Journal of Environmental Science and Management 24-1: 36-44 (June 2021) ISSN 0119-1144

Comparison of the Health Cost of Organic and Conventional Vegetable Cultivation in Getasan Sub-district, Semarang, Indonesia

ABSTRACT

Environmental damage will disrupt the ecosystem to support life. Unsustainable agriculture can be a source of environmental degradation. Conventional agriculture may have an effect on the environment, thus the participation of various parties in sustainable agriculture is needed. Organic agriculture is developed as an environmentally friendly agricultural cultivation with many benefits. Compared to the attention on occupational health, safety and environmental problems, economic motives receive less attention. This study aims to calculate the costs arising from the health impacts of vegetable cultivation. There were 314 respondents interviewed in this study. There were significant differences in the sickness complaints felt by respondents; organic farmer groups have the potential to incur health costs of Rp. 30,333.33, while the conventional group is higher, with a cost of Rp. 103.303.57 (US$ 7.38). Organic farming has a better impact because it uses natural ingredients and is not bad for health. The potential losses arising from health cases also show a high and significant number (p <0.001).

Keywords: *health cost, organic vegetable, sustainable, farmer's health, agriculture*

Supriyono Asfawi[1*]
Ari Probandari[1]
Prabang Setyono[2]
Hartono[3]

[1] Department of Public Health, Faculty of Health Sciences, Universitas Dian Nuswantoro, Semarang, Indonesia
[2] Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Indonesia
[3] Department of Environmental Science, Universitas Sebelas Maret, Surakarta, Indonesia

*corresponding author:
supriyono.asfawi@dsn.dinus.ac.id

INTRODUCTION

The environment may affect the level of human health. Improper environmental modification may cause deaths, since damage in the environment disrupts life-supporting ecosystems. Agriculture is also a source of ecological damage if mismanaged (*Seufert et al. 2012*). There are environmental damages from the overuse of chemicals in agriculture (*Bruinsma 2003*). Conventional farming is considered more manageable, but synthetic chemical inputs in traditional farming activities can interfere with biodiversity, soil fertility, ecosystems, and health (*Gabriel et al. 2013*).

With limited knowledge of conventional agricultural impacts, stakeholders must participate in various sustainable farming activities (*Cole et al. 2011*). The importance of farmer education and training to ensure safe pesticide use (*Aktar et al. 2009*), so the appropriate policy is required to contribute to the impact of its environment. When appropriately managed, conventional farming can also have good benefits (*Gomiero et al. 2011*).

In the future, farmers will improve their agricultural development and environmental interests (*Hansen et al. 2006*). Sustainable agriculture can help farmers maintain the environment (*Ryan et al. 2003, Kassam et al. 2009*). Crop pest resistance to chemicals disrupt the ecological system, so it is necessary to immediately change the agricultural system (*Horrigan et al. 2002*) to achieve adequate and sustainable agriculture (*Beddington et al. 2012*).

Organic farming is developed as an environmentally friendly agricultural practice with many benefits (*Bengtsson et al. 2005, Hole et al. 2005*), such as preserving species, natural richness and improving soil fertility (*Leifeld and Fuhrer 2010*), reducing greenhouse gases emissions (*Gomiero et al. 2008*), preserving the sustainability of agricultural environments (*Seufert 2012*) and preservation of biodiversity (*Foley et al. 2005, Mondelaers et al. 2009*). Organic agriculture has lower inputs than conventional. Under good condition and proper land management, organic agriculture can have a higher yield, based on the system and from environmental and economic assessments (*Seufert 2012*). Conventional farming can be more sustainable and environmentally safe by adopting some traditional organic farming technology (*Pimentel 2005*).

Compared to occupational health and safety, environmental issues (*Marshall and Toffel 2005*), do not

consider economic motives (*Lobley et al. 2009*). Risk analysis, the basis to determine the impact of land management, is needed in conducting economic assessments of horticultural plantations (*Holmes et al. 2009*). *Olabisi et al.* (*2015*), found out that there are constraints in the availability of organic supplements and local markets for organic products, in addition to insufficient land to retain harvest. Comparing conventional and organic agricultural advantages vary due to various techniques and plants (*Charyulu and Biswas 2010*).

Convincing farmers to switch from conventional farming patterns to organic farming is not easy. This include the farmers' awareness about the magnitude of health risks when using chemical pesticides (*Lima and Vianello 2011*). Farmers' understanding of long-term impacts is also necessary, as well as many other complications. Conventional agriculture has a high potential contribution to eutrophication, therefore it is necessary to pay attention to other environmentally friendly agricultural practices in increasing soil fertility (*Oliquino-Abasolo and Zamora 2016*).

Indonesia is an agricultural country where farmers are using conventional methods, such as using synthetic chemicals to pest problems and soil fertility. One reason for this is that farmers are more oriented towards fast and abundant harvests.

This study utilized a new and simple method that can show the difference in health costs in organic and conventional horticulture farming.

MATERIALS AND METHODS

This research is a quantitative descriptive study with a cross-sectional design which interviewed farmers in Getasan sub-district, Semarang, Indonesia (**Figure 1**). This study aimed to examine vegetable agricultural cultivation in terms of its health value and economic benefits.

In this study, the respondent farmers were defined as landowners and farmers. A total of 314 respondents were interviewed. Ninety respondents belonged to the organic farming group. The respondents were drawn from the villages with farmers who promote the Organic Village Movement led by the Tranggulasi and Bangkit Merbabu from Batur Village and Citra Muda from Kopeng Village. For the group practicing conventional farming, 224 respondents were taken from other villages.

Interviews were conducted to obtain information about conditions in the field such as agricultural farming used, costs incurred for production (costs; labor, fertilizers, pest control, irrigation, production facilities), crop yields, and complaints disease. The data were processed by statistical tests using non-parametric 2 independent sample, Mann-Whitney. Data collection was conducted in 2019.

The study's variables include; Production Costs- costs incurred during the farming process from clearing the land to sell crops in one harvest time. Fees are grouped as follows: labor costs, fertilizer costs, plant protection costs, seed costs, irrigation costs, and the cost of production facilities (*Adhikari 2009, Mehmood et al. 2011*). Health Costs- used to calculate the health benefits obtained in horticultural farming; the basis for calculating health costs used is the previous year. By identifying sickness complaints (*Quijano and Rengam 1999*) and using standard medical expenses, the average Social Security Administrative Body (Badan Penyelenggara Jaminan Sosia/ BPJS) medical cost is US$ 4.29 The number of days not working could potentially cause losses and calculate the cost of externalities. Cost-Benefit Ratio (CBR) compares the benefits gained with the cost incurred by incorporating the health cost elements. The CBR calculation is done to see how much net income the farm receives for every IDR of net expenditure. The CBR method indicates that farming cultivation is acceptable if the CBR has a value of more than 1. (*Ndeketeya et al. 2014, Adongo et al. 2016, Rajput and Kothari 2017*).

$$\boldsymbol{BCR = \frac{PVbenefit}{PVcost}}$$

where ; Pvbenefit = agricultural benefit,
Pvcost = Production cost + health cost

RESULTS AND DISCUSSION

Getasan District is one of the vegetable-producing areas in Semarang Regency. Vegetable is the main agricultural commodity of organic farmer groups. The study is limited to the vegetable commodity rather than fruits.

Farming is the main occupation, while a small number are engaged in other jobs in the formal and informal sectors. Most farmers are men, with the youngest is is 20 years old, while the oldest is 77 years old. The average age of a farmer is 43 years, and the length of time of an occupation being a farmer is from 5 years to 68 years. The area of fertile land owned by respondents is at least 1,000 m^2 and a maximum of 11,000 m^2, with an average fertile land area of 2,804.46 m^2.

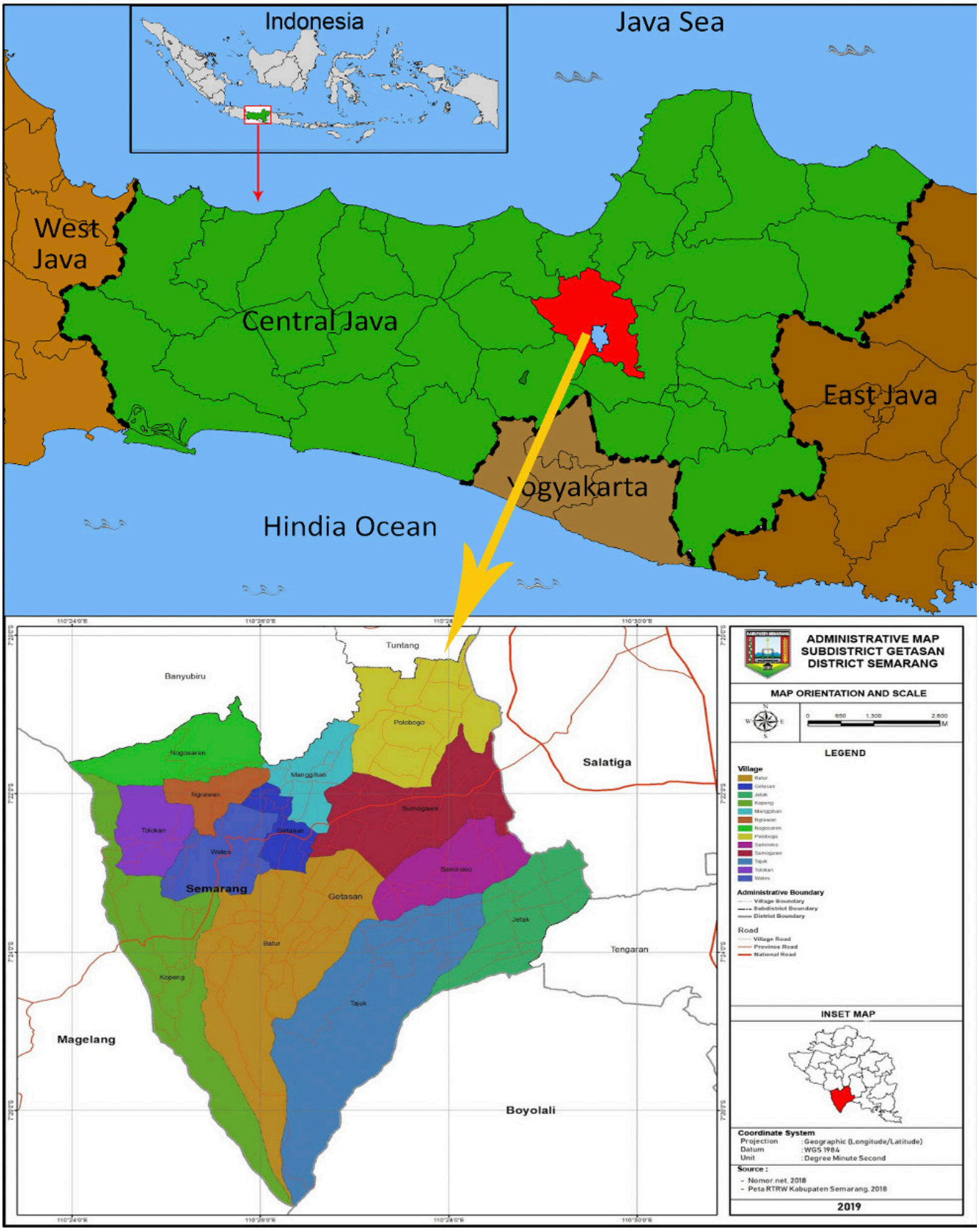

Figure 1. Studiy area in Getasan District, Semarang Regency, Province of Central Java, Indonesia 2019 (Source: District Government of Semarang, scale: 1:130000).

The farmers' activities regarding vegetable farming have no special difference in implementation compared to non-organic vegetable farmers. Farmers begin by plowing to clear the land, followed by fertilizer application, mulching, perforation, planting, trellising, pest management, *wijil* (early harvest) and harvest.

Irrigation is done by taking water from the upland areas. This helps reduce costs incurred in irrigation, aside from procurement of pipes and maintenance to repair leaks. The farmers take advantage of the existing land contour and gravity, because not all regions have water sources, such as wells and springs.

Based on the survey, farmers cultivate only with one type of commodity. However, others also grow alternative crops, by using cropping patterns adapted to the kind of entity.

Production Cost

Comparing the two types of cultivation in the study area showed the difference, where the production costs for conventional agriculture are higher than organic.

The cost of irrigation of conventional (US$ 0.52) and organic (US$ 0.50) is almost the same. The difference between the cost of fertilizers and pest control was US$ 1.85 and 0.27, where the difference is very significant ($p<0.001$). From this, it can be seen how much each productivity of the two types of agricultural cultivation by dividing the yield with production costs. Conventional agricultural products has lower productivity (2.35) than organic (2.64). Likewise, for land productivity, organic agriculture was higher (US$ 188.15) than conventional, which was only US$ 172.92 100 m^{-2} (**Table 1**).

The average total production cost per year for every 100 m^2 spent on organic horticultural agriculture (6 US$ 9.79 is lower than conventional agriculture (US$ 72.66). Although the test did not show a significant number ($p = 0.199$), it can be seen only that there is a difference. This difference is influenced by fertilizers and pest management of plant diseases, which have significant figures. Other studies have found no significant difference in the cost per hectare in the two agricultural models, even though the production cost structure shows considerable deviations (*Urfi et al. 2011*). *Sudheer* (*2013*) found out that organic farming is more profitable for farmers in terms of costs and returns than chemical agriculture. *Ehn and Fox* (*2019*) showed that the cost of organic farming per hectare is higher than conventional, the results are also more significant, the value of organic profits is still better.

Conventional agriculture showed a higher cost figure, although it is not significant. This is because only the variable costs of fertilizer use and pest management for organic farming are lower. This is in line with the study by *Forster et al.* (*2013*), *Pergola et al.* (*2013*), and *Sgroi et al.* (*2015*), which mentioned that high production costswill affect organic profits. In terms of production costs, organic horticultural agriculture is still recommended. However, it is not significantly different but it can be categorized lower because of natural ingredients and does not depend on industrial products.

Complaints of Sickness

The use of chemicals in conventional farming may have health effects to the farmers. Conventional horticultural cultivation has a higher risk to health (*Ye et al. 2013*). *Rakesh et al.* (*2013*) and *Nganchamung et al.* (*2017*) also stated that the use of chemicals in agriculture have implications on health and the environment. It contributes to the potential poisoning in humans (*Oliquino-Abasolo and Zamora 2016*). Farmers are also routinely exposed to more effective pesticides than consumers. Exposure

Table 1. Comparison of productivity cultivation of vegetables in Getasan District, Semarang Regency every 100 m^2.

Cost	Conventional Agriculture Mean[a]	Organic Agriculture Mean[a]	p-Value
Labor costs	46.95	46.75	0.753
Fertilizer costs	7.24	5.39	< 0.001*
Plant protection costs	1.69	1.42	< 0.001*
Seed costs	4.96	3.92	0.746
Irrigation costs	0.52	0.50	0.772
Production facilities cost	11.30	11.80	0.077
Production costs	72.66	69.79	0.199
Yield	172.92	188.15	0.058
Gross margin	98.57	105.72	0.221
Productivity	2.35	2.64	<0.001*

*significant at 95% level of confidence ($P \leq 0.05$); [a]US$

occurs during preparation, spraying, and the cleaning of spraying equipment (*Damalas and Koutroubas 2016*). Spraying pesticides is dangerous because it increases the adverse effects on users and the environment (*Damalas 2015*) if not applied properly. In addition to being dangerous to farmers, pesticides can also pose a risk to consumers of non-organic products due to chemical residues (*Reyes et al. 2017*). Despite the toxicity, environmental, and health risks it causes, pesticides are essential components of modern agriculture (*Colosio et al. 2013*).

One of the data related to the effect of agricultural cultivation is its impact on farmers' health. In this study, the health impact was limited to complaints of sickness from respondents related to the diseases reported last year no medical examinations were conducted. Of the 314 respondents, 173 had complaints about their condition. Among them were 143 farmers who were into conventional horticulture and 30 farmers who were practicing organic methods. Considering that no medical examinations were, the respondents' claims of sickness are purely subjective (**Table 2**).

Thirty respondents (33.3%) out of 90 respondents from the organic farmers group felt subjective complaints, including abdominal pain, chest pain, diarrhea, dizziness, excessive sweating, headaches, muscle aches (cramps), confusion, staggering, weak body, and muscle spasms. Whereas for the conventional group, 143 (63.8%) of 224 respondents felt the same complaint, coupled with complaints of blurred eyes, nausea and vomiting, anddifficulty concentrating (**Table 3**).

There are significant differences in the complaints in the past year such as dizziness ($p<0.001$), excessive sweating ($p<0.001$), headache ($p=0.001$), muscle aches ($p<0.001$), nausea and vomiting ($p=0.025$), and muscle spasms ($p= 0.036$). This shows that organic farming has a lower negative impact because of natural ingredients and does not have adverse effects on health (*Rakesh et al. 2013, Nganchamung et al. 2017*).

Health Costs

Health costs are used to calculate health benefits obtained in horticultural agriculture The basis for calculating the health costs the data from the previous year. The standard medical costs for subjective complaints used is the BPJS outpatient median rate of US$ 4.29, while the number of days off that could cause losses is used to calculate externality costs. The health costs and potential losses of the organic respondent group were significantly lower (p-value <0.001) compared to conventional farmer groups (**Table 4**).

Farmers who are vulnerable tend to incur high economic costs from exposure depending on geographic location, number, and frequency of pesticide use. Organic farmer groups have the potential to lose 2.17 US$ while the conventional group is more significant, with a potential loss of US$ 7.38.

Potential losses arising from health cases (subjective complaints) also showed a high and significant number ($p<0.001$). This potential arises because farmers cannot perform their activities to sustain their agricultural production. Farmers will be forced to hire others to work on their land.

Environment-friendly and sustainable organic farming can be achieved through the use of natural inputs to produce quality food. Thus, the agricultural produce are chemical-free and will further promote a healthier living. This study showed that organic farming has alower health risk than conventional agriculture, with ap-value <0.001 (*Asfawi et al. 2020*). Health problems hampered the productivity of the farmers and many were forced to take more rest than do agricultural activities. Individuals exposed tend to bear high economic costs from chemical exposure. Depending on geographic location, the amount and frequency of pesticide use varies, as farmers are willing to pay between 53% and 79% more than the price of existing pesticides to protect their health and the environment (*Atreya et al. 2012*).

Table 2. Complaints of sickness from respondents during the previous year in the cultivation of vegetables in Getasan District, Semarang Regency, n = 314.

Variable	Conventional n=224		Organic n=90		p-Value
	Frequency	Percentage	Frequency	Percentage	
Sickness complaints					
There are no complaints	81	36.2	60	66.7	<0.001*
There is a complaint	143	63.8	30	33.3	<0.001*
TOTAL	224	100.0	90	100.0	

*significant at 95% level of confidence (P≤0.05)

Table 3. Complaints of sickness from respondents in the previous year based on the type of complaint in the cultivation of vegetables in Getasan District, Semarang Regency, n = 314.

Sickness Complaints	Conventional n=224		Organic n=90		p-Value
	yes	no	yes	no	
Stomach ache	20	204	4	86	0.177
Blurred Eyes	15	209	0	90	0.012*
Chest pain	10	214	2	88	0.350
Diarrhea	11	213	3	87	0.541
Dizziness	66	158	8	82	< 0.001*
Excessive sweating	37	187	1	89	< 0.001*
Headache	55	169	7	83	0.001*
Muscle aches or cramps	65	159	3	87	< 0.001*
Nausea and Vomiting	12	212	0	90	0.025*
Confusion	21	203	5	85	0.268
Tottering	17	207	2	88	0.072
Difficulty in concentrating	7	217	0	90	0.900
Weak Body	38	186	7	83	0.036*
Muscle spasms	25	199	4	86	0.063

*significant at 95% level of confidence (P≤0.05)

Table 4. Cost of treatment for subjective complaints in cultivating of vegetables by the respondents in Getasan District, Semarang Regency, n = 314.

Variable	Conventional Agriculture Mean[a]	Organic Agriculture Mean[a]	p-Value
Sickness complaints in the previous year	1.78	0.51	< 0.001*
Sickness complaint costs in the previous year	7.63	2.19	< 0.001*
the number of days off, in the previous year	1.59	0.47	< 0.001*
Potential losses in the previous year	7.38	2.17	< 0.001*
Health cost	15.01	4.36	< 0.001*

*significant at 95% level of confidence (P≤0.05); [a]US$

Table 5. The benefit-cost ratio in horticultural agriculture of farmers in Getasan District, Semarang Regency.

Variable	Conventional Agriculture Mean[a]	Organic Agriculture Mean[a]	p-Value
Production costs	I72.66	69.79	0,199
Health cost	15.01	4.36	< 0.001*
Production + Health cost	87.67	74.15	0,648
Yield	172.92	188.15	0,058
Gross margin	98.57	105.72	0,221

*significant at 95% level of confidence (P≤0.05); [a]US$

Cost Analysis

Based on medical expenses over the past year, the cost ratio compared to the benefits gained in managing agricultural land from both organic and conventional farming obtained the BCR of 1.43 and 1.12, respectively, and with a p <0.001 (**Table 5**).

Although both farming methods have values above 1 (worth doing), organic farming has better discounts. *Mohammad* (*2014*) stated that the organic investment value is better than conventional. Other studies stated that organic farming will be better if the product prices are sold at a premium (*Crowder and Reganold 2015*). Organic farming offers better benefits (*Asfawi et al. 2019*).

CONCLUSION AND RECOMMENDATIONS

Organic farming has lower health risks than conventional agriculture because of the use of natural materials that are safe for health and the environment. A comprehensive program is needed to create awareness of overcoming health and environmental problems in managing pesticides. It is highly recommended for conventional farmers to shift to organic farming methods because it will be more beneficial in the environment and farmers' health. Conventional farmers can gradually shift from conventional agricultural cultivation to organic, starting with organic pesticides.

This research can be used as input to determine additional policies related to organic agriculture

development. An essential factor that allow organic farming to contribute to food security is the attitude of the decision-makers towards organic farming. Organic agriculture and certification are receiving increased attention in many parts of the world. The conversion of organic fertilizers and pesticides will save health costs by up to 45%. Fertilizer subsidies can be diverted to organic farming, considering that organic farming can only show results in the third planting period (*Hou et al. 2016*). This can convince the farmers to change their agricultural cultivation model from conventional to organic. Incentives for independent organic farming pioneers can motivate farmers to share their knowledge, especially in organic horticulture farming.

Encouraging the movement to consume healthy products without chemicals can be used to support changes in agricultural cultivation patterns from conventional to organic. More people choose to consume healthy vegetable products without chemicals, which will also stimulate farmers to switch.

This research recommends the policymakers be more directed to organic farming because it is safer for the health of farmers and the environment. One example is providing subsidies for farmers who are willing to move from conventional to organic horticultural farming.

REFERENCES

Adhikari, R.K. 2009. "Economics of Organic vs. Inorganic Carrot Production in Nepal". *Journal of Agriculture and Environment* 10 (0): 27.

Adongo, T., Abagale, F., and Kranjac-Berisavljevic, G. 2016. "Performance Assessment of Irrigation Schemes in Northern Ghana Using Comparative Performance Indicators". *International Journal of Scientific Engineering and Technology* (5) 217–224.

Aktar, W., Sengupta, D., and Chowdhury, A., 2009. Impact of pesticides use in agriculture: Their benefits and hazards. *Interdisciplinary Toxicology* 2 (1) 1–12.

Asfawi, S., Probandari, A., Setyono, P. and Hartono. 2019. "Economic Valuation of Horticulture Organic Farming in Getasan, Semarang Regency". IOP Conference Series: *Earth and Environmental Science* 328 (1).

Asfawi, S., Probandari, A., Setyono, P., and Hartono. 2020. "Health Benefits Impact Organic Horticulture Farmers In Semarang Regency, Indonesia". *Pollution Research* 39 (2): 202–206.

Atreya, K., Johnsen, F.H., and Sitaula, B.K., 2012. "Health and environmental costs of pesticide use in vegetable farming in Nepal". *Environment, Development and Sustainability* 14 (123): 477–493.

Beddington, J., Asaduzzaman, M., Clark, M., Fernández, A., Guillou, M., Jahn, M., Erda, L., Mamo, T., Van Bo, N., Nobre, C., Scholes, R., Sharma, R., and Wakhungu, J. 2012. Achieving Food Security in the Face of Climate Change. In: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark: The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), 1–64.

Bengtsson, J., Ahnström, J., and Weibull, A.C. 2005. "The effects of organic agriculture on biodiversity andabundance: A meta-analysis". *Journal of Applied Ecology* 42 (2): 261–269

Bruinsma, J., 2003. World Agriculture: "Towards 2015/2030. An FAO Perspective". *Land Use Policy* 20(4): 375.

.

Charyulu, D.K. and Biswas, S., 2010. Economics andEfficiency of Organic Farming vis-à-vis Conventional Farming in India. Working paper series, IIMA, 1–26.

Cole, D.C., Orozco T, F., Pradel, W., Suquillo, J., Mera, X., Chacon, A., Prain, G., Wanigaratne, S., and Leah, J. 2011. An Agriculture and Health Inter-sectorial Research Process to Reduce Hazardous Pesticide Health Impacts Among Smallholder Farmers in the Andes. BMC International Health and Human Rights, 11 (SUPPL. 2).

Colosio, C., Alegakis, A.K., and Tsatsakis, A.M., 2013. "Emerging health issues from chronic pesticide exposure: Innovative methodologies and effects on molecular cell and tissue level". *Toxicology* 307: 1–2.

Crowder, D.W. and Reganold, J.P. 2015. "Financial competitiveness of organic agriculture on a global scale". *Proceedings of the National Academy of Sciences* 112 (24).

Damalas, C.A. 2015. Pesticide Drift: Seeking Reliable Environmental Indicators of Exposure Assessment. Armon, R.H. and Hänninen, O. (Eds). In: Environmental Indicators. Springer Netherlands 251–261.

Damalas, C.A. and Koutroubas, S.D. 2016. "Farmers' exposure to pesticides: Toxicity Types and Ways of Prevention". *Toxics* 4 (1): 1–10.

Ehn, R.C. and Fox, J.R. 2019. A Comparative Analysis of Conventional, Genetically Modified (GM) Crops and Organic Farming Practices and the Role of Pesticides in Each. In: Conventional, GMO and Organic Farming Comparisons.

Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Coe, M.T., Daily, G.C., Gibbs,

H.K., Helkowski, J.H., Holloway, T., Howard, E.A., Kucharik, C.J., Monfreda, C., Patz, J.A., Prentice, I.C., Ramankutty, N., and Snyder, P.K. 2005. "Global Consequences of Land Use". *Science* 309 (5734): 570–574.

Forster, D., Andres, C., Verma, R., Zundel, C., Messmer, M.M., and Mäder, P. 2013. "Yield and Economic Performance of Organic and Conventional Cotton-based Farming Systems - Results from a Field Trial in India". *PLoS ONE* 8 (12).

Gabriel, D., Sait, S.M., Kunin, W.E., and Benton, T.G., 2013."Food Production vs. Biodiversity: Comparing Organic and Conventional Agriculture". *Journal of Applied Ecology* 50 (2): 355–364.

Gomiero, T., Pimentel, D. and Paoletti, M.G. 2008. "Energy and Environmental Issues in Organic and Conventional Agriculture". *Critical Reviews in Plant Sciences* 27 (4), 239–254.

Gomiero, T., Pimentel, D., and Paoletti, M.G. 2011. "Environmental Impact of Different AgriculturalManagement Practices: Conventional vs. Organic agriculture". *Critical Reviews in Plant Sciences*, 30 (1–2): 95–124.

Hansen, L., Noe, E., and Højring, K. 2006. "Nature and Nature Values in Organic Agriculture. An Analysis of Contested Concepts and Values Among Different Actors in Organic Farming". *Journal of Agricultural and Environmental Ethics* 19 (2): 147–168.

Hole, D.G., Perkins, A.J., Wilson, J.D., Alexander, I.H., Grice, P. V., and Evans, A.D., 2005. "Does Organic Farming Benefit Biodiversity?" *Biological Conservation* 122 (1): 113–130.

Holmes, T.P., Aukema, J.E., Von Holle, B., Liebhold, A., and Sills, E. 2009. "Economic Impacts of Invasive Species in Forests". *Annals of the New York Academy of Sciences* 1162 (1): 18–38.

Horrigan, L., Lawrence, R.S. and Walker, P. 2002. "How Sustainable Agriculture can Address the Environmental and Human Health Harms of Industrial Agriculture". *Environmental Health Perspectives* 110 (5), 445–456.

Hou, B., Wang, Z. wei, and Ying, R. 2016. "Pesticide Residues and Wheat Farmer's Cognition: A China Scenario". *Agricultural Research* 5 (1), 51–63.

Jaga, K. and Dharmani, C. 2006. "Ocular Toxicity From Pesticide Exposure: A Recent Review". *Environmental Health and Preventive Medicine* 11 (3): 102–107.

Kassam, A., Friedrich, T., Shaxson, F., and Pretty, J. 2009. "The Spread of Conservation Agriculture: Justification, Sustainability and Uptake". *International Journal of Agricultural Sustainability* 7 (4): 292–320.

Leifeld, J. and Fuhrer, J., 2010. "Organic Farming and Soil Carbon Sequestration: What Do We Really Know About the Benefits?" *Ambio* 39 (8): 585–599.

Lima, G.P.P. and Vianello, F. 2011. "Review on the Main Differences Between Organic and Conventional Plant-based Foods". *International Journal of Food Science and Technology* 46 (1): 1–13.

Litterick, A.M. and Watson, C.A., 2017. Organic Farming. In: Thomas, B.T., Murray, B.G. and Murphy, D.J. (Eds) Encyclopedia of Applied Plant Sciences. (2nd ed). Elsevier Ltd. Academic Press (pp 311-317)

Lobley, M., Butler, A., Courtney, P., Ilbery, B., Kirwan, J.,Maye, D., Potter, C., and Winter, M., 2009. Analysis of Socio-economic Aspects of Local and National Organic Farming Markets.

Marshall, J.D. and Toffel, M.W., 2005. "Framing the ElusiveConcept of Sustainability: A Sustainability Hierarchy". *Environmental Science and Technology* 39 (3): 673–682.

Mehmood, Y., Anjum, M.B., Sabir, M., and Arshad, M. 2011. "Benefit Cost Ratios of Organic and Inorganic Wheat Production: A Case Study of District Sheikhupura". *World Applied Sciences Journal*. 13(1): 175-180

Mohamad, R.S., Verrastro, V., Cardone, G., Bteich, M.R., Favia, M., Moretti, M., and Roma, R. 2014. "Optimization of Organic and Conventional Olive Agricultural Practices from a Life Cycle Assessment and Life Cycle Costing perspectives". *Journal of Cleaner Production* 70: 78–89.

Mondelaers, K., Aertsens, J., and van Huylenbroeck, G. 2009. "A Meta-analysis of the Differences in Environmental Impacts Between Organic and Conventional Farming". *British Food Journal*, 111 (10): 1098–1119.

Ndeketeya, A., Rusere, F., Svubure, O., Gwatibaya, S., Soropa, G., and Mashonganyika, J., 2014. "Drip Irrigation as a Potential Alternative to Furrow Irrigation in Sugarcane Production-A Case of the Lowveld Estate, Zimbabwe". *International Journal of Agricultural Policy and Research* 2 (1): 026–032.

Nganchamung, T., Robson, M.G., and Siriwong, W. 2017. "Chemical Fertilizer Use and Acute Health Effects among Chili Farmers in Ubon Ratchathani Province, Thailand". *Journal of Health Research* 31 (6): 427–435.

Olabisi, L.S., Wang, R.Q., and Ligmann-Zielinska, A. 2015. "Why Don't More Farmers Go Organic? Using a Stakeholder-informed Exploratory Agent-based Model to Represent the Dynamics of Farming Practices in the

Philippines". *Land* (4): 979–1002.

Oliquino-Abasolo, A. and Zamora, O.B. 2016. "Agro-Environmental Sustainability of Conventional and Organic Vegetable Production Systems in Tayabas, Quezon, Philippines". *Journal of Environmental Science and Management* 19 (1): 58–71.

Pergola, M., D'Amico, M., Celano, G., Palese, A.M., Scuderi, A., Di Vita, G., Pappalardo, G., and Inglese, P. 2013. "Sustainability Svaluation of Sicily's Lemon and Orange production: An Energy, Economic and Environmental Analysis". *Journal of Environmental Management* 128, 674–682.

Pimentel, D., 2005. Environmental and Economic Costs of the Application of Pesticides Primarily in the United States. Environment, Development and Sustainability, 7 (2): 229–252.

Quijano, R. and Rengam, V.S. 1999. Pestisida Berbahaya Bagi Kesehatan. Jakarta: Yayasan Duta Awan.

Rajput, J. and Kothari, M., 2017. "Performance Appraisal of Bhimsagar Irrigation Scheme using Comparative Performance Indicators". *International Journal of Current Microbiology and Applied Sciences* 6 (10):3383–3393.

Rakesh, P., P, A., Cherian, A.M., AshutoshMasih, Mohan, E., Rachel, G., Sunny, G., Simon, J., George, J.T., John, K., Schilling, P., Lombi, K.M., Alex, R., Balraj, V., and Mohan, V.R., 2013. "Chemical Use in Farming and its Health and Environmental Implications in a Rural Setting in Southern India". *IOSR Journal Of Environmental Science, Toxicology And Food Technology* 5 (5), 90–95.

Reyes, G.A., Gomez, R.A., Fomeg-As, D.Y., Lasangen, W.C.T., and Anacin, C., 2017. "Detection of Organophosphate Residues in Selected Crops in Benguet and Mt. Province, Philippines". *Journal of Environmental Science and Management* 20 (2): 28–33.

Ryan, R.L., Erickson, D.L., and De Young, R., 2003. "Farmers' Motivations for Adopting Conservation Practices Along Riparian Zones in a Mid-western Agricultural Watershed". *Journal of Environmental Planning and Management* 46 (1), 19–37.

Seufert, V., 2012. "Organic Agriculture as an Opportunity for Sustainable Agricultural Development". *Research to Practice Policy Briefs* (13), 1–26.

Seufert, V., Ramankutty, N., and Foley, J.A., 2012. Comparing the Yields of Organic and Conventional Agriculture. Nature, 485 (7397): 229–32.

Sgroi, F., Candela, M., Trapani, A., Foderà, M., Squatrito, R., Testa, R., and Tudisca, S. 2015. "Economic and Financial Comparison between Organic and Conventional Farming in Sicilian Lemon Orchards". *Sustainability* 7 (1): 947–961

Sudheer, P. 2013. "Economics of Organic Versus Chemical Farming for Three Crops in Andhra Pradesh, India". *Journal of Organic Systems* 8 (2): 36–49.

Urfi, P., Koch, K.K., and Bacsi, Z., 2011. "Cost and Profit Analysis of Organic and Conventional Farming in Hungary". *Journal of Central European Agriculture* 12 (1): 103–113.

Ye, M., Beach, J., Martin, J.W., and Senthilselvan, A., 2013. "Occupational Pesticide Exposures and Respiratory Health". *International Journal of Environmental Research and Public Health* 10 (12): 6442–6471

ACKNOWLEDGMENT

Our gratitude goes to the Ministry of Research, Technology and Higher Education for funding this study; Mr. Zaenal and Pitoyo, head of the "Bangkit Merbabu" and "Tranggulasi" peasant groups, and Mr. Sualim, an agricultural instructor in Getasan.