

## Review

of the official reviewer **Viktor Ivanovych Onychko**, candidate of agricultural sciences, associate professor

PhD thesis **Xihuan Zhang** “Effects of long-term biogas slurry application on soil properties and crop yield in the North China Plain”, submitted for a scientific degree of a Doctor of philosophy

Field of study: 20 – Agricultural sciences and food  
Specialty 201 – Agronomy

**Relevance of the dissertation topic.** Soil organic carbon storage is a major part of the global carbon cycle and plays an important role in global carbon changes. Its dynamic balance is an important indicator of soil fertility. High organic carbon content can effectively improve plant nutrient supply and soil structure to increase biodiversity and enhance microbial activity. Soil biochemical properties, such as microbial biomass and enzyme activity, are important indicators of soil quality because of their role in carbon sequestration, organic carbon decomposition, nutrient cycling and availability. Many studies have shown that the use of organic fertilizers can significantly increase the activity of soil enzymes. However, long-term application of mineral fertilizers is widely used and is a central problem of the green revolution all over the world. In addition, although the use of excessive amounts of mineral fertilizers can increase crop productivity, it also leads to pollution and degradation of the agricultural environment. Therefore, it is important to investigate other ways of fertilization. The use of biogas slurry (digestate) can improve soil nitrogen uptake because it contains a lot of nitrogen, increase crop yields, and can increase microbial biomass and species composition of microorganisms. Application of biogas slurry is an alternative for replacing mineral fertilizers and the main way to increase soil fertility, to solve the ecological problem of waste accumulation at biogas plants. However, what dose and ratio of biogas slurry and mineral fertilizers is best for soil fertility and productivity of agricultural crops remains insufficiently understood, therefore the relevance of the research of this dissertation is quite high.

**Connection with scientific programs, topics, plans.** The research work was supported by the science and technology key project of Henan Province (212102110388) and by the key scientific research project at Henan Provincial University (20B210004), China (appendix A). The research also was carried out in accordance with the thematic plans of research works of the department of agrotechnologies and soil science of the Sumy National Agrarian University and within the framework of the topics “Biologization of the farming system through a rational combination of methods of soil cultivation and sideration” 0115u0010055.

### **Scientific novelty and theoretical significance of the thesis.**

The impacts of applying biogas slurry to winter wheat on lime concretion black soil in Zhoukou were thoroughly investigated and assessed *for the first time*. The optimal biogas slurry application concentration (BS50:chemical fertilizers 50) was found along with the differences between the various concentrations of the



biogas slurry. The amount of biogas slurry applied in conjunction with agricultural and animal husbandry was enhanced, wheat yield and quality were raised, and a foundation for the scientific application of biogas slurry was established.

*It was improved* the application amount of biogas slurry in the combination of agriculture and animal husbandry, increased the yield and quality of wheat, and provided a basis for the scientific application of biogas slurry.

The issue of using waste from biogas plants as fertilizer *have been further developed*. In order to scientifically apply biogas slurry and improve soil texture, this study used winter wheat as the research object and examined the effects of biogas slurry returning to the field on the physical and chemical properties of nutrient soil, enzyme activity, and the yield and quality of winter wheat in lime concretion black soil to offer a scientific foundation for agriculture's sustainable development.

**Practical significance of the thesis results.** There are already a lot of research studies available on the use of biogas slurry both domestically and internationally in China. The application of suitable biogas slurry increases soil fertility, strengthens crop resistance, encourages crop growth, and improves product quality. It also improves the physical, chemical, and biological properties of the soil and increases the potential for sustainable agricultural development. On the other hand, excessive amounts of concentrated, ongoing, illogical fertilizer application would hinder crop growth, reduce yield and quality, and lead to secondary contamination of the soil and water, which will eutrophicate subsurface water and produce soil salinization. A sensible use of biogas slurry is especially crucial to guaranteeing agricultural product quality and production while preventing soil pollution. The main goals of agricultural scientists and scientists are constantly to guarantee national food security, raise farmers' incomes, and steadily improve grain output.

Agriculture and animal husbandry were intimately linked at the same time, and the usage of chemical fertilizers, the expense of agricultural output, and environmental pollution were all decreased. The research has been acknowledged by the Department of Science and Technology and the Department of Education of Henan Province, and it is advantageous to the sustainable growth of agriculture (appendix A). The experiment's findings are incorporated into the Sumy National Academy of Sciences' curriculum (appendix B).

**Number of scientific publications.** The main results of the dissertation are presented in 3 papers:

1. Tang J., Davy A. J., Wang W., Zhang X., Wu D., Hu L., Yin J. (2022). Effects of Biogas Slurry on Crop Yield, Physicochemical Properties and Aggregation Characteristics of Lime Concretion Soil in Wheat–Maize Rotation in the North China Plain. *Journal of Soil Science and Plant Nutrition*, 22, 2406–2417. <https://doi.org/10.1007/s42729-022-00817-9> (Scopus database, 1 quartile).



2. Zhang X., Wu D., Zakharchenko E. A. (2022). Review on effects of biogas slurry application on crop growth. *Agrarian innovations*, 13, 155-166. <https://doi.org/10.32848/agr.ar.innov.2022.13.24> (category B)

3. Zhang X., Zakharchenko E.A. (2023). Effect of biogas slurry returning to field on soil phosphatase activity. *Irrigation agriculture*, 79, 83-87. <https://doi.org/10.32848/0135-2369.2023.79.11> (category B).

Also, the results were presented in one publication in the EU journal, in three Chinese professional journals in the Chinese language (with English annotation) and in four conference abstracts.

**Discussion clauses, comments and wishes regarding the content.** There are a few points worth discussing regarding the content of the dissertation:

1. The dissertation contains expressions such as digestate and biogas suspension or slurry. What is the difference between these terms?
2. When is winter wheat usually sown in your region? What is the growing season in days of your wheat variety?
3. The dissertation presents the temperature and precipitation in the research years 2020-2022. But yield data are given on average for three years. It would be interesting to determine the influence of the year factor when studying the effectiveness of biogas slurry and mineral fertilizers in the cultivation of winter wheat.
4. Why is Lime concretion black soil used as a research object in your study to discuss the impact of biogas slurry returning to field on soil-wheat ecosystem?
5. Is the agricultural and animal husbandry combined ecological cycle model of biogas slurry return suitable for Ukraine?
6. What will be further research on the return of biogas slurry to the field in the future?

The comment and suggestions expressed are not of fundamental importance, some have a debatable nature, do not affect the value of the dissertation, which solves is an important scientific and practical problem and will contribute the the positive effect of biogas slurry application on the field.

**General conclusion.** The dissertation work of Xihuan Zhang intitled «Effects of long-term biogas slurry application on soil properties and crop yield in the North China Plain», which was submitted for defense to the specialized academic council for obtaining the degree of Doctor of Philosophy in the field of knowledge 20 – «Agricultural sciences and food» in the specialty 201 «Agronomy» in terms of its relevance, scientific and theoretical level, main results of validity, main provisions and results published in professional publications, and novelty of the setting and practical significance meets the requirements of the order of the Ministry of Education and Science of Ukraine No.40 dated January 12, 2017 «On approval of requirements for registration dissertation» and the Decree of the Cabinet of Ministers of Ukraine dated January 12, 2022 No.44 “On approval of the Procedure for awarding the degree of Doctor of Philosophy and cancellation of the decision of

the one-time specialized academic council of the higher educational institution, scientific institution on awarding the degree of «Doctor of Philosophy» with amendments made according to the Resolution of the Cabinet of Ministers No.341 dated 03.21.2022. The PhD candidate Xihuan Zhang deserves to be awarded the scientific degree of Doctor of Philosophy in specialty 201 – «Agronomy».

**Official Reviewer:**

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