Potato Organic Farming in Batu City, Indonesia

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Abstract

Organic potato cultivation was an effort to improve declining quality of potato agroecosystems and to preserve soil fertility. This study was conducted to analyze pattern of farming system and land management on the area of organic potatoes in Batu city. Research was conducted by the survey method, respondents were determined by the method of stratified cluster sampling. Farmer respondents were experienced organic potato farmer and as "expert leaders". Results show that the mindset of farmers were still characterized by limited understanding of "landuse and the environment" (Score = 2). While the availability of raw materials of organic fertilizer in research sites was very limited and insufficient (score = 1). Availability of organic seed potatoes were very limited, and even tend to be scarced (Score = 1). However, in the business area of potatoes, there were the local variety of potato that grows wild and the local farmer named them as "Crazy Potato". This potato high resistance to environmental stresses, pests, and diseases. Impact of conventional farming to changes in environmental quality (Score = 2) characterized by agro-ecosystems that had been damaged. Soil fertility at this point (Score = 2), including the criteria for "low fertility", meaning the land was considered infertile. Granola varieties of organic potato production average was 11.17 tons/ha, while the Atlantic variety was 12.43 tons/ha. Organic potato farming risk (score = 4), including the level of "high risk of failure". Decrease in the number of predators (Score = 3), reflecting the extinction rate was high (40-59%). Organic potato price stability (Score = 1) were low, and the price was considered unstable. Organic potato price (Score = 3) two times more expensive than conventional potatoes. Quality of the organic potato agroecosystem has suggested symptom of degradation. Improvement of the quality of agroecosystems requires a more stringent public policies that bind all actors in the center of potato farming organically. The sustainable organic farming of potato requires the local government support, the business community and potato farmer in solving any problems. Potato market institutions, farming partnerships and marketing linkages are relatively weak and must be strengthened and empowered.

Keywords: potato, organic farming, agro-ecosystem

INTRODUCTION

Organic potato farming minimize the application of pesticides and inorganic fertilizers. The manure, green manure, and compost are applied to replace or minimize the use of artificial inorganic fertilizers (Hepperly *et al.,* 2009). Management of farmland with intensive cropping patterns through the application of inorganic fertilizers and pesticides in excessive doses, become a major cause in bio-diversity degradation (Kleijn *et al*., 2009). Minimization of external input in potato farming is expected to maintain soil fertility, produce high quality of tuber, and environmental safety (Tilman *et al*., 2002; Flynn and Smith, 2010). The application of organic matter in the potato farming intended for preserving the soil fertility. Application of organic fertilizer on potato land as a substitute of inorganic fertilizers can improve the soil microorganisms communities, improve soil fertility, and soil biodiversity after two years of applications (Shannon *et al*., 2002); so the development of potato tuber are better (Suthamathy and Seran, 2013).

Organic management of soil by utilizing the crop residues can improve quality of potato agroecosystem in the potato regions. Land management with the regular inclusion of the biomass or organic fertilizer into the soil and soil water conservation practices can reduce surface runoff and soil erosion, resulting in improvement of soil productivity (Ashari and Saptana, 2007). Application of compost increase soil nitrogen supply, compost decomposition by decomposing bacteria produced an amount available nutrients into the soil (Herencia *et al.,* 2007).

Based on the ecological principles, organic farming practices should be directed at the

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improvement of soil fertility to support soil biological life, and crop can grow and produce well. The potato crops fertilized with chicken manure showed better tuber yield in comparison with dairy manure, it due to the chicken manure has a higher content of nitrogen (Ceylan *et al.*, 2006)

Availability and balance of nutrients in the soil can be improved by recycling biomass. Application of fresh biomass into the soil more speed up the decomposition process and produces amount of available nitrogen to plants. It is expected to restore the soil health, thereby reducing the needs of inorganic fertilizers (Ministry of the Environment, 2009).

Management of energy resources, water, air, and soil are based on the principles of micro-environmental management. Land management can be done with the improvement of the soil aeration, soil drainage, soil and water conservation by taking into account the environmental health (Brown *et al*., 2000).

The implementation of soil and water conservation techniques are to minimize surface runoff and soil erosion. Application of biomass into the soil, soil surface mulching with the crop residues, can serve as an protection to raindrops, surface runoff, and support the soil organism lives (Simanungkalit, 2006).

Minimization of crop losses due to the pests and diseases are through implementation of the integrated pest management principles. Utilization of biological agent of fungi (*Arthrobotrys oligospora, Dactylaria brochopaga, Dectylella spp., Paecilomyces lilacinus, Catenaria spp., Nepatophthora gynophilla*) as natural enemies are quite effective in controlling nematodes (Mustika *et al.*, 2010).

Utilization of local potato germplasm can be done by combination of biodiversity function in the integrated crop management. Germplasm is used to breed the plant with the expectation of obtaining improved varieties which are more resistence toward environmental stresses, better morphology, better physiological capabilities and its genetic properties are better (Levy *et al*., 1995).

Earthworms can be utilized in land management and cultivation techniques for improving soil aeration, improving soil water holding capacity, improve root development, and improving nutrient availability and soil fertility (Munnoli *et al.,* 2010).

Manure can improve the physical, chemical and biological properties of soil, because it contains nitrogen, phosphorus, potassium and micro nutrients. Restoration of land functions can be performed with the application of manure, green manure, and compost that are beneficial for the production of potato, because it contains an amount of macro and micro nutrients (Suthamathy massacre, 2013). The suitable crop environmental conditions become the supporting factors in potatoes farming. The application of manure can retain soil moisture, store more amount of soil water, and reduce soil erosion. Management of land to increase storage capacity of available soil water can be carried out through application of organic matter or biomass into the soil (KNLH, 2009). If the agricultural land are managed organically, it can facilitate rainwater infiltration, reducing surface runoff and improve available water storage in the soil, making it more beneficial to increase crop production (Seufert *et al*., 1969). Organic fertilizer is usually has a characteristic: (1) low nutrient content; (2) the slow available nutrients; (3) the amount of essential nutrients that can be absorbed by plants is limited; and (4) are useful for the improvement of the physical condition of the soil in the long term (KNLH, 2009).

The application of organic fertilizers can improve the soil biodiversity (Bengtsson *et al.,* 2005); improve quality of the soil ecosystem, so as to create a dynamic life of different levels of soil organisms (Gabriel *et al.,* 2010). Soil organisms is very important in the process of decomposition of complex organic compounds into simple inorganic compounds, making it available to plants (Lee *et al*., 2008). The application of organic fertilizer on a regular basis adding available nutrients in soil and increase the amount of food for soil biota. The application of manure is increase soil fertility, improve the physics, chemistry and biological properties of soil, also adds to the amount of food for soil organisms (Munnoli *et al*., 2010).

Land management and cultivation of organic potatoes are attempts to achieve the soil ecosystem stability, especially: (1) soil biodiversity; (2) symbiotic microorganisms community. Earthworm activities can increase the number of rizosfer bacteria of Pseudomonas, Bacillus, Rhizobium, Azotobacter, Azosprillium, it improves quality of soil micro-environment; activities of earthworms can improve growth of the Rhizobacteria (Sinha *et al*., 2010); (3) types of arthropods that are able to control the balance of soil biology, management of organic farming can increase biodiversity of soil arthropoda

(Gabriel, *et al.,* 2010); (4) improvement of energy efficiency in soil; (5) improvement of soil structure; and (6) improvement of nutrients and energy efficiency in the agroecosystem.

Application of dairy manure to improve the chemical, physical, and biological properties of soil; so as to improve plant growth and tuber yield of potato (Ahmad and Quadri, 2009). Earthworms are able to produce a useful vermicompost in sustainable land management because it could suppress pests and plant diseases. Organic matter and earthworms stimulates the growth of antagonist bacteria and fungi (*Pasteuria penetrans, Pseudomonas spp.,* chitinolytic bacteria, and *Trichoderma spp*.), nematode predators of Collembola and other Arthropods which selectively prey nematode (Thonden *et al*., 2006). The biological activities include biochemical, chemical, physical and physiological processes that produce the food chain, thus contributing to improve soil fertility (Umesh *et al*., 2006).

Soil bacteria of Bacillus, Pseudomonas and Streptomyces are the productive bioreactor in decomposing the secondary metabolites and it is functioned as a natural enemy for pathogenic fungi and bacteria (Pathma *et al.,* 2006). The balance agroecosystem can support a higher land productivity, so that the energy flows and nutrient cycles are more established in the strata of soil organisms. Application of organic fertilizer into the soil can improve nutrients biological cycles, so it is beneficial to growth and yield of potato tuber (Halloran *et al*., 1995). Potato crop management involves crop residues, biomass or compost, manure, and vermicompost (Arancon *et al*., 2004).

Organic agriculture is one of the alternatives for overcoming the problem of pollution of soil, water and air. Critical soil condition and has undergone the degradation of physical properties, chemical and biology can be reclaimed by the application of manure and organic material that can be decomposed rapidly by earthworms (Munolli *et al*., 2010). Pesticides can contaminate land and water outside the location of its application (Damalas and Ilias, 2011). Modern intensive agriculture in fact leads to the exploitation of land resources and little regard for the preservation of land resources. The use of chemical pesticides have a negative impact on the quality of the environment and crop yields (Kleijn *et al*., 2009; Geiger *et al.,* 2010). Inorganic fertilizer application in potato farming at a high levels can cause environmental damages, residual N and P are leached into the surface runoff and resulted in the aquatic pollutions (Robertson and Vitousek, 2009).

This study was conducted to analyze organic potato farming in Batu city. Development of the organic farming in Batu city refers to the government agriculture development program. Organic farming organizations hes been set the standards of production processes and procedures for products processing. IFOAM (International Federation of Organic Agriculture Movement) has developed the quality standards and organic certification. Organic farming in Indonesia still haven't got the full support of government, researcher, farmer communities, so that quality control and certification issues have not gotten the sufficient attentions.

Some constraints in implementing organic farming systems, namely: (1) any transmigran pest often cause the serious damages; (2) market of organic products is still restricted to a particular segments; (3) organic matter in potatoe lands are very limited, so have to deliver supplies from other locations with a high cost; (4) import of organic material requires a great place and transportation costs; (5) no competition with other interest in acquiring the crop residues and organic wastes; (6) marketing system of organic agriculture products not yet coordinated well; (7) the price of organic products are relatively cheap; (8) business partners and institutional management are not good; (9) farmer perceptions toward the risks of harvesting failures; (10) not all farmer understand environmental health properly; (11) government policy in the development of organic agriculture not capable in creating organic farming; (12) it is difficult to change the farmer perception toward the organic farming; (13) standardization of hygienic products are not yet implemented well.

Healthy food needs have created a large market demand, so that it is required the quality standards of healthy food in accordance with the Indonesian cultures. In these relations, development of organic farming is focused to: (1) produce a health and high quality of food products in sufficient quantities; (2) maintaining and improving soil health and its fertility; (4) avoid commercial inputs that damages the environment health; (5) minimizing the social and ecological impacts (IFOAM, 2005).

Development of organic agriculture must meet several requirements, including: (1) high quality yields in enough quantities; (2) taking into account the external impacts of social, ecology, and technology in the farm management; (3) enhance the biological cycle in the farming system by involving soil microorganisms, flora, fauna, crop and animals; (4) agricultural systems that are economically profitable; (5) maintaining a crop diversity and their natural habitats; (6) water efficiency and protect the aquatic ecosystem with all of its aquatic organisms; (7) the utilization of local renewable resources; (8) the ecological comfort for livestocks; (9) the organic products with the degradable wastes; (10) the fairness opportunities to produce organic foods (BP2HP Deptan, 2010).

Knowledge and perceptions of the people about organic farming are very diverse, such as the assumption that operational costs of organic farming are very expensive, it requires a lot of labor, back to the traditional agriculture, and crop production is low. Many problems arise because of lack of farmer knowledge about ecosystem functions, organic cultivation, so the operational costs of the organic crop production is relatively expensive (BP2HP Deptan, 2010). Organic land management with multiple croping regularly can increase the content of C and N in the soil, so that it can increase land productivity (Dube *et al.,* 1969). Organic farming is more resistant to extreme weather changes, organic crop can produce a higher yield than conventional crops (Pimentel *et al.,* 2005).

Organic potato crop management is characterized by the application of organic matter, organic fertilizers and soil - water conservation technologies to reduce soil erosion and improve land productivity (Ashari and Saptana, 2007). Planting the fast-growing species of trees around the organic farms to produce more biomass. Manufacture of organic fertilizers should be supplemented with decomposer microorganisms, to produce a high quality of organic fertilizer. The use of microorganisms in the composting of "bokashi" can accelerate the process of fermentation and mineralization of organic matter (Lee *et al*., 2008). The use of biological pesticides create opportunities for the utilization of local resources. Application of green technologies should be supported by crop management, crop protection and resistence varieties to environmental stresses. Application of the System of Local Potential Intensification (SLPI) can suppress the pests and diseases incidences, potato crop become more resistant to environmental stresses, and improve potato yield (Sugiarto *et al.,* 2013).

METHOD

Field research was carried out for April 2012 to July 2012 in the organic potatoes center of the Batu city. Research location includes organic potato lands owned by farmers, in Subdistricts of Bumiaji and Junrejo, that are in the village of Sumber Brantas, Tulungrejo, Cangar , and Bumiaji, at an altitude of between 900-3035 m above sea level. Geomorphology of this area is influenced by the Arjuno-Welirang volcanic activities. Soil types are dominated by the developing young soils, namely Andisols , Inceptisols, and Alfisols. Organic potato farmlands are high sensitive to erosion and degradation. About 60% of the lands are 8% slope, so the threats of soil erosion and runoff are very high. An average air temperature of 21.5°C, highest air temperature 27.2oC and lowest air temperature 14.9oC. On average the air relative humidity is 86% and the wid speed is 10.73 km/h. The annual highest rainfall in the Sub-District of Bumiaji is 2471 mm and 132 rainy days.

Research site selection is carried out by the purposive-sampling approach, i.e. locations that have implemented potato organic farming. Field surveys with the "Rapid Rural Appraisal" method is done to collect data and informations on human resources, potency of land, supporting means in potato organic farming, wild potato species ("Kentang Gendeng"), the quality of agroecosystem, organic potato production, impacts of conventional agricultural on organic potato farming, and marketing of organic potatoes.

Farmer respondents are determined by "the stratified cluster sampling". Stratification of respondents are based on the education level of respondents, that are formal and informal education ever reached. While the clusters for data collection are skills level and length of experiences in managing an organic potato farming. The number of farmer respondents as much as 19 people spread across the four villages, and one person of the agriculture field extension workers.

Research variables include level of formal education, the mindset ability in potato farming, environmental knowledge, response toward the technological innovations, land size, slope of land, location of land, raw materials of organic manure, availability of organic seeds, wild potato, plant height, number of leaves, plant age, resistance to environmental stresses, resistance to pests and diseases, the number of tuber, potato tuber weight, availability of organic fertilizers, local crop types, biomass, land productivity, agroecosystem damages, soil fertility, organic potato production, organic potato quality, impacts of pesticides, the risk of crop failure, organic potato marketing system, and prices of organic potatoes.

Organic potato crop samples as much as 5 plants per plot. Random sampling of plant specified in the field. The data obtained are subsequently analysed involving the scoring system. Scoring is done in a way to categorize data into five categories, namely: 1 = Very Bad (Vey Less); 2 = Bad (Less); 3 = Moderate; 4 = Good; and 5 = Very good.

RESULT AND DISCUSSION

In the organic potato farming are many factors affecting the success, includes competencies of human resource of farmers. The education level of farmers (score = 3.53) average of junior high school. Farmers' knowledge is still low, thereby affecting the decision-making process in farming activities. The mindset of potato farmers (score = of 1.89) are reflected in decision making that are based on a traditional values, it is difficult to adopt any new innovations. In solving their problems is oftenly instant, without considering the risk of losses.

Table 1. Human resources in organic potato farming

No.	Formal education	Mindset	Environmental knowledge	Technology innovation
	------------------------- (score) ------------------------			
1	3.53	1.63	1.73	1.47
2	3.53	1.73	1.79	2.05
3	3.52	2.31	1.73	1.68
Average	3.53	1.89	1.75	1.73

The knowledge of farmers about the environment have a score of 1.75, it is classified as “less knowledge about the function of land and the environment”. Organic potato land management should consider improvement of agroecosystem quality and preserving local resources. The farmer attitude in adopting technological innovations have a score of 1.75, it is classified as “the acceptance level of new innovations is relatively low”. Farmer knowledge and their perceptions are correlated with the level of education, so that cultivation of organic potatoes is considered traditional. The performance of farmers depends on: (1) ability to utilize, to solve problems, and to manage natural resources; (2) ability to access any facilities of the financial capital; and (3) ability to create and use technology (Yusdja, 2004). Organic potato land have the hilly landforms, it requires the appropriate soil and water conservation techniques.

Table 2. Land availability for organic potato in Batu city.

No.	Land area (ha)	Land slope	Location
		---------- (Score) -----------	
1	0.44	3.85	3.56
2	0.44	3.90	3.63
3	0.44	3.86	3.55
Average	0.44	3.87	3.58

The average land size in organic potato farming is less than 0.5 hectares, development of organic potatoes is relatively slow. This situation is related to the farmer attitude in considering the various risk factors in organic potato farming. The impact of conventional farming to organic potato farming is huge, especially disorders of pests and diseases. Some factors affecting development of organic farming of potato are: (1) pests and diseases which comes from conventional land moved into organic potato land; (2) quality of the agroecosystem is unsuitable, so that farmers are reluctant to expand its farming; and (3) the application of pesticides and inorganic fertilizers became the major concern of conventional potato farmers (Ashari and Saptana, 2007).

Score for land slope is 3.87, land with a slope of 15-20%. The rolling land to organic potato cultivation requires regular application of organic matter. Land management involves the application of organic fertilizer, organic mulching at ground surface, soil conservation techniques, multiple cropping, intercropping, crop rotation, and mixed farming (Wang et al., 2010). Location of potato land showed score of 3.58, and soil fertility is moderate (score = 3). These conditions suitable for potato farming, soil as the plant growth medium have an adequate fertility. The role of soil organic matter is the stabilization of soil organisms. The soil is rich in organic matter have a good aeration, the root growth can exploited soils for moisture and nutrients. The earthworms can be utilized in vermicomposting of organic matter, it is useful in improving the physical properties, chemical and biological properties of soils (Pathma and Sakthivel, 2012).

Raw materials of organic fertilizer shows score 1.21, the raw materials at the site are available in a limited anount and insufficient to supply the needs of organic fertilizer production.

Organic fertilizer needs quite a lot, so it should be supplied from other regions. Organic fertilizer is beneficial to plant growth and tuber formation of potato, improving soil structure so it facilitates roots penetration into the soil, so that the tuber development is better. Effect of organic fertilizer application on potato yield are very significant (Edwards et al., 2006; Halloran et al., 1995).

Table 3. Facilities of Organic Farming in Batu City

No.	Raw materials for Organic Fertilizer	Availability of Seeds
	---------------- (score)	-------------
1	1.13	1.89
2	1.20	1.30
3	1.30	1.47
Average	1.21	1.52

The availability of organic seed potato had a score of 1.52, it means "organic seed potato is not available". Organic potato development requires the availability of organic seed potato in large quantities and it suggests a high resistence to environmental stresses. So far, farmers use conventional seeds, it is very responsive to the water, inorganic fertilizers and sensitive to pests and diseases. Local potato varieties can still be found on the research locations, it grows wild ("Kentang Gendeng"). These wild potatoes growing in the bunds or on untilled land, it is resistance to environmental stresses, pests and diseases.

The majority of potato land have suggested any symptoms of degradation due to the application of intensive farming practices. Modern intensive agricultural practices can damage land resources and less considering land sustainability (Kleijn et al., 2009). The degradation of potato agroekositem had an negative impact on organic potato land which was in the vicinity. The scarcity of beneficial insects, predators, local microorganisms, due to the serious environmental stresses, resulted in the agroecosystem is not able to recover itself.

The use of chemical pesticides excessively induced the negative impact on plant and its environment (Geiger et al., 2010). Improvements of environmental quality can be done with the application of organic matter into the soil for stimulating the population of antagonistic bacteria and fungi to nematodes (Trichoderma, Pseudomonas, Pasteuria, and chitinolytic bacteria) and mites as the natural enemies for nematode, i.e. Nematophagous, Hypoaspis calcuttaensis, Collembola and arthropoda) (Thoden et al., 2011). Organic matter in the soil can enhance activity of earthworms and stimulate the growth of gram-negative bacteria (Elmer, 2009); the group of chitinolytic bacteria (Nocardioides oleivorans, Streptomyces, Staphylococcus) have the ability to suppress potato diseases of Rhizoctonia solani, Colletotrichum coccodes, Pythium ultimum, P. capsici and Fusarium moniliforme (Yasir et al., 2009).

Table 5. Natural resources in organic potato land

No	Availability of organic fertilizer	Local Crop	Biomass
	-------------------- (scor)	--------------------	
1	1.95	2.63	2.65
2	1.68	3.22	2.58
3	2.31	2.64	2.63
Average	1.98	2.83	2.62

The availability of organic fertilizers in organic potato farming locations has a score 1.98, this means that organic fertilizer is still "very less" to supply the needs. This is a serious constraint in land management and organic potato farming. The health and fertile soil indicate a dynamic agroecosystem and the high soil biodiversity. The positive effect of organic fertilizer on soil can increase diversity of arthropods (Hendrickx et al., 2007; Rundlof et al., 2010). Local plants in organic potato land shows a score of 2.83, it means that 'many kinds of local plants are available'. A variety local plants producing leaves can be used as raw material in the production of organic fertilizers. Application of crop residues into the soil can improve nutrient availability for plants. Planting legume can supply amount of nitrogen into the soil through the N2 fixation, this biomass can be used as organic fertilizer.

Table 4. Description of the wild-potato ("Gendeng Potato")

"Gendeng Potato"							
Plant Height (cm)	Leaves	Age	Resistence			Production	
			Stresses	Pest	Diseases	Tuber number	Tuber weight g/plant
65	Smaller than highyield variety	Growing periode 4-5 months	Extreme environment	Resistance	Resistance	16-18	100-250

Source: Leader of Organic Farmer Group in Batu city (Mr.Marsudi), 2012.

Application of biomass into the soil can increase soil organic matter content and improve soil drainage and aeration, are able to suppress pests and diseases, and improve the crop yield (Ebenezar et al., 2006). Biomass in the organic potato land shows score 2.62, this means the availability of biomass is considered "sufficient". Application of biomass into the soil can improve soil physical, chemical, and biological properties, soil structure become better, quality humus is better, so the crop can more efficiently use water (Pimentel et al., 2005).

Table 6. Quality of organic potato agroecosystem

No	Land Productivity	Agroecosystem Degradation	Soil Fertility
	------------------- (score)	-------------------	
1	2.76	1.64	1.89
2	3.31	1.76	1.78
3	3.65	2.24	1.88
Average	3.24	1.88	1.85

Land productivity showed a score of 4.24, soil fertility is included in the category "productive". Land productivity can decline if the management of farming does not consider its sustainability. Effects of application of inorganic fertilizers and pesticides is a degradation of agroecosystem qualities. The potato agroecosystem showed a score of 1.88, it suggests that condition of agroecosystems "have been degraded". This damage is believed to be caused by the inappropriate application of agrotechnologies, fallacy of farmers in managing the plant. Ecosystem degradation suggests a negative impacts on the productivity of land. The application of pesticides and inorganic fertilizers in excess has adverse effects on the plant and the environment (Kleijn et al., 2009; Geiger et al., 2010).

A high production orientation have encouraged the excess use of inorganic fertilizers and pesticides, so it becomes a trigger for degradation of soil fertility. Soil fertility has a score of 1.85, the degree of soil fertility in organic potato land is considered to be "low". Agricultural practices for the improvement of soil fertility are application of a high quality of organic matter (compost), in order to supply the crop nutrients needs (Warman et al., 2009). Implementation of multiple cropping and intercropping of legumes and potatoes are expected to produce nitrogen-rich biomass, thus reducing cost of nitrogen fertilizer (Bruns et al., 2006). Integrated crop management with the eco-friendly organic agriculture can improve population of the insect pollinators and it improve agroecosystem (Batary et al., 2010).

Table 7. Potency of Organic Potato Production

No	Production of organic potato		
	Granola cultivar	Atlantic cultivar	Tuber quality
	------ (ton/ha) ----		--- (score) ---
1	11.12	12.16	3.36
2	11.25	12.52	3.31
3	11.14	12.51	3.79
Average	11.17	12.43	3.82

Potato Cv. Granola organically grown can produce tubers about 11.28 tonnes/ha, whereas the Cv. Atlantic produce tubers of 12.43 tonnes/ha. These tuber yield is lower in comparison with the conventional potato, however the organic potato is considered more healthy. Organic potato production is low due to low soil fertility, so it needed the technologies that can improve soil fertility. The application of organic fertilizer on a regular basis can increase the soil biodiversity (Bengtsson et al., 2005). A dynamic biodiversity in the soil can enhance improvement of soil ecosystems (Gabriel et al., 2010). The quality of organic potato shows the score of 3.82, it suggests a high quality of tuber. Potato quality is considered good because during the process of crop production does not use any pesticides, so it is considered safe to eat. In the development of its preferences, the potato consumers no longer buy the cheap agricultural products, but they buy any agricultural products which its attributes are more complete, with a guarantee of quality, healthy and free from pesticide residues.

The government should be able to create policy on the healthy environment certification that ties all of the domestic agricultural products (Adnyana, 2005). Low production of organic potato is becoming a challenge for all stakeholders of organic potato to improve the agricultural productivity. This can be done by way of improving the quality of organic potato-ecosystem, so the potato crop more resistant to pests and diseases and are more resistant to environmental stresses. Application of organic matter into the potato land can increase the content of humic acid, fulvic acid, humus and available nutrients; so as to improve plant growth and yield of potato tuber (Sinha et al., 2010). Conventional agrotechnologies have been implemented along years ago, and it suggested any negative impacts on the quality of land resources. Excessive pesticide application in the potato crop management have resulted in serious problems of soil health and environmental health. Land management in the conventional potatoes also had an negative impact on declining biodiversity (Tscharntke et al., 2005).

Table 8. Impacts of conventional farming at the organic potato land

No	Pesticides impact	Harvest risks	Pest & diseases	Impacts on Predator
	---------------------- (scor)			------------------------
1	1.42	3.93	4.42	2.92
2	1.33	3.95	4.44	2.75
3	1.63	3.83	4.61	2.73
Average	1.46	3.87	4.47	2.80

The impact of pesticide application on the quality of the soil showed a score of 1.46, this means the soil is considered “infertile”. Decrease in soil fertility can be caused by a decline in the population of bacteria, fungi and other beneficial animals due to pesticide residues. Intensive cropping systems resulting in agroecosystem become unstable, because the application of inorganic fertilizers and pesticides is excessive for crop management (Kristiansen et al., 2006). Degradation of soil fertility and agroecosystem have been impacted on declining of the soil microorganism services in supporting soil qualities, it is impacted on the lower crop production.

Risks in potato organic farming showed a score of 3.87, it reflects that potato organic farming suggests a very great risk of failure. Utilization of plant-based pesticides and biopesticides are expected can reduce the risk of potato failure. Soil microorganisms on a dynamic agroecosystem can function optimally as a bioreactor, such as Bacillus, Pseudomonas and Streptomyces, in decomposing the secondary metabolites and acts as a predator for several types of fungal and bacterial pathogens (Pathma et al., 2006). On the conditions of the degraded agroecosystem, risks of the potato damages are very great. Soil fertility has a close relationship with the health of the potato crop. The infertile growing media makes the plant does not have a strong antibodies in overcoming environmental stresses, pests and diseases.

Disorders of crop of pests and diseases in organic potatoes showed a score of 4.47, this means disorders to potato crop are “very much”. Potato integrated crop management should consider the aspects of ecology, technology, economics and social. It is expected to control pests and diseases, improve biodiversity and biocontrol with the relatively low cost. Vermicompost applications can induce soil microbial diversity and supports the development of antagonistic bacteria to become effective agents for control the phytopathogenic fungi (Scheuerell et al., 2005; Singh et al., 2008).

Impact of pesticide application on the predator population in the potato agroecosystem is very significant. At this point it's hard to find a predator in potato land, it due to the high rate of mortality caused by the pesticides. Decrease in the number of predators showed a score of 2.80, this indicates that the rate of predator extinction is quite high (40-59%). This predator extinction resulted in the potato agroecosystem is not able to support the sustainable potato farming. The predator role is very important in creating a natural balance. Some types of insects, such as spiders and bees are functioned as agents of environmental change in the tropics, as well as the pollinators and the natural enemies, so it becomes a environmental stabilizing agents (Billeter et al., 2008; Vandewalle et al., 2010).

Table 9. Markerting of Organic Potato

No	Marketing system	Price Stabilization	Price of Organic Potato
	-----------------------	(score)	------------------------
1	2.36	1.45	3.12
2	2.45	1.64	3.43
3	2.23	1.53	3.22
Aver age	2.34	1.54	3.24

Organic agricultural products marketing system shows score 2.34, it suggests “not enough” marketing system. Marketing of organic potatoes is still not able to satisfy the expectations of organic potato farmer. Organic potato demand in the market is still relatively small. Network marketing of organic potatoes have not been well-organized, it is still partial. Stability of organic potatoes price shows score 1.54, it means “unstable selling price”. Organic potato demand is still limited, so some of organic potato is sold with a standard price of conventional potato. Organic potato prices had a score 3.24, the organic potato prices is twice higher than the price of conventional potato. The price of organic potatoes is highly prospective for increasing income of the organic potato farmer. The empowerment activities toward the commercial farming of organic potato are (1) dissemination of the meanings of sustainable agriculture; (2) improvement capabilities of the organic farmer groups in the partnership of agribusiness; and (3) development of the market information centre for organic potatoes. Supporting activities in empowering organic potato farmer are: (1) training of individual and farmer groups; (2) empowerment of farmer groups through the professional institutional strengthening (farmer's cooperative, cooperative of agribusiness, Association of organic potato farmer); and (3) empowerment of the extension agencies (Saptana et al., 2005)

CONCLUSION

Organic potato farming systems in Batu city are characterized by: (1) quality of organic potato agroecosystem have been degraded; (2) improvement of the agroecosystem quality requires the public policy that is tight and binding all stakeholders of organic potato farming; (3) sustainable organic potato farming requires the support of local governments, the business community and the local communities in solving the farming problems; (4) the market institutions, marketing partnerships and marketing networks must be empowered.

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