Evaluation of land suitability and factors influencing the development of shallots (Allium cepa L.) in North Padang Lawas, North Sumatera

S S Girsang, E D Manurung and M A Girsang
North Sumatera Assessment Institute for Agricultural Technology, Medan, Indonesia
Email: girsang313@gmail.com

Abstract. Allium cepa L. is a horticultural commodity that influences inflation. The objective of the study was to determine land suitability class and factors increasing the shallots productivity in North Padang Lawas. The study was conducted in 6 sub-districts, North Padang Lawas District, North Sumatra in period of May-August 2019. Survey method to obtain data on shallot farming (R/C ratio) and soil sampling were using a purposive sampling technique by descriptive exploratory survey method, with an analysis unit of the Land Mapping Unit (LMU). The results showed that the potential land suitability class increased to be moderately suitability (S2). Land quality and shallot production can be improved by planting shallots at the end to the beginning of the rainy season, organic matter application >5 t ha\(^{-1}\) continuously, certified high yielding varieties, nutrient management, and integrated pest control. If land management and cultivation techniques are implemented properly, the current R/C ratio of 1.31 can be improved. This can cater the local market also reduce inflation.

1. Introduction
Shallot (Allium cepa L.) is a popular spice vegetable in Indonesia as a flavoring and traditional medicinal ingredient. As the 6\(^{th}\) producer of shallots in Indonesia, North Sumatra is only able to meet the needs of its population by 41.10\% with consumption per capita of 2.76 kg [1]. Some constraining factors are the use of shallot seeds which are hereditary resulting in plants susceptible to viruses or withered bacteria carried by seeds, climatic factors, as well as nutrient balance needed by plants.

Based on Wahyunto et al. [2], the requirements for growing shallots are temperatures of 25 to 28°C; annual rainfall of 1,000 to 1,400 mm; pH H\(_2\)O 6.0 to 7.5; rather smooth to moderate soil texture; cation exchange capacity and moderate to high nutrient content; and flooding. Ikeda et al. [3] states that bulb growth and formation are influenced by temperature, Khokhar [4] mention that bulb formation and enlargement is strongly influenced by water availability. Furthermore, the nutrients needed for plants to produce 1 kg of shallots is 4.2 gr N, 0.8 gr P, 3.9 gr K; and 2.7 gr Ca [5]. Optimum nutrients such as N shallot of 100 kg ha\(^{-1}\) can produce 30.2 t ha\(^{-1}\) bulbs of shallot [6]; P\(_2\)O\(_5\) of 168.7 kg ha\(^{-1}\) to produce 48.9 t ha\(^{-1}\) [7]; K\(_2\)O combination of 90 kg ha\(^{-1}\) and N 172.6 kg ha\(^{-1}\) positively contributed to the production, fresh mass, and bulb classification [8].
At the present the shallot planting is spread in 22 regencies from 33 regencies/cities in North Sumatra [1]. North Padang Lawas District is a shallot producer with 70.4-ton production from a harvest area of 17 ha in 2018. This district has the opportunity to develop shallots to reduce inflation due to scarcity of shallots in certain seasons in North Sumatra because the annual productivity growth rate is negative (-1.54%) [9]. For this reason, an evaluation study of land suitability and factors affecting the development of shallots in the North Padang Lawas District were conducted. The purpose of this research is to get a class of land suitability and factors increasing the productivity of shallots in the development of plantations in North Sumatra.

2. Materials and methods

2.1. Location
The study was conducted in the North Padang Lawas, North Sumatra, Indonesia (10°13’50” and 20°2’32” North and 99°20’44” and 100°19’10” East, altitude 99-317 m.a.s.l.) period May-August 2019. The type of soil in this area is the Inceptisols [10].

| Table 1. Land characteristics and shallot growing requirements. |
|---------------------------------------------------------------|
| Land Characteristics | Land Suitability Class | S1 | S2 | S3 | N |
|----------------------|------------------------|----|----|----|---|
| Temperature (tc)     |                        |    |    |    |   |
| Annual mean temperature (°C) |                | 25-28 | >28-31 | >31-33 | >33 |
| Water availability (wa) |                       | 23<-25 | 21<-23 | <21 |
| Annual rainfall (mm year⁻¹) |            | 1,000-1,400 | 900-<1,000 | 800-<900 | <800 |
| No. of dry months (<100 mm) |                | 4-6 | >6 | - | - |
| Oxygen availability (OA) |                  | Good, somewhat blocked | A little fast, rather good | obstructed | Very blocked, fast |
| Rooting media (rc) |                       | Coarse material (%) | Somewhat smooth, medium | Smooth | A little rough, very fine | Rough |
| Soil depth (cm) |                                     | >15 | 15-35 | 35-55 | >55 |
| CEC (cmol) |                                         | >16 | 5-16 | <5 |
| Base saturation (%) |                               | >35 | 20-35 | <20 |
| pH H₂O |                                             | 6.0-7.5 | 5.5-6.0 | <5.5 |
| C-organic (%) |                                         | >2 | 0.8-2.0 | <0.8 |
| Nutrients available (na) |                                 | N total (%) | Medium | Low | Very low | - |
| P₃O₅ (mg 100 g⁻¹) |                                     | High | Medium | Low-very low | - |
| K₂O (mg 100 g⁻¹) |                                      | Medium | Low | Very low | - |
| Toxicity (xc) |                                         | <2 | 2-3 | 3-5 | >5 |
| Salinity (dS m⁻¹) |                                       | <2 | 2-3 | 3-5 | >5 |
| Sodicity (xn) |                                        | <20 | 20-35 | 35-50 | >50 |
2.2. Research design
This study used the survey techniques with a questionnaire as a data collection tool from 30 respondents. The method used in determining respondents and soil sampling is purposive sampling by determining farmers and location criteria. Soil analysis conducted in the North Sumatra AIAT laboratory. This research was conducted using a descriptive exploratory survey method, with an analysis unit of the Land Mapping Unit (LMU).

2.3. Soil analysis
Analysis of soil physical and chemical properties carried out in the North Sumatra AIAT laboratory includes texture; pH H₂O; C-Organic; N-total; C/N ratio; P₂O₅ and K₂O HCl; cation exchange capacity (CEC); exchange bases such as K, Na, Ca, Mg, and base saturation at a depth of 30 cm. Composite soil samples are taken randomly from four points at each location and then compiled. The method used for each parameter is the hydrometer method; pH meter; Walkley and Black; Kjehdahl; the division between C-organic divided by N-total; extraction of 25% HCl; Ammonium acetate 1 N pH 7.0; and calculation of the number of bases divided by CEC then multiplied by 100. Soil characteristics are adjusted to the requirements for growing shallots [11]. Matching results showed S1 = highly suitable; S2 = moderately suitable; S3 = marginally suitable; or N = not suitable.

2.4. Data analysis
Primary data analysis obtained from survey data and soil analysis tabulated into excel. Land suitability classes are carried out by matching the shallot growth requirements with land characteristics [2] in Table 1. Map unit was obtained from the overlay of soil type maps, slope maps, and land use maps of Padang Lawas Utara District using ArcGIS 10.3. This overlay produces 20 LMU. Agronomic productivity and costs are analyzed using revenue and cost ratios (R/C ratio). Calculation of total revenue divided by total expenditure with the criteria R/C ratio >1 means that the farm is feasible to be operated.

3. Results dan discussion
3.1. Land suitability evaluation of shallots by criteria
North Padang Lawas District is one of the youngest districts in North Sumatra which has a land area of 3,918.05 km². The District is located at 1° 13'50"- 2° 2'32" North and 99° 20'44"- 100° 19'10 East with altitude of 0-1,915-meters above sea level [1]. Leading commodities in this area are plantation and food crops such as oil palm, rice, cassava, chili, and shallots.
In North Padang Lawas District, shallot is the second commodity of horticultural crops after chili where there is an increase in harvested area of 58.8% from 2017 to 2018. As one of the agricultural commodities that affect inflation in Sumatra, it is necessary to develop the expansion of planting. Table 2 showed the results of the identification of biophysical characteristics based on pedoagroclimate in twenty villages in six sub-districts. According to the land suitability class, all locations included in the S3 class (marginally suitable) with a general limiting factor are water availability and other limiting factors that differed for each location.

The average temperature, total rainfall, and dry months at all locations are almost the same there are 25.8 to 27.1°C; 1740.7 mm; and 3 months. Sumarni and Hidayat [12] mentioned that shallots produce large, high-quality bulbs when they grow in dry climates, temperatures of 22°C, relative humidity of 50 to 70%, and irradiation for more than 12 hours. Based on Rejekiningrum and Kartiwa [13], the water requirement of shallot is 103.5 mm which is equivalent to 1035 m³ ha⁻¹ season⁻¹. Excess rainfall can increase relative humidity and soils which contribute to the disease triangle [14]. The highest intensity anthracnose disease in shallots (54.9%) occurred when it rains at night compared to the morning [15]. The advantaging characteristics of North Padang Lawas District, despite of the high rainfall, however, all locations have good drainage so that shallot can be developed in this location by determining the right planting time.

Shallot can be planted twice a year with the rice-shallot-shallot cropping pattern because all the planting locations are technical irrigated paddy fields. Figure 1 shows that suitable time for shallots are planted in May-September. For the first season, shallot planting can be conducted in May (the end of the rainy season) when the water is available during the vegetative growth period while in the generative water shortage could be anticipated by using irrigation water. Rejekiningrum and Kartiwa [13] mentioned that the highest yield shallot could be reached by giving daily water with a height of 7.5 to 15 mm (75 to 15 m³ ha⁻¹ day⁻¹).

Furthermore, the second season can be carried out in August when the moisture problem and pest attacks can be anticipated. Based on Sumarni and Hidayat [12] that the dry season is the right time to plant shallots when irrigated water is sufficient. On the other hand, shallot varieties recommended for lowland (99 to 317 m.a.s.l.) are the early maturing varieties such as Sembrani, Pikatan, Trisula, Pancasona, and Mentes which are mature in 50 to 58 days after planting [16].

![Figure 1. Mean annual rainfall, number of rainy days, and mean temperature in 2010-2019.](image)

The soil texture of all locations is generally sandy loam to loamy sand. Sumarni and Hidayat [12] mentioned that shallot plants are suitable to be planted in a medium to clay texture, good drainage, and contain organic material. Generally, the bulk density of sandy soils is due to the low content of organic matter and clay soils [17]. The problem of rooting media at LMU 19 can be overcome by adding organic material. Firmansyah and Bhermana [18] stated that the application of 16-ton chicken manure can reduce...
soil BD according to soil depth. Organic matter can increase total bulb and shallot production [19]. Recommendations for sandy soil are 20-ton ha\(^{-1}\) organic fertilizer, N 105.72 kg ha\(^{-1}\), P\(_2\)O\(_5\) 27 kg ha\(^{-1}\), K\(_2\)O 150 kg ha\(^{-1}\), and S 60 kg ha\(^{-1}\) [20]. The addition of 10 and 20-ton ha\(^{-1}\) organic fertilizer was able to increase shallot production by 20.25% and 40.79% compared to without organic matter [21].

Variation of nutrient retention at 20 LMU has an impact on differences in soil quality at each location. Limiting factors are found in LMU 1, 2, 3, 5, 10, and 16 in the form of base exchange, pH, and organic available. Ermadani et al. [22] mentioned that the addition of organic matter can improve c-organic, nutrition, and other chemical properties. The CEC increased by 11.8% and the pH approached neutral with the addition of organic matter to the land under cultivation [23].

Nutrient available problems occurred on LMU 2, 5, 8, 11, 14, 15, 16, 17, 20 (table 2). The application of organic material is an absolute prerequisite in improving soil properties in North Padang Lawas District because all types of soil are sandy loam to loamy sand. The addition of organic matter can increase pH and CEC [24]. It is also improved soil quality, encourage soil C sequestration, and crop production [25]. Based on Sumarmi et al. [26] to produce dry bulbs of 35.4 t ha\(^{-1}\) of Bangkok varieties needed N, P, and K elements of 69.7 kg ha\(^{-1}\) N, 22.9 kg ha\(^{-1}\) P\(_2\)O\(_5\), and 149 kg ha\(^{-1}\) K\(_2\)O. Deficiencies of these three elements can result in stunted growth of leaves, roots, cell multiplication, bulb size, delay maturation, and bulb quality [27, 28, 29]. On the other hand, toxicity occurs at LMU 5 with salinity 4.19 (dS m\(^{-1}\)) that will have an impact on nutrient absorption. According to Syamsiyah et al. [30] that an increase in soil salinity of 1 to 3 dS m\(^{-1}\) resulted in a decrease in NPK absorption, Ca-dd, and shallot production.

| No. | Land Mapping Unit | Land suitability classes | Limiting factor |
|-----|------------------|-------------------------|-----------------|
| 1   | LMU 1            | S3: wa, nr2, nr3        | Water and base saturation and pH |
| 2   | LMU 2            | S3: wa, nr3, nr4, na1   | Water, pH, Organic C, total N |
| 3   | LMU 3            | S3: wa, nr1, nr2        | Water, base saturation, CEC |
| 4   | LMU 4            | S3: wa                  | Water            |
| 5   | LMU 5            | S3: wa, nr4, na1, xc    | Water, organic C, total N, and Salinity |
| 6   | LMU 6            | S3: wa                  | Water            |
| 7   | LMU 7            | S3: wa                  | Water            |
| 8   | LMU 8            | S3: wa, na1             | Water and total N |
| 9   | LMU 9            | S3: wa                  | Water            |
| 10  | LMU 10           | S3: wa, nr3             | Water and pH     |
| 11  | LMU 11           | S3: wa, na2             | Water and phosphate available |
| 12  | LMU 12           | S3: wa                  | Water            |
| 13  | LMU 13           | S3: wa                  | Water            |
| 14  | LMU 14           | S3: wa, na2             | Water and phosphate available |
| 15  | LMU 15           | S3: wa, na1, na2        | Water, total N, and phosphate available |
| 16  | LMU 16           | S3: wa, nr4, na1, na2   | Water, organic C, total N, and phosphate available |
| 17  | LMU 17           | S3: wa, na1             | Water and total N |
| 18  | LMU 18           | S3: wa, nr3             | Water and pH     |
| 19  | LMU 19           | S3: wa, rc2             | Water, texture, and coarse material |
| 20  | LMU 20           | S3: wa, na2             | Water and phosphate available |

According to Wahyunto et al. [2]
Notes: Wa = water availability, nr = nutrient retention, na = nutrient availability, rc = root condition, xc = toxicity.
Erosion and land preparation for all LMUs included in S1 = highly suitable; S2 = moderately suitable. This proves that all locations are potential for planting shallots. According to Lal and Moldenhauer [31] lands in the tropics affected by erosion are significantly lower in productivity and less economical despite additional input. Because it gives an impact on the physical properties of the soil such as BD, sand content, infiltration, porosity, and organic matter content [32]. Girsang et al. [33] stated that crop production is inversely related to soil physical properties such as bulk density (BD) and permeability.

3.2. The relationship between soil properties and production
Table 3 shows the status and variability of soil properties and shallot production. The dominance of sandy soils with an average sand content of 60.7% (CV = 12.8) and EC 127.3 uS cm⁻¹ (CV = 74.3). In general, agricultural lands in tropical areas that have high sand content with low organic-c content [34] which is negatively correlated with EC [35]. Increasing organic-C and production on sandy soils through the addition of amendments and maintaining water availability through irrigation [34]. Furthermore, the highest CV was at available P₂O₅ (110.8) and Mg-dd (127.2) while the CV for production was only 37.0. This is due to the high variation in fertilizer application by each farmer without knowing the optimum nutrient of shallots.

Table 3. Status and variability of soil properties and production of shallot at Padang Lawas Regency, North Sumatera.

| Parameter               | Mean  | Min  | 25%   | 75%   | Max  | CV among field |
|-------------------------|-------|------|-------|-------|------|----------------|
| Sand (%)                | 60.7  | 47.8 | 54.8  | 66.4  | 77.4 | 12.8           |
| Silt (%)                | 21.2  | 13.7 | 14.8  | 27.5  | 38.3 | 32.0           |
| Clay (%)                | 18.1  | 4.1  | 12.6  | 24.0  | 36.5 | 46.2           |
| pH                      | 6.9   | 5.2  | 6.4   | 7.6   | 8.1  | 12.6           |
| Organic-C (%)           | 1.2   | 0.5  | 0.9   | 1.7   | 2.8  | 42.2           |
| N-total (%)             | 0.1   | 0.1  | 0.1   | 0.2   | 0.2  | 37.4           |
| Available P₂O₅ (ppm P)  | 7.5   | 0.6  | 2.8   | 9.1   | 45.0 | 110.8          |
| P-total (ppm P)         | 35.8  | 1.5  | 20.6  | 50.3  | 99.8 | 59.7           |
| K-tot                   | 27.5  | 15.6 | 18.8  | 35.3  | 50.8 | 34.9           |
| K-dd (me 100 g⁻¹ soil)  | 0.4   | 0.2  | 0.3   | 0.5   | 1.0  | 55.6           |
| Ca-dd (me 100 g⁻¹ soil) | 24.0  | 0.5  | 8.1   | 36.7  | 72.3 | 72.7           |
| Mg-dd (me 100 g⁻¹ soil) | 3.7   | 1.3  | 1.5   | 4.6   | 23.9 | 127.2          |
| EC (uS cm⁻¹)            | 127.3 | 43.5 | 70.5  | 141.6 | 419.0| 74.3           |
| CEC (me 100 g⁻¹ soil)   | 19.5  | 2.7  | 7.3   | 31.7  | 56.3 | 77.3           |
| Base saturation (%)     | 54.6  | 17.2 | 28.6  | 74.4  | 88.3 | 43.9           |
| Production (kg 1000 m⁻²)| 900.3 | 300.0| 637.5 | 1200.0| 1650.0| 37.0           |

Note: CV, the coefficient of variation calculated from the average value of 30 farmers at the survey location. The values shown are the mean CV of tidal swamp rice and the ranges in the two types (in brackets).

The relationship between soil properties and production (table 4) shows that all components of soil properties have a positive correlation with production except sand, silt, and P-total. Sand content was inversely related to all soil properties and production parameters, especially clay, organic-C, N-total (p <0.001), CEC (p <0.01), and production (p <0.05). Likewise, the clay content and CEC were correlated with production (p <0.01) and (p <0.05), respectively. Girsang et al. [36] stated that the decrease in production is closely related to the sand content. Furthermore, clay content and organic matter have a positive correlation with CEC [37] and production [34].
Table 4. Pearson correlation coefficient between soil properties and production of shallot at Padang Lawas Regency, North Sumatera.

| Parameter          | Clay   | pH     | Organic-C | N-total | P-total | K-dd  | Ca-dd  | Mg-dd  | EC    | CEC   | BS    | Production |
|--------------------|--------|--------|-----------|---------|---------|-------|--------|--------|-------|-------|-------|------------|
| Sand (%)           | -0.65*** | -0.08  | -0.65**   | -0.72   | -0.07   | -0.29 | -0.21  | -0.26  | -0.14 | -0.51*** | -0.04 | -0.45*     |
| Silt (%)           | -0.49**  | -0.23  | 0.24      | 0.34    | 0.48*** | -0.33 | -0.12  | -0.19  | -0.35 | -0.24  | -0.04 | -0.17      |
| Clay (%)           | 0.26    | 0.40*** | 0.39***   | -0.45*** | 0.53*** | 0.29  | 0.40*** | 0.43*** | 0.67*** | 0.07  | 0.52*** |           |
| pH                 | -0.31   | -0.36  | -0.08     | -0.06   | 0.60*** | -0.07 | 0.33   | 0.00   | -0.39* | 0.10  |       |           |
| Organic-C          | 0.85*** | -0.15  | 0.41**    | 0.05    | 0.33    | -0.18 | 0.56*** | 0.32   | 0.16  |       |       |           |
| N-total (%)        | 0.00    | 0.26   | -0.21     | 0.35    | -0.08   | 0.43  | 0.20   | 0.07   |       |       |       |           |
| P-total (ppm P)    | -0.39*  | -0.28  | -0.15     | -0.30   | -0.40** | -0.44* | -0.20  |       |       |       |       |           |
| K-dd (me 100 g⁻¹ soil) | 0.32     | 0.26   | 0.17      | 0.76*** | 0.42*   | 0.32  |       |       |       |       |       |           |
| Ca-dd (me100 g⁻¹ soil) |          |       |           | -0.03   | -0.04   | 0.46** | -0.07  | 0.18  |       |       |       |           |
| Mg-dd (me 100 g⁻¹ soil) |          |        |           |        | -0.07   | 0.39*  | 0.34   | 0.31  |       |       |       |           |
| EC (uS cm⁻1)       |         |        |           |        | -0.03   | 0.12   | 0.19   |       |       |       |       |           |
| CEC (me 100 g⁻¹ soil) |          |        |           |        | 0.27    | 0.43*  |       |       |       |       |       |           |

* *, **, and *** denote significance at the probability level of 0.05, 0.01, and 0.001, respectively.

Soil is a top 0.3 m soil layer.

3.3. Shallot farming analysis

Analysis of farming using the interview method of 20 farmers in each village observed in table 5. Seed and labor are the highest costs for shallot cultivation in North Padang Lawas District. Susanawati et al. [38] mentioned that costs of seeds, labor, and insecticides are the main components affecting the income of farmers in Brebes. Generally, shallot farmers in North Sumatra use hereditary seeds (non-certified). Simatupang et al. [39] stated that the shallot production decreased by 8 to 11 t ha⁻¹ due to the use of hereditary and uncertified seeds. The survey proved that farming business in North Padang Lawas District is market oriented with a planting pattern of rice-shallot-shallot or intercropped chili with shallots. Based on Schreinemachers et al. [40] government support is needed in increasing agricultural productivity such as certified varieties, cultivation, postharvest management, food security, and market access. This will facilitate the development of the shallot area in North Padang Lawas District.

Furthermore, table 5 shows the cost of shallot production for an area of 1000 m² is Rp.8,197,500,- with a production of 900 kg or equivalent to 9-ton ha⁻¹. The profit gained by farmers is Rp.18,900,000,- with a net income of around Rp.10,702,500,-. From the results obtained by the R/C ratio of the shallot farming is 2.31, which means that for every one rupiah spent in the shallot farming, a return of 2.31 rupiah is obtained. This is supported by Hakim et al. and Apriani [41,42], a R/C ratio of an average shallot is >2. This figure shows that the shallot farming activities in North Padang Lawas District are very economically and financially feasible.
Figure 2. Land suitability of shallot at Padang Lawas Regency, North Sumatera.
Table 5. Analysis of shallot farming of 30 farmers in North Padang Lawas Regency with an area of 1000 m².

| Description | Number and type of workers | Value (Rp.) | Description | Volume | Unit | Unit price (Rp.) | Value (Rp.) |
|-------------|---------------------------|-------------|-------------|---------|------|-----------------|------------|
| Variable cost | A1. Pre harvest labor | | A3. Production Facilities | | | | |
| | 1. Land clearing | 2 | 140,000 | 1. Seed/seedling (labeled/not*) | 120 Kg | 35,000 | 4,200,000 |
| | 2. Fertilizer | | | | | | |
| | a. Inorganic | | | Urea | Kg | | |
| | 3. Fertilizing | | | Chlorpyrifos 200 g/l (liquid) | 1.5 ltr | 10,000 | 150,000 |
| | - Basic fertilization | 1 | 40,000 | Deltamethrin 25 g/l (liquid) | 1.5 ltr | 85,000 | 127,500 |
| | - Fertilization follow-up I (15 HST) | 1 | 40,000 | Propineb 70% dan zinc (solid) | 1 Kg | 95,000 | 95,000 |
| | - Secondary fertilization (30 HST) | 1 | 40,000 | Chlorpyrifos 200 g/l (liquid) | 1.5 ltr | 65,000 | 97,500 |
| | 4. Weeding | | | Isopropyl Amina glyphosate (Liquid) | 2 btl/100cc | 160,000 | 320,000 |
| | - Weeding I | 1 | 70,000 | | | | |
| | - Weeding II | 1 | 70,000 | | | | |
| | - Weeding III | 1 | 70,000 | | | | |
| | 5. Control of pests/diseases | | | Plastic to cover after harvest | 2 roll | 60,000 | 120,000 |
| | - Pesticides every 2 days until 50 days | 35 | 700,000 | | | | |
| | 6. Other: | | | Total of production facilities (A3) | | | 5,902,000 |
| | - Irrigating | 5 | 200,000 | | | | |
| | Total A1 | 1,790,000 | | Total of production facilities (A3) | | | 5,902,000 |

| Description | | | Description | | | | |
|-------------|---------------------------|-------------|-------------|---------|------|-----------------|------------|
| Variable cost | | | A2. Post-harvest | | | | |
| | | | 1. Harvesting and drying | 2 | 150,000 | | |
| | | | 2. Cleaning/sorting/binding | 2 | 150,000 | | |
| | | | 3. Transportation | 2 | 70,000 | | |
| | Total A2 | 370,000 | | | | | |
| | Total Labor (A1+A2) | 2,160,000 | | | | | |

R/C ratio | 2.31 |
B/C ratio | 1.31 |
Based on Marpaung and Rosliani [43], the production of shallots can still be increased by using Agrihoth-
1 and Bima varieties which are capable of producing up to 25-ton ha$^{-1}$. The gap between production and
potential yield of shallots can be reduced by the application of organic matter, planting in the dry season,
NPK application according to crop requirements, using certified superior varieties, and support from the
government in terms of increasing human resources and marketing.

4. Conclusions
North Padang Lawas Regency has biophysical differences in climate, rooting media, nutrient retention,
nutrient available, and toxicity with limitations in the form of excess water in off-season, texture of sandy
loam to loamy sand, low nutrient content and organic matter, and pH. According to land characteristics and
shallot growing requirements, the land suitability class is marginally suitable (S3) with limiting factors such
as water availability, nutrient retention, nutrient availability, root condition, and toxicity. Increasing land
suitability and shallot productivity can be done through planting shallots at the end until the beginning of
the rainy season, organic material application, fertilizing, liming, new improved varieties, and farmers
training with the topic cultivation to marketing facilitated by the government. Based on the R/C value of the
existing farmer's ratio of $>2$, shallots are feasible to be developed in North Padang Lawas Regency both
based on economic and regional values.

Acknowledgments
The first author is the main contributor while the rest is supporting contributors. The reported work was
supported in part by the Padang Lawas Regency Regional Expenditure Budget in collaboration with AIAT
North Sumatra. We thank Palmarum Nainggolan and Syabil Hidayat Lubis for assistance as researcher of
AIAT North Sumatra.

References
[1] BPS-Statistics Indonesia 2019 Statistical yearbook of Indonesia BPS-Statistics Indonesia pp 1-748
[2] Wahyunto, Hikmatullah, Suryani E, Tafakrensanto C, Ritung S, Mulyani A, Sukarman, Nugroho K,
Sulaeman Y, Apriyana Y, Suciantini, Pramudia A, Suparto, Subandiono R E, Sutriadi T,
Nursyamsi D 2016 Petunjuk Teknis Pedoman Penilaian Kesesuaian Lahan Untuk Komoditas
Pertanian Startegies Tingkat Semi Detail Skala 1:50.000 (in Bahasa) Badan Penelitian dan
Pengembangan Pertanian Kementrian Pertanian pp 1-29
[3] Ikeda H, Kinoshita T, Yamamoto T and Yamasaki A 2019 Sowing time and temperature influence
bulb development in spring-sown onion (Allium cepa L.) Scientia Horticulturae 244 242-248
[4] Khokhar K M 2017 Environmental and genotypic effects on bulb development in onion-a review The
journal of Horticulture Science and Biotechnology 92 448-454
[5] Pire R H, Ramirez-Guerrero, Riera J and Gomez N 2001 Removal of N, P, K, dan Ca by an Onion
Crop (Allium cepa L.) in a Silty-clay Soil, in a Semiarid Region of Venezuela Acta
horticulturae 255(555) 103-109 DOI: 10.17660/ActaHortic.2001.555.12
[6] Biru F N 2015 Effect of Spacing and Nitrogen Fertilizer on the Yield and Yield Component of Shallot
(Allium ascalonium L.) Journal of Agronomy 14 220-226 DOI: 10.3923/ja.2015.220.226
[7] Jose N J, Rayanne M P R, Chaves A and Valdivia d F L S 2016 Effect of phosphorus fertilization on
yield and quality of onion bulbs African journal of agricultural research 11(45) 4594-4599. DOI:
10.5897/AJAR2016.11560
[8] de Resende G M and Costa N D 2014 Effects of levels of potassium and nitrogen on yields and post-
harvest conservation of onions in winter Rev. Ceres vol 61 no 4 Viçosa July/Aug. 2014
https://doi.org/10.1590/0034-737X201461040018
[9] Novita D, Asaad M and Rinanda 2019 Potensi dan peluang pengembangan sentra produksi bawang merah provinsi Sumatera Utara (in Bahasa) Agric Jurnal Agribisnis Sumatera Utara 12 (2) Available online http://ojs.uma.ac.id/index.php/agrica.10.31289/agricav12i2.2661.g2238

[10] Badan Litbang Pertanian, 2013 Peta AEZ Provinsi Sumatera Utara skala 1: 250.000 (in Bahasa) Badan Litbang Pertanian pp 1-20

[11] Ritung S, Nugroho K, Mulyani A, Suryani E 2011 Pedoman Teknis Evaluasi Lahan Komoditas Pertanian Edisi Revisi (in Bahasa) BBSDLP Pertanian Bogor P 166

[12] Sumarni N and Hidayat A 2005 Budidaya Bawang Merah (in Bahasa) Panduan Teknis No 3 Balai Penelitian Tanaman Sayuran, Pusat Penelitian dan Pengembangan Hortikultura, Badan Penelitian dan Pengembangan Pertanian pp 1-22

[13] Rejekiningrum P and Kartiwa B 2018 Pengembangan Sistem Irrigasi Pompa Tenaga Surya Hemat Air Dan Energi Untuk Antisipasi Perubahan Iklim Di Kabupaten Bantul, Daerah Istimewa Yogyakarta (in Bahasa) Jurnal Tanah dan Iklim 41(2) 159-171

[14] Zayan AS 2019 Impact of climate change on plant diseases and IPM strategies Current threats and management trends book DOI: 10.5772/intechopen.87055.

[15] Hadisutrisno B 1999 Peranan Faktor Lingkungan terhadap penyakit antraks pada bawang merah (in Bahasa) Jurnal Perlindungan Tanaman Indonesia 5(1) 20-23

[16] Balitsa 2015 Bawang Merah (in Bahasa) Balai Penelitian Tanaman Sayuran http://balitsa.litbang.pertanian.go.id/ind/index.php/berita-terbaru/365-bawang-merah-yang-dirilis-oleh-balai-penelitian-tanaman-sayuran.html. Downloaded on July 25 2020

[17] Brady N C 1990 The nature and properties of soils 10th ed New York: Macmillan Publishing Company.

[18] Firmanasyah A and Bhermana A 2019 The Growth, Production, and Quality of Shallot at Inland Quartz Sands (Quarzipsamments) in the Off Season Jurnal Ilmu Pertanian (Agricultural Science) Vol 4 No 3 December 2019: 110–116. DOI: doi.org/10.22146/iplas.39676.

[19] Lasmini S A, Kusuma Z, Santoso M and Abadi A L 2015 Application of organic and inorganic fertilizers improving the quantity and quality of shallot yield on dry land International Journal of Scientific & Technology Research 4(4) 2277-8616

[20] Sutardi and Porwoninsih H 2018 Kultivasi bawang merah ramah lingkungan di wilayah berpasir spesifik di Yogyakarta (in Bahasa) Jurnal Sumberdaya HAYATI 4(1) 1-6

[21] Ramadhan A F N and Sumarni T 2018 Response of shallot (Allium ascalonicum L.) to manure and inorganic fertilizer Jurnal Produksi Tanaman 6(5) 815-822. ISSN:2527-8452

[22] Ermadani, Hermansah, Yulnafatmawita and Syarif A 2018 Dynamics of organic carbon and nutrients after organic waste addition in an acid soil International Journal of Agriculture, Environment and Biotechnology 11(1) 55-64 DOI: 10.30954/0974-1712.2018.00178.7.

[23] Avevedo-Gomez R, Sanchez-Hernandez M A, Gomez-Merino F C, Ponce-Pena P, Gonzalez-Lozano M A, Navarro-Moreno L and Poisot M 2020 Soil quality of Ananas comosus cultivation land in the Papaloapan Basin Region of Mexico after waste addition as fertilizer supplement. Agriculture 10 173; doi:10.3390/agriculture10050173 www.mdpi.com/journal/agriculture.

[24] Cooper J, Greenberg I, Ludvig B, Hippich L, Fischer D, Glaser B and Kaiser M 2020 Effect of biochar and compost on soil properties and organic matter in aggregate size fractions under field conditions Agriculture, Ecosystems, and Environment Volume 295, 15 June 2020, 106882
[25] Majuru L, Rusinamhodzi L, Nyamangara J and Hoosbeek M R 2016 Effects of nitrogen fertilizer and manure application on storage of carbon and nitrogen under continuous maize cropping in Arenosols and Luvisols of Zimbabwe *The Journal of Agriculture Science* 154(2) 242-257

[26] Sumarni N, Rosliani R and Basuki R S 2012 Respons Pertumbuhan, Hasil Umbi, dan Serapan Hara NPK Tanaman Bawang Merah terhadap Berbagai Dosis Pemupukan NPK pada Tanah Alluvial (in Bahasa) *Journal Horticulture* 22(4) 366-357

[27] Assefa G, Girma S and Lammesa K 2016 Effects of nitrogen and phosphorus fertilizer rates on yield and yield component of shallots (*Allium cepa* L.) at Gemechis and Daro Labu Districts, West Hararghe Zone *Journal of Biology, Agriculture and Healthcare* ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) 6(24) 2016

[28] de Resende G M and Costa N D 2014 Effects of level potassium and nitrogen on yields and post-harvest conservation of onions in winter *Soil Science and Plant Nutrition Rev. Ceres* vol 61 no 4 Viçosa July/Aug. 2014 http://dx.doi.org/10.1590/0034-737X201461040018

[29] Hilman Y, Lukman Land Sopha G 2014 Nitrogen effect on production, nutrients uptake and nitrogen-use efficiency of shallots (*Allium cepa* var aggregatum) *Advances in Agriculture & Botanics* 6 (2), 128-133 http://www.aab.bioflux.com.ro

[30] Syamsiyah J, Rahayu, Herawati A and Binafsihi W 2020. Study of level water salinity on the growth of varieties of shallost (*Allium ascalonicum* L.) in Alfisols. The 4th International Conference on Climate Change 2019 (The 4th ICCC 2019). IOP Conf. Series: Earth and Environmental Science 423 (2020) 012065. doi:10.1088/1755-1315/423/1/012065

[31] Lal R and Moldenhauer W C 2008 Effects of soil erosion on crop productivity *Critical reviews in plant science* pp 303-367. https://doi.org/10.1080/07352688709382244

[32] Abdullahi A 2018 Erosion effect on soil physical properties in selected farmlands in Gidan Kwano, Niger State *Journal of Horticulture and Plant Research* ISSN: 2624-814X 2 10-22. Doi: 10.18052/www.scipress.com/JHPR.2.10. 2018 SciPress Ltd, Switzerland

[33] Girsang S S, Quilty J R, Correa Jr T Q, Sanchez P B and Buresh R J 2019 Rice yield and relationships to soil properties for production using overhead sprinkler irrigation without soil submergence *Geoderma* 352 277-288

[34] Yost J L and Hartemink A E 2019 Soil organic carbon in sandy soils: A review *Advances in Agronomy* DOI: 10.1016/bs.agron.2019.07.004: https://www.researchgate.net/publication/335163738

[35] Girsang, S S, Correa Jr, T Q, Quilty, J R, Sanchez, P B, Buresh, R J 2020 Soil aeration and relationship to inorganic nitrogen during aerobic cultivation of irrigated rice on a consolidated land parcel *Soil and Tillage Research* 202 (2020) 104647

[36] Parfitt R L, Giltrap D J and Whitton J S 1995 Contribution of organic matter and clay minerals to the cation exchange capacity of soil *Communications in Soil Science and Plant Analysis* 26(9-10):1343-1355 DOI: 10.1080/00103629509369376

[37] Susunanawati, Jamhari, Masyhuri and Darwanto D H 2018 Factors influencing income of shallot farming in Java Indonesia using UOP profit function model Advances in Engineering Research, volume 172 68. 4th International Conference on Food and Agriculture Resources Published by Atlantis Press

[38] Simatupang S, Sipahutar T and Jamil A 2013 Pengembangan Bawang Merah di Sumatera Utara *Laporan Kegiatan BPTP Sumatera Utara* 2013

[39] Schreinemachers P, Simmons E B and Wopereis M C S 2018 Tapping the economic and nutritional power of vegetables *Global food security* 16 36-45
[41] Hakim A R, Rajiman and Nalinda R 2017 Analisa nilai ekonomi ushatani bawang merah (Allium cepa L.) off season dan in season pada lahan pasir pantai (Studi Kasus di Desa Srigading Kecamatan Sanden Kabupaten Bantul DIY) (in Bahasa) SEPA: Vol 14 No 1 Sept 2017: 53 – 60 ISSN: 1829-9946

[42] Apriani L N 2011 Analisis Efisiensi Teknis dan Pendapatan Usahatani Bawang Merah (Studi Kasus: Desa Sukasari Kaler, Kecamatan Argapura, Kabupaten Majalengka, Provinsi Jawa Barat (in Bahasa) [thesis] Bogor (ID): Institut Pertanian Bogor

[43] Marpaung A E and Rosliani R 2019 Adaptability of growth and yield on 5 varieties of shallot (Allium ascalonicum L.) in wet highland Journal of tropical horticulture Vol 1 Available online at http://jthort.org.