Implementing sustainably agricultural system to accelerate food sovereignty after covid-19 through farmers’ participation

Wulan Sumekar¹, Sumarsono², Agus Subhan Prasetyo¹, Kadhung Prayoga¹

¹) Extension and Community Empowerment Laboratory, Department of Agriculture, Faculty of Animal and Agricultural Sciences, Diponegoro University, Indonesia
²) Ecology and Crop Production Laboratory, Department of Agriculture, Faculty of Animal and Agricultural Sciences, Diponegoro University, Indonesia

E-mail: wulan_sumekar@yahoo.co.id

Abstract. Sustainably agricultural systems emphasizing economy and ecology might become basic principles in accelerating food sovereignty. In its implementation, farmers’ participation, as the main actors, is essential; however, the wide-ranging characteristic of farmers determines their involvement. The research aimed to analyze the degree of farmers’ participation and the influence of farmers’ characteristics on farmers’ participation level in implementing a sustainably agricultural system. The study analyzed 65 farmers practicing sustainably agricultural systems through the implementation of agricultural farming systems of dairy cows and horticulture in Getasan Sub-district, Semarang District, Central Java Province. This research employed a descriptive analysis and multiple regression analysis. The results showed that most of the farmers were categorized as productive although they belonged to socially and economically low. The number of farmers admitted that implementing a sustainably agricultural system increased, remained stable, and decreased dairy cow production by 47.70%, 26.15%, and 26.15%, respectively, and in horticulture by 40.00%, 24.62%, and 35.38%, respectively. The level of farmers’ participation at the implementation stage was medium, while at the planning and evaluation stages were low. Experiences in doing farming (P<0.01) and farm production (P<0.05) significantly and positively influenced farmers’ participation, while land tenure negatively (P<0.10) influenced farmers’ participation.

1. Introduction

Covid-19 has changed the people’s lifestyle in the world and it makes a big impact, both positive and negative. The positive impact is the growth of brotherhood ties in society, while the negative impacts are interrelated, namely the limitation of community activities, the real sector stops, agricultural production is not absorbed by the market so that the price of products at the farmer level drops and the FAO forecasts the threat of a food crisis.

The phenomenon that occurs in Indonesia during the covid-19 crisis is the availability of food, mostly the food supply is imported, including rice, horticulture, and livestock products. Covid-19 has influenced each food exporting country to reduce or stop food exports to other countries to maintain food availability. Covid-19 has shown policyholders to change their strategy to fulfill food availability so that the negative impact does not spread.

Covid-19 concerning the food crisis is not independent, but a commodity and industrial-oriented agriculture and climate change have proven unable to meet food needs, thus requiring changes in a
sustainable food system. A participatory, equitable and ecological food system to meet food needs by natural conditions and local food sources is called food sovereignty.

The Declaration of Nyéléni, namely the Forum for Food Sovereignty in 2007, formulates that food sovereignty is the right of people to eat healthy and in accordance with their culture, which is produced through environmentally friendly and sustainable technology, and their right to produce food and agriculture with their systems. Ecologically, socially, economically, and culturally by its uniqueness [1]. The World Food Organization (FAO) stated that the full participation of civil society, social movements, and indigenous peoples is very important in achieving food sovereignty. Food sovereignty development approaches include stopping imports of food specifically for rice, corn, beef, soybeans, shallots, and red chilies.

Many researchers also take comments that the level of participation or direct involvement of the society in the community empowerment program means that the program results are in accordance with the aspirations and needs of the community. The difference in the level of farmer participation in the implementation of rural mina business development is influenced by the characteristics of farmers, including in terms of frequency of socialization, training that is attended and workshops [2]. Besides, social and economic factors also affect the level of farmer participation in making farming decisions [3;4]. Therefore, in achieving food sovereignty, the participation of farmers as the object of development is required to participate in planning, implementing and evaluating the implementation of sustainable agriculture under ecological, social and economic principles.

Based on the relationship between the level of community participation and the success of the program, this study was conducted to analyze the level of farmer participation and the influence of farmer characteristics on the level of farmer participation in implementing a sustainable agricultural system.

2. Material and methods

This research was conducted by survey methods. The population of this research were dairy cattle farmers who applied an integrated farming system of dairy cattle and horticulture in the center of dairy farming, namely Getasan District, Semarang Regency, Central Java Province. The number of samples was 65 which was determined using simple random sampling (25% of the total population)

Primary data were collected using the interview method with respondents accompanied by a questionnaire as a guideline which were data on socio-economic characteristics, agricultural production, farmer participation in implementing an integrated agricultural system. Then, observation was conducted in the research location to know the implementation of the integrated agricultural system. The data analysis tool used was descriptive statistics.

The level of participation was analyzed using a participation formula [5;6].

\[ X = \frac{\sum_{i=1}^{n} x_i}{n} \times 100 \]

\( X \) = the percentage of the participation score against the ideal participation score

\( X_i \) = the total score of participation in each activity

\( N \) = the total ideal scores for each activity

Difference score and interpretation for the level of participation were classified into 3 classes with the following criteria:

\( \leq 55 \% \) = low

\( > 55 \% - 67 \% \) = moderate

\( > 67 \% \) = high

Multiple linear regression were used to analyze to the effect of farmers' socio-economic characteristics on the level of farmer participation in implementing a sustainable agricultural system with the formula according to [6].

\[ Y = f(X_1, X_2, X_3, X_4, X_5, X_6) \]

\( Y \) = farmer participation in the implementation of an integrated agricultural system

\( X_1 \) = age
X₂ = education
X₃ = experiences
X₄ = farming productivity
X₅ = labor is involved
X₆ = landowner

3. Result and discussion

3.1. Sustainable farming system for food sovereignty

The sustainable farming system has been implemented by farmers through an integrated farming system for dairy cattle and horticulture. Farmers' perceptions of production results from the application of an integrated agricultural system are as shown in Table 1.

| No. | Perception of the State of Farming Products | Number of farmers |
|-----|--------------------------------------------|-------------------|
|     |                                            |       Percentages | Sample size |
| 1.  | Vegetable and fruit production             |                  |              |
|     | Increase                                   | 47,70            | (31)         |
|     | Stable                                     | 26,15            | (17)         |
|     | Decrease                                   | 26,15            | (17)         |
| 2.  | Milk Production                            |                  |              |
|     | Increase                                   | 40,00            | (26)         |
|     | Stable                                     | 24,62            | (16)         |
|     | Decrease                                   | 35,38            | (23)         |

Some of the horticulture farmers (47.70%) had their vegetable and fruit production increased after implementing integration of horticulture and dairy cattle. Types of vegetables planted were broccoli, carrots, cabbage, lettuce, mustard greens, and pumpkin, and the type of fruit planted was strawberry. Meanwhile, farmers who raised dairy cattle (40.00%) have their production of milk increased substantially. However, some mentioned that the production of both food products in the IFS was remained stable.

Farmers who focused on vegetable farming alone generated fewer results than those who prioritized in the integration of horticulture and dairy cattle. The low production of horticulture was presumably caused by the application of improperly processed fertilizers. Hence the function of the fertilizer for plants become was not optimal and the production of the plants did not increase as expected.

Some research also showed that most of the farmers used manure as vegetable fertilizer, but very few respondents processed it into compost [7]. Besides, agroecological factors such as temperature, ranging from 18ést - 23°C, and rainfall which was 2500 mm/year, caused manure processing to take longer time. Consequently, farmers needed the assistance of tools and equipment to speed up manure processing time. Meanwhile, farmers who applied vegetables and dairy cattle integration generated double benefit, as additional forage from vegetable waste fostered increased milk production, reduced feed costs, and reduced fertilizer utilization. This was under the finding of [8] that the integration of crop and livestock is more profitable than the integration of crop and another crop.

The application of an integrated farming system of dairy cattle with horticulture has not fully met the requirements for a sustainable farming system. However, has met 3 of those stated by the 4 objectives of an integrated farming system namely: 1) stable income, 2) achieving agroecological balance, 3) natural planting system management for pest control, 4) reduce the use of chemical fertilizers and pesticides to produce healthy and environmentally friendly products [9]. The management of the planting system is still monotonous, because farmers have not been able to market by self so that the products grown are demand-oriented by marketing agencies.
Most of the farmers were still economically and ecologically oriented, they were till implementing it individually with a little technology, especially in processing cow waste into fertilizer and gas. In accordance with the opinion that sustainable agricultural system stimulates the achievement of a balance of environmental, economic and social dimensions [10]. However, if one dimension was in a position of high achievement, then it was very difficult to achieve high in other dimensions.

The marketing patterns of milk and horticultural products were highly dependent on marketing institutions (middlemen, milk processing industry), the farmers in the category did not have food sovereignty. This was related to the opinion that food sovereignty is related to farmers' rights and access to all agricultural resources including land, water, production facilities, technology, marketing, as well as consumption and opposing companies, food agribusiness [1;11].

3.2. Social and economic characteristics of farmers

The characteristic of the respondents implementing the IFS of horticulture and dairy cattle is exhibited in Table 2.

| No. | Characteristic Category | Frequency | Sample size |
|-----|-------------------------|-----------|-------------|
| 1.  | Age (years)             |           |             |
|     | Non productive (> 64)   | 7.70      | 5           |
|     | Productive (15 – 64)    | 92.30     | 60          |
| 2.  | Education (years)       |           |             |
|     | ≤ 6                     | 64.62     | 42          |
|     | > 6 - 9                 | 21.54     | 14          |
|     | > 9                     | 13.84     | 9           |
| 3.  | Experiences in farming (years) | | |
|     | ≤ 5                     | 20.00     | 13          |
|     | > 5 – 10                | 29.23     | 19          |
|     | > 10                    | 50.77     | 33          |
| 4.  | Land ownership area (m²) |           |             |
|     | ≤ 500                   | 66.15     | 43          |
|     | > 500 - 1000            | 16.92     | 11          |
|     | > 1000 - 2000           | 10.77     | 7           |
|     | > 2000 - 3000           | 6.16      | 4           |
| 5.  | The number of dairy cattle (AU) | | |
|     | 1 – 2                   | 58.46     | 38          |
|     | > 2 - 3                 | 29.23     | 19          |
|     | > 3 – 4                 | 12.31     | 8           |
| 6.  | Milk Production (liter/head/day) | | |
|     | ≤ 10                    | 21.54     | 14          |
|     | > 10 - 15               | 66.15     | 43          |
|     | > 15 - 20               | 9.23      | 6           |
|     | > 20                    | 3.08      | 2           |

The age aspect is a description of the maturity level of a person's rational thinking in making decisions related to the problem at hand. Age also reflects the physical ability to complete work. The results showed that the majority of farmers were in the productive age category in the age range 15 -
64 years (92.30%). There were 64.62% of farmers who did not complete elementary school and more than 50% of farmers had arming experience > 10 years. A total 66.15% of farmers only owned land with an area less than ≤500 m². Most of the farmers had airy cattle (58.46%) less than 2 AU, as part of the IFS, with the production of >10 - 20 liter/head/day (66.15%) and >20 – 30 liter/head/day (9.23%).

The implementation of the IFS potentially developed as shown by its physical capability, experiences, and self-owner land. Although most farmers’ scale of land to do farming was small, it was presumed that there was a positive relationship in the integration of horticulture and dairy cattle as indicated by high production of their dairy cattle (13.9 liters/head/day) compared to the average production of dairy cattle in other regions in Semarang District; such as, in Getasan Sub-district (8.8 liters/head/day), in Ungaran Barat Sub-District (12.3 liters/head/day) [12;13].

3.3. Participation of farmers in the implementation of integrated agricultural systems

The progress of the implementation of the IFS took place continually through individual or collective participation. The application of the integration of horticulture and dairy cattle is shown in Table 3.

### Table 3. Number of farmers participating in the implementation of ifs of horticulture and daisy cattle

| No. | Activities          | Distribution of respondents answer | Average score | Ideal score | Outcome (%) |
|-----|---------------------|------------------------------------|---------------|-------------|-------------|
|     |                     | 1   | 2   | 3   |               |             |             |             |
| Planning |                        |     |     |     |               |             |             |             |
| 1.   | Activity plan       | 10  | 38  | 17  | 2,10         |             |             |             |
| 2.   | Equipment           | 38  | 15  | 12  | 1,70         |             |             |             |
| 3.   | Labour              | 34  | 22  | 9   | 1,61         |             |             |             |
|      | Total score         | 5,41| 100 | 60,11| moderate     |             |             |             |
| Implementing |                          |     |     |     |               |             |             |             |
| 1.   | Schedule            | 9   | 44  | 12  | 2,06         |             |             |             |
| 2.   | Processing          | 6   | 27  | 32  | 2,14         |             |             |             |
| 3.   | Implementation      | 5   | 22  | 38  | 2,12         |             |             |             |
|      | Total score         | 6,32| 100 | 70,22| High         |             |             |             |
| Evaluation |                          |     |     |     |               |             |             |             |
| 1.   | Monitoring and evaluation | 28  | 22  | 15  | 1,80         |             |             |             |
| 2.   | Recording result    | 17  | 30  | 18  | 2,02         |             |             |             |
|      | Total score         | 3,82| 100 | 63,67| Moderate     |             |             |             |

Farmers’ participation in an integrated agricultural system is needed to achieve food sovereignty. As in Table 3, it showed that the average participation of farmers in the implementation of the integrated farming system was moderate (64.67%), but based on the participation stage, only the implementation stage was high (70.22%).

The high category of participation was supported by the fact that farmers believed in the implementation of IFS from which they might be able to generate income for their family. Most of the farmers (>50.77%) had experiences for more than 10 years in implementing the integration system of horticulture and dairy cattle and 86.15% of farmers stated that they relied upon the integration system of horticulture and dairy cattle as the main source of their families income.

Furthermore, the IFS was able to create empowerment for farmers, farmer groups, and cooperative community based social and economic value by utilizing dairy cattle waste for free. This finding was in line with the research that showed willingness to be volunteers strengthens power so that either
individual, group, or community who is becoming independent was a process of strengthening capacity towards empowerment or self-sufficiency [14]. Women farmers having experiences in implementing IFS of crop and cattle are able to get out of poverty [15]. Likewise, IFS is an efficient and environmentally friendly farming system accompanied by the development of local wisdom in the form of participatory technology development [16].

3.4. Socioeconomic factors affecting farmers’ participation in implementing IFS

The degree of participation of farmers implementing IFS of horticulture and dairy cattle varied (Table 3), as socioeconomic of the farmers was varied (Table 2) so that level of farm productivity was also varied (Table 1). The influence of socioeconomic factors on farmers’ participation in implementing the IFS is exhibited in Table 4.

Table 4. The influence of socioeconomic factors on the participation of farmers in implementing IFS

| Variable Socioeconomic Factors | Farmers’ Participation in Implementing IFS | Std Coefficient | t-value |
|--------------------------------|------------------------------------------|-----------------|---------|
| Constant                       |                                          | 0.249           |         |
| Age                            |                                          | -0.008          | -0.128  |
| Education                      |                                          | 0.032           | 0.258   |
| Experiences                    |                                          | 0.825           | 10.479*** |
| Farm Productivity              |                                          | 0.288           | 2.034** |
| Labor (non-family members) Involve |                                        | 0.149           | 1.640   |
| Land Tenure                    |                                          | 0.368           | -1.905* |
| R Squared                      |                                          | 25.177***       |         |
| Number of observation          |                                          | 0.726           |         |

Note: *** significant at 1% level, ** significant at 5% level, * significant at 10% level
Source: Primary data processed, 2019

The degree of participation of farmers in this study was measured based on variety of involvement in technical activities in the IFS of horticultural and dairy cattle to produce food, feed, fertilizer, and fuel products. Table 5 showed that in aggregate, factors of age, education, experience, farm productivity, labor requirements and land tenure significantly affected (P <0.01) the implementation of IFS. The result of multiple linear regression is as follows:

\[ Y = 0.249 - 0.008X_1 + 0.032X_2 + 0.825X_3 + 0.288X_4 + 0.149X_5 - 0.368X_6 + e \]

The significant effect of socioeconomic factors on the farmers’ participation in the implementation of the IFS was corroborated by the correlation coefficient of socioeconomic factors on participation \( R^2 \) which was 0.726. This finding was in line with some research that factors of experience, farm land size, and agro-ecological conditions significantly affected the participation of farmers in agricultural intensification programs [17;18].

However, separately, variables having a significant effect on the participation of farmers in the implementation of the IFS were experienced (P <0.01), farm productivity (P <0.05), and land tenure (P <0.10). As shown in Table 2, experiences of farmers in implementing the IFS were acquired by doing it all the time for a long time and they believed that they could rely upon it as the main source of income for their families. Experience is one of the determinants of human advantage in industrial competitive strategy and similarly, the efforts of farmers in increasing value added of their farming are still based on the experience of each farmer [19].

Furthermore, farming productivity significantly influenced farmers' participation in implementing the IFS of horticultural and dairy cattle. The highly productive farm had always been expected, as 86.15% of farmers stated that farming was the mainstay of family activities as the source of family income (Table 2). Therefore, farmers tried to maintain it by doing more participation in implementing
the IFS of horticultural and dairy cattle until efficient and sustainable farming was achieved. The concept of an integrated farming system by implementing 4 F (food, feed, fuel, and fertilizer) provides benefits for farmers [20]. However, the level of farm income does not affect the participation of farmers in soil erosion management [21].

On the other hand, land tenure had a negative influence on farmers' participation in implementing the IFS of horticultural and dairy cattle. It was presumably that the more extensive the farming land to be controlled, the less the family member to be involved in doing farming; therefore, the participation in implementing the IFS was becoming less. Similar result showed that land tenure factors negatively affect the participation of farmers (men and women) in rice cultivation [22].

4. Conclusion
Based on the results of the study, it can be concluded that the participation of farmers in implementing the IFS of horticultural and dairy cattle can be classified as medium. The factors of age, education, experience, farm productivity, labor involved, and land tenure together have a very significant effect on the participation of farmers in the implementation of the IFS. Partially, only experience factors had a very significant effect (P <0.01), while farm productivity had a significant (P <0.05) effect, and land tenure has a negative effect (P <0.10) respectively on farmer participation in the implementation of the IFS.

5. Suggestion
Efforts need to be made to increase farm productivity so that farmers' participation in the adoption of horticultural and dairy farming integration systems is increasing.

6. Acknowledgment
The author would like to deliver an appreciation to the Faculty of Animal and Agriculture Science, Diponegoro University, Semarang, Indonesia for funding research.

References
[1] Syahyuti, Sunarsih, S Wahyuni, W K Sejati and M Azis 2016 Kedaulatan pangan sebagai basis untuk mewujudkan ketahanan pangan nasional. Forum Penelitian Agro Ekonomi 33(2): 95-109.
[2] Deswanti R H and R Triyanti 2015 Tingkat partisipasi masyarakat dalam pelaksanaan Pengembangan Usaha Mina Pedesaan (PUMP) pengolahan dan pemasaran hasil perikanan. J. Sosial Ekonomi Kelautan dan Perikanan 10(1): 125-136.
[3] Ahmed Y E, A B Girma and M K Aredo 2016 Determinants of smallholder farmers participation decision in potato market in Kofele district, Oromia region, Ethiopia. International J. of Agricultural Economics 1(2): 40-44.
[4] Sowerwine J, D Sarna-Wojcicki, M Mucioki, L Hillman, F K Lake and E Friedman 2019 Enhancing Indigenous food sovereignty: A five-year collaborative tribal-university research and extension project in California and Oregon. J. of Agriculture, Food Systems, and Community Development 9(2): 167-190. https://doi.org/10.5304/Jafscd.2019.09B.013
[5] Suhardjo B 2013 Statistika terapan. Yogyakarta: Graha Ilmu.
[6] Usman H and P S Akbar 2000 Pengantar statistika. Jakarta: Bumi Aksara.
[7] Siswati L and Nizar R 2012 Model pertanian terpadu tanaman hortikultura dan ternak sapi perah untuk meningkatkan pendapatan petani. Jurnal Peternakan Indonesia 14(2): 379-384.
[8] Cruz E, E Quinga, I Arnelas, E Ibarra and D Risko 2016 Sustainability assessment of two system of ecological farming in the province of Tungurahua, Ecuador. Livestock Research for Rural Development 28(7).
[9] Manjunatha S B, D Shivmurthy, S A Satyareddi, M V Nagaraj and K N Basavesha 2014 Integrated farming system – An holistic approach : A review. J. of Agriculture and Allied Sciences 3(4): 30-38.
[10] Sulewski P, A Kloczko-Gajewska and W Sroka 2018 Relation between agri-environmental,
economic ans social dimensions of farms’ sustainability. *Sustainability* 10: 4629. DOI: 10.3390/su.10124629

[11] Sage C 2014 The transition movement and food sovereignty : From local resilience to global engagement in food system transformation. *Journal of Consumer Culture* 3. DOI: https://doi.org/10.1177/1469540514526281

[12] Eddy B T, Roessali W and Marzuki S 2012 Dairy cattle farmers’behaviour and factors affecting the effort to enhance the economic of scale at Getasan Distric, Semarang Regency. *Journal of the Indonesian Tropical Animal Agriculture* 37(1): 34-40.

[13] Dolewikou R I, Sumekar W and Setiadi A 2016 The Profitability analysis of dairy cattle business on the group of dairy farmers in West Ungaran District Semarang Regency. *Journal of the Indonesian Tropical Animal Agriculture* 41(4): 216-223.

[14] Mardikanto T 2010 Konsep konsep pemberdayaan masyarakat. Surakarta: UNS Press.

[15] Soni R P, M Katoch and R Ladohia 2014 Integrated farming system - A review. *J. of Agriculture and Veterinary Science* 7(10): 36-42.

[16] Ansar M and Fathurrahman 2018 Sustainable integrated farming system : A solution for national food security and sovereignty. *IOP Conference Series: Earth and Environmental Science* 157: 012061. DOI:10.1088/1755-1315/157/1/012061

[17] Nahayo A, M O Omondi, X Zhang, L Li, G Pan and S Joseph 2017 Factors influencing farmers’ participation in crop intensification program in Rwanda. *J. of Integrative Agriculture* 16(6): 406-416. DOI: https://doi.org/10.1016/S2095-3119(16)61555-1

[18] Rondhi M, J M M Aji, A F Hasan and R Yanuarti 2020 Factors affecting farmers participation in contract farming : The case of Broiler Sector in Indonesia. *J. of Tropical Animal Science* 43(2): 183-190. DOI: https://doi.org/10.5398/tasj.2020.43.218.3

[19] Lasalewo T, N A Masruroh, Subagyo, B Hartono and H A Yuniarto 2016 The effect of competitive advantage and human advantage on industrial competitive strategy (Case Study : SMIs in Gorontalo Province). *J of Indonesian Economy and Business* 31(3): 307-324.

[20] Sumarsono, Yafizham and D W Widjajanto 2017 The level of organic farming technology at farmer group in Ketapang village, Susukan sub-district, Semarang district, Central Java Province, Indonesia. *IOP Conf. Series : Earth and Environmental Science* 102: 012078. DOI: 10.1088/1755-1315/102/1/012078

[21] Janeth C, E Saina, S Kebene and W Chepng’eno 2019 Socio-economic factors influencing participation by farm households in soil erosion management in Chepareria Ward, West Pokot County, Kenya. *J. of Agriculture and Environmental Sciences* 8(2): 75-85. DOI: 10.15640/jaes.v8n2a10

[22] Anshu and Varma 2017 Involvement of man and women in paddy cultivation operation. *International Journal of Scientific and Research Publications* 3(10): 36-40.