The Application of Drying Technology Utilizes Integrated Energy Sources to Process Various Agricultural Products for the People of the Border Area in Talaud Islands Regency

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Abstract. Talaud Islands is a regency in North Sulawesi Province, which is the northernmost region of the Republic of Indonesia. The condition and geographical location make this area included in the category of frontier, outermost, and disadvantaged regions. Consequently, people of this region experience various limitations in utilizing local resources to meet their daily needs. A community service activity, Produk Teknologi yang Didesiminasikan ke Masyarakat (PTDM) scheme has been carried out in this area with the aim of applying technology that utilizes integrating sources of energy in the form of solar cells, gas, and closed furnaces in the processing of various agricultural food crop products (corn, soybeans, and beans) and plantations (nutmeg and cloves). The approach method applied in the implementation of this activity is a combination of pilot project methods and the application of technology products, especially cabinet-shaped dryer technology that utilizes integrated energy sources for postharvest processing of agricultural food crops and plantations. The technology resulting from the research and development of the implementation team can be applied to meet the needs of the people of the Talaud Islands. The following impact arising from PTDM activity is an increase in regional potential and community participation.

1. Introduction
1.1 Situation analysis

The Talaud Islands are the foremost and outermost regency in North Sulawesi Province. One of the islands of this regency is the northernmost island of Republic of Indonesia, namely Miangas Island. Bulude Village is precisely located in Kabaruan Subdistrict, Kabaruan Island (figure 1). According to data in Indeks Desa Membangun (IDM) in 2015, Bulude Village is categorizing as Desa Tertinggal (underdeveloped villages) with an index value of 0.592484 (villages are categorized as underdeveloped if IDM index values are in the range of > 0.491 and ≤ 0.599). Underdeveloped
villages are villages that experience vulnerability, such as economic shocks, natural disasters, or social conflicts [1].

The main factor that makes Bulude Village susceptible to vulnerability is its location on Kabaruan Island, which has limited accessibility because it is surrounded by oceans that experience a sea wave season for 6-7 months in 1 year, which results in a low level of affecting the community's economy. Beyond its limitations, the village of Bulude has potential in various fields, including agriculture and plantations. It is said to have the potential, even though this field has been passed down through generations because the community is still unable to optimize its production. In agriculture, the commodities produced are field rice, corn, soybeans, and various other commodities, while in the plantation sector, the main commodities are coconut, nutmeg, and cloves.

Coconut fruit is one of the leading commodities because it acts as a source of community economic income with processed products such as vegetable oil, raw materials for the food industry, pharmaceuticals, and others. The main processed coconut products produced by the community Bulude Village are still in the form of *kopra* (dried coconut flesh which will be processing into vegetable oil) with varying quality. The quality of *kopra* produced is high in variation because it is
very dependent on the drying process. The drying process that is generally carried out is still dependent on the weather [3-5]. During the dry season, the people of Bulude Village generally use the sun’s heat to dry the coconut flesh by drying it in the streets or other open spaces (figure 2A). Another case when the rainy season comes, drying is done by roasting coconuts on the fireplace. However, this method raises other problems, namely the unequally dryness of coconut flesh (some are charred, some are still high in water content), and also have an impact on environmental pollution.

Other plantation commodities, which are the mainstay of Bulude Village and other villages community in the Talaud Islands, are nutmeg [3,6]. There are three main components of nutmeg, which have economic value, namely seeds, fuli (mace, the membrane that encloses the seed shell), and nutmeg. The components of nutmeg have varying market prices, the order of market prices from the highest to the lowest per kilogram of dry weight, namely mace, seeds, and flesh. Drying mace, seeds, and nutmeg are carried out by the community as well as coconuts, by drying them on the streets and other open spaces (figure 2B). The weakness of this drying process, besides not being able to control the decrease in water content, the drying time also uneven because it depends on weather conditions [6].

Figure 2. Pictures of post-harvest handling of agricultural and plantation products in the Bulude Village, such as A) coconut flesh; B) nutmeg flesh and seeds; C) clove; D)
soybeans; E) corn and F) field rice. Generally, agricultural and plantation products such as corn, coconut, nutmeg, and cloves are only dried in the yard and roadside, while soybean and field rice is allowed to grow until they dry up at the planting location.

Besides coconuts and nutmeg, clove plants are also a mainstay commodity in supporting the economy of the people of Bulude Village and other villages in the Talaud Islands Regency [3,7]. These three mainstay plantation commodities are generally marketed by selling to collectors, which has an impact on depressed selling prices when compared to market prices in general. One of the problems related to the marketing of cloves is that the quality of the dried cloves produced is sometimes uneven and is below the market demand standard. Sub-standard quality of dried cloves is generally caused by the clove harvest season occurring in the middle of the year, where the rainy season is still ongoing. Clove farmers who generally dry their cloves only depend on the availability of sunlight; of course, they will be overwhelmed by these conditions.

The problem of quality degradation due to post-harvest handling that has not been optimal is not only experienced by plantation commodities, agricultural food crops (such as field rice, corn, and soybeans) also experience the same thing. The most dangerous impact due to less optimal handling of post-harvest agricultural and plantation commodities in the rainy season is easily contaminated with toxic fungi, which then develop and produce mycotoxin compounds. This compound is classified as a poison that can cause damage to the structure of hepatocytes and impaired liver function for the organisms that consume them. One of the efforts to handle post-harvest agricultural and plantation products is a controlled drying system [8-11].

1.2. Objectives and goals

1.2.1. Objectives. The objectives of PTDM activities are as follows:

1) Improving the knowledge and skills of partner group members about postharvest handling using dryer technology with integrated energy sources to produce postharvest products of agricultural food crops and plantations that meet quality and health standards;

2) Facilitating the construction of the drying chamber installation and the making of dryers that utilize integrated energy sources; and

3) Increasing the economic income of the farmers of food crops and plantation.

1.2.2. Goals. The goals of PTDM activities are as follows:

1) Facilitated the supply of installation of cabinet-model dryer based on integrated energy using solar cells, gas stoves, and covered furnaces;

2) Disseminated the technology of dryer based on integrated energy sources to improve the quality of the agricultural postharvest product so that they meet the standards; and

3) Formed the new entrepreneurs based on the handling of post-harvest products of food crops and plantations that are equipped with knowledge about the management of group business administration.

2. Methods of implementation

2.1. Parties involved in the activity

The main parties involved and the targets of this activity were the farming communities that were members of the Eklesia Farmers Group (37 people) and the Sengkanaung Farmers Group (25 people). Other parties involved were village government officials and community leaders.

2.2. Methods and stages of activity

Approach methods applied in the implementation of PTDM activities are a combination of Participatory Rural Appraisal, and Rapid Rural Appraisal approaches [12-14], appropriate technology [15], and pilot projects. The stages of activities carried out include focus group discussions, socialization, dissemination, and pilot project practices.
2.3. Description of disseminated technology product

Integrated drying technology is a drying system with an energy source that is a combination of solar energy, a source of heat energy that comes from a gas stove, and a closed furnace. Dryers are designed in the form of a cabinet with multi-level shelves as needed. Solar energy dryers consist of 4 main parts: collectors, plenum chambers or heat collectors, drying chambers, and vents. The collector used will convert solar energy into thermal energy [16], thereby reducing dependence on electricity and fuel oil. The air inside the collector's room is not confused with the outside air because it is tightly closed, so the hot air heats the shelves arranged inside the collector's room. At the base of the collector is equipped with a fan that serves to flow heat from the absorbent plate to the drying chamber. Furthermore, to reserve heating energy, a gas stove is used, the dryer can still be used during the rainy season or at night. This artificial dryer, besides to overcome the effects of weather (high relative humidity throughout the year), This artificial dryer also intended to improve the quality of the drying results [17-19].

2.4. Operational work procedures

2.4.1. Preparation. Preparation begins with a discussion of the program and the work steps of the implementing team, starting from the division of tasks and responsibilities based on the competencies of each member to administrative preparation and supporting tools. Next, the implementation team compiles an instrument used as a reference in capturing accurate information or data about the partner's fundamental problems. Other preparatory steps are to unify perceptions about the program to be run, and preparation of materials and tools to use in the implementation of activities.

2.4.2. Focus group discussion and socialization. The focus group discussion was carried out by the implementation team with an audience of farmer group members to formulate actual problem solving using instruments that have been prepared previously. Furthermore, the team carried out the program socialization to members of the farmer groups, village government officials, and community leaders.

2.4.3. Learning and Practice. The next step after the socialization, the team educated members of the farmer groups through learning and practical implementation of science and technology. This step was going through lecture, discussion, and simulation methods with audiovisual media. Furthermore, the practice is carried out, starting from the design and construction of the dryer chamber to the design and manufacture of integrated dryers.

2.4.4. Technology implementation. After the dryer, the chamber has been built, and the dryer has been made, activities will continue with the technology implementation beginning with a demonstration of the introduction of the workings and functions of the dryer. The farmer group members immediately practiced the dryer to process coconut and nutmeg harvests accompanied by the team.

3. Results of the implementation of activities

3.1. Outputs

Through PTDM activities, several outcomes have been obtained, including:

1) An increase in community knowledge and skills on postharvest technology for drying crops and plantations using an integrated energy-based dryer with a drying time that can be controlled and the results meet quality and health standards;

2) Facilitation of technology packages in the form of a production chamber with dimensions of length, width, and height of 4 x 3 x 3 meters, respectively. The installation is not only a place for drying machine for the production process but also as a workspace and a place for storing agricultural products which have been dried or not; and
3) Facilitation of design of 1 unit of cabinet dryer with dimensions of length, width, and height of 2 x 0.5 x 1.70 meters, respectively. With this dryer, the limitation of drying capacity can be avoided because the drying time is shorter and can be controlled, product quality can also be maintained so that it can meet the standards.

3.2. Outcomes
3.2.1. Functions and benefits of technology products. Based on the results of the initial evaluation, most of the community (90%) were not familiar with the technology of drying agricultural products using various sources of energy, other than sunlight. During this time, no effort has been made to improve the drying process when the harvest and rainy season arrives. People often suffer losses, especially from the high level of damage caused by the drying process, which could not be done properly when the rainy season arrived. The level of damage to materials during harvest and the rainy season reaches 30-40%, and this has been going on for years without adequate treatment. Through this PTDM activity, community resources and productivity (quality and quantity) of post-harvest agricultural products have increased. In terms of productivity, positive impacts arising in the form of increased production capacity, uniform drying results, and an emphasis on drying time.

3.2.2. Economic and social impact. The process of drying agricultural products is an important part of postharvest handling because it plays a role in improving the quality and quantity of agricultural food crops and plantations. The economic impact of this DPTM activity is an increase in added value, quality, quantity, and product competitiveness, without being influenced by weather and time factors. The real social impact felt by the community is that the partner group does not only use the facility members but also by other communities in the Village of Bulude. This facility has become a new field of work and a place for friendship in strengthening the spirit of community cooperation.

Figure 3. A series of processes for the construction of a drying chamber unit for postharvest products: A) the making of foundations and floors; B) installation of poles, walls, and frames of door and window; C) installation of the roof; and D) finishing of building construction.
3.2.3. Contribution to other sectors. Drying facilities using integrated energy sources have become a source of learning, not only for members of partner groups but also for people in the Village of Bulude, even communities from various villages in Kabaruan Island. In general, people come to learn, especially want to understand the technology in terms of construction, efficiency, and usefulness.

3.3. Lesson learned
The appropriate technology applied through PTDM activities has succeeded in changing the habits of the people of Bulude Village from postharvest handling by drying agricultural food crops and plantations, which are still traditional with drying techniques relying on sunlight in a more modern direction using a dryer based on integrated energy sources. This change has an impact on increasing people's economic income. The application of appropriate technology in various fields of agriculture as a form of community empowerment in Kabaruan Subdistrict has been carried out by members of the implementation team before PTDM activities are carried out, including the technology of soybean cultivation [20], vegetables [21], field rice [22], and corn [23].

From various community empowerment activities in agriculture, both through this PTDM activity and through activities that have been carried out before, the selection of learning approaches and the application of appropriate technology as a form of technology transfer has a very important role in the successful implementation of activities. The people of Bulude Village have their traditions according to their characteristics in the agricultural business although sometimes they face various challenges in increasing productivity. The implementation of community empowerment activities needs to pay attention to the characteristics of the community so that the process of technology transfer to take the community from traditional habits to the modern can be carried out well.

Figure 4. A series of processes for the manufacture of cabinet dryers that utilize a variety of integrated energy sources: A) designing the cabinet frame; B) manufacturing cabinet frames; C) installing wall cabinet, and D) finalizing the cabinet dryers.
4. Conclusions and recommendation

4.1. Conclusions

The PTDM activities that have been carried out in the framework of the application of dryer technology products that utilize a variety of integrated energy sources for handling post-harvest agricultural and plantation commodities are a form of empowerment of Bulude Village community that produces various outcomes in the form of facilitation, such as 1) increasing aspects of human resources in terms of knowledge and community skills in dealing with post-harvest problems; 2) providing 1 unit of the installation building as a place for drying machines; and 3) making of 1 unit of dryer that utilizes various integrated energy sources. Postharvest handling through the application of technology can streamline time and energy which increases people's economic income.

4.2. Recommendation

The PTDM activities in Bulude Village are going well, but for the benefits to continue to be felt by the community, it is necessary to provide continuous assistance from various parties, especially from universities, through upgrading technology based on community needs.

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