CIRCULAR ECONOMY FOR PIG FARM IN VIET NAM

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Abstract

Pig farming has provided an important source of income for farmers. However, alongside its many benefits, animal husbandry also brings significant problems such as diseases and environmental pollution. Notably, the failure to safely treat livestock waste has serious impacts on both the environment and people.

Integrated livestock models have been successful in minimizing pig herd pollution and increasing farmers' incomes. Reusing waste from pig farms to produce fertilizer for crops is essential in reducing environmental pollution.

Livestock waste is a recyclable resource for crop fertilization, which can benefit family farms both economically and environmentally. Research and production of fulvic bio-organic fertilizer – amino acids from pig farm emissions – aim to protect the environment and promote sustainable development.

An experimental model on the effect of foliar fertilizer on leafy vegetable crops was conducted in vegetable gardens in Hoc Mon district.

Methods

Pork was obtained from Co-opmart in Phu Nhuan, Ho Chi Minh City. Pig manure was collected from a pig farm in Binh Chanh, HCM City. Protease enzyme was purchased from Hoang Gia Long Biotech Company. Microbial fish hydrolysate was procured from the Vietnam Green Technology Application Corporation. KOH and H3PO4 were bought from a chemical store in District 5; they are industrial chemicals.

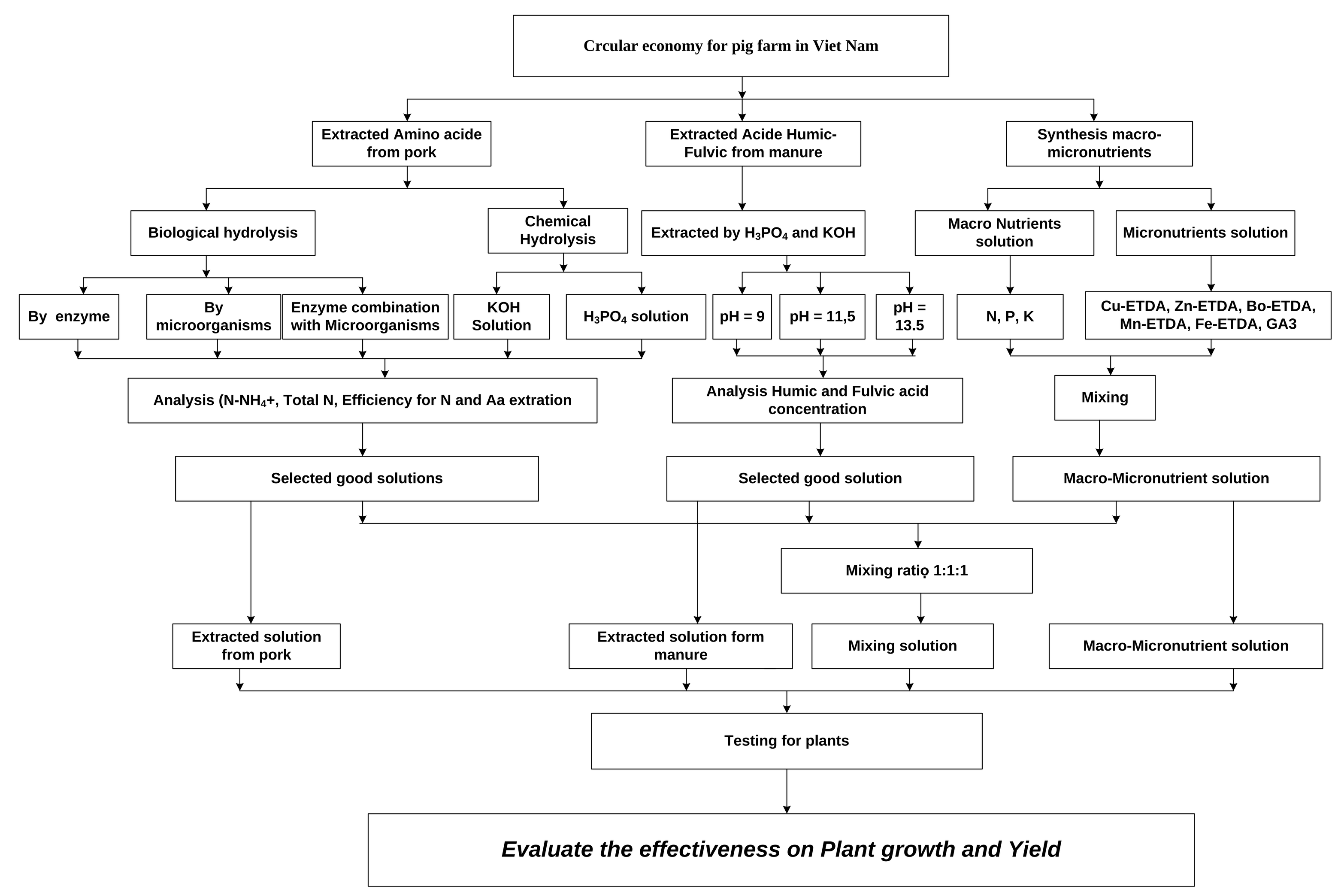
Method for total nitrogen analysis: TCVN 8557-2010

Method for protein (N-NH4+) analysis: AOAC 920.03

Method for total amino acid analysis: TCVN 12621:2019

Method for fulvic acid and humic acid analysis: TCVN 8561-2010

An investigation into the impact of nutrient solutions on Chinese mustard and watercress plants was conducted in the vegetable garden of Mr. Nguyen Van Huung, in Dong Thanh commune, Hoc Mon District, Ho Chi Minh City.



Introduction

Currently, pig farming is a central occupation in our country's development, providing many economic resources and products such as food, fur, and labor. Livestock products offer a stable economic source and significantly contribute to daily life.

In Vietnam, animal husbandry is a primary occupation. Besides providing benefits and food to the country, the livestock industry also exports to countries worldwide, greatly contributing to our economic growth.

To reduce livestock costs and make full use of discarded waste, the livestock industry is now closely integrated with the farming industry. The pig industry is particularly notable as it can significantly complement agricultural activities and vice versa.

However, alongside its many benefits, animal husbandry also brings numerous problems, such as diseases and environmental pollution. Notably, the failure to safely treat livestock waste has serious impacts on both the environment and people. According to research by scientists, the livestock industry can emit 18% of global greenhouse gas emissions, which is higher than the transportation sector.

Livestock accounts for 9% of global CO_2 emissions and also emits 37% of CH4 methane (a gas 23 times more potent than CO2 and containing 65% NOx), which is 296 times more potent than CO2. This sector is responsible for 2/3 of all ammonia emissions and is a major cause of acid rain, which destroys ecosystems. The waste discharged directly into rivers and streams also affects water sources, and wells and groundwater are increasingly depleted because wastewater is not treated and buried properly. These wastes seeping into the ground will damage the soil and prevent any further cultivation.

Figure 1. Methods

Figure 2. Extracted Acid Humic and Fulvic form manure and Synthesis Macro-Micronutrient solution

Results and Discussion

Effect of different methods on Nitrogen and HA, FA recovery

Table 1: Effect of different method on protein hydrolysis.

Treatment	N-NH_4^+ (%)	Total N (%)	N recovery (%)
Enzyme	1.15	1.60	51.1
Microorganism	0.819	1.28	40.8
+ Enzyme			
Microorganism	0.533	0.871	27.8
KOH	0.096	1.25	39.9
H_3PO_4	0.037	0.667	21.3

Enzyme and KOH solution show that they have more effective on protein hydrolysis to compare with other methods.

Solution with pH = 13 show fast extraction humic and fulvic acid than pH 9 and 11.5

Biological methods of protein hydrolysis result in higher production of nitrogen ammonia compared to chemical methods.

Table 2: Effect of pH solution on humic and fulvic acid extraction

Parameter	Axit fulvic (%)	Axit humic (%)
pH 11.5	1.64	0.226
pH 13	2.12	1.62

Effects of nutrient solutions on the growth and yield of vegetables

Table 3: Effect of different nutrient solutions on high of Bok choy

Treatment	Height of Bok Choy vegetable after sowing (cm)			
	10 day	17 day	24 day	31 day
NT1	3.25±0.5	9.85±0.69	17.66±0.8	21.25±1.89
NT2	3.66±0.51	10.83±0.75	20.50±0.75	23.40±0.54
NT3	3.33±0.57	10.75±0.70	20.62±1.06	23.50±0.70
NT4	3.60±0.54	10.62±0.51	18.85±0.89	21.60±1.07
NT5	3.80±0.44	11.00±0.70	19.00±1.00	23.12±1.12
NT6	3.60±0.54	12.00±0.63	17.83±1.16	23.00±0.57
NT7	3.50±0.58	10.00±0.81	18.53±0.42	23.35±0.76

Table 4: Effect of different nutrient solutions on leaf area of Bok choy

Treatment	Leaf Area (cm^2)	
	24 day	31 day
NT1	39.52 ± 4.44	48,72 ± 10,91
NT2	61.74 ± 13.64	129,3 ± 7,57
NT3	57.54 ± 14.36	118,2 ± 8,49
NT4	39.00 ± 5.62	73,02 ± 15,48
NT5	43.08 ± 6.65	130,45 ± 15,45
NT6	40.32 ± 10.47	67,00 ± 4,24
NT7	38.0±4.95	105,00±4,49

Effect on Chili yeild

Nghiệm thức	Chiều dài quả (cm)	Đường kính quả (cm)	Năng suất lý thuyết (tấn/ha)	Năng suất thực thu (tấn/ha)
NT11	5,45	0,99	11,9	10,2
NT12	5,61	1,02	13,9	10,8
NT13	5,47	1,01	12,0	10,0

Table 5: Effect of different nutrient solutions on yeild of Bok choy

Treatment	NSLT (ton/ha)	NSSV (ton/ha)	NSKT (ton/ha)
NT1	36	35	28
NT2	48	42	37
NT3	60	42	37
NT4	51	44	37
NT5	62	45	45
NT6	50	40	31
NT7	51	45	34

A mixing solution that includes amino acids, fulvic acid, humic acid, as well as macronutrients and micronutrients, shows greater effectiveness compared to other solutions.

Table 6: Effect of different nutrient solutions on dry matter of Bok choy

Treatment	Dry Matter (%)
NT1	2.87
NT2	3.77
NT3	3.30
NT4	3.01
NT5	3.06
NT6	3.74
NT7	3.41

Comments of garden owners on fertilizer quality

Table 7: Effect of different nutrient solutions on high of Jute vegetable

Treatment	Height of Jute vegetable after 24 days sowing (cm)		
	10 day	17 day	24 day
NT8	3.85 ± 0.37	24.30 ± 0.67	60.80 ± 1.03
NT5	3.75 ± 0.46	25.85 ± 1.06	63.00 ± 1.11
NT17	3.87 ± 0.35	25.83 ± 0.40	62.57 ± 1.39
NT9	3.87 ± 0.25	25.78 ± 0.85	62.48 ± 1.40

Table 8: Effect of different nutrient solutions on leaf area and yield of jute vegetable

Treatment	Leaf area (cm^2)	Yeild (ton/ha)
NT8	25.50 ± 8.48	25
NT5	33.30 ± 3.00	30
NT7	32.04 ± 4.24	30
NT9	33,15 ± 3.80	30

The quality of nutrient solutions made from pig waste is good to compare with commercial foliar fertilizer

Improvement soil quality

Parameter	Before experiment	Solid after extraction (5 ton/ha)	Solid after extraction (10 ton/ha)	Solid after extraction + Liquid (10 ton/ha)	Compost (25 ton/ha)
pH	6.36	6.74	6.76	6.67	6.80
Moisture (%)	21.2	19.2	16.4	20.3	21.6
Total organic (%)	2.51	5.22	5.65	5.77	5.47
Density	5.73	2.53	2.50	2.50	2.52

Effect on environment and economy

Nitrogen and carbon accumulation on bok choy vegetables

Treatment	N (%)	C (%)
NT1	0.125	1.15
NT2	0.158	1.63
NT3	0.153	1.28
NT4	0.121	1.21
NT5	0.126	1.19
NT6	0.16	1.5
NT7	0.147	1.16

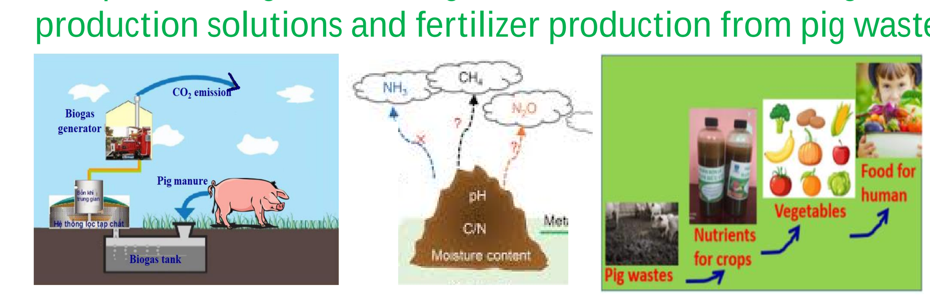
Estimate the reducing of GHG emission

GHG	1 kg GHG emission/kg pig meat			1 m^3 GHG emission/kg pig manure		
	Normal	Enzyme	KOH	Normal	pH = 11.5	pH = 13
CH_4	3.78	2.411	1.276	0.45	0.392	0.3525
N_2O	0.83	0.406	0.499			
CO_2	0.11	0.069	0.036			

Increasing income

Treatment	Yield (ton/ha)	Price/kg (VNĐ)	Income (VNĐ)	Benefit (VNĐ)
NT1	23.2	3.000	69.600.000	0
NT2	33.6	3.000	100.800.000	31.200.000
NT3	41.6	3.000	124.800.000	55.200.000
NT4	34.4	3.000	103.200.000	33.600.000
NT5	50.4	3.000	151.200.000	81.600.000
NT6	31.2	3.000	93.600.000	24.000.000
NT7	30.4	3.000	91.200.000	21.600.000

Comparison of greenhouse gas emissions between biogas production solutions and fertilizer production from pig waste



Circular Economy in Agriculture

Conclusion

Recovering amino acids from pork hydrolysis and fulvic and humic acids from pig manure significantly enhances the growth and development of spinach and jute crops, increasing plant height, leaf area, and yield compared to controls. These extracts, used as foliar fertilizers, reduce the need for chemical fertilizers, protecting crops and increasing farmers' income.

Based on the results, an appropriate fertilization procedure for cabbage plants can be developed for different growth stages to boost yield. For 10-17 days, apply pork extract and manure at 100 ml/16 liters. For 17-24 days, apply at 50 ml/16 liters. For 24-31 days, revert to 100 ml/16 liters.

Research indicates that foliar nutrient solutions of organic origin are significantly more effective than those of inorganic origin.

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