Digitization of Sustainable Smallholder Oil Palm Plantations
Towards Modern Oil Palm Cooperatives

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Abstract. Based on palm oil producers in Indonesia, private plantations are the largest national producers (54%), followed by smallholders (39%) and state-owned plantations (7%). In managing smallholder oil palm still have limited access to technology, production facilities, institutions, and marketing. With the system of digitizing sustainable smallholder, it is designed to transform the business processes carried out by oil palm farmers who join cooperatives into digital work patterns while still providing a permanent role and appreciation for their work from farmers and for farmers. The research was carried out in the KUD Tunas Muda, Teluk Merbau Village, Dayun District, Siak Regency, Riau Province, and was planned for three years. In the first year, the research objectives were to socialize the digital system; identification of smallholder oil palm plantation production factors; and record assistance in the implementation of input-output. The socialization activities showed that most farmers (80%) were very enthusiastic about this program. Farmers understand the factors that affect FFB production. Assistance in recording the implementation of inputs and outputs for smallholders is carried out to representatives of farmer groups using laptops or computers.

1. Introduction

Agro-maritime is a concept that integrates Indonesia's land and sea dimensions, especially in Natural Resources. As the world's largest palm oil-producing country, Indonesia cannot be left behind in the implementation of the 4.0 industrial revolution. Among the three palm oil producer groups in Indonesia, private plantations are the largest national producers (54%), followed by smallholders (39%) and state-owned plantations (7%). In the management of smallholder oil palm, especially ex-plasma and independent smallholders, they still have limitations in access to technology and institutions [1]. The digitization of Sustainable Smallholder Oil Palm Plantations is designed to transform the business processes carried out by oil palm farmers who join cooperatives into a form of digital work patterns while still providing roles and appreciation for their permanent work from
farmers, by farmers, and for farmers, so that smallholder oil palm plantations are industrial-based agricultural activities. era 4.0 [2]. The agribusiness system includes four subsystems as follows: (1) Upstream agribusiness subsystem (up-stream agribusiness); (2) Subsystem of primary agriculture (on-farm agribusiness); (3) downstream agribusiness subsystem (down-stream agribusiness); and (4) Subsystem for agribusiness service providers (agribusiness services) [3]. The four subsystems are integrated into a digitalization where the smallholder business institutions are part of a larger national oil palm agribusiness process. The study of the digitalization system for smallholder oil palm plantations is planned for three years consisting of 6 focuses, namely agronomy, smart farming, water management and conservation, institutions, knowledge management system (KMS), and the environment.

The research objectives in the first year in detail were (1) socializing the digital system of smallholder oil palm; (2) identification of smallholder production factors; (3) assistance for recording the digitalization of the input-output implementation of smallholder oil palm plantations.

2. Methods

2.1. Time and location

The research will be carried out at KUD Tunas Muda, Teluk Merbau Village, Dayun District, Siak Regency, Riau Province. The tools used are in the form of GPS, tablets/smartphones, maps, drones, stationery, computers/laptops, meters, and questionnaires. The research will be carried out for 3 (three) years, and in this first year, it will be carried out from June - November 2020.

2.2. Method of developing smallholder digitalization system application

The focus of developing this application was creating a smallholder digitalization system that can facilitate and accelerate the processing of digital data related to oil palm managed by the people. This application can be used by farmers, administrators, extension workers, market players, and the community to process and access digital data through information technology tools.

The system development used the Software Development Life Cycle (SDLC), which combines the Waterfall and Rapid Application Development (RAD) methods. The waterfall method consists of 6 stages, namely: Planning, Analysis, Design, Development, Implementation, and Maintenance. Whereas in the RAD method, the stages used are the modeling process (carried out at the Analysis stage), Application generation (carried out at the Development and Implementation stages) and Testing and Turn Over (carried out at the Maintenance stage). The stages of application development and a framework in system development can be seen in Table 1.

| No. | Stage             | Activity                                          | Objective                                           | Output                                      |
|-----|-------------------|---------------------------------------------------|-----------------------------------------------------|---------------------------------------------|
| 1.  | Planning          | Planning the right model and conducting a feasibility study | The data model for the digitalization system for smallholder oil palm | 1. Notulent  
|     |                   |                                                   |                                                      | 2. Form                                    |
| 2.  | System Analysis   | Conduct further analysis to obtain more detailed functional and non-functional requirements specifications through various methods such as interviews | Integrated and comprehensive conceptual data model (ERD/EERD) and user output requirements | SKPL documents, in the form of:  
|     |                   |                                                   |                                                      | - BPMN                                      |
|     |                   |                                                   |                                                      | - Data Flow Diagram,                       |
|     |                   |                                                   |                                                      | - Entity Relationship Diagram (ERD)        |
| 3.  | Design (Conceptual, Logical, and) | Make detailed design specifications, programs, data structures, the | Database logic design (relationships between entities, transactions, | SKPL documents, in the form of:  
|     |                   |                                                   |                                                      | - Design (logic) of                      |
| No. | Stage | Activity | Objective | Output |
|-----|-------|----------|-----------|--------|
| Physical | technology used, and system design as needed | forms, displays, views, data and application integrity and security | the Keswan database - System UI design - UI based system output mockup - Installation and Implementation of the DBMS - Design - Template implementation (outline) based on the mockup. |
| 4. | Implementation | Creating operational programs according to the specifications specified in the design phase, documentation (technical and non-technical), and training materials | Database implementation, database program, application, documentation, installation, transformation, and system migration | 1. Deploy smallholder database to the DBMS on the server 2. Implementation (coding) of the application of Digitalization of smallholder palm oil. |
| 5 | Data Migration | Inputting (Entry/ Loading) existing data into the application database and integrating it with existing ones | Entering new data and integrating with existing data (if any) and database migration according to application needs | Entering data for application needs |
| 6 | System Testing (UAT) | Conducting application trials to several users | Test all functional requirements that have been made | UAT Test Documents |
| 7 | Deployment | Perform system installation | Document installation |
| 8 | Technical Guidance (Bimtek) | User training and testing of all user levels | Training and system testing for users, such as farmers and related agencies. | User Manual Documents |
| 9 | Maintenance | Maintaining a system that has been installed on the server and users. | This maintenance is expected to be sustainable to ensure the system continues to run and functions according to the target outputs and research outcomes for the benefit of smallholder oil palm | Research Report |
2.3. Data collection
This study has used primary and secondary data with qualitative and quantitative research methods. Primary data was obtained by surveying respondents, namely independent oil palm planters and those who are members of KUD Tunas Muda. The determination of respondents to oil palm planters was carried out by purposive sampling by considering the condition of the farmers’ oil palm plantations. The number of respondents was 35 farmers representing 11 farmer groups.

Data were collected by conducting interviews, discussions with the management and members of the KUD Tunas Muda cooperative, farmer groups, and oil palm farmers. Production factor data collected included seed authenticity, fertilization data, pest control, weed control, and harvest methods.

2.4. Smallholder farmers assistance
Smallholder farmer assistance is carried out to representatives of each farmer group in the KUD Tunas Muda. Mentoring activities include filling in production input-output data into a computer/laptop and tabulating the Excel program’s input-output data. Descriptive qualitative and quantitative methods carried out data analysis.

3. Results and discussion

3.1. Socialization programs
The field activities carried out until September 16, 2020, in this study include team consolidation, socialization of activity plans, hearings, data collection, data analysis, and data processing.

Team consolidation activities were carried out to equalize perceptions and views among the research team, assign assistants, and administrative and technical personnel. Activities carried out consist of online and offline meetings, preparation of field activity plans, and preparation of materials and equipment.

The socialization activity was carried out on August 9, 2020, at KUD Tunas Muda, Teluk Merbau Village, Dayun District, Siak Regency, Riau Province. At the time of the socialization, it was attended by the Head of Teluk Merbau Village (Penghulu), the Chairperson and administrators (secretary, treasurer) of KUD Tunas Muda, farmer groups members of KUD Tunas Muda, the Chairperson and secretary of KUD Tandanmas Jaya. Socialization activities are carried out directly and indirectly online (zoom meeting) with the LPPM leadership and experts who cannot attend directly. At the time of the socialization, it was explained about the research activity plan, the benefits for the cooperative and its members to become a modern/advanced digital-based cooperative. Discussions were held openly and also conveyed about the role of IPB, cooperatives (KUD) and villages in realizing these activities. IPB, through research activities, will provide assistance and transfer of digitalization technology, while cooperatives (KUD) and villages are expected to support the equipment needed by KUDs such as drones, GPS, computers/laptops. The socialization activities showed that most (more than 80%) farmers were very enthusiastic and interested in this research plan.

Hearing activities to the Regional Government of Siak district should have been held at the end of July 2020, but because the Siak area has experienced an increase in covid-19, it has been postponed until conditions allow. Hearing activities to the Regional Government of Siak Regency can only be held on September 7, 2020, at the Agriculture Service Office, Siak Regency, Riau Province. The audience was attended by the Deputy Head of the Regional Development Planning Agency (Bappeda) of Siak Regency, the Head of the Siak Regency Cooperative Office and Staff, the Deputy Head of the Siak Regency Agriculture Office, the Head of the Plantation Division of the Siak Regency and the Siak Regency Agriculture Service Staff. Audience activities are carried out directly and indirectly online (zoom meeting) with the LPPM leadership and experts who cannot attend directly. At the hearing, the research activity plan explained the benefits for the local government and cooperatives and their members to become a modern/advanced digital-based palm oil cooperative. Discussions were held openly and conveyed about IPB, Regional Government and Cooperatives (KUD) in realizing these activities. IPB through research activities will provide assistance and transfer of
digitalization technology; local governments are expected to provide infrastructure support such as communication network towers.

In addition to the local government of Siak district, an audience was also held to the Dayun sub-district head. The subdistrict head welcomed this activity positively and was ready to help/support its smooth running.

3.2. Information of the village
Teluk Merbau Village was located between 100°45 – 100°52 East Longitude and 0°25 – 0°32 North Latitude. The area of Kampung Teluk Merbau is approximately ± 1,627.5 ha. The distance from Teluk Merbau Village to the Dayun District Office ± 15 KM, to the Regency Capital ± 35 KM, and the provincial capital is ± 100 KM. Teluk Merbau Village is a low to medium land area, with a tropical climate, with an average daytime temperature of 31°C - 32°C with humidity of 90-100% and rainfall ranging from 780-2,461 mm/year.

3.3. Information of KUD Tunas Muda
Tunas Muda KUD was founded in 1990 with the legality of Legal Entity Number 105 / BH / PAD / KWK. 4 / 5.1 / II / 1996. KUD Tunas Muda is located at Teluk Merbau Village, Dayun District, Siak Regency, Riau Province. Currently, the number of KUD members are 411 families consisting of 19 farmer groups with a business area of 820 ha. The business units consist of savings and loans, convenience store businesses (waserda), transportation businesses, and general businesses (Table 2).

Table 2. KUD Tunas Muda Profile

| No | Item                      | Note                                                                 |
|----|---------------------------|----------------------------------------------------------------------|
| 1  | Cooperative Name          | Tunas Muda                                                            |
| 2  | Address                   | Teluk Merbau Village, Dayun Sub-district, Siak District               |
| 3  | Legality                  | Legal entity No. 105/ BH/ PAD/ KWK. 4/ 5.1/ II/ 1996                  |
| 4  | The number of member farmers | 411 families                                                   |
| 5  | Area                      | 820 ha                                                               |
| 6  | Business unit             | Savings and loans, waserda (convenience store business), transportation, and general business. |

Tunas Muda KUD was very supportive of this program [5] because:
• Currently, the KUD was conducting a replanting program from BPDPKS, whose communication is online.
• Implementing the digitalization program for smallholder oil palm farmers, it was hoped that it would make plant management activities easier, especially in providing treatment to plants, providing recommendations for input doses (fertilizers and pesticides) for oil palm plants, monitoring land conditions such as anticipating land fires, plant nutrient status, pests and diseases level, and others.

3.4. Interview results
Data collection and assistance activities that have been carried out in the field include:
• General condition of Teluk Merbau village
• The general condition of Tunas Muda KUD
• Determination of the plot sample area by determining the coordinates of each sample location using GPS
• Interview with respondent farmers to obtain input and output data on oil palm business
• Assistance by farmer group representatives on how to digitize input and output of oil palm business using the Excel computer program
The number of respondent farmers was 50 people representing 15 farmer groups from 19 farmer groups in the KUD Tunas Muda. Most of the respondent farmers are ex smallholder plantations of Buatan Plantation, PTPN V, who will start replanting their oil palm plantations. Based on the interview results, the production factors of smallholder oil palm Fresh Fruit Bunches (FFB) included the authenticity of the seeds (certified seeds), types and dosages of fertilizers, types, and doses of pesticides, weed control, and harvest equipment. The identification of fresh fruit bunch production factors showed that the production of fresh fruit bunches was influenced by 70% fertilizer factors, 5% weed control factors, 7% disease control factors and 3% equipment condition factors, and 15% infrastructure condition factors. Fulfillment percentage of respondents for input-output of smallholder oil palm business showed in Table 3.

Table 3. Fulfillment percentage of respondents for input-output of smallholder oil palm business

| No | Parameters | % fulfillment of respondents | Note |
|----|------------|------------------------------|------|
| 1  | The authenticity of the seeds (certified seeds) | 100 | PPKS (IOP) seed producers |
| 2  | Fertilization | 100 | a. NPK fertilizer 100 | |
|    |            |    | b. Organic fertilizer 45 | Empty bunch |
| 3  | Pest control | 100 | a. Pesticide 100 | |
|    |            |    | b. Biological control 60 | Beneficial plant and owl |
| 4  | Weed control | 100 | a. Manual 100 | |
|    |            |    | b. Chemical 100 | |
| 5  | Harvest methods | 100 | Standard | |
| 6  | Average FFB production per month/ha (ton/month/ha) | 100 |      |
|    | • > 2.0 tonnes FFB/month/ha | 55 |      |
|    | • 1.5 – 2.0 tonnes FFB/month/ha | 30 |      |
|    | • 1.0 – 1.5 tonnes FFB/month/ha | 10 |      |
|    | • < 1.0 tonnes FFB/month/ha | 5 |      |

Average FFB production per month / ha (tonnes / month / ha) = 2.1 tonnes FFB/ month / ha
Source: Field data

Most of the farmer groups that have joined the Tunas Muda KUD are plasma farmers, and some are independent farmers. The performance of farmer groups is presented in Table 4.

In the conventional farming system, farmers' access to production and marketing facilities was very low. Farmers are more focused on production activities, such as cultivating the land, planting, and harvesting. Outside, the activities, as mentioned above, were carried out and controlled by traders [6]. This situation was then exploited by these traders unfairly. The traders sold all production facilities to farmers at the highest possible price, either through credit sales or by bartering the product. These conditions were caused all of the profits, both from the subsystem of production facilities and from the subsystem of selling products, belong to the traders.

The agribusiness system was a system that integrates all existing subsystems. From upstream to downstream, it was symmetrical and functional so that the added value formed in each subsystem will all belong to the farmer. Likewise, market information and consumer preferences, and changes that occur can be transmitted and coordinated quickly in each existing subsystem.
Table 4. Farmers group performance

| No | Item                                      | Plasm farmers                                              | Independent farmers |
|----|-------------------------------------------|------------------------------------------------------------|---------------------|
| 1  | Access to production input providers     | Farm/ Agricultural shop                                    | Farm/ Agricultural shop |
| 2  | Financial access                         | Bank                                                       | Personal            |
| 3  | Stakeholder                               | • KUD Taunas Muda                                          | KUD Tunas Muda      |
|    |                                           | • PTPN V                                                   |                     |
|    |                                           | • The Regency Agriculture Service                          |                     |
|    |                                           | • PT. Sinar Agro Raya (SAR) mill                           |                     |
|    |                                           | • PT. Berlian Inti Mekar (BIM)                             |                     |
| 4  | Access to Information and Technology for List of updated FFB prices | List of updated FFB prices from the Plantation Office | KUD Tunas Muda, The Plantation Office, PPKS |
| 5  | FFB Sales Place                           | • Middleman                                                | Middleman          |
|    |                                           | • PT. Sinar Agro Raya mill                                 |                     |
|    |                                           | • PT. Berlian Inti Mekar mill                              |                     |
| 6  | Warehouse for FFB                         | Available                                                  | Not available       |
| 7  | Implementation of ISPO Certification     | On progress                                                 | Not yet             |

The development of a palm oil digitization system for smallholders will be oriented towards oil palm farmer groups' activities as the main player in producing palm oil, which was the raw material for sharing agro-industrial products. The raw materials produced were determined by the on-farm results so that farmers with farms should have a high bargaining position in determining the price of inputs and their agricultural products, but in reality, in the field, the upstream-downstream sector determines the price, while farmers remain as price followers. So that farmers were able to increase their productivity and gain added value.

4. Conclusion
Preparatory activities for digitizing sustainable smallholder oil palm plantations that have been carried out in the first year include hearings and program socialization to local governments, farmer interviews, farmer group assistance to computerize production input outputs, and collection of primary and secondary data.

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