable material and diameter to give sufficiently light loading to convey the work platform 10 across the top of the tea bushes without any ground contact. Again,

Figure 6A shows an articulated version similar to Figures 4 and 5A.
As described above, many activities necessary to be carried out in a lea estate can be carried out using apparatus which employs a work platform as described in the foregoing. Figure 7, for example, illustrates a preferred form of tea leaf harvester 26 which employs a work platform 10 similar to that of Figure 1 except that the forward roller 15 is replaced by an upper idler roller 27 and a forward idler roller (not shown) of smaller diameter than roller 13 but larger than the rollers 14, 27. At the rear end of the harvester 26, an operator's platform 28 is provided, mounted from the support frame 16 on which a bag support frame 29 is provided to support bags 30 so that during harvesting, they receive cut leaf therein.

A drive transmission 24 shown in Figures 14 and 14A (not seen in Figure 7) including an independent motor 31 is provided to drive the rear rollers 13 and thereby the belts 11, 12. The transmission further includes a V-belt 32 driven by the motor 31 and via cone V-belt pulleys 33 (so that speed ratios can be changed) driving a primary shaft 34. On the outer ends of the primary shaft 34 are V-belt pulley wheels 35, 36 adapted to receive V-belts 37,38. Adjacent to but inwardly of the pulley wheels 35, 36 are rollers 39, 40 each having a compressible material on the rim (such as polyurethane, rubber or friction material).

From the primary shaft 34, the V-belts 37,38 are arranged to drive pulley wheels 41, 42 on respective intermediate shafts 43, 44. The right-hand intermediate shaft 44 drives the right-hand belt 12 via roller 13 and the left-hand intermediate shaft 43 drives the left-hand belt 11 via its associated roller 13. On the inner ends of the intermediate shafts 43, 44 are respectively sprockets 45, 46 which drive sprockets 47, 48 connected to the shafts 49, 50 of the rollers 13 via chains 51, 52. Finally, on the intermediate shafts 43, 44 there are provided steel run rollers 53, 54 aligned with the rollers 39, 40 on the primary shaft 34. Connected to the roller 54 is a brake (not shown), which may be used as a parking brake.

The function of the drive transmission 24 is as follows. The transmission is operated by two levers 55 (see Figure 14A) each with a linkage 56 to the primary shaft 34. If both levers 55 are pushed forward (as in Figure 14A) the linkages 56 raises the primary shaft 34 which drivingly engages the V-belts 37,38 and causes forward movements of both belts 11, 12. This position is maintained via spring tension applied by springs 57,58. If the two levers 55 are pulled back to a vertical position, the V-belts 37, 38 are disengaged from driving their respective pulleys and the machine is placed in neutral disengaging both belts 11, 12 from the drive motor 31. If both levers 55 are pulled back towards the operator, this engages the two rollers 39,53 and 40,54 causing reverse motion to be applied to both belts 11, 12. For turning left or right, one lever 55 is kept forward keeping its associated belt 11, 12 moving in a forward direction and the other lever is pulled back to enable the other of the belts 11, 12 to either stop or move in a reverse direction depending on the tightness of the turn required.

Reference is again made to figure 7 of the accompanying drawings. The harvester illustrated comprises a main support frame 16 with a sub frame assembly mounted therefrom for pivotal movement about a transverse pivot axis 69. The sub frame assembly comprises a rearwardly directed chute 64 with a leaf cutter bar assembly 59 mounted from a lower end of the chute 64 and a forwardly directed frame member 70 with a roller 71 pivotally mounted at its forward extremity. The leaf cutter bar assembly 59 comprises a pair of blades 60, 61 having forwardly directed teeth and adapted to reciprocate relative to one another across the forward end of the work platform 10 defined by the main support frame 16. The blades 60,61 are driven by a cam mechanism 62 and an independent drive motor 63 as best seen in figure 15.
As described above, many activities necessary to be carried out in a lea estate can be carried out using apparatus which employs a work platform as described in the foregoing. Figure 7, for example, illustrates a preferred form of tea leaf harvester 26 which employs a work platform similar to that of Figure 1 except that the forward roller 15 is replaced by an upper idler roller 27 and a forward idler roller (not shown) of smaller diameter than roller 13 but larger than the rollers 14, 27. At the rear end of the harvester 26, an operator's platform 28 is provided, mounted from the support frame 16 on which a bag support frame 29 is provided to support bags 30 so that during harvesting, they receive cut leaf therein.

A drive transmission 24 shown in Figures 14 and 14A (not seen in Figure 7) including an independent motor 31 is provided to drive the rear rollers 13 and thereby the belts 11, 12. The transmission further includes a V-belt 32 driven by the motor 31 and via cone V-belt pulleys 33 (so that speed ratios can be changed) driving a primary shaft 34. On the outer ends of the primary shaft 34 are V-belt pulley wheels 35, 36 adapted to receive V-belts 37,38. Adjacent to but inwardly of the pulley wheels 35, 36 are rollers 39, 40 each having a compressible material on the rim (such as polyurethane, rubber or friction material).

From the primary shaft 34, the V-belts 37,38 are arranged to drive pulley wheels 41, 42 on respective intermediate shafts 43, 44. The right-hand intermediate shaft 44 drives the right-hand belt 12 via roller 13 and the left-hand intermediate shaft 43 drives the left-hand belt 11 via its associated roller 13. On the inner ends of the intermediate shafts 43, 44 are respectively sprockets 45, 46 which drive sprockets 47, 48 connected to the shafts 49, 50 of the rollers 13 via chains 51, 52. Finally, on the intermediate shafts 43, 44 there are provided steel run rollers 53, 54 aligned with the rollers 39, 40 on the primary shaft 34. Connected to the roller 54 is a brake (not shown), which may be used as a parking brake.

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Reference is again made to figure 7 of the accompanying drawings. The harvester illustrated comprises a main support frame 16 with a sub frame assembly mounted therefrom for pivotal movement about a transverse pivot axis 69. The sub frame assembly comprises a rearwardly directed chute 64 with a leaf cutter bar assembly 59 mounted from a lower end of the chute 64 and a forwardly directed frame member 70 with a roller 71 pivotally mounted at its forward extremity. The leaf cutter bar assembly 59 comprises a pair of blades 60, 61 having forwardly directed teeth and adapted to reciprocate relative to one another across the forward end of the work platform 10 defined by the main support frame 16. The blades 60,61 are driven by a cam mechanism 62 and an independent drive motor 63 as best seen in figure 15.
The upwardly and rearwardly directed chute 64 has an open lower end adjacent the cutter bar assembly 59 and an upper end adapted to discharge cut leaf into collection bags 30. To cause leaf material to flow up the chute 64, a blower bar 66 is provided with a plurality of nozzles 67 (see figure 16) to direct high velocity air into the chute 64 from its lower end. Compressed air is supplied to the blower bar 66 from a motor/compressor unit 68. To balance the rearward weight of the chute 64 the forwardly extending frame member 70 is provided which at its forward extremity pivotally supports the roller 71 and at its inner extremity (not seen in Figure 7) is pivotally mounted to the chute 64. A pair of turn buckle type mechanisms 72 (or any other suitable means) is provided to enable the relative angle between the chute 64 and frame member 70 to be held constant during use but selectably varied as may be desired to vary the height of the roller 71 relative to the cutter bar 59. The positioning of the mechanism 72 enables the height of the cut depth to be varied. The use of the roller 71 in the arrangement illustrated enables control of the cutting height of the cutting bar assembly 59 automatically to give precision depth of cut irrespective of variations that might occur in the height of the canopy of the tea bushes. Such a configuration, used in advance of the mobile work platforms, causes a levelling effect between harvesting operations and very accurately controls the operational height of the cutter assembly 59 relative to the tea bush.

Such function being automatic in that the machine rises with the growth of the tea bush canopy thereby still maintaining the precise positioning of the cutter assembly.

Figure 8 illustrates a tea harvester generally similar to that of Figure 7 except that the, tea leaf collection chute 64 is somewhat shorter and directs the cut leaf directly into generally horizontally disposed bags 73. In this case the forwardly located weight of the chute 64 relative to its pivot axis 69 is balanced by spring means 74 acting between the chute 64 and the frame 16. In this case also, the forward roller 71 is carried by links 75 pivoted at their rearward ends to the chute 64. Stabilising links 76 of adjustable effective length may be provided to serve a similar purpose to the turn buckle mechanism 72 of Figure 7. At the rear of the work platform, an operator's station 77 is illustrated together with the drive transmission control levers 55 previously discussed.

Figure 9 of the accompanying drawings illustrates a further possible use for the work platforms constructed in accordance with Figures 1 to 6. In this embodiment a distributor assembly 80 is provided for passing fertiliser or other similar particle materials to distribution nozzles 81 in a transversely extending distribution bar 82. A rear platform 83 enables supplies of the particle material to be carried. Conveniently, the fertiliser or other particulate material is blown down at high velocity from the nozzles 81 penetrating through the leaves and branches of the tea bush thereby depositing same around the base of the bushes. Alternatively, the particle material distribution system could be replaced with a liquid spraying system for distributing insecticides or the like as may be required from time to time.

Figures 10 and 11 of the drawings illustrate work platforms 10 carrying pruning facilities. When pruning, the work platform 10 moves forwardly supported solely by the tea bushes 17 and uses either a band saw 84 (Figure 11) or reciprocating cutters to saw off the underside of the tea bushes. Alternatively, as shown in Figure 10, an array of circular saws 85 may be used for deeper pruning or for skiffing. Figures 12 and 12A illustrate a further use for the work platforms of the present invention where they may be used as a transport means for transporting filled bags 85 of cut-tea leaves to suitable collection points around the estate.

The support frame of each mobile work platform is conveniently designed to be torsionally strong and very light, using predominantly high strength lightweight chrome molybdenum tubing or other
suitable alloys. As discussed previously, each track unit is independent of the other and joined together at assembly.

Each track unit has its own chassis or support frame 16, each precision jig built using high strength lightweight tubing. Each section is preferably a triangulated truss section, torsionally strong in all directions. Fitted to these triangulated frames are the rear drive rollers 13, front rollers 15 and the intermediate rollers 14.

The front and rear rollers 13, 15 may be aluminium tubing or rolled aluminium sheet riveted to circular gussets spaced within the tube. The intermediate rollers 14 may be aluminium or PVC tubing which in turn are fitted to lightweight pressed bearings which are mounted to the underside of the frame 16. Conveniently, assembly is completed on site by pushing together interfitting parts and bolted together. The belts 11, 12 are tensioned by means of a take up bearing at the front of the frames 16.

Figure 13 of the accompanying drawings illustrate a still further preferred form of tea harvester according to the present invention. This device is primarily intended for use with tea bushes planted on steep inclines although the principles disclosed need not be limited to this use. In this embodiment, a work platform 10 substantially as described with reference to Figure 1 is employed with a tea leaf cutter bar 59 carried thereby. An upwardly directed collection chute 64 is provided to direct cut leaves into bags 73. The arrangement may generally be as described in previous embodiments with the exception that the work platform does not carry a drive motor but rather motive force to the platform is provided by a winch mechanism 90 partly carried by the platform 10 and partly located at a fixed point 91. A flexible cable 92 or the like forms part of the winch mechanism forming the platform 10 to the fixed point 91. The fixed point 91 may be a stationary anchor point or it may be movable on a rail 93 or the like. The cable 92 is attached on a swivel 94 at the centre point of the platform 10 allowing a full 360-degree rotation shown by arrows 95. The device can harvest up the steep slope in the direction of arrows 96 and travel backwards down the harvested path in the direction of arrows 97. Thereafter part 90 is moved along the rail 93 left or right (arrow 98) and harvest up the slope on a new path.

On moderate to steep slopes the device can be rotated through 90 degrees in either direction of arrows 95 and move across to the next harvesting path and then rotate a further 90 degrees and proceed to harvest down the slope in the opposite direction 97.

The work platform 10 can be free running with the belts 11, 12 freely moving over the supporting rollers or powered by means of a friction geared transmission assembly, hydrostatic drive or the like. If desired, the device could be operated from a distance by radio control or could be manually pushed or pulled along while still being fully supported by the tea bushes. This latter possibility is not preferred, however, as it would require minimum access tracks between the tea bushes.

Young bud shoots and the tender tea stems supporting two leaves and a bud are damaged by sliding or dragging any device across the upper surface of the tea bushes. As a result, it is preferred that the work platforms be supported by belts, membranes or rolling surfaces which during the passage of the machine across the surface of the tea bush, results in the contacting surface remaining stationary relative to the engagement force with the tea bush.

Figures 17, 17A, 18, 18A, 19 and 19A illustrate alternative means of maintaining the belts 11, 12 in alignment. In Figures 17, 17A, the means of providing support alignment and drive to the belt or membrane 11, 12 comprises a stiffener cleat 99 fitted to the outwardly directed face of belt 11. The belt 11 has edge strips 100 formed thereon to engage against the ends of the rollers 13, 15. The
suitable alloys. As discussed previously, each track unit is independent of the other and joined together at assembly.

Each track unit has its own chassis or support frame 16, each precision jig built using high strength lightweight tubing. Each section is preferably a triangulated truss section, torsionally strong in all directions. Fitted to these triangulated frames are the rear drive rollers 13, front rollers 15 and the intermediate rollers 14.

The front and rear rollers 13,15 may be aluminium tubing or rolled aluminium sheet riveted to circular gussets spaced within the tube. The intermediate rollers 14 may be aluminium or PVC tubing which in turn are fitted to lightweight pressed bearings which are mounted to the underside of the frame 16. Conveniently, assembly is completed on site by pushing together interfitting parts and bolted together. The belts 11, 12 are tensioned by means of a take up bearing at the front of the frames 16.

Figure 13 of the accompanying drawings illustrate a still further preferred form of tea harvester according to the present invention. This device is primarily intended for use with tea bushes planted on steep inclines although the principles disclosed need not be limited to this use. In this embodiment, a work platform 10 substantially as described with reference to Figure I is employed with a tea leaf cutter bar 59 carried thereby. An upwardly directed collection chute 64 is provided to direct cut leaves into bags 73. The arrangement may generally be as described in previous embodiments with the exception that the work platform does not carry a drive motor but rather motive force to the platform is provided by a winch mechanism 90 partly carried by the platform 10 and partly located at a fixed point 91. A flexible cable 92 or the like forms part of the winch mechanism forming the platform 10 to the fixed point 91. The fixed point 91 may be a stationary anchor point or it may be movable on a rail 93 or the like. The cable 92 is attached on a swivel 94 at the centre point of the platform 10 allowing a full 360-degree rotation shown by arrows 95. The device can harvest up the steep slope in the direction of arrows 96 and travel backwards down the harvested path in the direction of arrows 97. Thereafter part 90 is moved along the rail 93 left or right (arrow 98) and harvest up the slope on a new path.

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Young bud shoots and the tender tea stems supporting two leaves and a bud are damaged by sliding or dragging any device across the upper surface of the tea bushes. As a result, it is preferred that the work platforms be supported by belts, membranes or rolling surfaces which during the passage of the machine across the surface of the tea bush, results in the contacting surface remaining stationary relative to the engagement force with the tea bush.

Figures 17, 17A, 18, 18A, 19 and 19A illustrate alternative means of maintaining the belts 11, 12 in alignment. In Figures 17, 17A, the means of providing support alignment and drive to the belt or membrane 11, 12 comprises a stiffener cleat 99 fitted to the outwardly directed face of belt 11. The belt 11 has edge strips 100 formed thereon to engage against the ends of the rollers 13, 15. The
stiffener cleats 99 are contained in side keepers 101 which prevents belt misalignment. As shown in Figure 17A, the keepers 101 also form part of the support structure to which the roller bearings 102 for the rollers 14 are attached. The cleats 99 provide tractive grip for propelling the device if desired. Figures 18 and 18A show a belt 11 with very large tracking strips 103 and a central "V" groove 104 in the centre of the rollers 13, 15, the tracking strips and "V" rollers provide belt alignment. As can be seen in Figure 18A the tracking strips 103 are notched at 105 to allow sufficient flexibility for the strips to bend about the rollers 13, 15.

Figures 19 and 19A shows a lightweight low cost structure 106 which is constructed from metal sheet in continuous section to form inverted "V"s 109 and lipped side skirts 110. The assembly further includes a belt 11 with guide ribs 111 adapted to engage in the inverted V slots 109 in the metal panel 106. Again cleats 99 can be provided or left off as may be desired. The belt 11 in this embodiment is made from a material having a low coefficient of friction. Figure 19A shows a side elevation of the structure showing driven roller 13 and idler roller 15. Both rollers would be idlers in the case of the device being supported by the tea bushes and pulled or pushed along from an external source. The large tracking strips 111 are notched along their length at 112 to maintain depth while enabling flexure around the small end rollers 13, 15. The material in the belts 11 and strips 111 are of a very low coefficient of friction allowing slippage on the underside of the floor support 106.

It will be appreciated by those skilled in the art that quite substantial advantages are achieved by use of apparatus as now described in the foregoing text. These advantages include:

(i) that there is no longer any need for passages between tea bush rows and therefore intergrowth of the tea bushes can be permitted to form one continuous interconnecting canopy of tea bushes without any access tracks or opening through to the ground thereby controlling weeds and reducing the need for herbicides.
(ii) A machine supported by tea bushes enables the harvesting of tea in any direction regardless of the rows or placement of the bushes.
(iii) The device enables harvesting of tea on tea estates irrespective of the direction or quantity of drains underlying the tea bushes.
(iv) The device enables very accurate control of cutting heights of the young freshly grown tea leaf and enables automatic adjustment by picking from the top of the bush without contact on the ground.
(v) The device prevents ground compaction because it is supported by the tea bushes and the load is spread across a large area.
(v i) The device increases the quality of leaf by being supported by the top of the tea bush thereby automatically raising the harvesting as the tea bush and leaf canopy grows.
(vii) The device that increases the yield of the tea bushes by being able to pluck a long stem length of tea material.
(viii) The device can harvest tea without the necessity of pruning to maintain a reasonable height from the ground.
(ix) The device can harvest tea on steep inclines simply because it is not ground supported. In such situations (see Figure 21), the tea bushes are normally pruned flat on top so that the machine can be supported thereon.

Present mechanical means of harvesting tea can only be carried out on flat or undulating ground. If tracked or wheeled harvesting machines are operated on steep inclines they can slip due to the usual wet conditions and slide into tea bushes causing damage to the tea bush. On plantations in steep country tea bushes are often terraced, making the use of hand held harvesters extremely difficult and dangerous as one operator is on the down side of the terrace and one operator on the top side of the terrace. Another difficulty in steep terrain is soil erosion. To rectify this problem drains
are dug horizontally around the hills joining into vertical down drains to carry away any water. With hand held wheeled or tracked machines, negotiating these drains is difficult. With the present invention, the machine supported solely by the tea bushes can be directed around the contour of the incline so that the tops of a row (or perhaps two rows) around this contour are maintained essentially horizontal so that the machine is also maintained horizontal. Alternatively, the tops of the tea bushes may have a surface which generally follows the incline of the land with the machine being directed up or down the incline.

Variations or modifications within the scope of the accompanying claims are also anticipated. For example, rather than blowing air up the collection chutes 64, air could be drawn through by suitable means located at the upper ends of the collection chutes.
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Variations or modifications within the scope of the accompanying claims are also anticipated. For example, rather than blowing air up the collection chutes 64, air could be drawn through by suitable means located at the upper ends of the collection chutes.
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A tea harvester for use on a plurality of tea bushes growing adjacent one another, said tea harvester comprising a main support frame means having a forward zone and a rear zone, a sub frame assembly pivotally mounted to said support frame means for pivotal movement about a first transverse pivot axis, said sub frame assembly carrying tea leaf cutter means located forwardly of the forward zone of said main support frame, said sub frame assembly further including roller means adapted to rotate about a second transverse pivot axis, said roller means being located forwardly of said leaf cutter means and in use contacting and being supported by a top zone of said tea bushes, and transport means being carried by said main support frame means and located at least partially below said main support frame means, said transport means being adapted to contact and be supported on the top zone of said tea bushes, said transport means further being movable whereby said main transport means is moved over said top zone of the tea bushes while being supported thereon.

2. A tea harvester according to Claim 1 wherein height adjustment means is provided to vary the position of said second transverse pivot axis relative to the leaf cutter means.

3. A tea harvester according to Claim 1 or Claim 2, wherein said transport means includes one or more moving surfaces in contact with said top zone of said tea bushes, the or each said moving surface having a surface velocity equal to and in an opposite direction to a translational velocity of said platform.

4. A tea harvester according to Claim 3, wherein the transport means includes a plurality of rollers with a peripheral surface of each said roller forming a said moving surface.

5. A tea harvester according to Claim 3, wherein the transport means includes at least one endless belt with a lower run of the or each said endless belt forming a said moving surface.

6. A tea harvester according to Claim 5, wherein the or each said endless belt, together with side skirting provides a substantially enclosed chamber, means being provided to pressurise air within the or each said chamber to support said support frame means above said tea bushes.

7. A tea harvester according to Claim 5, wherein a plurality of transverse rollers carried by and at least partially below said support frame means engage against an upper surface of a lower run of the or each said endless belt.
Fig 6.

Fig 6 A.
Fig 6.

Fig 6 A.