A study on superior-environment friendly red potato production development

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Abstract. Hasanuddin University team has succeeded in applying the seed production technology of the Kentang Raja - known as the Red Potato - through tissue culture technology seed production can be driven 5-fold over conventional systems; the seeds of the Red Potato G0 have been tested. The long-term outcomes of the research are: (1) strengthening the role of farmers in a sustainable manner in the environmentally friendly Red Potato agribusiness in South Sulawesi; and (2) establishing a business network as a partner of Red Potato farmers, and a participatory farmer-based synergy to develop sustainable Red Potato agribusiness in South Sulawesi. The research findings were: (1) net income of Red Potato farm of IDR. 43,701,700 per hectare per season at cost efficiency (R / C-ratio) of 1.92; large production costs are the costs of seed and labor; labor costs represent 1/3 of the value of revenue after deducting the cost of production facilities; (2) the general distribution pattern of Red Potato production is the pattern in which the Red Potatoes from the farmers are sold to Large Traders, then sold to Retailers and Consumers in traditional markets of Makassar, this pattern runs relatively constant, business networks. The research suggests (1) Red Potato commodities as new varieties produced by Hasanuddin University, the farmers need to get subsidized seed prices from the government in order to increase farmer’s income and more vigorously develop Red Potato commodities; (2). The Gowa Regency Government needs to continuously improve the services to farmers and farmer groups through increasing the activities of the Agricultural/Rural Training Center and the Agribusiness Sub-Terminal.

1. Introduction
Potato commodities are included in commodities with high economic value. Therefore, many farmers or investors began to invest in cultivating it. Its use which is quite varied plus it’s very important role for diabetics makes it much sought after and valuable enough among other agricultural commodities [1]. One type of potato variety is red potatoes. Red potatoes contain more carbohydrates and have lower water content. This makes processed red potatoes chips and other foods will be more savory and delicious. besides that in red potatoes there are some sodium content, as a source of vitamins C and B1, phosphorus minerals, iron and potassium. In terms of cultivation, red potatoes are more resistant to pests or diseases so that it is one of the important vegetable commodities that has...
prospective business opportunities [2]. According to [3], despite having an advantage, red potato production is still limited. Red potatoes are cultivated in the Dieng Mountains region, Central Java, Bengkulu and Solok District (West Sumatra). One reason that not many farmers have grown red potatoes is the difficulty of getting red potato seeds and the price tends to be more expensive than the price of ordinary potato seeds [4].

Hasanuddin University Team has successfully implemented the technology of King Potato seed production, another name for red potatoes, through tissue culture technology, which can then be synergized with aeroponic technology to produce G0 source seeds. By using this technology, the production of G0 seeds can be pushed five times compared to conventional systems. G0 seeds of red potatoes have been field-tested limited in North Toraja and produce an average production of 25 tons/ha [5].

In the 2015 Intensive Research Program, the University of Hasanuddin and the Research and Development Agency of South Sulawesi Province carried out purification and development of the superior seeds of the Red Potatoes in North Toraja and Toraja Regencies in collaboration with the North Toraja Regional Government to build Potato Seed Garden Installation facilities and local farming communities [6,7]. To encourage optimal and environmentally friendly productivity, the introduction of synergic technology packages has been used such as the utilization of organic fertilizers, decomposers, bio stimulators and biopesticides so that through the technology package based on local wisdom can increase crop productivity sustainably, support environmentally friendly farming systems, increase farmers’ income and more stimulating the economy of the community [5].

Research results of Rukmana et al. (2013) [8] show that (1) the problem at the level of potato farmers is the lack of capital, especially for seed and labor financing; (2) farmer groups are still weak in accessing potato production inputs and determining the selling price of products produced by farmers; (3) potato farmers tend to manage and search for potato farming partners individually; (4) potato farmers need socio-economic institutions as funding partners and technology transfer in potato seeding; and (5) socio-economic institutions prioritized to be organized and strengthened are groups of farmers and agricultural cooperatives at the local level.

To develop red potato commodities, especially in South Sulawesi, Research Center for Agricultural Biotechnology, Hasanuddin University in collaboration with PT. Labiatae Indah in the Malino District, Gowa, which produces superior red potato seeds from tissue culture; therefore, accurate information is needed regarding the socio-economic study of the development of the Red Potatoes superior variety produced by Hasanuddin University [9]. The long-term goals of this study are: (1) the strengthening of the role of farmers in a sustainable manner in the development environmentally friendly red potato agribusiness in South Sulawesi Province; and (2) the establishment of business networks of red potato farmer partners, and synergy based on participatory farmers to develop sustainable red potato agribusiness in South Sulawesi.

2. Method
This research was carried out in Gowa Regency, Indonesia, namely in Bulu Balle Village Malino Area - Tinggi Moncong Subdistrict. Determination of the location of the study was done intentionally (purposive sampling) with the consideration that the location is the central area of Red Potato production in Gowa Regency. This research is a qualitative descriptive study. The survey research method is used as the basis for research design. Data collection is done by using individual interviews, in-depth interviews and through FGD (focus group discussion) for economic business institutions, policymakers and stakeholders. For individual interviews, respondents were grouped into groups of farmers, traders, actors providing red potato seeds. The use of the Focus Group Discussion (FGD) method is carried out to obtain comprehensive data and information. SWOT analysis is carried out to develop a sustainable strategy for developing red potato agribusiness [10].
3. Results and Discussion

3.1. Research Site
In the District of Tinggi Moncong, Gowa Regency, the highest rainfall occurs in December and January. However, in abnormal conditions rainfall often occurs earlier, namely in November and December, and the highest rainfall occurs in January, February and March. While the lowest rainfall occurs in July, August and September. According to the climate division by Koppen which is based on monthly and annual temperature conditions, the Tinggi Moncong Sub-district categorized as type A climate which has an average monthly temperature between 15ºC - 20ºC, with an average rainfall of 2,800 mm / year. It has altitude between 1,200 - 1,500 meters above sea level with climate type A, that suitable for potato plant growth.

Gowa Regency is the largest producer center area for potato commodities, including red potatoes, in South Sulawesi with total potato production in 2016 amounting to 345,396 tons or 69.07% of the total potato production in South Sulawesi Province which reached 499,950 tons. In addition to potatoes, Tingggi Moncong Subdistrict is also a production center for various types of highland vegetables, scallions, Chinese cabbage / mustard greens, chillies, tomatoes, eggplants, cucumbers, kale, and others. Potato production in Gowa Regency is still fluctuating. In 2013 and 2014 potato production - including red potatoes – decreased dramatically compared to the previous year; but in 2015 and 2016 potato production increased significantly.

3.2. Farmers and Analysis of Red Potato Farming
The characteristics of red potato farmers shown in table 1. The average age of red potato farmers is 37.4 years with an equivalent level of junior secondary education and has an average family burden of 4 people. Their experience of potato farming is long enough for about 15 years even though the main experience is planting potato crops, while their experience in growing red potato plant has only for the past 2.5 years. The average area of land cultivated by farmers to grow vegetables is 1.2 hectares.

| Item                      | Description                | Average |
|---------------------------|----------------------------|---------|
| 1. Age (year)             |                            | 37.4    |
| 2. Farming experience:    |                            |         |
| - General (year)          |                            | 15.0    |
| - Potato (year)           |                            | 12.5    |
| - Red Potato (year)       |                            | 2.5     |
| 3. Education Level        |                            | 8.5     |
| 4. Dependent of household (person) |            | 4       |
| 5. Land managed (hectare) |                            | 1.25    |

Table 1. Characteristics of red potato farmers

Table 2 shows that red potato farmers in the Malino Region - Gowa Regency earn a net income of Rp.43,701,700, - /ha/season with a cost efficiency (R/C) of 1.92. Large production costs are the cost of red potato seeds and labor. Seed costs are around 33% of the total costs incurred by farmers, and labor costs account for 46% of the total costs.

| No.  | Item          | Unit | Qty  | Price (Rp) | Total Value (Rp) |
|------|---------------|------|------|------------|------------------|
| 1.   | Yield/season  | Kg   | 13,000 | 7,000     | 91,000,000.-     |

Table 2. Analysis of average cost and income per acre of farmers' red potato farming
2. Production inputs:

| Item                  | Unit | Quantity | Cost  
|-----------------------|------|----------|-------|
| Seed                  | Kg   | 1,300    | 12,000| 15,600,000.00 |
| Manure                | Kg   | 4,000    | 800   | 3,200,000.00  |
| NPK                   | Kg   | 400      | 2,400 | 960,000.00    |
| ZA                    | Kg   | 600      | 2,000 | 1,200,000.00  |
| POC (Hi-Tech)         | Ltr  | 20       | 60,000| 1,200,000.00  |
| Biopesticide          | Ltr  | 25       | 70,000| 1,750,000.00  |
| Bio-insecticide       | Ltr  | 25       | 60,000| 1,500,000.00  |
| **Subtotal**          |      |          |       | 25,410,000.00 |
| Labor/season          |      |          |       | 21,863,300.00 |
| Fixed cost:           |      |          |       | 25,000.00     |
| Land tax/season       |      |          |       | 47,298,300.00 |
| **Total Cost**        |      |          |       | 43,701,700.00 |
| **Net income (1 – 5)**|      |          |       | 1.92          |

### 3.3. Red Potato Marketing Channels

There are six wholesalers who are the main customers of farmers in the Malino Region with a trading volume of 100 tons in the harvest season. The sale of red potatoes to Makassar, is also often collaborated with Idris Daeng Diri because these traders have trucks and are relatively more active in picking up crops on farmers’ land with pickup trucks with a capacity of 1.5 tons. Collection of red potato yields is important because the location of land managed by farmers is not on one stretch but spread on a relatively small scale, for example the harvest area is 0.25 ha - 1.0 ha. Each farmer who manages a relatively large area or above 1.0 ha also fosters other small farmers, especially to access red potato seeds. Idris Daeng Diri (40 years) as one of the wholesalers for the commodity of red potatoes in the Malino Region by using a trading business company UD. Eka Jaya, at Hala-Halaya Hamlet, Kanreapia Village, Tombolo Pao District, Gowa Regency, is about 3 km away from production centers in Bulu Ballea Village. Another trader was H. Bahar (56 years), in Pattapang Urban Village, Tinggi Moncong Subdistrict, he collaborate with Idris Daeng Diri to send red potatoes to Makassar once per week on Thursday.

Red potatoes were purchased from farmers belonging to the Hala-Halaya Farmers Group in Kanreapia Village and Gema Tani Farmers Group Bulu Ballea Village, for Rp. 7,000, per kilogram by way of a delayed payment, ie payment is made after 7-10 days after receiving payment from Makassar. The purchase capital of potatoes by the collector is from a large trader, and the collecting trader makes a profit of Rp. 500,-/kg. This model is limited to large traders at the local level. Channels for marketing red potatoes from farmers to consumers can be divided into three marketing channels:

- The first channel: farmers, retailers, consumers
- The second channel: farmers, wholesalers, retailers, consumers
- The third channel: farmers, collectors, wholesalers, retailers, consumers

### 3.4. SWOT Analysis of Red Potato Agribusiness Development

The red potato agribusiness system consists of several subsystems, namely subsystems of production inputs such as fertilizer and seeds; production subsystem consisting of farmers who cultivate red potatoes; marketing subsystem that markets red potato products from farmers to consumers; and supporting subsystems from government institutions, private financial institutions and research institutions from universities. The processing subsystem that turns red potatoes into processed...
products is still undeveloped in the research area. SWOT analysis is carried out by identifying the weaknesses and strengths of the agribusiness and used as basis for formulating a red potato agribusiness strategy. The steps taken in carrying out the SWOT analysis are explained in the next section.

3.4.1. Identification of strength and weakness. Strength and weakness factors are internal factors that make a business different from its competitors. Table 3 illustrates internal factors that are strengths and weaknesses in red potato agribusiness. Red potato agribusiness can optimize its strength and minimize its weaknesses.

| Internal Factors                      | Strength                          | Weakness                        |
|---------------------------------------|-----------------------------------|---------------------------------|
| Management dan human resources        | a. A high sense of family between farmers and farmer groups |                                 |
|                                       | b. The desire of red potato farmers to always progress, and the desire to learn. |                                 |
|                                       | c. There is a strong system of cooperation within farmer groups |                                 |
| Marketing                             | Local trader located in the area  | Marketing is limited            |
| Production activities                 | a. Red potato cultivation is feasible and profitable financially. b. Availability of customer (trader and consumer) |                                 |
| Financial                             | a. Working capital of red potato farmers still limited |                                 |
|                                       | b. Payment system is still not good for farmers |                                 |
| Technology                            | Simple technology used by the farmers |                                 |

3.4.2. Opportunity and threat factors. Opportunity and threat factors are external environments whose conditions cannot be controlled in business management. Red potato agribusiness must be able to take advantage of existing opportunities and always be ready to anticipate threats. Based on the results of environmental analysis, table 3 illustrates the external factors that influence the development of red potato agribusiness using the PEST analysis approach (Politics, Economy, Socio-Culture, and Technology). It shows both critical factors in the form of opportunities that can be utilized by the Malino Region and also threats that need to be minimized.
Table 4. Opportunities and Threats of Red Potato Agribusiness

| External Factor | Opportunities | Threats |
|-----------------|---------------|---------|
| Political and government environment | a. Growing market share | a. Increase of oil price |
| Economic environment | b. Credit for agribusiness is available from financian credit institution | b. Potato processing industry is undeveloped in South Sulawesi |
| Socio-culture and demographic environment | c. Vacant land still available | |
| Technology environment | Changes in people’s lifestyler (incline to potato) | Progress in innovation technology |

3.4.3. SWOT Matrix Analysis. After identifying the position of red potato agribusiness from the combination of the main internal and external factors, several strategic alternatives for red potato agribusiness can be formulated; these strategies are grouped into four cells, namely, the S-O strategy, the S-T strategy, the W-O strategy, the W-T strategy. such as the results of the analysis as seen in table 5.

Table 5. Red Potato Agribusiness SWOT Matrix Analysis

| Strength (S) | Weakness (W) |
|--------------|--------------|
| 1. A high sense of family between farmers and strong cooperation in farmer groups | 1. Production capital of red potato farmer is low to access for potato seed |
| 2. The desire of red potato farmers to always progress, and the desire to learn. | 2. Red potato seed is considered expensive |
| 3. Availability of customer (trader and consumer) | 3. Production technology used is still simple |
| 4. Local trader located in the area | 4. Marketing is limited |
| 5. Red potato cultivation is feasible and profitable financially. | |

| Opportunities (O) | S-O Strategy | W-O Strategy |
|-------------------|--------------|--------------|
| 1. Support from local government | 1. Increase routine meetings that bridge government programs with farmer groups (S1, S2, S4, O1) | 1. Business development by utilizing capital assistance (W1, O4) |
| 2. Growing market share | 2. Increase yield and its quality (S2, S3, S4, O2, O5) | 2. Cooperation in marketing fresh product (W1, O1, O2, O5) |
3. Availability of land
3. Utilized vacant land for growing red potato (S2, S3, S6, O2, O3)

4. High quality seed is available product of tissue culture of Hasanuddin University
4. Widen marketing area (S3, S5, O2)

Threats (T)

1. Increase in fosil fuel
1. Develop collaboration inter Maarket and business

S-O strategy
1. Use vacant land for the cultivation of red potatoes.
   The availability of vacant land in the Malino area can be utilized by farmers to cultivate Red potatoes. The use of vacant land is expected to increase the amount of red potato production in the Malino Region.
2. Add market distribution areas.
   Another strategy in utilizing the opportunities and strengths of red potato agribusiness is to increase the market area for red potato distribution which is now only distributed to two regions, namely Makassar City and Tanah Bumbu Regency, South Kalimantan; one way that can be taken is to add red potato sales agents in other regions.

W-O Strategy
The W-O strategy is a strategy used to overcome weaknesses by utilizing the opportunities available. Some strategies that can be applied are as follows:

1. Business development using capital aid.
   With the existence of financial institutions, farmers can make use capital loans to conduct business development by utilizing land that is still empty for the cultivation of red potatoes.
2. Collaboration in marketing raw or processed products.
   The form of marketing cooperation that can be applied to the red potato agribusiness system is by utilizing agricultural service support through exhibition events held outside the Malino area. Through the event, the agency can promote red potatoes, both in the form of fresh and processed products, thereby increasing the number of consumers who consume red potatoes. In addition, to have support from the Agriculture Service, farmers or farmer groups can collaborate with stakeholders to market red potatoes out of the area. Farmers can also take advantage of gadget technology advances to carry out promotions online.
3. Improve production and information technology
   With a strategy to improve production and information technology in red potato agribusiness, the development of red potato agribusiness in the Malino Region can be achieved. Production is a field that continues to evolve in line with technological developments because production has a close relationship with technology; production and technology need each other. Production needs to operate at lower costs, improve quality and productivity, and create new products that have become the forces that drive technology to make new breakthroughs and discoveries. Production in an agribusiness system is the core activity. Production systems are integrated systems that have structural and functional components. In modern production systems, there is a value-added transformation process that converts inputs into an output that can be sold at competitive prices in the
market. Efforts to improve production technology that can be carried out include developing red potato seed breeding in the Malino Region, which is expected to produce quality and certified seeds. This is intended to make a better quality yield, and the quantity of the crop also increases from before when farmers used seeds from their own crops.

**S-T Strategy**

The S-T strategy is a strategy that uses the power possessed by red potato agribusiness in the Malino Region to avoid the threat posed. Some strategies that can be applied include:

1. Develop a partnership system that has been implemented between farmers and farmer groups.

   One of the strengths possessed by red potato farmers in the Malino Region is the partnership between members in farmer groups and with other farmer groups. The partnership that has been formed can be used for mutual interests such as meeting the needs of production facilities. To maintain the partnership system that has been implemented, farmers are expected to be able to do the following:

   a. Nurture a group or association of groups that have grown together is encouraged to cooperate with other groups in the form of larger organizations called groups or associations. The formation of a combination of groups or associations based on the needs or interests of the group itself.

   b. Establish formal economic institutions combined groups/associations are encouraged to have the desire and be able to become a formal economic institution, and one of the choices is cooperatives. In order to grow farmers’ self-reliance and be able to work in the market system, group savings need to be improved.

   c. The development of partnerships in the framework of strengthening businesses requires a partnership between small and medium-scale economic enterprises with large-scale businesses.

2. Making processed products made from raw red potatoes

   This strategy was formed against the background of no potato processing industry that uses red potatoes as raw material. Making red potatoes as raw material for processed products can produce value added to the commodity, which were previously only sold in fresh and raw forms.

**W-T Strategy**

1. Market and Business Environment Research

   This is needed by red potato agribusinesses actors in the Malino Region to find out the opportunities for red potato agribusiness in the Malino Region to market their products more broadly. The business environment is also important to minimize weaknesses in red potato agribusiness in the Malino Region.

3.5. **Strategic design**

In the context of developing Red Potato agribusiness, the objectives to be achieved and the challenges faced by farmers are as follows: Goals to be achieved by red potato farmers in Malino areas are: the availability of high-quality red potato seeds, the availability and continuity of high-quality red potato seeds from seed developers in Malino Area, the availability of red potato agroindustry, making red potato as raw material input for potato processed food, such as potato chips, potato sticks and others. The strategic challenges faced by the red potato farmers in achieving the target are: limited resources of farmers, especially in cultivating red potatoes, the absence of research or research on the cultivation of red potatoes which states the productivity of red potatoes per hectare can rival the productivity of potatoes that are widely cultivated by the community, namely granola potato, the absence of budget support from the Gowa District Government to develop red potatoes, red potato seeds was not continuously available in the region. To make it easier for the Malino Region to implement the strategic design of red potatoes development, the program design of this activity is additional in nature, for implementation, if there are additions or
shortcomings that can be modified according to environmental conditions. The extraction results of the SWOT strategy shown in table 6.

**Table 6. Design of the Red Potato Agribusiness Actors Work Program in Malino Region**

| Strategy          | Program                                                                 | Responsible Institution                                      |
|-------------------|-------------------------------------------------------------------------|-------------------------------------------------------------|
| S-O Strategy      | Increase routine meetings that bridge government programs with farmer groups | Head of farmers group and Agricultural Services of Gowa District |
|                   | 1. Training on management                                               |                                                             |
|                   | 2. Training on cultivation technique                                     |                                                             |
|                   | 3. Agricultural extension services                                       |                                                             |
| S-O Strategy      | Increase the production quality of its product                         | Head of farmers group and Agricultural Services of Gowa District |
| W-O Strategy      | Business development and capital utilization                           | Farmers and Head of Farmers’ Group                          |
| Marketing         | Provision of production inputs such as seeds and postharvest facilities | Hasnauddin University, Agriculture Services and Farmers group |
| Marketing         | Growing red potato on suitable and vacant land                           | Head of farmers group and Agricultural Services of Gowa District |
| Widening market area | Increase marketing agent in the area                                     | Farmers and Head of Farmers’ Group                          |
| W-T Strategy      | Credit application for business development capital                      | Hasnauddin University, Agriculture Services and Farmers group |
| Marketing         | 1. Participate in the events held by government agencies                 |                                                             |
| Marketing         | 2. Use gadget (technology) to do marketing online                        |                                                             |
| Marketing         | 1. Develop red potato seed production                                    |                                                             |
| Marketing         | 2. Using certified seed                                                  |                                                             |
| Marketing         | 3. Learn to use internet marketing product                               |                                                             |
| S-T Strategy      | Maintaining partnership has been carried out                            | Head of farmers group                                       |
|                   | 1. Strengthen family ties between farmers and farmer groups              |                                                             |
|                   | 2. Providing *reward* to outstanding farmers                             |                                                             |
| W-T Strategy      | Market and business environment research                                | Head of farmers group                                       |
|                   | Conducting market research                                              |                                                             |

In table 6 there are sixteen work programs from ten strategies obtained from SWOT matrix analysis. These sixteen work programs have different institutions that responsible for each program; those who are in charge of these programs include Hasanuddin University, Gowa District Agricultural Service, farmer group leaders, and farmers.
4. Conclusion
Net income for red potato is Rp. 43,701,700 /ha/season with cost efficiency (R/C) of 1.92: large production costs are seed and labor costs that 1/3 of the revenue value after deducting the cost of production facilities. The general distribution pattern of red potato production is a pattern where red potatoes from farmers were sold to large traders, then sold to retailers and consumers in the traditional Makassar market. This pattern which runs relatively constant, this also shows the formation of business networks. The results of the identification of strength aspects in managing red potato farming were: (a) Management and Human Resources, that include (a.1) a high sense of kinship between farmers and farmer groups, (a.2) the desire of red potato farmers to progress and the desire to learn, and (a.3) the existence of a strong system of cooperation in farmer groups; (b) marketing, where local traders are located near in the village; and (c) production and operation, including (c.1) Red potato farming is feasible to be cultivated and provides financial benefits; (c.2) the availability customers. The results of the identification of weakness aspects in the management of red potato farming were: (a) marketing, namely marketing channel were still limited; (b) finances, including (b.1) the working capital of red potato farmers is still limited, and (b.2) payment systems that are less profitable to farmers; and (c) technology, namely the use of simple technology. The Government needs to continually improve services to farmers and farmer groups through increased activities in the Self-Help Agriculture/Rural Training Center and the Bulu Ballea Agribusiness Sub-Terminal It is hoped that the red potato farmers will implement a strategic design that has been formulated by making adjustments to the conditions and development of red potato agribusiness as a system.

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