Financial analysis of red chili farming business with green cultivation technology in South Sulawesi

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Abstract. The demand for chili production continues to increase in Indonesia and South Sulawesi in particular, both for local, inter-island demand and the potential for export. On the other hand, chili production is still low. Chili productivity in 2010 was only 5.6 t/ha, although the potential productivity can reach 12 t/ha. Therefore, an assessment of chili technology innovation according to GAP in South Sulawesi was carried out through the application of efficient chili technology innovation, appreciation of local wisdom and environmental insight. The assessment was carried out in a participatory manner in the chili development center area in Maros Regency, South Sulawesi involving 4 cooperative farmers in an area of 1.0 ha. The data used are production, inputs used, output prices, input prices. To determine the farming use R/R (Return Cost Ratio) analysis, and to determine the optimal level of use of production inputs obtained from the application of chili technology is to calculate MBCR (marginal benefit cost ratio) or IBCR (incremental benefit cost ratio). The results of the study showed 1) The application of GAP in red chili cultivation resulted in higher chili production and a smaller number of anthracnose attacks than the farmers' treatment. 2) Chili productivity achieved in P1 treatment reached 24.64 t/ha, significantly different from P2 treatment which reached 27.52 t/ha, but not significantly different from P3 treatment reached 25.92 t/ha. 3) The application of GAP can increase farmers' income from Rp. 173.14 million to Rp. 194.25 million or an increase in revenue of 10.86% with an IBCR of 2.05.

1. Introduction

The area of chili planted in Indonesia ranks first among the main vegetable commodities such as shallots, cucumbers, potatoes, tomatoes and cabbage [1,2]. The demand for chili production continues to increase in Indonesia and South Sulawesi in particular, both for local, inter-island demand and the potential for export. On the other hand, chili production is still low. Chili productivity in 2010 was only 5.6 t/ha [3], although the potential productivity could reach 12 t/ha [4, 5], much lower than chili productivity in China which reached 21.5 t/ha, Thailand 14.2 t/ha and India 9.3 t/ha. One of the causes of the low productivity of chili is the low application of technology, especially cultivation techniques according to GAP, namely the use of seeds from low-quality varieties. Most chili farmers use local seeds and often use seeds from gardens for chili production, and institutional innovation and maintenance are not optimal due to high pest and disease disturbances [6].

Therefore, it is necessary to develop chili production technology in accordance with local conditions and the needs of farmers both in the lowlands and highlands. One of the chili production techniques that has the potential to solve problems related to production, quality, competitiveness and sustainability is...
chili technology innovation in accordance with Good Agricultural Practice (GAP/SOP). So far, the application of chili production technology has not been widely developed and in accordance with GAP at the farmer level. In addition, the Directorate General of Horticulture, has focused on chili development through the planting movement during the dry season (GTCK), namely planting chilies in a certain month or period (July-October) by choosing near water sources or simple irrigation facilities and cultivation infrastructure.

A more important aspect besides increasing production is that information is needed on financial analysis of chili farming on various chili cultivation techniques so that it can motivate farmers to produce better.

2. Materials and Methods
The study was carried out in chili development centers in South Sulawesi. The assessment was carried out in a participatory manner by involving farmers as the main actors in applying the technology. Researchers and extension workers are more of a supervisor in the application of technology. This assessment was carried out on a 1.0 ha farmer's land with 4 cooperating farmers who were determined jointly by researchers, extension workers, local government and farmers. In this activity, the existing technology components are assembled into a specific technology package.

The materials needed are chili seeds of various varieties, organic fertilizers, MOL, Urea fertilizer, SP-36, KCl, or NPK, fungicides, insecticides, and other supporting materials. The variety planted is a Panex brand hybrid chili produced by Arrow Red. The description given to Panex is as follows: it is a hybrid chili for medium to highlands, tolerant of hot temperatures, wide plant type, resistant to bacterial wilt and resistant to Phytophthora capsici. The fruit is slightly flattened, 17 cm x 2 cm, shiny red, tolerant of cracking and tolerant of yellow fruit tips. It is classified as early maturity, harvesting from 80-105 DAP with a potential yield of 1-1.5 kg/plant, 16-25 tons/ha. However, disease resistance, harvest age, weight and yield potential depend on the environment and cultivation treatment.

The field study used 3 treatments and 5 replications, as follows:

- **P1**: Cultivation of chili plants is carried out according to the habits applied by farmers, black silver plastic mulch (MPHP)
- **P2**: Chili cultivation is carried out by fertilizing according to the recommendations of the Vegetable Crops Research Institute, black silver plastic mulch, Recommendation 225 kg N+225 kg P2O5+225 kg K2O, integrated pest control, and timely harvesting
- **P3**: chili cultivation by organic mulching with raw husks, fertilization based on nutrient status, application of MOL, integrated pest control, and timely harvest

**Cultivation technology according to GAP, GHP chili applied:**
- Seed source labeled free of disease from various superior varieties.
- Regulating cropping and production patterns in the main production centers
- Selection of sites that meet the requirements (biophysics of land and altitude 0-750 m above sea level)
- Tillage was carried out with a tractor 2 weeks before planting,
- Planting in beds with a distance of 50 x 50 cm, using plastic and organic mulch.
- Fertilization: based on analysis of soil nutrient status, 12 liters of MOL and 10 tons of organic fertilizer per hectare.
- Irrigation with flooded.
- Increasing the control of environmentally friendly pests, carried out intensively, but using pesticides wisely.
- Harvesting is done at the age of 90-120 HST.

The data collected in this activity included growth, namely plant height (cm), flowering time, unit fruit weight, crop fruit production (kg), percentage of fruit damage due to anthracnose, and fruit production per hectare (t/ha). The calculation of production per hectare uses the formula for production per plant
times the total population. The total population of 32,000 plants. To determine the level of income, farming analysis used the following formula (Downey and Erickson 1985).

\[ I = (Y \cdot Py) - (Xi - Pxi) \]

Information:
- \( I \) = Chili farming income (Rp/ha)
- \( Y \) = Chili Production/ha
- \( Pxi \) = Input price (Rp)
- \( Py \) = Chili Price (Rp)
- \( Xi \) = Input (I = 1, 2, 3, …… n)

Meanwhile, to determine the feasibility of farming used R/C ratio analysis (Return Cost Ratio), namely the ratio (ratio) between income and costs [7]. Mathematically it can be written as follows:

\[ a = \frac{R}{C} \]

\[ R = Py \cdot Y \]

\[ C = FC + VC \]

\[ a = \frac{(Py - Y)}{(FC + VC)} \]

where:
- \( a \) = Ratio Value
- \( R \) = Receipt
- \( C \) = Cost
- \( Py \) = Output Price
- \( Y \) = Output
- \( FC \) = Fixed Cost (Fixed Cost)
- \( VC \) = Cost is not fixed (Variable Cost)

If;
- \( a > 1 \) farming is said to be feasible
- \( a = 1 \) the farm is said to break even (no profit, no loss)
- \( a < 1 \) Farming is not economically feasible

To determine the optimum level of use of production inputs obtained from the application of chili technology is to calculate the MBCR (marginal benefit cost ratio) or IBCR (incremental benefit cost ratio), namely the ratio of the increase in net income with additional variable costs from each treatment [8]. Mathematically formulated as follows.

\[ IBCR = (RR(n+1) - Rn)/(CC(n+1) - Cn) \]

\( Rn \) is the nth net income and \( Cn \) is the nth variable cost

3. Results and Discussion

3.1 Chili technology characteristics

To obtain soil nutrient status at the study site, a soil sample was tested. Samples were taken at the location where chili (Camba) will be planted and then the samples were taken to the South Sulawesi AIAT Soil Laboratory in Maros. In order for the preparation of fertilizer recommendations to be right on target, it is necessary to refer to the nutrient status of the soil in that location (Table 1).

According to the proportion of soil fraction, the tested soil belongs to the class of clay loam texture, the largest fraction is clay. The content of organic matter, both carbon and nitrogen, is low, so supplementation is needed. Giving compost is good for application. The pH of slightly acidic soil tends to be neutral. For low levels can be done by offering dolomite (Agricultural Lime). Likewise, the organic matter content of the soil, the higher the organic matter, the higher the CEC of the soil [9]. Low soil
CEC can be increased by adding organic matter such as compost or manure, the addition of crushed zeolite rock can also significantly increase soil CEC [10].

Based on the nutrient status in Table 1, a site-specific fertilization recommendation is made so that it is right on target according to the needs of the soil. Fertilizer recommendations based on nutrient status consist of 200kg N+150kg P2O5+148kg K2O. Supplementation of organic matter by application of local microorganisms and organic mulching. It is important to carry out appropriate fertilization, therefore it is highly recommended that soil status analysis be carried out before determining the dose of fertilizer. According to Hidayat [11] ase in yield. Excessive use of macro fertilizers will cause deficiencies of micro elements such as Cu and Zn (Ismunadi et al., 1988). The optimal dose of fertilizer for plants is determined by soil nutrient status, fertilization efficiency and plant nutrient requirements. According to Widjaja-Adhi [12] nutrient status can be measured quantitatively by determining the ability of the soil to provide nutrients for plants and soil test values. Fertilizer recommendations so far are still general in nature, not site-specific, meaning that they are not adapted to agroecology, soil type, nutrient availability, and plant needs. Several research results, both overseas and domestically, show that the loss of nutrients from food-agricultural land on sloping land is quite large. However, this can be overcome if erosion and eroded land are rehabilitated, so that the use of fertilizers will be more efficient [13].

### Table 1. Soil nutrient status at the study site

| Parameter                  | Value           |
|----------------------------|-----------------|
| Texture                    |                 |
| Sand                       | 21%             |
| Dust                       | 37%             |
| clay                       | 42%             |
| Organic Ingredients        |                 |
| C                          | 2.21%           |
| N                          | 0.12%           |
| C/N                        | 19              |
| Ph                         |                 |
| H2O                        | 6.12            |
| KCl                        | 5.35            |
| P2O5 potential             | 11mg/100g       |
| P2O5 available             | 71ppm           |
| K2O potential              | 49 g/100g       |
| K2O available              | 36ppm           |
| Cation Exchange Value      |                 |
| Ca-dd ( me 100 g-1 )       | 29.57           |
| Mg-dd ( me 100 g-1 )       | 3.56            |
| K-dd ( me 100 g-1 )        | 0.08            |
| Na-dd ( me 100 g-1 )       | 0.38            |
| CEC (cation exchange capacity) | (me 100 g -1 ) | 24.19 |

### 3.2 Vegetative growth

The growth and development of the vegetative parts of plants above ground is mainly determined by the activity of the apical meristem because leaf primordia are formed, because the initial stem maturation depends on the new stem tissue formed at the tip and because of hormonal stimuli that determine the growth and development of all subsequent plant parts. Known to originate from both the tip and from young leaves that are tightly wrapped to form apical buds. The arrangement of leaves on the stem (phylotaxis) can be traced directly to the geometric position and time of formation of new leaf primordia.
Between the tip and the primordia a side shoot which under suitable conditions can develop into a lateral side branch (usually called a tiller) [14].

The vegetative growth of chilies is shown in Table 2. Based on observations, the vegetative growth of chilies planted is quite good, and there are very few pests and diseases. Pruning of side shoots needs to be done during the vegetative period to maintain a proportional crown shape to get more optimal production results.

### Table 2. The vegetative growth of chilies

| Treatment | 21 DAP | 50 DAP |
|-----------|--------|--------|
| P1        | 31.0   | 71.3   |
| P2        | 30.4   | 72.0   |
| P3        | 29.4   | 69.9   |

In the vegetative phase, the results of photosynthesis are used for the growth of leaves and stems, as stated by Irmayanti [15] that the translocation of assimilate products in the growth phase is mostly used for the formation and development of vegetative organs such as leaves and stems. Furthermore, according to Surtinah [16] vegetative growth can make a positive contribution to generative growth. The vegetative growth of chili plants is influenced by environmental factors, namely biotic and abiotic factors.

#### 3.3 Generative growth of chili

Plants are said to enter the generative phase when flowers appear. The occurrence of interest in this study was recorded on September 5, 2016. Environmental factors will affect the process of forming flowers and fruit, one of the environmental factors that affect the formation of flowers and fruit is pest and disease attacks. [17] states that plant growth and development is influenced by environmental factors, namely biotic factors (pests and diseases) and abiotic factors (temperature, sunlight, soil, rain and fertilizers). Pests that attacked during the study were trips which is a vector that causes curls, and yellow virus disease which is transmitted by whitefly or mealybugs. Infected chili plants show symptoms or are pale, leaves, curls and flowers fall. Infection at the beginning of growth will cause the plant to become stunted and produce few flowers and fruit. As a result of this disease, plants can no longer carry out photosynthesis perfectly so that it will affect the flowering and harvesting ages of chili plants [18].

Red chili can be harvested several times in one growing season. In this study, chili can be harvested up to 8 times. The 6th to 8th harvests are decreasing in quality and quantity, this is related to the production capacity and the weather which tends to start with high rainfall intensity (November-December). Humidity and high temperatures allow the development of pests and diseases to multiply. In addition, from the farmer's point of view, the beginning of the rainy season is the time to cultivate the land to grow rice. The average chili production from the first to the last harvest is tabulated which is shown in Table 3.

### Table 3. Production of red chili

| Treatment | Production per plant (kg) | Production (tons/ha) |
|-----------|--------------------------|----------------------|
| P1        | 0,77                     | 24,64                |
| P2        | 0,86                     | 27,52                |
| P3        | 0,81                     | 25,92                |

The treatment given has a different effect on the results. The highest production per plant was achieved by chili plants which were given the second treatment. The difference between the general recommendation of fertilization for Vegetable Crops Research Institute and fertilization according to nutrient status lies in the quantity of macro substances given. Fertilization based on nutrient status uses less N (difference 25kg) P (difference 75kg) and K (difference 77kg).
This underlies the difference in yields, as stated by [19], that the quantity and quality of yields are influenced, among other things, by the availability and balance of nutrients in the soil. Element N is for the formation of protein, P is for improving skin color and flesh color, hardness, and vitamin C. While element K can increase sugar, acid, carotene, and lycopene.

Stated that fruit formation is influenced by nutrients N, P and K. Fruit formation and filling are strongly influenced by nutrients (N, P and K) which will be used in the photosynthesis process, namely as constituents of carbohydrates, fats, proteins, minerals and vitamins that will be translocated to the fruit storage section [20]. For fruit development, it is strongly influenced by the formation of auxin in developing seeds and other parts of the fruit that serve to supply food reserves to increase fruit development.

3.4 Pest and disease observation

Pests and diseases that attack chili plants vary in each treatment. Pests and diseases tend to be more common in the observation of the generative phase of plants. Several pests and diseases found in the field include armyworm (Spodoptera litura), thrips, anthracnose disease, as well as viruses that cause yellowing, curling and stunted leaves. Attacks of anthracnose caused by Colletotrichum were more in the first treatment (P1) than other treatments (Table 4).

| Treatment | Number of Fruits attacked by Anthracnose (100 DAP) |
|-----------|--------------------------------------------------|
| P1        | 0.60                                             |
| P2        | 0.13                                             |
| P3        | 0.29                                             |

Anthracnose in chili is the most common disease and almost always occurs in every area of chili plants. Anthracnose is caused by the fungus Colletotrichum capsici (Syd.) Bult.et.Bisby. This disease in addition to causing a decrease in yield can also damage the aesthetic value of the chili itself. This pathogen attack can occur both before and after harvest. The decrease in yield due to anthracnose can reach 50 percent or more [21].

3.5 Economic analysis

3.5.1 Production and factors of production

Chili production is the result of a production process using various inputs that are influenced by biological technology (varieties) and chemical technology. The productivity and production factors of cooperative farmers can be seen in Table 5 and Appendix I. In this study, each of the production factors was analyzed because the three treatments used different inputs. Chili productivity achieved in treatment P1 reached 24.64 t/ha, significantly different from treatment P2 which reached 27.52 t/ha, but not significantly different from treatment P3 reached 25.92 t/ha.

![Table 5. Farming analysis, red chili in Maros Regency](image)
3.5.2 Farming costs and income
A technology, before being applied at the farmer level, must be technically, economically and socially feasible. The technology must be able to provide greater revenue compared to the previous technology. Therefore, in doing farming, farmers are always faced with costs that must be incurred and taken into account to increase production. According to [22] there are three variables that need to be known when conducting farming analysis. The three variables include revenue, costs, and farm income. The way of analyzing these three variables is often referred to as cash flow budget analysis (cash flow analysis). According to [7] farm revenue is the multiplication between production and selling price, farming costs are all expenditures used in a farm. Meanwhile, what is meant by farm income is the difference between revenue and expenditure. Furthermore, [23] state that farm income analysis has benefits for owners of production factors where the two main objectives of income analysis are (1) describing the current state of a farming activity, and (2) describing the future state of an activity farming. Farming income analysis is very useful for farmers to measure the level of success of their farming.

Profit is the difference between revenue and production costs incurred [24]. In this study, the production costs that are taken into account are variable production costs and some fixed production costs, because some fixed costs, such as land taxes, are still paid by farmers. However, in the opinion of Kay (1981) farming profits obtained are short-term profits so that fixed costs are considered not to affect profits. Revenues, costs and benefits obtained by farmers are shown in Table 5. According to [25] there are three ways to maximize farm income, namely: (1) technical efficiency, (2) input efficiency, and (3) production efficiency. Achieving high technical efficiency is very important to increase the competitiveness and profitability of farming.

3.5.3 Additional farmer income
The additional income that farmers get if they apply the recommended technology is Rp. 21.11 million or an increase in revenue of 10.86% which is illustrated by the IBCR of 2.05. Revenues, costs and
benefits obtained by chili farmers based on GAB supporting an environmentally friendly farming system can be seen in Table 6.

Table 6. Additional costs and income from chili farming with advised technology versus farmer technology

| Description                  | Introductory Technology (Rp) | Farmer Technology (Rp) | Additional Introductory Technology Fee (Rp) | Change (%) |
|-----------------------------|------------------------------|------------------------|--------------------------------------------|------------|
| Seed                        | 960.000                      | 960.000                | 0                                          | 0          |
| Black Silver Plastic Mulch/Organic Mulch | 4,800.000                    | 4,800.000              | 0                                          | 0          |
| inorganic fertilizer        |                              |                        |                                            |            |
| a. Urea                     | 3,996,400                    | 2,220,000              | 0                                          | 0          |
| b. SP36                     | 1,100,000                    | 220,000                | 880,000                                    | 80,0       |
| c. NPK                      | 1,625,000                    | -                      | -                                          | -          |
| d. KCl                      | 1,271,400                    | 2,000.000              | -                                          | -          |
| organic fertilizer          | 7,800,000                    | 7,800,000              | 0                                          | 0          |
| Pesticide                   |                              |                        |                                            |            |
| a. Liquid                   | 500,000                      | 500,000                | 0                                          | 0          |
| b. Congested                | -                            | -                      |                                            |            |
| Labor                       | 8,350,000                    | 8,200,000              | 0                                          | 0          |
| a. Land preparation         | 2,000,000                    | 2,000,000              | 0                                          | 0          |
| b. Nursery                  | 750,000                      | 750,000                | 0                                          | 0          |
| c. Hollowing and Mulching   | 1,000,000                    | 1,000,000              | 0                                          | 0          |
| Planting                    | 1,250,000                    | 1,250,000              | 0                                          | 0          |
| Fertilization               | 400,000                      | 250,000                | 150,000                                    | 37,5       |
| Sprinkling                  | 1,000,000                    | 1,000,000              | 0                                          | 0          |
| Spraying                    | 250,000                      | 250,000                | 0                                          | 0          |
| Harvest                     | 1,500,000                    | 1,500,000              | 0                                          | 0          |
| Freight/transport           | 200,000                      | 200,000                | 0                                          | 0          |
| Total cost                  | 25,906,400                   | 3,980,000              | 1,030,000                                  |            |
| Revenue                     | 220,160,000                  | 197,120,000            | 23,040,000                                 | 10,46      |
| Income                      | 194,253,600                  | 173,140,000            | 21,113,600                                 | 10,86      |
| R/C ratio                   | 8.5                          | 8.2                    |                                            |            |
| B/C ratio                   | 7.5                          | 7.2                    |                                            |            |
| Additional Benefits         | (194,253,600-173,140,000) = 21,113,600 |                        |                                            |            |
| IBCR                        | 21,113,600:1,030,000 = 2,05 |                        |                                            |            |

The differences in chili productivity obtained by each treatment indicate that the method and application of fertilizers are different in each treatment, indicating differences in productivity and income obtained. That is, the income obtained in the P2 (Recommendations for Vegetable Crops Research Institute) treatment obtained an income of Rp. 194.25 million, followed by P3 treatment (Cultivation of chili with organic mulching) Rp. 186.05 million, and finally P1 treatment (Farmers' habits) Rp. 174.14 million. The difference in income obtained from the three treatments is due to differences in productivity, so to get even greater benefits from farming management, it is necessary to use adequate production factors to a certain level so that the resulting production can be higher. As stated by that at a higher level of use of production factors, the output produced by new technology will be higher than the old technology. With the increase in production at different treatments, it is hoped that farmers can get greater income so that their income can be even greater as illustrated in Table 6.
4. Conclusion
The application of GAP in red chili cultivation resulted in higher chili production than the farmers’ treatment. Chili productivity achieved in treatment P1 reached 24.64 t/ha, significantly different from treatment P2 which reached 27.52 t/h, but not significantly different from treatment P3 reached 25.92 t/ha. The application of GAP can increase farmers' income from Rp. 173.14 million to Rp. 194.25 million or an increase in revenue of 10.86% with an IBCR of 2.05.

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