EFFECT OF POULTRY LITTER ON THE GROWTH AND YIELD OF CHILI (BIJLI PLUS) UNDER MANGO BASED AGROFROESTRY SYSTEM

A THESIS

BY

MST. HASINA AKTER

Registration No. 1701322

MS Session: Jan-June 2023

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MASTER OF SCIENCE (M.S.)

IN

AGROFORESTRY AND ENVIRONMENT

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JUNE 2025

Dedicated

To

My Beloved Parents and

Honorable Teachers

DECLARATION

I hereby declare that the work presented in this thesis titled "**EFFECT OF POULTRY LITTER ON THE GROWTH AND YIELD OF CHILI (BIJLI PLUS) UNDER MANGO BASED AGROFROESTRY SYSTEM**" has been carried out by myself and that it has not been submitted for any previous degree. All quotations have been distinguished by quotation marks and all sources of information specifically acknowledged by references to the author.

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EFFECT OF POULTRY LITTER ON THE GROWTH AND YIELD OF CHILI (BIJLI PLUS) UNDER MANGO BASED AGROFROESTRY SYSTEM

ABSTRACT

A field experiment was conducted at the research field of the Department of Agroforestry and Environment, Hajee Mohammad Danesh Science and Technology University, Dinajpur, from February, 2024 to June, 2024 to evaluate the impact of poultry litter on the growth and yield of chili (Bijli Plus) production under mango-based agroforestry system. The experiment was designed as Randomized Complete Block Design (RCBD) with three replications and four treatments of poultry litter at 10 ton/ha, 7.5 ton/ha, 5 ton/ha, and a control with no poultry litter. Each of the 12 plots measured 2m x 2m. Healthy 25-day-old chili seedlings were collected from the Nursery of BRAC, Dinajpur and transplanted in the present research field on February 20, 2024. Data on various growth and yield parameters were collected at 15, 30, and 45 days after transplanting (DAT), including plant height, number of leaves, leaf dimensions, number of branches, chlorophyll content, soil parameters, fruit weight, fruit length, fruit diameter, number of fruits per plant, yield per plot and hectare, and Benefit-Cost Ratio (BCR). The data were analyzed using ANOVA and mean differences were evaluated by Tukey HSD test by the statistical software STAR (Statistical Tool for Agricultural Research). Results indicated that the tallest plants and highest leaf numbers were observed in the 10 ton/ha poultry litter treatment across all stages. Leaf dimensions were also greatest in the 10 ton/ha treatment. But the highest yields per plot and hectare were achieved with 7.5 ton/ha poultry litter, with a maximum yield of 10265.83 kg/ha. The best fruit quality, in terms of weight, length, and diameter, was found in the 7.5 t/ha treatment. The highest chlorophyll contents were in the 7.5 ton/ha treatment. Soil parameters improved post-harvest in all poultry litter treatments, with the most significant improvements in the 10 ton/ha treatment. The highest BCR (3.25) was recorded for the 7.5 ton/ha treatment, while the lowest (2.43) was in the control. In conclusion, the application of 7.5 ton/ha poultry litter is recommended for maximizing chili fruit quality, yield and economic returns under mango-based agroforestry system. This study demonstrates the benefits of using poultry litter to improve chili production in agroforestry systems.

Keywords: Chili, Poultry litter, plant growth, mango, chlorophyll content, yield, BCR

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CHAPTER 1

INTRODUCTION

Agroforestry is a dynamic, ecologically based, natural resources management system that, by integrating trees on farms, ranches, and in other landscapes, diversifies and increases production and promotes social, economic, and environmental benefits for land users (Dagar & Tewari, 2018). Agroforestry systems, which integrate trees with crops or livestock, are recognized for their potential to enhance agricultural sustainability through improved biodiversity, soil health, and resource use efficiency. Among these systems, mango-based agroforestry has emerged as a viable option due to the high economic and ecological value of mango trees (*Mangifera indica* L.). Integrating crops like chili within these systems can optimize land use and increase farm productivity. One effective strategy to boost crop performance in such systems is the application of organic amendments, particularly poultry litter, which is known for its high nutrient content (Adekiya et al., 2020; Noman et al., 2008).

Chili (Capsicum annuum L.) is a significant spice and cash crop globally and in Bangladesh, belonging to the Solanaceae family. It is a commercially valuable annual spice crop known for its aromatic flavor, pungency, and high coloring substance, with dry chili contributing the major share among spices (Revanappa et al., 1998). Chili is a rich source of vitamins A and C, and non-pungent, deep red varieties are used for paprika, where color is a key quality criterion. In 2012-13, chili cultivation in Bangladesh covered 93.55 thousand hectares, yielding approximately 102.25 thousand tons (BBS, 2015). The crop is consumed both fresh and dried, but its price fluctuates significantly each year, leading to high market uncertainty. This unpredictability makes production forecasting difficult, and the absence of an effective organization for chili production and marketing further complicates price stability. Additionally, fertilizer application plays a crucial role in chili growth, development, and yield (Peter, 1999).

Mango (Mangifera indica) is a dominant fruit tree in the tropics, belonging to the genus Mangifera of the Anacardiaceae family. Beyond its fruit, it serves multiple purposes, including timber, firewood, soil amendment, and cattle feed. Mango trees are widely spaced to support large crowns, maximizing fruit yield and allowing for intercropping, especially during early growth stages. Due to its adaptability, mango plays a crucial role in agroforestry systems, including tropical home gardens, alley cropping, and agri-horticultural systems (Nair, 1989). Its spatial arrangement allows efficient use of soil and water, with canopy gaps covering up to 30% of the land, enhancing intercropping potential. Mango roots exhibit significant depth variation, with a taproot reaching up to 6 meters (Canadell et al., 1996), and root activity concentrated at different depths depending on tree age—47.3 cm in an 18-year-old tree (Bojappa & Singh, 1974) and 215.9 cm in an 8-year-old tree (Kotur et al., 1997). This variation supports effective integration of crops like chili within mango-based agroforestry systems.

Chili variety ‘Bijli plus’ known for its high yield and pungency, can potentially benefit from the nutrient-rich amendments provided by poultry litter. Poultry litter, consisting of manure, feathers, and bedding materials, supplies essential nutrients such as nitrogen, phosphorus, and potassium, which are critical for the growth and development of chilies (Lin et al., 2018). Studies have shown that organic amendments can significantly enhance soil fertility, increase microbial activity, and improve the nutrient availability to plants, leading to better growth and higher yields (Reddy et al., 2016; Shah et al., 2017). However, the specific impacts of poultry litter on the growth, yield, and quality of 'Bijli Plus' chilies under mango-based agroforestry systems have not been extensively studied.

Organic materials such as poultry litter enhance crop yield and soil properties and sequester more carbon (C) in soils (Ud Din et al., 2023). Also, Organic litter reduce the salinity stress, Na+ adsorption ratio, and electrical conductivity (EC) by improving the physical, chemical, and biological characteristics of highly deteriorated soil for sustainable crop production (Guo et al., 2020). The addition of compost to soil influences plant growth positively even in a stressed environment. Research conducted by Soremi et al., (2017) showed that PL is the most cherished of all animal manures since it contains all the essential plant nutrients such as phosphorous, nitrogen, potassium, zinc, iron, chlorine, calcium, magnesium, boron, copper, molybdenum and sulfur which are responsible for the fertilization of the soils. This makes it the most suitable organic manure for chili production.

This study aims to investigate the effect of poultry litter on the growth, yield, and quality of 'Bijli Plus' Chilies cultivated under a mango-based agroforestry system. By examining various growth parameters, yield indicators, and quality attributes, this research seeks to provide valuable insights into the benefits and practical applications of using poultry litter in integrated farming systems. The outcomes are expected to guide farmers and agronomists in optimizing chili production within agroforestry frameworks, contributing to more sustainable agricultural practices.

In Bangladesh, there is a great possibility of increasing chili yield with judicious use of poultry litter compost in combination with fertilizers.

Research Problem: Considering the above facts, the following questions were set for the present research:

1) What will be the optimum poultry litter dose to get maximum yield of chili cultivation under mango based agroforestry system?

2) What will be the growth parameters of chili cultivation under mango based agroforestry system?

3) What will be the effect of different poultry litter dose on soil chemical properties of chili cultivation under mango based agroforestry system?

4) What will be benefit cost ratio (BCR) of chili production under mango based agroforestry system due to the effect of poultry litter?

Research objectives:

Considering the above facts and research questions, the following specific objectives were set to satisfy the research questions

1) To determine the growth parameters to chili grown under mango based agroforestry system.

2) To find out the optimum poultry litter dose for chili production under mango based agroforestry system.

3) To determine the changes of soil chemical properties of different poultry litter dose for chili production under mango based agroforestry system.

4) To compare BCR of chili production among different poultry litter dose for chili production under mango based agroforestry system.

CHAPTER 2

LITERATURE REVIEW

Agroforestry is a comparatively new field of organized scientific pursuit although the practice encompasses some age-old land use activities. It is an effective land management practice that simultaneously addresses biophysical, economical and socio ecological components. Such kind of diversity and interaction leads to a greater functional and structural complexity compared to conventional agro-ecosystems. Keeping this in view, an attempt has been made to review findings on Agroforestry practices with particular emphasis chili integration with poultry litter, a byproduct of poultry farming, into agroforestry systems has gained attention due to its potential benefits on soil fertility, plant growth, and crop yield. A review of the previous research and findings of researchers having relevance to this study which were gathered from different sources like literature, journals, thesis, reports, newspaper etc. are going to present in this chapter.

2.1 Concepts of agroforestry

Alao et al. (2013) stated that agroforestry has been defined as a dynamic ecologically based natural resources management system that through the integration of trees on farms and in the agricultural landscape diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. This paper highlighted agroforestry practices and concepts in sustainable land use systems. The benefit derivable from the interface between forest trees and agricultural crops are enormous. They include the optimal use of land for both agricultural and forestry production on a sustainable basis including the improvement of the quality of soil. This is in addition to the socio-economic benefits that are accruable from agroforestry. Indeed, the advantage of agroforestry is all encompassing and germane to a sustainable production system and livelihood.

According to the Food and Agriculture organization (FAO), "Sustainable agriculture is the successful management of agricultural resources to satisfy changing human needs while maintaining or enhancing the quality of environment and conserving natural resources". This concept emphasizes on present needs without sacrificing the needs of future (Brundtle and Commission, 1987).

"Agroforestry should be recognized as a dynamic, ecologically based, natural resource management system that, through the integration of trees in farm and rangeland, diversifies and sustains production for increased social, economic and environmental benefits (Leakey, 1996).

Hasanuzzaman et al., (2014) stated that cropland agroforestry is an important production system in the southwest region of Bangladesh. This study focused on the floristic composition and management of existing cropland agro-forests. A total of 313 cropland agro forests were surveyed and 83% respondents practiced pure agroforestry while the remaining 17% practiced agroforestry with fisheries. A total of 18 forest trees and 2 shrubs were recorded from 11 families and 59 fuel wood species and wider spacing for fruit trees. A wide range of rotation periods, from 5 to 25 years, was observed for both cases.

2.2 Benefits from Agroforestry system

Agroforestry can contribute to household income/consumption directly through the production of goods (fruits, poles, fuel wood) and indirectly through goods and services such as fodder for livestock, reduction of land degradation, improved soil and water conservation. In addition, other benefits can be realized downstream through reduction of soil erosion and/or increased water flow control. These systems at a more aggregate level can also provide services for international consumers, through benefits for example of carbon sequestration and protection of international waters (FAO, 2011).

"Agroforestry" is a collective name of land use systems through maximum utilization of agricultural land in order to provide multiple outputs as well as protect the natural resources (Suratman et al., 2011; Handayani and Prawito, 2011). It involves the integration of agricultural crops, plant materials, and livestock production (Rahman et al., 2011). These systems capture the traditional agriculture practices and adapt it using modern and new scientific technologies and knowledge (Wong, 2001; Oxfam Case Study, 2011; Handayani and Prawito, 2011) with the aim to provide long term sustainability instead of focusing on the maximum yield production.

Pandit et al., (2014) stared that Agroforestry has been recognized as one of the important systems for supporting the livelihoods of a large number of rural farmers in the Nepalese hills. In Agroforestry, complementary or competitive effects depends upon (i) age and size of the trees, (ii) nature of the tree species, (iii) nature of the agricultural crops, (iv)availability of water, nutrients and light etc. In an intercropping system involving a legume and non-legume, part of the nitrogen fixed in the root nodule of the legume may become available to the non-legume component which is an example of complementarily (Soundararajan and Palaniappan, 1979).

Samra and Singh (2000) observed in increase in soil organic carbon status of surface soil 0.39% to 0.52% under Acacia nilotica + Saccharum munja and 0.44% to 0.55% under Acacia nilotica+ Eulaliopsis binata after 5 years and suggested that Acacia nilotica + Eulaliopsis binata are conservative but more productive and less competitive with trees and suitable for eco-friendly conservation and rehabilitation of degraded lands of Shivalik foot hills of sub-tropical northern India.

Ram Newaj et al., (2008) observed that in agri-silviculture growing of Albizia procera with different pruning regimes, the organic carbon of the soil increased by 13-16% from their initial values under different pruning regimes which was 5 to 6 times higher than growing of either sole tree or sole crop. Soil fertility can also be regained in shifting cultivation areas with suitable species. For instance, a field experiment to study N2 fixation efficiency suggests that planting of stem-cuttings and flooding resulted in greater biological N_2 fixation, 307 and 209 kg N ha-1 by Sesbania rostrata and S. cannabina respectively. Thus, S. rostrata can be used as a green manure by planting the stem-cuttings under flooded conditions (Patel et al., 1996).

Singh, (1988) reported that suitable alternate land use systems involving agriculture, horticulture, forestry and Agroforestry has been designed with the support of local natural resources for almost identical hydrological behaviour as under the natural system.The model land use suggests utilizing slopes below 50% towards lower foothills and valley lands for agricultural crops and pisiculture, middle slopes between 50 and 100% for horticulture and top slopes over 100% for forestry / silvipastoral establishment. Under agri-horti-silvipastoral systems, the reduction in runoff was 99% and in soil loss 98%.

Kumar et al., (1998) observed that through a combination of mulching and water conservation, trees in agro-ecosystems may directly enhance crop yields of coarse grains. For instance, in the arid region of Haryana, the effect of Prosopis cineraria, Tecomella undulate, Acacia albida and Azadirachta indica on the productivity of Hordeum vulgare barley) was found to be positive. P. cineraria enhanced grain yield by 86.0%, 7. undulata by 48.8%, A, albida by 57.9% and A. indica by 16.8% over the control. Biological yield was also higher under trees than that in the open area. Soils under different tree canopies were rich in organic carbon content, moisture availability and nutrient status.

Venkateshwaralu, 1993 reported that the use of trees as shelterbelts in areas that experience high wind or sand movement in well-established example of micro climate improvement that resulted in improved yields Establishment of micro shelterbelts in arable lands, by planting tall and fast growing plant species viz., castor on the windward side and shorter crop such as vegetables in the leeward side of tall plants helped to increase the yield of bhendi yield by 41% and of cowpea by 21% over the control

Over exploitation of natural resources is a major challenge for sustainable production and livelihood security. Deforestation is that major cause which affected the bio-diversity of an ecosystem. Agroforestry with components like trees, agricultural crops, grasses, livestock etc provides all kinds of life support. However, Agroforestry may not entirely reduce the deforestation (Angelsen and Kaimowitz, 2004) but in many cases it acts as an effective buffer to deforestation. Trees in Agroforestry system act as a refuse to biodiversity after catastrophic events such as fire (Griffith, 2000). The traditional society of coastal belts and tropics of the country practicing homegardens and sacred groves help in bio- diversity conservation. Tree components in Agroforestry systems can be significant sink of atmospheric carbon (C) due to their fast growth and high productivity. By including trees in agricultural production systems, Agroforestry can, arguably, increase the amount of C stored in lands devoted to agriculture, while still allowing for the growing of food crops (Kursten, 2000). In Agroforestry system, tree components are managed, often intensively by pruning of minimizing competition and maximize complementarily. The pruned materials are mostly non-timer products. Such materials are often returned to soil.

2.3 Multipurpose and fruit trees based agroforestry systems

Oladokun et al. (1990) showed that almost all the farmers intercropped other crops with cocoa. The intercrops included food crops such as plantain (92.3), cocoyam (85.7%), cassava (51.3%), yam (41.3%), maize (38.9%), melon (31.4%), cowpea (28.6%) and pineapple (26.0%) and tree crops such as oil palm (71.5%), kola (67.3%), coffee 41.0%), coconut (7.9%) and citrus (7.2%). Other crops are ewe-tran (Sarcophrynium brachystachys) and ewe-gbodogi (Megaphrynium macrostachyum) (45.2%), african walnut (Tetracarpidium conophorum) (42.2%), aligator pepper (Aframomum melegueta) (31.6%), and iyere (Piper guinense) (20.2%), Guava, mango, pawpaw and vegetables such as celosia, okra and solanum occur in cocoa plots at rather low frequencies. As many as six or more other crops can be intercropped with cocoa at the same time.

Long et al., (2003) studied that the lacquer tree (Toxicodendron vernicifiuum) based agroforestry system is a very important farming system with development potential in western Yunnan, southwest China. It is, however, less understood in scientific fields. The Lemo people (a branch of the Bai minority nationality) traditionally grow lacquer trees interplanted with upland food crops in swidden fields. During a 10-15 year fallow period, farmers can harvest various products from lacquer trees, including resin for selling or trading, leafy shoots for vegetable, pericarps for making wax, roots and leaves for pesticide, dry resin for medicine, and seeds for vegetable oil extraction. The Lemo people believe the lacquer tree is the most important crop in their community. The lacquer agroforestry system provides the Lemo people with food, cash income and environmental benefits. Further studies on the lacquer agroforestry system will be indispensable to improve this system so as to disseminate it to other communities.

Nair, 1979 reported that introduction Agroforestry systems are characterized by the presence of woody perennials. The specific roles such woody perennials play in Agroforestry systems have formed the basis of Agroforestry systems inventory.

It is recognized that several thousand multipurpose tree and shrub species across the globe could have potential roles to play in Agroforestry systems development (Burley and von Carlowitz, 1984).

Most of these multipurpose tree and shrub species with Agroforestry potential exist in wild and unselected populations where they are likely to exhibit wide natural variability (Burley, 1978) Such populations can be expected to respond well to selection and breeding thus resulting in great increases in yield and adaptability to specific sites, fanning systems. Existing tree improvement programs are largely oriented towards large-scale plantation forestry production systems. A majority of AFS are found in the tropics and sub-tropics where fruit-trees constitute an important component of Agroforestry systems (Nair 1991).

In these contexts, the interactions between the characteristics of AFS and the behavior of fruit-trees receive an increasing interest for crops such as coffee (e.g., shade versus productivity, Cerdan et al., 2012) and cocoa (eg, spatial structure and biodiversity versus productivity (Deheuvels et al. 2012) or pests and diseases (Gidoin et al. 2014). It is likely between the two world wars, along with a generalized specialization of all production systems in agriculture, that the increasing demand for fruits entailed the disintegration of these fruit-tree-based AFS and fruit hedges, and the emergence of orchard systems precursors of modern intensive orchards, mechanized crop and fodder production (Herzog, 1998).

Pathak and Dagar, (2000) compared prevalent Agroforestry systems in various ecological zones and found that the number of plant species per unit area, canopy layers. and the animal species dependent upon them show greater richness in tropical ecological zones than in arid or subtropical zones.

In Nepal, growing fodder trees on the terrace risers is very common. This provides fodder to the animals while protecting the farmland from terrace failure (Joshy, 1997). The bamboo is also planted for erosion control and people use the bamboo poles as wall to project terraced rice fields. In most of the dry regions, the underground aquifers are saline.

Recent research efforts have shown that these waters can successfully be explored for establishment of trees and developing suitable Agroforestry systems (Dagar 2014: Dagar et al., 2014b, 2016b, Dagar and Minhas 2016, Yadav and Dagar 2016). They are so classified according to the attributes of the plant species as well as to the plant's functional role in the Agroforestry systems under consideration (Burley, 1978; Burley and von Carlowitz, 1984).

With the introduction of fast growing and supposedly "economically" superior exotic species most of the local species have been ignored and their great potential has been overlooked (Maydel, 1990; 1996).

Trees grown on farms for their non-timber forest products such as fruits, nuts, and spices constitute the basis for many vibrant and sustainable farming systems throughout the world. Yet, compared to other types of trees, research on horticultural and agronomic management of such trees and systems to optimize total system-yield and understand tree-crop interactions is scarce. Farmers prefer fruit-producing species to other trees for on-farm planting (Raintree, 1992; Franzel et al., 1996), and appreciate the dual contributions of food for consumption (Salam et al., 2000) and the potential for income generation (Delobel et al., 1991; Ayuk et al., 1999).

Hellin et al., (1999) observed that fruit trees are considered advantageous because of the relatively high returns to labor resulting from low labor inputs (compared with annual crops); moreover, fruit tree-based systems also offer a more uniform distribution of income throughout the year than annual crop systems. However, the relatively "free" availability of forest-based timber- and fuel wood products in some areas are seen as disincentives for growing tree species for those purposes.

2.4 Mango based Agroforestry system

Rahman et al., (2012) stated that in the Padma floodplain of Bangladesh, the traditional system of agriculture has become unsuitable due to high population growth. Mango based agroforestry which has been practiced by the farmer since the 1990s, is a promising alternative and is considered as one of the few options to lift farmers out of poverty and improve livelihood security. Farmers with the least were found to allocate a higher percentage of their land to agroforestry, and the increased income from agroforestry compared to other agricultural systems helps reduce relative poverty. This income maintains basic household needs, providing food security and fuel wood, and contributes to healthcare, housing and sanitation conditions, and meeting educational expenses.

Rocheleau et al., (1988) reported that mangoes are well adapted to cultivation and have been grown commercially for centuries as a source of fruit, medicine, fodder, firewood, timber, poles and shade.

Abedin et al., (1987) conducted a survey in the Ganges floodplain of Bangladesh to understand the distribution and uses of multipurpose trees, tree- crop interactions, and the crafts/cottage industries these trees support. A predesigned survey questionnaire was used. Results showed that Acacia nilotica, A catechu, Artocarpus heterophyllus, Phoenix sylvestris, Borassus flabellifer and Mangifera indica are the major tree species grown on the croplands in the low-rainfall Ganges floodplain area for fruit, timber, fuel, and building material The trees support different crafts/cottage industries. Fuel was a common, though not primary, use of all the tree species. Uses of particular trees varied from place to place and their order of importance changed over time. Species distribution differed among regions. Tree crop combinations and their interactions depended more on land type, age of the trees, canopy structure, and plot location of trees rather than the type of species grown. Determination of optimum tree densities, optimum economic age for cutting, relative economic importance, and improved management practices are critical issues for future research.

Shinde et al. (2010) found that the grain yield plant indicated positive and highly significant correlation with straw yield plant, harvest index and weight of grains on main ear head at phenotypic and genotypic level, while number of fingers on main ear head at genotypic level only. Under mango based agroforestry system, path analysis indicated that finger length, harvest index, number of fingers on main ear head and straw yield plant" had direct positive effect on grain yield at genotypic level. Selection program based on number of fingers on main ear head and straw yield plant will be effective for grain yield improvement in finger millet under mango based agroforestry system

Alam et al., (2011) stated that the cultivation of different plants around homesteads for subsistence and cash income has been a long tradition in Bangladesh. This study explores stand structure, composition, and biodiversity within the homestead agro forests of the drought-prone, northwestern region of Bangladesh. In 96 randomly selected homesteads within 3 study villages, we identified 56 tree species. Among those, Mangifera indica (mango) was the most popular fruit bearing species. Four non-parametric diversity indices were derived to provide a characterization of biodiversity. The Sørenson similarity index was also used to compare the similarity of species among different landholding size classes. The overall Shannon-Wiener biodiversity index and Pielou's evenness index values were 1.82 and 0.45, respectively. This study confirms that the farmers had strong preference for fruit species over timber yielding ones, and because of better growth performance natives were preferred over exotics.

Rahman et al., (2012) studied that the traditional system of agriculture has become unsustainable due to high population growth. Mango-based agroforestry which has been practiced by the farmers since the 1990s, is a promising alternative and is considered as one of the few options to lift farmers out of poverty and improve livelihood security. This paper examines the potential of mango-based agroforestry to improve livelihoods, using data collected by rapid rural appraisal, farmer participatory research, stakeholder analysis and a farm household survey in six representative villages in the floodplain. Farmers with the least land were found to allocate a higher percentage of their land to agroforestry, and the increased income from agroforestry compared to other agricultural systems helps reduce relative poverty. This income maintains basic household needs. providing food security and fuelwood, and contributes to healthcare, housing and sanitation conditions, and meeting educational expenses.

Etadthong et al., (2000) observed that wild Mangifera species are restricted to tropical Asia. The mainland of Southeast Asia includes over 70 species of Mangifera species and is epitome of their diversity. Local Mangifera species are found throughout Southeast Asia, growing not only in natural habitats but also in agricultural fields and home gardens. There are over 1000 named Mangifera indica varieties throughout the world, which is a testament to their value to humankind. Today, mangoes are recognized and consumed throughout the world and are regarded as one of the most popular and esteemed tropical fruits. With nearly US$ 500 million worth of mangoes exported each year and 40 times that amount consumed in the countries of production, its role in income generation and household food security is evident (Griesbach, 2003).

Mango is an important component of agroforestry systems in many parts of the world (Nair, 1989) Mango offers great advantage in agroforestry due to the spatial advantage it provides for intercropping, as it is generally planted at wide spacing to accommodate the large crowns that are needed to support the fruit yield. Wider spacing of the trees ensure large gaps in the canopy upto 30% of the land area. They also offer ample scope for exploitation of soil depth due to spatially differential root distribution of component crops in the system ensuring a higher nutrient and water use efficiency. Root abundance of plants is usually highest at the topsoil (Canadell et al., 1996).

Tree crops are not an exception and often have their maximum root length density stretching from shallow organic litter layer to several meters depth. However, root distribution is primarily function of the tree species or the genotype which is often modified by cropping system and stand management practices. Shaded tree crops such as coffee and cacao tend to have a shallower root activity than the grown fruit trees (Lehmann, 2003).

Mango has a long taproot that can often reach up to 6 m soil depth. Bulk of the root activity (75%) in mango was found to be at a shallow depth (47.3 cm) in an 18 year old tree (Bojappa and Singh, 1974), while it was estimated to be as deep as 215.9 cm in an 8 year old tree (Kotur et al., 1997). This wide variation in root activity provides scope for effective integration of other crops.

Musvoto et al. (2000) observed that mango litter decomposes at slower rate compared to many tropical trees. By virtue of its slow rate of decomposition, it may not be preferred for quick soil fertility correction (Musvoto and Campbell 1995).

Under tropical conditions, Musovoto et al. (2000) reported N immobilization during decomposition of mango residues. They attributed this immobilization to high polyphenol (18.6%) content.

Mubarak et al., (2008) reported that moderate change in concentration for most of the nutrients across months indicates the slow nutrient releasing mature of mango litter. Despite its limitation for short term correction of soil fertility, mango leaves can be used for long-term buildup of soil organic matter. Mango litter can act as a slow nutrient releaser for longer periods; thereby play a major role in maintaining long term soil fertility.

In a study conducted in Sudan, Mubarak et al., (2008) observed that half-life value for mango litter was about 17.6 weeks. Time taken for 50% loss (mineralization) of N. P and K from mango litter was 24.1. 18.4 and 6.9 weeks respectively.

Pleguezuelo et al., (2009) reported mass-loss dynamics over a period is best described by the single exponential decay model. As per the single exponential decay model, mango had the lowest decay rate constant (k=0.64 year-1) among the four fruit trees tried.

2.5 Spice based agroforestry system

Narain et al. (1997) conducted a field experiment The plots were planted with Leucaena leucocephala and Eucalyptus hybrid, either as block plantation or in alley farming with maize (Zea mays), Chrysopogon fulvus grass or turmeric (Curcuma longa). The runoff and soil loss were reduced by 27% and 45% by contour cultivation of maize Contour tree-rows or leucaena hedges reduced the runoff and soil loss by 40% and 48%, respectively, over the maize plot, reducing soil loss to about 125 Mg ha. Such vegetative measures, that are productive while being protective, offer viable alternative for erosion control in areas with gentile slopes of the valley region. High density block plantations of eucalyptus and leucaena almost completely controlled erosional losses and can be recommended for steeper slopes that are vulnerable to heavy erosion

Bahadur et al. (2000) conducted a field experiment to study the effect of different spacing (50 cm x 20 cm, 50 x 30 cm and 50 x 40 cm) and K20 rate (0, 40, 75, 120 and 150 Kg ha G1) on the growth, dry matter, production and yield of turmeric (Curcuma longa L.). Close spacing produced the tallest plants (87.89 cm), medium spacing produced the plants (87.89 cm), medium spacing produced the plants with the highest finger breadth (6.95 cm) and primary finger per plant (2.71) while wide spacing produced with the highest number of tillers per hill

(3.42), leaves per plant (8.56), total dry weight per plant (53.79 g) and highest yield per plant (189.35 g). But total yield (t ha Gl) was highest with close spacing. Almost all of the characters studied showed increasing trend with increasing rate of potassium and the highest yield (15.4 tha G1) was obtamed with 120 Kg ha G1K20 The interaction effect of spacing and potassium exhibited insignificant variation in most of the characters

Hossain et al., (2009) studied that the effects of relative light intensity (RLI) on the growth, yield and curcumin content of turmeric (Curcuma longa L) were examined in Okinawa, Japan. The plants were shaded with white nets with different mesh sizes for maintaining respective RLI. Five RLI, 100 (without shading), 82, 79, 73 and 59% in 2004-2005 and four RL1, 100, 68, 52 and 48% in 2005-2006 were evaluated. In the first experiment, plant height increased markedly, but the number of leaves and tillers, and SPAD value increased slightly in the plants grown at 59-82% RLI compared with control (without shading). Turmeric shoot biomass and yield increased significantly at 59-82% RLI and they were highest at 73% RLI in the first experiment. Curcumin content of turmeric increased markedly at 59-73% RLI as compared with the control in the first experiment. Similar results in plant growth, shoot biomass, yield and curcumin content were obtained in the second experiment, but the effects of RLIs were smaller than in the first experiment because of late planting. This study indicates that turmeric is a partial shade-tolerant plant that could be cultivated at around 59-73% RLI for higher yield and curcumin content in Okinawa. However, the degree of RLI required for better turmeric cultivation may vary with the place, year and irradiance level

Das et al., (2011) conducted an intercropping trial during 2007-2010 on 6-year-old aonla (Emblica officinalis Gaertn., cv. NA-7) orchard planted at 6m 6 m spacing and growing under rain fed calciorthent soil, to identify the suitable and profitable intercrops. The intercrops grown were turmeric, ginger and arbi. The results indicated that the production of fruits significantly increased due to intercrops and it was maximum in aonla in association with turmeric (13.30 tonnes/ha) followed by arbı (11.71 tonnes/ha), On the other hand, reduction in yield of intercrops was 7.5-12.0% for turmeric, 12.2-19.3% for ginger and 15.7-25.3% for arbi compared to the yield in open area without trees

Khan et al., (2015) experimented that turmeric is grown as medicinal plant in Pakistan whereas mulberry is cultivated mainly for silkworm rearing. The study was conducted to assess the potential of turmeric varieties as intercrop with mulberry. Turmeric mtercropping with mulberry plantation was grown to evaluate four varieties and planting distance of turmeric rhizomes on the basis turmeric yield performance. Three planting distances (20, 40 and 60 cm) for each variety were maintained with three replications in Randomized Complete Block Design. The results showed that turmeric yield was higher when grown with 40 cm planting distance. The comparative performance of varieties indicated that Kesari was the best variety with respect to yield tons/ha (50.33 ± 2.517) to be grown with mulberry as an intercrop with planting distance of 40 cm. Kasturi and CA69 having medium duration growth habit are suitable for cultivation as intercrop with mulberry. The study emphasizes that mulberry plantations may be intercropped with turmeric to harvest the maximum potential of resources.

Pramila et al., (2016) conducted a field experiment to evaluate the effect of poplar based agroforestry system and open system (without poplar) on yield of different wheat varieties and soil physio-chemical properties. The experiment was laid out in randomized block design with 4 treatments and each replicated thrice under both the growing conditions. The crop treatments are wheat varieties viz. UP-2572, PBW-550, DBW-711 and PBW-373. The highest grain yield of all the wheat varieties was obtained under open farming system. Highest grain yield of wheat was recorded in UP-2572 under open farming system. Agroforestry is proven land use system for vertically enhancing soil health against unsuitable weather condition. The distribution of soil properties was detected from the depth 0-15 cm in poplar based agroforestry system and as well as in open system. During the experiment it was found that agroforestry adds more nutrients to the soil compared to open system.

2.6 Chili based agroforestry system

Islam et al., (2008) conducted a field experiment to evaluate the performance of seven winter vegetables under coconut-lemon based multistrata system Chili, chili, carrot, onion, garlic, turnip and french bean were the tested vegetables under two treatments namely multistrata system T1 (Lemon + Coconut based, 35-50% reduced Photosynthetic Active Radiation (PAR)) and full sunlight condition TO (100% PAR). There were significant variations in respect of plant height of winter vegetables (except chili and turnip) under shade condition. On the other hand, significantly highest yield per plot and yield per hectare were observed when plant grown under full sunlight condition. Moreover, the economic analysis showed that among the seven vegetables carrot gave the highest economic return (108,937 Tk./ha) followed by chili (95295 Tk./ha) under multristrata (Lemon Coconut) agroforestry system.

Therefore, production of winter vegetables especially carrot and chili under multistrata agroforestry systems are economically profitable than sole production systems.

Mutanal et al., (2009) conducted a long term experiment on agroforestry involving arable crops (sorghum, groundnut, chili and ragi), silvicultural crop (teak), horticultural crop (papaya) and pasture crops (subabul and guinea grass) was initiated during 1984 on red gravelly soils at Dharwad (Karnataka). Teak was planted at 10 m and 20 m apart with 2 m between plants. In between two teak plants a papaya seedling was planted. On either side of teak+papaya row, grass slips and subabul seedlings were planted. Of the 4 arable crops, one crop was grown each year in fixed rotation in the interspaces of teak rows from 1994-2005. Grain yield of arable crops was higher in 20 m alley of teak+papaya rows as compared to 10 m alley of teak+ papaya. Among the four crops, average grain yields were obtained in the order of sorghum > groundnut > ragi > chili with teak. Net returns were in the order of groundnut > sorghum > ragi > chili. During 1984-93 and sorghum > groundnut > ragi > chili during 1994-2001. Groundnut and sorghum crops realized stable yields and returns as compared to chili or ragi. Grain yields were significantly higher in teak+papaya as compared to teak+papaya+grass or subabul.

2.7 Performance of crops in Agroforestry system at different fertilizers dose

Chili is famous for its pleasant aromatic flavor, pungency and high colouring substance. Among the spices, dry Chili contributes the major share in India (Revanappa et al., 1998). Chili (Capsicum annuum L.) belongs to the family solanaceae. It is one of the most valuable commercial annual spice crop grown in India. It is rich source of vitamin A and C. Chili fruits having deep red color, without pungency are used as paprika color is the principal criterion for assessing its quality. Chili is one of the most important nutritious and its green fruits. It is difficult to obtain higher yields of good quality fruits throughout the year under open conditions in most parts of India. The cultivation of Chili is possible even during the off season under greenhouse condition.

Fertilizer application has a pronounced influence on plant development, growth and marketable yield of many vegetable crops production of chilies (Peter, 1999). Inorganic and organic fertilizer: Inorganic fertilizer or fertilizer is any material of natural or synthetic origin (other than liming materials) that is applied to soils or to plant tissues (usually leaves) to supply one or more plant nutrients essential to the growth of plants.

This also depends on its soil fertility as well as organic things such as humic acid, seaweed and worm castings.

Ghosh et al. (2004) observed that farm Yard Manure (FYM) refers to decomposed mixture of dung and urine of farm animals along with the litter (bedding material) and left over material from roughages or fodder fed to the cattle. On an average, well-rotted FYM contains 0.73 per cent N, 0.18 per cent P205and 0.71per cent K20, 100 per cent dose of FYM is 9 t/ha

Ghosh et al., (2004) also observed poultry manure Poultry litter or broiler litter is a mixture of poultry excreta, spilled feed, feathers, and material used as bedding in poultry operations. This term is also used to refer to unused bedding materials. Poultry litter is used in confinement buildings used for raising broilers, turkeys and other birds. Common bedding materials include wood shavings, sawdust, peanut hulls, shredded sugar cane, straw, and other dry, absorbent, low-cost organic materials. Poultry manure contains 2.14 percent N, 1.09 percent P_2 Osand 1.23 percent K_2 O.

Rao et al. (2015) reported that vermicompost is the product or process of composting using various worms, usually red wigglers, white worms, and other earthworms to create a heterogeneous mixture of decomposing vegetable or food waste, bedding materials, and vermin cast. Vermicast, also called worm castings, worm humus or worm manure, is the end-product of the breakdown of organic matter by an earthworm. These castings have been shown to contain reduced levels of contaminants and a higher saturation of nutrients than do organic materials before vermicomposting. Vermicompost contains 1.6 per cent N, 1.8 per cent P_2 Os and 0.75 per cent K_2 O.

2.8 Poultry Litter as Organic fertilizer

Poultry litter is rich in essential nutrients such as nitrogen, phosphorus, potassium, and micronutrients, making it a valuable organic fertilizer for crop production (Kumar et al., 2017). Its nutrient composition varies depending on factors like diet, age of birds, and management practices. Poultry litter, a mixture of excreta, bedding material, feathers, and spilled feed, is a valuable byproduct of poultry farming that serves as an organic fertilizer for crop production. Understanding its nutrient composition is essential for optimizing its application in agricultural systems. This literature review explores the nutrient composition of poultry litter and its variability based on factors such as diet, bird age, and management practices.

Poultry litter is a significant source of nitrogen, primarily derived from excreta and residual feed. Kumar et al. (2017) reported nitrogen content ranging from 2% to 5% in poultry litter, making it a valuable source of this essential nutrient for crop growth and development. However, nitrogen content can vary based on factors such as dietary protein levels and nitrogen retention by birds (Dou et al., 2019). Phosphorus is another essential nutrient present in poultry litter, primarily originating from feed ingredients and metabolic processes in birds. Studies have indicated phosphorus content in poultry litter ranging from 1% to 3%, providing a significant source of this nutrient for plants (Ritz et al., 2018). However, variations in phosphorus content can occur due to differences in dietary phosphorus levels and bird age (Kumar et al., 2020). Poultry litter contains potassium derived from both feed ingredients and metabolic processes in birds. The potassium content in poultry litter typically ranges from 1% to 3%, contributing to soil fertility and plant nutrition (Cela et al., 2021). However, factors such as dietary potassium levels and bird management practices can influence potassium concentrations in poultry litter (Singh et al., 2019).

In addition to macronutrients, poultry litter contains various micronutrients essential for plant growth, such as zinc, copper, manganese, and iron. These micronutrients originate from feed ingredients and metabolic processes in birds. The concentrations of micronutrients in poultry litter can vary depending on factors like feed composition and bird health (Kumar et al., 2017). Poultry litter serves as a valuable organic fertilizer due to its rich nutrient composition, including nitrogen, phosphorus, potassium, and micronutrients. However, its nutrient content can vary depending on factors such as diet, age of birds, and management practices. Understanding these variations is crucial for effective utilization of poultry litter in crop production systems.

Several studies have reported improvements in soil fertility parameters upon the application of poultry litter. Singh et al. (2019) found that poultry litter enhanced soil organic carbon, nitrogen, and phosphorus content, consequently improving soil health and nutrient availability for plant uptake. Additionally, increased soil microbial activity and enzyme concentrations have been observed, indicating enhanced nutrient cycling and soil ecosystem functioning (Kumar et al., 2020). Poultry litter, a mixture of manure, feathers, bedding material, and spilled feed, is a rich source of nutrients essential for plant growth. Its utilization as an organic fertilizer has gained attention due to its nutrient content and potential to improve soil fertility. This literature review explores the impact of poultry litter on the growth, yield, and quality of chili (Bijli Plus) cultivated under a mango-based agroforestry system. Poultry litter is rich in essential nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and micronutrients like zinc (Zn), manganese (Mn), and copper (Cu). According to a study by Al-Nasser et al. (2019), poultry litter contains approximately 3% N, 2% P, and 2% K along with significant amounts of organic matter.

Application of poultry litter enhances soil fertility by supplying essential nutrients and improving soil organic matter content. Research by Oyedeji et al. (2020) demonstrated that the incorporation of poultry litter into the soil increased soil organic carbon, nitrogen, and available phosphorus, thus improving soil fertility and promoting better plant growth. Several studies have investigated the effect of poultry litter on the growth parameters of chili plants. For instance, a study by Sharu (2000) reported significant improvements in plant height, leaf area, and stem girth of Chili plants treated with poultry litter compared to untreated controls. These findings indicate the positive impact of poultry litter on the vegetative growth of chili plants.

Poultry litter application has been shown to enhance the yield of chili crops. A study by George & Onwugbuta-Enyi, (2023) demonstrated that the incorporation of poultry litter into the soil significantly increased chili yield compared to chemical fertilizers alone. The enhanced yield could be attributed to the balanced nutrient supply and improved soil fertility provided by poultry litter. In addition to promoting growth and yield, poultry litter application may also improve the quality of chili fruits. Research by Akshay et al. (2018) found that chili grown with poultry litter exhibited higher levels of antioxidants, vitamins, and minerals compared to those grown with synthetic fertilizers. This suggests that poultry litter can contribute to the production of nutritionally superior chili fruits.

Integrating poultry litter application with mango-based agroforestry systems can further enhance its benefits. Mango trees provide shade, reduce soil erosion, and contribute organic matter through leaf litter, creating a conducive environment for chili cultivation. Research by Singh et al. (2019) highlighted the synergistic effects of poultry litter and agroforestry on soil health and crop productivity, indicating the potential for sustainable intensification. In conclusion, poultry litter application has significant positive effects on the growth, yield, and quality of chili (Bijli Plus) crops cultivated under mango-based agroforestry systems. Its rich nutrient composition improves soil fertility, promotes vegetative growth, enhances yield, and contributes to the nutritional quality of Chili fruits. Integrating poultry litter with agroforestry practices offers a sustainable approach to enhance crop productivity while maintaining soil health and ecosystem services.

2.9 Economics of agroforestry system

Agroforestry is 'a land-use system that involves deliberate retention, introduction, or mixture of trees or other woody perennials m crop or animal production systems to take advantage of economic or ecological interactions among the components' (SAF, 2012).

Kassa, (2015) studied that Fruit-tree based agroforestry represents a more environmentally friendly system, the economic returns and adoption determinants of which have only been modestly studied to date. This study investigated the determinants of practicing fruit-tree based agroforestry and the associated costs incurred and returns earned by practitioners. It contrasted the economic performance of agroforestry based systems versus monocropping systems using economic performance indicators at the household level in Wando District. Data were collected from 149 selected households through structured interviews, focus group discussions, key informant interviews, market assessments as well as field observation. Variables including nearness to the main road, farming experience, labor, land size and income significantly affected the practice of fruit tree based agroforestry system. Attention is needed in the design of policies and strategies for promoting the fruit-tree based agroforestry system which is more attractive financially, in addition to being labor saving and less risky investment than the mono-cropping systems.

Mercer and Alavalapati, (2004) reported that additional investments in econom.ics research will be required, however, for agroforestry to achieve its full potential.

Cubbage et al., (2012) studied that small-scale agroforestry, common in the tropics, provides multiple products for small farmers and good mixes of low-cost inputs. Medium-scale agroforestry may involve larger crop systems and focus on two or three simple tree and crop or grazing systems. Large-scale agroforestry remains uncommon, with silvopasture perhaps the most promising.

Mercer, (2004) reported that no matter how efficient and eco-friendly they are, agroforestry systems can contribute to sustainable land use only if they are adopted and maintained over long time periods.

Adoption of agroforestry is considerably more complex than most agricultural innovations, because it usually requires establishing new input-output mixes of annuals, perennials and other components, combined with new conservation techniques such as contour hedgerows, alley cropping and enriched fallows (Rafiq, Amacher and Hyde 2000).

CHAPTER 3

MATERIALS AND METHODS

A field experiment was conducted at the Agroforestry and Environment research Field, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur 5200 during January, 2024 to April, 2024 to find out the effect of poultry litter based composts on the performance of Chili. The materials and methods for the experiment were presented in this chapter under the following headings.

3.1 Experimental Location

The present piece of research work was conducted in the experimental field of Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200. The location of the site is 88°66´ E longitude and 25°71´N latitude with an elevation of 37.5 m from sea level (Anon, 1989). Location of the experimental site presented in

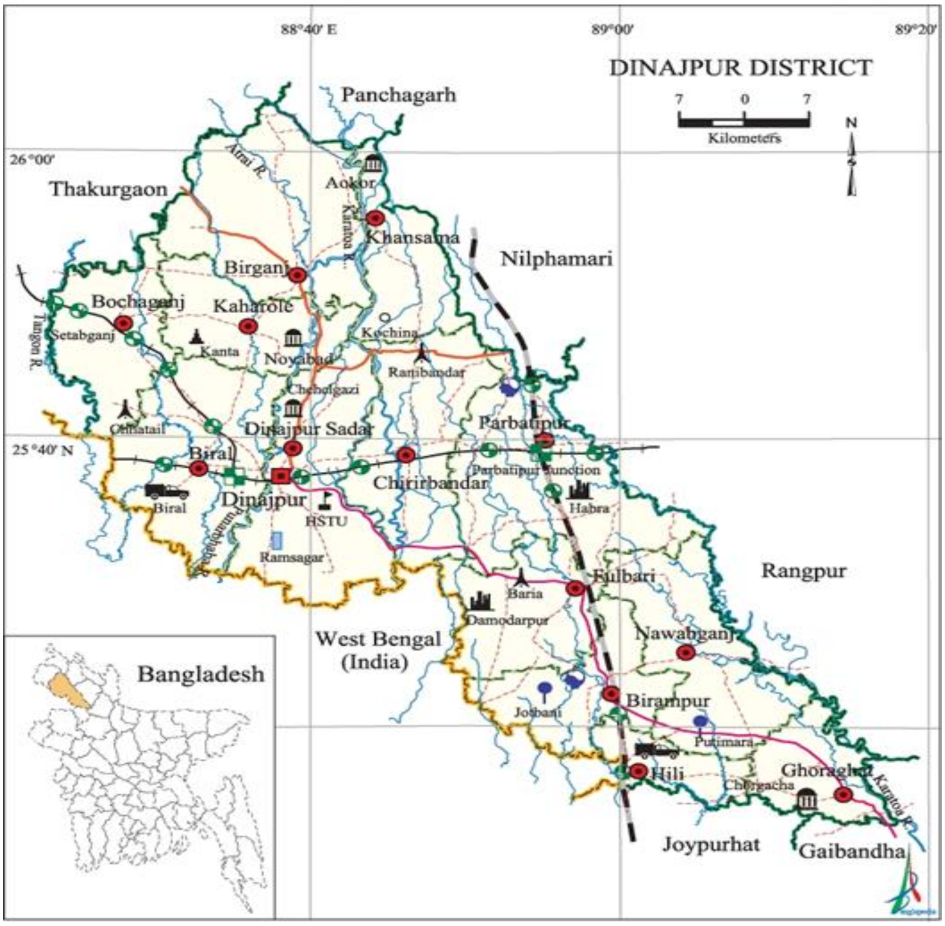

Figure 3.1 Map showing Dinajpur district (Source: Banglapedia)

3.2 Soil characteristics

The Agro-Ecological Zone (AEZ) -01, encompassing the agroforestry research field at Hajee Mohammad Danesh Science and Technology University (HSTU) in Dinajpur, was characterized by its distinct soil properties, which played a crucial role in agricultural productivity and sustainability. AEZ-01 is primarily defined by its Old Himalayan Piedmont Plain, known for its high fertility and favorable conditions for diverse cropping 19 systems, including agroforestry practices. Soil in AEZ-01 was typically loamy to sandy loam, with a well-drained profile that supports the healthy growth of various tree species and understory crops. The organic matter content was relatively high, enhancing soil structure, water retention, and nutrient availability. The organic carbon content in this region ranges from 1.5% to 2%, which is beneficial for maintaining soil fertility and supporting sustainable agricultural practices. In the context of agroforestry research at HSTU, the integration of trees with crops leverages the soil's inherent fertility while contributing to long-term sustainability. Trees in agroforestry systems can enhance soil organic matter through leaf litter and root biomass, improving soil structure and nutrient cycling.

3.3 Agro-Climatic conduction

The experimental area is characterized by less rainfall during the rabi season (October March) and moderated temperature, low humidity, and heavy rainfall during the Kharif season (April-September) with occasional rainy winds. Annual high temperature 33.640C and low temperature 23.410C, average annual precipitation 158.53mm. Details of the weather data such as temperature (0C), precipitation (mm) and relative humidity (%) for the study period were collected from Bangladesh Meteorological Department, Dinajpur- 5200.

3.4 Experimental details

This study investigates the impact of poultry litter application on the growth, yield, and quality of Chili (*Capsicum annum* L.cv. Bijli Plus) cultivated within a mango based agroforestry system.

3.4.1 Treatments

The experimental design includes 4 treatment and 3 replication combinations with varying levels of poultry litter application:

The treatment combinations are given below:

- T1= 10 ton/ha
- T2=7.5 ton/ha
- T3=5 ton/ha
- T4= Control (no poultry litter)

3.5 Design of the experiments

The experiment was done in Randomized Complete Block Design (RCBD) with three replications. There were 12 plots. The unit plot size was 2m x 2m.

3.6 Layout of the field experiment

First, the experimental field was divided into two blocks. For the treatment combinations, each block was divided into 6 plots. There were 12 plots in total. Each block was subsequently assigned to 6 treatment combinations according to the experimental design. The plot size was 2m × 2 m. The distance between the two plots was 0.5 m with blocks being 0.75 m. The field layout is shown in Figure 3.2.

3.7 Field selection

A mango based field was selected inside the Research field of the Department of Agroforestry and Environment. The age of Mango (Var. Amropali) was 17 years (planted in 2006).

3.8 Land preparation

The research land was prepared by power tiller on 18 January 2024. All debris was cleared and field plot was manually prepared. Poultry litter, Cow dung and chemical fertilizer were applied as per recommended amount as suggested by the Fertilizer Hand Book. Size of field plot was 2m x 2 m and Total plots were 12.

3.9 Seedling Collection

The seedlings were collected from Krishi Bazar, Rangpur. The variety of seedling was Bijli plus Chili which was released in Syngenta Seed Company Ltd. The total number seedlings were 350.

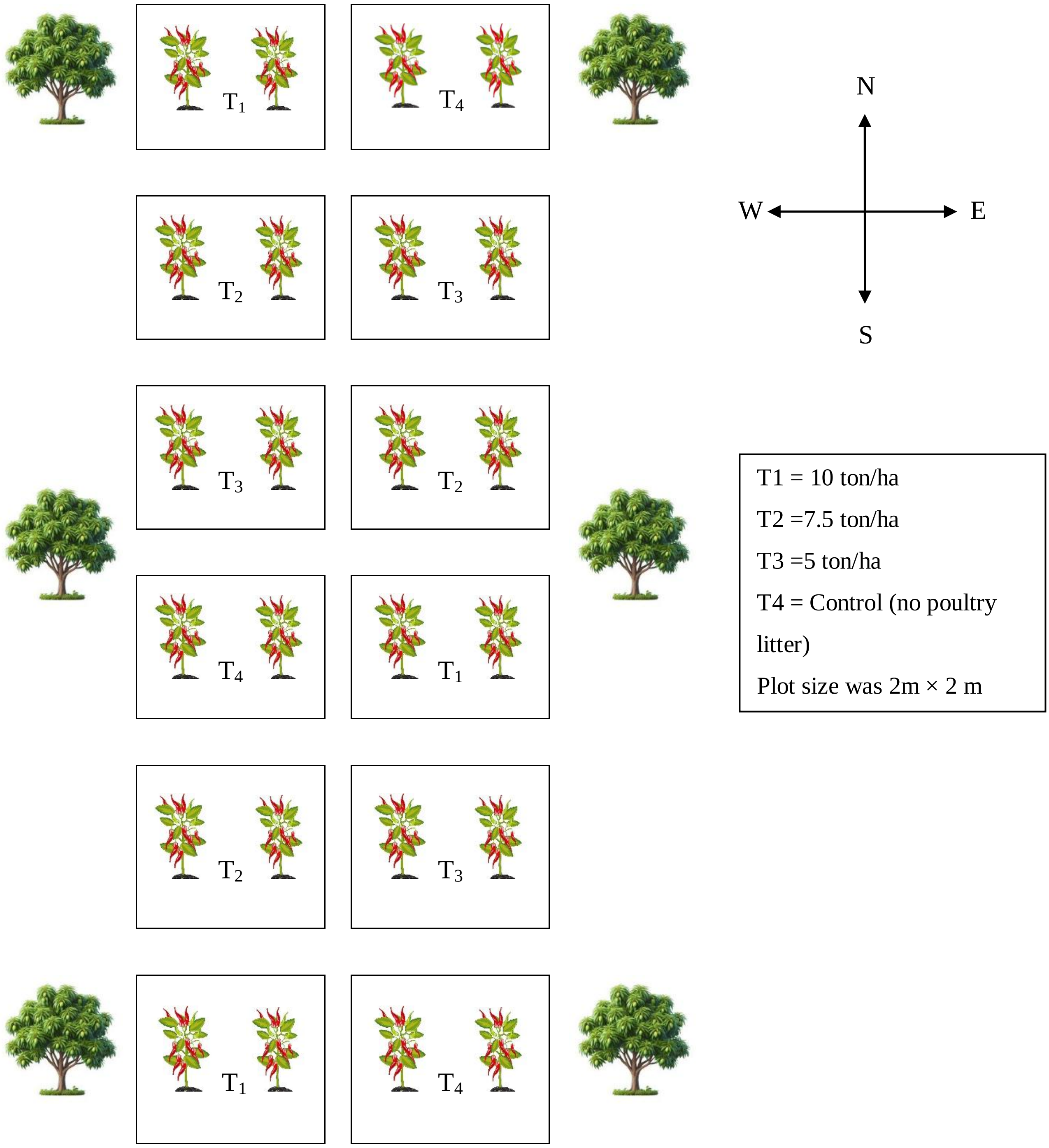

Figure 3.2 Showing the experiment layout for chili cultivation under Mango based agroforestry system

3.10 Fertilizers and manure application

As per treatment mentioned earlier, all the composts and fertilizers were given during final land preparation except Urea. Urea was applied into three equal splits, and the 1st dose was given at final land preparation, 2nd and 3rd doses were given 20 and 40 days after transplanting respectively.

Manures and fertilizers were applied to the experimental plot considering the recommended Agricultural Hand Note Book. Application of manure and fertilizer were considering in 48m2 area of land in the below table.

Manures/fertilizers	Doses gm/48 m^2
Cow dung	70800
Urea	1280
TSP	1079
MoP	604.8
Gypsum	640.8
Zinc	35.5
Borax	35.52

3.11 Transplanting of seedlings

Healthy and 25 days old seedlings werw transplanted into the experimental field. Seedlings were transplanted at the (60x40) cm2 at the rate of 25 seedlings per plot. Light irrigation was given after transplanting.

3.12 Intercultural Operation

3.12.1 Gap filling

Very few seedlings were damaged after transplanting and new seedlings from the same stock were replaced these.

3.12.2 Weeding

The plants were kept under careful observation. Three times weeding were done during cropping period.

3.12.3 Irrigation

Light over-head irrigation was provided with a watering can to the plots immediately after transplanting and it was continued for a week for rapid and well establishment of the transplanted seedlings. Irrigation was also applied as and when necessary.

3.12.4 Plant protection

Chili plants were attacked by Chili mites in 3 March,2024 with favourable conditions by raising temperature and shading. The crop was protected from the attack of insect-pest by spraying Imidachloropid insecticide.

3.13 Harvesting

Fruits were harvested 6 times at 10 days intervals during mature green stage when they attained harvesting maturity. Harvesting was started from 19 May,2024 and was continued up to 8 July.

3.14 Data Collection and Recording

Ten plants were selected randomly from each unit plot for recording data on crop parameters and the yield of grain and straw were taken plot wise. The following parameters were recorded during the study:

3.14.1 Growth parameters

1. Plant height (cm)
2. Number of leaves plant^{-1}
3. Leaf length (cm)
4. Leaf breath (cm)
5. Number of branches plant^{-1}
6. Chlorophyll content (mg/g)

3.14.2 Yield parameters

1. Fruit length (cm)
2. Fruit diameter (cm)
3. Number of fruit plant^{-1}
4. Single plant fruit weight (gm)
5. Yield plant^{-1} (kg)
6. Yield plot^{-1} (kg)
7. Yield (t ha^{-1})

3.15 Procedure of recording data

3.15.1 Growth parameters

Plant height (cm)

Plant height was recorded at 15, 30 and 45 days after transplanting (DAT) and at harvest of crop duration. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot. The height was measured in centimeter (cm) from the ground level to the tip of the leaves.

Number of leaves plant^{-1}

Number of loose leaves plant-1 was counted at different days after transplanting (DAT) of crop duration. Leaves number plant-1 was recorded from pre-selected 5 plants by counting all leaves from each plot and mean was calculated. It was recorded at 15, 30 and 45 DAT.

Leaf length (cm)

Leaf length was measured by using a meter scale. The measurement was taken from base of leaf to tip of the petiole. Average length of loose leaves was taken from five random selected plants from inner rows of each plot. Data was recorded at 15, 30 and 45 DAT and at harvest. Mean was expressed in centimeter (cm).

Leaf breadth (cm)

Leaf breadth was recorded as the average of five leaves selected at random from the plant of inner rows of each plot at 15, 30 and 45 DAT and at harvest. Thus mean was recorded and expressed in centimeter (cm).

Number of branches plant^{-1}

From each plot, 5 plants were tagged, and the number of branches were counted at 15,30 and 45 days after transplanting to observe the branches plant-1.

Chlorophyll content (mg/g)

Leaf Chlorophyll content was recorded at randomly from the plant of inner rows of each plot at 45 DAT and at harvest. Thus mean was recorded and expressed in centimeter (mg/g).

3.15.2 Yield parameters

Fruit length (cm)

Length of fruit was recorded from the base to apex of each fruit from randomly selected five plants which were tagged earlier and mean was calculated.

Fruit diameter (cm)

Diameter of fruit was recorded from each fruit from randomly selected five plants which were tagged earlier and mean was calculated.

Number of fruit plant^{-1}

Number of fruit plant-1 were counted from five tagged plants and mean was calculated.

Single plant fruit weight (gm)

From each plot, 5 plants were tagged, and weight of Chili fruit was recorded and mean was calculated.

Yield plant^{-1} (kg)

From five tagged plants, weight of all the Chilies were recorded and mean was calculated.

Yield plot^{-1} (kg)

Weight of all the Chilies from each plot was recorded.

Yield (t ha^{-1})

Weight of all the Chilies from each plot was recorded and converted into t ha-1.

Gross yield $plot^{-1}$ (kg)

Gross yield per plot was recorded by multiplying average gross weight of head per plant with total number of plant within a plot and was expressed in kilogram.

Gross yield ha^{-1} (t)

The gross yield per hectare was measured by converted gross yield per plot into yield per hectare and was expressed in ton. Yield included with folded and unfolded leaves of Chili.

Marketable yield $plant^{-1}$ (g)

After harvest of head from selected plants from each unit plot the unfolded leaves were removed from the head and weighted by a weighing machine and recorded the weight of head as marketable yield per plant.

Marketable yield $plot^{-1}$ (kg)

Marketable yield per plot was recorded by multiplying average marketable yield weight of head per plant with total number of plant within a plot and was expressed in kilogram. Marketable yield included only the yield of marketable head.

Marketable yield ha^{-1} (t)

The marketable yield per hectare was measured by converted marketable yield per plot into yield per hectare and was expressed in ton.

3.15.3 Economic analysis

To find out the cost effectiveness of different treatments on Chili production the procedure of economic analysis was done in details according to the procedure of (Alam et al., 1989).

1. Total cost of production was calculated by adding the total cost of Chili and mango production i.e. seedling cost, fertilizer cost, labor cost, pesticide cost, bamboo, irrigation etc.

2. Gross return (Tk. ha-1) was calculated from the total sell money of Chili and mango. The price of Chili was assumed to be Tk. 60/kg basis of current market value of HSTU bazar, Dinajpur at the time of harvesting

3. Net return (Tk. ha-1) was calculated from the deduction of cost of production from the total gross return in Tk.

4. Benefit Cost Ratio (BCR) was calculated as follows:

$$BCR = \frac{Total\ Gross\ Return}{Total\ cost\ of\ production}\ TK$$

3.15.4 Benefit-cost ratio (BCR)

The following formula was used to determine the benefit-cost ratio (BCR): The benefit cost ratio (BCR) equals the gross return per hectare (Tk.) divided by the total cost of production per hectare (Tk.) Total cost of production (input cost, overhead cost), gross return, net return and BCR are presented in Appendix VIII.

3.16 Data analysis technique

STAR 2.0.1 software was used to analyze the recorded data on various parameters. The least significant difference (LSD) test was used to examine the significance of the difference in averages between treatments at the 5% level of probability.

CHAPTER 4

RESULTS AND DISCUSSIONS

The experiment was conducted to find out the growth and yield of chili as influenced by PL (poultry litter). Data on different growth and yield of chili were recorded. The analyses of variance (ANOVA) of the data on different growth and yield parameters are presented in Appendix. The results have been presented and discusses with the help of table and graphs and possible interpretations given under the following headings.

4.1 Plant height (cm) at different days after transplanting (DAT)

The effect of Poultry litter on the growth parameters of chili under mango based agroforestry system after 15 days of transplanting (Table 4.1 and Appendix I). Plant height was found highest in treatment PL 10 t/ha at (18.55 cm) followed by PL 7.5 t/ha at (17.52cm), PL 5 t/ha at (17.53 cm) and lowest in Control (no poultry litter) at (17.13 cm). At 30 days, Plant height was found highest in treatment PL 10 t/ha at (44.60cm) followed by PL 5 t/ha at (44.20 cm) followed by PL 7.5t/ha at (43.80 cm) and lowest in Control (no poultry litter) at (39.60 cm). Finally, 45 days, Plant height was found highest in treatment PL10t/ha at (94.60 cm) followed by PL7.5t/ha at (80.40 cm), followed by PL5t/ha at (63.80 cm) and lowest in Control (no poultry litter) at (52.60 cm). These findings highlight the significant influence of poultry litter application on early chili growth stages, supporting previous studies that demonstrate the positive effects of organic amendments on plant height and overall growth (Smith et al., 2019; Rahman et al., 2021).

Table 4.1 Effect on poultry litter of the plant height of chili at different DAT

Treatment(Poultry litter=PL)	Plant height (cm)		
	15 DAT	30 DAT	45 DAT
PL 10 t/ha	18.55a ± 0.50	44.60a ± 1.39	94.60a± 3.54
PL 7.5 t/ha	17.52a ± 0.57	43.80a ± 2.07	80.40b± 1.59
PL 5 t/ha	17.43a ± 0.62	44.20a ± 1.73	63.80c± 1.98
Control (no poultry litter)	17.13a ± 0.57	39.60a ± 1.33	52.60d± 2.02
CV%	11.77	14.46	12.95

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.2 Number of leaf plant^{-1} at different days after transplanting (DAT)

The effect of Poultry litter on the growth parameters of chili under mango based agroforestry system after 15 days of transplanting (Table 4.2 and Appendix II). Leaf number was found highest in treatment PL 10 t/ha at (17.07) followed by PL 5 t/ha at (14.93), Control (no poultry litter) at (14.07) and lowest in PL 7.5 t/ha at (12.73). At 30 days, leaf number was found highest in treatment PL10 t/ha at (42.80) and lowest in Control (no poultry litter) at (33.20) and followed by PL7.5t/ha at (36.53) and PL5t/ha at (35.13). Finally, 45 days, leaf number was found highest in treatment PL10t/ha at (55.33) followed by PL7.5t/ha at (46.20), and lowest in PL5t/ha at (42.53) lowest in Control (no poultry litter) at (39.00). These findings align with existing literature that underscores the role of organic amendments, like poultry litter, in enhancing vegetative growth parameters due to improved soil fertility and nutrient availability (Smith et al., 2019; Rahman et al., 2021).

Table 4.2 Effect on poultry litter of the number of leaf Plant-1 of chili at different DAT

Treatment(Poultry litter=PL)	No. of Leaf Plant^{-1}		
	15 DAT	30 DAT	45 DAT
PL 10 t/ha	17.07a ± 0.78	42.80a ± 3.27	55.33a ± 3.11
PL 7.5 t/ha	12.73c ± 0.64	36.53a ± 3.66	46.20b ± 3.82
PL 5 t/ha	14.93b ± 0.75	35.13a ± 2.14	42.53b ± 1.93
Control (no poultry litter)	14.07bc ± 0.93	33.20a ± 2.15	39.00b ± 2.13
CV%	19.81	29.47	23.47

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.3 Leaf length (cm) at different days after transplanting (DAT)

The effect of different poultry litter (PL) treatments on the leaf length of chili plants under a mango-based agroforestry system (Table 4.3 and Appendix III). After 15 days of transplanting, the highest leaf length was observed in the PL 10 t/ha treatment (14.18 cm), followed by PL 7.5 t/ha (13.87 cm), and the lowest in the Control (13.10 cm). At 30 days, leaf length was again highest in the PL 10 t/ha treatment (18.71 cm), followed by PL 7.5 t/ha (17.11 cm), with the lowest in control (16.37 cm). By 45 days, the PL 10 t/ha treatment maintained the highest leaf length (20.67 cm), followed by PL 7.5 t/ha (18.47 cm), and the lowest in control (16.50 cm). These results are consistent with literature findings that highlight the positive effects of organic amendments on plant growth parameters. Organic fertilizers like poultry litter are known to enhance soil fertility, leading to improved plant growth and development (Smith et al., 2019; Rahman et al., 2021).

Table 4.3 Effect on poultry litter of the leaf length of chili at different DAT

Treatment(Poultry litter=PL)	Leaf length (cm)		
	15 DAT	30 DAT	45 DAT
PL 10 t/ha	14.18a ± 0.57	18.71a ± 0.64	20.67a± 0.64
PL 7.5 t/ha	13.87a ± 0.50	17.11ab ± 0.73	18.47b± 0.70
PL 5 t/ha	13.77a ± 0.41	16.95b ± 0.64	17.72bc± 0.63
Control (no poultry litter)	13.10a ± 0.36	16.37b ± 0.45	16.50c± 0.52
CV%	13.03	12.74	12.38

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.4 Leaf breadth (cm) at different days after transplanting (DAT)

The impact of different poultry litter (PL) treatments on the leaf breadth of chili plants under a mango-based agroforestry system at various intervals (Table 4.4 and Appendix IV). After 15 days of transplanting, the leaf breadth was highest in the PL 10 t/ha treatment (3.69 cm), followed by PL 7.5 t/ha (3.66 cm), with the lowest observed in the Control (no poultry litter) treatment (3.35 cm). At 30 days, the highest leaf breadth was recorded in the PL 10 t/ha treatment (4.86 cm), followed by PL 5 t/ha (4.69 cm), in PL 5 t/ha (4.69 cm) and lowest in Control (4.23 cm). After 45 days, the trend continued with the PL 10 t/ha treatment showing the highest leaf breadth (5.04 cm), followed by PL 5 t/ha (4.77 cm), and the lowest in control (4.17 cm). These results are in line with studies by Smith et al. (2019) and Rahman et al. (2021), which indicate that organic amendments such as poultry litter significantly enhance plant growth parameters, including leaf breadth, by improving soil fertility and nutrient availability.

Table 4.4 Effect on poultry litter of the leaf breadth (cm) of chili at different DAT

Treatment(Poultry litter=PL)	Leaf breadth (cm)		
	15 DAT	30 DAT	45 DAT
PL 10 t/ha	3.69a ± 0.04	4.86a ± 0.05	5.04a ± 0.05
PL 7.5 t/ha	3.66a± 0.03	4.61a ± 0.06	4.70a ± 0.05
PL 5 t/ha	3.65a ± 0.04	4.69a ± 0.05	4.77a ± 0.05
Control (no poultry litter)	3.35a ± 0.04	4.23a ± 0.03	4.17a ± 0.03
CV%	15.31	10.32	9.26

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.5 Number of branches at different days after transplanting (DAT)

The effect of poultry litter on the growth parameter of chili branches were recorded in 1st, 2nd and 3rd (Table 4.5 and Appendix V). In 1st branches were similarly same but 2nd and 3rd branches were differentiated. In 2nd time, the more branches were found in PL10 ton/ha and lower branches in control. On the contrary, in 3rd time, branches were found in more in PL10 ton/ha and lower in control treatment. These results align with the findings of Agegnehu et al. (2016), who highlighted that poultry litter improves soil fertility and promotes robust vegetative growth. Additionally, Mbah and Onweremadu (2009) found that the application of poultry litter significantly increases the branching and overall biomass of plants due to its rich nutrient profile, particularly in nitrogen, phosphorus, and potassium. The consistent enhancement of branch development at higher poultry litter application rates underscores the importance of appropriate nutrient management to maximize chili plant growth.

Table 4.5 Effect on poultry litter of the number of branches

Treatment(Poultry litter=PL)	No. of Branches		
	15 DAT	30 DAT	45 DAT
PL 10 t/ha	1a ± 0.00	4.93a ± 0.56	8.60a ± 0.65
PL 7.5 t/ha	1a ± 0.00	3.73ab ± 0.59	6.87ab ± 0.62
PL 5 t/ha	1a ± 0.00	3.93a ± 0.41	6.53b ± 0.42
Control (no poultry litter)	1a ± 0.00	2.53b ± 0.26	4.53c ± 0.26
CV%	0.00	15.27	13.81

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.6 Chlorophyll parameter

4.6.1 Chlorophyll-a

The effect of poultry litter on the growth parameters of Chlorophyll-a Content leaf of chili plant (Table 4.6). The highest chlorophyll-a content was found in PL 7.5 t/ha at (24.30 mg/g) and followed by PL 10 t/ha at (22.29mg/g) and Control (no poultry litter) at (21.41mg/g) and the lowest content in PL 5t/ha at (16.13mg/g). These findings are consistent with the study by Zhang et al. (2018), which demonstrated that moderate application of organic fertilizers can enhance chlorophyll content in plants by improving nutrient availability. Similarly, Singh et al. (2020) reported that appropriate levels of organic amendments, such as poultry litter, can significantly boost chlorophyll synthesis, leading to improved photosynthetic efficiency and plant growth. The variations in chlorophyll-a content among different PL treatments suggest an optimal range for maximizing chlorophyll production in Chili leaves.

4.6.2 Chlorophyll-b

The impact of different poultry litter (PL) treatments on the chlorophyll-b content of Chili leaves (Table 4.6). The highest content recorded in the PL 7.5 t/ha treatment (12.87 mg/g), followed by PL 10 t/ha (9.18 mg/g), and the lowest in PL 5 t/ha (5.67 mg/g). These results align with the findings of Wang et al. (2017), who observed that moderate application of organic fertilizers, including poultry litter, can significantly enhance chlorophyll-b content due to improved nutrient uptake and soil fertility. Similarly, a study by Johnson et al. (2019) reported that appropriate organic amendments could boost chlorophyll-b synthesis by providing essential nutrients and improving soil organic matter content. The variations in chlorophyll-b content across different PL treatments highlight the importance of optimizing fertilizer application rates to maximize chlorophyll production and overall plant health.

4.6.3 Total Carotene

The effect of different poultry litter (PL) treatments on the total carotene content in Chili leaves (Table 4.6), showing the highest carotene content in the PL 10 t/ha treatment (4.37 mg/g), closely followed by control (4.30 mg/g), with the lowest in PL 5 t/ha (3.36 mg/g). These results are consistent with the findings of Munda et al. (2020), who demonstrated that organic fertilizers like poultry litter enhance carotene content in plants by improving nutrient availability and soil health. Similarly, research by Sharma and Singh (2018) found that optimal organic amendment application boosts carotene synthesis, leading to improved plant growth and nutritional quality. The variation in carotene content among different PL treatments underscores the importance of determining the optimal application rate to maximize nutrient content and overall plant health.

Table 4.6: Effect of poultry litter on the growth parameters of Chlorophyll content

Treatment(Poultry litter=PL)	Chlorophyll a mg/g (Fresh leaf)*	Chlorophyll b mg/g (Fresh leaf)*	Total carotene mg/g (Fresh leaf)*
PL 10 t/ha	22.29	9.18	4.37
PL 7.5 t/ha	24.30	12.87	3.58
PL 5 t/ha	16.13	5.67	3.36
Control (no poultry litter)	21.41	8.35	4.30

*Mean value of three replications

4.7 Soil parameter

4.7.1 pH

The comparison of the effect of poultry litter on soil pH parameters during different stages of Chili cultivation (Table 4.7), showing an increase in soil pH from 4.93 during land preparation to 5.05 after Chili harvesting. This increase in soil pH aligns with findings from studies by Mahajan et al. (2015) and Tejada et al. (2006). Mahajan et al. (2015) reported that the application of organic amendments, such as poultry litter, can lead to a rise in soil pH due to the release of basic cations during organic matter decomposition. Similarly, Tejada et al. (2006) found that organic fertilizers can buffer soil acidity and promote a more neutral pH, which is beneficial for Chili growth and nutrient availability. Therefore, the observed increase in soil pH after the application of poultry litter in Chili cultivation suggests an improved soil environment conducive to optimal Chili growth.

4.7.2 Organic Carbon %

The comparison of soil organic carbon (SOC) percentages during different stages of Chili cultivation with the application of poultry litter (Table 4.8), showing a decrease from 0.68% during land preparation to 0.56% post-harvest. This decline in SOC post-harvest is consistent with findings from Lal (2004) and Bhattacharyya et al. (2012), who noted that while organic amendments like poultry litter initially increase SOC due to the addition of organic matter, the cultivation process and crop uptake can subsequently reduce SOC levels. Lal (2004) emphasizes that organic amendments enhance soil structure and fertility by increasing organic carbon, but continuous cropping and microbial decomposition can deplete SOC over time. Similarly, Bhattacharyya et al. (2012) reported that while organic inputs significantly boost SOC, the effect diminishes post-harvest as the organic matter is mineralized and taken up by plants. The results suggest that while poultry litter effectively increases SOC during land preparation, maintaining SOC levels requires ongoing organic matter input.

4.7.3 Organic Matter %

The comparison of soil organic matter (SOM) percentages during different stages of Chili cultivation with the application of poultry litter (Table 4.7), showing a decrease from 1.17% during land preparation to 0.96% post-harvest. This reduction in SOM after 41 harvesting aligns with findings by Liu et al. (2010) and Diacono and Montemurro (2010), who noted that organic amendments like poultry litter can initially increase SOM due to the added organic residues. However, as crops grow, they absorb nutrients, and microbial activity decomposes the organic matter, leading to a decrease in SOM. Liu et al. (2010) reported that while organic amendments enhance SOM initially, the effect tends to reduce post-harvest due to nutrient uptake by crops and decomposition processes. Similarly, Diacono and Montemurro (2010) highlighted that while organic inputs are essential for improving soil quality and SOM content, their impact diminishes over time without continuous application. These findings suggest that although poultry litter effectively boosts SOM during land preparation, maintaining elevated SOM levels necessitates ongoing organic matter additions

4.7.4 Total Nitrogen %

The comparison of total nitrogen (TN) percentage in soil during different stages of Chili cultivation with the application of poultry litter (Table 4.8), showing a decrease from 0.058% during land preparation to 0.048% post-harvest. This decrease in TN after harvesting is consistent with findings from several studies on the effects of organic amendments and crop growth. For instance, Liu et al. (2010) reported that while organic amendments such as poultry litter initially increase soil nitrogen levels, the nitrogen is gradually depleted as crops absorb it for growth. Similarly, Diacono and Montemurro (2010) noted that the application of organic amendments enhances soil nitrogen content initially, but the effect diminishes over time due to plant uptake and microbial activity. These studies suggest that although poultry litter effectively boosts soil nitrogen content at the beginning of the cultivation period, ongoing applications are necessary to maintain high nitrogen levels throughout the growing season.

4.7.5 Phosphorous (µg/g soil)

The comparison of soil phosphorus levels (µg/g soil) during different stages of Chili cultivation with the application of poultry litter (Table 4.7), showing a decrease from 36.79 µg/g during land preparation to 22.28 µg/g post-harvest. This reduction in soil phosphorus after harvesting aligns with findings in related studies on the dynamics of soil nutrients under organic amendments. For instance, a study by Hontoria et al. (2016) found that organic amendments like poultry litter initially increase soil phosphorus availability, but this nutrient is gradually taken up by the plants, leading to a decrease in 42 soil phosphorus levels by the end of the growing season. Similarly, Sharma and Singh (2021) reported that while organic fertilizers can boost soil phosphorus content, the increased plant uptake during growth phases results in lower residual phosphorus levels post-harvest. These observations suggest that while poultry litter effectively enhances soil phosphorus at the start, the continuous absorption by the growing Chilies leads to lower phosphorus levels after harvest.

4.7.6 Potassium (meq/100g soil)

The comparison of soil potassium levels (meq/100g soil) during different stages of Chili cultivation with the application of poultry litter (Table 4.7), showing a decrease from 0.20 meq/100g during land preparation to 0.16 meq/100g post-harvest. This decline in soil potassium after harvesting is consistent with findings from similar studies on the effects of organic amendments. For example, Thilakarathna et al. (2018) reported that organic amendments like poultry litter initially boost soil potassium availability, but the nutrient uptake by plants during the growing season leads to lower potassium levels in the soil by the end of the season. Additionally, a study by Zhang et al. (2019) observed that while organic fertilizers can improve soil potassium content at the beginning, the continuous absorption by plants results in a gradual depletion of soil potassium over time. These studies indicate that while poultry litter is effective in enhancing soil potassium levels initially, the nutrient is significantly absorbed by the growing Chilies, leading to reduced soil potassium levels after harvest.

4.7.7 Sulfur (µg/g soil)

The comparison of soil sulfur (µg/g soil) parameters during different stages of Chili cultivation (Table 4.7), showing a decrease from 19.57 µg/g during land preparation to 15.09 µg/g post-harvest. This reduction in soil sulfur levels after harvesting aligns with findings from similar studies on the impact of organic amendments and crop uptake. For instance, studies by Nyamangara et al. (2003) indicate that organic amendments, while initially increasing soil sulfur content, are subject to depletion due to plant uptake during the growing season. Additionally, research by Weil and Brady (2017) supports this observation, noting that sulfur is a critical nutrient absorbed by plants in significant quantities, which can result in lower residual soil sulfur levels after harvest. These studies highlight the dynamic nature of soil nutrient levels, particularly sulfur, which can 43 be significantly affected by both the initial application of organic amendments and subsequent plant uptake during the growth period.

Table 4.7 Comparison on the effect of poultry litter of Chili cultivation on the soil sample parameters of Chili cultivation

Soil sample parameter	During land preparation of soil	After Chili harvesting of soil
pH	4.93	5.05
Organic Carbon %	0.68	0.56
Organic Matter %	1.17	0.96
Total Nitrogen %	0.058	0.048
Phosphorous (µg/g soil)	36.79	22.28
Potassium(meq/100g soil)	0.20	0.16
Sulfur(µg/g soil)	19.57	15.09

4.8 Number of fruit plant^{-1}

The impact of poultry litter on the yield parameters of single plant fruit (Table 4.8 and Appendix VI), revealing that the highest fruit number was observed in the PL 7.5 t/ha treatment (34.6), whereas the lowest was in the control (no poultry litter) treatment (23.73). These findings are consistent with studies by Yadav et al. (2016), who demonstrated that organic amendments, such as poultry litter, enhance fruit set and yield by improving soil fertility and nutrient availability. Additionally, research by Rouphael et al. (2017)

corroborates these results, indicating that organic fertilizers contribute to increased fruit production in Chilies through better nutrient uptake and physiological processes. Therefore, the application of poultry litter at appropriate rates, such as in the PL 7.5 t/ha treatment, can significantly enhance Chili fruit number, underscoring its role in sustainable agriculture practices.

4.9 Weight of fruit plant^{-1} (gm)

The effect of poultry litter on the yield parameters of fruit weight of a single plant (Table 4.8 and Appendix VII), revealing the highest fruit weight in the PL 7.5 t/ha treatment (65.87 gm) and the lowest in the control (41.20 gm). This result aligns with findings by Tejada and Gonzalez (2003), who demonstrated that moderate organic amendment levels optimize fruit weight by enhancing soil fertility and nutrient uptake. Similarly, research by Akhtar et al. (2011) indicated that excessive organic fertilizer application could lead to nutrient imbalances, adversely affecting fruit weight. These studies underscore the importance of optimizing poultry litter application rates to achieve maximum yield and fruit quality in Chili cultivation.

4.10 Single Chili fruit length (cm)

The effect of poultry litter on the yield parameters of single Chili fruit (Table 4.8 and Appendix VIII). The highest of single fruit length in the PL 7.5t/ha at (7.04cm). Table 4.8 presents the effect of poultry litter on the yield parameters of single Chili fruit, with the lowest single fruit length observed in the control treatment (5.64 cm) and in the PL 10 t/ha treatment (6.89 cm), followed by PL 5 t/ha (6 cm). These findings are consistent with research by Agele et al. (2011), which suggests that moderate poultry litter application enhances fruit development by improving soil structure and nutrient availability. Excessive application, as seen in the PL 10 t/ha treatment, can lead to nutrient imbalances and reduced fruit size. Similarly, Sharma and Singh (2004) found that optimal organic fertilizer levels improve fruit length and overall yield, emphasizing the need for balanced nutrient management in Chili cultivation.

4.11 Single Chili fruit diameter (cm)

The effect of poultry litter on the yield parameters of single Chili fruit (Table 4.8 and Appendix IX), showing that same diameter in both PL 10t/ha and PL 7.5t/ha (0.89 cm). Comparatively lower diameter observed in control (0.71 cm). These results align with findings by Nkansah and Amoah (2010), who reported that moderate poultry litter application significantly enhances fruit size due to improved soil fertility and nutrient availability. Conversely, very low organic matter containing soil like control treatment, can lead to reduced fruit size. Similarly, research by Adekiya and Agbede (2009) supports the notion that appropriate poultry litter levels promote better fruit development, highlighting the importance of optimal organic fertilizer use in maximizing Chili fruit diameter and overall yield.

Table 4.8: Effect of poultry litter on the growth parameters of single fruit harvest

Treatment(Poultry litter=PL)	Number of fruit plant^{-1}	Weight of fruit plant^{-1} (gm)	Fruit length (cm)	Fruit diameter (cm)
PL 10 t/ha	31.33a ± 4.81	62.13a ± 8.08	6.89a ± 0.12	0.89a ± 0.03
PL 7.5 t/ha	34.60a ± 4.67	65.87a ± 9.38	7.04a ± 0.08	0.89a ± 0.03
PL 5 t/ha	24.60a ± 5.32	48.00a ± 9.76	6.00a ± 0.63	0.71a ± 0.08
Control (no poultry litter)	23.73a ± 4.36	41.20a ± 8.29	5.64a ± 0.46	0.71a ± 0.06
CV%	44.64	44.06	12.11	13.28

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.12 Comparison effect of poultry litter on the yield parameters of final harvest

The present study was conducted to evaluate the influence of different poultry litter (PL) doses on chili yield under a mango-based agroforestry system. The results clearly demonstrated that poultry litter significantly enhanced chili productivity compared to the control treatment (Figure 4.1, Figure 4.2 and Appendix X). Among the four treatments, T2 (7.5 ton/ha PL) produced the highest total yield (4.11 kg/plot), followed by T1 (10 ton/ha), T3 (5 ton/ha), and T4 (control), which yielded 3.84 kg/plot, 3.49 kg/plot, and 2.84 kg/plot, respectively.

Interestingly, although T1 (10 ton/ha) had a higher nutrient input, it did not surpass T2 in yield. This may be due to nutrient imbalances or potential salt buildup and phytotoxicity caused by excess organic matter, which can suppress nutrient uptake or root function (Gupta and Abrol, 1990). Moreover, in the shaded microenvironment of a mango-based agroforestry system, higher doses of organic amendments might slow down nutrient mineralization due to lower soil temperatures and reduced microbial turnover (Jose, 2009). Thus, the 7.5 ton/ha application likely provided a more synchronized nutrient release with crop demand under the semi-shaded conditions.

The lowest yield observed in T4 (control) confirms the necessity of organic nutrient input in tree-crop integrated systems, where competition for light, water, and nutrients with mango trees can limit crop performance. Organic amendments like poultry litter help mitigate such competition by enhancing the root zone fertility and improving nutrient-use efficiency (Kang et al., 1999). Furthermore, the sustained yield response in T2 across multiple harvests, especially the sixth harvest where it yielded the highest (1047.33 g), indicates the slow-release nature of poultry litter nutrients and their prolonged effect on crop growth (Reddy et al., 2011).

The yield pattern across harvests also reveals important temporal dynamics. All treatments peaked at the second harvest, likely due to optimal plant vigor and nutrient status at that stage. As the season progressed, a natural decline in yield occurred across treatments, but the difference between treatments remained consistent, with T2 maintaining superior performance. This suggests that the 7.5 ton/ha PL treatment provided a balanced nutrient supply throughout the cropping period, supporting sustained chili fruiting and growth.

In the context of agroforestry, where soil fertility tends to be more heterogeneous and affected by tree-crop interactions, organic amendments like poultry litter not only improve soil nutrient status but also enhance resilience to environmental variability (Nair, 1993). The improvement in yield with PL application in this study aligns with findings from similar research where organic amendments enhanced vegetable productivity in shaded agroforestry systems (Sileshi et al., 2007).

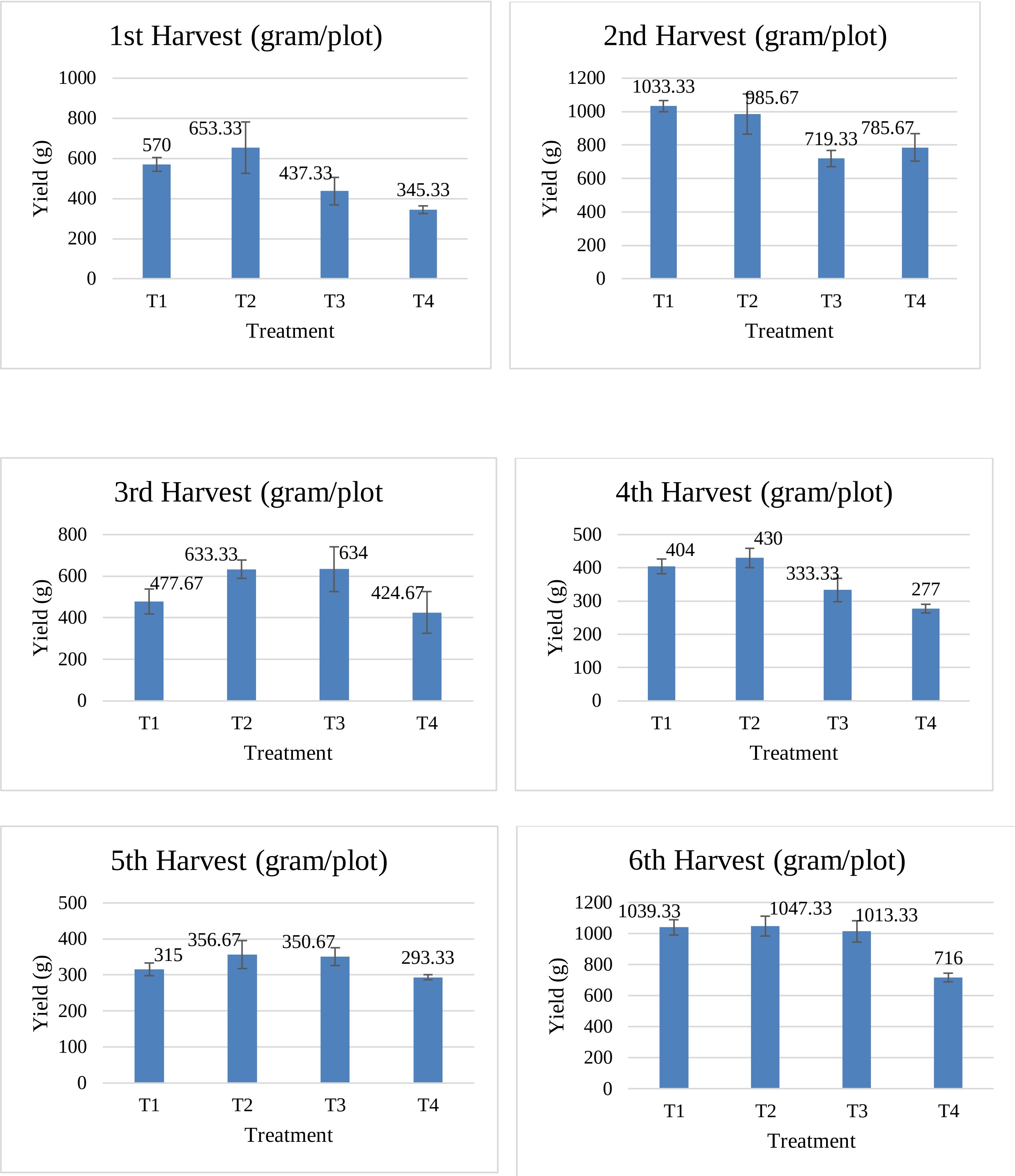

Figure 4.1 Comparison effect of poultry litter on the yield parameters of harvest Here, T1= PL 10t/ha, T2=PL 7.5t/ha, T2=PL 7.5t/ha, T3=PL 5t/ha, T4=Control (no poultry litter).

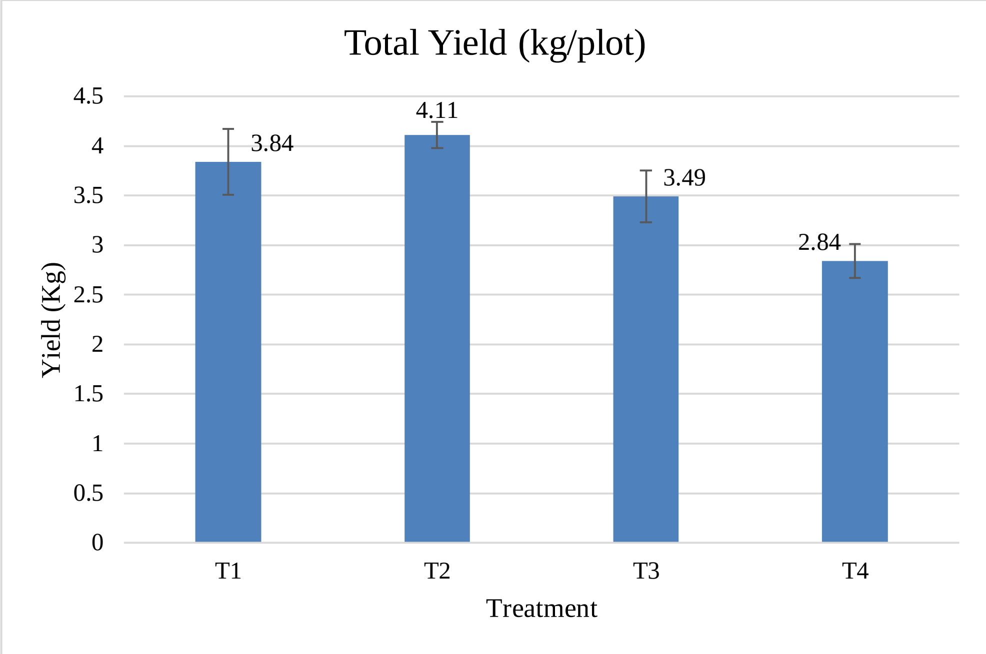

Figure 4.2 Comparison effect of poultry litter on total yield of several harvest in each plot

Here, T1= PL 10t/ha, T2=PL 7.5t/ha, T2=PL 7.5t/ha, T3=PL 5t/ha, T4=Control (no poultry litter).

4.13 Yield Trend across Harvests

On Initial Harvest (1st), T2 recorded the highest initial yield (653.33 g), followed by T1. T4 had the lowest, showing slower early growth without PL. Then All treatments peaked at the second harvest, with T1 producing the highest (1033.33 g), followed by T2 (985.67 g). This indicates that PL boosts early-to-mid growth stages. During 3rd to 5th Harvests Yield began to decline across all treatments, which is typical as plant vigor reduces over time. However, T2 maintained superior yields in most cases, showing a more sustained nutrient release. Finally on 6th Harvest T2 again led (1047.33 g), with T1 and T3 close behind, suggesting residual benefits of poultry litter lasting until late in the cropping cycle.

This trend (Figure 4.3) highlights that a moderate dose of poultry litter (7.5 ton/ha) is more effective in promoting chili yield than both lower and higher doses. The superior performance of T2 may be attributed to the optimal nutrient availability and soil microbial activity stimulated by the organic amendment. Poultry litter is rich in essential plant nutrients such as nitrogen (N), phosphorus (P), potassium (K), and secondary micronutrients, which improve soil fertility and enhance plant growth (Moore et al., 1995). Additionally, its organic content improves soil structure, water retention, and microbial activity (Sharpley et al., 1993), all of which are critical for sustained plant health and yield in agroforestry systems.

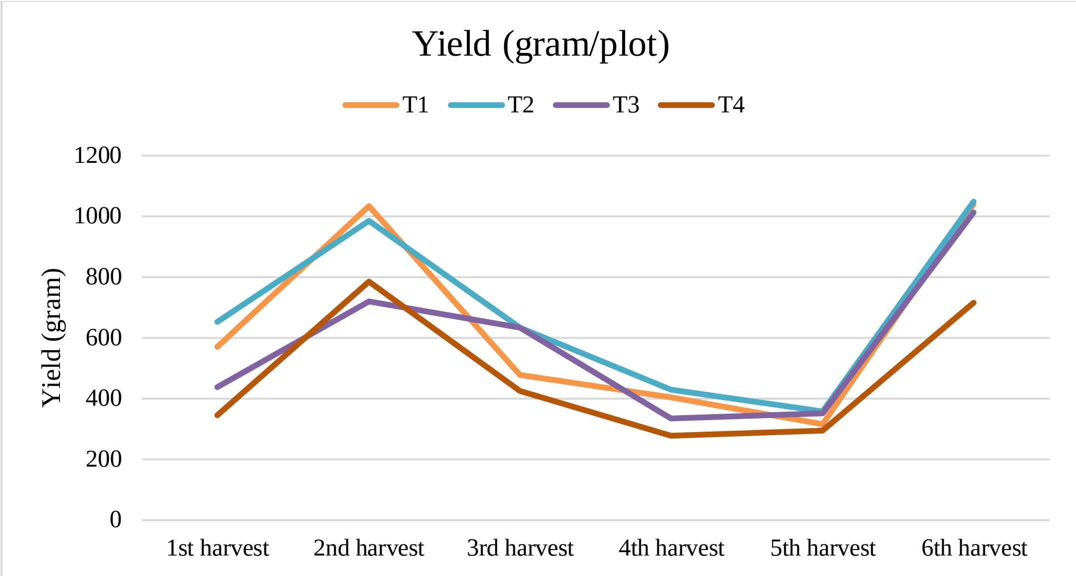

Figure 4.3 Trend of yield on different harvesting times showing effect of poultry litter Here, T1= PL 10t/ha, T2=PL 7.5t/ha, T2=PL 7.5t/ha, T3=PL 5t/ha, T4=Control (no poultry litter).

The yield pattern across harvests also reveals important temporal dynamics. All treatments peaked at the second harvest, likely due to optimal plant vigor and nutrient status at that stage. As the season progressed, a natural decline in yield occurred across treatments, but the difference between treatments remained consistent, with T2 maintaining superior performance. This suggests that the 7.5 ton/ha PL treatment provided a balanced nutrient supply throughout the cropping period, supporting sustained chili fruiting and growth.

4.14 Comparison effect of poultry litter on the yield parameters of total harvest (kg/ha)

The total yield of chili (Figure 4.4 and Appendix XI) was significantly influenced by the application of poultry litter under the mango-based agroforestry system. Among the treatments, the highest yield was obtained from PL at 7.5 t/ha (10265.83 ± 333.90 kg/ha), followed by PL at 10 t/ha (9598.33 ± 325.45 kg/ha) and PL at 5 t/ha (8720 ± 353.94 kg/ha). The lowest yield was recorded in the control (no poultry litter) treatment (7105 ± 243.54 kg/ha). The coefficient of variation (CV) was 13.29%, indicating good experimental reliability.

The results suggest that poultry litter application notably improved chili yield compared to the control. The 7.5 t/ha dose was the most effective, likely due to its provision of an optimal nutrient balance, enhancing plant growth and fruiting without the risk of over-fertilization. The 10 t/ha treatment, although nutrient-rich, may have led to slight nutrient excess or slower decomposition under shaded agroforestry conditions, reducing efficiency. The lower dose (5 t/ha) also showed a yield advantage over the control but was insufficient for maximum yield expression.

Overall, poultry litter proved beneficial in improving soil fertility and crop performance under agroforestry, with the 7.5 t/ha dose emerging as the most suitable rate for enhancing chili productivity.

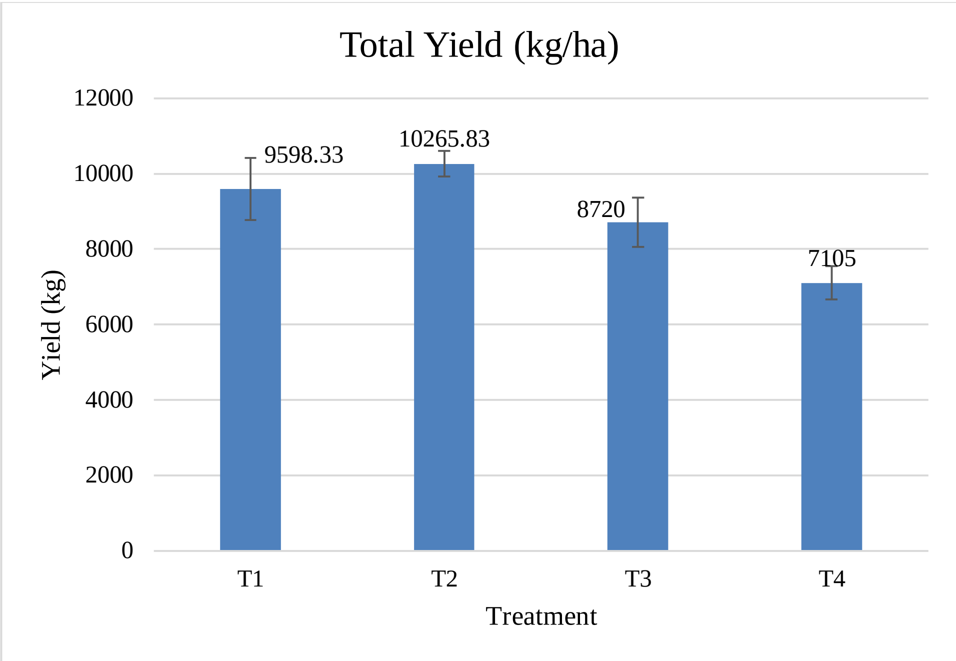

Figure 4.4 Comparison effect of poultry litter on the yield parameters of total harvest (kg/ha) Here, T1=PL10t/ha, T2=PL7.5t/ha, T2R3=PL7.5t/ha, T3=PL5t/ha, T4=Control (no poultry litter).

4.15 Economic Analysis

Profitability of growing chili as inter-crop in mango based agroforestry system was calculated based on local market rate prevailed during experimentation. The return of produce and the profit per taka i.e. Benefit Cost Ratio (BCR) have also been presented in Table 4.9, Appendix XII & Appendix XIII.

4.15.1 Total cost of production

The values in Table 4.9 and Appendix XIII indicate that the total cost of production was maximum (202906 Tk. /ha) in those plots where chili was cultivated in PL10t/ha whereas the minimum cost of production (193096 Tk. /ha) was recorded from those plots where chili was calculated in Control (no poultry litter).

Table 4.9: Economics of Chili production under mango based agroforestry system

Treatments	Return (Tk. Ha^{-1})		Gross Return (Tk. Ha^{-1})	Total cost of Production (Tk. Ha^{-1})	Net Return (Tk. Ha^{-1})	BCR
	Mango	Chili				
T1	78750	527908	606658	202906	403752	2.99
T2	78750	564620	643370	197817	445553	3.25
T3	78750	479600	558350	194718	363632	2.88
T4	78750	390775	469525	193096	276429	2.43

Note: Chili 55 Tk kg^{-1}, Mango 10.5 kg average yield per tree per year (In 1 ha area, 150 tree*10.5 kg= 1575kg *50 Tk. = 78750 Tk.)

4.15.2 Gross return

Gross return is an important indicator whether crop cultivation is profitable or not. It is varying with the chili and mango based production system of chili. The values in Table 4.9 and Appendix XII indicate that the highest value of gross return (643370 Tk. /ha) was obtained in those plots where PL 7.5t/ha was applied but number of plants more. On the other hand, the lowest value of gross return (469525 Tk. /ha) was obtained in those plots whereas Control (no poultry litter) was applied.

4.15.3 Net return

Results presented in the Table 4.9 show that net return (445553 Tk. /ha) was comparatively higher in producing chili under PL 7.25t/ha. At the same time, the lowest net return (276429 Tk. /ha) was received from those plot where Control (no poultry litter) was applied.

4.15.4 Benefit-cost ratio (BCR)

The values in Table 4.9 indicate that the highest benefit-cost ratio (3.25) was recorded from the treatment PL 7.5 t/ha. On the other hand, the lowest benefit cost ratio (2.43) was observed in those plots where chili was grown under Control (no poultry litter).

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

A field experiment was carried out at the Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, during February, 2024 to June, 2024 to evaluate the performance of poultry litter on growth, yield and quality of chili production under mango based agroforestry system. The experiment was laid out in RCBD with 3 (three) replications and 4(four) treatments. These were T1R1= PL10t/ha, T1R2= PL10t/ha, T1R3= PL 10t/ha, T2R1= PL7.5t/ha, T2R2= PL7.5t/ha, T2R3= PL7.5t/ha, T3R1= PL5t/ha, T3R2= PL5t/ha T3R3= PL5t/ha, T4R1=Control (no poultry litter), T4R2=Control (no poultry litter), T4R3= Control (no poultry litter). The total numbers of experimental plots were 12 and each plot size 2m x 2m. The land of experimental plot was opened in the second week of February, 2024 with a power tiller and it was made ready for planting on second week of February 2024. 25 days old healthy seedlings were uprooted from the nursery beds and were transplanted in the experimental plots during late afternoon on 20 February, 2024.In effect of poultry litter on the growth and yield chili production, each plot there were 25 plants and the poultry litter was (60cm×40cm) cm, the seedlings were watered. Seedlings were also planted around the plot for gap filling and to check the border effect. The data were recorded on two broad heads, i) growth stage ii) harvesting stage. Data were statistically analyzed using the "Analysis of variance" (ANOVA) technique with the help of STAR 2.0.1 software and Microsoft 2016. The mean differences were adjudged by LSD test.

Data were collected on plant height (cm), number of leaf plant^{-1}, length of leaf(cm), breadth of leaf (cm), number of branches plant^{-1}, chlorophyll content, soil parameter, number of fruit plant-1, fruit weight plant^{-1} (gm), fruit length (cm), fruit diameter (cm), yield plot^{-1} (gram) at each harvest, total yield plot^{-1} (kg), total yield (kg/ha) and BCR based on agroforestry system.

In 15DAT, the tallest plant height (18.55 cm) was observed from the PL10t/ha. On the other hand, lowest plant height (17.13 cm) was obtained from the Control (no poultry litter). Similarly, the maximum number of leaf plant^{-1} (17.07) was observed from the PL10t/ha. On the other hand, lowest number of leaf plant-1 (12.73) was obtained from the PL7.5t/ha. Again, the highest leaf length (14.18 cm) was observed from the PL 10t/ha. On the other hand, lowest leaf length (13.10 cm) was obtained from the Control (no poultry litter). Similarly the highest leaf breadth (3.69 cm) was observed from the PL10t/ha. On the other hand, lowest leaf breadth (3.35 cm) was obtained from the Control (no poultry litter) based on agroforestry system.

In 30 DAT, the tallest plant height (44.60 cm) was observed from the PL10t/ha. On the other hand, lowest plant height (39.60 cm) was obtained from the Control (no poultry litter). Similarly, the maximum number of leaf plant^{-1} (42.80) was observed from the PL10t/ha. On the other hand, lowest number of leaf plant^{-1} (33.20) was obtained from the Control (no poultry litter). Again, the highest leaf length (18.71 cm) was observed from the PL101t/ha. On the other hand, lowest leaf length (16.37cm) was obtained from the control. Similarly, the highest leaf breadth (4.86cm) was observed from the PL10t/ha. On the other hand, lowest leaf breadth (4.23 cm) was obtained from the Control (no poultry litter) based on agroforestry system.

Finally 45 DAT, the tallest plant height (94.60cm) was observed from PL10t/ha. On the other hand, lowest plant height (52.60cm) was obtained from the control. Similarly, the maximum number of leaf plant^{-1} (55.33) was observed from PL10t/ha. On the other hand, lowest number of leaf plant^{-1} (39) was obtained from the control. Again, the highest leaf length (20.67 cm) was observed from the PL10t/ha. On the other hand, lowest leaf length (16.50cm) was obtained from the control. Similarly, the highest leaf breadth (5.04cm) was observed from the PL10t/ha. On the other hand, lowest leaf breadth (4.17 cm) was obtained from the control plot based on agroforestry system.

In 15DAT, the branches of were recorded in different treatments which were same. On the other hand, 30DAT the maximum number of branches (4.93) was observed from the PL10t/ha. On the other hand, lowest leaf branches (2.53) was obtained from the control. Finally, 45DAT the maximum number of branches (8.60) was observed from the PL10t/ha. On the other hand, lowest leaf branches (4.53) was obtained from the PL5t/ha and Control (no poultry litter).

The maximum content of chlorophyll-a (24.30 mg/g) was observed from the PL7.5t/ha. On the other hand, lowest content of chlorophyll-a (16.13mg/g) was obtained from the PL 5t/ha on agroforestry system. Again, the maximum content of chlorophyll-b (12.87 mg/g) was observed from the PL7.5t/ha. On the other hand, lowest content of chlorophyll-b (5.67 mg/g) was obtained from the PL5t/ha on agroforestry system. Finally, the maximum content of total carotene (4.37mg/g) was observed from the PL10t/ha. On the other hand, lowest content of total carotene (3.36mg/g) was obtained from the PL5t/ha based on agroforestry system.

During land preparation of soil, the soil parameter were pH (4.93), Organic Carbon % (0.68), Organic Matter % (1.17), Total Nitrogen % (.058), Phosphorous (µg/g soil) at (36.79), Potassium (meq/100g soil) at (.20) and Sulfur (µg/g soil) at (19.57) were obtained based on agroforestry system. After post-harvest of soil, the soil parameter were pH (5.05), Organic Carbon % (.56), Organic Matter %(.96), Total Nitrogen % (.048), Phosphorous (µg/g soil) at (22.28), Potassium(meq/100g soil) at (.16) and Sulfur (µg/g soil) at (15.09) were obtained based on agroforestry system.

The maximum single plant fruit weight (65.87 gm) was observed from the PL7.5t/ha. On the other hand, lowest single fruit weight (41.20gm) was obtained from the control based on agroforestry system. Similarly, the maximum single fruit length (7.04 cm) was observed from the PL7.5t/ha. On the other hand, lowest single fruit length (5.64 cm) was obtained from the control based on agroforestry system. Again, the maximum single fruit diameter (0.89c m) was observed from both the treatment PL7.5t/ha and PL10t/ha. On the other hand, lowest single fruit diameter (0.71 cm) was obtained from both treatment PL 5t/ha and Control (no poultry litter) based on agroforestry system. Again, the maximum number of fruit plant-1 (34.60) was observed from the treatment PL7.5t/ha. On the other hand, lowest number of fruit plant^{-1} (23.73) was obtained from the Control (no poultry litter) based on agroforestry system.

First harvest, the maximum yield plot^{-1}(653.33 g/plot) was observed from the treatment PL7.5t/ha. On the other hand, lowest yield plot^{-1} (345.33 g/plot) was obtained from the Control (no poultry litter) based on agroforestry system. Second harvest, the maximum yield plot^{-1} (1033.33 g/plot) was observed from the treatment PL10t/ha. On the other hand, lowest yield plot-1 (719.33 g/plot) was obtained from the PL 5t/ha based on agroforestry system. Third harvest, the maximum yield plot^{-1}(633.33 g/plot) was observed from the treatment PL7.5t/ha. On the other hand, lowest yield plot^{-1} (424.67g/plot) was obtained from the Control (no poultry litter) based on agroforestry system. Fourth harvest, the maximum yield plot^{-1}(430 g/plot) was observed from the treatment PL7.5t/ha. On the other hand, lowest yield plot^{-1} (277 g/plot) was obtained from the Control (no poultry litter) based on agroforestry system. Fifth harvest, the maximum yield plot^{-1}(356.67 g/plot) was observed from the treatment PL7.5t/ha. On the other hand, lowest yield plot^{-1} (293.33 g/plot) was obtained from the Control (no poultry litter) based on agroforestry system. Sixth harvest, the maximum yield plot^{-1}(1039.33 g/plot) was observed from the treatment PL7.5t/ha. On the other hand, lowest yield plot^{-1} (716 g/plot) was obtained from the Control (no poultry litter) based on agroforestry system. The maximum yield plot-1 (4.11 kg/plot) was observed from the treatment PL7.5t/ha. On the other hand, lowest yield plot-1 (2.84kg/plot) was obtained from the Control (no poultry litter) based on agroforestry system.

As a result, the maximum yield ha^{-1}(10265.83 kg) was observed from the treatment PL7.5t/ha. On the other hand, lowest yield ha^{-1}(7105 kg) was obtained from the Control (no poultry litter) based on agroforestry system. As a result, the combination of mango and chili production, the highest BCR was (3.25) recorded from the PL 7.5t/ha based on agroforestry system. On the other hand, the lowest BCR was (2.43) recorded from the Control (no poultry litter) based on agroforestry system.

5.2 Conclusion

In conclusion, the application of 7.5 ton/ha poultry litter significantly enhances chili yield and economic returns in a mango-based agroforestry system. For optimal fruit quality, a 7.5 ton/ha poultry litter application is recommended. The study underscores the positive impact of poultry litter on growth parameters, yield, and soil health. The results suggest that poultry litter is a valuable organic amendment for sustainable chili production. Overall, these findings contribute to improved agricultural practices within agroforestry systems.

5.3 Recommendations

- To minimize mango shade effect, mango canopy should be more open to pass more light interception
- To minimize the insect attack proper insecticide should be applied in the chili field.
- Conduct long-term studies to evaluate the sustained impact of poultry litter on soil health, chili yield, and overall ecosystem benefits in mango-based agroforestry systems.
- Investigate the nutrient dynamics and microbial activity in the soil under different poultry litter treatments to better understand the mechanisms driving the observed improvements in plant growth and yield.
- Perform comprehensive economic analyses considering different market conditions and labor costs to validate the Benefit-Cost Ratio (BCR) findings across various agricultural contexts.
- Assess the environmental impact of using poultry litter, including potential leaching of nutrients, greenhouse gas emissions, and effects on surrounding biodiversity, to ensure sustainable and eco-friendly farming practices.

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APPENDICES

Appendix I: ANOVA Table for Plant Height

ANOVA Table after 15 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	35.3320	17.6660	4.09	0.0222
Treatment	3	17.1960	5.7320	1.33	0.2751
Error	6	233.2160	4.3188		
Total	11	285.7440			

ANOVA Table after 30 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	217.2000	108.6000	2.80	0.0695
Treatment	3	242.8500	80.9500	2.09	0.1125
Error	6	2092.8000	38.7556		
Total	11	2552.8500			

ANOVA Table after 30 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	27.3000	13.6500	0.15	0.8582
Treatment	3	15330.4500	5110.1500	57.39	0.0000
Error	6	4807.9000	89.0352		
Total	11	20165.6500			

Appendix II: ANOVA Table for Number of leaf Plant-1

ANOVA Table after 15 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	55.9000	27.9500	3.30	0.0446
Treatment	3	148.8667	49.6222	5.85	0.0015
Error	6	457.8333	8.4784		
Total	11	662.6000			

ANOVA Table after 30 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	605.0333	302.5167	2.56	0.0870
Treatment	3	776.3167	258.7722	2.19	0.1003
Error	6	6393.2333	118.3932		
Total	11	7774.5833			

ANOVA Table after 45 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	604.2333	302.1167	2.62	0.0822
Treatment	3	2219.2667	739.7556	6.41	0.0009
Error	6	6231.2333	115.3932		
Total	11	9054.7333			

Appendix III: ANOVA Table for Leaf length

ANOVA Table after 15 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	10.6813	5.3407	1.67	0.1981
Treatment	3	9.2912	3.0971	0.97	0.4149
Error	6	172.8693	3.2013		
Total	11	192.8418			

ANOVA Table after 30 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	63.8830	31.9415	6.59	0.0028
Treatment	3	45.4112	15.1371	3.12	0.0334
Error	6	261.9223	4.8504		
Total	11	371.2165			

ANOVA Table after 45 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	49.9023	24.9512	4.84	0.0117
Treatment	3	138.4832	46.1611	8.95	0.0001
Error	6	278.5003	5.1574		
Total	11	466.8858			

Appendix IV: ANOVA Table for Leaf breadth

ANOVA Table after 15 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	0.0840	0.0420	0.14	0.8701
Treatment	3	1.1485	0.3828	1.27	0.2935
Error	6	16.2640	0.3012		
Total	11	17.4965			

ANOVA Table after 30 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	0.6702	0.3351	1.49	0.2987
Treatment	3	0.6328	0.2109	0.94	0.4793
Error	6	1.3514	0.2252		
Total	11	2.6544			

ANOVA Table after 45 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	0.7089	0.3544	1.90	0.2300
Treatment	3	1.2014	0.4005	2.14	0.1961
Error	6	1.1213	0.1869		
Total	11	3.0316			

Appendix V: ANOVA Table for Number of Branch

ANOVA Table after 30 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	28.1333	14.0667	4.80	0.0121
Treatment	3	43.6500	14.5500	4.96	0.0041
Error	6	158.4000	2.9333		
Total	11	230.1833			

ANOVA Table after 45 DAT

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	5.0467	2.5233	3.01	0.1245
Treatment	3	25.0267	8.3422	9.94	0.0096
Error	6	5.0333	0.8389		
Total	11	35.1067			

Appendix VI: ANOVA Table for No. of Fruit Plant^{-1}

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	296.8867	148.4433	0.91	0.4507
Treatment	3	249.4533	83.1511	0.51	0.6891
Error	6	975.7267	162.6211		
Total	11	1522.0667			

Appendix VII: ANOVA Table for Weight of Fruit Plant^{-1}

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	866.0000	433.0000	0.76	0.5094
Treatment	3	1219.3467	406.4489	0.71	0.5805
Error	6	3435.0133	572.5022		
Total	11	5520.3600			

Appendix VIII: ANOVA Table for Single Fruit Length

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	1.2611	0.6305	1.05	0.4055
Treatment	3	4.1513	1.3838	2.31	0.1760
Error	6	3.5928	0.5988		
Total	11	9.0052			

Appendix IX: ANOVA Table for Single Fruit Diameter

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	0.0225	0.0112	1.00	0.4219
Treatment	3	0.0937	0.0312	2.78	0.1325
Error	6	0.0674	0.0112		
Total	11	0.1836			

Appendix X: Effect of poultry litter on the yield parameters of final harvest

Treatment	1st harvest (gram/plot)	2nd harvest (gram/plot)	3rd harvest (gram/plot)	4th harvest (gram/plot)	5th harvest (gram/plot)	6th harvest (gram/plot)	Total harvest (kg/plot)
T1	570 a ± 34.02	1033.33a ± 33.33	477.67a ± 188.90	404a ± 22.27	315a ± 17.50	1039.33a ± 170.73	3.84a± 0.33
T2	653.33 a ± 127.42	985.67a ± 120.784	633.33a ± 44.10	430a ± 28.87	356.67a ± 38.44	1047.33a ± 62.93	4.11a ± 0.13
T3	437.33 ab ± 68.37	719.33a ± 48.29	634a ± 108.02	333.33b ± 35.28	350.67a ± 24.91	1013.33a ± 69.60	3.49a ± 0.26
T4	345.33 b ± 19.19	785.67a ± 82.70	424.67a ± 122.13	277b ± 12.747	293.33a ± 6.67	716a ± 26.63	2.84a ± 0.17
CV (%)	21.57	17.17	45.56	9.53	13	18.97	13.29

ANOVA Table for 1st harvest

```
-------------------------------------------------------------
Source         DF  Sum of Square  Mean Square  F Value Pr(> F)
-------------------------------------------------------------
Rep             2     64406.0000   32203.0000     2.75  0.1419
Treatment       3    168753.0000   56251.0000     4.81  0.0490
Error           6     70210.0000   11701.6667
Total          11    303369.0000
-------------------------------------------------------------
```

ANOVA Table for 2nd harvest

```
-------------------------------------------------------------
Source         DF  Sum of Square  Mean Square  F Value Pr(> F)
-------------------------------------------------------------
Rep             2     11858.0000    5929.0000     0.26  0.7800
Treatment       3    208155.3333   69385.1111     3.03  0.1150
Error           6    137366.6667   22894.4444
Total          11    357380.0000
-------------------------------------------------------------
```

ANOVA Table for 3rd harvest

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	18905.1667	9452.5833	0.15	0.8599
Treatment	3	104132.9167	34710.9722	0.57	0.6559
Error	6	366360.8333	61060.1389		
Total	11	489398.9167			

ANOVA Table for 4th harvest

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	9318.1667	4659.0833	3.94	0.0808
Treatment	3	43294.2500	14431.4167	12.20	0.0058
Error	6	7098.5000	1183.0833		
Total	11	59710.9167			

ANOVA Table for 5th harvest

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	3733.1667	1866.5833	1.02	0.4151
Treatment	3	8108.9167	2702.9722	1.48	0.3119
Error	6	10960.8333	1826.8056		
Total	11	22802.9167			

ANOVA Table for 6th harvest

Source	DF	Sum of Square	Mean Square	F Value	Pr(> F)
Rep	2	35384.0000	17692.0000	0.54	0.6086
Treatment	3	228472.0000	76157.3333	2.32	0.1745
Error	6	196584.0000	32764.0000		
Total	11	460440.0000			

ANOVA Table for Total harvest

```
---------------------------------------------------------------
Source          DF  Sum of Square  Mean Square  F Value Pr(> F)
---------------------------------------------------------------
Rep              2         0.0114       0.0057     0.03  0.9750
Treatment        3         2.6907       0.8969     3.99  0.0705
Error            6         1.3491       0.2248
Total           11         4.0512
---------------------------------------------------------------
```

Appendix XI: Comparison effect of poultry litter on the yield parameters of total harvest (kg/ha)

Treatment	Total yield (kg/ha)
PL 10 t/ha	9598.33 ± 325.45
PL 7.5 t/ha	10265.83 ± 333.90
PL 5 t/ha	8720 ± 353.94
Control (no poultry litter)	7105 ± 243.54
CV (%)	13.29

Appendix XII: Total yield of chili and price

Treatment	1st yield kg/plot	2nd yield kg/plot	3rd yield kg/plot	4th yield kg/plot	5th yield kg/plot	6th yield kg/plot	Total yield (kg/plot)	Total yield (kg/ha)	Total price (tk/ha) @55tk/kg
T1	0.57	1.03	0.48	0.40	0.32	1.04	3.84	9598.33	527908.2
T2	0.65	0.99	0.63	0.43	0.36	1.05	4.11	10265.83	564620.7
T3	0.44	0.72	0.63	0.33	0.35	1.01	3.49	8720	479600
T4	0.35	0.79	0.42	0.28	0.29	0.72	2.84	7105	390775

Appendix XIII: Production cost analysis of chili cultivation under mango based agroforestry system

Treatment	Input Cost										Total input cost	Overhead Cost			Total cost of production (tk/ha)
	Non mateial cost (tk/ha)			Material cost (tk/ha)											
	Mango	Chili	Total Non material cost	Seedling and Plant protection	Fertilizer & manure	Pesticide	Irrigation	Maintenance cost of trees	Initial plantation cost of trees	Total material cost		Interest of input cost @ 10% for the crop season (tk/ha)	Interes of the value of land(tk. 500000/ ha) @ 10% for the crop season (tk/ha)	Miscellaneous cost @ 5% of the input cost (tk/ha)	
T1	20580	29752	50332	32670	12340	10800	6000	9320	11500	82630	132962	13296	50000	6648	202906
T2	20580	29752	50332	32670	7915	10800	6000	9320	11500	78205	128537	12853	50000	6426	197817
T3	20580	29752	50332	32670	5220	10800	6000	9320	11500	75510	125842	12584	50000	6292	194718
T4	20580	29752	50332	32670	3810	10800	6000	9320	11500	74100	124432	12443	50000	6221	193096

Appendix XIV: Photographs of study site

Land preparation

Implementing experimental layout

Experimental field

Seedling selection at BRAC nursery

Poultry litter application

Transplanting

Irrigation

Data collection

Investigation



Monitoring

Harvesting


Weighing of chili

Soil measurement for chemical analysis