Area-based citrus commodity development to grow the regional economy of Nunukan District, North Kalimantan Province

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Abstract. The Development of Horticultural Agribusiness Areas (PKAH) is one of the implementations of the Ministry of Agriculture's policy, where the development of superior commodities is directed at developing areas which are integrated vertically and/or horizontally with the consolidation of productive businesses based on community economic institutions that are highly competitive in local and international markets. This development study was carried out in one major citrus agribusiness area in Indonesia, namely Nunukan District, North Kalimantan Province since January 2017 to December 2018. The aim of the study was to develop citrus agribusiness in Nunukan, North Kalimantan. The method used participatory development conducted by the Ministry of Agriculture, local government and farmer groups to formulate policy recommendations based on the results of applied research on farmers' land in the border areas of Indonesia and Malaysia. The approach included the establishment of demonstration plots for technology implementation of Integrated Management of Healthy Citrus Orchard (IMHCO), field assistance, and program evaluation. This involved four farmer groups and 17 farmers. Primary data were collected by survey and analyzed descriptively. The results showed that (1) the establishment and maintenance of the demonstration plots which were managed properly and consistently had been carried out on new crops and productive crops of 10 hectares each; (2) farmers assisted intensively had applied 95% of the IMHCO technology, while farmer groups nearby the location of IMHCO treatment had applied 80-90% of the IMHCO technology, and less active farmers only applied 55% of the IMHCO technology; (3) farmers had comprehended all the technology components in IMHCO, indicated by the understanding and application scores ranged from 2.38–3.00.

1. Introduction

Citrus is one of favourite fruits and has a great demand by consumers in Indonesia. Almost all provinces in Indonesia have citrus development areas. However, the condition of citrus agribusiness performance in Indonesia is lacking. In general, citrus cultivation carried out by most farmers has not been fully supported by the application of adequate technology. In both upstream and downstream sectors, the implementation of technology has not adopted the innovations that have been produced by the Research Institute. The institutional sector of farmers is also weak, resulting in a slow rate of technology adoption. As a result, the productivity and product quality are difficult to reach optimal, and product continuity cannot be guaranteed.
This condition has an impact on the low bargaining position of farmers in the markets and the weak competitiveness of the national citrus fruit.

On the other hand, the import of citrus fruit to Indonesia in the last five years has increased sharply, which is 9 times greater than the exported citrus fruit. The number of imported citrus fruits reached 180,000 tons with a value of 1.6 trillion rupiah in 2011 [1]. The trend of increasing import indicates that domestic citrus fruits are powerless to face the penetration of the imported ones. Moreover, the imported citrus is mostly from the mandarin group, which basically is not widely cultivated in Indonesia. Nearly about 85% of citrus in Indonesia are tangerines, which are less attractive in colour than the appearance of imported mandarins, even though tangerines are also widely preferred by Indonesians.

The potential for export-oriented citrus agribusiness development in Indonesia is quite large. In addition to the diversity of citrus varieties with high quality, the potential for available development areas is still large, the market potential is very open and tends to increase every year, the availability of labour is high, as well as the availability of innovative citrus cultivation technology that developed rapidly over the last ten years. This great potential has not been optimally utilized. By the assumption that all agribusiness components can be implemented effectively, the optimistic of the development of citrus agribusiness areas can be realized to suppress the imports.

In addition, CVPD (Citrus Vein Phloem Degeneration) is still a serious threat to the success of citrus agribusiness in Indonesia. CVPD is caused by the gram-negative alpha-proteobacteria *Candidatus Liberibacter asiaticus* (CLas), which can be transmitted by the vector insect *Diaphorna citri* and by seedlings using bud stick and rootstock seed infected with CVPD pathogens. In the process of development, the CVPD epidemic goes beyond three phases, namely biotropie, symptomatic and epidemic [2]. The local government has attempted to control and prevent this deadly disease, but it does not appear to be well managed. The main problem faced is the use of uncertified citrus seedlings, which is not blue labelled. A previous related study showed that approximately 70-80% of citrus seedling distributed to and bought by farmers in Sambas District was uncertified [3] and several mother plants used for bud-stick was positively infected by CVPD. The fragility of farmer institutions has been proven to cause the slow adoption of research recommended technology [4]. Meanwhile, the lack of supervision by the Seed Monitoring and Certification Institution in the production process of standardized citrus seeds has resulted in the widespread of uncertified seeds for which their health is unknown. Guidance for citrus farmers is often mis-targeted due to the limited knowledge of the field officers.

The Development of Horticultural Agribusiness Areas (PKAH) is one of the implementations of the Ministry of Agriculture's policy. The development of superior commodities is directed at developing areas that are integrated vertically and / or horizontally with the consolidation of productive businesses based on community economic institutions that are highly competitive in local and international markets to significantly increase farmers' income and welfare. One of the supports needed in PKAH is the application of technological innovations in the form of technologies, institutions and policies as the main factors in increasing competitiveness and added value. Given its strategic role, it is necessary to support the application of technological innovation systemically. Taking into account the urgency of the development of the national citrus problem over the past decade, the Ministry of Agriculture has formulated a strategic program for the development of border areas. In this regards, Indonesian Agency of Agricultural Research and Development (IAARD) plays a role in supporting the success of the program in border areas.

According to Pakpahan [5], natural resources, human resources, technologies, and institutions are the driving factors (four prime movers) in agricultural development. These four factors are sufficient conditions to achieve the desired development performance. This means that if one or more of these factors are not in accordance with the required requirements, then the goal of achieving a certain desired performance will not be achieved. Furthermore, [6] mentioned that future agricultural development is directed to develop agribusiness system and businesses that are competitive, democratic, sustainable and decentralized. The
reorientation of agricultural development requires a paradigm shift from agribusiness development driven by resource factors (factor driven) to capital driven and to innovation driven. In addition, the development of strengthening human resources as the perpetrators must be improved in an independent institutional forum that is environmentally sustainable and agribusiness oriented. Therefore, the aim of this study was to develop citrus agribusiness in Nunukan, North Kalimantan as the border area between Indonesia and Malaysia. Specifically, the purpose of the study was (1) to establish a demonstration plot for technology implementation of Integrated Management of Healthy Citrus Orchard (IMHCO), (2) to conduct field assistance regarding the technology application, and (3) to conduct the evaluation of the program.

2. Materials and methods

2.1 Materials

Materials used for establishing the demonstration plot and conducting field assistance were citrus productive plants (at age of 5 years), production inputs such as fertilizers, pesticides, and agricultural equipment such as pruning shears to do fruit thinning and harvesting. Other specific materials for controlling fruit freckle were based on the guidance book by [7]. Meanwhile, materials used for program evaluation was a questionnaire consisting of structured questions.

2.2 Methods

This study was carried out in January 2017 to December 2018 in order to increase agribusiness competitiveness of Mandarin Borneo Prima in Nunukan District, North Kalimantan. The approach used was by increasing innovative technology in the management of citrus orchards in order to produce fruit with high quality that meets market demand.

The first activity included the establishment of demonstration plots for technology implementation of Integrated Management of Healthy Citrus Orchard (IMHCO). IMHCO as a technology package consists of five components which are related to one another as a guideline that must be implemented completely and simultaneously in a citrus agribusiness development area. The components of IMHCO includes: (1) using disease-free certified citrus seedlings, (2) controlling CVPD vector *Diaphorina citri* Kuw., (3) performing consistent orchard sanitation, (4) maintaining plants optimally, and (5) consolidating the management of farmers' orchards in implementing the technology. The maintenance of the demonstration plot of productive plants were carried out at the farmer group of Hidup Bersama 2, located in Mansapa Village, South Nunukan Subdistrict (Figure 1). The implementation of IAARD’s program can be seen in this district during the last 6 years, which covered 442 ha of citrus planting area of Mandarin Borneo Prima and Mandarin Tejakula.

The second activity was field assistance in the technology application of fruit quality improvement. The acceleration of recommended technology adoption was carried out using the technology innovation support model in the development of citrus agribusiness, as proposed by [3] and [8]. The technology assistance carried out on farms belonging to cooperator farmers around the area of farmer group’s demonstration plot aimed to determine the level of technology diffusion that can be accepted by farmer groups who did not directly receive guidance through demonstration plot. The assistance activities were adjusted to the condition of the plants’ age in the farms and technology required by farmers. Plant management was carried out on newly planted plants until productive plants.

The third activity was program evaluation to assess the level of technology adoption at the early stage and after the guidance and assistance program. This was done by a survey involving four farmer groups, and each group was taken four to five respondents. Sampling method for the survey was done purposively. A three-point Likert scale where 1=“do not understand/do not apply” and 3=“understand/apply” was used to measure the ratings of respondents’ understanding and application towards the technology at the early
Figure 1. (A) The maintenance of demonstration plot of 10 hectare in Mansapa Village, Nunukan District. (B) Institutional development by holding regular meetings at farmer group Hidup Bersama 2

stage of the program. While the evaluation of technology adoption after the end of the program was measured by giving a weight on each technology component and was distinguished based on different category of the four farmer groups, namely P = farmer group with full technology application treatment, AI = farmer group I outside the one with full IMHCO treatment, AII = farmer group II outside the one with full IMHCO treatment, and NP = farmer group not implementing IMHCO. The primary data collected were then analyzed descriptively.

3. Results and discussion

3.1. The establishment of demonstration plots for technology implementation of Integrated Management of Healthy Citrus Orchard (IMHCO)

The development of citrus commodity in Indonesia is directed at expanding agriculture in Indonesia’s border areas with neighbouring countries to encourage export opportunities [9]. Therefore, citrus development in Nunukan District was to support that direction. The establishment of demonstration plot located in farmer’s fields has become a pilot learning place for farmer groups and farmers around the demonstration plot. It was used for learning media to farmer groups to be able to apply the IMHCO technology correctly and consistently. The success of citrus farmers in managing their crops cannot be separated from the high willingness of farmers to learn to manage commodities that have never been planted, and the discipline in applying the recommended technology of IMHCO. Previous study [10] showed that the method of demonstration plot is effective to improve farmers’ confidence to apply technology, with the assumption that external factors (non-behaviour aspects are controllable) a demonstration plot is essential since it is considered as the most preferred and accessible source of technology information to farmers [11].

3.2. Field assistance for the technology application

The assistance in the form of dissemination program has been carried out for several years in Nunukan District. The continuous development and assistance program done by the Office of Agriculture, Food Crops and Animal Husbandry referred to the program set by the IAARD Ministry of Agriculture. The results of the assistance program showed that farmer groups in Nunukan District were able to properly implement IMHCO technology and produced Mandarin Borneo Prima and Tejakula with orange colour ready to be marketed to local markets of North Kalimantan and East Kalimantan, as well as throughout Indonesia.
The impact of this assistance program was the increase of productivity and income of citrus agribusiness actors in Nunukan District. Subsequently, this would increase the motivation of agribusiness actors in citrus development areas to support bioindustry program of national citrus. Furthermore, the increased competitiveness for Mandarin Borneo Prima was necessary to improve the premium quality of fruit, including uniform size, fresh sweet taste, evenly yellow colour, free from dull disease and safe for consumption. The uniformity of fruit size was be done by thinning the fruit, while the fresh sweetness was the result of balanced fertilizer application, and the yellow colour was treated by hormone after the fruit harvested.

The guidance and assistance program of PKAH in Nunukan District lasted for two years. The assistance program carried out was started with the same treatment, that was by explanation and extension regarding IMHCO technology. After two years, the results of the guidance and assistance program that have been carried out were observed whether the farmers implemented the technology package or not, thereby the level of adoption could be assessed.

3.3. The evaluation of the program

The level of understanding and application of the technology at the early stage of the guidance and assistance program was measured. In general, based on the aspect of citrus cultivation activities, farmers have understood the various technological components that need to be carried out in the IMHCO. This could be seen from the mean score of respondents' understanding towards IMHCO technology, which ranged from 2.38 - 3.00 (Table 1), showing that farmers already understood the aspects of technology components for maintaining healthy citrus orchards. Only the irrigation technology component received the lowest score (2.38), so that the level of understanding for irrigation activities was lower than that of other technology components.

However, in terms of application, farmers have not really implemented all the components of the technology, where the average score of the application of technology at all components showed lower results than that of the technology understanding, except for weed control. Table 1 indicated that the lowest score for technology application was on irrigation (2.13), thinning fruit (2.20), good harvesting practice (2.40) and the use of sex pheromones (2.47). This showed that the application rate of the four technology components was still low and only a small part of the technology was applied by farmers. Farmers were still reluctant to do irrigation, thinning fruits and good harvesting practice, while sex pheromones were considered difficult to apply by farmers. On the contrary, several technology components received high score in application such as weed control (3.00), the use of certified seedlings (2.93), lime sulfur application (2.93), and fungicide spraying (2.93), indicating that these parts of technology had been applied by farmers. These technology components were considered easy to apply by farmers.

However, previous relevant study regarding the adoption level of IMHCO technology in South Sulawesi showed that the technology component of good harvesting practice was highly adopted, while lime sulfur application was lowly adopted because it was considered difficult and took time [12]. Thus, the result of the current study was a little different with the previous one. According to [13], factors that influence the adoption level of a technology included the characteristics of the technology, the characteristics of the adopter and the behavior of agent of change (researcher/extension officer).

Furthermore, the level of adoption after the guidance and assistance program was also measured. In terms of the use of disease-free citrus seedlings, all groups have used blue-labelled disease-free seedlings supplied by the Agriculture Office of Nunukan District and North Kalimantan Province. The adoption of this technology component was achieved maximumly 20% of the weight of IMHCO package. Other technology component such as controlling CVPD vector and orchard sanitation was also adopted maximumly across three groups, except the non-implementing group. While the technology component of optimum maintenance was not applied completely by all groups, showed by the scores of all groups that
were below the maximum weight (Table 2). Some technology application such as pruning for plant architecture 1-3-9 (1 main stem – 3 main branches – 9 secondary branches) had been applied by farmers, although not all of them could apply it correctly. Controlling technology for stem disease had been applied using lime sulfur application.

Table 1. The level of understanding and application of technology components of Integrated Management of Healthy Citrus Orchard (IMHCO).

| Technology components                              | Understanding | Application |
|----------------------------------------------------|---------------|-------------|
| 1. Certified citrus seedlings                      | 2.94          | 2.93        |
| 2. Controlling CVPD vector:                        |               |             |
| a. Yellow trap                                     | 2.94          | 2.87        |
| b. Lime sulfur application                         | 3.00          | 2.93        |
| c. Insecticide spraying                            | 2.94          | 2.87        |
| d. Sex pheromone                                   | 2.56          | 2.47        |
| e. Fungicide spraying                              | 3.00          | 2.93        |
| 3. Optimum maintenance:                            |               |             |
| a. Pruning for plant architecture                  | 2.56          | 2.53        |
| b. Pruning for maintenance                         | 2.88          | 2.67        |
| c. Soil cultivation                                | 2.63          | 2.47        |
| d. Balanced fertilizer application                  | 2.63          | 2.60        |
| e. Irrigation                                      | 2.38          | 2.13        |
| f. Fruit thinning                                  | 2.63          | 2.20        |
| g. Weed control                                    | 3.00          | 3.00        |
| h. Good harvesting practice                        | 2.69          | 2.40        |
| 4. Orchard sanitation:                             |               |             |
| a. Pruning the infected plant parts                 | 2.94          | 2.87        |
| b. Eradication of CVPD infected plants              | 2.81          | 2.67        |
| c. Replanting with certified seedling              | 2.56          | 2.47        |
| 5. Consolidation with other citrus farmers/farmer groups in good citrus farming practices | 2.69          | 2.67        |

Moreover, the group with full technology application treatment (P), which had been assisted intensively, applied IMHCO technology by 95% of the recommended technology package. Meanwhile, the adoption level of the farmer groups around the group with full IMHCO technology application ranged from 80% to 90%, and non-IMHCO application (NP) group performed by less active farmers indicated a low adoption level of 55% (Table 2). The IMHCO adoption rate in Nunukan District was 90% higher than that reported in South Solok District of West Sumatra Province at 86% adoption rate [14], and higher than that of East Nusa Tenggara Province at 85.2% [8].
### Table 2. Adoption level of IMHCO technology in Nunukan Regency at the end of the assistance program, 2018

| No | Component of technology | Weight (%) | Adoption Level (%) |
|----|-------------------------|------------|--------------------|
|    |                         | P | AI | AII | NP |
| 1  | Certified citrus seedlings | 20 | 20 | 20 | 20 | 20 |
| 2  | Controlling CVPD vector  | 20 | 20 | 20 | 20 | 10 |
| 3  | Optimum maintenance      | 30 | 25 | 20 | 15 | 10 |
| 4  | Orchard sanitation        | 15 | 15 | 15 | 15 | 10 |
| 5  | Consolidation with other citrus farmers | 15 | 15 | 15 | 10 | 5 |
|    | Total                    | 100 | 95 | 90 | 80 | 55 |

Description: (P) Full application of IMHCO technology; (AI) Farmer Group I outside IMHCO; (AII) Farmer Group I outside IMHCO; (NP) Farmer Group not implementing IMHCO.

### 4. Conclusions

Proper and consistent maintenance of demonstration plots had been carried out on newly planted and productive plants of 10 hectares each. In terms of understanding towards IMHCO technology components, farmers had understood the various components of this technology, showed by the mean score of respondents' understandings ranged from 2.38– 3.00. However, in terms of application, farmers had not really implemented all the components of the technology, where the mean score of the technology application showed lower results than that of the technology understanding. This applied to almost all of the technology components. Citrus farms that had been intensively assisted resulted in technology application of 95% of the recommended technology, while the adoption level of farmer groups around the group with full IMHCO technology application ranged from 80% to 90%, and non-IMHCO application (NP) group performed by less active farmers indicated a low adoption level of 55%.

The results of this study suggest some policy implications that the local government of Nunukan District along with other related institutions need to keep supporting the farmers, so that the sustainable citrus farming in this district can be attained, and strengthen the monitoring and technical guidance to farmers. Thereby, area-based citrus commodity development by using IMHCO technology is significant as the reference to grow regional economy as has been carried out in Nunukan District.

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