EFFECTS OF ORGANIC MATTER ON SOIL EROSION AND RUNOFF PEANUTS AND GREEN PEA IN CULTIVATION

(Pengaruh Bahan Organik Terhadap Erosi Dan Aliran Permukaaan Pada Pertanaman Kacang Tanah Dan Kacang Kedele)

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RINGKASAN

Bahan organic dari pupuk kandang digunakan selain untuk pupuk tetapi juga untuk mengontrol erosi tanah dan aliran permukaan. Bagaimana mengelola pupuk kandang untu pertanaman kacang tanah dan kedele sangat penting karena banyak petani menanam tanaman tersebut. Tujuan penelitian ini mengidentifikasi pengaruh bahan organic dari pupuk kandang ayam, sapi dan kambing terhadap erosi dan aliran permukaaan pada pertanaman kacang tanah dan kedele . Selain itu juga menidentifikasikan pengaruh mulsa dari padi , jagung dan daun pisang terhadap erosi dan aliran permukaan.

Pengaruh pada persipana lahan dengan menggunakan pupuk kandang ayam yaitu menurunkan bulk density tanah dan meningkatkan porositas tanah serta stabilitas indeks aggregat. Erosi tanah dan aliran permukaan yang paling rendah didapat pada penggunaan pupuk kandang ayam. Pengaruh produktivitas tanaman meningkat dengan menggunakan pupuk kandang. Mulsa dari padi menghasilkan erosi tanah dan aliran permukaan lebih rendah dibandingkan dengan mulsa dari jagung atau daun pisang.

ABSTRACT

Organic matter from manure are used not only for fertilizer but also can be used for preventing soil erosion and runoff. How to manage manure to soil for peanut and green pea cultivation is especially important, because most farmers plant these crops. The objective of this research is to identify effect of : 1) organic matter from chicken manure, cow manure and sheep manure on soil erosion and runoff in peanuts and green pea cultivations, 2) mulch from paddy, corn and leaf of banana on soil erosion and runoff. The design is divided into three experiments. First, field experiment for land preparation with treatment plowing with harrowing. Second, field experiment for peanuts and green pea crops with treatment chicken, cow and sheep manure. Third, laboratory experiment for mulching uses treatment with cover percentage of mulch from paddy, corn and leaf of banana.

Land preparation using chicken manure decreased soil bulk density and increased soil porosity and aggregate stability index. Lower soil erosion and runoff is attained when treated with chicken manure. Productivity of peanuts and green pea are increased with the increase of manure. Using mulch of paddy, soil erosion and runoff are lower compared with using mulch of corn and leaf of banana.

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INTRODUCTION

Manure and mulch can be used in soil and water conservation, since their appropriate use in soil treatment will reduce soil erosion and runoff on the sloping land. By maintaining the effect of manure, soil condition will stabilize, and in turns it will help reduce erosion and runoff. Fertile soil also produces higher yielding crops through this treatment, For this reason the use of fertilizer and manure should be first considered when developing program [(5)].

Organic matter from manure is an important fertilizer because it supplies not only plant nutrients but also control soil erosion. Crop cultivation management is one problem in soil and water conservation [(7)].

Peanut and green pea are very popular in Indonesia agriculture crops. The crops influence soil structure in Indonesia farm by their root system activity and the amount of organic residue from roots and tops that is returnable to soil.

The objective of this research is to identify the effect of organic matter from cow, chicken, sheep manure, and mulch on soil erosion and runoff with peanut and green pea crops cultivation.

METHODOLOGY

The design of field experiment is set with standard small plot 22 X 2 meter, land slope of 9 percent. Laboratory experiment uses plots of size 1.15 X 1.15 meter and uses rainfall simulator.

A. Land preparation experiment:
Field experiment using chicken manure of dosage 10 ton/ha, which is usually used by the farmers. Treatment on land preparation is shown in Table 1.

B. Field experiment
Influence on peanut and green pea crops by adding manure from chicken, cow and sheep to soil erosion. Each crop is with 8 small plot of size 2.5 x 25 m is made for the crops on land slope is 9 % ; Treatment 1 is with chicken manure of dosage 10 t/ha. Treatment 2 with cow manure of dosage 30 t/ha, and Treatment 3 with sheep manure of dosage 10 t/ha. This dosage is usually used by the farmer.

C. Laboratory experiment:
Investigation of soil erosion and runoff with mulch from paddy, corn and banana leaf with different land covering.

Table 1. Treatment on Land Preparation

Treatments		Harrowing (Hand tractor)		
		1 Times (B1)	2 Times (B2)	3 Times (B3)
Plowing (dishplow)	1 Times (A1)	A1B1	A1B2	A1B3
	2 Times (A2)	A2B1	A2B2	A2B3

Table 2. Treatment of mulching

Treatment	Soil Cover Percentage			
	0%	30%	60%	90%
Paddy (C1)	C1D1	C1D2	C1D3	C1D4
Corn (C2)	C2D1	C2D2	C2D3	C2D4
Leaf of Banana (C3)	C3D1	C3D2	C3D3	C3D4

Total plot of 24 each of size 1.15 x 1.15 m is used Rainfall Simulator. Estimation of soil erosion is made using Rose formula . The experimental design is set up in a randomized block wit factorial experiment and wit 2 replications. The field experiment has taken place at Bogor Agriculture University in Darmaga Bogor, Indonesia.

D. Methods

Rose developed a physical model for predicting soil loss and deposition considering mass conservation of sediment in a section unit of overland flow combined with theory of sediment deposition and hydrology [(10)].

Methods for calculation and analysis :

- Volumetric water flux. This parameter was computed from the amount of runoff divided by the width of plane.
- Volumetric water flux per area of plot
- Sediment flux
- Stream power of runoff
- Threshold value of stream power and efficiency of entraiment
- Parameter of X^*
- Predicted sediment concentration

Estimation Soil Erosion:

Estimation of soil erosion used of Rose Formula [(9)].

$C = 2700\ SnCr(1-X^*)L$,

Where:

C = Sediment Concentration (kg/m/s)
S = Land Slope (%)
n = Efficiency of entrainment (transportation efficiency)
Cr = Soil surface uncovered fraction
X^* = Threshold distance to another lower slope after sediment transport
L = length of plane (m)

The result of soil erosion by Rose Formula and cumulative method are shown in Table 10.

RESULT AND DISCUSSION

A. LAND PREPARATION

1. Bulk Density of Soil

Land preparation added with chicken manure result in a decrease of its bulk density. Comparison on bulk density before and after land preparation is shown in Table 3 as follows.

Table 3 The result of bulk density soil before and after land preparation

Treatment	Before				After				Effect	Reduction
	1	2	3	Mean	1	2	3	Mean	Different	%
A1B1	0.93	0.95	0.91	0.93	0.81	0.82	0.81	0.81	-0.12	13
A1B2	0.96	0.95	0.96	0.96	0.81	0.81	0.81	0.81	-0.15	16
A1B3	0.88	0.88	0.88	0.88	0.70	0.70	0.77	0.72	-0.16	18
A2 B1	0.81	0.81	0.81	0.81	0.73	0.73	0.73	0.73	-0.08	10
A2B2	0.94	0.95	0.94	0.94	0.82	0.82	0.81	0.81	-0.13	14
A2B3	0.87	0.86	0.86	0.86	0.85	0.82	0.81	0.83	-0.03	4
A0B0	0.87	0.85	0.92	0.91	0.91	0.91	0.91	0.91	0.00	0

Treatment on land preparation with added chicken manure results in a decrease of soil bulk density. The decrease of soil bulk density is shown on all treatment except for A0B0 treatment. It means, that with plowing and harrowing treatment both show an indication the effect of using chicken manure.

With treatment A1B3, most different soil bulk density is observed, while the smallest one is with treatment A2B3. The number of plowing and harrowing times seems to influence the soil

structure and have relation to soil bulk density. The low value of soil bulk density may affluent effect on root crop and water drainage. Soil bulk density is also an important factor for soil fertility or water requirement.

2. Soil Porosity

The value of soil porosity before and after treatment shown in Table 4.

Treatment on land preparation with chicken manure has effect of an increase in soil porosity. Soil porosity after treatment higher than before treatment, except AOBO treatment. It means that land preparation by using chicken manure has the effect on soil porosity. Treatment A1B3 gives soil porosity than any other treatment.

Soil harrowing 3 times in latosol soil with clay texture make soil porosity hoghly increased. Soil porosity depends on soil structure and soil texture. Compared with in result. As harrowing times increase, the soil porosity also increases. Organic matter from chicken has high effect on soil porosity compared with no manure.

3. Aggregate Stability Index

The aggregate refers to the soil itself, in contrast to its constituent parts. Aggregate stability index is indicate of stability aggregate. Dry and wet soil shifting is used for measuring aggregate stability index. The size of filter is 2 mm, 1 mm, 0.5 mm and 0.1 mm. The difference between wet and dry of soil sifting is the aggregate stability index. Value of index stability aggregate before and after treatment with chicken manure shown in Table 5 .

Table 4. Soil porosity before and after treatment

Treatment	Before(% v/v)				After(% v/v)				Effect	Increase %
	1	2	3	Mean	1	2	3	Mean		
A1B1	64.62	64.18	65.72	64.91	69.43	69.12	69.36	69.30	+4.39	7
A1B2	83.71	63.73	66.90	65.78	69.46	69.48	69.56	69.56	+3.72	6
A1B3	66.83	66.77	66.78	66.79	73.75	73.75	74.01	73.87	+7.08	11
A2B1	66.60	69.54	69.58	69.57	71.94	72.52	71.99	72.15	+2.58	4
A2B2	69.38	64.07	64.63	64.36	69.11	69.50	69.76	69.46	+5.10	8
A2B3	67.12	67.78	67.57	67.49	68.75	67.91	68.92	68.53	+1.04	2
A0B0	67.15	67.97	68.05	67.72	65.11	65.11	66.18	65.66	-2.06	3

Table 5. Index Stability Aggregate before and after land preparation

Treatment	Before				After				Reduction (%)
	1	2	3	Mean	1	2	3	Mean	
A1B1	54.48	58.17	59.83	58.83	44.23	46.35	45.45	46.34	23
A1B2	49.02	51.23	50.70	50.32	35.71	36.80	35.82	36.11	28
A1B3	50.00	52.41	54.47	52.32	31.35	32.43	31.74	31.84	39
A2B1	63.29	64.73	60.85	62.96	30.86	30.15	40.84	33.95	46
A2B2	64.93	64.66	65.23	64.94	41.49	42.01	40.84	41.45	36
A2B3	51.83	52.42	51.73	52.00	44.24	43.95	44.75	44.32	15
A0B0	36.08	38.89	37.14	36.70	30.30	31.17	30.89	30.79	16

Treatment of land preparation with chicken manure added has decreased aggregate stability index. The index stability aggregate before treatment is higher than after treatment except for A0B0 treatment. The decrease in aggregate stability index is related to the soil structure change. Soil aggregate with pressure of water added has increase in soil porous. More times of soil harrowing will make soil aggregate smoother and more

homogeneous in size. The decrease in water content will cause soil particle easier to split. The lowest value of aggregate stability index is on treatment A1B3. Land preparation for crop plant should be with minimal tillage. It means that soil plowing and harrowing with the optimum condition depend on soil characteristic. Land preparation is used for immediate needs and saved for future use.

B. PEANUTS AND GREEN PEA CROP CULTIVATION

1. Runoff

Total runoff for each plot of peanuts and green pea crop shown in Table 6. Manure from chicken (A), cow (B) and sheep (C) have the effect on decrease in runoff. The runoff value from treatments A,B, and C (with manure) are lower than that of treatment D (without manure). Statistic analysis indicates that treatment A,B and C gives significantly lower runoff than treatment D. runoff high different with treatment D.

Manure from chicken, cow and sheep has effect to runoff. It means that manure has the effect on runoff. For peanut and green pea cultivation, chicken manure causes lower runoff than cow or sheep manure. The effect of chicken manure in reducing runoff is higher than any other manure. Runoff from rainfall on crop cultivated land needs more attention to be minimized. Use of manure as an organic matter will decrease the runoff. Application of manure for crop field needs labor forces, however with inexpensive labor forces, this will not be the real problem. The cost for chemical fertilizer is higher than manure. For the environmental impact, use of manure needs more careful attention. For the water quality research done in Pujon, East Java, where farmers use manure, the water condition was not bad.

Table 6. Total runoff (m^3/ha) from peanut and green pea crops.

Treatment	Dosage	Total runoff (m^2/ha)			
	(ton/ha)	Peanut Crop	Reduction (%)	Green pea Crop	Reduction (%)
With Chicken Manure(A)	10	11.08	74	142.20	95
With Cow Manure(B)	30	14.95	65	201.56	93
With sheep manure(C)	10	23.11	46	308.22	89
Without Manure (D)		43.03		3027.69	

Manure for peanut and green pea crops is not only used as fertilizer but also used to decrease runoff. Runoff has the relation with soil erosion and will need careful attention in soil and water conservation. The importance of soil conservation is to decrease runoff until it is not erosive to soil.

Infiltration is a process of water into the soil and is an important factor to runoff ([7]). Measurement on infiltration is taken tree times: before treatment, when crop growing, and after harvesting. Infiltration is accumulative and the rate of infiltration increase after treatment. Infiltration rate increase by application of manure.

When the accumulated infiltration increases, it means that the water proportion increase in the soil. Increased rate of infiltration enable more water content in the soil. With this condition, runoff will decrease.

2. Soil Erosion

Soil erosion becomes a problem in crop cultivation. The question now how to protect soil from erosion in crop cultivation using manre as organic matter. The importance of organic

matter is for soil formation and natural factors of humus formation, such as plant cover , soil microorganism, hydro thermal condition, chemical and physical properties of soil.

Manure treatment to each plot results in different values of soil erosion. Manure treatment has good effect on peanut and green pea crops. Manure treatment decreases soil erosion. There is significant statistical difference between treatment with manure and without manure. Strongest effect of manure is given first by chicken manure, second by cow manure and third by sheep manure. Chicken manure dosage of 10 t/ha gives stronger effect than cow manure dosage of 30 t/ha.

Chicken manure which has smaller size than cow and sheep manure has better possibility of mixing wit soil and fill soil pore easily. Soil pore has relation with texture and structure to influence runoff and soil erosion.

Table 7. Equation of infiltration accumulative, rate of infiltration with manure treatment For green pea cultivation

Time of measurement	Water Content (%)	Infiltration Accumulative	Rate of Infiltration
Before Planting	49.1	$D = 1.866\ t^{0.075}$	$I = 0.141\ t^{-0.925}$
After Planting	19.31	$D = 0.379\ t^{0.084}$	$I = 0.196\ t^{-0.916}$
After Harvesting	47.37	$D = 2.292\ t^{0.078}$	$I = 0.227\ t^{-0.922}$

Table 8. Total soil erosion from peanuts and green pea crops

Treatment	Total soil erosion (ton/ha)			
	Peanuts Crop	Reduction(%)	Green pea Crop	Reduction (%)
Chicken Manure(A)	0.59	95	1.27	99
Cow Manure(B)	0.62	95	3.07	98
Sheep Manure(C)	0.85	93	3.40	97
Without Manure(D)	12.16		167.15	

Control plot differs highly from any other treatment plot. Soil erosion from this plot is higher than from plots with manure treatment. The difference in soil erosion among treatments with manure is small except with chicken manure for green pea crop. For peanut crops, the effect of manure to soil erosion is not significant. It means that crop with manure treatment decreases soil erosion, but not so much.

The ability of plants and land cover to protect the soil against erosion depend not only on planting density but also on total plant growth. Density or closely grown crops such as peanut and green pea crops give the greatest protection against soil erosion.

The main purpose of plant crops for the farmers level is for crop production. The use of manure, beside for growth of the plant, it is also for decreasing soil erosion. Cost of production with manure is higher than without it. The increase in peanut and green pea productivities, however, is much more beneficial; than without manure. Therefore, the effect of manure is better than without manure. There is a relationship between soil erosion and crop productivity ([11]). While soil erosion decreases, crop production increases. This situation is the same for both peanut and green pea crops. Crop productivity is for development, whereas soil erosion should be decreased. The role of manure is to decrease soil erosion and in the same time to increase crop productivity. Crop productivity of peanut and green pea with manure treatment is shown in Figure 3.

In the island of Java, peanut and green pea crops are planted on upland area, The mean of national productivity for peanut is 1.56 t/ha, and for green pea is 1.38 t/ha. The crop productivity for both peanut and green pea are higher than national productivity.

Table 9. Peanuts and Green pea Crop Productivity

Treatment	Peanuts Crop(ton/ha)	Green pea Crop(ton/ha)
Chicken Manure(A)	4.46	2.48
Cow Manure(B)	2.85	1.04
Sheep Manure (C)	1.64	0.91
Mean	2.98	1.48
National production (1999)	1.56	1.38

Table 10. Soil erosion with mulch treatment

Type of mulch	Percent of Cover	Soil erosion(ton/ha)		Total Erosion
		Rose Formula	Total Erosion	Reduction(%)
Paddy	0	2.73	2.80	
	30	0.25	0.26	90.7
	60	0.20	0.19	71.8
	90	0.04	0.05	18.2
Corn	0	2.93	2.92	
	30	0.74	1.83	37.3
	60	0.63	0.64	78.1
	90	0.15	0.14	95.2
Leaf of Banana	0	2.96	2.95	
	30	0.09	0.09	96.9
	60	0.07	0.07	97.6
	90	0.06	0.06	97.9

C. MULCHING

Test validation of Rose formula and cumulative measures is made by regression analysis. The coefficient of correlation is for paddy 0.994, for corn 0.999, and for leaf of banana 0.999.

The effect of mulch with different percentage of covering is to decrease is to decrease soil erosion. The higher percentage of covering by mulch of paddy does not cause different soil erosion. In fact, different soil erosion is more visible without mulch.

Mulch of corn and banana leaf with different percentage of covering will not cause different soil erosion, except for with no mulch. The treatment results indicate that with 30%, 60%, and 90% covering of mulch from paddy, corn and banana leaf show essentially the same soil erosion, except for treatment with no mulch.

CONCLUSIONS

1. Land preparation with added chicken manure has effect to bulk density, soil porosity, aggregate stability index and infiltration. Soil bulk density is decreased after treatment, but soil porosity is increased. After treatment with the same aggregate stability index, the infiltration value will increase. Land preparation with A1B1 treatment has the effect to soil performance, especially soil conservation becomes higher than other treatment because the soil erosion and runoff are higher. The use of manure to land preparation with minimum tillage well effective.
2. Chicken manure has effect of decreasing runoff and soil erosion from peanuts and green pea crops. The runoff and soil erosion from

plot peanuts and green pea plots with chicken manure are lower than with cow and sheep manure. Mean of runoff and soil erosion from treatment with chicken manure are respectively, 76.40 m^3/ha and 0.93 ton/ha.

3. Productivity of peanuts and green pea crop with chicken manure higher than with cow and sheep manure. Peanuts productivity with chicken, cow and sheep manure are 4.46 ton/ha, 2.85 ton/ha and 1.84 ton/ha. Green pea productivity obtained in this research using chicken manure and cow manure for peanuts crops is higher than national productivity.
4. Estimation of soil erosion by Rose Formula with percentage covering from paddy, corn and banana leaf, giving essentially the same soil erosion. The use of paddy mulch with 30% covering is likely to be more suitable to apply for soil conservation. has effect same its mean no different of soil erosion. Therefore applied for soil conservation in Indonesia.
5. The use of manure in agriculture should be taken into attention not to damage natural resources. Dosage of application to soil should not exceed the amount recommended by the environmental institution in Indonesia.

ACKNOWLEDDGEMENT

The authors wish to express their deepest appreciation to Prof Dr Ir H Sedodo Hardjoamidjojo MSc for helping to finish the research. Special thanks are also conveyed to Dr Ir H Moh Azron Dhalhar MSAE and Prof Dr H Kamaruddin Abdullah from Bogor Agriculture University for their supporting in finishing this paper. Thanks very much to JICA for helping on facility from implementation of this research.

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