EFFICIENT HARVESTING OF HASKAP BERRIES IN JAPAN

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ABSTRACT As yet, Haskap (blue honeysuckle) is the earliest fresh fruit which can be harvested from late June in Hokkaido, Japan. Compared with highbush blueberry, Haskap varieties ripen all at once, and the Haskap berries are very easy to detach by gentle shaking while blueberries need to be harvested several times. The firmness of blueberries is an advantage for harvesting and processing; instead of that, Haskap berries get broken easily and juice each other. Farmers in Japan have to harvest them manually and carefully. In order to develop a highly efficient harvesting method with low cost for fresh market quality Haskap berries, we developed some fruit picking, collecting and cleaning equipments. Plastic hoses and Jig Saws were modified into fruit picking appliances; buckets, umbrellas and plastic nets were converted into fruit collecting devices; mesh net with the help of water and electric fan were used as fruit cleaning units. We compared the results achieved when various combinations of picking, collecting and cleaning equipment were tested in an experimental orchard. The data show that the picking aids used in the trials increased average per worker production from 1.79 kg (conventional hand picking) to as much as 7.69 kg per hour. This test indicated that when effective methods of separation and collection are combined with adequate cleaning, the fruit is suitable for the fresh market. It also showed that we can remove foreign materials and immature fruit successfully, but additional grading was required to separate large immature, damaged by insects and bruised berries.

Keywords: Haskap, Blueberry, Harvesting method, Low cost.

INTRODUCTION Haskap is a unique form of blue honeysuckle (*Lonicera caerulea* L. var. *emphylocalyx* Nakai) that has exceptionally fine edible berries. It is native to Hokkaido in Japan, has only recently been domesticated, and is virtually unknown outside of this region. The plant originates from Central and Western Eurasian continent, and was used by the Ainu people, the aboriginal people of Hokkaido, for its medicinal
properties. The early and prolific production of berries is the reason for the naming of the plant. In the Ainu language, Haskap means “lot of little things on top of the branches”.

Figure 1: Haskap tree and berries

Haskap appears to be the berry of future. It is easy to grow in areas not traditionally well suited for agriculture, and has minimal requirements. It produces berries that ripen ahead of other berry varieties, assuring a ready market of customers who want raw berries in early spring. It supplies an excellent tasting berry for jelly, jam, juice, and freezing, adding to ice cream or yogurt, drying, or eating fresh. Hokkaido Prefectural Agriculture Experiment Station transplanted 60 selected wild bushes in 1967, evaluated them for several years, and selected the best few for regional trials (Tanaka, 1994). Currently, at Hokkaido University there is an active program for evaluation of Haskap selections from wild populations, the goal is to identify elite forms to use in breeding for superior cultivars that will be profitable for the industry (Hoshino, 2003). Thompson (2007, 2006a, 2006b) was the first researcher to collect, study and breed Haskap for fruit production in America. In Canada, Bob Bors (2009a, 2009b, 2006) began to breed blue honeysuckle from 1998; they tested the Siberian types, Russian Cultivars and Japanese selections.

Haskap production in Japan is traditional and has a good prospect. Berries are handpicked and sorted twice by hand, before being sent to the processors. Hand harvesting of Haskap berries is labor intensive and requires as much as 35–45 min for 1kg. Especially, the harvesting season from late June to early July is the busiest period for farmers in Hokkaido, it is hard to gather so many people for Haskap berries harvesting during that time. Unfortunately, although a much appreciated berry with high nutrition, the original acreage and production of Haskap has declined in recent years because of the high labor cost of hand-harvesting. The Haskap production in Hokkaido totaled 147 tons in 2007 (Fruit and Flower Division, Agricultural Production Bureau, MAFF, 2007). Currently, because of successful promotion and great appreciation of the very tasty Haskap processed products, there appears to be more demand than product. And the Japanese trading company expressed a need of 200 tons of Haskap berries per year as soon as possible (LeFol, 2007). If we can develop an easy and labor-saving way for Haskap berries harvesting and selection, more farmers will grow it in going the extra mile.

Most Haskap varieties have upright bushes and similar in size and shape to commercial highbush blueberry cultivars among the well known berry varieties. Compare with highbush blueberry, Haskap varieties ripen all at once while blueberries have to be
selectively harvested three to five times over three- to four- week period. The blueberry is firmer than Haskap berry, which is an advantage for harvesting and processing, and the rounded shape of blueberries is better for cleaning and sorting lines. Haskap fruit requires less pull force to detach but its fruit is more delicate and get broken easily, then juice each other. Farmers in Japan have to harvest it manually and carefully. At the same time, most orchards are small scale with 10a and slope in Japan, unsuited for large mechanized harvester. Even for blueberry, there are many harvesters in the world, but not yet in Japan.

Japanese people also have a great interest for blueberries “Made in Japan” because of their incredible flavours and how good they look. The imported blueberries are not beautiful and fresh enough to attract them. People found this business and the blueberry planted areas in Japan were rising from 1998 at a rate a 90 hectare each year, reaching 853 hectares in 2007 (Fruit and Flower Division, Agricultural Production Bureau, MAFF, 2007). All the fruits were harvested by conventional hand picking and mainly for fresh market. So Japanese also have same demand of low cost harvesting on blueberry. And Japanese researchers already began to study it. Yamagishi et al. (2002a, 2002b) made a mechanical vibrator to find the degree of force required to dislodge the fruit from the pedicel and one required to dislodge the pedicel from the peduncle, and also found that ripe blueberry dislodged most efficiently at a 30mm stroke and 7.5HZ frequency. Akase et al. (1999, 2000) tested the pull resistance force between a spur and a fruit. But all of them didn’t work on the whole harvesting system, like fruit collections and cleaning method. What we doing on Haskap berries is absolutely suit for blueberries, because blueberries are more easily to be handled with than Haskap berries.

The main objective of this research was to develop an efficient harvesting method with low cost for fresh market quality Hsakap berries. Although we can produce sophisticated machines which can perform almost any function, we must limit our development to harvesting machines and systems which enable the growers to not only get the job done but also make a profit on his operation. Considering the small scale of farm in Japan, and the little investment farmers will put on Haskap, it’s impractical for us to develop a totally new system for the harvesting of Haskap berries. The only way we can do is that modifies things that common in farm sheds or easy to buy in market, make it suitable for berry harvesting.

**MATERIALS AND METHODS**

This research was performing at the Yoichi Orchard (43°10'N, 140°46'E) of Hokkaido University in Hokkaido, Japan from 2008. The orchard covers 57,939 square meters, planted by apple, pear, grapes, cherry, blueberry and Haskap. There are 90 Haskap trees which were transplanted from wild varieties in 1995, cover an area of 33a.

Before our harvesting experiment, Hoshino et al. (2003) had done a research to measure the physical properties of Haskap berries in Yoichi Orchard. They randomly chosen 42 Haskap trees, and 12 berries were selected from each tree at the same way. The results are list below, all the values were the mean of 12 berries from each tree with standard deviation: the maximum length is 19.43±1.25mm, the minimum length is 11.16±0.96mm; the maximum width is 11.06±1.16mm, the minimum width is 7.05±0.74mm; the maximum mass is 1.01±0.09g, and the minimum mass is 0.37±0.05g. For the sampling
berries, average length is 14.60±1.90mm; average width is 9.30±0.96mm and 0.67±0.16g for average mass.

The harvesting trials were started by making time and motion studies of conventional hand picking methods. The purpose of this part of the work was to determine what phases of the harvest operation could be successfully mechanized. The conventional hand picking was doing everything by hand. First, picking Haskap berries one by one by both hands carefully, and then putting them into a bucket which was placed on soil, finally removing possible foreign materials by hand picking also.

So, the harvesting work of berries should include three parts. Fruit picking equipment was used to separate berries from bush. At the same time, collecting device must be provided to gather separated berries. After that, fruit cleaning unit was applied to remove foreign materials such as leaves, twigs, and small, unripe berries from the harvested fruit.

In 2008, we separated Haskap berries from bush by pick and drop method, modified umbrella to collect separated fruits, used mesh net and water as the cleaning units.

**Fruit separation method**

- **Pick and drop method:** Taking berries to the bucket would cost much time when keep repeating doing this. In order to improve efficiency, we placed an opened umbrella under tree, rolling the Haskap berries off with fingers and let them drop into the umbrella.

**Fruit collecting method**

- **Umbrella:** Vinyl umbrella was used with pick and drop method. With an opened umbrella placed under tree, there is no damage to the berries when they drop onto the cover. But if there was contact with ribs and stretchers, Haskap berries were easily broken, and sometimes fruits will roll into gaps between ribs and cover. So we covered the stretchers and eliminate the gap with packing tape (as shown in Figure 2).

![Figure 2: Umbrella used as collection to gather Haskap berries](image)

**Fruit cleaning method**

- **Mesh net:** The sizes and shapes of leaves, branches, unripeness and other twigs are different from Haskap berries. The bigger length of Haskap berries are near 15~18mm and the smaller width of Haskap berries are near 7~8mm, which was
used as a reference for choosing the sizes of mesh net. A hexagonal hole net with a diameter of 20mm was used to remove foreign materials that are bigger than fruits, and a square hole net with a side of 7mm was used to sieve foreign materials that are smaller than Haskap berries (as shown in Figure 3). After that, foreign materials left were removed manually.

Figure 3: Removal of foreign materials with mesh net

- **Water:** We found that the foreign materials are easy to stick by surface tension in comparison with the spherical berry when they get wet. In this method, most foreign materials especially leaves can be removed by repeating several times, just left small unripeness and leaves which stuck on berries. Then put all of them into water with a 7mm size mesh net placed in the water to eliminate smaller ones, and removed the remaining foreign materials manually. With the help of water, the stuck leaves could be separated from wet berries easily and there was little damage to berries.

Considering the poor efficiency of pick and drop method, and that berries can not be avoided dropping onto stretchers of umbrella which would cause damage, and berries with water could not be accepted in fresh market. In 2009, we modified plastic hose and Jig Saws into fruit picking equipments, converted plastic net into the collection, and electric fan was used as the fruit cleaning unit.

**Fruit separation method**

- **Hand-held plastic hose:** It was found that mature Haskap berries can be separated from the bush by striking the stems with a short length of plastic hose held in hand. The results obtained depended upon the nature of the bearing wood, the amount of fruit and the working skills of pickers. The use of a short length hose adds little to picking costs.

- **Jig saws:** A picking aid made from a Jig Saws (Hitachi, CJ65V) was constructed and tried. The blade was changed to a special metal hook, which moved through amplitude of 18mm at the rate of 400–3200 cycles per minute. We made many different directions and sizes of metal hooks, in order to test the difference
between “pushing” and “pulling” way which they held against the fruit-bearing stems. And some Haskap plants have wide-spread stems which need longer hooks. When the hook was held against fruit-bearing stems the mature berries separated quickly and completely. This unit powered by a small electric generator (Honda, EU9i), and we are going to test cordless Jig Saws this year.

Figure 4: Jig Saws and metal hooks for Haskap berries separation

Fruit collecting method

- **Plastic net box:** The smallest width of Haskap berries in the samples which was taken from Yoichi Orchard is 7.08mm. We have chosen the size 7mm net hole to make a box for holding berries. Different sizes of rectangular plastic net boxes, which could be placed under the bush, were constructed and tried. This aid was used by pickers who separated the berries off with plastic hose and Jig Saws and let them drop into the collecting unit. In order to pour the berries easily and reduce damages, the plastic net box was designed one side higher than the other side, as shown in figure 5.

Figure 5: Special designed plastic net box, the right side was higher than left side
Fruit cleaning method

- **Electric fan:** An electric fan was tested. It separated foreign materials on the basis of specific gravity (relative density) and surface texture. When the harvested fruit was poured out from the top of electric fan, leaves and stems could be blew away by air force during fall, and berries dropped into collection. We used the plastic net box to collect the berries, where the small immature berries can go through the net hole.

**Evaluation of methods and equipments** Table 1 compares the results achieved when various combinations of picking, collecting and cleaning equipments were used in an experimental orchard. The data show that the picking aids used in the trials increased average per-worker production from 1.37 kg (when the work was done by conventional hand picking) to as much as 7.69 kg per hour.

Table 1. A comparison of results achieved when various combinations of equipment were tested

<table>
<thead>
<tr>
<th>Separation</th>
<th>Collection</th>
<th>Cleaning</th>
<th>Separating rate(^{(a)}) (kg/h)</th>
<th>Cleaning rate(^{(a)}) (kg/h)</th>
<th>Total harvesting rate(^{(a)}) (kg/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>By hand</td>
<td>Bucket</td>
<td>-</td>
<td>1.37</td>
<td>-</td>
<td>1.37</td>
</tr>
<tr>
<td>Pick and drop</td>
<td>Umbrella</td>
<td>Mesh net</td>
<td>3.43</td>
<td>4.76</td>
<td>2.00</td>
</tr>
<tr>
<td>Pick and drop</td>
<td>Umbrella</td>
<td>Surface tension + Water + Mesh net</td>
<td>3.43</td>
<td>13.95</td>
<td>2.75</td>
</tr>
<tr>
<td>Pick and drop</td>
<td>Plastic net box</td>
<td>Electric fan</td>
<td>3.92</td>
<td>12.24</td>
<td>2.97</td>
</tr>
<tr>
<td>Plastic hose</td>
<td>Plastic net box</td>
<td>Electric fan</td>
<td>6.32</td>
<td>10.71</td>
<td>3.97</td>
</tr>
<tr>
<td>Jig Saws</td>
<td>Plastic net box</td>
<td>Electric fan(^{(b)})</td>
<td>27.27</td>
<td>10.71(^{(b)})</td>
<td>7.69(^{(b)})</td>
</tr>
</tbody>
</table>

\(^{(a)}\) The fruit was weighed after it had been cleaned. \(^{(b)}\) Because the cleaning rate of berries harvested by Jig Saws method has yet to be tested (which was planned for this harvesting season). In order to give a comparison among different harvesting method, the cleaning rate of Jig Saws method was supposed same as plastic hose method.

Among them, conventional hand picking with bucket could get the best quality fruit absolutely. And the second was Jig Saws method, there was no direct force to berry when separated from the stem, while pick and drop method put effort in berry with fingers and plastic hose method hit berries inevitable. The only force to berries of Jig Saws method was the interaction between berries and collection when drop into it, while other methods also suffered. In addition, Haskap berries were easier separated from bush than leaves during vibration, few foreign materials in collection for Jig Saws method; while plastic hose hit on the stems and leaves, it took off much leaves to collection which was not good for cleaning.

The Jig Saws method was the fastest which could harvest 27.27 kg Haskap berries per hour before cleaning, but also the most expensive way compared to other methods. Even the most expensive way, just would cost $200 to buy a new one. However, consider that nearly all the farmers, especially the fruit-growers, used Jig Saws for farming in Japan.
The only extra investment was to make metal hook instead of the blade. The disadvantages included: the Jig Saws was relatively heavy and therefore difficult to hold in the bushes for any considerable length of time; the motion of this unit was “positive” in one direction only, and it tended to damage the fruit-bearing stems. And we also should find the most efficient stroke and frequency for Haskap berries separation.

Between collections, umbrella was very cheap and very easy to get, just needed a little bit modify for collecting berries. However, when umbrella worked with plastic hose and Jig Saws, it was not easy to control them simultaneously on one’s own. And berries can not be avoided dropping onto stretchers which would cause fruit damage. For plastic net box, the fruit damage was quite low compared to umbrella, and it could sieve small immature berries during cleaning. But there was no finished market product could be directly used, we had to buy plastic net and make the boxes by ourselves which was a little bit difficult.

During cleaning, the mesh net method caused much damage to berries when we had to sift the mesh net to let berries through it. While with the help of water and surface tension, the berries were clean and had little damage. However, water cleaning was limited to berries destined to be processed since fresh marketed berries need to be dry, and it was also not good for subsequent sorting. For electric fan method, it proved to be an effective means of doing the work, but addition grading was required to remove large, immature berries. And it was impossible to avoid fruit damage caused by impacts of berries on collection when dropping into it. What we can do is that to reduce the distance of fall and increase the cushioning action of collection, thereby reduce bruising.

**CONCLUSION** This trial indicated that when effective methods of separation and collection, combined with adequate cleaning, the Haskap berries is suitable for fresh market. It means that the new harvesting method makes it possible to harvest a given amount of fruit with less than 1/5 the number of workers required when picked by hand, while without much added cost. In that condition, there is excellent potential to plant more Haskap and blueberry in Japan.

It also showed that we can remove foreign materials and immature fruits successfully, but additional grading was required to separate large-immature, damaged by insects and bruised berries. So we are planning design a grading system with RGB camera which connects to a computer, and then develop software by using image processing technology to separate berries.

Whether the non-conventional-hand-picking berries can be sold successfully on the fresh fruit market has yet to be determined. In any event, keeping-quality and consumer-acceptance studies will have to be made before any new harvesting method can be recommended, when the berries in question are destined for the fresh fruit market. We should learn more about how those new harvesting method affects the marketability of the product.

**REFERENCES**


