STUDY ON THE MANAGEMENT OF ORGANIC NUTRIENTS AT THE FARM LEVEL IN THE DEVELOPMENT MACRO REGIONS 1 AND 2 IN ROMANIA

Gheorghe MATEI[1], Nicoleta Olimpia VRÎNCEANU[2], Lorena Diana POPA[3], Simona Florina ISTICIOAIA[3], Valentin Nicolae VLĂDUȚ[4], Mihai Ștefan Boboc[1]

[1]University of Craiova, 19 Libertății street, Craiova, Romania;
matei.gheorghe@gmail.com
[2]National Research-Development Institute for Pedology, Agrochemistry and Environmental Protection (INCDPAPM-ICPA Bucharest), 61 Blv. Mărăști, Bucharest, Romania;
nicvrinceanu@yahoo.com
[3]ARDS Secuieni Neamt, 377 Principal Street, Secuieni, Neamt, Romania;
dy.hemp420@gmail.com; simonapochi@yahoo.com
[4]INMA Bucharest, 6 Ion Ionescu de la Brad Blvd, Bucharest, Romania;
valentin_vladut@yahoo.com

Corresponding author email:matei.gheorghe@gmail.com

Abstract

The management of organic nutrients at farm level is essential for agricultural sustainability and environmental protection, with the main objective of efficiently using the farm's own resources (manure, plant residues etc.) and reducing pollution (especially with nitrates). An efficient management requires an integrated vision at farm level, treating animal manure and plant residues not as garbage but as valuable resources for soil fertility.

Maximizing the use of nutrients from animal manure and plant residues on the farm (part of the plant-animal cycle) must be achieved in accordance with regulations regarding compliance with legal norms, in particular those of the Nitrates Directive, which impose restrictions on the quantity (max. 170 kg/ha/year organic fertilizers), but also those regarding the period of their application, namely the prohibition of the application of organic fertilizers during periods of vegetative dormancy or when the risk of runoff/leakage is high (for example - on frozen, flooded or snow-covered soil).

The study conducted in the development macro regions 1 and 2 was based on the method of questionnaires addressed directly to farmers in the mentioned area who use organic fertilizers (manure, plant residues or sewage sludge) on their farms. From the total number of respondents, 50% mentioned the use of this practice on a regular basis, and 66.7% stated that they have been using this practice for over 10 years, having as their source of manure exclusively their own farm. Another aspect highlighted by the research was that relating to the average amount of organic fertilizer applied per unit area, a dose that ranged between 10 t/ha and 20 t/ha of fermented or semi-fermented manure together with the plant residues of the crops established on the farm.

Key words*:*manure management, organic fertilizers, agricultural practices, macro regions

INTRODUCTION

According to the National Centre of Organic and Natural Farming, the management of organic nutrients at the farm level is a holistic approach focused on building soil health rather than just "feeding the plant." Unlike conventional farming, which relies on soluble synthetic fertilizers, organic management depends on the biological breakdown of organic matter to release nutrients over time.

Managing nutrients starts with diversifying the inputs to ensure a balanced supply of Nitrogen (N), Phosphorus (P), and Potassium (K). As main sources of organic matter for soil are used:

- *animal manures* - a "complete" nutrient source but highly variable. Fresh

manure has high available N but can burn crops while aged or composted manure is more stable;

- *compost* - acts primarily as a soil conditioner. It provides low amounts of immediate nutrients but builds long-term Soil Organic Matter – SOM (Muhammad Waqas et al., 2023);
- *green manures & cover crops* - legumes (like clover or vetch) "fix" atmospheric nitrogen into the soil, while non-legumes (like rye) "mop up" leftover nutrients to prevent leaching;
- *approved amendments* - for specific deficiencies, farmers use rock phosphate (P), greensand (K), bone meal, or bio-fertilizers (Utah Vegetable Production GuideExtension).

The organic fertilizers, especially manure, due to the content of organic and chemical constituents, has an energetic role in soils, reducing and equalizing entropy, which provides them with sustainable effects in the evolution of soil fertilization.

In organic farming, animal manures and plant residues are the "biological engines" of soil fertility. Unlike synthetic fertilizers, which provide immediate mineral salts, these organic sources must be processed by soil microbes before crops can use them Also has a positively influences some physico-chemical and microbiological characteristics of soils, essential to their fertility - cationic exchange capacity, buffering capacity, reaction regime and nutrient elements. It activates microbiological life and gives it a high biological and biochemical level, specific to fertile soils (Whalen, J.K., 2000).

EU agricultural policy covers a wide range of areas, including food quality, traceability, trade and promotion of EU farm products (Paraschivu M. et al., 2023). The EU financially supports its farmers and encourages sustainable and eco-friendly practices, while also investing in the development of rural areas (Matei Gh. et al., 2022; Matei Gh. Et al., 2024).

Due to the increase in the consumption of meat and meat-based products, as well as the increase in the export of meat and dairy products, a sharp increase in the amount of manure generated in intensive agricultural systems was noted. Thus, in Europe, in 2018, 80% of the amount total garbage was produced in about 4% of agricultural farms (Amann et al., 2018).

The composition of manure (table 1) is different depending on the species of animal, breed, feeding method, feed quality, breeding system, etc. Thus, Velthof et al. (2015) noted that poultry litter has the highest N and P contents (estimated 34 grams N/kg litter and 9 grams/kg litter), while in pig sludge suspension, due to the low content of dry matter, the concentrations of nutrients are lower (2 grams nitrogen (N) respectively 0.3 grams phosphorus (P) per kilogram of litter).

Table 1 – Manure classified content in NPK related the species

Animal Source	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
Poultry (Broiler)	Very High	Very High	High
Swine (Slurry)	High	Medium	Medium
Dairy Cattle	Medium	Medium	High
Beef Cattle	Medium	Medium	Medium

However, a pig will excrete 8 to 20 kg of nitrogen (N) during a year and a chicken less than 1 kg nitrogen (N).

The physico-chemical properties of manure justify its wide use as a soil conditioner and organic fertilizer (Liang et al., 2014), improving the physical and chemical properties of soil (Kheyrodin and Antoun, 2011; Rayne and Aula, 2020). Because it can slow down the rate of

decrease pH value in soil due to its high buffering capacity (Cai et al., 2015) and/or contribute to the decrease of aluminium toxicity (de la Luz Mora et al., 2017).

MATERIALS AND METHODS

In order to collect data about the way as manure is usedat farms level in the development of macro regions 1 and 2 we start to develop a set of questions in a questionnaire to answer the issues proposed in the study regarding the monitoring and evaluation of agricultural practices at the farm level regarding nutrient management. The structure of the questionnaire included 4 parts:

• *the first part* concerned the identification elements of the farm and its legal representative;

• *the second part* included a set of questions that included questions about the farm's economic activity, emphasizing the perspective of the legal representative in relation to a series of agricultural indicators and practices:

• *the third part* included a set of questions that referred to the quality, fertilization and exploitation of the soils within the farm;

• *the last part* concerned information on the livestock sector - where it existed - with an emphasis on the use of manure, compost and digestate to maintain and restore soil health in terms of improving environmental sustainability.

Different types of questionnaires are used to analyse and collect different information, depending on the nature of the information to be collected (Constantin M. et al., 2007)

The questionnaire must comply with certain rules regarding its size and structure, as well as the way of formulating the questions (Pânzaru R. L. et al., 2007: Pânzaru R. L., 2019).

Evaluation of the data collected in the questionnaires made available through the application used in the survey carried out at the level of the 2 development macro regions (1 and 2) - Google forms (https://www.google.com/intl/ro/forms/about/) was made following the synthesis and graphic expression related to each question in the questionnaire.

RESULTS AND DISCUSSIONS

European Union is a large producer of a significant amount of organic manure or waste: more than 1.4 billion tonnes of manure from farmed animals were produced annually in the period of 2016 – 2019 in the EU27 and the UK (Eurostat, 2019).

At world level,in period of 2018-2023, (figure 1) from the total amount of manure applied to soil, the most used was provided by chickens (15,6%), followed by swine (14,5%), cattle non-dairy and cattle dairy, both with 13,7% and chicken broilers with 9,3%.

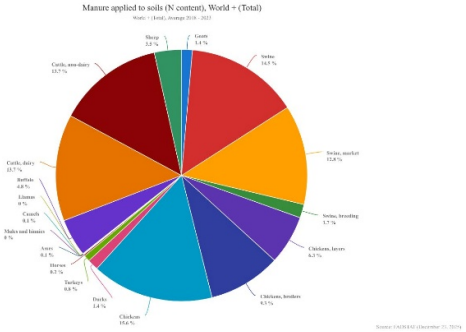

Figure 1. Manure applied to soil (N content) at world level, by species, in the period 2018-2023

From the top 10 of the countries that used large amount of manure applied to soil (N content - cattle non-dairy – average 2018 - 2023) we highlight the follow: China (mainland) with over 600 M kg manure, India and United States of America with over 400 M kg manure. At the opposite side is Ireland, with a small quantity over 100 M kg manure (figure 2).

According to Eurostat, the use of different types of manure storage facility on farms

varied considerably among EU countries. Nevertheless, storage facilities for solid dung were the most common form of storage in almost all EU countries in 2020. The exceptions were in Ireland (just 36% compared to 47% for covered liquid manure facilities) and the Netherlands (30% for both solid dung and covered liquid manure facilities). Indeed, storage facilities for solid dung represented above 60% of all types of farm storage facility in 13 EU countries: there were shares above 90% in Cyprus, Bulgaria, and Greece.

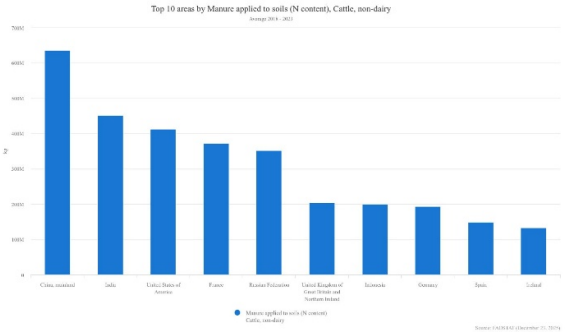

Figure 2. Top 10 areas by manure applied to soil (N content), Cattle non-dairy, in the period 2018-2023

The situation in Romania (figure 3), for the same period, show us that the use of cattle dairy manure has serious decreased, from 46 t/ha in 2018 to almost 42 t/ha in 2023 (figure 3).

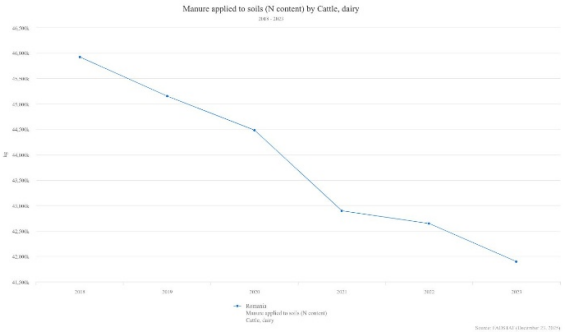

Figure 3. Romania: manure applied to soil (N content), Cattle dairy, in the period 2018-2023

Related to the species, the situation in Romania is presented in the figure 4. The highest percent of manure applied to soil (N content) provide from sheep (17,9%). Close to this value is situated cattle dairy, with a contribution of 17,8%, followed by chicken (13,6%) and cattle non-dairy (9,6%).

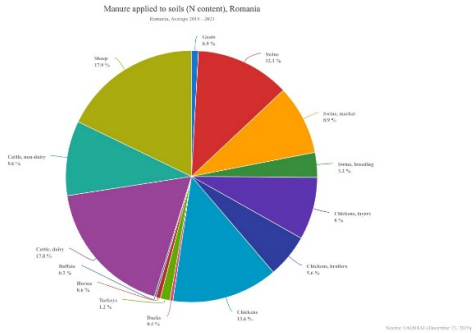

Figure 4. Manure applied to soil (N content) in Romania, by species, in the period 2018-2023

From the total number of responses regarding **the organisational form of the farm**, 58.8% stated that they manage individual (family) farms, 20.4% were agricultural companies, and 5.9% were research and development stations. In this study, we did not receive any responses indicating non-profit companies in the two development areas studied (fig. 5).

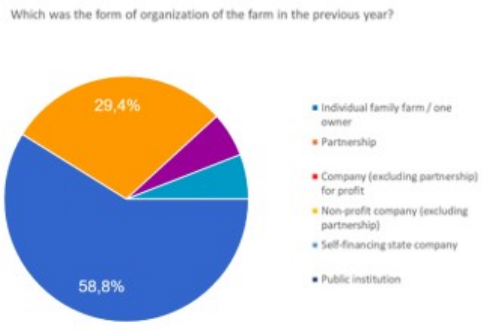

Figure 5. Graphical quantification of responses relating to form of farm organization

Regarding **the main area of activity of the farm**, Figure 6 shows that over 76.5% of farms have the cultivation of field crops (cereals, legumes, etc.) as their main objective, followed by farms with livestock farming and those with a mixed character (crop and animal production).

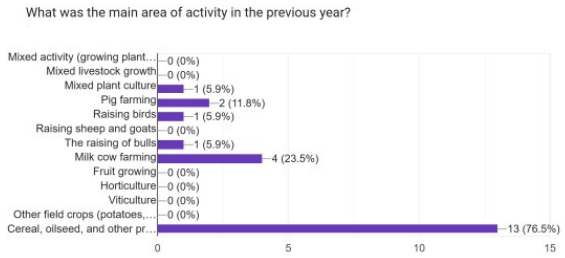

Figure 6. Graphical quantification of responses relating to the main area of activity on the farm

Regarding **the quality, management of fertilisers**, and the way soils are exploited within the farm, questions were formulated that led to responses with a wide range of variation on the evaluation scale. Thus, concerning the respondents' assessment of the quality of the farm's soils, we observe that 64.7% assessed their quality as very good, while, at the opposite end of the spectrum, only 5.9% of the interviewees considered the soils on the farm to be of poor quality (figure7).

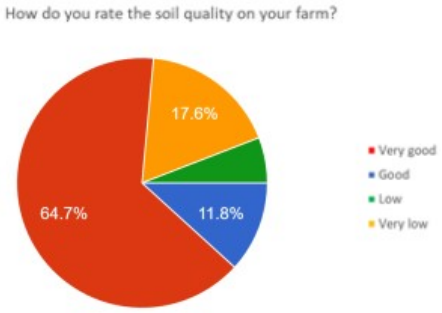

Figure 7. Graphical quantification of responses relating to the assessment of soil quality from farm

The application of a **nutrient management system at the farm level** is a characteristic of companies that manage their use responsibly, both for synthetic and organic nutrients. The stated intentions of the respondents regarding this aspect (figure8) show that the adoption of such a practice is perceived by farmers primarily from an economic point of view (47.1%) and subsequently with reference to the rational use of inputs (29.4%).

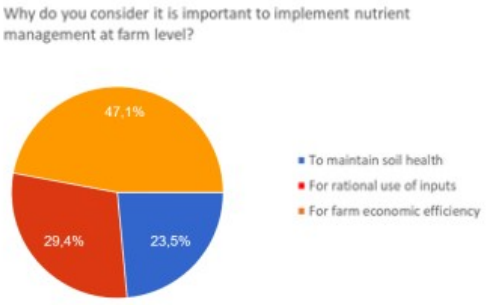

Figure 8. Graphical quantification of responses on the intention of the importance of implementing a nutrient management system at farm level

Regarding the **implementation of such a nutrient management system**, 64,7% of respondents have already carried out an initial form of monitoring of how these resources are managed at the farm level (figure 9).

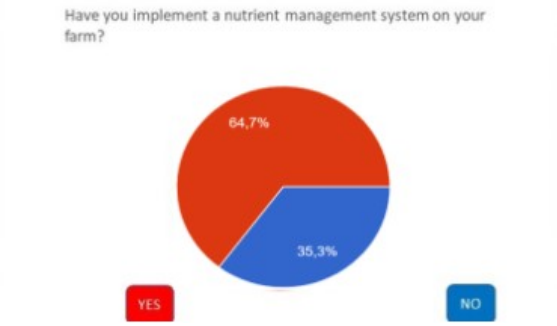

Figure 9. Graphical quantification of responses on the implementation of a nutrient management system at farm level

Agricultural practices that can correctly manage the level of adequate soil use within vegetable or mixed farms in development macro regions 1 and 2 are

diverse, and nutrient management, by the nature of the system, the time of application and the type of intervention can ensure optimal exploitation or they can negatively influence the evolution of the state of natural fertility or other agro-productive characteristics of them.

Regarding the **manure used as organic fertiliser in large or mixed crop farms**, ICPA Bucharest recommends, within the Code of Good Agricultural Practices, the application as early as possible, during the crop growth period, in order to maximise the uptake of crop nutrients and minimise the risk of pollution; every year, at least half of the amount of litter produced during the winter must be spread by July 1, and the rest by September 30.

The respondents to this question mentioned in proportion of 50% that they frequently apply manure within the plant cultivation technologies (figure 10).

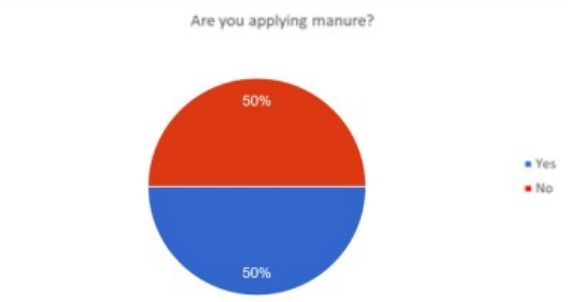

Figure 10. Graphical quantification of responses on application of organic fertilizers (manure)

Almost 67% of the respondents stated they frequently use farmyard manure in their crop cultivation methods and have maintained this practice for a period of between 5 and 10 years (figure 11).

Regarding the **origin of the manure applied** per hectare of land used (figure 12), it had as its source the farm itself for 100% of respondents.

The average amount of manure applied by farmers varied from 10 t/ha to over 20 t/ha equally in the responses generated by farmers.

Regarding the **intention expressed by respondents concerning the retention or modification of this practice in the following years**, it is evident from figure 13 that the majority's tendency is to keep this practice unchanged (66.7%), and only 33.3% mention that they will no longer use it.

Figure 11. Graphical quantification of responses related to period of application of organic fertilizers (manure)

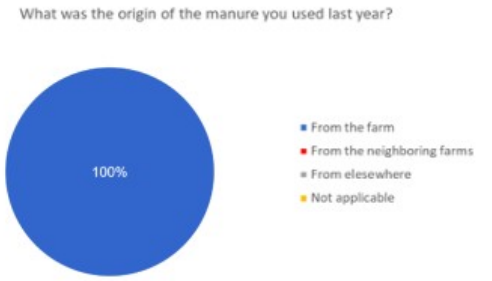

Figure 12. Graphical quantification of responses on the source of organic fertilizers (manure)

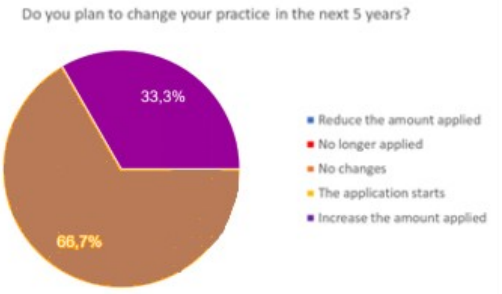

Figure 13. Graphical quantification of responses on intention to change this practice

CONCLUSIONS

Applying manure on the farm offers a "triple-win" benefit: it improves the physical structure of the soil, boosts biological activity, and provides a cost-effective source of nutrients. Unlike synthetic fertilizers, which primarily feed the plant, manure acts as a "soil builder."

Manure is rich in organic matter, which acts like a "glue" for soil particles. Also, the use of manure it increases the soil's ability to hold water, acting like a sponge. This is critical during dry spells or in sandy soils where water drains too quickly. By creating stable soil aggregates, manure reduces the risk of topsoil being washed away by rain or blown away by wind. Large quantity of manure applied to soil it makes the soil looser and easier for roots to penetrate and for air to reach those roots.

This practice allows for the recycling of nutrients. Animals eat the crops, excrete the waste, and the waste goes back to feed the next generation of crops.Regular application of manure increases Soil Organic Carbon (SOC), helping to pull carbon out of the atmosphere and store it in the ground.

The soil exploitation policies in environmentally friendly conditions promoted by the European Union over time have had quantifiable results in the level of use of organic fertilizers at the global level, where on the continent of Europe the highest percentage of manure application is used, of over 41% on farm surfaces.

Unfortunately, in Romania, due to the decrease in livestock, especially cattle, the amount of manure used as direct fertilizer in agriculture tends to decrease at level of under 200 M kg manure.

Romanian farms from macro regions 1 and 2 are most organized family business or belongs to private owners. From those, over 76.5% of farms have the cultivation of field crops (cereals, legumes, etc.) followed by farms with cattle dairy sector, of 23,5%.

A gratifying aspect found in the farmers' responses is that there is a system at farm level regarding the implementation of a nutrient management, 64,7% of respondents have already carried out an initial form of monitoring of how these resources are managed at the farm level. Even more, the origin of the manure is their own farm, that shows the importance which subscribes give to the new Sustainable and Inclusive Growth Strategy to stimulate the economy, improve health and quality of life, take care of nature, while responding to the EU 2030 Biodiversity Strategy (with reference to the Management of genetic resources (animals, plants) in order to maintaining biodiversity) and the Climate Target Plan (EU 2030).

ACKNOWLEDGEMENTS

This research work was carried out with the support of Ministry of Agriculture and Rural Development, financed from Project ADER 18.1.1. – Program 2023 – 2026.

REFERENCES

Amann, M., Anderl, M., Borken-Kleefeld, J., Cofala, J., Heyes, C., H¨oglund Isaksson, L.,Kiesewetter, G., Klimont, Z., Moosmann, L., Rafaj, P., 2018. Progress Towards the Achievement of the EU's Air Quality and Emissions Objectives. IIASA, Laxenburg, Austria.

Cai, Z., Wang, B., Xu, M., Zhang, H., He, X., Zhang, L., Gao, S., 2015. Intensified soil acidification from chemical N fertilization and prevention by manure in an 18-year

field experiment in the red soil of southern China. J. Soils Sediments 15, 260–270.

De la Luz Mora, M., Demanet, R., Acu˜na, J.J., Viscardi, S., Jorquera, M., Rengel, Z., Dur´an, P., 2017. Aluminum-tolerant bacteria improve the plant growth and phosphorus content in ryegrass grown in a volcanic soil amended with cattle dung manure. Appl. Soil Ecol. 115, 19–26.

Kheyrodin, H., Antoun, H., 2011. Tillage and manure effect on soil physical and chemical properties and on carbon and nitrogen mineralization potentials. Afr. J. Biotechnol. 10, 9824–9830

Liang, Q., Chen, H., Gong, Y., Yang, H., Fan, M., Kuzyakov, Y., 2014. Effects of 15 years of manure and mineral fertilisers on enzyme activities in particle-size fractions in a North China Plain soil. Eur. J. Soil Biol. 60, 112–119

Matei Gheorghe, Dragoș Ionuț Popescu, Radu Lucian Pânzaru, Mirela Paraschivu, Valentin Vladuț, Lorena Diana Popa – 2022. Compensatory payments granted by measure 11 - organic agriculture in Vâlcea county (2015-2020). Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 22, Issue 1, p. 407-412.

Matei Gheorghe, Nicoleta Olimpia VRÎNCEANU, Lorena Diana POPA, Simona Florina ISTICIOAIA, Valentin Nicolae VLĂDUȚ, Mădălina PLEȘOIANU, Iustin Mihai IACOB – 2024. Study on the management of organic nutrients at the farm level in the development macro regions 3 and 4 in Romania. Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series.Vol. 54/1/2024.

Paraschivu Mirela, Elena Partal, Călin Sălceanu – 2023. Assessment of the application effects of the derogationcoveringGAEC 7 and 8 standards on agricultural and environmental condition, food security, environmental preservation and climate change. Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series Vol. 53 (2)/2023, p. 139-143.

Rayne, N., Aula, L., 2020. Livestock manure and the impacts on soil health: a review. Soil Systems 4, 64.

Sălceanu, C., Paraschivu, M., Cotuna, O., Sărățeanu, V., Prioteasa, M.A., FLONDOR, I.S. – 2022. Global pesticide market: size, trends, forecasts. Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series Vol. 52 (2)/2022, p. 146-157.

Velthof, G.L., Hou, Y., Oenema, O., 2015. Nitrogen excretion factors of livestock in the European Union: a review: Nitrogen excretion factors of livestock in EU. Journal of the Science of Food and Agriculture 95, 3004–3014.

Waqas, M., Hashim, S., Humphries, U. W., Ahmad, S., Noor, R., Shoaib, M., Naseem, A., Hlaing, P. T., & Lin, H. A. (2023). Composting Processes for Agricultural Waste Management: A Comprehensive Review. *Processes*, *11*(3), 731. https://doi.org/10.3390/pr11030731

Whalen, J.K., Chang, C., Clayton, G.W., Carefoot, J.P., 2000. Cattle manure amendments can increase the pH of acid soils. Soil Sci. Soc. Am. J. 64, 962–966.

*** Utah Vegetable Production GuideExtension (acc. 2025);

***https://nconf.dac.gov.in/NutrientManagement.