ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2521-0858 (Print)
ISSN: 2521-0866 (Online)
CODEN: SHJCAS

Science Heritage Journal (GWS)

DOI: http://doi.org/10.26480/gws.02.2023.91.103

CrossMark

RESEARCH ARTICLE

ORGANIC FARMING: A RELIABLE STRATEGY FOR SUSTAINABLE AGRICULTURE IN NEPAL

Sushmita Tiwari*, Shreya Rai, Jasmin Adhikari, Samarth Bista

College of Natural Resource Management, Pakhribas, Dhankuta,
Nepal Agriculture and Forestry University
****Corresponding Author Email: tiwari.sushmita321@gmail.com***

ARTICLE DETAILS

Article History:

Received 07 November 2023
Revised 10 December 2023
Accepted 13 January 2024
Available online 18 January 2024

ABSTRACT

Agriculture and agricultural practices should be the wisest pursuits as they contribute to the well-being of Mother Earth. Organic farming is a system of farming that is guided by principles designed to promote environmental conservation, biodiversity, soil health, and the overall well-being of the ecosystem. This comprehensive review delves into the efficacy of organic farming as a dependable strategy for achieving sustainable agriculture in Nepal. Against the backdrop of Nepal's diverse agroecological zones and traditional farming practices, the study meticulously examines the multifaceted advantages, challenges, and implications of adopting organic farming within this unique context. Organic farming, characterized by the exclusion of synthetic chemicals and the emphasis on ecological balance, stands out as a promising approach to address the pressing issues faced by Nepalese agriculture. The review underscores the enhanced soil fertility associated with organic practices, attributing it to the utilization of natural fertilizers such as compost and manure. This sustainable farming method not only fosters soil health but also safeguards vital resources like water and promotes biodiversity by refraining from synthetic pesticides and fertilizers. With the dawn of the 21st century and the exponential rise in the population, food security has become an alarming issue. To access food demand of the growing population the use of chemical fertilizers has been rampant contributing to sustainability issues. As a result, it becomes increasingly important to address how to achieve food security while simultaneously addressing the imbalance in the ecosystem. In this review paper, we have discussed some of the amendments used for the promotion of organic farming such as Jholmol (1,2,3), Biochar, Panchagavya, Jeevamrut, Bijamrita, Vermin-compost, Vermiwash.

KEYWORDS

Biodiversity, Soil health, Vermiwash.

1. INTRODUCTION

According to IFOAM (ifoam organics international), "Organic agriculture is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity, and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and good quality of life for all involved." Growing organically involves considering the soil and surrounding environment as a resource that needs to be preserved for future generations while acknowledging that all living things are interconnected and dependent on one another and that the environment in which plants grow is much more than the sum of its parts (singh, 2021). The emergence of concern towards organic farming is attributed to the response to the damaging effects of chemical pesticides and synthetic fertilizers on the environment. The primary goals of sustainable organic agriculture are to provide for the needs of the present while safeguarding those of future generations, as well as to guarantee the financial stability of farmers and the well-being of the community (Banjara and Poudel, 2017).

To strike a balance between agricultural output and sustainability, a natural approach is essential. Nepal is an agriculture-dominated country where most of the people especially in rural parts are dependent on agriculture for their livelihood. Since food demand was rising, Nepalese farmers started using agrochemicals to improve produce. They did this negligently, not considering the chemicals' detrimental impact on the soil. The purpose of increasing productivity by using chemicals on the other hand, costs the fertility of soil and soil health. The establishment of Teresa's Farm in Bhuwan Basti and Pereira's Farm in Saradanagar of Chitwan district in the early 1990s marked the foundational moments of the organic movement in Nepal, serving as significant landmarks for enthusiasts of organic farming (Nandwani et al., 2021).

To introduce organic and chemical-free farming, it is necessary to develop various composite herbal formulations with bio stimulating properties. It is essential to formulate, standardize and evaluate the various biostimulants, and biopesticides for their safety use and to avoid chemical residues in the soil (Charapale et al., 2022). Nepalese farmer lacks modernized resources for farming which draws their attention toward low-cost organic amendments. In the Nepalese agricultural system, it is a normal occurrence for each farm family to keep a few pairs of goats and chickens, a couple of bullocks, and one or two cows or buffaloes that are linked with crop cultivation and the wastes of farm animals can be effectively used for making organic fertilizers (Pokhrel and Pant, 2009). The practices of making organic fertilizers such as Jholmol(1,2,3), Vermi-wash, Vermi-compost, Panchagavya, Bio-char, Jeevamrut, Beejamrut, etc have not only helped small-scale farmers to increase their crop production

Quick Response Code	Access this article online	
	Website: www.jscienceheritage.com	**DOI:** 10.26480/gws.02.2023.91.103

Cite The Article: Sushmita Tiwari, Shreya Rai, Jasmin Adhikari, Samarth Bista (2023). Organic Farming: A Reliable Strategy for Sustainable Agriculture in Nepal. *Science Heritage Journal, 7(2): 91-103.*

but also has helped to produce safer products for consumption while on the other hand, indigenous knowledge of farmers is conserved.

1.1 JHOLMOL

Jholmol is a homemade bio-pesticide and bio-fertilizer that lowers the cost of production and usage of hazardous pesticides while enhancing crop health and yields. Jholmol is water soluble and has no negative after effect. Jholmol represents an organic fertilizer variant crafted by blending Jeevatu, recognized as Effective Microbes (EM), a native microbial solution in Nepal.

This mixture undergoes fermentation with water, along with the inclusion of cow or buffalo urine, cow dung, and biomass like fallen leaves sourced from the farmland (the better india, 2018). Jholmol is created through the blending and fermentation of regionally accessible materials, including water, animal (cow/buffalo) urine and dung, beneficial microbes, and plant components in a specified proportion. Three distinct types of Jholmal can be produced utilizing these resources. Jholmal-1 supplies crucial nutrients for the growth and advancement of plants, while Jholmal-2 and Jholmal-3 manage insect/pest invasions and safeguard crops from fungal and vector-borne illnesses (Kiran Bhusal and Erica Udas, 2020).

In Nepal, components such as cattle urine, farmyard manure, water, forest dirt, beneficial bacteria, and leaves are fermented to create Jholmal, a locally produced bio-fertilizer and bio-pesticide. It supplies vital nutrients for plant growth, controls insect pests, and shields crops from disease when applied as foliar spray. For smallholder farmers who are also raising cattle, this is a cost-effective alternative. Jholmal, which is widely known for being rich in both macro and micronutrients—particularly in cow urine—is an affordable substitute for plant nourishment and insect control. It also improves soil fertility and air purity (Vista et al., n.d.). By traditions from the locale, CEAPRED, and ICIMOD are undertaking comprehensive studies on Jholmal to enhance its use and develop customized blends and uses for certain crops (*icimodJholmal.Pdf*, n.d.).

1.2 Ingredients

Animal urine is applied as a pesticide as well as a fertilizer. It has nutrients including phosphates, potassium, and nitrogen. Rich in antioxidants, anthelminthic, antibacterial, and both antifungal and antibacterial qualities. Typically, a cow or buffalo excretes 6–9 l of urine and 10-15 kg of manure every day. Typically, dung is used to prepare farmyard manure (fertilizer), however, urine has two possible uses for fertilizer or, when combined with other substances, a pesticide (Bhusal and Erica Udas, 2020). Jeevatu, a blend of beneficial microbes naturally occurring in Nepal, was developed by a team of Nepalese scientists led by Mr. Khadga Bhakta Paudel, the Chief Scientist of the Nepalese Farming Institute. Scientifically proven, Jeevatu effectively addresses various issues related to soil, crops, and medicinal plants across diverse agroecological zones, ranging from 60 meters above sea level to 3,200 meters above. (Poudyal and Poudel, 2013).

Jeevatu has been employed in Nepal and selected regions of India, Bhutan, and Afghanistan for economical organic farming practices. It has received official registration from the Ministry of Agriculture and Livestock Development located in Singh Durbar, Kathmandu, Nepal (Equator Initiative, 2020). Jeevatu expedites the decomposition process and is predominantly made up of beneficial microorganisms, including lactic acid bacteria, Azotobacter species, Trichoderma species, phosphate-solubilizing bacteria, potassium-solubilizing bacteria, photosynthesizing bacteria, and yeast. In the absence of Jeevatu, it can be substituted with alternative effective microorganisms such as actinomycetes and fermenting fungi or locally sourced fresh curd (Poudyal and Poudel, 2013).

Farmyard manure in liquid form provides plants with easily accessible macro- and micronutrients. Local plants possessing bitter, hot, astringent, and pungent tastes or odors

contain attributes that deter or eliminate diverse insects and pests while also acting as a preventive measure against diseases. Extracts from these plants can be utilized in the preparation of insecticides and pesticides (Kiran Bhusal, Erica Udas, 2020). Plants that are available locally and have bitter (taro), sour (amilo), and pungent (piro) taste or smell are used to prepare Jholmol 3 (Ahamad et al., 2020).

Below is a table of such plants available in Nepal.

Nepali name	English name	Scientific name	Plant Parts used
Asuro	Adulasa	Justicia adhatoda	leaves
Aduwa	Ginger	Zingiber officinale	rhizomes
Aaru	Peach	Prunus persica	leaves
Titepati	Mugwort	Artemisia vulgaris	Leaves and stem
Sisnoo	Stinging nettle	Urtica dioica	Leaves and stem
Bakaino	Chinaberry	Melia azedarach	Leaves and fruit
Neem	Neem	Azadirachta indica	Leaves and fruits
Ketuki	Century plant	Agave Americana	Stem and leaves
Banmara	Crofton weed	Ageratina adenophora	Leaves and stem
Banfanda	West Indian Lantana	Lantana camara	Leaves and flowers
Timur	Sichuan pepper	Zanthoxylum simulans	fruit
Bojho	Sweet flag	Acorus calamus	Leaves and rhizome
Lasun	Garlic	Allium sativum	Bulb
Khursani	Chilli	Capsicum annum	Fruit
Mewa	Papaya	Carica papaya	Leaves
Kanike ful	Elderberry	Sambucus javanica	Leaves
Sayapatri	Marigold	Tagetes erecta	Leaves and stem
Pyaj	Onion	Allium cepa	Bulbs
Khirro	Tallow tree	Sapium insigne	Leaves

2. Preparation Methods

The temperature affects how long it takes to prepare jholmal; the warmer the surrounding air, the less time it takes. Jholmal-1 and Jholmal-2 can be used in 15 days (about 2 weeks) at a temperature between 15 and 30 degrees Celsius, whereas Jholmal-3 requires roughly 21 to 30 days (about 4 and a half weeks). Generally, Jholmol-1 requires 15 to 20 days (about 3 weeks) in summer and 25 to 30 days (about 4 and a half weeks) in winter to prepare. The preparation period may increase by 5-7 days at colder temperatures and the quantity of ingredients to be utilized is determined according to the container's capacity (Bhusal and Udas, 2020). \

The preparation of Jholmol (1, 2 and 3) in detail:

1) A blend of farmyard manure (FYM), animal urine, and water is combined in a ratio of 1:1:1, becoming ready for field application within two weeks. This mixture, when mixed with water in a 1:3 ratio, is sprayed at the base of plants. This serves a dual purpose, functioning as both fertilizer and pesticide, effectively controlling soil-borne pests.

2) A combination of animal urine and water is prepared in a 1:1 ratio. After a two-week period, this mixture is diluted with water in a 1:3 ratio and then applied to leaves and stems. The aim is to effectively manage a variety of pests and insects.

3) Plant varieties possessing natural insecticidal properties are combined with animal urine and water in a ratio of 1:5:5. This mixture is prepared within a three-week timeframe, then filtered and further combined in a 1:5 ratio for seedlings and a 1:3 ratio for crops that are one month old.

Benefits of Jholmol (Dolma Diki Sherpa, 2021)

1. Mitigates the harmful effects of chemicals on soil and minimizes the adverse impacts of pesticides on both the environment and human health.

2. Provides a cost-effective alternative by lowering expenses associated with purchasing chemical fertilizers.

3. Demonstrates eco-friendly characteristics.

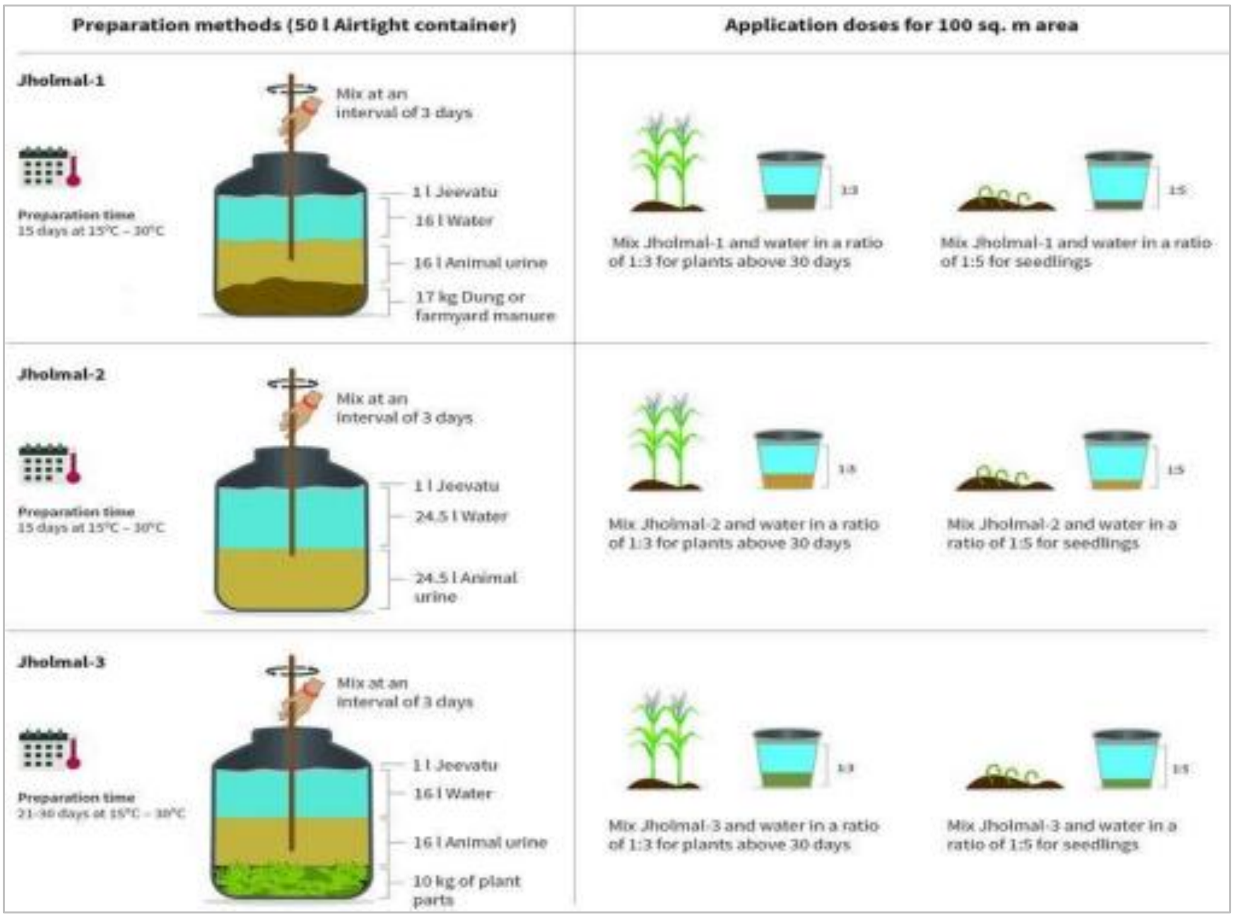

Figure 1: (Bhusal et al., 2022)

Jholmol Uses (Kiran Bhusal, Erica Udas, 2020)

JHOLMAL 1 serves as a biofertilizer, supplying vital macronutrients and micronutrients necessary for the growth and development of plants.

JHOLMAL 2 is primarily employed as a bio-pesticide to manage infestations of insects or pests in crop plants.

JHOLMAL 3 is utilized as a bio-pesticide to regulate infestations of insects or pests in crop plants.

Figure 2: We students from the different agriculture universities across Nepal preparing JHOLMOL at HASERA Agriculture Research and Training Center, Patalekhet during our Student Exchange Program.

3. Biochar

When biomass such as wood, manure, or leaves are burned in a confined container with little or no air circulation, the resultant substance formed is known as biochar, which is high in carbon (Lehmann and Joseph, 2009). A distinctive strategy for generating a substantial, long-term sink for atmospheric carbon dioxide in terrestrial ecosystems is the application of biochar, commonly referred to as charcoal or biomass-derived black carbon (C), to soil (Lehmann et al., 2006). With the increasing concerns of climate change due to the emission of greenhouse gases from different sources, while carbondioxide plays a significant role, carbon sequestration is considered vital for combating climate change issues. Applying biochar to the soil offers a better way to manage agricultural residue in addition to aiding in the sequestration of carbon since it is stable and rich source of carbon (Gupta et al., 2020). The ability of biochar to effectively modify soil is comparable to that of traditional slash-and-burn farming methods. Slash and burn practices, however, harm the environment since they exacerbate erosion and degrade the surrounding air quality. In contrast, a controlled technique of manufacturing biochar will offer a larger yield with fewer negative environmental effects. Because of it's stubborn aromatic carbon structure, which prevents microbial breakdown, biochar can stay in the soil for up to 100–1000 years, steadily accumulating and releasing soil organic carbon. However, because of these qualities, biochar is a great soil supplement that may be applied in sustainable agriculture (Lehmann and Joseph, 2009). Soil application of biochar is being frequently reported as a potential option for climate change mitigation through carbon sequestration and other agricultural and environmental benefits (Gupta et al., 2020). Several studies on recent times have shown that mixing of nutrients with biochar before applying in the fields have significantly increased the yield of crops and this technique is referred as biochar nutrient enrichment. Recently, techniques for biochar nutrient enrichment, i.e. mixing nutrients with biochar before addition to the soil, have resulted in some promising increases in crop yield (Pandit et al., 2017). Biochar amendment is beneficial for agronomical and environmental aspects, in addition to demonstrating a promising improvement in soil physicochemical properties like pH, organic carbon, exchangeable bases (Ca+, Mg+, K+), bulk density, water holding capacity, and available nutrients like total nitrogen (N), phosphorous (P), and potassium (K) (Pandit et al., 2021). Farmers in Nepal can benefit by using biochar as an organic fertilizer in their field which not only increases productivity but also supports the sustainability of the ecosystem.

3.1 Preparation of Biochar

If farmers have the necessary supplies, making biochar is not that difficult. It is not necessarily important to use wood; instead, waste materials that are readily available in the community, like branches, broken twigs, leaves, straws, bran, and other broken materials that are of not much use, can be put to good use. Usually, farmers prepare it in a Kon-Tiki, but if one is not accessible, they can still use an earthen kiln (NARC Nepal, 2017). The temperature and duration of the production process have a major impact on the quality and characteristics of the biochar that is generated. The process of making biochar can be done in various ways. Pyrolysis is the most popular technique for producing biochar out of all of them (Lamichhane et al., n.d.).

3.2 Pyrolysis

The main by-product of pyrolysis is biochar, which is created by heating biomass in anaerobic conditions. It is the most widely applied technique. Two distinct forms of pyrolysis exist slow pyrolysis and quick pyrolysis

• The process of slow pyrolysis involves the breakdown of biomass with a sufficient residence period (>30 min) and a low heating rate (0.1°C0.8°C/s).

• The major products of rapid pyrolysis are syngas (co and H2) and bio-oil, which are produced by heating biomass at a faster rate (1000°C/s) for a residence time of less than two seconds (Lamichhane et al., n.d.).

3.3 Gasification

It is the process in which residual carbon-based raw materials are converted into a controlled supply of oxygen however biochar is the main by-product.

3.4 Torrefaction

At this stage, biomass is transformed at a temperature of 200–300°C without the presence of oxygen to produce torrified materials, bio-oils, charcoal, etc (Pan et al., 2019).

3.5 Flash Carbonization

A method that converts biomass mostly into gaseous and solid products by starting a flash fire under a densely packed bed of biomass and holding it there for less than 30 minutes at higher pressures (1 to 2 MPa) (Lamichhane et al., n.d.).

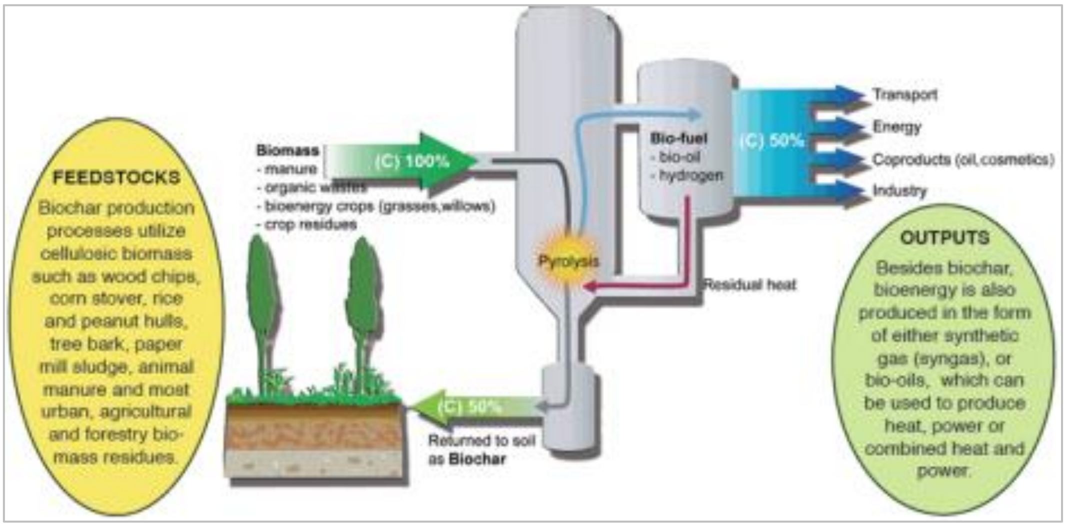

Figure 3: Biochar production diagram courtesy of Johannes Lehmann. (International Biochar Initiatives, 2022)

The making of biochar through traditional method (Heartyculture Nursery, 2021)

Step 1: Cut logs to a height of 3 to 4 feet.

Step 2: Arrange them in the form of a circular pyre.

Step 3: Cover the grass around the pyre.

Step 4: Mix red soil with water and apply it around the pile in a thick paste.
Step 5: Make holes in the bottom around the pyre.

Step 6: Lit fire on the top.

Step 7: In about a few hours biochar will be ready then remove the outer layer of the soil to collect the biochar.

3.6 Vermicompost

As per recent statistics, over 38 billion metric tonnes of organic waste are produced globally, with approximately 40–60% of waste being organic (Ganti S, 2018). The swift expansion of industrial zones, animal farming, waste disposal methods, and the use of agrochemicals in farming systems has led to a surge in various contaminants present in the soil. If not handled with due care, the existence of organic and inorganic residues in the soil poses significant threats to both the environment and human health due to their potentially harmful effects. Rampant and unsafe agricultural practices have resulted in a deterioration of food security, an escalation in greenhouse gas emissions, a reduction in biodiversity, a depletion of soil fertility, and a substantial generation of organic waste. Within the realm of organic waste, one finds agro-industrial remnants, waste from farming activities, animal-derived byproducts, sewage sludge

(SS), municipal solid waste (MSW), and discarded food materials. This category also encompasses garden waste, particularly substantial quantities of dried leaves referred to as leaf litter. The collective impact of these elements is intricately woven into the intricate web of environmental and agricultural challenges we face. This waste can be a boon if able to is used properly (Patra et al., 2022). One of the best ways to revive and outgrow this condition is through a process known as vermicomposting.

Vermicompost is basically, the end product of the vermicomposting process which is obtained through the faecal casting of earthworms (Ahmad et al., 2021). Detritivorous earthworms are engaged in a bio-oxidative mesophilic process along with the collaboration with microorganisms that speeds up the organic matter decomposition, hasten stabilization, and significantly alter its physical, chemical, and biological characteristics.

The process of vermicomposting entails turning organic waste into vermicompost by means of earthworms and microorganisms working together. Worm casts are called as black gold (Mundiyara and Kumar Jat, 2019).

Vermicast is known to contain growth hormones like ethylene, auxin, gibberellin, and enzymes such as cellulose, nitrogenase, and phosphatase. These nutrients are generated as degradable material passes through the earthworm's digestive system.

(Ahmad et al., 2021).

It is a nutrient-rich organic fertilizer and soil conditioner.

3.7 Process of Vermicomposting

The science of vermicomposting can be divided into two types

namely:

a) Mechanical and Physical

b) Bio-chemical and Ecological.

The physical and mechanical procedures involve oxygenating the organic material, and then blending it with both earthworms and soil. The biochemical and ecological processes illustrate the interconnectedness of earthworms and microorganisms. This interaction between earthworms and microorganisms occurs in three phases: the micro stage, mesostage, and macro stage. While macro-stage interactions are less conspicuous, they contribute to the overall decomposition process. This phase involves larger-scale ecological processes that support the breakdown of organic material. The meso-stage involves a more intricate relationship, with microorganisms breaking down complex organic compounds into simpler forms that are then consumed by earthworms. In the micro-stage interaction, priority is given to fulfilling the food requirements of the earthworm. Microorganisms at this stage serve as a crucial food source for earthworms, facilitating their growth and activity.

3.8 Methods of Vermicomposting Practice

There are other ways to vermicompost, however the bed and pit procedures are the most widely used ones

I. Bed method: On the pucca/kachcha floor, composting is accomplished by creating an organic mixture bed that is 6 by 2 by 2 feet in size (Rajdeep Mundiyara and Mukesh Kumar Jat, 2019). The choice between a pucca (concrete) or kachcha (earthen) floor depends on local preferences and resources. A pucca floor may offer stability and longevity, while a kachcha floor promotes a more natural environment for earthworms.

II. Pit method: The 5 x 5 x 3 foot cement pits are used for composting. Thatch grass or any other locally available material is used to cover the unit. As this method results in water logging at the bottom, lower aeration, and increased production costs, this method is not recommended.

III. Unlike other vermicomposting methods, regulating conditions within the pit is more challenging. The enclosed nature of the pit makes it difficult to control factors such as moisture, aeration, and temperature effectively.

3.9 Different Earthworms Utilized in Vermicomposting

Only a tiny fraction of the approximately 4000 earthworm species that can be classified into three biological categories—epigeic, anecic, and endogeic—have been used in the vermicomposting process (Ratnasari et al., 2023). Only epigeic earthworms can be utilized in the process of vermicomposting since organic matter serves as both the substrate and the diet, and soil is not used. The environments that epigeic organisms inhabit are erratic and unstable, with highly fluctuating environmental factors, food availability, and predation pressures. It finds out that in these difficult circumstances, their reproduction rate significantly rises. Under such circumstances, the ability to proliferate and expand quickly becomes essential. Epigeic earthworms are typical "r-strategists," or fast developers, in the slow-fast continuum based on their life history (Domínguez, 2018). (Organisms classified as r-selected typically have brief life cycles, are small in size, quickly reach sexual maturity, and possess high metabolic rates. In adverse environmental conditions, the earthworms' high reproductive rates play a vital role in ensuring the survival of the population. As earthworms form cocoons, it further aids in their resilience, allowing them to endure until conditions improve, thus providing an explanation for the observed fluctuations in population density.

Among epigeic groups, *Eisenia fetida* and *Eudrilus eugeniae* species are widely used for the vermicompostingprocess**.**

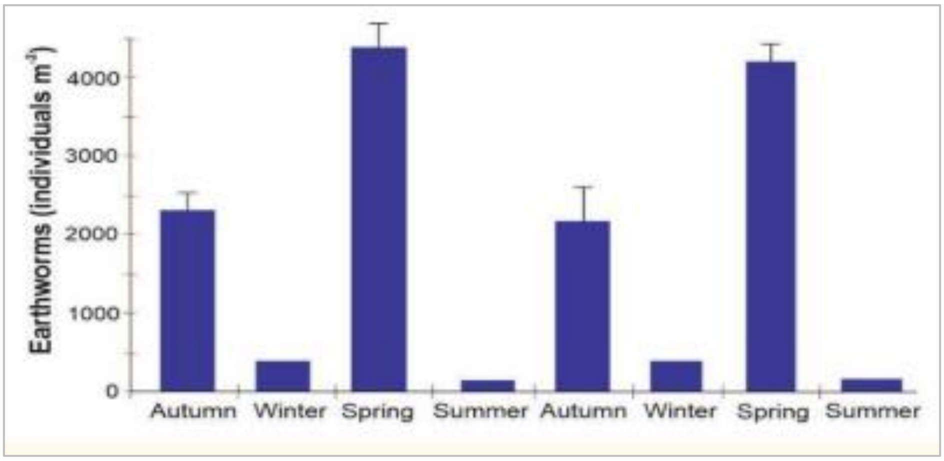

Figure 1: (Domínguez, 2018)

Eisenia fetida

It is commonly known as tiger worm. *Eisenia fetida* is the most commonly used for vermicomposting. It has special features like rapid rate of growth and easy handling nature due to which it is most preferred for vermicomposting. Table 2 shows some of its features.

Dendrobaena veneta is frequently referred to as a European night crawler. *Dendrobaena veneta* is most commonly used for industrial vermicomposting because of its large structure. However, it has a share of disadvantages like low reproduction and maturity rates when compared to E. fetida, P. excavatus, and E. eugeniae. (Table 3) given below shows different characteristics features sowing its suitability fo the particular purpose.

Table 2 : Characteristic features of Eisenia Fetida

Characteristic features (*Eisenia fetida*)		
1	Moisture range	60%-90%
2	Temperature tolerance	Up to 35°C
3	life cycle	45 to 51 days
4	Hatching time for sexual maturity	21 to 30 days
5	Rate of cocoon production	0.4 to 1.3 Cocoonday $^{-1}$
6	Incubation period	18 to 26 days
7	Life expectancy	4.5 to 5 years
8	Average life survival rate at 18°C to 28°C	20 months
9	Hatching viability	80%

Table 2: Characteristic features of *Eisenia fetida*.

Table 3: Characteristics Features of Dendrobaena Veneta

Characteristic features (*Dendrobaena veneta*)		
1	Temperature range	9°C to 30°C
2	Moisture content	60% to 85%
3	Life cycle	100 to 250days
4	Sexual maturity rate	65days
5	Cocoon rate	0.28 Cocoon day-1
6	Hatching viability	20%
7	Incubation period	42 days

Table 3: Characteristic features of *Dendrobaena veneta*.

4. Bedding Material

The Selection of bedding materials is one of the most crucial steps in developing a good vermicompost. Various materials such as rice straw, coconut coir, peat moss sawdust, cardboard, and dried leaves (*G. sepium*) are used for bedding considering the adequate supply of moisture and oxygen in the bin. Animal manures such as cow dung and horse manure are also used in the process of vermicomposting.

Newspaper bedding proves superior in terms of promoting the growth rate and biomass production of worms, while sawdust bedding yields better outcomes in the production of worm numbers and cocoons. According to the Duncan test, the composting potential with earthworms reveals enhanced biomass and growth rate when utilizing newspaper beddings. Conversely, sawdust emerges as a more effective option for cocoon production and increasing the overall number of worms.

Worms can be used to turn the *G. sepium* leaves into vermicompost, which has a high microbial diversity and nutrient content (Manaig Elena M, 2016). It is essential to shred the selected bedding material in order to reduce oxygen blockage. Anaerobic conditions may occur in the vermicomposting bin if appropriate oxygen flow is not allowed. It's imperative to sufficiently shred the bedding material to prevent this.

Avoid paper that contains too many chemicals. Every few months, replenish the bedding material. To enhance the bedding materials, it is necessary to incorporate bedding additives. These additives play a crucial role in balancing the pH levels within the worm bin. Materials employed as bedding additives include eggshells, calcium carbonate, and rock dust (Manaig Elena M, 2016)

4.1 Maintenance of Temperature

Temperature affecting the rate of metabolism and reproduction rate of the earthworms is vital and therefore its maintenance enacts great advantages to better compost preparation. therefore an optimum temperature of about 15°C to 25°C (59°F to 77°F) is required for composting. temperatures above 35°C (95°F) can prove fatal to the worms(plus 2 vers, n.d.)

Often, The stress level of earthworms increases as the temperature drops below 10°C which ultimately reduces the efficiency of vermicomposting.

Organic matter degradation is seen higher during winter than summer seasons. Thus, avoiding the spells of heat waves as well as maintaining temperature seems to be essential. Adding an extra layer of Insulation such as the addition of bedding materials in the case of freezing temperatures will help to cope with the decreasing temperature while minimizing the addition of waste materials, providing extra shade during high heat spells as well as

How to recognize heat stress in worms:

- Above 25°C (77°F), worms and other organisms exhibit reduced feeding activity.
- At 30°C (86°F), worms seek cooler areas within the composter, such as along the sidewalls or beneath the lid. They may also migrate to the collector tray, which offers higher humidity and cooler conditions (plus 2 vers, n.d.) .

4.1.1 Moisture

The degradation of organic substances was slightly higher at 70% moisture than at 80% and 60% (Hossen et al., 2022).

Earthworms have a water content ranging from 75% to 90% in their bodies, and their respiration occurs through their skin. If they dry out, earthworms cannot respire through their skin and will ultimately perish. As this level of water content is vital for their respiratory function, insufficient moisture poses a critical risk, as dry conditions impede the earthworms' ability to breathe, leading to potential fatalities. The rate at which an earthworm breathes can be lowered if the moisture content falls below 60%.

Beyond growth and respiration considerations, the study underscores the importance of moisture management in optimizing the vermicomposting process. Adequate moisture levels not only facilitate earthworm activity but also contribute to efficient organic waste breakdown and nutrient cycling in the ecosystem. These insights emphasize the delicate balance required for successful vermicomposting, where the well-being of earthworms is intricately connected to moisture content regulation.

4.1.2 PH

pH is the crucial parameter in vermicomposting and an optimum range of Potential Hydrogen must be maintained. The problem with maintaining pH is that the organic waste presence leads to the increase of acidic content in the pit which is a potential danger to the survival of earthworms. Thus, an Optimum Ph range of 6.5 to 7.5 is suitable.

To address this, regular monitoring using a pH meter is recommended, allowing farmers and composting practitioners to make timely adjustments and ensure a conducive environment for the effective breakdown of organic matter and the thriving of earthworms in the vermicomposting process

5. Importance

I. Vermicompost methods are techniques that ensure food safety for humans, and animals, support a sustainable agricultural production model that is reliable in terms of environmental health, and has high economic value (Kayabasi & Yilmaz, 2021).

II. It is very reliable in the context of Nepal, especially for small and medium-sized farmers who can greatly benefit from low-input production systems.

III. In order to improve soil fertility, structure, and plant yield, worms are essential. Their burrowing and feeding activities accelerate the infiltration of water, improve soil balance, and combine organic matter, lime, and fertilizers placed to the soil's surface. Research validates that worms increase crop and pasture yields with better grain quality, decrease root infections, and promote plant root growth. (Kayabasi & Yilmaz, 2021)

IV. In addition to decreasing organic debris, worms also stabilize the medium and also mineralize certain elements found in the substrate. Compost or vermicompost made of mineral-rich organic manure can serve as a beneficial substitute for chemical fertilizers.

V. Vermicompost restores the microbial population, comprising a combination of nitrogen fixers and phosphate solubilizers, essential for enhancing soil health and fostering nutrient availability in the ecosystem

VI. Provides major and micronutrients to the plants:

VII. Vermicompost offers a rich source of essential nutrients such as nitrogen, phosphorus, and potassium, vital for the fundamental processes of plant growth. Additionally, it contains a spectrum of micronutrients like iron, zinc, and manganese, which play pivotal roles in enzyme activation and overall plant development.

VIII. Using vermicompost reduces the need for insecticides to control infections, acting as a natural defense mechanism against harmful microorganisms in the soil. By fostering a balanced microbial community, vermicompost helps suppress pathogenic activity, promoting a more resilient and disease-resistant environment for plants

IX. Vermicompost goes beyond mere plant nourishment; it actively contributes to the enhancement of grain and fruit quality by elevating sugar content. This not only results in improved taste but also translates to a more enticing visual appeal. The organic richness provided by vermicompost instills a distinctive flavor profile and heightened sweetness in crops, offering consumers a more gratifying and flavorful agricultural produce.

X. Vermicompost provides a significant advantage to farmers by reducing their reliance on purchased inputs, resulting in cost savings and a more sustainable farming approach. This helps to create a self-sufficient agricultural system, which is in line with environmentally benign methods and builds long-term resilience in farming communities, all while reducing the financial burden on farmers.

XI. Enhanced crop growth and productivity are attributed to vermicompost, as it facilitates the formation of soil aggregates. By enhancing soil structure, vermicompost boosts soil porosity, promoting optimal air intake and water retention. These improvements are instrumental in supporting robust root development, enabling plants to efficiently absorb vital nutrients from the soil. This, in turn, leads to heightened plant characteristics and increased crop yield (Kayabasi & Yilmaz, 2021).

XII. Provides a valuable solution for small to medium-sized farmers by facilitating a low-input production system. This proves particularly crucial as it can offset the initial decrease in product yield often experienced during the shift from traditional farming to organic practices.

XIII. To remove the soil's lack of biological origin, various vegetable residues, farm and chicken manures, composted trash, and organic industrial wastes can be utilized. By enhancing the physical, chemical, and biological characteristics of the soil, these materials supply nutrients to it, which has a favorable impact on plant production's output and quality.

5.1 Application of Vermicomposting

Vermicompost, an eco-friendly practice with widespread application in agriculture, harnesses the organic content and valuable plant nutrients found in organic waste. Beyond its agricultural use, vermicomposting emerges as a viable technique for managing domestic wastewater. With its adaptability to organic and small-scale sustainable farming, vermicompost boasts several commendable properties, delivering manifold advantages when integrated into the soil.

Functioning as a nutrient-rich organic fertilizer, vermicompost significantly enhances plant growth, fostering improved yields. It's introduction to the soil plays a pivotal role in augmenting productivity, thanks to its abundance of organic compounds. Serving as a comprehensive and balanced plant food, vermicompost acts as a growth regulator, containing essential plant nutrients in optimal proportions. Beyond the realms of agriculture, this organic resource, rich in proteins and vital nutrients, finds utility in aquaculture feed as a sustainable alternative.

Regular application of vermicompost extract emerges as a promoter of plant growth, bolstering plant health and fortifying against various plant diseases. The versatility of vermicompost extends far beyond its role as a fertilizer, showcasing its potential impact across diverse domains of environmental and agricultural management.

5.2 Vermiwash

Vermi wash is a potent liquid organic fertilizer obtained from the decomposition of organic matter in the form of drainage from vermicompost (Nayak, H., et al., 2019). Vermiwash in today's context can be brought up as one of the promising biofertilizers to

enhance the germinability and productivity of diverse crops (Suvathi et al., 2023). Vermiwash is thought to be one of the biofertilizers that could improve crop productivity and germination. Its abundance of vitamins, minerals, and plant development hormones—which serve as both feeding agents and pest and disease control agents—is credited with this. Liquid vermiwash is a highly suitable method of fertilizer application when compared to solid vermicompost for germination and plant growth because it becomes a readily accessible material for seed germination and seedling growth (Suvathi et al., 2023**).**

Vermiwash, rich in sugar, amino acids, phenols, and plant-growth-promoting hormones like Indole acetic acid and humic acid, contains beneficial microorganisms that foster plant growth and provide protection against diseases (Arfarita et al., 2020).

What sets vermiwash apart is its liquid form, which proves to be an effective and easily accessible fertilizer for agricultural applications. As a liquid, it can be readily absorbed by plant roots, providing a quick and direct supply of nutrients. This makes it a preferred choice over traditional solid vermicompost for agricultural applications.

5.3 Preparation of Vermiwash

With the preparation of vermicompost after the selection of earthworm, bedding materials and proper bin or pot for the preparation and maintenance and regulation of optimum environmental conditions extraction of vermiwash follows.

The production of vermiwash/vermicompost can be undertaken on both larger and smaller scales through batch and continuous methods.

Batch mode: This mode basically requires periodic inoculation of verms/worms). Batch mode is often more manageable for small-scale or home vermicomposting setups. Harvesting in batch mode involves removing the top layer of vermicompost and collecting the vermiwash. **Continuous mode:** In continuous preparation mode, the products are consistently produced as worms are introduced to an ongoing stream of raw materials (Gudeta et al., 2021). Continuous mode is suitable for large-scale operations. In continuous mode, vermiwash is collected regularly, and harvesting vermicompost may be a separate process.

The vermiwash producer or farmer can establish the vermiwash unit in a large container, choosing between a concrete or a 200-liter plastic barrel. A hole is drilled at the container's bottom, and a tap is fixed to it.

5.4 Principle of Vermiwash Preparation

The fundamental concept behind vermiwash preparation is straightforward. Earthworms create burrows in the soil, known as drilospheres, where bacteria reside. When water is directed through these burrows, it picks up nutrients and transports them to plant roots, facilitating absorption by the plants (Gilll et al., 2018).

The base of the barrel is fill with gravel or broken bricks (10-15 cm or 10% of the container). Addition of coarse sand (10-15 cm or 10%) is performed which is topped off with hay. Include pre-decomposed organic wastes or 10-day-old cow dung, moisten it properly and introduce 1000 to 1500 earthworms. Moisturize the unit daily.

For vermiwash, suspend water from a bucket with a hole at the center, use cotton wicks or bamboo sticks for the activity. Water trickles down, carrying nutrients through the filter unit. Add 4 to 5 liters of water daily for moisture. In 7 to 10 days, collect vermiwash and by the 15th day, around 35 to 40 liters can be obtained. Store in a cool, dry place, and dilute to 10-15% for use as a pesticide or fertilizer for crops or soil.

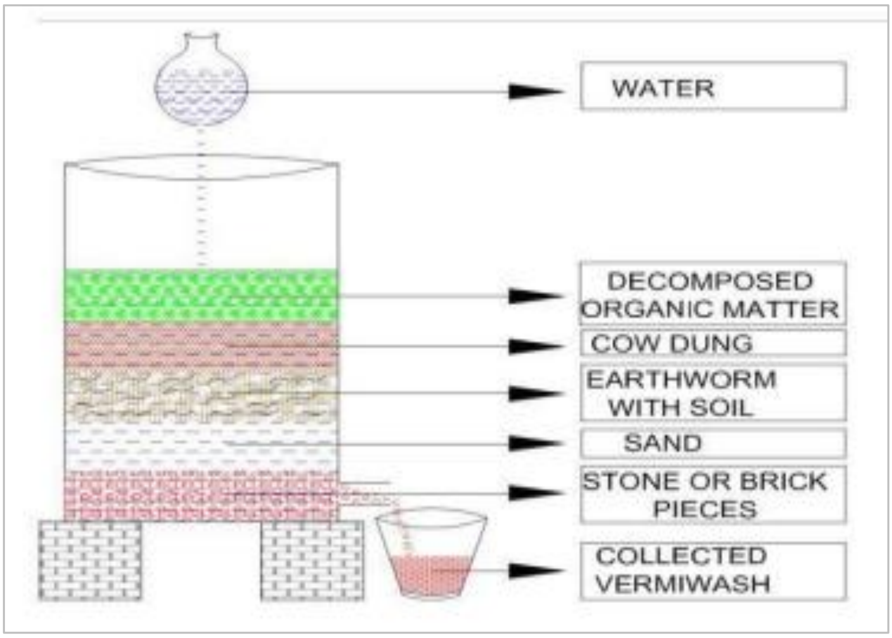

Figure 2: (Gudeta et al., 2021)

5.5 Composition of Vermiwash

Earthworms break down organic materials to produce vermiwash, a nutrient-rich liquid fertilizer. It has a wide range of advantageous elements that support the general well-being and production of plants. Vermiwash contains decomposer bacteria that are essential for reducing infections and maintaining a healthy environment for plant growth. Hormones like auxin and cytokines also aid in the development of roots and shoots, which supports strong plant growth. In addition to suppressing diseases and pests, amino acids and mucosal secretions support the plant's defensive system as a whole. Vermiwash contains vitamins that aid in the growth and development of plants. Phosphatase suppresses pathogens and improves soil quality while also helping to stabilize the physical, chemical, and biological aspects of the soil.

Table 1: Composition of vermiwsh and its benefit.

Table 1. Composition of vermiwash and its benefit.

Contents of vermiwash	Benefit of vermiwash
Decomposer bacteria	Suppress pathogen
Hormones (Cytokines, auxin)	Facilitate plant root and shoot growth
Amino acid and mucosal secretion	Suppress pathogen and pest
Vitamines	Facilitates growth and development of plant
Phosphatase	Stabilize physical, chemical and biological properties of soil as well suppress pathogen and solubilize phosphorus
Actinomycetes	Suppress pathogen
Amylase, cellulase	Stabilize physical, chemical and biological properties of soil as well applied in carbon turnover by degrading organic matter
Varieties of micronutrients Ni, Mg, Fe, Ca, K	Facilitate the growth and productivities of plant

(Gudeta et al., 2021)

Cite The Article: Sushmita Tiwari, Shreya Rai, Jasmin Adhikari, Samarth Bista (2023). Organic Farming: A Reliable Strategy for Sustainable Agriculture in Nepal. *Science Heritage Journal, 7(2): 91-103.*

5.6 Vermiwash Dosage and Application

Vermiwash offers versatile applications in agriculture, serving as a valuable resource for plant growth and disease prevention.

One effective method involves immersing seedlings or plant cuttings in a 10-15% vermiwash solution for 15-20 minutes before transplanting. This ensures a nutrient-rich start for the young plants (VENS, 2019). This method is strategically employed to provide young plants with a robust and nutrient-rich foundation as they embark on their early growth stages. By allowing

the delicate roots or cuttings to absorb the enriched vermiwash solution, the plants gain immediate access to essential nutrients, growth-promoting hormones, and beneficial microorganisms present in the vermiwash. This immersive treatment primes the seedlings for transplantation, fostering a healthier start and establishing favorable conditions for sustained development in the subsequent stages of their growth cycle.

Additionally, applying vermiwash through foliar spray at a concentration of 10-15% directly on the crop's foliage provides essential nutrients while bolstering the plant's defense against potential diseases (VENS, 2019). The foliarspray ensures that the plants efficiently absorb the nutrient-rich solution through their leaves, promoting overall health and resilience in the face of potential threats.

Furthermore, when used as a soil application, vermiwash acts as a natural fertilizer, enhancing nutrient absorption by the crops and promoting overall soil fertility.

5.7 Importance and Advantages of Vermiwash

5.7.1 Vermiwash and Earthworm Extract as An Antifungal Agent

Worldwide, the roots of wheat (*Triticum aestivum* L.) faced a significant 20% reduction in both production and quality due to the impact of the pathogenic fungus *Fusarium graminearum*. The application of vermiwash to the wheat farm successfully mitigated the detrimental effects (Gudeta et al., 2021). Thus, vermiwash offers a sustainable alternative to synthetic chemicals by helping to fortify the natural defense mechanisms of plants against fungal infections.

5.7.2 Application of Vermiwash as Pesticide

The control of the root-knot nematode (*Meloidogyne javanica*) in vitro and in a greenhouse was experimented with vermiwash (Gudeta et al., 2021). This can also be particularly useful in deterring common pests such as aphids, mites, and caterpillars.This helps in reducing the damage caused by insect feeding.

5.7.3 Environmentally Friendly Substitute to Fertilizers And Pesticides

Aligning with the principle of organic farming, vermiwash promotes natural and sustainable methods to boost production acting as a fertilizer and has repellant properties mimicking pesticides.

5.7.4 Boosts Plant Growth and Yield

Vermiwash spray was found to improve the parameters of yield and growth in brinjal plants. Vermiwash is abundant in phytohormones like auxins and cytokinins, as well as vital nutrients like potassium, phosphate, and nitrogen. These nutrients are essential for promoting cell elongation, division, and general plant growth.

Applying 100% recommended dose of fertilizer (RDF) along with 100 liters of vermiwash per hectare led to a significant improvement in plant height, dry matter accumulation, leaf area index, and the development of both primary and secondary branches (Nayak et al., 2019).

5.7.5 Soil Enhancement

The combined use of vermicompost and vermiwash exhibits a significant positive impact on soil biochemistry, elevating micronutrient levels and improving both physical and chemical properties. This synergy fosters a balanced, nutrient-rich soil environment for sustainable plant growth, enhancing physico-chemical properties, ensuring long-term fertility, and improving aeration, tilth, texture, and water retention, while also optimizing nutrient status for both macro and micronutrients (Nayak et al., 2019).

5.7.6 Cost-Effective

The raw materials for vermiwash, such as kitchen scraps and pre-decomposed organic matter, are inexpensive or often free, reducing the overall production cost. Additionally, the use of earthworms in the vermicomposting process contributes to the sustainable recycling of organic waste, minimizing disposal expenses. Vermiwash eliminates the need for purchasing synthetic fertilizers and pesticides, offering a more economical and environmentally friendly alternative for farmers. Its affordability, coupled with the numerous benefits it provides to soil health and plant growth, makes vermiwash a financially prudent choice in agricultural practices.

Figure 3: We students from the different agriculture university of Nepal preparing bedding and feed for vermicompost at HASERA Agriculture Research and Training Center, Patalekhet during our Student Exchange Program

5.8 Panchagavya

Panchagavya is an organic formulation that is used in traditional Hindu rituals prepared by mixing five product of cow in specific ratio i.e. milk, curd, cow ghee, cow urine, and cow dung out of which cow dung, urine and, milk is the direct constituents, whereas cow ghee and curd are the derived ones. Panchagavya, as used in Sanskrit literature, refers to a mixture of five cow-derived goods. Together, these five products are referred to as "Panchagavya" and are each named "Gavya" (Kumar et al., n.d.). Since it is based on cow-derived products, it is also known as a cowpathy treatment in Ayurvedic medicine. In agricultural operations, panchagavya is utilized as pesticides and fertilizers. The use of panchagavya as manure has a good chance of improving the physical, chemical, and biological properties of soil because it is a rich source of micronutrients, vitamins, and growth regulators like Auxins and Gibberellins, as well as macronutrients like N, P, and K, and beneficial microorganisms like phosphor bacteria, azatobacter, and pseudomonas. The rhizosphere environment created by the beneficial microorganisms present in Panchagavya enhances plant growth and crop yield and helps sustain agriculture. Heavy reliance on chemicals in agriculture has degraded soil, water resources, food quality, and the ecological foundation, so when it comes to organic farming, Panchagavya is crucial in replacing chemical farming. In Long-term soil productivity will rise leading to the production of nutritious crops free of chemical residues. It is essential to develop a strong, workable, and harmonious package of nutritional management using organic resources for a variety of crops based on empirical data, regional conditions, and commercial viability, since "Panchagavya" is soon to be adopted as a panacea for the ills of modern chemical agriculture. The systematic agricultural methods described in Vedic literature (Vrikshayurveda) emphasize the use of panchagavya to improve crop plants' biological efficiency and produce more fruits and vegetables. (Sarkar et al., 2014).

Preparation:

Mix 1 kg of fresh cow dung and 7 kg of cow ghee well. Let that incubate for two days. Next, add ten lit of water and three lit of cow manure. For a week, thoroughly mix in the morning and evening. Next, add two lit of cow's milk, two lit of sugarcane juice, and two lit of cow curd. Add three lit of coconut water after that. Next, include 100 grams of yeast and 12 ripe bananas.

After two weeks of incubation, the entire mixture should be filtered through two layers of muslin cloth. After that, the preparation should be kept in the refrigerator in a bottle and utilized as needed. (Raghavendra et al., 2014)

Advantages:

- Panchagavya increases the organic matter, macro and micronutrient levels improves the soil fertility, and preserves the health of the soil.
- Cow urine contains a variety of properties, including immunomodulatory, wound-healing, antioxidant, and anti-diabetic properties. It also functions as a bio enhancer, boosting the effectiveness of nutrients, antibiotics, and anticancer medications like taxol.
- When Panchgavya is sprayed on leaves, it produces larger leaves with a denser canopy that improves photosynthetic material, which leads to the highest possible production of metabolites and photosynthates.
- When Panchagavya is applied, the plants exhibit increased side shoot growth. It will contribute to an increase in fruits.
- It will greatly aid in boosting root growth.
- Using panchagavya will prolong the fruit and vegetable's shelf life.
- The yield's quality rises significantly.
- In agriculture, panchagavya aids in reducing the application of chemical fertilizers. It is ideal for farming organically.
- Without requiring more technical expertise, making and using this magic fertilizer at home is easy and simple.
- It lowers the cost of farming by using fewer chemicals for things like growth regulators, fungicides, pesticides, and fertilizers.

5.9 Beejamrit

Bijamrita (Bija means 'seed' | Amrita means 'nectar') is a seed treatment that protects seedlings or any planting materials against soil borne, seed borne diseases as well as fungi that usually affect the plant after the monsoon season. Many diseases can attack seeds during the germination stage, hence seed treatment is crucial for seed germination. It is also called an organic pesticide. Bijamrit is prepared from locally obtainable materials, local cow urine, and cow dung. According to just the dung of indigenous cows is effective in enriching barren soils (Palekar, 2007). Dung from exotic breeds, Jersey and Holstein cows are not very effective**.**

In case cow dung is not available one can go for buffaloes and bullocks dung. The dung of the cow that gives less milk is more beneficial towards reviving the soil. Bijamrita contains hormones and alkaloids that promote germination, counteract the anti-germinating substances in the embryo, and provide seedlings with protection. It functions as a potent fungicide and antibacterial agent, protecting the crop from harm during the initial phases of germination and establishment. have documented the existence of numerous advantageous microorganisms in Bijamrita, including fungi, actinomycetes, phosphorus solubilizers, and nitrogen fixers (Devakumar et al., 2008). Its application supports, encourages, and improves plant growth, as well as produces high-quality crops. Its application in sustainable agriculture has been referenced in several ancient Indian treaties, including the Charak Samhita, Sushrut, Vagbhaat, and Nighantu, Ratnakar, among others. Regular application of it for seed treatment will lessen reliance on chemical use, which will in turn lessen pollution from chemical treatments. Also, not using chemicals in soil can conserve biodiversity and nurture balance. It allows the soil to breathe again while also reducing soil erosion. It adds nutrients to the soil to improve it. Furthermore, it shields us from dangerous chemicals and diseases like cancer, diabetes, and many others by avoiding the use of fertilizers, herbicides, and pesticides that slowly contaminate human bodies through a process known as biomagnification. Jibamrit is a significant contributor to Zero Budget Natural Farming (ZBNF) as a seed treatment method. ZBNF is an agricultural method that avoids using chemical pesticides and fertilizers but instead focuses on growing crops in tune with nature. By guiding farmers toward sustainable farming methods, ZBNF helps to maintain soil fertility, ensure chemical-free agriculture, guarantee low production costs (zero cost), and ultimately increase farmer's income.

5.10 Preparation

The preparation process was carried out according to (Palekar, 2007). A cloth that had been taped shut around five kilograms of the local cow excrement was taken and left in 20 liters of water for a full day. In a different container, 50g of slaked lime was dissolved in 1 liter of water simultaneously and left stable for the entire night. This bundle of cow dung was squeezed three times after it had been for twelve hours, which allowed the essence of the cow dung to be brought to the water phase (cow dung extract). Cow dung extract was mixed well with one kilogram of soil to dissolve it. This was combined thoroughly with five liters of wild cow urine and lime water. You can prepare bijamrit in 12 to 24 hours.

Use: To get ready for the 100 kg seed production, 20 liters of water can be used. For leguminous seeds, a quick dip and drying is all that is required before sowing, they should not be rubbed hard, but in case of other crops, bijamrit is added, mixed by hand, and allowed to dry thoroughly before sowing. In comparison to lower concentrations, the application of 100% concentrated bijamrit boosted seed vigour Index, seedling growth, and germination percentage according to the experiment done in India (Pratap Naikwade, 2019)

5.11 Advantages

- Bijamrit is a traditional biofertilizer that increases seed germination percentages. 2. It guards against infections caused by phytopathogens and boosts till ring and plant vitality.
- It contains vital nutrients that enhance crop growth and yield.
- It is easy to make as it is prepared from locally available ingredients.
- Can be prepared in significantly less time.
- Reduces cost of production.

- Keeps fungus and other seed-borne diseases away from the young plants. 8. Reduce the application of chemicals.
- 9. Supports organic and sustainable farming.
- 10. It maintains the fertility and productivity of the soil and aids in the decomposition of soil organic materials.

5.12 Jeevamrut

Jeevamrut is another important and beneficial organic manure that supports sustainable agriculture. A relatively inexpensive source of natural carbon, beneficial microorganisms like phosphate-fixing and nitrogen-fixing bacteria, and macro- and micronutrients, Jeevamrut is a liquid organic manure that is ideally utilized between the eighth and twelfth days shortly after preparation (R. Singh et al., 2021). The two words Jeevan and Amrut are combined to form Jeevamrut. They are both of Sanskrit origin. "Jeevan" signifies life, and "Amrut" denotes a healing concoction. Jeevamrut has a moderate green tint and a mildly foul fragrance; as storage time goes on, the colour darkens and the odour intensifies. From the perspective of agriculture, Jeevamrut is for crop life (Kaur, 2020). Jeevamrut utilizes farm animal wastes that are safe, economical, and eco-friendly.

5.13 Procedure (Sagar et al.,2022)

- Dissolve 500 g of jaggery in 1 ltr of water in the early morning.
- Mix 5 ltr of cow urine and 5 kg of cooled fresh cow dung in a clean bucket to make a paste, and make sure there is no aggregate of cow dung in it.
- Add 250 g of soil (soil from the place where it is to be applied or from the root zone of *Ficus religiosa* (Peepal tree), 500 g of pulse flour, and 1 ltr of jaggery liquid in the paste of cow dung and cow urine prepared before.
- Stir the mixture properly.
- It is preferred to take soil from the root zone of Peepal tress because it contain lots of beneficial microorganisms whereas jaggery and pulse flour are nutrient sources for those beneficial microorganisms and helps in their rapid multiplication.
- Then, put the mixture in a 100 liter drum containing 85 liter of water.
- Stir it regularly for 12 times in clockwise and 12 times in anticlockwise direction for seven days and make sure to cover it properly after each stirring.
- Stirring can be done by using any suitable means however, It is recommended to use a neem stick as it increases the efficacy of Jeevamrut against insects.
- After nine days of fermentation, Jeevamrut can be used in our crops field.

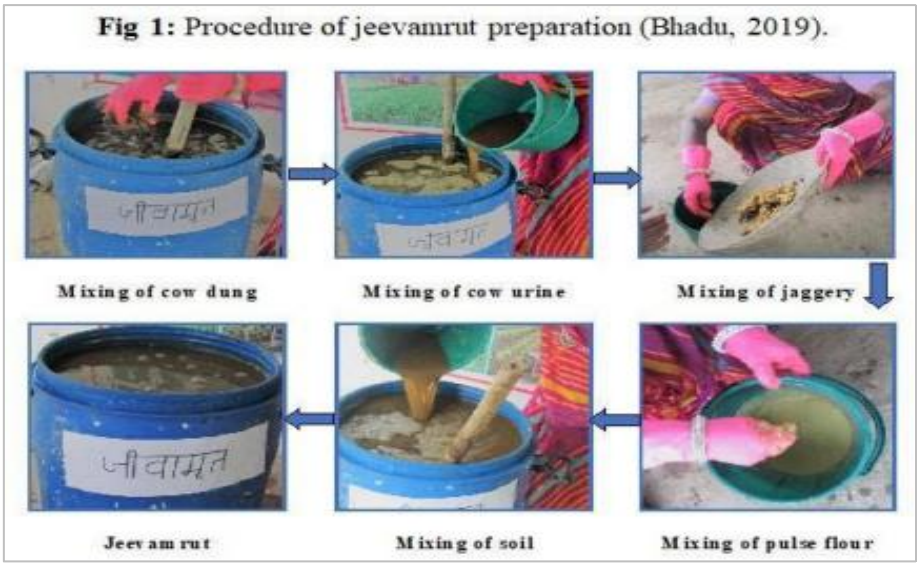

Figure 1: Procedure of jeevamrut preparation (Bhadu, 2019)

5.14 Future Prospects

The future holds promise for a greener, more resilient Nepal through the widespread adoption of organic farming, fostering economic growth while safeguarding the environment for generations to come. There has been a promising trajectory for organic farming, emerging not just as a conscientious choice but as a cornerstone for resilient and sustainable development. By relying on natural inputs and biological pest control methods, organic farming supports enhanced crop yields without a significant dependence on expensive external inputs making it a viable agricultural approach. Organic farming addresses consumer preferences by providing products that are free from chemicals, non-genetically modified, and produced sustainably. It aligns with health, environmental consciousness, and ethical values, ensuring transparency through certification and emphasizing premium quality and biodiversity.

The combination of cost savings, market demand, and sustainable practices contributes to the economic viability of organic agriculture. Lower input costs and a premium price for organic products can offset reduced yields, making organic farming more profitable than conventional methods. In comparison with conventional and contemporary farming practices, organic farming demands a higher labor input. Therefore, Nepal which has extremely high rates of underemployment and labor unemployment will discover organic farming a draw. Additionally, the issue of periodic unemployment will also become more minimized because of crops' diversity and varied planting and harvesting schedules that call for a significant amount of labor. Organic farming fosters long-term stability for marginalized farmers through reduced costs, diversified income sources, access to premium markets, community empowerment, climate resilience, preservation of traditional knowledge, and environmental sustainability. These elements collectively contribute to improved livelihoods and economic security for vulnerable agricultural communities. Furthermore, it helps mitigate climate change by storing carbon in the form of organic matter, contributing to soil health and overall environmental sustainability.

5.15 Challenges

- The conversion period poses a significant obstacle to the adoption of organic farming, primarily due to the associated direct and indirect costs. When transitioning from a conventional to an organic farm, strict adherence to international production, processing, and labeling standards is imperative. Throughout this conversion period, the farm must meet and verify all the necessary criteria for certifying products as 'organic,' as mandated by a certifying agency.
- Among the various organic amendments that we have discussed above, the storability of bijamrita has been a challenge for Nepalese farmers.
- Due to limited space, strict regulations, high costs, and waste management issues in urban and periurban areas of Nepal, hinder the

integration of livestock into urban farming practices that challenges it's sustainability.

- Although these practices provide locally relevant and environmentally friendly solutions, there is insufficient scientific evidence to support larger replication and scaling, which undermines the viability of these local practices as stand-alone solutions for widespread implementation elsewhere.

6. Conclusion

In a nutshell, this review provides an in-depth analysis of promoting sustainability in Nepal through the utilization of organic amendments. Organic farming emerges as a reliable strategy for sustainable agriculture in Nepal, offering a holistic approach to address environmental, economic, and social challenges. This approach prioritizes ecological balance, fostering soil health and biodiversity without the use of synthetic pesticides and fertilizers.

Conflict of Interest

We hereby confirm that there is no conflict of interest.

References

Ahamad, K., Thapa, R., Regmi, R., Thapa, R. B., Gautam, B., 2020. Efficacy And Profitability Of Using Different Ipm (Integrated Pest Management) Measures For The Control Of Cauliflower Aphids (Brevicoryne Brassicae Linn.) In Different Genotypes Of Cauliflower In Chitwan District, Nepal. Sustainability in Food and Agriculture, 1(2), Pp. 80–87. https://doi.org/10.26480/sfna.02.2020.80.87

Ahmad, A., Aslam, Z., Bellitürk, K., Iqbal, N., Idrees, M., Nawaz, M., Nawaz, M. Y., Munir, M. K., Kamal, A., Ullah, E., Jamil, M. A., Akram, Y., Abbas, T., Aziz, M. M., 2021. Earth Worms and Vermicomposting: A Review on the Story of Black Gold. Journal of Innovative Sciences, 7(1). https://doi.org/10.17582 /journal.jis/2021/7.1.167.173

Arfarita, N., Lestari, M. W., Prayogo, C., 2020. Utilization of Vermiwash for the Production of Liquid Biofertilizers and Its Effect on Viability of Inoculant Bacteria and Green Bean Germination. AGRIVITA Journal of Agricultural Science, 42(1). https://doi.org/10.17503/agrivita.v42i1.2263

Banjara, R. K., Poudel, M., 2017.Aryasamaj Foundation Chennai. (n.d.). The four pillars of Natural Farming.. Sustainable Model of Organic Agriculture: A Case study of Nepalese Farmers. Journal of Advanced Academic Research, 3(1), Pp. 142–163. https://doi.org/10.3126/jaar.v3i1.16624

Bhusal, K., Udas, E., Bhatta, L. D., 2022. Ecosystem-based adaptation for increased agricultural productivity by smallholder farmers in Nepal. PLOS ONE, 17(6), e0269586. https://doi.org/10.1371 /journal.pone .0269586

Bishnoi, R., and Bhati, A., 2017. An Overview: Zero Budget Natural Farming. 10(46), Pp. 9314–9316.

Charapale, S. T., Narayankar, C. U., Desai, N. M., Gaikwad, S. A., Samant, I. A., 2022. Organic Farming Approach For Riliable And Sustainable Agriculture Practices. 22(6).

Chauhan, A., Dheer, M., 2023. Zero Budget Natural Farming (ZBNF) for Sustainable Agriculture: A Review. 14(5).

Das, K., 2004. Transitioning to organic, available at: http://www.indiatogether.org/ 2004/jun/ agr-transorg.htm.

Dolma Diki Sherpa. 2021. Jholmol: Biopesticide. Tunza Eco Generation. https://tunza.eco-generation.org/worldReportView.jsp?viewID=54041

Domínguez, J., 2018. Earthworms and Vermicomposting. In S. Ray (Ed.), Earthworms—The Ecological Engineers of Soil. InTech. https://doi.org/10.5772/intechopen.76088

Yad Vir Singh, 2020. Organic Farming Practices And Sustainable Agriculture (Vol. 2). AkiNik Publications.

Equator Initiative. 2020. Nature- based actions advancing sustainable development. https://www.equatorinitiative.org/2020/04/24/solution11449/)

Erica Udas, Laxmi Dutt Bhatta. (n.d.). Jholmal for small-scale farmlands. Jholmal for Small-Scale Farmlands. https://www.icimod.org/rms/jholmal-for-small-scale-farmlands/

Ganti, S., 2018. Vermicomposting. International Journal of Waste Resources, 08(03). https://doi.org/10.4172/2252-5211.1000342

Gilll, K., Sandhu, S., Kalmodiya, T., Mor, M., Singh, M., 2018. Vermiwash and its uses in Agriculture: An Article. 5(12).

Gudeta, K., Julka, J. M., Kumar, A., Bhagat, A., Kumari, A., 2021. Vermiwash: An agent of disease and pest control in soil, a review. Heliyon, 7(3), e06434. https://doi.org/10.1016/j.heliyon.2021.e06434

Gupta, D. K., Gupta, C. K., Dubey, R., Fagodiya, R. K., Sharma, G., A., K., Noor Mohamed, M. B., Dev, R., Shukla, A. K., 2020. Role of Biochar in Carbon Sequestration and Greenhouse Gas Mitigation. In J. S. Singh and C. Singh (Eds.), Biochar Applications in Agriculture and Environment Management. Pp. 141–165. Springer International Publishing. https://doi.org/10.1007/978-3-030-40997-5_7

Nayak, H., Rai, S., Mahto, R., Rani, P., Yadav, S., Prasad, S. K., and Rajesh Kumar Singh. 2019. Vermiwash: A potential tool for sustainable agriculture. Journal of Pharmacognosy and Phytochemistry, 5. https://www.phytojournal. com/archives /2019/ vol8issue5S /PartG/SP-8-5-51-341.pdf

Heartyculture Nursery. 2021. Biochar series: Making Biochar through traditional Method. https://www.youtube.com/watch?v=3My0QyRNSpU&t=122s

Hossen, M., Khan, M., Azad, M., Hashem, M., Bhuiyan, M., Rahman, M., 2022. Effects of moisture content on the quality of vermicompost produced from cattle manure. Bangladesh Journal of Animal Science, 51(2), Pp. 40–46. https://doi.org/10.3329/bjas.v51i2.60493 icimodJholmal.pdf. (n.d.).

International Biochar Initiatives. 2022. How to make biochar. International Biochar Initiatives. https://biochar-international.org/about-biochar/how-to-make-biochar/biochar-technology/ Jemal, K. (2020). Effect of Different Bedding Materials and Waste Feeds on Vermicompost Production and Local Earthworm Performance in Wondo Genet Ethiopia.

Kayabasi, E. T., Yilmaz, O., 2021. The Importance of Vermicompost in Agricultural Production and Economy. 5(2). https://dergipark.org.tr/tr/download/article-file/2037420

Bhusal, K., Udas, E., 2020. Jholmal: A nature-based solution for mountain farming systems. ICIMOD. (https://www.icimod.org/wp-content/uploads/2021/01/Jholmal_English.pdf Kumar, K., Verma, G., Veer, R., Kumar, S., Kumar, P. (n.d.). Exploitation of Panchagavya, benefits and eco-friendly management of plant diseases: A review. Journal of Entomology and Zoology Studies.

Lamichhane, B., Dunn, B., Ouedraogo, A., Singh, H. (n.d.). HLA 6502 Preparation of Biochar for Use as a Soil Amendment.

Lehmann, J., Gaunt, J., Rondon, M., 2006. Bio-char Sequestration in Terrestrial Ecosystems A Review. Mitigation and Adaptation Strategies for Global Change, 11(2), Pp. 403–427. https://doi.org/10.1007/s11027-005-9006-5

Lehmann, J., Joseph, S., 2009. Biochar for environmental management: An introduction. Biochar for Environmental Management: Science and Technology, Pp. 1–12.

Manaig Elena M., 2016. Vermicomposting Efficiency and Quality of Vermicompost with Different Bedding Materials and Worm Food Sources as Substrate. Research Journal of Agriculture and Forestry Sciences, 4(1), Pp. 1–13.

Devakumar, N., GGE Rao, Shubha, S., Imrankhan, N., Gowda, S.B., 2008. Activities of organic farming research centre. Navile, Shimoga, University of Agriculture Sciences Bangalore, 12.

Nandwani, D., Jamarkattel, D., Dahal, K. R., Poudel, R., Giri, S., Joshi, T. N., 2021. Attitudes of Fruit and Vegetable Farmers towards Organic Farming in Kathmandu Valley, Nepal. Sustainability, 13(7), 3888. https://doi.org/10.3390/su13073888

NARC. 2017. Nepal (Director) Biochar and its Application. http s://www.yout ube.co m/wat ch?v =SwD RoK345Zw&t=587s

Pal, S., Patel, N. (n.d.). Importance of soil microbes on panchagavya based fertilizer for sustainable agriculture: A review.

Palekar. S., 2007. Zero Budget Spiritual Farming.Research Development and Extension Movement, AmirSubhash Palekar Publication, India.

Palsania, J., 2008. Effect Of Moisture Content Variation Over Kinetic Reaction Rate During Vermicomposting Process. Applied Ecology and Environmental Research, 6(2), Pp. 49–61. https://doi.org/10.15666/aeer/0602_049061

Pan, Z., Zhang, R., Zicari, S., 2019. Integrated processing technologies for food and agricultural sby-products. Academic Press.

Pandit, N. R., Dahal, S., Shrestha, S., Vista, S. P., Gautam, D. K., 2021. Biochar as an efficient soil enhancer to improve soil fertility and crop productivity in Nepal. 21.

Pandit, N. R., Mulder, J., Hale, S. E., Schmidt, H. P., Cornelissen, G., 2017. Biochar from, Kon Tiki, flame curtain and other kilns: Effects of nutrient enrichment and kiln type on crop yield and soil chemistry. PLOS ONE, 12(4), e0176378. https://doi.org/10.1371/journal.pone.0176378

Patra, R. K., Behera, D., Mohapatra, K. K., Sethi, D., Mandal, M., Patra, A. K., Ravindran, B., 2022. Juxtaposing the quality of compost and vermicompost produced from organic wastes amended with cow dung. Environmental Research, 214, 114119. https://doi.org/10.1016/j.envres.2022.114119 plus 2 vers. (n.d.). Vermicomposting during heatwave: Tips to safeguard your worms.

Pokhrel, D. M., Pant, K. P., 2009. Perspectives of Organic Agriculture and Policy Concerns in Nepal. Journal of Agriculture and Environment, 10, Pp. 103–115. https://doi.org/10.3126/aej.v10i0.2135

Poudyal, B. K., Poudel, P., 2013. Beneficial microbes “Jeevatu” for biodegradable waste management and plant disease control. 2013 IEEE Global Humanitarian Technology Conference (GHTC), Pp. 232–237. https://doi.org/10.1109/GHTC.2013.6713686

Naikwade, P., 2019. Effect of Bijamrita and other organic liquid treatments on seed germination and seedling growth of legume crops. Researchgate, 9(3).file:///C:/Users/User/Downloads/OnlineInternationalInterdsicplinaryResearchJournalEffectofBijamrit%20(1).pdf

Raghavendra, K. V., Gowthami, R., Shashank, R., Kumar, S. H., 2014. Panchagavya in Organic Crop Production.

Mundiyara, R., and Mukesh Kumar Jat. 2019. Importance of Vermicompost. Biotech Articles. https://biotecharticles.com/Agriculture-Article/Importance-of-Vermicompost-4013.html

Rakesh, S., Poonguzhali, S., Saranya, B., Suguna, S., Jothibasu, K., 2017. Effect of Panchagavya on Growth and Yield of Abelmoschus esculentus cv. Arka Anamika. International Journal of Current Microbiology and Applied Sciences, 6(8), Pp. 3090–3097.https://doi.org/ 10.20546/ijcmas.2017.609.380

Ratnasari, A., Syafiuddin, A., Mehmood, M. A., Boopathy, R., 2023. A review of the vermicomposting process of organic and inorganic waste in soils: Additives effects, bioconversion process, and recommendations. Bioresource Technology Reports, 21, 101332. https://doi.org/10.1016/j.biteb.2023. 101332

Sagar G.C., Bhusal, A., and Khatri, L., 2022. Organic Fertilizer (Jeevamrit) and Organic Pesticide (Beejamrit). Local Initiatives for Biodiversity, Research and Development (LI-BIRD). https://libird .org/wp-content/uploads/2022/04/Organic-Fertilizer-English.pdf

Sarkar, S., Kundu, S.S., Ghorai,D., 2014. Validation of ancient liquid organics—Panchagavya and Kunapajala as plant growth promoters. NISCAIR-CSIR, India, 13(4). https://nopr.niscpr.res.in/handle/123456789/27935

Singh, M., 2021. Indian Journal of Organic Farming. 1(1), Pp. 1–9.

Singh, R., Verma, G., Dhaka, A. K., Kumar, S., Saha, S., Devi, E. L., Bhupenchandra, I., Gudade, B. A., Hasanain, M., 2021. A low cost organic liquid manure in organic farming for sustainable.

Subedi, R., Bhatta, L. D., Udas, E., Agrawal, N. K., Joshi, K. D., Panday, D., 2019. Climate-smart practices for improvement of crop yields in mid-hills of Nepal. Cogent Food and Agriculture, 5(1), 1631026. https://doi.org/10.1080/23311932.2019.1631026

Suvathi, S., Rathi, R., Ravichandran, K., Kavitha, P., Ayyanar, M., Praseetha, P., Chidhambaram, N., 2023. Improved photocatalytic dye degradation and seed germination through enzyme-coupled titanium oxide nanopowder-Acost-effective approach. Environmental Research, 218, 114973. https://doi.org/10.1016/j.envres.2022.114973

Vista, S. P., Shrestha, S., Rawal, N., Joshi, S., Rayamajhi, K., Devkota, S., Kandel, S., Amgain, R., Paneru, P., Timilsina, S., 2018. The better india. Jhol Mol! What Indian Farmers Can Gain From Nepal's Organic Manure. https://www.thebetterindia.com/127786/nepals-organic-manure-indian-farmers-pesticides/).Ve Ns. 2019, December 24. How to make Vermiwash at Home With Easy Steps. Times Of Agric Ult Ure. https://timesofagriculture.com/how-to-make-vermiwash-prepare-vermiwash-at-ease/ (n.d.). Fertiliz ers In Nepal.