DEVELOPMENT OF GRAFTING TECHNOLOGY TO SUPPORT FRUIT AND VEGETABLE BUSINESS IN INDONESIA

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ABSTRACT

Grafting is one of the various seed propagation technologies that has several advantages. On fruit trees, grafting has been commonly used to produce good quality seedlings. The fruit crop seedlings produced by utilizing grafting technology and has become big businesses in Indonesia are mangoes, citrus, avocados, and durian. These fruit seedlings have been distributed in practically all areas in Indonesia. In addition, grafting technology is also made to undertake replanting or replacing old varieties on the field using top working methods. Utilization of grafting technologies in vegetable crops is a new method in Indonesia. AVRDC - The World Vegetable Center has helped introduce this technology, especially on tomato plants. The guidance coming from AVRDC started, in 2010 and ended in 2014 in the area of Bedugul Bali and Kediri East Java. But the agribusiness of grafted-vegetable seedlings in Indonesia has not yet reached widespread levels.

Keywords: Grafting, Seedlings, Development, Fruit, Vegetable, Indonesia

INTRODUCTION

Within the last five years (2009-2013) in Indonesia, the horticulture subsectors have grown into one of the new emerging economic powers in rural and urban areas. Currently, the horticulture subsectors have played significant roles in the national economic development as shown by some indicators, i.e: the contribution of horticulture subsector at the macro national economic level such as GDP, labor, balance of trade, national tariff policy, etc., In the micro economic level, however, the indicators include production, planting and harvest areas, seed availability, etc. The GDB of fruit agriculture sector increased by 5.63% from Rp. 132.01 trillion in 2009 to Rp. 153.69 trillion in 2014, while the GDB of vegetable sector increased by 9.86% from Rp. 56.82 trillion in 2009 to Rp. 73.78 trillion in 2014. The government has given more attention to the development of agricultural commodities as alternative efforts to increase economic growth (IAARD, 2015).

The development of horticultural commodities-vegetables and fruits, are headed towards the increase of product quantity and quality, so they can respond to the market demands both in the domestic and international arena. The increase of product quantity is done by the increase of productivity and the expansion of planting areas, while the increase of quality is to produce high and uniform quality of fruit and vegetable products. One of the support extended to realize those programmes is to maximize the availability of qualified seeds that are able to express superior traits and represent the cultivar.

The appropriate seed propagation technology is expected to produce qualified fruit and vegetable seeds. One of horticultural seed propagation technologies that has been applied in Indonesia is grafting, especially for fruit tree propagation. However, the application of grafting technology has not been widely applied in vegetables. Until now the multiplication of vegetables still rely on the use of seeds.

In principle, grafting is a technique of combining the two organs or tissues that are still alive, so they can be merged into an intact plant. Two parts of the plant that are combined are called called the rootstocks and the scions. Grafting has several purposes, such as to improve the quality and quantity of crops, for rejuvenation, disease control, and to accelerate the plants’ reproductive maturity.

The conditions of fruit and vegetable seeds production that apply grafting propagation technology to support the development of Indonesian horticulture will be reviewed in this paper.

Government programs to support the development of fruits and vegetables

Horticultural crops are very diverse agricultural commodities. The Ministry of Agriculture has set 40 national commodities, 11 of them are horticulture crops: chili, onion, potato, citrus, mango, mangosteen, bark, banana, durian, rhizomes and ornamental plants.
In 2014, the Directorate General of Horticulture has conducted some refocused strategic activities for the Improvement Program on Production, Productivity and Quality of Horticultural Products. The refocusing activities are to undertake the development of major commodities on the production center areas and introduce the new horticulture cultivars which agro-ecologically will support new development areas. It also gives the considerable attention to the chili and shallot because both these commodities have significantly contributed to the national inflation. These two developmental efforts are also directed to maintain the price stability through the increase of production and improvement in the quality of products (Indonesian General Directorate of Horticulture, 2014).

In 2016, the Directorate General of Horticulture has prepared a development programme for fruits and vegetables that require a fair amount of seed availability, such as:
- Prioritizing the expansion of dry land for horticultural area of 15.450 ha that are located outside of Java
- The development of 70 villages that are into organic horticulture
- The development of planting areas for shallot (10.645 ha) and chilli (10.855 ha)
- The development of planting areas for citrus (6000 ha)
- The development of planting areas for fruit crops (10.000 ha)

Tabel 1. The production target for fruit and vegetable crops in 2016

<table>
<thead>
<tr>
<th>Number</th>
<th>Items</th>
<th>Production target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Production of Chili (tons)</td>
<td>1.910.503</td>
</tr>
<tr>
<td>2.</td>
<td>Production of Shallot (tons)</td>
<td>1.231.765</td>
</tr>
<tr>
<td>3.</td>
<td>Production of Citrus (tons)</td>
<td>1.765.702</td>
</tr>
<tr>
<td>4.</td>
<td>Production of Horticulture Crops</td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Fruits (tons)</td>
<td>18.735.649</td>
</tr>
<tr>
<td>b.</td>
<td>Vegetables (tons)</td>
<td>11.328.388</td>
</tr>
</tbody>
</table>

Tabel 2. The seed production target for fruit and vegetable crops in 2016

<table>
<thead>
<tr>
<th>Number</th>
<th>Items</th>
<th>Volume target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Production of Shallot seeds (kg)</td>
<td>3.000.000</td>
</tr>
<tr>
<td>2.</td>
<td>Production of Citrus seedlings (plants)</td>
<td>500.000</td>
</tr>
<tr>
<td>3.</td>
<td>Production of other fruits seedlings (Plants)</td>
<td>600.000</td>
</tr>
</tbody>
</table>

(Indonesian General Directorate of Horticulture, 2016)

The contribution of grafting technology in fruit and vegetable agribusiness

In Indonesia, the multiplication of planting materials, especially fruit trees, has long been done by grafting. The objectives of the grafting technology application in seed production are to control the disease, get uniform seed quality, and accelerate the plants’ reproductive maturity.

Grafted seedlings are very useful to support the development of the fruit business in Indonesia because grafted plants will produce uniform growth and fruit production according to market demand. The seedling business of fruit crops in Indonesia has a good prospect because the need of seedlings is high enough. It is proven from the figures of the seedling demand in year 2011-2014: in a row as many as 1.167 million, 1.203 million, 1.239 million and 1.276 million plants.

Fruit crop seedlings that are produced through grafting with quite a lot of demand are mango, durian, avocado, and citrus. In citrus, grafting technology is primarily intended to produce the seedlings that are free from HLB, citrus vein phloem degeneration (CVPD) and tristeza virus diseases. As for other fruit trees, grafting aims to get the plants with properties according to the parents.

In vegetable crops, plant propagation is mainly done using seeds. Grafting is a new technology for vegetable crops and introduced to tomato which is grafted onto eggplant. Grafting technology in vegetable crops is needed, especially for controlling the soilborne diseases. The opportunities for the adoption of grafting
technology in vegetable crops is quite high due to the high demand for vegetable products with minimum pesticide residues.

![Grafting process on fruit crops. A) Avocado, B) Durian, C) Mangosteen, D) Soursop, E) Mango, F) Mango (budding).](image)

The development of grafting technologies in vegetable crops in Bedugul Bali

The introduction of grafting technologies in vegetable crops in Indonesia is conducted by AVRDC through project activities which involved USAID, Udayana University, Indonesian Vegetables Research Institute (IVEGRI), The International Air Transport Association (IAIAT), conducted in Bedugul Bali and East Java Kediri. The project was conducted from 2010-2014. This paper presents the information of the activities only in Bedugul Bali, because the information in Kediri has not been obtained. Previously known that the vegetables from Bedugul Bali has low competitiveness compared to those imported from other regions because of farmers’ lack of knowledge about marketing and consumers’ need. Consumer cares about product quality, food safety,
and environmental safety. For these reasons, the programme was implemented to improve the competitiveness of vegetables from the respective region.

Program objectives:

- Improvement of the human resource capacity in responding the dynamic development of market values;
- Development of practical innovative technologies in the creation of market value in an efficient and effective way, and
- The development of the agribusiness system with efficient and effective value chain in response to the dynamic market

In this project, the grafting technology is introduced to tomato plants. The major concern is the presence of *Fusarium* wilt infection during the rainy season. For that reason, AVRDC introduced grafting technology using *Fusarium* wilt resistant eggplant rootstock (Utama *et al.*, 2013).

A review conducted in 2014, shown that one of the educated farmers named Ketut Santika developed grafting technology for tomatoes, and contracted with FRESHGROW company, which engaged in the vegetable business including supplying grafted tomato seedlings. FRESHGROW established in 2013, and partnerships with 18 farmers, and also the media to develop grafted tomatoes (Elizabeth, 2014).

![Fig. 2. Grafting process on tomato and plants condition in field. Photos courtesy of IVEGRI](image)

**Top working on mature fruit trees**

Top working technique was developed to make uniform or replace the existing cultivars of fruit trees in the field with new cultivars according to consumer preferences. The basic principle of this technique is the same as the propagation through grafting in general, *i.e.* combine the rootstocks to the scions. The difference is the top working using rootstock in the form of a large tree. Many old fruit trees originated from the seeds in Indonesia encounter issues of producing unequal quantity and quality fruits. For that reason, top working technology is applied for the purpose of rejuvenating the orchard, and achieving uniformity in the cultivars, as well as shortening the young plants without dismantling/removing the existing plant. Top working method in citrus, can be carried out by bark grafting, cleft grafting, bud grafting, and shoot grafting (Sugiyatno *et al.*, 1994). The Implementation of top working to replace existing cultivars in the field with the desired new cultivars have been conducted on mango, avocado, durian, grapes, apple, mangosteen, guava, oranges and soursop.
East Java Province became the first pioneer of the application of top working technique in Indonesia. More than 20 districts / cities in East Java have applied this technique on fruit trees. From East Java province, this technique developed into other areas like in Bogor, local cultivars of durian have been replaced by Monthong. In Pontianak, the district of Sambas, Siam mandarin citrus was replaced to Terigas tangerines and produced fruits after 2 years. Other areas were not being documented yet. In general, top-worked plants will produce fruits after 2-5 years. Top working technique is able to change the “face” of the national fruit if carried out simultaneously, planned and in large scales (Sugiyatno, 2010).

Fig. 3. Top working on avocado. Photos courtesy of ICSFRI.

Fig. 4. Top working on grapes. Photos courtesy of ICSFRI.

Fig. 5. Top working on durian
**Agribusiness opportunities of grafted seedlings of fruit crops**

As mentioned earlier, the needs of fruit plant seedlings in Indonesia are high enough, so that the availability of quality seeds is a major requirement for the realization of fruit development in Indonesia. Almost all the needs of fruit seedlings were fulfilled by grafted seedlings. From 2015-2019, the Ministry of Agriculture has been focusing on citrus cultivation in a large scale to increase the availability of citrus fruits. It is also planning to reduce the imports of citrus. The citrus seedlings business has a promising future in the next five years. In 2016, the land development plan to grow 6,000 ha citrus, hints that the need of of grafted citrus seedlings of approximately 2,400,000 (Indonesian General Directorate of Horticulture, 2016).

For other fruit crops, the government program in 2016 which aims to undertake the development of 10,000 hectares has not shown the real developmental data of fruit planting area made by growers. This is due to the unavailability of a valid data on the planning of development program of fruit crops on years 2015 to 2016. It is believed that the increase of planting area of horticulture commodities especially fruit crops outside of Java will be the backbone of the increase in farmers' income. All of these require the availability of qualified fruit seedlings. Some areas have been initiating the development of fruit crops such as durian in Papua, mango in South Sulawesi and Central Sulawesi, citrus in West Kalimantan, North Kalimantan and West Sumatra. The data from IAARD showed that between 2000-2010, the growth rate of fruit planting area was 1.97%. Based on these data, it was estimated that the needs of seedlings of fruit per year during 2015-2017 is 1.6 million plants. This number does not include the needs for a special programmes from the government, e.g. citrus development programme (IAARD, 2011).

**Constraints in seeds production of fruits and vegetables through grafting technology**

For fruit crops, seeds production through grafting will never be a problem because it has been widely used in nurseries throughout the country. The average successful rate of this technique is 80-95%. This new grafting technology on tomato was introduced to the public through the activities carried out by AVRDC. The adoption process was running slow due to local farmers still propagate tomato through seeds (generative propagation).

Producing tomatoes through seeds is more common than grafted seedlings in Indonesia. Still now, these non-grafted tomato plants encounter disease problems in the raining season.

**CONCLUSION**

Grafting is a propagation technology that has been applied in Indonesia, especially for fruit crops. Fruit planting materials that are propagated through grafting that are considered in demand in large quantity are mangoes, durian, avocados and citrus. From 2016-2019, the Ministry of Agriculture is focusing on the development of citrus as a national programme. The need of citrus planting materials is increasing.

In vegetable crops, grafting is a new technology for the public. Therefore, development of vegetables using grafted planting materials is still slow, so it needs the efforts to introduce more intensively to the central area of vegetable production in Indonesia. The introduction of grafting technology should not only be on tomato, but also on other vegetable crops, e.g. chili.

Grafting technology is also applied for the rejuvenation of old plants without trimming down the plant through the top working technique. Currently top working has been applied on some fruit crops for the purpose of rejuvenating the orchards and achieving uniformity of cultivars in the existing orchard.

There is a bright prospect for the future of Indonesia’s fruits and vegetables seedlings’ The Indonesian government will develop horticulture areas to support and improve household incomes. In 2015 and 2016, the Indonesian government is focusing on the development of horticulture commodities such as chili, shallot, and citrus.

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