Mechanization of Plucking of Tea Leaves

H. TORII

Head, Tea Technology Division, Tea Research Station

Introduction

Tea-making in our country had, for a long time, been allowed to rest in its original form of processing···namely, hand-plucking and hand-crumpling···until World War 1. With the advent of the economic crisis, the tea industry has eventually confronted by the higher cost of labor, and more efficient production methods were necessarily sought. In the meantime, a model of plucking shears was invented and a mechanical process of tea-making came to be employed. Thus, the industry could hardly escape the hit of the crisis.

Since that time tea leaves had been plucked either by hand or by shears. Very recently, however, hand plucking is locally practised only in the tea fields that specialize in such superior qualities as "Gyokuro" or "Sencha" of higher grade, or in small holdings where labor is intensively used. On the other hand, shears-plucking became the prevailing harvesting method because it is ten times more efficient than hand plucking.

In the tropics, tea leaves are plucked out of the just matured shoots selectively in each of the incessant growing stages of trees. In our country, however, the growing season is divided into several parts, in each of which newly grown shoots come to a stand still after a short period of growth, while adjacent buds grow out. Therefore plucking is practised intensively in a rather short optimum plucking time.

In these days, labor shortage is so severe and level of wages so high that it is almost impossible for the tea industry to employ laborers on such an irregular basis as required intermittently throughout the year. Eventually several firms devised shoulder-type models of power tea plucker and they came into practical use by 1961.

The Tea Research Station, Ministry of Agriculture and Forestry and prefectural research organizations concerned have endeavored to expedite researches in the construction, performance and application of such power pluckers.[1] More farmers are using the machine and around 10,000 units were in operation by the end of 1965.

Mechanical Structure of Power Plucker

A popular type of small-size power tea plucker has a small engine (2 cycles and around 1HP) and a reduction gear. They are mounted on a frame by which the operator shoulders the plucker on his back. Power is transmitted by a flexible shaft of 80 cm in length through the cutter. The operator holds the cutter in both hands and moves it over surface of tea bush. At the rear of cutter, a leafcollecting bag, two meters in length, is attached.

There are three types of cutters; cylinder blade-, reciprocating knife- and rotary blade-type. Length of blade of these types is 25~30 cm, 30~33 cm, 18 cm, respectively. There are several devices for collecting shorn leaves into the attached bag: one conveys leaves

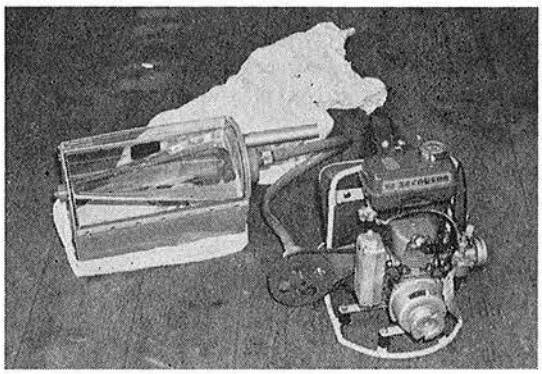


Fig. 1 Small-size power tea plucker Cylinder blade-type.

directly through the rotating mechanism of knives; one blows off shorn leaves with a small-size fan; one sucks leaves into the bag with a draft; one conveys leaves through a reeling device, etc.[2]

An initial model of the power plucker weighed 12~13 kg. It seemed too heavy for a woman worker to wear on her shoulder for a long working period. Considerable efforts were made to reduce its weight, and this has resulted in a 50 per cent reduction in weight.

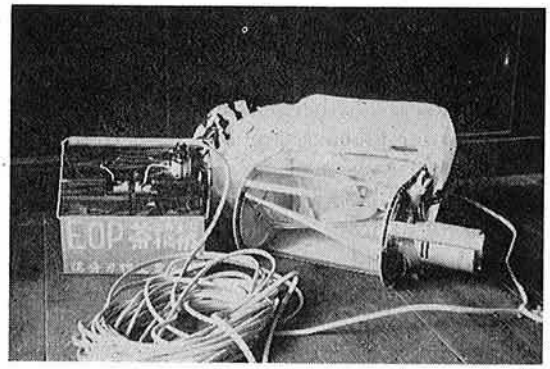


Fig. 2 Small-size electric tea plucker motor is connected to battery.

An electric tea plucker was developed recently. It is either driven by 70 W variable speed motor charged by alternating current linked to a 400 W portable generator (which is powered by 1.2 HP engine), or driven by a small motor charged by 24 V lead batteries. The electric tea plucker is lighter in weight, less noisy and less vibration in the drive than combustion type tea plucker. For these reasons, it is now gaining popularity. The generator, however, seems to deserve further tests in its practicability.

Fig. 3 Practice by power plucker.

Harvesting with Pluckers

There are two ways in harvesting with pluckers on tea leaves. One is to cut along leaves paralell to the rows of ridges of trees, while the other is perpendicullar to them. The latter is applied more often. There are also two methods of handling pluckers; moving the cutter forward, and moving it backward. A comparison test between these two methods shows that the efficiency, in terms of kilograms of leaves plucked per unit of time, was higher in the forward cutting method.[3] The machine plucker is, of course, driven by a single person, but in view of its monotonous repeated action, a 2- man team is advisable. The operator might occasionally be replaced by the second person who otherwise cares for the job of carrying collected leaves to the depot.

The operator must be careful to keep the machine in at the optimum cutting speed which is specified by each type. High speed cutting is not necessarily efficient because it may sometimes cause harsh and uneven trim.[4],[5]

Type	Cutting speed	Reciprocating or rotating speed of blade
Reciprocating Knife	40~ 70 cm/sec	700 ~ 1,000/min
Cylinder Blade	50~100 〃	300 ~ 400 〃
Rotary Blade	40~ 70 〃	1,500~3,000 〃

Efficiency of Pluckers

One person shears-plucking may harvest 100~150kg of leaves per day, while a man with a shoulder type power plucker can harvest 300~450kg. Though there are some differences among various commercial models, per hour kilograms harvested are larger with cylinder blade and reciprocating knife types than by rotary blade. As to the quality of leaves thus plucked, machine harvests result in more broken leaves than shears-plucking.

Among various types of machine the cylinder type results in more broken leaves than the reciprocating type. Cylinder blade is liable to cause broken leaves by the effects of cutting speed and rotating speed of blades. That is, a combination of high rotating speed with low cutting speed causes duplicated cuts of the same leaf and results in too many broken leaves.[1),2),3)]

Training of Tea Bushes

Even though machine plucking is three times as fast as shears-plucking, the more efficient use of small-size power pluckers calls for the shape of the bush be trained and trimmed to better cope with the machine. Power pluckers can not be easily applied on an uneven surface of bushes, which does permit easy access of hand-plucking. Thus, the shapes of bushes to be cut will affect the yields of leaves as well as the speed of cutting. Three shapes of surface as classified by its vertical section (arc-, flat- and triangular-shaped) were tested in a comparison.[1),3)] The results were as follows: arc shape allows the largest cuts of leaves per hour; flat permits the harvest of the finest quality of leaves, but it is not deemed appropriate in areas liable to damage by frost. Each one has proved to have merits as well as demerits, and any concrete conclusion has not been reached yet.

Prospects for the Future of Mechanical Plucking

Power tea pluckers, as mentioned above, may well be adopted to such small-scale tea holdings as seen in present day Japan. Models are almost completed mechanically and are ready for application on bushes grown on flat-land areas. They are likely to become generally used.

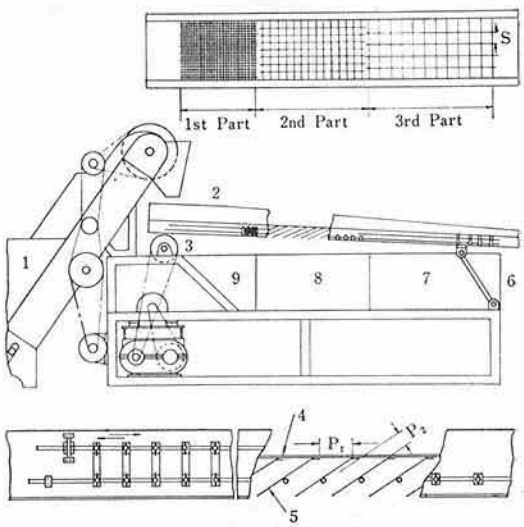
Looking further into the future when the structure improvement program now in force is implemented and the size of holding is enlarged, the need for still more efficient pluckers become important. To date, remodel ling of plucking machines is on schedule. A 2-man powered pluckers (18kg in weight and 8~14 ares per hour in capacity) and a 2-man drive cultivator (6~8IP) with attached plucking equipment (5~6 ares per hour in capacity) are now under practicability tests. These models are expected to be able to harvest 1~1.5 tons of leaves a day.

The Tea Research Station, Ministry of Agriculture and Forestry and Kagoshima Prefectural Tea Experiment Station have collaborated in the trial manufacture of a large tractor-type plucker, which is driven by 2 operators and plucks 5 tons of leaves a day. The Tea Research Station is now trying to improve the cutting part of this machine so that it can be driven automatically with a single driver.[1)]

Sorting of Plucked Leaves

Tea leaves, whether plucked by hand-shears or by power plucker, are not free from admixture of trash such as broken leaves or stalks. These practices inevitably deteriorate the quality of leaves as compared with leaves plucked by hand. Hence, the quality of the

Fig. 4 Oscillatory Sifter-type Sorter



1. Leaf Feeder
2. Frame ef Oscillatory Sifter
3. Eccentric Wheel
4. Longitudinal Bar
5. Sorting Plate
6. Large Leaves (with stalks) Take-Off
7. Full Leaves Delivery
8. Torn-off Leaves Delivery
9. Leaf Fragements Delivery

P_1P_2 Distance of Sorting Plate
S Clearance of Longitudinal Bar

product is maintained by sorting leaves and rejecting unfavorable matter. If, by such practice, materials are kept homogeneous and the quality of the product might certainly be controlled much more easily throughout the continuous manufacturing process, the completion of which is eagerly sought in the near future.

In sorting leaves, two methods deserve investigation; wind-sorting, and sifting. Trial manufacturing aimed first at a tea leaf sorter in which the ideas above were embodied as wind-sorting and a revolving sifter. Then an oscillatory sifter type sorter was invented, and the initial aim was almost attained.[6]

The oscillatory sifter-type sorter is shown in Fig. 4. The sorting apparatus is devided into 3 parts according to sieve mesh: the first part sieves fragments of leaves; the second part, torn-off leaves; and the third part, full leaves. Big leaves with stalk may not come through the eye of sieve and they are expelled.

Distance of the sorting plate is adjustable and the following table shows its relative effectiveness.

Part	Clearance of longitudinal bar	Distance of sorting plate p_1	p_2
1	20mm	20mm	7mm
2	40	35	10
3	57	60	20

Assuming the moving speed of tea leaves on the sorting plate is 30 cm/sec, about 100 kg of leaves may be sorted in 1 hour.

This model has just passed the utility tests, and so is not introduced for use yet. With the increasing use of power tea pluckers, we expect that the effectiveness of this model will be extensively accepted.

References

1) Tea Exp. Sta., MAF; Tea Res. Inst., Saitama Prefecture; Tea Exp. Sta., Shizuoka Pref.; Tea Res. Inst., Kyoto Pref.; Agr. Exp. Sta., Mie Pref.; Agr. Exp. Sta., Nara Pref.; Agr. Exp. Sta., Fukuoka Pref., Agr. Exp. Sta., Nagasaki Pref.; Tea Exp. Sta., Kumamoto Pref.; Agr. Exp. Sta., Miyazaki Pref.; Tea Exp. Sta., Kagoshima Pref.: Working paper for tea research & experiment coordinating meeting for 1964-65 Fiscal Year. (in Japanese)

2) Mochizuki, K.: Composition of blades mounted on power tea plucker and their effects on quality and efficiency of plucked raw leaves. Cha(Tea), 17, No. 4 (1964) (in Japanese)

3) Oishi, S. and others: Mechanization of tea plucking practices. Nogyo Gijutsu (Agricultural Techniques) 20, No. 12 (1965)(in Japanese)

4) Nakagawa, K.: Characteristics of tea plucker blades and their correct use. Cha (Tea) 18, No. 4 (1965) (in Japanese)

5) Kuno, K.: Technical questions in applying power tea plucker. Cha (Tea) 18, No. 10 (1965) (in Japanese)

6) Kuno, K. and Nakano, F.: Study on sorting raw leaves of tea. Rep. Tea Res. Sta. 3 (1966) (in Japanese with English summary)