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Green Resilient Agricultural Productive Ecosystems

Vermiwash
A low cost and ecofriendly liquid fertilizer

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Background

The haphazard use of chemical fertilizers in Nepalese farming practice poses a significant threat to both crop production and the environment. While these fertilizers are often seen as a quick fix for the challenges in farming, they can have detrimental effects on soil health, water quality, and the well-being of farmers, leading to long-term impacts on the ecosystem and human health.

In this context, vermiwash emerges as a promising solution, offering a cost-effective and organic alternative. Functioning as a sustainable and environmentally friendly substitute for chemical inputs, vermiwash has demonstrated efficacy in enhancing soil health, promoting plant growth, and increasing crop yields (Gudeta et al., 2021). The adoption of vermiwash stands to mitigate the environmental impact, simultaneously enhancing the livelihoods of farmers.

What is Vermiwash?

Vermiwash, a liquid byproduct of vermicomposting, is derived from the interaction of water with a mixture of earthworms and organic waste. These earthworms play a crucial role in transforming organic waste into a nutrient-rich manure known as vermicompost. The liquid extract obtained from this process is termed vermiwash, which serves as an effective organic liquid fertilizer.

The liquid that seeps through the vermicompost contains water-soluble nutrients, enzymes, and other beneficial microorganisms that are derived from the decomposition of organic matter by the worms. vermiwash is rich in essential plant nutrients such as nitrogen, phosphorus, potassium, and micronutrients. It also contains growth-promoting substances and beneficial microorganisms that can enhance soil fertility and plant health (Zambare et al., 2008; Gosh et al., 2018; Gudeta et al., 2021).

Process of making vermiwash

In preparing vermiwash, we can use either single filtration in one container or double filtration with an additional bucket. This flyer focuses on the double filtration system which produces a vermiwash in its purest form making it ideal for experiments and nutrient measurements. However, as both methods are effective, farmers can choose between single or double filtration based on their preference and needs.

Different types of vermiwash demonstrated at community learning centers *(Photo: Hem GC)*

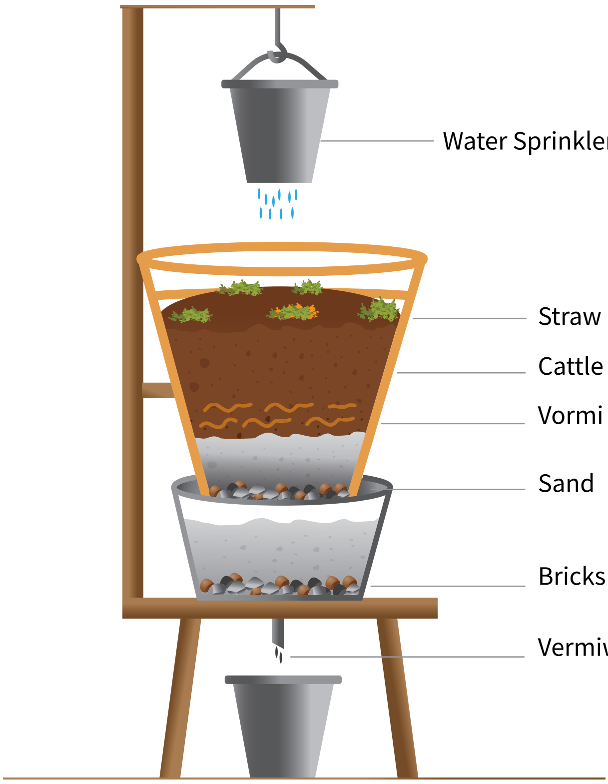
Materials required

- To prepare vermiwash through double filtration system, the following is required
- Main container with a capacity of approximately 35 Litres (e.g., a plastic bucket, Doko , concrete tank, or any other suitable vessel)
- Additional container such as a plastic bucket with a capacity of 10 Litres (for additional filtration)
- Broken pieces of bricks
- Stone pebbles
- Sand
- Coal
- Two-week-old cattle dung
- Organic waste
- Earthworms (e.g., Eisenia fetida or Eudrilus eugeniae)

The step-by-step procedure

- Frist drill a hole at the bottom of the bucket, Doko or any other locally available vessel. If you are using a Doko, cover it from the inside with a cotton cloth to seal the holes.
- Then fill the bottom of the container with a 2-inch-thick layer of broken brick pieces followed by 2-inches of stone and 2-inches of coal. Finally, pour a 2-3-inch-thick layer of sand. This will provide filtration for the vermiwash.
- To add double filtration, you'll need to prepare a second container. Drill a hole at the bottom edge of this container to create an outlet for the vermiwash to drain out.
- Fill the bottom of the container in same way as the main container. This will create a double filtration system for vermiwash. Place the second container under the main, ensuring they are tightly placed together.
- Following this, introduce about 1 kg of earthworms along with vermicompost into the main container. You can use any species of earthworms that are suitable for vermicomposting, such as Eisenia fetida or Eudrilus eugeniae.
- Add about 30 kgs of two-week old cow dung on top of the earthworm and vermicompost. This will provide food for the earthworms.
- Add about 2 kgs of organic waste on top of the layer of cow dung. This can be any biodegradable material such as kitchen scraps, garden waste, or agricultural residue. Make sure to chop or shred them into small pieces to facilitate earthworm feeding.
- Sprinkle/pour some water over the organic waste to moisten it. The moisture content should be around 60%. Farmers can assess the moisture content in biomass through visual inspection, touch and feel, weight change methods, use of moisture meters, and the squeeze test. Visual cues such as watery appearance and excessive liquid can indicate higher moisture levels. The touch and feel method involve assessing the consistency, while the weight change method measures moisture by weighing the fresh weight and dry weight of the sample. Portable moisture meters offer direct readings, and the squeeze test involves observing water dripping when squeezing the biomass. Investing in a moisture

FIGURE 1: Diagrammatic representation of a vermiwash (double filtration)



meter designed for liquids can provide more accurate and consistent results and maintaining records of ingredient quantities during preparation aids in controlling moisture effectively.

- Cover the container with a lid or a mesh to prevent flies and other pests from entering.
- The earthworms will start feeding on the organic waste and produce vermicast, which is their excreta. The vermicast contains nutrients and microorganisms that are beneficial for plants. The water that passes through the vermicast is vermiwash.
- After 7-10 days, the vermiwash starts to drain from the tap at the bottom of the container. With this system, about 20-30 litres of vermiwash can be collected every 15 days. The vermiwash can be stored in bottles or cans secured tightly with a lid for later use.
- The organic waste and/or cow dung needs to be replaced after 35-40 days while keeping the other materials as they are. By this time, earthworm converts organic waste into vermicompost, and fresh feed for earthworm is required.

Application of Vermiwash

Dilution and Frequency

To use Vermiwash as a liquid fertilizer, it can be applied after dilution with water at a ratio of 1:5 to 1:10. Young or sensitive plants require a more diluted solution (1:10) to avoid nutrient burn or shock, while mature or larger plants may benefit from a slightly concentrated solution (1:5) to meet their nutrient needs. Moreover, for foliar spray or general soil drenching/application, a 1:10 dilution is often recommended. However, for plants that require more nutrients or have shown nutrient deficiency symptoms, a 1:5 dilution is recommended to use on the leaves or roots of the plants once or twice a week.

Method of Application

Vermiwash can be applied to plants using a watering can, spray bottle, or drip irrigation system. As liquid fertilizer, vermiwash can be applied during the planting phase, it is particularly beneficial for providing an initial nutrient boost to support the early development of plants. This helps establish a solid foundation for healthy growth.

As plants progress through the early growing stage, applying vermiwash becomes instrumental in promoting root establishment. The nutrient content aids in the development of robust root systems, contributing to overall plant vigor.

For consistent nutrient supply throughout the growing season, regular application of vermiwash every 2-4 weeks is recommended. This ensures a steady infusion of essential nutrients, maintaining the plant's health and productivity.

As a foliar spray, it is best applied when plants require additional supplementary nutrients. This need becomes evident through various signs such as slow growth, yellowing of leaves (chlorosis), stunted growth, and drooping or wilting, even when adequately watered. Additionally, plants may exhibit increased susceptibility to pests and diseases, along with poor flowering or fruit production. The overall health of the foliage might suffer, displaying general yellowing or browning. Soil depletion is also a concern, particularly when there's continuous cultivation of crops without adequate nutrient replenishment.

Recommended Crops

Vermiwash is versatile and beneficial for various crops, including cauliflower, bitter gourd, tomatoes, peppers, cucumbers, squash, melons, leafy greens, and herbs. Its broad application spectrum makes it an asset in promoting the growth and productivity of diverse plants.

TABLE 1: Cost estimation for making vermiwash

Materials	Unit	Cost NPR
Plastic Dustbin(5L)	2	240
Doko (Bamboo Dustbin)	1	600
Earthworm	1 kg	2200
Chair	1	500
Funnel	1	120
Cotton rope	10 m	10
Bamboo (7 feet)	4	400
Total		**4070**

Yield comparison in Vermiwash

In 2023, the Green Resilient Agricultural Productive Ecosystem (GRAPE) Project (jointly implemented by LI-BIRD, CEAPRED, and ICIMOD) conducted an on-farm research trial in Surkhet district, Nepal, to study the efficacy of vermiwash as liquid fertilizer in cauliflower. The study involved comparing vermiwash with concentrations of 10%, 20%, and 30% mixed with water against a control treatment, which represented the farmers conventional practice (without vermiwash).

FIGURE 2: Yield comparison of cabbage under different composition of Vermiwash

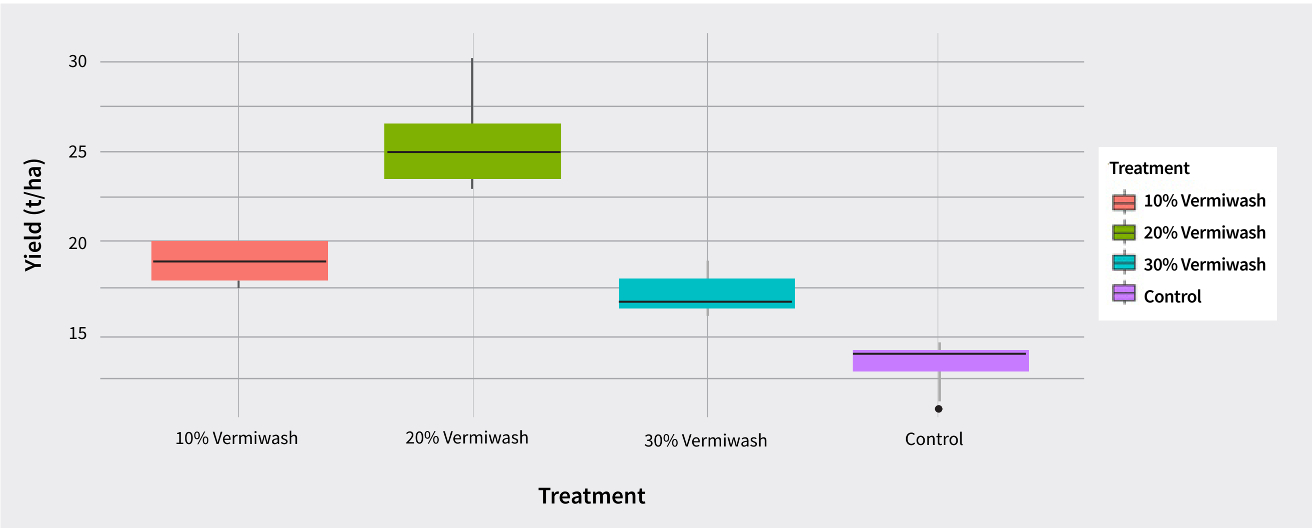


TABLE 2: Nutrient composition of vermiwash

Nutrient	Methods	Concentration
Nitrogen (N)	Wet Digestion (Kjeldahl Method)	<0.04
Phosphorus (P)	Wet Digestion (Vanadomolybdate)	0.01-0.04
Potassium (K)	Wet Digestion (Flame Photometry)	0.25-0.33%
Calcium (Ca)	Acid Digestion and EDTA titration	0.03-0.06%
Magnesium (Mg)	Acid Digestion and EDTA titration	0.02-0.5%
Iron (Fe)	Acid digestion and AAS	6-12 ppm
Manganese (Mn)	Acid digestion and AAS	5-10 ppm
Zinc (Zn)	Acid digestion and AAS	0.82-0.84 ppm
Copper (Cu)	Acid digestion and AAS	0.5-0.6 ppm

Under the treatments, the vermiwash was applied at 10 days interval making a total of 6 applications per treatment. The study showed a significant increase in crop yield under the treatment as compared to the controlled condition. Among the treatments, results showed that the crops cultivated under 20% concentration of vermiwash showed better yield compared to other concentrations. Vermiwash helped the plants grow faster, healthier, and become more resistant to pests and diseases. This could be due to the nutrient and microorganisms present in the vermiwash (Patnaik, et al., 2022, Nayak, et al., 2019).

Nutrient composition of vermiwash

A laboratory analysis was conducted on vermiwash, which was prepared in a farmer's field using cattle dung, leftover fodder, and vermicompost as feed. The nutritional composition is presented in Table 2. The vermiwash sample, which was one week old, was analyzed for various nutrients using different methods:

These methods provide accurate nutrient analysis and are widely used in agricultural and environmental studies. It's important to note that the nutrient composition of vermiwash can vary depending on the type of organic matter used to feed the earthworms, the conditions of the vermiculture system, and the duration of vermiwash fermentation (Manyuchi et al., 2013; Nayak et al., 2019; Gudeta et al., 2021).

Microorganism present in vermiwash

Different studies report that vermiwash is also rich in microorganism content. Described below are the various microorganisms present in vermiwash.

- **Aerobic bacteria**: Predominantly composed of Bacillus, Pseudomonas, and Enterobacter species, aerobic bacteria are the most prevalent microorganisms in vermiwash. Their primary role is to decompose organic matter, thereby facilitating the release of nutrients into the vermiwash (Tripathi et al., 2005). In addition, this bacteria plays a crucial role in suppressing pathogens. The mechanism of pathogen suppression involves competition for resources, production of antimicrobial substances, and induction of systemic resistance in plants. This dual functionality not only contributes to nutrient cycling but also enhances the health and resilience of the ecosystem (Simsek-Ersahin, 2010).
- **Anaerobic bacteria**: Anaerobic bacteria is also found in vermiwash, but in lower numbers than aerobic bacteria. They include species of Clostridium, Bacteroides, and Fusobacterium. These are responsible for breaking down complex organic matter that aerobic bacteria cannot break down (Singh et al., 2015). In addition to this, anaerobic bacteria play a significant role in disease suppression. They contribute to the creation of a disease-resistant environment in several ways. Firstly, they compete with pathogens for resources, thereby limiting the growth and spread of disease-causing organisms. Secondly, they produce certain bioactive compounds that have antimicrobial properties, which can directly inhibit the growth of pathogens. Lastly, they can induce systemic resistance in plants, enhancing their ability to fend off diseases (Gudeta et al., 2021).
- **Actinomycetes**: Actinomycetes are a type of bacteria that produce a sticky substance called glomalin. Glomalin is a key component of soil health that helps improve the water retention capacity of soil. Actinomycetes are also found in Vermiwash, and they contribute to the nutrient content of the Vermiwash. Moreover, it also acts as pathogen suppression (Das et al., 2014; Tripathi et al., 2005; Balachandar et al., 2018a, b).
- **Fungal spores**: Fungal spores are also found in Vermiwash. These spores can germinate and grow in the soil, providing plants with additional nutrients (Singh et al., 2015).

Chandra Bahadur GC harvesting Vermiwash *(Photo: Hem GC)*

Adoption of Vermiwash

The adoption of vermiwash as a sustainable and environmentally friendly alternative to chemical fertilizers has gained significant traction among farmers in Karnali and Sudurpaschim provinces of Nepal. This organic fertilizer has proven to be a cost-effective and efficient solution improving soil health, increasing crop yields, and reducing the environmental impact. One notable example is the story of Dalli Bohara, a 35-year-old farmer from a remote village of Bajura district, who successfully transformed her farming practices using vermiwash. Despite the additional work required to prepare vermiwash, Gita embraced this innovative approach. She found that it not only saved money on inputs but also eliminated the need for chemical fertilizers, improving the health and quality of her crops. Her story demonstrates that vermiwash has the potential to enhance agricultural productivity and promote sustainable farming practices in Nepal. Its widespread adoption can contribute to improved livelihoods, food security, and environmental conservation.

> "Even though preparing vermiwash involves more work, the money I save on chemical fertilizers and pesticides makes it completely worthwhile."
>
> - Dalli Bohara, Farmer from Bajura

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