

Local Potential Intensification System (SIPLo) the Sustainable Management of Soil Organic Potatoes

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Abstract- Farm management system leads to intensive use of chemical fertilizers and pesticides overdoses, apparently a serious impact on the decline in land productivity and degradation of agro-ecosystems. Management of organic potato farming with the Local Potential Intensification System aims to improve the potential of local resources and increase fertility of the land to be utilized in a sustainable manner. The study took place in Batu, Malang, and data collection is done by survey. Respondents are experienced potato farmers and revered as the expert. Analysis of data using Strategic Analysis (SWOT) and Analytical Hierarchy Process (AHP). The determination of criteria and sub-criteria of SIPLo using pairwise comparison method in the AHP. Result of analysis is hierarchy of priority criteria and sub-criteria, which is used in SIPLo and SWOT analysis on the value of vision, mission and values, that influence management of potato farms. The policy strategy that must be addressed: Introduction SIPLo profile strategic priority value 12; Socialization, training and make a pilot strategic priority value 12; Establish partnership with educators and the government or the competent strategic priority value 12. The strategy of sustainable land management and potatoes productivity can be increased and the state of agro-ecosystems can be restored. It is necessary to: implement SIPLo on organic potato farms; implement SIPLo the time of induction of land must be in wet or flooded; increase productivity and improve of the agro land at land management should be given an appropriate organic fertilizer type, maturity and recommended doses of fertilizer; organic fertilizer should be given to speed up the process of bacterial decomposition of soil organic matter mineralization.

Keywords: SIPLo, Induction, bacteria

I. INTRODUCTION

The recent issues are how to create a farming management that can improve soil fertility, agro-ecosystem conditions and quality of production. The emphasis on organic farming systems is to provide feedback that can reduce environmentally damaging inputs. The addition of organic fertilizers and soil microorganisms are proven improve fertility and quality of tuber, which is a larger size, of potato tuber [1]. Cropping pattern of organic farming system focused on cropping, adding organic matter into the soil to improve agro-ecosystem was stressed conventional monoculture systems with the use of chemical fertilizer and pesticide intensive [2]. Modern agricultural system (Green Revolution) is supported with high external inputs (High External Input Agriculture-HEIA), now it reveals a serious negative impact on agricultural land. Applying a lot of chemical fertilizers on potato detriment real enough where N and P are much washed and participated to farmland run off that contribute to water pollution [3]. In Java, it has happened a shrinkage of soil organic matter content and in some places. There is a critical status of agricultural land [4]. That about 60% of the area of rice fields in Java, organic matter content <1% [5]. Cropping pattern that must be developed is by intercropping or multiple cropping pattern. The best farm management with multiple cropping pattern or integrated land use of the plant with a monoculture system, if it is done regularly, can improve the content of C and N, thus increase productivity [6].

The increase of agricultural production has changed the farmer thinking from traditional organic farming into the modern agriculture. In fact, the modern agriculture can lead to the exploitation of land resources and less concerned with the long-term interests. The increase of the use of chemical pesticides result in any negative impacts on the plants and its environment [7,8]. The emergence of agro-ecosystem degradation problems are complex and have any impacts on reducing soil fertility. Extinction of soil microorganisms, such as earthworms, will reduce soil fertility. Earthworms suggests the crucial role in the soil carbon cycle, the formation of soil aggregates, helping decomposition of cellulose and formation of soil humus, their roles are is helpful in improving soil structure as well as activities of soil organisms. Earthworms are very active in decomposing any

organic wastes, which requires only very little food. The most remaining organic wastes will be decomposed until it releases any available plant nutrients. Earthworms have advantages, in their body contain many microorganisms, enzymes and hormones that can accelerate mineralization of organic matter and release any available nutrients [9,10]. An understanding of the soil status that should be regarded as a living thing, so the soil health should be maintained. The health soil management is done by applying soil organic matter or incorporate biomass into the soil. Organic compost will help to supply nitrogen in the soil, although the numbers are relatively small compared to chemical fertilizers. Mineralization process depends on the ability of decomposing soil bacteria [11]. The decomposition process runs naturally that will be providing available nutrients to the plant (feeding the soil that feeds the plant). Returning the natural function of land by applying manure of cows, goats, chicken, green manure and compost, is very beneficial for the growth and production of plants, because it contains any macro and micro nutrients [1]. At this time farmers prefer to undertake instant or fast-paced culture in addressing agriculture issues, such as application any chemical fertilizers and pesticides [12]. Optimization of local natural resources as a natural change agent should be empowered to support improvement of land. Vermicompost can be utilized in environmental improvements, it is a simple fabrication process, relatively expensive and does not cause soil pollution. Utilization of earthworms in the location will be utilized by existing organic waste into vermicompost as a source of biological fertilizers in improving physical, chemical and biological properties of soil [13].

Management of organic potato farms Local Potential Intensification System aims to improve the potential of local resources and increase the fertility of the land to be utilized in a sustainable manner. Land management with the Local Potential Intensification System (SIPLO) is an attempt to bridge the gap that occurs in the system impact of organic farming and conventional farming systems, where the two systems are the advantages and disadvantages. Implementation SIPLO potato land management based on the principles of ecological health of soil and plants also improve the capacity of land resources. SIPLO operationally focused on environmentally friendly land management and use of all local potential. Improvements to governance cultivation technique of air, water, soil nutrients and energy to consider aspects of environmental health. One of the local potential that can be used is earthworms which are able to make the air space in the soil, increase water absorption capacity, and ease root development. Afterall, the worms accelerate soil enrichment agro-ecosystem better [14,15,16]. Life on agro-ecosystem there are a number of interrelated activities between biotic and abiotic components. It is as stated [17] that is able to produce vermicomposting earthworms are very useful in eco-friendly land management and can suppress plant disease. These activities may include the biochemical, chemical, physical or biological resulting in a food chain or energy for living organisms. The contribution of these activities on the environment can improve soil fertility. Restoration of land productivity is mostly done by soil microorganisms, insects and worms that can remodel in a rapid state of physical, chemical and biological more conducive [16]. Managing agricultural land Noteworthy aspects of renewal and repair, so that all the components can function normally form chains balanced life. Many soil microorganisms that can give each other in the chain of life in the ecosystem. The bacteria grow best if the soil can not suffer contamination of farm land, so that it can function optimally as *Bacillus*, *Pseudomonas* and *Streptomyces* is a productive bioreactor in secondary metabolic remodel and could act as natural enemies of mushroom or bacterial pathogens [18]. As the presence of mycorrhizal symbiosis has the ability to crop plants such as potatoes which Arbuscular mycorrhiza infects plant roots and make hyphae in the epidermal cells are also the root cortex. Outer hyphae can absorb more nutrients so the larger root surface can help absorption of nutrients needed by plants cultivation [19].

Farming methods should routinely include biomass or organic fertilizer into the soil and conserve soil, reducing erosion and increasing land productivity improved [20]. The organic matter content of N rated quality when many, then low concentrations of lignin and polyphenols and has an accuracy right natural decomposition process plants need. The quality of the organic material to supply nitrogen rated critical if concentrations of 1.9% nitrogen; lignin > 15% and polyphenols > 2%. Quality materials related to the supply of organic phosphorus is determined by the concentration of P in organic materials and critical value of P is 0.25% levels [21]. The state of a lot of land shortage C and N in large quantities and the availability is low, this is due to high mobility in soil is high. Conditions and the amount of organic matter in soils is positively correlated to the availability of nutrients N. Land of nitrogen fixation can be obtained free air as the plants leguminosae rhizobium symbiosis with bacteria. The addition of biomass from any Leguminosae are able to supply N for 20-45% of the total nitrogen [22] during one growing season. Only 30% of which can be utilized by plants, many limiting factors are involved that nitrogen is not utilized because when plants need nitrogen, it is not available. Synchronization level is influenced by the rate of organic matter decomposition. Rate of organic matter decomposition is determined by condition of soil humidity, soil temperature, and soil organic matter quality. The quality of organic matter is characterized by the N content > 2.5%, lignin content < 15%, and polyphenol < 4 [21].

II. RESEARCH METHODS

The study was conducted in the Batu city, as the respondents are farmers conventional and organic potatoes, who have the experience and the cast of experts in the management of organic potato farms. Data is collected by survey methods, sampling methods approach "stratified cluster sampling". Data analysis (1). Strategic Analysis (SWOT), it is necessary for the analysis of internal and external aspects of the environment. (2). Analytical Hierarchy Process (AHP), [23] states that for the prioritization criteria and sub-criteria for distribution of questionnaires is conducted to review the models that have been developed previously. The determination can be carried out by the method of pairwise comparison in the AHP. From that method it can be determined from the analysis of the hierarchy of criteria and sub-criteria SIPLO in organic potato sustainable land management. Examine the relationship Swot analysis then assessed the relationship of vision, mission and values that most affect the implementation SIPLO potato sustainable land management to determine the policy decision-making strategies[24].

III. RESULTS AND DISCUSSION

The pairwise comparison analysis suggest the criteria of importance SIPLO priority in land management based on sustainable organic potatoes, and are considered as the most important factor.

Table 1. Pairwise Comparison Between Normalization Matrix Criteria on SIPLO in Sustainable Land Soil Management (Score)

Criteria	Tillage	Agro-ecosystem	SIPLO	Land Productivity	Organic Fertilizer	Average Score
Tillage	0.08	0.11	0.17	0.15	0.08	0.118
Agro-ecosystem	0.21	0.19	0.37	0.14	0.21	0.224
SIPLO	0.23	0.21	0.21	0.29	0.34	0.256
Land Productivity	0.14	0.27	0.13	0.16	0.13	0.166
Organic Fertilizer	0.34	0.22	0.12	0.26	0.24	0.236
Total	1.00	1.00	1.00	1.00	1.00	1.00

The results of analysis indicate SIPLO management with an average score of 0.256, which indicate that land management is a top priority potatoes SIPLO application, organic fertilizer score 0.236 and improved agro-ecosystem score 0.224 compared to the criteria in land productivity and soil. Local potential in the management and treatment plants play an important role, and this is all a series of processes cannot be separated from the surrounding natural factors, so the local potential biotic and abiotic organic potato farms need to be repaired. The local potential in the form of food waste, biomass crops, manure and other organic wastes have a high humus content in vermicompost [25,26,27]. Organic material containing humic acid, fulvic humus or minerals available to plants and can help plants to cope with environmental stress and stimulate growth [28]. Low levels of soil organic matter and microbial activity less often the root cause of disease susceptibility of plants [29], the addition of organic fertilizers proved effective in suppressing plant diseases [30,31,32]. Soil organic matter stimulates the population of bacteria and fungi nematode antagonists (*Trichoderma*, *Pseudomonas*, *Pasteuria* and *Chitinolytic bacteria*) are also natural enemies of Nematode groups that *Nematophagous mites*, *Hypoaspis calcuttaensis*, *Collembola* and *Arthropods* where choosing foods of plant parasitic nematodes type [33] and *Fusarium* [34,35]. Vermicompost stimulate microbial diversity and the antagonistic activity of bacteria, so that they can be effective biocontrol agents in reducing *phytopathogenic* fungal disease [36,37,38].

Implementation SIPLO the most important potato farms did induction during the production value of the score 0.275, shows the value of the score of water 0.230. The process of induction on potato farms will help the process of releasing the anode and the cations in the soil, making it available to plants. Two polar electrodes (anode and cathode) were grown in soil electrified will happen electrolysis are Anode: $2\text{H}_2\text{O}-4\text{e}^- \rightarrow \text{O}_2 + 4\text{H}^+$ and Cathode: $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$, the process followed by transfer of H^+ to the poles of the cathode and OH^- to the anode pole (electromigration) and soil pore water displacement from the area around the anode to the cathode (electroosmosis). Transfer of soil pore water has a major impact in increasing the carrying capacity of the land around the poles anode [39]. In an effort to increase production can be done using the superior seeds score of 0.173. Plants that have the genetic trait superior production will be able to provide high yields. Land management and maintenance of the plant to be sustainable in the control of pests and plant diseases should capitalize on the value of the score 0.095 biopesticide plants, including weed control should be done manually score 0.082, granting fewer chemical fertilizers score 0.080 and sanitary land score 0.065. Optimization of the local potential by [40] sustainable land management should be developed first cornerstone of ecological principles, namely: (1). Restoring the function of resources, (2). Conserve resources with a healthy environment, (3). Prevent damage of agro-ecosystem. Second runway cultivation techniques: (1). Organic fertilizer, (2).

Increased root growth by plant spacing, (3) Seed potatoes are planted should have a superior nature, healthy, pest and disease resistance, (4) Water taste is not excessive, (5) Improve soil aeration intensive system, (6) maintain the biological balance of the soil with sanitation systems, and (7) Increase the potential use of local resources optimally. Management in controlling plant pests and diseases do with utilization biological agents that do not damage the environment. Earthworm activity increases the number of Gram-negative bacteria [41,42]. Casting *Chitinolytic bacteria* associated with the group are: *oleivorans Nocardioides*, *Streptomyces*, *Staphylococcus epidermidis* has the ability to suppress disease *phytopathogens Rhizoctonia solani*, *Colletotrichum coccodes*, *Pythium ultimum*, *P. capsici* and *Fusarium moniliforme* [43]. The addition of low doses of chemical fertilizers do, it is because the land is degraded, so that the production of potato plants can produce, it is necessary to stimulate chemical fertilizers gradually reduced the dose, if the land is back to normal. The treatment plants should be combined NPK fertilizer and organic fertilizer to get the additional benefit of nitrogen, potassium and phosphorus [44].

Table 2. Application of Organic Fertilizer in SIPLO Sustainable Management of Organic Potato

Sub criteria	Score
Organic fertilizers	0.115
Maturity of organic fertilizers	0.158
Types of organic fertilizer	0.288
Microorganisms decomposing soil organic matter	0.232
Organic fertilizer level	0.035
Availability of raw organic matter	0.095
Composting techniques	0.077

Result of analysis shows that the application of organic fertilizer into the soil is the most important criteria, the type of fertilizer is given the score of 0.288, because it affects growth, and crop yield, improve agro-ecosystems and land productivity. Vermicompost contains compounds that grow enough cytokinin, gibberellin and auxin [10]. Testing vermiwash and urea solution on seed germination, root and shoot length proved vermiwash substance containing hormones to grow [45]. Livestock waste vermicompost aqueous extract showed a significant amount of indole-acetic-acid (IAA), gibberellins and cytokinins [46]. Nutrient availability in the soil depends on the type of organic fertilizer and can replace the need for chemical fertilizers to meet crop nutrient requirements [11,47]. The role of bacteria decomposing organic fertilizer is very strategic in determining nutrient availability for plants with 0.232 score. This is due to the activity of microorganisms can be a limiting factor in nutrient availability in the soil. The use of microorganisms in bokashi fertilizer can speed up the fermentation process and mineralization are useful for improving crop production [48]. Maturity of organic fertilizer while deployed to great effect on the availability of soil nutrients for plants. Organic fertilizer can reduce erosion, improve water retention for plant growth, nutrient retention through increased charge an ion and cations in soil, improve soil corrected capacity, supplying energy for soil organisms, and increase saprophyte organisms and suppress plant parasitic organisms [49]. The results [50], granting the application of organic fertilizer and irrigation on rainfed lands and irrigated lands, greatly affect the increased production and the cost of potato cultivation. SIPLO techniques can help speed up the release of ions and cations, so that when applied to the induction of the availability of soil organic matter will be accelerated to the plant. However, the state of the reality in the field of raw materials for making organic fertilizer in areas where land is still relatively less potatoes, which can affect the availability of fertilizer needed by farmers.

Table 3. Priority Matrix Test Options Linkage strategies in the management of land SIPLO Sustainable Organic Potatoes

Strength – Opportunities (SO) Strategy	Linkage to the: Vision Mission Value ----- (Score) -----			Priority Strategies (Total Score)
Introduction to engineering profile SIPLO about the benefits and usefulness	4	4	4	12
Required socialization, training in applications SIPLO farmer groups	4	4	4	12
Keep in cooperation with the instructor or competent authorities	4	4	4	12

Information: (1). Unrelated; (2). Less related; (3). Related; (4). The most relevant

Sustainable potato land management can be implemented by introducing the SIPLO profile (value of linkages 12), socialization and training (value of linkage 12), and the extension or cooperation with the competent authorities (value of linkage 12). Policy decision-making strategy is aggressive. Effects resulting from factors of success in a value of 2.14. This is due to SIPLO can help optimize an availability of nutrients in soil (value of 0.31), increase the release of an ion of nutrient (value of 0.28), technically does not cause pollution of soil, water, air and crops (value of 0.26), this technique can help controlling pests and diseases (value of 0.17), the plant becomes more rigid (value of 0.16), can neutralize chemical residues in soil and water that will enter crops (value of 0.16), and production can be increased (value of 0.15). The process of soil induction on potato farms will help the process of releasing the cations in the soil, the movement of H^+ to the poles of the cathode and OH^- to pole anode, soil water around the anode move into the cathode and it increase the soil carrying capacity [39]. The vermicompost fertilizer can increase physical activity, chemical and biological soil fertility and soil productivity, also useful for controlling pests and diseases [16,17].

Effect of environmental factors in determining success in managing the organic potato farming suggest (value of 3.22). It due to the technical improvement of cultivation SIPLO (value of 0.50), it can increase land productivity (value of 0.47), the production is safe for consumption (value of 0.47), it should be able to reduce the cost of the production (value of 0.46), to reduce the pollution of water, air, soil, and crop yield (value of 0.45), technically SIPLO environmentally friendly (value of 0.35), can increase the availability of compost in quick time (value of 0.34), and was able to improve agro-ecosystem (value of 0.30). Land management can be done with improved cultivation techniques through the governance of air, water, soil nutrients and energy to the consideration of aspects of environmental health [14,15]. Utilization of local potential by increasing the population of microorganisms through the role of earthworms could increase airspace, enhance capacity and water absorption, facilitate the development of plant roots, soil enrichment and improvement accelerates agro-ecosystem [16]. The addition of organic fertilizer in rainfed and irrigated agroecosystems showed improvement cycle where biological activity, and increased physical and chemical linkages biotic and abiotic components affect the increase of production and the cost of potato cultivation [50].

IV. CONCLUSION

Strategy of sustainable land management include the following practices: (1). Implementation of SIPLO on organic potato farming; (2). In engineering applications SIPLO the time of land induction must be in condition of wet or flooded; (3). At the time of land preparation should be given an appropriate organic fertilizer type, maturity, and recommended doses of fertilizer; and (4). Organic fertilizer should be applied to support the process of bacterial decomposing of soil organic matter.

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