Jurnal Pengabdian Magister Pendidikan IPA

Original Research Paper

Improving High Order Thinking Skills With Republic Polytechnics Singapore Lecturers Through Field Trip Implementation of Biochar On Soil In Pangambatan Village, Merek District, Tanah Karo Regency

Charloq[1]

[1] *Lecturer of Agrotechnology Study Program, Faculty of Agriculture, Universitas Sumatera UtaraJl. Dr. Sofyan Kampus USU Medan 20155, Indonesia*

DOI : https://doi.org/10.29303/jpmpi.v7i2.7467
Sitasi: Charloq. (2024). Improving High Order Thinking Skills With Republic Polytechnics Singapore Lecturers Through Field Trip Implementation of Biochar On Soil In Pangambatan Village, Merek District, Tanah Karo Regency. *Jurnal Pengabdian Magister Pendidikan IPA* 7(2)

Article history
Received : 05 Januari 2024
Revised: 18 April 2024
Accepted: 25 April 2024

*Corresponding Author: Charloq, Lecturer of Agrotechnology Study Program, Faculty of Agriculture, Universitas Sumatera Utara, Jl. Dr. Sofyan Kampus USU Medan 20155, Indonesia; Email: charloq@unsu.ac.id

Abstract: Fieldtrip assistance for lecturers from the Republic Polytechnic of Singapore, and the Consulate-General of the Republic of Singapore Medan by lecturers and students of the University of North Sumatra to Pangambatan Village, Merek District, Karo Regency, as a form of applied scale learning directly in the field. The purpose of this field trip is to socialize the benefits of biochar technology as a soil and plant improver. In the implementation of this learning, an approach was taken using the Service Learning Method: It is a learning, teaching and reflection strategy that provides opportunities for lecturers and students to apply biochar technology and serve farmers and communities, by combining learning in lectures with the needs and problems that exist in the soil and plants and the environment in the form of sustainable agriculture in farming communities. Socialization and technology on biochar, how to make an application in the field were delivered by USU lecturers and students. The next meeting continued in the form of discussions in the seminar room of the Taman Simalem Resort Hotel which was attended by participants and Indonesian Geology experts. The meeting was followed by a discussion in the Seminar Room of Taman Simalem Resort Hotel attended by the participants. The field trip produced and honed the ability of high order thinking skills (HOTS), lecturers, students of Republic Polytechnic of Singapore, and Consulate-General of The Republic of Singapore Medan, Geology Experts and Plasma Farmers, know and understand the importance of biochar for agricultural soils for soil improvement in terms of physical, chemical and biological soil to be healthy and increase crop production. The results of investigations in the field some farmers want to apply biochar on their land in the next planting season and will form a biochar user farmer group.

Keywords: HOTS, Fieldtrip, Biochar, Soil Amendment.

Introduction

The ability to think at a high level or known as High Order Thinking Skills (HOTS), because high-level thinking is one of the stages of thinking that cannot be separated from the daily life of every lecturer and student, is directed to have a high-level thinking pattern, because the ability to think at a high level allows lecturers and students to think critically (Abdullah et al., 2015; Yuliati et al., 2018; Merta et al., 2017 and Murawski et al., 2014). Especially for students, the investigative

type learning style is a learning style that has characteristics, namely: logical thinking, analytical, critical, high curiosity and humble (Fadhlullah & Ahmad, 2017; Chabeli, 2006; Alsaleh, N. J., 2020). This field trip uses the service learning method, a holistic method that aims to understand the meaning of biochar implementation in the context of life (Berte & Jones, 2014; Skop, 2009; Cotten & Thompson, 2017. Mathews et al., 2012; and Kenworthy & Peterson, 2005), so that there is a reciprocal relationship between lecturers, students and farmers.

Given the importance of adding insight into sustainable agriculture, lecturers and students are also enthusiastic about adding knowledge about new renewable energy, one of which is biochar. According to Harris, Birdwell, & Basdogan, 2024; Morag & Tal, 2012, that field trips are an effort to learn in informal spaces can be more effective and efficient, making it easier for lecturers and students to design, plan and carry out activities structurally. Biochar is a highly porous solid substance, made from various biomasses through pyrolysis. Biochar has a multifunctional value that includes its use for the following purposes: soil amendments to improve soil health, nutrient and microbial carriers, immobilization materials for remediation of toxic metals and organic contaminants in soil and water, catalysts for industrial applications, porous materials to mitigate greenhouse gas emissions and odorous compounds, and feed supplements to improve animal health and nutrient intake efficiency and, thus, productivity (Bolan, et al., 2022 and Liu & Yu, 2015). The utilization of plant biomass waste and animal manure in Pangambatan Village comes from biochar of rice husk, empty palm bunches, cow dung and chicken manure.

Biochar can be one of the innovations that can be applied for farmers to overcome the decline in soil acidity. (Dai et al., 2017; Liao & Thomas, 2019 and Wang et al., 2014), soil water holding capacity (Atkinson, 2018 and Wang et al., 2014), increased crop productivity, and carbon stock savings (Das et al., 2023 and Lehmann & Joseph, 2015) to address global environmental issues.

The objectives of this field trip are to: a) Introduce the benefits of biochar as a soil improver; b) Practice biochar production using the pyrolysis method from biomass waste; c) How to apply biochar to infertile or acidic soil. This application uses Participatory Learning and Action (PLA) (De Brún et al., 2017 and Mahdi 2023) by empowering plasma farmers from the Taman Simalem Resort Brand Tanah Karo who have been coached to implement biochar on their land. Participants of this field trip were lecturers and students of Republic Polytechnics Singapore, Consulate-General of The Republic of Singapore Medan as well as Soil Geologists and Director of Taman Simalem Resort (TSR) who sponsored this field trip.

Methods

The field trip was conducted in Pangambatan Village, Merek District, Tanah Karo Regency, North Sumatra, Indonesia, and continued in the seminar room of Taman Simalem Resort, on Monday and Tuesday, February 26-27, 2024.

The methods used in this field trip mentoring are Service Learning and Participatory Learning and Action (PLA) methods. Service Learning is one approach in mentoring that combines current topics and academic goals in an effort to foster innovation in solving problems directly. Participatory Learning and Action (PLA) is an approach to the mentoring process through interaction with communities or farmers in the field. The data generated is qualitative data, data in the form of non-numbers, photos, where researchers carry out activities, analyze, and explain the results in the field. This field trip activity was carried out in Pangambatan Village with stages:

1. Planning and implementation phase
2. The stage of assisting lecturers and students in implementing the field trip program.

The activities focus on honing high order thinking skills including problem solving, creative thinking, investigative skills and decision-making skills,

especially biochar can improve soil and plant fertility.

The steps of the field trip mentoring activity are presented in Table 1.

Fase	Activity Phase
Pre Trip	● Received an invitation letter from the Consulate-General of the Republic of Singapore Medan dated February 20, 2024 regarding Request for Assistance related to the visit of lecturers from the Republic Polytechnic of Singapore to Karo Regency, to be willing to provide direction on Biochar for Soil and Plant Improvement research on February 24 to 27, 2024. ● Received a letter of assignment from the Dean of the Faculty of Agriculture, University of North Sumatra to be carried out with full responsibility. ● Determine the location of the field trip ● Preparing transportation and accommodation ● Designing investigation activities ● Checking the readiness of the field trip
Trip Strage	● Coordination between the companion and the Singapore Consulate Staff, to get the location of the visit. ● Arriving at the location, the lecturers conducted interviews and discussions with the facilitator about biochar, soil and plants on smallholder land in Pangambatan Village. ● Record observations in the worksheet
Post Trip	● Presentation of more detailed observations from the field in the Taman Simalem Resort seminar room and accompanied by questions and answers. ● Make a report on the results of mentoring ● Evaluation and reflection on the field trip activities that have been carried out

Documentation Of Field Trip And Discussion In Tsr Seminar Room

Figure 1. Visit of Lecturers of Republic Polytechnic of Singapore & Consulate-General of the Republic of Singapore Medan to the Plasma Farmers of Taman Simalem Resort, Village of Pangambatan Merek Tanah Karo

Figure 2. POC Integrated Biochar Technology Education and Benefits to Soil

Figure 3. Effect of Biochar on the Growth of Mustard Plants (*Brassica juncea* L.)

Figure 4. Group Photo showing Rice Husk Biochar, TKKS, Chicken Dung & Cow Dung

Figure 5. Presentation and Discussion by Fieldtrip Facilitators on the Effect of Biochar For Soil and Horticultural Plants

FIELDTRIP ASSISTANCE

Field trip assistance encourages the activities of lecturers and students of Republic Polytechnic of Singapore and Consulate-General of The Republic of Singapore Medan quite active in this visit and gives them direct experience and know the benefits of biochar combined with the maintenance of mustard vegetable crops with organic ingredients, namely Liquid Organic Fertilizer (LOF) and Bio-pesticides made entirely from natural ingredients around the field.

BIOCHAR APPLICATION ON SOIL

The method of biochar implementation in crop fields is carried out before planting begins so that soil amendments occur both physically, soil chemistry and soil biology development, which is very beneficial for soil fertility and health, this is beneficial for plant growth. Biochar is produced through a pyrolysis process, where the long and complex hydrocarbon chains of biomass are broken down into shorter and simpler chains resulting in the product of carbon-rich activated charcoal (biochar). Biochar is defined as carbon-rich material produced during the pyrolysis process which is the thermochemical decomposition of biomass at temperatures around ≤500°C in the absence or limited supply of oxygen, soil treatment with biochar causes favorable changes in the soil, (Keerthanan et al., 2020). Biochar is a solid product resulting from the thermal conversion of carbon-enriched unstable materials into stable carbon-rich charred materials.

MAINTENANCE OF MUSTARD GREENS (*Brassica juncea* L.)

Mustard plants have the Latin name Brassica juncea L. is a seasonal vegetable type plant. Usually watering LOF on plants is given per 3 weeks and also see the condition of the plant. Making liquid organic fertilizer is made from vegetable and fruit leaves that are around the land. LOF is prepared from the results of fermentase which is carried out for ± 30 days until decomposition occurs, the most interesting thing from the results of laboratory analysis is that there are microbes that are both Nitrogen solvents, Phosphorus solvents are very useful for the availability of nutrients.

Mustard plants are produced from organic maintenance and the LOF ingredients come from around the land, the content is very close to the benefits for plants, as reported by Odlare et al., 2011 that LOF significantly increased nutrient content and changed the soil functional microbial community at the rhizosphere level compared to chemical fertilizer treatments. Some important soil microbiological properties, such as substrate-induced respiration, ammonium oxidation potential and nitrogen mineralization were enhanced after the application of liquid organic fertilizer. These results are supported by the reports of Ji et al., 2017; and Mahdi et al., 2010, that no negative impacts could be detected from the use of organic waste. The main conclusion of this field experiment is that liquid organic fertilizer produces yields that are almost the same as mineral fertilizers, the benefits of liquid organic fertilizer can convert nutrients in the soil into a form that is available for plant

growth, this is supported by Nhu et al., 2018; Phibunwatthanawong & Riddech, 2019 and Gupta et al., 2019, reported, that the number of Nitrogen, Phosphorus and Potassium solubilizing microbes found in soil supplemented with liquid organic fertilizer.

PEST AND DISEASE MANAGEMENT

In the field, when the mustard plants are several weeks old, leaf-eating caterpillars and aphids repeatedly attack the leaves. If this is observed, it is because maintenance does not use toxic pesticides so that the frequency of watering when spraying organic pesticides (biopesticides) can be more intensive. The advantage of biopesticides is that there is no need to worry because organic pesticide ingredients do not poison the soil and plants because they are environmentally friendly. There are caterpillars and fleas, they can be watered 1x/3 days, even if there is an explosive attack, the mustard greens can be sprayed 1x/2 days instead of chemical pesticides and by spraying the plants from plant leaf material around the vegetable area.

Result and Discussion

A more detailed explanation in the TSR seminar room was presented by a lecturer at the University of North Sumatra, namely Mrs. Charloq. Explains how to deepen the analysis of the results of soil amendments by biochar in the field in terms of changes in physical properties, chemical properties and biological properties of the soil, the effects and benefits for the growth of mustard greens (caisim). The growth of mustard greens plants is based on observed variables including plant height, number of leaves, plant fresh weight and wet weight roots and the results of laboratory analysis produced consistently better results in plants treated with biochar compared to those without fertilizer and chemical fertilizers. Both the chemical and physical content of soil treated with biochar show better results and with consistent models. The results of applied application in the field of biochar significantly influenced soil conditions and the growth of mustard greens (*Brassica juncea* L.).

The effect of giving Chicken Animal Manure Biochar on soil planted with mustard greens, had a significant effect compared to not giving biochar and applying chemical fertilizer, while giving chemical fertilizer showed insignificant different results with Cow Animal Manure, Palm Oil Empty Bunch Biochar and Rice Husk Biochar. These results show that without chemical fertilizers, biochar produces higher crop production. This field trip provides insight into future directions regarding the implications of using biochar as a soil amendment for effective biochar-plant nutrient interactions.

The improvement of these properties is the result of cumulative effects due to changes in microbial activity in the soil associated with the use of chemical fertilizers and pesticides, and biochar has a significant impact on soil properties and plant growth. In addition, changes in nutrient uptake mechanisms for crop growth due to changes in biochar in soil were also investigated by Khalifa and Yousef, 2015, that treating biochar produced from date palm fronds on sandy textured soil showed that treatment with biochar increased soil water retention, increased cation exchange capacity (CEC) and decreased soil sodium adsorption ratio (SAR) to below sodic.

Field trips are generally enjoyable for academics and students. The technique of giving lecturers and students unique and interesting experiences outside the campus, and getting new experiences from the topic and reality of the results of soil improvement by biochar, this provides motivation and interest in the concept of sustainable agriculture (sustainable agriculture) also faces drought due to climate change and scarcity of expensive and scarce chemical fertilizers. Farmers can provide horticultural crops into healthy food and vegetable products, free from chemicals and pesticides that are harmful to health and provide agricultural input efficiency and ultimately provide more profit margins. The effect of biochar results in harvesting mustard vegetables (caisim) 1 week earlier than conventional harvesting, greener leaves and more cost-effective, because biochar application is combined with liquid organic fertilizer (LOF) and vegetable biopesticides.

This activity was able to hone the lecturers and students from Republic Polytechnic of Singapore and Consulate-General of The Republic of Singapore Medan high order thinking skills including problem solving skills, investigative skills, skill, and decision making skills. Participants were very interested and understood how important biochar as a soil improver is able to improve soil

and plant fertility, increase crop production which ultimately contributes to the substitution of chemical fertilizers which are currently expensive, of course very helpful for farmers.

Conclusions

The field trip resulted in the implementation of biochar:

- Able to improve the high order thinking skills (HOTS) of lecturers and students at the Republic of Singapore Polytechnic, the importance of biochar for agricultural soil to improve the soil in terms of physical, chemical and biological soil to make it healthy and the production of horticultural mustard greens (Brassica juncea L.) to increase.
- As a result of investigations in the field, several farmers want to apply biochar to their land in the next planting season and will form a group of farmers using biochar.

References

Abdullah, A. H., Abidin, N. L. Z., & Ali, M. (2015). Analysis of students' errors in solving Higher Order Thinking Skills (HOTS) problems for the topic of fraction. *Asian Social Science*, *11*(21), 133. DOI:10.5539/ass.v11n21p133 https://www.ccsenet.org/journal/index.php/ass/article/view/47330

Alsaleh, N. J. (2020). Teaching Critical Thinking Skills: Literature Review. Turkish Online Journal of Educational Technology-TOJET, 19(1), 21-39. https://eric.ed.gov/?id=EJ1239945

Ashiq, A., & Vithanage, M. (2020). Biochar-mediated soils for efficient use of agrochemicals. Agrochemicals Detection, Treatment and Remediation, 621-645. https://doi.org/10.1016/B978-0-08-103017-2.00023-4

Berte, E., & Jones, K. J. (2014). The field trip as an experiential teaching strategy to promote reflective learning. Journal of the Academy of Business Education, 15. ISSN: 2156-5155. © 2024 EBSCO Industries, Inc. All rights reserved.

Bolan, N., Hoang, S. A., Beiyuan, J., Gupta, S., Hou, D., Karakoti, A., ... & Van Zwieten, L. (2022). Multifunctional applications of biochar beyond carbon storage. International Materials Reviews, 67(2), 150-200. https://doi.org/10.1080/09506608.2021.1922047

Chabeli, M. M. (2006). Higher order thinking skills competencies required by outcomes-based education from learners. Curationis, 29(3), 78-86. DOI: https://doi.org/10.4102/curationis.v29i3.1107

Cotten, C., & Thompson, C. (2017). High-impact practices in social work education: A short-term study-abroad service-learning trip to Guatemala. Journal of Social Work Education, 53(4), 622-636. https://doi.org/10.1080/10437797.2017.1284626

Dai, Z., Zhang, X., Tang, C., Muhammad, N., Wu, J., Brookes, P. C., & Xu, J. (2017). Potential role of biochars in decreasing soil acidification-a critical review. Science of the Total Environment, 581, 601-611. https://doi.org/10.1016/j.scitotenv.2016.12.169

Dai, Z., Zhang, X., Tang, C., Muhammad, N., Wu, J., Brookes, P. C., & Xu, J. (2017). Potential role of biochars in decreasing soil acidification-a critical review. Science of the Total Environment, 581, 601-611. https://doi.org/10.1016/j.scitotenv.2016.12.169

Das, S. K., Ghosh, G. K., & Avasthe, R. (2023). Biochar application for environmental management and toxic pollutant remediation. Biomass Conversion and Biorefinery, 13(1), 555-566.

https://doi.org/10.1007/s13399-020-01078-1

De Brún, T., O'Reilly-de Brún, M., Van Weel-Baumgarten, E., Burns, N., Dowrick, C., Lionis, C., ... & MacFarlane, A. (2017). Using Participatory Learning & Action (PLA) research techniques for inter-stakeholder dialogue in primary healthcare: an analysis of stakeholders' experiences. Research involvement and engagement, 3, 1-25. https://doi.org/10.1186/s40900-017-0077-8 https://link.springer.com/article/10.1186/s40900-017-0077-8

Fadhlullah, A., & Ahmad, N. (2017). Thinking outside of the box: Determining students' level of critical thinking skills in teaching and learning. Asian Journal of University Education (AJUE), 13(2), 51-70. https://ir.uitm.edu.my/id/eprint/21917/

Giwa, A., Yusuf, A., Ajumobi, O., & Dzidzienyo, P. (2019). Pyrolysis of date palm waste to biochar using concentrated solar thermal energy: Economic and sustainability implications. Waste Management, 93, 14-22. https://doi.org/10.1016/j.wasman.2019.05.022

Gupta, R., Tiwari, S., Saikia, S. K., Shukla, V., Singh, R., Singh, S. P., ... & Pandey, R. (2015). Exploitation of microbes for enhancing bacoside content and reduction of Meloidogyne incognita infestation in Bacopa monnieri L. Protoplasma, 252, 53-61. https://doi.org/10.1007/s00709-014-0657-5

Harris, T., Birdwell, T., & Basdogan, M. (2024). Exploring efficiencies of informal learning space: a case study. Journal of Applied Research in Higher Education. https://www.emerald.com/insight/content/doi/10.1108/JARHE-06-2023-0267/full/html

Ji, R., Dong, G., Shi, W., & Min, J. (2017). Effects of liquid organic fertilizers on plant growth and rhizosphere soil characteristics of chrysanthemum. Sustainability, 9(5), 841. https://doi.org/10.3390/su9050841

Jouiad, M., Al-Nofeli, N., Khalifa, N., Benyettou, F., & Yousef, L. F. (2015). Characteristics of slow pyrolysis biochars produced from rhodes grass and fronds of edible date palm. *Journal of analytical and applied pyrolysis*, *111*, 183-190. https://doi.org/10.1016/j.jaap.2014.10.024

Khalifa, N., & Yousef, L. F. (2015). A short report on changes of quality indicators for a sandy textured soil after treatment with biochar produced from fronds of date palm. Energy Procedia, 74, 960-965. https://doi.org/10.1016/j.egypro.2015.07.729

Keerthanan, S., Bhatnagar, A., Mahatantila, K., Jayasinghe, C., Ok, Y. S., & Vithanage, M. (2020). Engineered tea-waste biochar for the removal of caffeine, a model compound in pharmaceuticals and personal care products (PPCPs), from aqueous media. Environmental Technology & Innovation, 19, 100847. https://doi.org/10.1016/j.eti.2020.100847

Kenworthy-U'Ren, A. L., & Peterson, T. O. (2005). Service-learning and management education: Introducing the "WE CARE" approach. Academy of Management Learning & Education, 4(3), 272-277. https://doi.org/10.1007/s12564-019-09580-6

Lehmann, J., & Joseph, S. (2015). Biochar for environmental management: an introduction. In Biochar for environmental management (pp. 1-13). Routledge. https://doi.org/10.4324/9780203762264

Liu, W. J., Jiang, H., & Yu, H. Q. (2015). Development of biochar-based functional materials: toward a sustainable platform carbon material. Chemical reviews, 115(22), 12251-12285. https://doi.org/10.1021/acs.chemrev.5b00195

Liao, W., & Thomas, S. C. (2019). Biochar particle size and post-pyrolysis mechanical processing affect soil pH, water retention capacity, and plant performance. Soil Systems, 3(1), 14. https://doi.org/10.3390/soilsystems3010014

Mahdi, S. S., Hassan, G. I., Samoon, S. A., Rather, H. A., Dar, S. A., & Zehra, B. (2010). Bio-fertilizers in organic agriculture. Journal of phytology, 2(10), 42-54. ISSN (Print): 2075-6240. ISSN (Electronic): 2075-6240. https://www.cabidigitallibrary.org/doi/full/10.5555/20113064342

Mahdi, Y. (2023). Participatory Learning and Action (PLA) and Reflective Practices: Training Teachers to Become Effective Promoters of Freedom of Religion or Belief Principles in Education. In Using Participatory Methods to Explore Freedom of Religion and Belief (pp. 144-162). Bristol University Press. https://doi.org/10.51952/9781529229295.ch009

Mathews, S., Andrews, L., & Luck, E. (2012). Developing a Second Life virtual field trip for university students: an action research approach. Educational Research, 54(1), 17-38. https://doi.org/10.1080/00131881.2012.658197

Merta Dhewa, K., Rosidin, U., Abdurrahman, A., & Suyatna, A. (2017). The development of Higher Order Thinking Skill (Hots) instrument assessment in physics study. IOSR Journal of Research & Method in Education (IOSR-JRME), 7(1), 26-32. http://repository.lppm.unila.ac.id/3223/

Morag, O., & Tal, T. (2012). Assessing learning in the outdoors with the field trip in natural environments (FiNE) framework. International Journal of Science Education, 34(5), 745-777. https://doi.org/10.1080/09500693.2011.599046

Murawski, L. M. (2014). Critical thinking in the classroom and beyond. Journal of Learning in Higher Education, 10(1), 25-30. https://files.eric.ed.gov/fulltext/EJ1143316.pdf

Nhu, N. T. H., Chuen, N. L., & Riddech, N. (2018). The effects bio-fertilizer and liquid organic fertilizer on the growth of vegetables in the pot experiment. Chiang Mai Journal of Science, 45(3), 1257-1273. http://epg.science.cmu.ac.th/ejournal/

Odlare, M., Arthurson, V., Pell, M., Svensson, K., Nehrenheim, E., & Abubaker, J. (2011). Land application of organic waste–effects on the soil ecosystem. Applied Energy, 88(6), 2210-2218. https://doi.org/10.1016/j.apenergy.2010.12.043

Phibunwatthanawong, T., & Riddech, N. (2019). Liquid organic fertilizer production for growing vegetables under hydroponic condition. International Journal of Recycling of Organic Waste in Agriculture, 8, 369-380. https://doi.org/10.1007/s40093-019-0257-7

Skop, E. (2009). Creating field trip-based learning communities. Journal of Geography, 107(6), 230-235. https://doi.org/10.1080/00221340802620164

Wang, L., Butterly, C. R., Wang, Y., Herath, H. M. S. K., Xi, Y. G., & Xiao, X. J. (2014). Effect of crop residue biochar on soil acidity amelioration in strongly acidic tea garden soils. Soil use and management, 30(1), 119-128. https://doi.org/10.1111/sum.12096

Yuliati, S. R., & Lestari, I. (2018). Higher-order thinking skills (hots) analysis of students in solving hots question in higher education. Perspektif Ilmu Pendidikan, 32(2), 181-188. https://doi.org/10.21009/PIP.322.10