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# Adoption of Horticultural Innovations by Smallholder Farmers in North Lombok - Indonesia

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**ABSTRACT**

Various approaches have been promoted by the *Innovative Farm Systems and Capability for Agribusiness Activity* (IFSCA) *Program* to improve small farmers' the livelihoods in North Lombok District - Indonesia. Through this collaborative action-research program involving Mataram University (Lombok - Indonesia), Massey University (New Zealand), and the local government, some horticulture innovations had been introduced to the smallholder farmers such as growth hormone, growing safe, high beds, plastic mulch, compost, pruning technique, and drip irrigation. A study was conducted to understand (1) farmers' adoption behavior of these innovations, (2) the impacts of the innovation adoption the horticulture production, job creation, and farmers' income, (3) factors affecting farmers' adoption behaviors – impacts of earthquake and COVID-19 pandemic. A mix method approach was used for the study interviewing 60 farmers from 8 farmer groups participated in the IFSCA Program. The results show 100% farmers have adopted the horticulture innovations, increased the production and smallholder farmers' income. Changes in work patterns were identified as the results of the adoption behavior and changes of farming system, from previously food crop farming system to hoticulture farming. The adoption of horticulture innovations has created new jobs along the value chain. Higher profit, continuous production, job creation, and doing horticultural business are important factors affecting farmers' adoption behaviors. However, a big earthquake in July – August 2018, and COVID-19 pandemic that took place early 2020 have had significant impacts on the smallholder farmers' adoption rate. Horticulture farming scale decreased due to the big earthquake and COVID-19 pandemic, and another challenging effort is needed to bring the horticulture business back to normal.

## 1. INTRODUCTION

The Agricultural Development Program led by The University of Mataram (Unram) since 2017 through the IFSCA Program in the development of the horticultural sector in North Lombok district has begun to show the results. Until early July 2018, the IFSCA Project has worked and supported farmers in 4 sub-subdistricts, namely Pemenang, Gangga, Kayangan and Bayan, and covering 11 villages, and with the number of farmers being coached reaching nearly 574 people who are organized in more than 28 horticultural farmer groups. These farmers and farmer groups have also formed an association called the North Lombok Horticultural Farmer's Association as a joint forum in building partnerships and marketing the products.

Various activities had been carried out to strengthen the capacity of the smallholder farmers, especially in the last 4 years (2017 - 2020). These activities include (1)training for trainers in post-harvest handling and marketing, (2) training for trainers in cultivation techniques, handling pests and diseases, (3) training for trainers on the management of plant nutrition and fertilization, (4) comparative studies of farmers, field officers and extension workers to the locations and horticulture production centers such as Lembang Bandung and Bedugul-Bali, and Sembalun-East Lombok district, and (5) training on strengthening the capacity of field extension workers in managing groups, facilitation & gender [1].

The programs and activities that were initiated during the 4 years program (2017-2020) have started to show encouraging results. At a glance, it is observed that a number of farmers have started to adopt best practices in the management and cultivation of high economic value horticultural crops. Based on the data released by *the Agribusines Support Center (established by the IFSCA Project)*, there are around 24 kinds of horticulturel products produced and marketed by horticultured farmers in North Lombok district. These high economic values of horticulture products are chilies, curly chilies, letuce, melon, Japanese cucumber, paprica, red chili, lettuce, carrots, basil, yukini, and others. Farmers start to use cultivation techniques and horticultural production that are environmentally friendly and provide high productivity, such as the use of PGPR, liquid and solid fertilizers, grow safe, plastic mulch, biopesticides, plastic tunnel, intercropping for chilli, cabbage, paprica & basil [1].

This research activity was aimed to understand (1) the adoption of horticulture innovations introduced by the IFSCA Project during 2017-2020 in North Lombok; (2) socio-economic impacts of the innovation adoption on smallholder

farmers' livelihood; and (3) factors that influence the adoption & diffusion of innovations – including the impacts of earthquake and COVID-19 pandemic.

## 2. METHODS

Mix method approach was applied to the study [2]. Quantitative data were collected to measure the adoption behavior while qualitative data were collected to get various additional qualitative information and data on reasons and factors related to the adoption rates, and the impacts of the earthquake and COVID-19 pandemic on the adoption. Data collection was carried out using questionnaires, interview guidelines, key questions for data collection through Focus Group Discussion [3], and observation guidelines for data collection through observation [4].

This research was conducted in two sub-subdistricts of North Lombok District, namely **Kayangan** and **Pemenang** Subdistricts, where the IFSCA program implemented during 2017 – 2020 (due to COVID-19 pandemic, another one-year extension was made, and the project ended by the end of 2021). In every sub-subdistrict, two villages were selected purposively as the study sites, and these villages are **Pendua** and **Salut** in **Kayangan** Subdistrict, while **Pemenang Barat** and **Pemenang Timur** villages were selected in Pemenang Subdistrict. A total of 60 farmers from 8 farmer groups were interviewed for the study. Quantitative and qualitative approaches were applied to data collection, processing and analysis [5].

## 3. RESULTS

### 3.1 General description of the study area

**Geographical Situation:** North Lombok District is one out of 8 subdistricts in NTB Province. Geographically, the district surrounded by the Java Sea in the north, West Lombok District in the south. Central Lombok and East Lombok Districts in the east, and the Lombok Strait in the west.

North Lombok has an area of about 809.53 km$^2$ and most of the land is non-rice fields, especially for gardens and forests. Administratively, North Lombok is divided into 5 subdistricts, namely *Pemenang, Tanjung, Gangga, Kayangan*, and *Bayan* Subdistricts. The widest sub-subdistrict is Bayan with an area of 329.10 km$^2$ or 40.65% of North Lombok, and the smallest is Pemenang with an area of 81, 09 km2 or about 10.02% of the district area [6].

**Topography and Climate:** The four villages in the two subdistricts are characterized by almost the same topographical conditions, flat and hilly, ranging from 5 to 7 meters above sea level with two main seasons, the rainy season and the dry season. The number of rainy days was 151 days in a year, and the rainfall reaches 1992 mm in a year. Statistical data shows that in 2021 the rainy season lasted from November to April, and the highest rainy days occurred in March - 26 days, and the highest rainfall occurred in January - 760 mm [7]. The number of days of rain and rainfall generally reaches its lowest point in June and July. Research locations (4 villages) in North Lombok District, West Nusa Tenggara (NTB) Indonesia Province are shown in Figure 1.

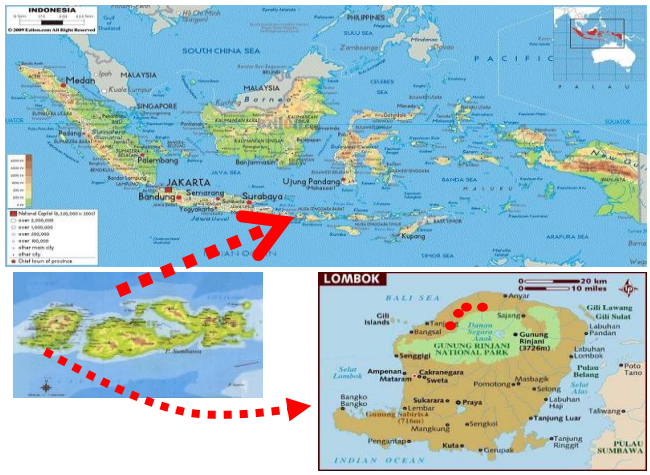



**Figure 1.** Research sites

**Demographic Characteristics:** Population data shows that Pendua and Salut Villages have a relatively small population compared to the Pemenang Barat and Pemenang Timur Villages. The total population of Pendua and Salut was 2,244 and 3,499, respectively, with a density 437 people and 393 people per km$^2$. Meanwhile, the population of Pemenang Barat reached 13,845 people and Pemenang Timur was around 7,565 people per km$^2$.

**Age:** The data show the average age of the study respondents is 47 - 98 years with a range of 22 - 80 years. Most respondents (35%) were in the age range of 36 - 45 years, and a total of 7 farmers (11.67%) were over 65 years old - Table 1.

**Table 1.** Respondents' characteristics

| No. | Age group | N (60) | % |
|---|---|---|---|
| 1 | Age group | | |
| | 22 - 35 | 11 | 18.33 |
| | 36 - 45 | 21 | 35.00 |
| | 46 - 55 | 14 | 23.33 |
| | 56 - 65 | 7 | 11.67 |
| | > 65 - 80 | 7 | 11.67 |
| **2** | **Level of education** | | |
| | Never went to school | 1 | 2 |
| | Did not finish elementary school | 5 | 8 |
| | Elementary School | 15 | 25 |
| | Junior High School | 16 | 27 |
| | Senior High School | 19 | 32 |
| | Higher Education | 4 | 7 |
| **3** | **Occupations** | | |
| | *Main occupation* | | |
| | Farmer | 55 | 92 |
| | Trader | 0 | 0 |
| | Private | 1 | 2 |
| | Civil servants | 2 | 3 |
| | Others | 2 | 3 |
| | *Additional occupation* | | |
| | Farmer | 17 | 28 |
| | Trader | 10 | 17 |
| | Private | 2 | 3 |
| | Civil servants | 0 | 0 |
| | Others | 28 | 47 |
| **4** | **Land ownership status** | | |
| | Owner | 24 | 40 |
| | Rent | 10 | 17 |
| | Share cropping | 1 | 2 |
| | Pawn | 3 | 5 |
| | Average area (ha) | | 0.33 |
| | Range (ha) | | 0.14 - 2.5 |

Source: Primary data is processed.

The data in Table 1 also shows that the majority (about 88%) of the study respondent who participated in the IFSCA program were in the productive age range, that is, the age range between 15 - 65 years. This condition means that the IFSCA Project may expect that the horticulture-based agribusiness development program will be able to increase smallholder farmers' income considering that farmers who participated in the program are in a productive age.

**Education level:** The education of most (32%) of the respondents is relatively good, that is, formally completing education up to Senior High School level, and there are even 4 people or 7% who graduated from higher education or university - Table 1. The data in Table 1 also shows that about 35% of the respondents have only elementary school education, did not graduated from elementary school and never attended school. This seems understandable given the limited educational facilities in the past 30 years.

**Job:** Agriculture is the main job for most respondents (92%) while 5 respondents work as a civil servant, private sector and others. Apart from being farmers, most of the respondents claimed to have jobs as traders, and others such as agricultural laborers and laborers outside of farming.

**Land ownership:** The data in Table 1 shows that most of the respondents (40%) manage paddy fields that belong to them, while 17% of them manage farm land whose status is rented from other farmers or other people. A profit-sharing system was also identified from this study, although it was only carried out by 1 farmer (2%). The data in Table 1 also shows the average land size managed by farmers was around 0.33 ha, with a range between 0.14 ha to 2.5 ha.

The average land size managed by the respondents in the last 3 years for growing commodities is in the range of 0.47 - 0.56 ha (Table 2), and there is a slight decrease each year. In 2018, the farm area managed by the respondents was 0.56 ha and in 2020 it decreased to 0.47 ha. This decline may have been caused by the earthquake and COVID-19 pandemic that occurred in North Lombok in 2018 (earthquake) and 2020 (COVID-19 pandemic).

**Table 2.** Average planted area of respondents for three commodities in the last 3 years

| Year | Commodities | | | Average |
|---|---|---|---|---|
| | Rice | Second crops | Horticulture | |
| 2018 | 0.13 | 0.20 | 0.24 | 0.56 |
| 2019 | 0.15 | 0.20 | 0.19 | 0.55 |
| 2020 | 0.09 | 0.16 | 0.22 | 0.47 |
| Total | 0.37 | 0.55 | 0.66 | 1.58 |

Source: Processed primary data.

The data in Table 2 and Figure 2 show that the average planting area for horticulture was higher than the area for planting rice and secondary crops, although in 2019 there was a decrease. This fact could be the impact or influence of the IFSCA program, which introduced horticultural farming.

In line with the increase in horticulture planting area from an average of 0.19 ha per farmer in 2019 and to 0.22 ha per farmer in 2020, the average area of rice cultivation has decreased in the last two years, from 0.15 ha in in 2019 it decreased to 0.09 ha in 2020. This data means that farmers have seen the importance of horticultural crops as an important source of income for their families.

**Membership in farmer groups:** A hundred percent respondents stated that they belong to the farmer groups facilitated by the IFSCA Program. All farmers can properly and correctly name the groups and the names of the group administrators, which consists of the group head, secretary and treasurer. The groups mentioned by the respondents were as follows: **Horsepen** and **Lokok Bata** farmer groups (located at **Pendua** village), **Banjar Mundah** and **Sehati** farmer groups, which are located in **Pemenang Timur** and **Pemenang Barat** villages, respectively. The other four farmer groups mentioned by the respondents are **Tani Tulen**, **Sambik Rindang 1, Antih Ujan II,** and **Pade Girang** farmer groups, all located in **Salut** village.

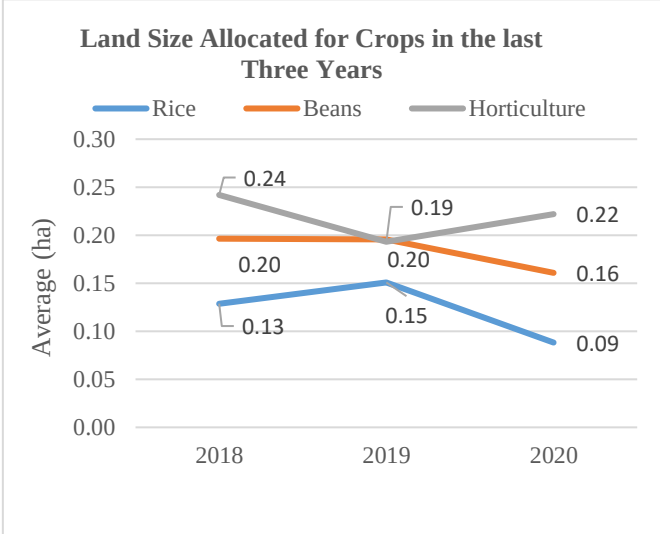



**Figure 2.** Average of commodity planted area in the last three years

Activities carried out by farmer groups in the last 4 years as mentioned by the group members are: (1) *Group meetings* - discussing group activity and plans, and capacity building activities; (2) *group fee collection*; (3) *facilitation of extension activities and capacity building* - in line with learning topics facilitated and supported by the IFSCA project in terms of the horticultural cultivation system, such as *the use of plastic mulch, raised bed systems, intercropping, irrigation, fertilization, pest control and diseases, and learning about seeds and seedlings;* (4) *mutual cooperation activities*. Farmers' knowledge of these various aspects of farmer groups shows that the farmer groups have been active and provide benefits to their members. This also means that farmer groups also have routine activities to support their members and the surrounding communities.

### 3.2 Farming system before IFSCA program

The initial conditions of the agricultural and community systems in the 4 research villages (**Pendua, Pemenang Timur and Salut**) when the IFSCA Project entered in 2016 were dominated by food crop farming systems where farmers grow rice, maize and peanuts, with a production orientation only for their own (subsistence) needs. For some farmers who grow horticultural crops, the production process was limited to vegetable crops whose seeds are available nearby, such as spinach and others. These conditions are clearly illustrated by the following statements by the IFSCA Project Field Officers - in response to questions during the FGD:

(1) *Only 1-2 farmers do horticultural cultivation business*
(2) *Horticultural cultivation is carried out only to meet the needs of household consumption of vegetables* -

*subsistence*

(3) *The management of vegetable crops is carried out simply and not based on the necessary knowledge - no commercial seeds and seedlings, no raised beds and, if any, only the necessary beds*

(4) *The types of vegetables cultivated are limited, which are only around by using local seeds and / or seeds such as kale, spinach and chili*

(5) *The planting system that is carried out is still very simple, without balanced fertilization, monoculture with a limited area - improvised*

(6) *Farmers' knowledge, attitudes and skills in horticultural management are still very limited, both in terms of types of vegetables, cultivation techniques and marketing.*

(7) *There is no seed and nursery business or business in the village*

(8) *Farmers only plant during the rainy season or when it is in season*

(9) *At that time farmers only focused on planting staple food crops such as rice, maize, soybeans, beans and others - as was the concern and focus was on rice, corn and soybean.*

(10) *Extension workers and extension workers are still and only focus on staple food crops such as rice, corn, soybeans, beans and others*

The above conditions show that the activities and productivity of agricultural labor only manage staple food farming system with limited labor productivity.

### 3.3 IFSCA program conceptual model

Several strategies and activities designed to produce the expected outputs, which will then result in further changes until the ultimate goal of the project is achieved. In general, the strategies and approaches in implementing the IFSCA Program in North Lombok District can be described as follows.

**Increase in Farmers' Income:** Increasing farmers' income in a horticultural agribusiness development project in North Lombok can be done in the following two strategies, (1) Increasing the value of farmer revenue through 3 (three) approaches, namely, increased production (quantity and quality) in the fruit and vegetable production system, including the use of the Plant Growth Promotion Rizobium (PGPR); market and quality assurance for all fruit and vegetable products through the development and role of the packhouse; and increased selling prices for products produced by farmers; (2) Reduction of production costs through reducing the use of production facilities (including excessive use of chemicals - Grow safe) and / or reducing input or efficiency in production and marketing costs.

**Increase in Farmers' Revenue:** The following describes several strategies used by the project in order to increase the acceptance of farmers who are involved and involved in project activities. As shown in Figure 2, an increase in farmer income can be achieved through an increase in the production of vegetables and fruit, an increase in the value of production or selling price, and a decrease in production costs as a result of more efficient use of resources.

**Increased Vegetable and Fruit Production:** Increasing farmers' income through increased vegetable and fruit production (quantity and quality) managed by farmers in this project is carried out by introducing at least 3 (three) technical innovations, namely: Introduction and adoption of Plant Growth Promotion Rizobium (PGPR); Introduction and use of growth safe and plastic mulch in vegetable and fruit production systems; Management of vegetable and fruit production systems more efficiently by applying best agricultural practices - Good Agricultural Practices (GAP).

**Vegetable and Fruit Price Increase and Guarantee:** Another alternative in increasing farmers' income through this horticultural agribusiness development project is through increasing prices for products produced by farmers, namely vegetables and fruit. In addition to increasing the quantity and quality of production outputs, it is hoped that an increase in prices will be realized through the following steps: (i) Facilitating, providing and increasing farmers' access to market information, which includes information on prices, quantity of requests, quality of products requested, and others (time and buyers). This can be done by facilitating the establishment of an Agribusiness Service Center, and facilitation of farmer groups in order to have adequate capacity to access market information. (ii) Facilitating farmers through the formation and development of horticultural farmer groups, which will then have better bargaining power and ability. The existence of horticultural farmer groups is also expected to be a forum for learning, decision making, access to market information, and procurement of production facilities. The formation of a packhouse as a forum for farmers to build partnerships and sell vegetable and fruit products to hotels and restaurants in North Lombok District.

**Reduction of Production Costs:** Reducing production costs in the horticultural agribusiness system can be done through the following two main approaches: (i) Reducing the use of production facilities and or decreasing input or cost efficiency. Current facts show that the use of production facilities, especially fertilizers, is not carried out on the basis of understanding and information on the level of nutrient availability on land managed by farmers in North Lombok District. The approach taken through this project is to analyze the level of macro and micro nutrient availability at the farm level, which will then produce recommendations on the level of fertilization required. It is hoped that the results of the analysis will provide direction to farmers regarding the ideal amount of fertilizer needed by plants, especially in vegetable and fruit production systems. The role of the group in the procurement of production facilities collectively. (ii) Groups can play a role in the procurement of production facilities collectively, and if this can be realized, a number of means of production such as fertilizers, medicines and seeds will be obtained in the appropriate amount needed by farmers at lower prices and lower transaction costs - bulk purchases can even be delivered and at lower prices.

### 3.4 Benefits of the IFSCA program

Survey data show that 100% of farmers claim to have learned a lot from the IFSCA project. Table 3 shows the distribution of farmers by innovations learned through the IFSCA Project in the last 4 years.

Table 3 shows the sequence of farmers' responses when it was asked *"what have you learned from the IFSCA Project from 2017 to 2020?"* Noting the responses in Table 3, some 50% of the respondents stated that they had learned a lot about "the horticulture farming system or c*ultivation techniques", among others* regarding the use of plastic mulch which has never been done and or thought to be too expensive. In addition, these 50% farmers also revealed that they also learned about planting with the raised bed system, which was

done seriously during the IFSCA Project. The system of taller beds has actually protected farmers' crops from water immersion, which can then cause rot and crop failure. In addition, making better beds has made it easier for farmers to look after their plants, including in monitoring the plant conditions, and doing other activities such as watering, weeding, and harvesting plants. A good bed also turns out to be important in the effectiveness of basic fertilizer application, pest and disease control and management, and improving fertlizer application effectiveness. The raised bed system can also optimize root growth, maintain soil moisture, facilitate spacing and plant planting to look tidier and form irrigation channels between the beds.

**Table 3.** Three learning topics mentioned by respondents obtained from the IFSCA program

| Learning topics | Mentioned | | | | | |
|---|---|---|---|---|---|---|
| | 1st | | 2nd | | 3rd | |
| | n | % | n | % | n | % |
| (1) Fertilizer - Application techniques & doses | 9 | 15.0 | 10 | 16.7 | 11 | 18.3 |
| (2) Pest and disease control | 6 | 10.0 | 9 | 15.0 | 7 | 11.7 |
| (3) Irrigation | 3 | 5.0 | 1 | 1.7 | 2 | 3.3 |
| (4) Cultivation (plastic mulch, raised beds, intercropping, plant care, spacing) | 30 | **50.0** | 25 | **41.7** | 19 | **31.7** |
| (5) Seeds and seedling | 6 | 10.0 | 6 | 10.0 | 2 | 3.3 |
| (6) Soil management | 3 | 5.0 | 1 | 1.7 | 0 | 0.0 |
| (7) Work in group | 1 | 1.7 | 0 | 0.0 | 1 | 1.7 |
| (8) Marketing | 1 | 1.7 | 1 | 1.7 | 0 | 0.0 |
| (9) New technology | 1 | 1.7 | 1 | 1.7 | 0 | 0.0 |
| (10) Cost of farming | 0 | 0.0 | 1 | 1.7 | 0 | 0.0 |
| Total | 60 | 100 | 55 | 91.7 | 42 | 70.0 |

Source: Primary data is processed.
Note: In terms of fertilization, the respondents specifically explained the topic of learning which includes techniques or techniques for making fertilizers, fertilization techniques, fertilization doses, compound fertilizers, organic fertilizers, and balanced fertilization.

Other lessons learned by farmers are about planting systems such as *intercropping*, *plant care*, *and spacing*. Moreover, other learning topics that were also mentioned earlier by the respondents are fertilizer application techniques and dose (15%), pest and disease control (10%), seeds and seedlings (10%), and irrigation (5%).

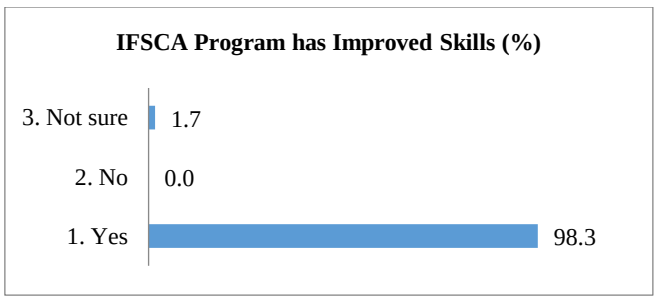



**Figure 3.** The role of the IFSCA project in increasing the knowledge and skills of horticultural farmers in North Lombok District

Looking at the responses of the respondents in Table 3 and Figure 3, it appears that the second and third responses (respondents mentioned them in the second and third order) are very consistent with the first response, which shows that through the IFSCA Project farmers have learned about the cultivation system (41.7% and 31.7%), fertilization (16.7% and 18.3%), pest and disease control (15.0% and 11.7%), seeds and seedlings (10.0% and 3.3%), and about irrigation (1.7% and 3.3%). Especially for the irrigation systems, farmers were taught the use of a drip irrigation system - to overcome water scarcity and to promote water use efficiency. Farmers even did their own experiments using an infusion system where farmers used plastic containers to keep water and release it slowly according to the plant water needs. The farmers claimed that the IFSCA Program has not only facilitated learning and knowledge improvement, but also has changed their skills (Figure 3).

### 3.5 Innovation adoption and impacts

This study found that 100% respondents claimed for the adoption of horticulture innovations introduced through the IFSCA Program, even though they may adopt one or few innovations (Figure 4). The data in Table 4 shows that in general all innovations introduced to farmers by the IFSCA Project were adopted, however, the data show that most farmers applied innovative fertilization (37%), plastic mulch (37%), and cultivation techniques (37%). Plant disease control techniques (33%) and drip irrigation (22%) are also recognized innovations that have been applied by respondents in the management of horticultural farming.

**Table 4.** Distribution of respondents by their adoption of horticulture innovations

| Practices that Change | Responses* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | Total | |
| | n | % | n | % | n | % | n | % |
| (1) Fertilize on time and dose | 13 | **22** | 9 | **15** | 0 | 0 | 22 | **37** |
| (2) Plastic mulch | 8 | 13 | 5 | 8 | 9 | **15** | 22 | **37** |
| (3) Beds | 6 | 10 | 0 | 0 | 1 | 2 | 7 | 12 |
| (4) Drip irrigation | 11 | **18** | 2 | 3 | 0 | 0 | 13 | **22** |
| (5) Intercropping / planting series | 3 | 5 | 0 | 0 | 0 | 0 | 3 | 5 |
| (6) Cultivation technique - seeds/seedlings /harvest/stake | 14 | **23** | 7 | **12** | 1 | 2 | 22 | **37** |
| (7) Pest and disease control | 2 | 3 | 12 | **20** | 6 | **10** | 20 | **33** |
| (8) High yield varieties | 1 | 2 | 6 | 10 | 1 | 2 | 8 | 13 |

Source: Primary data is processed.
Information: * Response 1 is called the first, response 2 is called the second, and response 3 is called the 3rd (Each respondent can mention more than 1 innovation that they implemented.

The intercropping system is an innovation that not all farmers do as it is revealed in Table 4. This may be because the management of more than one type of crop will make farmers do not focus, or will get lower production for each type of crops compare to the monoculture system.

The changes in farm and horticulture management practices have significantly increased the production (87%) and quality of horticultural products (90%). Farmers also have broader access to market information, and as a consequence of

changing the farming system towards a market-oriented production, farmers then have a planting schedule – Figure 5.

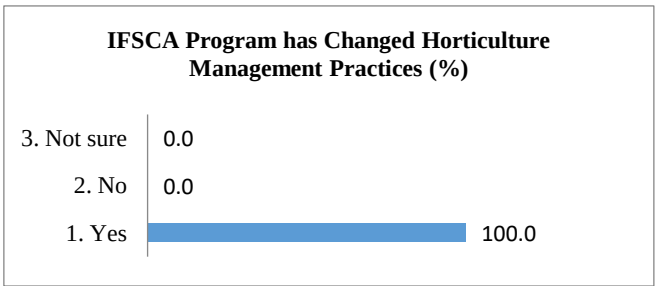



**Figure 4.** Change in practices (adoption) in horticulture farming in North Lombok District

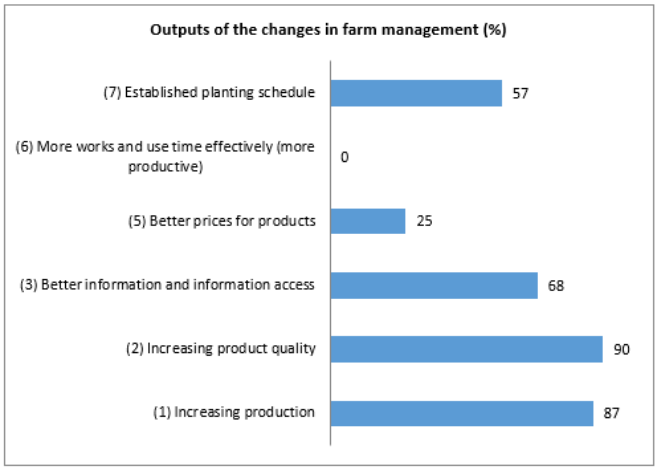
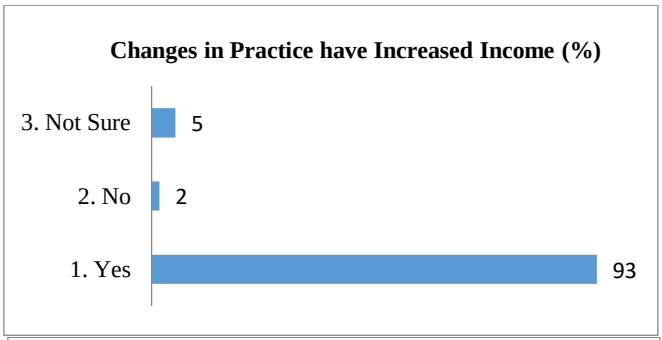



**Figure 5.** Results of changes in practices (adoption) in horticultural farming in North Lombok District



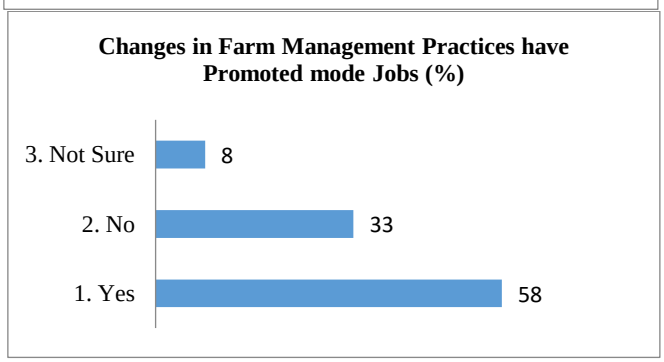




**Figure 6.** Results of changes in practices (adoption) in horticultural farming in North Lombok District

Increasing households' income and employment opportunities are the identified impacts of the adoption of horticultural innovations by farmers - Figure 6. When farmers grow food crops such as paddy, they just harvest once during the seasons, while after growing horticulture then they can harvest mores every few days during the harvesting time. The study also found that weeding, seedling activities and marketing of seedling and horticulture products have become new activities and jobs for the village communities.

### 3.6 Factors affecting innovation adoption

Farmers' perceptions of the horticulture innovations have been identified as the key factors contributed to the adoption and the diffusion of the innovation. The first five improved innovations that were perceived favorably by the study respondents are higher planting beds, the use of plastic mulch, fertilizer application/dose/types, multiple cropping system, and drip irrigation technique. Most respondents perceived these innovations were profitable, compatible to their situation and practices, less complex, and they could be tried, and the results are observable – Tables 5 and 6.

**Table 5.** Respondents' perceptions of the innovations (profitability, compatibility & complexity)

| Horticulture innovations | Profitable | | Compatible | | Complexity | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| (1) Bed system | 24 | 40.0 | 21 | 35.0 | 23 | 38.3 |
| (2) Plastic mulch | 44 | 73.3 | 41 | 68.3 | 43 | 71.7 |
| (3) Composite fertilizer/application/dose | 27 | 45.0 | 24 | 40.0 | 24 | 40.0 |
| (4) Multiple cropping | 13 | 21.7 | 9 | 15.0 | 10 | 16.7 |
| (5) Drip irrigation | 13 | 21.7 | 14 | 23.3 | 12 | 20.0 |

Data presented in Table 5 and 6 confirmed positive and favorable perceptions of farmers to the benefits of using the plastic mulch – more than half of the study respondents.

**Table 6.** Respondents' perceptions of the innovations (triability & observability)

| Horticulture innovations | Triability | | Observability | |
|---|---|---|---|---|
| | n | % | n | % |
| (1) Bed system | 22 | 36.7 | 22 | 36.7 |
| (2) Plastic mulch | 32 | 53.3 | 38 | 63.3 |
| (3) Composite fertilizer/application/dose | 22 | 36.7 | 26 | 43.3 |
| (4) Multiple cropping | 8 | 13.3 | 8 | 13.3 |
| (5) Drip irrigation | 4 | 6.7 | 9 | 15.0 |

This research also clearly indicates that the earthquake and COVID-19 pandemic had significantly influenced the adoption of horticultural innovations by farmers. The survey results showed that most (90%) of the respondents stated that the 2018 earthquake greatly affected horticultural farming activities.

**Earthquake effect:** The effect of earthquakes on farming activities can be a direct influence on the farming system or an indirect effect on the farming system. A statistical test on the effect of the earthquake on horticulture farming indicate a significant decreased of land size allocated for producing horticulture where before the earthquake the farm size was about 0.20 ha and after the earthquake became 0.08 ha (t-value 3,526 higher than t-tabel 1,980; *p-value* 0,000 < alpha 0,05, reject Ho, significant).

The data presented in Table 7 reveals that the direct effects of the earthquake on the farming system include damage to farmland (50%), damage to irrigation channels (50%) which disrupt water flow, and even the loss of a number of springs (35%). Meanwhile, two other factors related to farming are "Not focusing on managing the farm because the house is damaged" (75%) and "Difficulty in farming capital - because it is used for other purposes such as house repairs" (53.3%).

**Table 7.** The effect of the earthquake on horticultural farming activities

| | Effect of earthquakes on farming | n | % |
|---|---|---|---|
| (1) | *Farm land is damaged - cracked and cannot be cultivated* | 30 | **50** |
| (2) | *The irrigation channel is damaged* | 30 | **50** |
| (3) | Water disappears and there is no irrigation | 21 | 35 |
| (4) | *Not focused on taking care of farming because the house was damaged* | 45 | 75 |
| (5) | It is difficult to find workers to work on farms because workers move to construction jobs | 14 | 23.3 |
| (6) | *The difficulty of farming capital - because it is used for other purposes such as house repairs* | 32 | 53.3 |
| (7) | Others Do not carry out farming activities on a large scale/change of profession for a while until there is capital | 9 | 15 |

Source: Primary data is processed

The data in Table 7 also reveal farmers' difficulties in getting agricultural labor for farming activities, including in the decision to reduce the scale of the business or change the profession. This fact is in line with the response of farmers to the question "Do you take adaptation action?" as shown in Table 9. Most of the respondents (72.88%) claimed to have taken adaptation or adjustment actions to post-earthquake conditions and conditions.

**Effects of the COVID-19 pandemic:** Survey data also showed that most of the respondents (71.7%) stated that COVID-19 affected horticultural farming activities. For farmers, COVID-19 has led to a decline in activities requiring vegetable and fruit products such as at wedding receptions and other gatherings. This situation then causes a decrease in demand for horticultural products produced by farmers. Most farmers stated that the decline in prices (50%) and market demand (28.3%) for horticultural products was caused by the corona-19 pandemic. Data in Table 8 also shows that the corona outbreak has caused other impacts such as being limited and decreased activities in farming, decreased production, and crops that cannot be sold. Even though some farmers claimed to reduce their farm size (stated by 32% farmers), the decreasing of average farm size from 0.08 ha before the COVID-19 pandemic to 0.04 ha after the COVID-19 pandemic is not significant -the statistical test confirmed this change is not significant (t-value 1.786 < t-tabel 1,980; *p-value* 0,077 > alpha 0,05, reject Ho, not significant).

Conditions of low demand, falling prices, and difficulties in selling their crops have caused farmers to take adjustment or adaptation strategies. A total of 40 respondents (66.7%) stated that they had taken adaptation measures to the situation they faced, and a number of 20 farmers (33.3%) stated that they did not "taken adaptation actions". Adaptation measures taken by farmers were reducing the farm area (53.3%), re-planting rice and secondary crops (18.3%), and doing work outside agriculture (11.7%) - Table 9.

**Table 8.** Respondents' perceptions of the effects of COVID-19 pandemic on farming activities

| | The effect of corona on farming | n | % |
|---|---|---|---|
| (1) | *Prices go down* | *30* | *50* |
| (2) | Purchasing power is down | 5 | 8.3 |
| (3) | *Market demand fell* | *17* | *28.3* |
| (4) | Down market access - limited mobility | 6 | 10.0 |
| (5) | Farming activity is limited or decreasing | 4 | 6.7 |
| (6) | Production decreased | 1 | 1.7 |
| (7) | The harvest was not sold - divided among the residents | 4 | 6.7 |
| (8) | Loss | 4 | 6.7 |

Source: Primary data is processed.

**Table 9.** Distribution of respondents by their adaptation measures due to earthquake and COVID-19 pandemic

| | Adaptation action | n | % |
|---|---|---|---|
| (1) | Not doing horticultural farming activities | 3 | 5 |
| (2) | *Keep doing horticultural farming, but in a smaller area* | **32** | **53.3** |
| (3) | *Return to the old practice of growing only rice and / or corn and / or soybeans / beans* | 11 | 18.3 |
| (4) | There is nothing that can be done because the conditions do not allow | 0 | 0.0 |
| (5) | Doing other work outside of agriculture | 7 | 11.7 |
| (6) | Others *such as working as farm labor, and horticulture product sellers* | 16 | 26.7 |

Source: Primary data is processed.

## 4. DISCUSSION

This research shows that the farmers involved in the IFSCA Program adopted the innovations such as plastic mulch, a planting system using higher beds, fertilizer application techniques and doses, multiple and intercropping planting system. The adoption of these innovations has been due to the higher economic benefits compared to their current farming management practices - planting rice and secondary crops. In addition, farmers also considered that innovations were compatible with the farmers' needs, existing practices and traditions, can be tried on a small scale, and the results can also be observed. These findings confirm Rogers' concept of innovation characteristics that affect peoples' willingness to adopt and decided to implement innovations [8]. According to Rogers, peoples tend to adopt those innovations which are compatible to their existing practices, have a relative advantage, less complex, triable and observable. Other findings are also consistent with the findings from this study where the adoption had been due to the innovations' characteristics [9, 10].

The high level of adoption of horticultural innovations is also related to the extension approach undertaken by the IFSCA Project for a period of four years (2016 – 2020). Some of the activities carried out by the IFSCA Project such as a study visit to **Pengalengan - Lembang Bandung** (West Java), to **Ubud** and **Tabanan** (Bali), and to Sembalun (East Lombok)

– the places are well knowns as vegetable production areas. In addition, the IFSCA Program facilitated farming demonstrations, cross-visits between farmers, and trials on horticultural planting such as demonstration plots managed by the Agribusiness Support Center (ASC). This learning approach consistent with the approach used by Muktasam at.al. [10, 11], and are in line with the concept of *Cone of Learning Experiences* from Edgar Dale which states that a person will learn more when involving all his five senses in the learning process. Learning from just hearing the results will be less than the learning process by seeing and doing it themselves [11, 12].

The impacts of natural disaster such as earthquake on farming practices and the adoption of innovations also reported by some researchers and agencies such as The United States Environmental Protection Agency (EPA) where natural events and disasters may have significant and common impacts on agriculture such as *"contamination of water bodies, loss of harvest or livestock, increased susceptibility to disease, and destruction of irrigation systems and other agricultural infrastructure"* [13]. The findings from this study also highlight that farmers' activities had been affected not only due to the irrigation and infrastructure damage, but also due to their house lost and broken. As results, they did not focus to manage their farms, but to rebuild and reconstruct their houses. Significant and critical efforts need to be taken to address the adverse impacts and bring the agricultural production into normal such as those reported by Japanese researchers to address the adverse impacts of big earthquake in Japan in 2011 [14-16]. The findings on the impacts COVID-19 pandemic found in this study are also consistent with the findings reported by other researchers on the impacts of COVID-19 on agriculture [17-27].

## 5. CONCLUSION

On the basis on the data from this study, the following conclusions are made: (1) Most farmers who participated in the IFSCA Program have adopted some or all of the horticulture innovations introduced during the period of 2017 - 2020. The five major innovations adopted and spread widely in the communities at the study sites in North Lombok are the used of *higher planting bed technique, the use of plastic mulch, fertilizer application/dose/types, multiple cropping system, and drip irrigation technique.* Most respondents perceived these innovations were profitable, compatible to their situation and practices, less complex, and they could be tried, and the results are observable; (2) The adoption of horticulture innovations has apparently changed the socio-economic conditions of the social systems which is in line with the changes of their farming management practices. The adoption of the horticulture farming system has promoted more job opportunities, and improve the smallholders' livelihoods; (3) Innovation characteristics such as the relative advantages or profitability, compatibility, complexity, triability and oberservability have contributed to the smallholder farmers' decisions to adopt the innovation. However, the big earthquake that occurred in mid-2018, and followed by COVID-19 in early 2020 have had bad impacts on the farming communities, including the communities living at the study sites. Strong efforts and supporting policies and programs are needed to bring the situation back to the normal.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