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Land Management and Local Resources in Sustainable Organic Potato Farming Systems in Batu, Indonesia

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Abstract Objective of this research is to determine good management strategies to get potential utilization of local resources optimally in continuous improvement of potato land. Research took place in Batu City, Indonesia. Respondents are farmers who have the experience and expertise in the management of potato farms. The criteria of the respondent selection is by using sampling methods approach "stratified cluster sampling". Analysis of the data using (1) the Strategic Analysis (SWOT) and (2). Analytical Hierarchy Process (AHP). Results of analysis suggested that application of technology in land management and local resource shows value score of (0.27) is greater than the empowerment of implementation of strategy and the utilization of local potential value score of (0.258) and the improvement of the state of agroecosystems value score of (0.214). It shows that the technology has a very strong influence in the condition of agricultural land change and the potential of local resources. The important thing to note is that organic fertilizers should be given as recommended score of (0.24), and local biopesticides value score (0.23). The recommended policy strategies are: the use of local varieties and improved varieties to get tolerant to pests and diseases; improvement of local agro-ecosystems to stimulate; optimization utilizing microorganisms so that can develop properly; giving organic fertilizer on potato farms to improve productivity; and utilization of local resources plant biopesticides to reduce environmental pollution and providing biomass to improve soil fertility.

Keywords Management, Local Potential

1. Introduction

The management of agricultural land is currently required a wise action as the land productivity is declining gradually. The neglected aspects of agro-ecosystems can lead to the fundamental issues. Agricultural land management in intensive cropping with chemical fertilizers and giving excessive doses of pesticides can be a major trigger for the decline of biodiversity[1]. Potential deterioration of local diversity in potato fields showed damage and decreased function of the agro-ecosystem. The management of potential local resources in improving the condition of the land should pay attention to ecological aspects (1). Restoring the function of potential local resources as it should be; (2). Conserving potential local resources and create a healthy area of plantation; (3). Preventing damage to environmental plant; (4). Doing the best cultivation techniques; (5). Giving an organic fertilizer regularly; (6). Createing an ideal spacing of plantation; (7). Seed of potatoes should have a superior nature, a healthy, pest and disease resistant; (8) Watering sufficiently, not excessive and well aerase of plantation; (9) Maintaining the biological balance of the soil, and (10) Optimizing the utilization of local resources[2]. Scarcity of predators, beneficial insects and microorganisms that caused local land and existing organisms are not able to keep up pressure of environmental changes that is very fast and heavy in a long time. The increased use of agricultural chemicals has been shown that it has detrimental effects on crops, so that populations of plants and animals are less[3]. Organic farm management system with multiple cropping planting patterns is very suitable for plant resistance and improve a good environment, while the conventional system which emphasizes on the use of chemical fertilizers and pesticides has a negative impact on environment[4].

Agricultural development with modern farming systems cause complex problems, such as: (1) reducing productivity and land tends to be infertile, (2) increasing pollution and environmental damage, (3) having capacity of the soil (microorganisms, medicinal plants, pollinating insects, birds, earthworms) encountered increasingly scarce to find, and (4). Plants treated with synthetic chemical fertilizers are more susceptible to pests and diseases than organic crops and showed a better growth[5]. The use of chemical ingredients

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proven increasingly has negative effects on plants and environment. Environmental changes occur due to the technology-intensive from the package of applications that are not recommended, as many pests are resistant, so it happens a resurgence, blasting of certain pests, and accumulation of pesticide residues in agricultural products [6]. The use of fertilizers and pesticides with excessive doses on a long period can cause changes in the lives of animals, plants and other living organisms in an ecosystem. The giving of organic fertilizer when it is compared to chemical fertilizer, it has the input of organic matter to the soil that will further enhance the biodiversity[7,8]. The use of pesticides in the potato farmers' community is an important which can not be left in the care of plants. This thing can lead to an emphasis on environment continuously, give rise to the pollution and residues in potato tubers. 48% of potato tuber is contaminated by organophosphorus residues. The result of Methimedopous showed 16.7% residue levels is higher than the maximum permissible limit of 6.3-6.5%[9]. The impact of pesticides use resulted to the chlorpyrifos residues , endosulfan and carbofuran in soil and water exceeds the tolerance level[10]. These compounds affect the ability of bacteria or microorganisms decomposing the function in the ecosystem. Potato farmers in caring for the majority of the rules to apply pesticides is not recommended, it can cause the extinction of various local predators and microorganisms [11]. Environmental damage that is caused by intensive use of herbicides to kill weeds is proved to harm the microbial community, increased susceptibility to plant diseases[12,13], glyfosat reduce the viability of earthworm[14].

Several researchs to determine potential utilization of local resources optimally in continuous improvement of the potato fields. Each location by micro-climatic conditions usually has a specific community or specific population that is very tolerant. Organisms in a particular area have the ability of survival that is strong enough and has the distinctive characteristic of the morphology, anatomy and physiology of environment. Changes in weather conditions from time to time, spurring efforts to cope to environmental stress and improved properties of plant characteristics. The development of biotechnology by using transcriptomics to identify the nature and character of the local potato (wild potatoes). The local potatoes are breeding to create another genetic advantage in order to get varieties which are tolerant and result to a high production. Use of gene in a cross can detect proteins that control which enable the development of improved varieties tolerant and effective for the use of the nutrients in the soil[15]. On potato farms in Batu region, a wild potato species is found. The potato plants grow alongside regular land or rice. They the advantage of pest and disease resistant, as well as resistant to water shortage. These plants produce small tubers amount of about 16-18 tubers to tubers' weight 100-200 g/clump (this is the result of interview with a leader of organic potato farmer, by Marsudi, 2012)

Potato land management is very important in maintaining and improving the carrying capacity of land. Organic fertilizer can add organic matter content, establishing structural stability, better biological activity, biodiversity, insects in the soil increases, may reduce losses due to leaching (run off) the nutrients nitrogen and phosphorus [16,17]. Though it is often found that nitrogen derived from organic fertilizers is smaller than the total amount of chemical fertilizer[18]. Land is the source of life for the organisms living in a life chain network, where each other are interrelated and need. Giving organic fertilizer, green manure and compost on potato plants showed a positive effect on the increase of carbon and nitrogen in the soil, it can improve soil structure, increase soil moisture, increase cation exchange capacity, soil pH, improve chemical, biological and suppress pests and plant diseases [19]. Land management, if it is done with crop rotation patterns, will give increase the overall pro-fitabilias[20,21]. Linkage of biological activity on agricultural land is very dynamic and complex. Earthworms strongly encourage on plant growth as a form of activity of *Rhizosphere bacteria* such as *Pseudomonas, Rhizobium, Bacillus, Azosprillium, Azotobacter*. Earthworm activity can boost the growth of Rhizobakteri (PGPR) and plant population[22]. This group of bacteria stimulate plant's growth directly due to solubilization of nutrients[23,24] and capable of producing the growth of hormone, 1-aminocyclopropane-1-carboksilat (ACC) deaminase[25], capable of nitrogen fixation from the air[26], and it is not directly suppress fungal pathogens. Produce antibiotics, fluorescent pigments, siderophores and fungi[27,28,29,30]. Environmental damage has an impact on scarcity or extinction local potency. The more agricultural lands which are intensively managed, the level of biological diversity will be more reduced[31]. Testing technique of organic and conventional farming systems on crop land management also maintenance for the diversity of arthropods proven organic farming systems can increase the biodiversity of insect species of *Spiders, Carabidae* and *Orthoptera* [32,33].

2. Methods

The research was conducted in Batu potatoes field from April to July 2012 with respondents were conventional potato farmers and organic potato farmers. The qualification of respondents were potato growers which have the experience and experts in the management of potato farms. The determination of the respondents was using the sampling method approach "stratified cluster sampling". Data were collected by means of surveys and distributing questionnaires to the respondents. Analysis of the data using (1). Strategic analysis (SWOT) (2). Analytical Hierarchy Process (AHP)[34,35] to use it in the prioritization criteria and sub-criteria approach to distribute questionnaires conducted pairwise comparison method in the AHP and to review the models that have been developed previously. From this analysis, it can be determined that the hierarchy of criteria and sub-criteria SIPLO in land management and resource potential local power. The determination of policies' decisions need to test the relationship strategy of swot analysis with relationship vision, mission and values which believed to be most influencial.

3. Results and Discussion

Result of survey obtained by quantitative data some variable perceived, in area Batu city (Table 1).

Results of pairwise comparison analysis is determined by the importance of the priority of criteria based on factors that are considered as the most important (Table 2).

The result of analysis shows technological applications value score (0.270) greater than the implementation of the strategy of local empowerment and utilization potential (score 0.258), improvement of the state of agro-ecosystems (score 0.214). This situation shows that the technology has a very strong influence on changes in the condition of agricultural land and the potential of local resources. Land management and organic farming system crop maintenance proven to increase the number and class of Arthropods biodiversity[36]. If the local potential and its utilization are optimized well, it can help and sustain the sustainable use of agricultural land. Each location of potato field has properties and characteristics of specific advantages, if they are managed with the appropriate technology they will be able to provide maximum carrying capacity of the land[2]. An environmentally-friendly applied technology when combined to the use of all local potentials will be useful to improve high land agro potatoes. Land management can be done to the manure, organic fertilizer, mulch litter, tillage to the conservation techniques, multiple cropping, intercropping, crop rotation, cover crops, nutrient management and integrated farming mix[37]. Management strategies has the aim to increase land productivity (score 0.17) and farming (score 0.08).). Good farm management is implementing multiple cropping planting patterns or integrated land use which can enhance C and N in the soil, thus increasing land productivity[38].

The application of technology in the management of land and resources must pay attention to the importance of note that organic fertilizer according to recommended dosage value score (0.24) (Table 3); Strategies optimizing the utilization of local biopesticides value score (0.23). Giving organic fertilizer will be greatly help in sustainable organic land management and the main types of fertilizer recommended doses, because each field site of different fertility levels. Chicken manure feces proven chicken dung pellets available of higher nitrogen content and show the growth and yield better than compost fertilizer[39]. Organic farming affects to the increased number of biodiversity[32]. Humic and fulvic acids in organic matter in the form of minerals available to plants, useful for solving the stress and stimulate the plant's growth[22]. The use of compost manure is proven to lower the level of concentration of mineral nutrients Nmust pay attention K in the plant tissue and leaf chlorophyll. The importance thing is a change in protein expression profiles of potato tubersmust pay attention ie an increase in proteins involved in responses to stress regulation[40]. The use of genomics to identify protein functions related to the causative gene so the chances of developing the potential of functional molecules for crop improvement[15].

Table 1. Quantitative Data Situation of Farm Potato in area Sumber Brantas, Tulungrejo, Bumiaji, and Cangar Batu City

Repeated	Local Potential	Techno logical Compos ting	Organic Manure	Dose of Organic Manure	Damage of Agro-ecosystem	Land Productivity
			(Score)			
1	3.63	4.12	1.95	3.63	1.64	2.76
2	3.26	4.36	1.68	3.52	1.76	3.31
3	2.79	4.62	2.31	3.73	2.24	3.65
Average Score	3.23	4.37	1.98	3.63	1.88	3.24

Table 2. Normalization Matrix Criteria Pairwise Comparison Between the Land and Resource Management in the Local Sustainable Organic Potato Farming Systems

Criteria	Agricultural patterns	Agro ecosystem conditions	Application Technology	Land Productivity	Local Potential	Average Score
Agricultural patterns	0.04	0.11	0.08	0.13	0.08	0.088
Agro ecosystem conditions	0.18	0.19	0.35	0.12	0.23	0.214
Application Technology	0.27	0.25	0.24	0.29	0.30	0.270
LandProductivity	0.16	0.23	0.16	0.17	0.13	0.170
Local Potential	0.35	0.22	0.17	0.29	0.26	0.258
Total	1.00	1.00	1.00	1.00	1.00	1.00

Table 3. Application of Technology in Land Management and Local Resource in Sustainable Agricultural Systems Organic Potatoes

Sub criteria	Score
The use of chemical fertilizers	0.082
The use of insecticides	0.110
Organic fertilizer	0.240
The use of fungicides	0.120
Utilization of local bio-pesticides	0.230
Mixing pesticides	0.140
Use of heavy equipment	0.078

In the conventional farming system the changes of this potato state in agro land decreased sharply, this state is due to the spraying of pesticides, insecticides and fungicides that do not fit the rules. To mixing various kinds of pesticides to the no measurable dose value score 0.14. The use herbicides cause adverse effects on the plants forming which plant community within the same planting area[1,3]. Conventional farm management that the use of insecticides has a strong negative impact on arthropods and reducing biocontrol[3]. This situation shows that the organic fertilizer and bio-pesticides is more important than the use of pesticides in managing natural resources. The use pesticides leads to pest resistance, resurgence, the extinction of predators, insects and animals benefit. Decrease plant resistance to pests and diseases caused by the unwise use of pesticides[41]. Environment that has the decreasing potency carrying capacity of land resources, continuous improvement is needed. This can be done by way of land management and maintenance of integrated crop through biological control or utilization of bio-pesticide plant.

Table 4. Exploiting the potential of local strategies on Land and Resources Management in the Local Sustainable Organic Potato Farming Systems

Sub criteria	Score
Very high plant diversity	0.142
The diversity of insects and animals benefit	0.170
Plant local specifics	0.145
Bio-pesticide plants	0.140
Diversity of microorganisms	0.175
Utilization of local	0.094
Maintenance of local potential	0.064

Empowerment and utilization of local potential, the role of diversity of microorganisms is very big in supporting land management and local resource score of 0.175 (Table 4). Use of effective microorganisms (EM) in the manure and compost that have fermented shown to have a significant effect on crop production[42]. On the ground which only processed a little, it turns out bracket fungi dominate the microbial biomass, as the primary decomposers and controlling high residue input management system, so that its existence as a measure of soil health[43]. Implementation of land improvement strategy of to the the benefits of animal diversity value score 0.17. Poor soil conditions and changing the physical, chemical and biological soil quickly reclaimed by earthworms[19]. Giving organic fertilizer can improve the organic carbon content, soil structure becomes stable, increasing activity of microorganisms, soil biological processes, spurring the addition of invertebrates, biodiversity, reduces nitrogen and phosphorus leached from the flow surface[44,45]. The diversity of microorganisms in the soil is helpful in improving soil fertility and nutrient availability on plants potato. State of soil microorganisms, insects, animals will be thrive better if high levels of biodiversity in an ecosystem. This state is an indicator of fertile agricultural land. The use of biopower or effective microorganisms can accelerate the decomposition of organic matter in manure and green manure, making it useful for improving growth and yield[46].

Utilization of specific local plants will be very helpful in creating which tolerant crop varieties by the value 0.145. Specific local plant species has a characteristic that strongly adapted to extreme this state but production is relatively low. Land of potatoes in Batu City is kind of a local potato farmer named Potato Gendeng ("Java Language"). These potatoes have showed resistance to pests and diseases so it can be used as plasma for improvement of local varieties excel. Germplasm can be utilized through crossbreeding or genetic engineering to the potato plants that have superior properties. Efforts to change the rate adaptation can be done to the improved plant morphology physiology and the ability of plant genetic and its properties are expected to be able to survive in extreme conditions[47]. Plant diversity in agroecosystems can help stability of agro-ecosystem sustainable in potato land management. Land management in organic farming is able to increase the biological richness in agroecosystems[31]. Rich agricultural land with wild plants have a value score of 0.142. Plant diversity strongly supports the creation of the state of the agro-ecosystem that is more stable and balanced. This makes biodiversity be better due to the availability of food is quite diverse. Land management with organic fertilizer has a positive correlation with biological activity in the soil with the process of decomposition and soil water availability[48].

Biodiversity are used as biological control by the value 0.14. Organic matter and earthworm population growth of bacteria and fungi nematode antagonists (such as, *Pasteuria penetrance*, *Chitinolytic bacteria* and *Pseudomonas spp., Trichoderma spp.*), And predatory nematodes *Collembola* and other *Arthropods* that selectively consuming plant-parasitic nematodes[49]. The addition of vermicompost fertilizer into the soil can reduce pests sucking and two-spotted mites (*Tetranychus spp*) and aphids (*Myzus persicae*)[50]. Use of biopesticides can reduce environmental damage caused by polluted chemical drugs used to control potato pests and plant diseases. Soil bacterium *Bacillus, Pseudomonas* and *Streptomyces, Trichoderma* that are biological agent that can fight the fungus and bacteria that cause disease and as producers of secondary metabolic products[30].

Table 5. Priority Matrix Test Options Linkage Strategies in the Management of Land and Resources in Local Sustainable Organic Potato Farming Systems

Strength-Opportunities (SO) Strategy	Linkages to the: Vision	Mission	Value	Priority Strategies (total score)
	----score----			
Perform integrated farming systems mix farming; Farmer groups to make organic fertilizer, bio pesticides , perform maintenance and repair of integrated crop agro-ecosystems.	4	4	4	12
In collaboration with business partners, higher education institutions, Governmental agencies in the management of local potential.	4	4	4	12
Improve the condition of agro-ecosystems by optimizing the function of all the components in order to perform the process in restoring the natural biodiversity.	3	4	4	11

Explanation : Score 1: Unrelated ; Score 2: Less related; Score 3: Related; Score 4: The most relevant

The local potentcy of an area if it is managed properly will contribute positively to an increase in land productivity and agro-ecosystems. Wealth of microorganisms can help the process of decomposition of soil organic and natural enemies of pests and plant diseases. Earthworms can increase the activity of microflora and suppress harmful microbial pathogens. *Trichoderma sp*. has the antagonist ability and controlling disease *Phytopthora infestansi*[51]. Diverse agroecosystems of insects and predators are useful in controlling pest populations. Vermicomposts use can improve soil nutrient status, number of microbial antagonist ability. Vermicompost from food residue and manure can be used as a medium for the growth of seedlings and plant growth[52].

Linkage analysis show that strategy to be done are (Table 5): (1) Application of mixed farming, (2). Collaboration with business partners, and (3). Improve agro-ecosystem. The application of integrated farming system (Mixed Farming), farmer groups are required to make organic fertilizer, biopesticides, conduct in land management, integrated crop and agro-ecosystem repair have a total score of 12. Organic fertilizer can increase soil carbon content, structural stability, biological activity, and insects[44]. Land as a place to life a variety of microflora, the bacteria *Bacillus, Pseudomonas, Streptomyces* as a producer of secondary metabolites natural enemies phytopathogeic fungi and bacteria[30]. This policy if it is applied to the all power and capture all opportunities will able to give good results in the management of land and resources. Strategies working with business partners higher education institutions non-governmental organizations in the management of the local potential total score 12. The role of stakeholders in supporting organic farming activities is very big and important, so that the necessary understanding in support of the decided policy. Agricultural development can be successful if done agribusiness participation by all actors in the process of planning, implementing, monitoring and evaluating. Implementation requires coordination within the container farmer groups independent legal entity and form associations. Developing business partnerships is expected to achieve stability, continuity of production, commodities must be tailored to the potential region, increased revenue, business continuity, satisfy the market demand, and environmental sustainability[16]. Efforts to improve the condition of agroecosystems by optimizing the function of all the components in order to perform the process in restoring the natural biodiversity (total score 11). Application of organic farming systems can significantly improve biodiversity[32]. The biodiversity of agroecosyste ms is proven to improve wheat plants and other organisms it is helpful in groups[36].

Applying the guidance and counseling are important part of the training activities of farmers in managing their lands and local resources. Improvement of skills and knowledge of farmers can be enhanced through individual and group skills training; independent farmer group coaching can be done through institutional improvements profession (farmer cooperatives, agribusiness cooperatives, farmers associatio ns certain commodities), and spontaneous development of extension leads to coaching achievement[53]. Management of organic potato farms has the "power" with a score of (2.6) while the "weakness" by a score (1.05), so it has the effect of success with the score (1.55). This is due to the potential of local varieties that can help optimizing the supply of seeds resistant to pests and diseases with the score (0.41). Utilization of gene function in a cross is intended to improve varieties, so it can produces the qualified varieties and has a strong adaptability[15]. The existence of local microorganisms which can be better can improve and maintain the sustainability of land use potential of local resources (value score of 0.4). Earthworm activity is very useful in increasing the number of rhizosphere bacterial populations such as *Pseudomonas, Rhizobium, Bacillus, Azosprillium, Azotobacter* and improve the ideal microenvironment. Earthworm activity interacts positively to the increase of the rhizobakteri's growth (PGPR)[22]. Manure will increase land productivity value score of (0.38). Plant botanical pesticides greatly help reduce pollution and damage to agroecosystems (score 0.38). The diversity of predators help control many pests and diseases naturally (score 0.36) and the more plants in the location it is possible that biomass that can be returned to the land (score = 0.29). The addition of organic fertilizers on potato farms can improve the physical, biological and soil chemistry and cation exchange capacity, carbon stocks, soil nitrogen, reducing crop pests and diseases[54]. The influence of environmental factors contributing to the success of the management of organic potato farms (score = 2.09), while the disorder that inhibits the success has the score 0.59, so it has contribution to the success of the score 1.49. This is due to eco-friendly in land management can be beneficial to the improvement of agro-ecosystems (score = 0.97). Good environment creates a state of stable agroecosystems, thus it becomes better plant growth, productivity and carrying capacity of the land are increased. Phase of growth and production of potato crop is affected by the the ability of physiological process and weather changes over time[55]. Manure applications to agricultural land can improve chemical, physical, biological, improve soil fertility, thus increasing the growth and yield[56, 57, 58].

4. Conclusions

Land management and local resources in a sustainable organic potato farming can be carried out by: (1) the utilization of local varieties as germplasm to the improvement of varieties that has strong adaptability to extreme weather and resistant to pests, plant diseases; (2) the improvement of the agro-ecosystem utilization of local microorganisms; (3) provide organic fertilizer on the land to increase productivity; and (4) the utilization of local resources of biopesticides to reduce environmental pollution.

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