Revitalization of Agricultural in Flat Land Through Humic Acid and Irrigation in Kampong Cibeureum, Sukanagalih, Cianjur, West Java

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Abstract. Farmers in kampong Cibeureum, Sukanagalih village, generally use excessive amounts of fertilizers and pesticides to increase yield horticultural production. In addition, farmers also face water shortages during extreme dry seasons caused by climate change. Therefore, research is needed to address these issues. The purpose of this study is to find solutions to reduce fertilizer use and overcome water problems. The study was conducted on 5900 m2 of flat land agriculture managed by three farmers. The research method involved interviews, observations, and experiment by comparation before and after applying humic acid (HA) and irrigation system from pond. The results of the research indicate application of HA and irrigation system from the pond is effective in improving crop quality and increasing yields by up to 38.38%. Create production of organic fertilizer mixed by HA is prospectively can reduce fertilizer purchase costs. Ensuring sufficient water for agriculture can be achieved by constructing pond and piping equipment The availability of pond can be utilized for freshwater fish farming and contributes to reduced organic fertilizer.

1 Introduction

Soil with optimal physical, chemical, and biological conditions is necessary to support plant growth. Soil fertility is determined by the completeness of nutrients, soil structure, and the soil's ability to retain water and allow sufficient air circulation. Fertile soil contains sufficient organic matter and minerals and has a pH balance that supports the activity of soil microorganisms [1], which are able to protect the soil from heavy metal contamination [2]. The case study was conducted in the kampong Cibeureum, located in the village of Sukanagalih, Pacet District, Cianjur, West Java. Based on data from the village office, the village is located in the watershed of Mount Gede and Pangrango. The village of Sukanagalih

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is located at an altitude of ± 935 meters above sea level (masl) [3]. Farmer's knowledge of agriculture is still relatively conventional, passed down from generation to generation. Important natural resources for agriculture in the kampong Cibeureum that need to be preserved are soil fertility and water resources.

The land in the kampong Cibeureum has been cultivated for generations, but minimal land conservation has resulted in a decline in soil quality. The continuous use of chemical fertilizers in excessive doses is also one of the factors contributing to the decline in soil quality. The agricultural land in the kampong Cibeureum is dominated by land with a slope of 45°. Planting crops on sloping land presents its own challenges, particularly in relation to soil erosion. Rainwater falling on sloping land flows more quickly, carrying away fertile soil and reducing soil fertility [4]. This results in sediment accumulation, which disrupts agriculture on flat land. The suboptimal use of groundwater, such as allowing it to flow freely without being dammed, can cause erosion. Techniques for utilizing water include planting water retaining plants and constructing ponds [5].

The pond that collect water from springs and rainwater can be used for fish farming. The water from fish farming is then used to irrigate crops on agricultural land. The use of water from fish farming for irrigating plants is an effort to enhance soil fertility. This is because fish farming water contains organic matter derived from leftover feed, fish waste, feed particles [6] as well as bacteria and algae. Soil fertility is also improved by applying HA at a specific dosage, it can influence the activity of microorganisms in the soil and promote root growth, which facilitates the absorption of nutrients in the soil. HA is an organic soil conditioner used in agriculture to improve soil quality, promote root growth, enhance plant resistance to environmental stress, and increase crop yields. HA supports soil microorganisms that aid in the nutrient cycle and accelerate the decomposition of organic matter [7]. It can be applied directly to the soil or through watering and irrigation systems. The goal is to find a solution to reduce fertilizer use by up to 50% and improve water availability to increase harvesting agriculture.

2 Methodology

This research was conducted in kampong Cibeureum, Sukanagalih village, Pacet district, Cianjur regency, West Java, Indonesia. The activity was carried out from June 2023 until 2025. The study involved quantitative analysis through interviews and observation with three farmers regarding age, education, types and doses of fertilizer, pesticide use, planting methods, and harvest yields. The experiment was conducted on 5,900 m² of flat land, comparing the yields between horticultural crops cultivated using the fertiliser doses commonly used by farmers and those cultivated using 50% less fertiliser combined with HA and irrigation system from a pond whose water comes from water flowing from springs and rain. HA at a dose of 5 tablespoons (40 g), dissolved in 200 L of water for 1,000 m² of land. The irrigation system originated from a pond measuring 6 m x 3 m x 1.5 m. The following are maps of the research location and the condition of the agricultural land during the extreme drought (Figures 1 and 2). The crop productivity observed in this study was only on flat agricultural land.

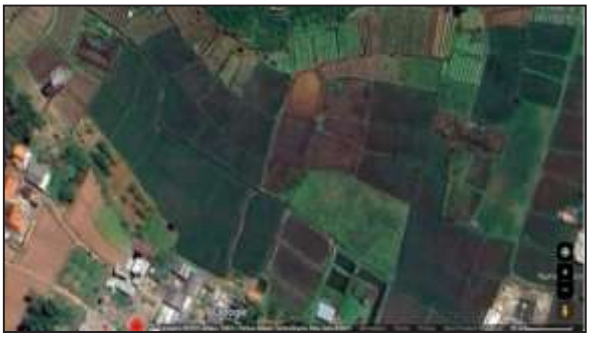

Fig. 1. Maps of the research location
(Source:https://maps.app.goo.gl/ttQmJGDZeHn5TFDL9 . 31 July 2025, 09.20 WIB)

Fig. 2. Condition of the agricultural land during the extreme drought

3 Result and Discussion

Based on interviews with farmer 1, who manages a leased plot of land measuring approximately 2,400 m2, it was found that the land is flat. Water requirements are met from the pond with an irrigation system, especially during the dry season. In one year, farmer 1 grows Capsicum annum (red chili peppers) as the main crop (Figure 3). and additional crops such as Capsicum frutescent (cayenne peppers), Allium fistulosum (leek), Phaseolus vulgaris (green beans), Brassica rapa (bok choy), Brassica juncea (mustard greens), and Brassica oleracea (cabbage). The fertilization carried out by Farmer 1 in 2023 includes manure at a rate of 1 kg per 1 m² of land or 1,000 kg per 1,000 m², Chemical fertilizer N (Nitrogen):15%, P2O5 (Fosfat):10%, K (Kalium):12%, S (Sulfur):10%) at 100 kg, urea fertilizer at 50 kg, and NPK fertilizer at 30 kg. Chemical fertilizers are applied three times during one planting period. Chemical fertilizer N (Nitrogen):15%, P2O5 (Fosfat):10%, K (Kalium):12%, S (Sulfur):10%), a mixed fertilizer, contains N, P, K, and sulfur with a composition of 15%:15%:15%; 10%. Urea contains high nitrogen at 46%, and NPK fertilizer is 16:16:16 used in farmer 2 and 3 (Table 1).

Irrigation in 2023 relied on rainfall, often resulting in crop failure. Farmer 1 also uses plastic mulch to reduce weed growth. The use of mulch reduces the need for chemical fertilizers as they are not absorbed by weeds. The application of mulch in farming offers a wide range of advantages for soil health, including minimizing moisture loss, raising soil temperature, regulating microbial populations, preserving organic carbon levels, boosting nutrient turnover, stimulating enzyme functions, enhancing the stability of soil aggregates,

and controlling weed growth. Additionally, nitrogen fertilization plays a crucial role in enriching soil fertility and increasing crop productivity [8]. The application of fungicide pesticides on red chili peppers by farmer 1 is a pesticide with the active ingredients 75 g/l Pidiflumetofen, 125 g/l Difenoconazole and Azoksistrobin 200 g/L. Farmers apply pesticides variably based on estimates and do not follow the rules regarding crop type suitability and recommended dosage. Fungicides are applied to additional crops such as leek, mustard greens, cabbage, and bok choy using the active ingredient mancozeb 80%. Pesticide application by Farmer 1 occurs from before pest infestation until one week before harvest. Spraying is done every two weeks.

The use of pesticides at inappropriate doses can also endanger the health of farmers, consumers, and non-target microorganisms, as well as have an impact on environmental pollution, including soil and water contamination. Pesticides have the potential to induce multiple forms of toxicity, including effects on the nervous system, genetic mutations, cancer development, birth defects, and hormonal imbalances. The degree of toxicity in pesticide formulations can vary based on the active chemical used and the inclusion of synergistic or inert substances that may intensify or modify its toxic impact [9].

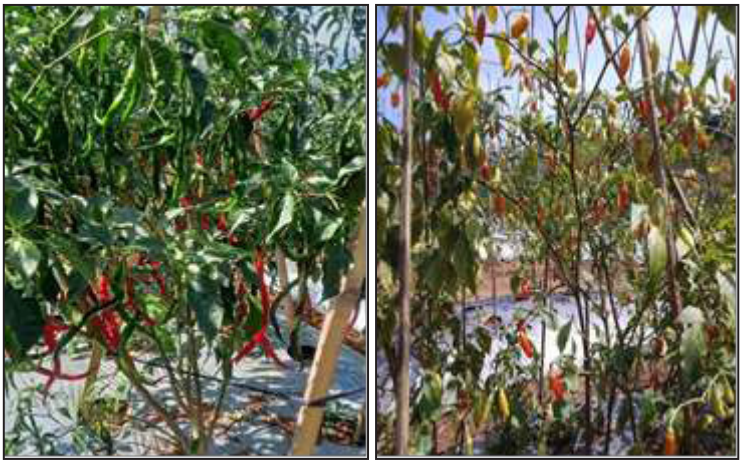

Fig.3. condition of chili peppers and cayenne peppers

In 2024, farmer 1 tried applying HA and reducing the amount of fertilizer by up to 50% in 2024, applying mulch for weed control, and using irrigation from water pond. The growth of plants treated with HA fertilizer and pond water irrigation began to show results after one month. Plant growth appears faster, with wider and taller stems, greener leaves, and greater resistance to pest and disease attacks compared to those not treated with HA and excessive fertilizer. The application of HA by Farmer 1 also reduces production costs. The number of red chili harvests previously reached 12 times, and after using HA, it can reach 18 times.

The harvest weight for red chili peppers, cayenne peppers, leek, green bean, bok coy, mustard greens, and cabbage and in a single harvest reached 1,050 kg, 350 kg, 560 kg, 525 kg, 560 kg, 340 kg, and 550 kg, respectively, after reducing fertilizer use by up 50% and using HA at 1,500 kg chili peppers, 500 kg cayenne, 800 kg leek, 750 kg green beans, 800 kg bok choy, 500 kg mustard greens, and 750 kg cabbage. The application of HA appears to have an impact on improving soil fertility even though the use of other fertilizers was reduced by 50%. Studies have demonstrated that incorporating HA can lead to notable improvements in agricultural performance, with average increases of 12% in crop yield, 27% in nitrogen use efficiency, and 17% in nitrogen uptake. The most favourable outcomes were recorded in regions receiving over 300 mm of annual rainfall and experiencing average

temperatures above 10 °C, particularly in soils with a moderately acidic to neutral pH (between 6 and 8) or low total nitrogen levels. However, HA tends to be less effective in alkaline soils and in environments with elevated nitrogen concentrations (≤1.5 g/kg) or limited organic carbon content (<10 g/kg) [10]. HA contributes positively to various soil properties physical, chemical, and biological such as texture, structure, moisture retention, cation exchange capacity, pH balance, carbon levels, enzymatic activity, nitrogen cycling, and nutrient availability [7]. Adequate water supply, including access to irrigation systems, is also a key factor in enhancing plant growth and boosting agricultural productivity [11]. The results of observations and interviews with farmers 1, 2, and 3 are shown in Table 1.

Table 1. Table of interview data for farmers 1, 2, and 3.

No	Indicator	Description		
		Farmer 1	**Farmer 2**	**Farmer 3**
1	**Age**	**35**	**62**	**53**
2	Last Education	Elementary school	Elementary school	Elementary school
3	Area of Cultivated Land	2400 m2	1500 m2	2000 m2
4	Land Conditions	Flat	Flat	Flat
5	Fertilizer application rate before applying HA and reducing fertilizer by 50%	1 kg/1 m2 of land or 1000 kg/1000 m2, 100 kg of chemical fertilizer (N (Nitrogen) : 15% P2O5 (Fosfat) : 10% K (Kalium) : 12% S (Sulfur) : 10%), 50 kg of urea fertilizer, and 30 kg of NPK fertilizer. Chemical fertilizers are applied three times during one planting period.	For an area of approximately 1500 m2 , use 1500 kg of manure, 50 kg of urea, 50 kg of NPK, and Special fertilizer which contains P, K, and calcium.	1000 kg/1000 m2, NPK 25 kg, manure 200 kg, urea 35 kg.
6	Types of pesticides used	Chili plants using Fungisida: Pidiflumetofen 125 g/L Difenoconazole 12 g/L and Azoksistrobin 200 g/L Leeks, mustard greens, cabbage, and bok choy using Fungisida : Mancozeb Ditiokarbamat dan Zink 6 gr/L	Insektisida : Profenofos 500 g/l	1. Antracol : Propineb 70% Fungisida 2.Fungisida Mancozeb

Fertilization carried out by farmer 2 in 2023 used manure, NPK fertilizer, and urea fertilizer. Fertilizer use on an area of approximately 1500 m2 used 1500 kg of manure, 50 kg of urea, 50 kg of NPK, and special fertilizer containing P, K, and calcium. In 2024, Farmer 2 reduced fertilizer use by 50% and applied HA at a dose of 5 tablespoons (40 g), dissolved in 200 L of water for 1,000 m² of land. The farmer also used mulch to reduce weed growth. Observation results showed faster plant growth compared to chili plants that did not use HA. This was evident from the plant height and faster fruiting compared to chili plants that were not previously given HA. Zea mays (corn) harvest in 2024 after HA and the pond irrigation application 1,250 kg, green beans: 250 kg, bok choy: 100 kg, and leek: 50 kg, compared to

2023: 875 kg, 175 kg, 70 kg, and 35 kg, respectively (Table 2). The effectiveness of HA in improving soil quality, which impacts increased crop yields, has also been proven by the second farmer. HA is an environmentally friendly product that requires only a small amount and can reduce the use of manure and chemical fertilizers. Its presence can improve soil conditions, stimulating plant growth and enhancing plant resistance to pests and diseases [12].

The type of pesticide used by farmer 2 contains the active ingredient Profenofos at a concentration of 500 g/l, which acts as an insecticide. The use of this insecticide also exceeds the recommended dosage. Its excessive use causes significant environmental problems. This compound accumulates in various environmental components, contaminating food, water, and air. This insecticide can cause neurotoxicity. Profenofos inhibits the activity of acetylcholinesterase receptors, causing dizziness, paralysis, and the death of pests. This compound also affects other eukaryotic organisms, such as pollinators, birds, mammals, and invertebrates, which impacts ecosystem function [13]. The following shows the growth of bok choy and leek given HA.

Fig.4. Condition of bok choy and scallion given HA

Observations of farmer 3 showed flat land with an area of 2000 m2. The fertilizers used were typical of farmers, namely 1 kg of manure per 1 m2 of land or 1000 kg per 1000 m2, 25 kg of NPK, and 35 kg of urea. Chemical fertilizers were applied three times during the planting period. In 2024, the dosage was reduced by 50%, with AH applied once at 40 grams dissolved in 200 L of water for 1,000 m² of land. Farmer 3 also used mulch to reduce weed growth and irrigation system is sourced from a pond. The harvest yield was 700 kg of red chili peppers, compared to 500 kg before applying AH and the irrigation system. Vigna unguiculata (long bean) (fig.5) harvest reached 200 kg, compared to 150 kg previously. A comparison of the harvest yields of farmers 3 is shown in Table 2.

Table 2. Table of Yield of each crop type planted during one growing season

No	Indicator	Farmer 1		
		Type plant	**Before (kg)**	**After (kg)**
1.	Yield of each crop type planted during one growing season after applying HA three times and reducing fertilizer by 50%	Capsicum annum	1,050	1,500
		Capsicum frutescent	350	500
		Alium fistulosum	560	800
		Phaseoulus vulgaris	525	750
		Brassica rapa	560	800
		Brassica juncea	340	500
		Brassica oleracea	550	750
2.	Yield of each crop type planted during one growing season after applying HA three times and reducing fertilizer by 50%	Farmer 2		
		Type plant	Before (kg)	After (kg)
		Zea mays	875	1250
		Phaseoulus vulgaris	175	250
		Brassica rapa	70	100
		Alium fistulosum	35	50
3.	Yield of each crop type planted during one growing season after applying HA three times and reducing fertilizer by 50%	Farmer 3		
		Type plant	Before (kg)	After (kg)
		Capsicum annum	500	700
		Vigna unguiculata	150	250

HA increases total nitrogen (TN), available potassium (AK), organic matter (OM), and Fe, and neutralises soil pH. HA also maximises rhizosphere microbial diversity, especially bacteria. Microbial community variation correlates with changes in pH, OM, TN, AK, and Fe. The best agronomic indices are achieved with HA application, including increased dry root weight, flower yield, and aromatic compounds [14].

Fig. 5. Condition long beans

Utilizing water from the pond by implementing irrigation systems protects crops from extreme droughts caused by climate change. This is also in line with research explaining that agricultural irrigation systems play a crucial role in meeting water needs for agroecosystems affected by climate change [15]. HA does not seem to be commonly used by farmers yet and is still considered unfamiliar and expensive [16]. Although in fact the use of HA and the reduction of fertilizers commonly used by farmers are low cost. Farmers are more familiar with using organic fertilizers derived from the processing of agricultural by products. To

promote the use of HA, a formulation for producing organic fertilizer using HA has been developed. The pond used for irrigation systems can also be utilized for the cultivation of Orechormis niloticus. The success of fish farming is due to the suitability of pH, Total Dissolved Solids (TDS), and temperature [17]. Measurements showed that the pH of the water ranged from 6.5 to 7.2, TDS was 0.2, and the temperature was 26°C. Farmer 3 also showed an increase in crop yield, namely 700 kg of red chillies from 500 kg and 250 kg of long beans from 150 kg.

4 Conclusion

Research findings indicate that the use of HA contributes to reduced fertilizer consumption. Applying HA on flat land agriculture, mulch, and irrigation effectively enhances crop quality and increases yields by up to 38.38%. Producing organic fertilizer is essential to minimize the cost of purchasing chemical fertilizers. Agricultural water needs can be met through the construction of pond equipped with pumps and piping systems. Additionally, the presence of pond provides opportunities for freshwater aquaculture initiatives. Farmers need to be educated on reducing excessive pesticide use, given the negative impacts on both human health and the ecosystem. Additional research is required to develop organic fertilizers that demonstrate effects comparable to humic acid in minimizing the reliance on chemical fertilizers while achieving increased crop yields.

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