

PERFORMANCE OF SMALL RUMINANTS ON SOME PASTURES FERTILIZED
WITH COMPOST AND OTHER SOURCES.

By

Oyor Moses Ayul Goang

B.Sc. (Animal Production) College of Natural Resources and Environmental Studies,
Juba University (1995)

M.Sc. (Environmental Studies) Institute of Environmental Studies,
University of Khartoum (1999).

A thesis Submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
In
Environmental Biology

Department of Basic Science
Institute of Environmental Science and Research
Ain Shams University

2012

APPROVAL SHEET
**PERFORMANCE OF SMALL RUMINANTS ON SOME PASTURES
FERTILIZED WITH COMPOST AND OTHER SOURCES.**

By

Oyor Moses Ayul Goang

B.Sc. (Animal Science) Faculty of Natural Resources & Environmental Studies
Juba University (1995)

M.Sc. (Environmental Studies) Institute of Environmental Studies,
University of Khartoum (1999)

This Thesis Towards a Doctor of Philosophy Degree in Environmental Science Has
been Approved by:

Name

Signature

- 1. Prof. Dr. Mehreshan Taha El Mokadem**
Prof. of Microbiology
Faculty of Girls
Ain Shams University
- 2. Prof. Dr. Ahmed Zaki El-Basiony**
Prof. of Animal Production,
Faculty of Agriculture
Ain Shams University.
- 3. Prof. Dr. Hamdy Mohamed Ahmed El-Sayed**
Prof. of Animal Nutrition
Faculty of Agriculture
Ain Shams University
- 4. Prof. Dr. Mamdouh Salem Ali El Gamal**
Prof. of Microbiology
Faculty of Science
Al-Azhar University

2012

PERFORMANCE OF SMALL RUMINANTS ON SOME PASTURES FERTILIZED WITH COMPOST AND OTHER SOURCES.

By

Oyor Moses Ayul Goang

B.Sc. (Animal Science) Faculty of Natural Resources & Environmental Studies
Juba University (1995)

M.Sc. (Environmental Studies) Institute of Environmental Studies ,
University of Khartoum (1999)

A Thesis Submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
In
Environmental Science
Department of Environmental Basic Science

Under The Supervision of:

1- Prof. Dr. Mehreshan Taha El Mokadem

Prof. of Microbiology

Faculty of Girls

Ain Shams University

2- Prof. Dr. Ahmed Zaki El-Basiony

Prof. of Animal Production,

Faculty of Agriculture

Ain Shams University.

3- Prof. Dr. Faten Ahmed Abu Ammo

Prof. of Animal Production - Institute of Animal production

Agriculture Research Center

4- Prof. Dr. Atef Fathalla Mohamed Abdel Wahab

Pro. of Soil Microbiology

Institute of Soil, Water and Environmental Research

Agricultural Research Centre.

2012

أداء المجترات الصغيرة على المراعي المخصبة ببعض الأسمدة العضوية

رسالة مقدمة من الطالب
ايور موسى ايول قوانق

بكالوريوس (الانتاج الحيواني)- كلية الموارد الطبيعية و الدراسات البيئية جامعة جوبا (١٩٩٥)

ماجستير (دراسات البيئية) معهد دراسات البيئية جامعة الخرطوم (١٩٩٩)

لاستكمال متطلبات الحصول على درجة دكتوراه فلسفة
في علوم البيئة

قسم العلوم الأساسية البيئية
معهد الدراسات و البحوث البيئية
جامعة عين شمس

أداء المجترات الصغيرة على المراعي المنصبة ببعض الأسمدة العضوية

رسالة مقدمة من الطالب
ايور موسى ايول قوانق

بكالوريوس (الانتاج الحيواني) كلية الموارد الطبيعية و دراسات البيئية جامعة جوبا ١٩٩٥
الماجستير (دراسات البيئية) معهد دراسات البيئية جامعة الخرطوم (١٩٩٩)

لاستكمال متطلبات الحصول على درجة دكتوراه فلسفة
في علوم البيئة
قسم العلوم الاساسية البيئية

و قد تمت مناقشة الرسالة و الموافقة عليها:
اللجنة:

التوقيع

الاسم

١. د. /مهرشان طه المقدم

استاذ الميكروبيولوجي - كلية البنات

جامعة عين شمس

٢. د. /احمد زكي البسيوني

استاذ انتاج الحيواني- كلية الزراعة

جامعة عين شمس.

٣. د. /حمدي محمد احمد السيد

استاذ تغذية الحيوان- كلية الزراعة

جامعة عين شمس.

٤. د. /ممدوح سالم علي الجمل

استاذ الميكروبيولوجي- كلية العلوم

جامعة الازهر

أداء المجتازات الصغيرة على المراعي المخصصة ببعض الأسمدة العضوية

رسالة مقدمة من الطالب
ايور موسس ايول قوائق

بكالوريوس (الانتاج الحيواني) كلية الموارد الطبيعية ودراسات البيئية جامعة جوبا (١٩٩٥)
الماجستير (دراسات البيئية) معهد دراسات البيئية جامعة الخرطوم (١٩٩٩)

لاستكمال متطلبات الحصول على درجة الدكتوراه الفلسفة
في علوم البيئة
قسم العلوم الأساسية البيئية

تحت اشراف:

١. د/ مهرشان طه المقدم

استاذ الميكروبيولوجي - كلية البنات
جامعة عين شمس

٢. د/ احمد زكي البسيوني

استاذ انتاج الحيواني- كلية الزراعة
جامعة عين شمس

٣. د/ فاتن فهمي ابو عمو

استاذ انتاج الحيواني – معهد بحوث الانتاج الحيواني
مركز البحوث الزراعية

٤. د/ عاطف فتح الله محمد عبدالوهاب

استاذ ميكروبيولوجي التربة- معهد البحوث الاراضي و المياه
مركز بحوث الزراعية

ختم الاجازة

اجيزت الرسالة بتاريخ / / ٢٠١٢

موافقة مجلس الجامعة

موافقة مجلس المعهد

/ / ٢٠١٢

/ / ٢٠١٢

Introduction

Fertilization can both increase forages yield, quantity and alter the nutrient content of forages as well as improving ruminant usage of grazed forages. Some fertilizers were found to contain several contaminants, of which heavy metals are considered to be of most concern because they have potentially harmful effects on soil quality, livestock health, and food safety. Incidences of fluorosis in grazing livestock, and accumulation of heavy metals and other toxic materials in the edible offal products of livestock, above the maximum permissible concentration set by food authorities have been reported in many countries **(Loganathan, et al., 2008)**. Repeated use of P-fertilizers such as triple superphosphate may result in accumulation of these elements and increase the contamination potential, especially of Cadmium, in the soil **(Mortvedt and Beaton, 1995)**. Cadmium is present as a pollutant in phosphate fertilizers **(Järup et al., 2003)**. Heavy metal contamination affects the biosphere in many places worldwide **(Cunningham, et al., 1997; Raskin and Ensley, 2000)**. The grazing animal can ingest the metals either by consuming herbage that is internally or externally contaminated **(Aitken, 1997)** or by consuming contaminated soil **(Wilkinson, et al. (2003)**, and young animals ingest the metals through milk **(Kincaid, et al., 2003)**. The elements accumulated in soils are transferred in to edible plants, and when animals are fed with these plants; they accumulate high levels of these toxic metals in their bodies **(Mor, 2005)** and to the milk **(Licata et al., 2003; Patra, 2008)**. **Phillips et al, (2005)** stated that Cd is absorbed more efficiently by sheep if it is in the organic form in grass, than if it is added as an inorganic supplement to the diet. Although contamination of animal feed by toxic

metals cannot be entirely avoided given the prevalence of these pollutants in the environment, there is a clear need for such contamination to be minimized, with the aim of reducing both direct effects on animal health and indirect effects on human health (**Miranda et al., 2004**). **Parkpian, et al., (2003)** stated that improvements on farm management give significant reduction in elevated levels of Pb and Cd in soil and plants, and however leads to minimize the amount of Pb and Cd in consumed milk. Lambs management from birth to breeding is an essential component of the small ruminants' enterprise and has the greatest effect on the long-term productivity of the dairy or meat herd, as well as maintaining low mortality from birth to weaning while producing body weight gain (**Greiner and Wahlberg, 2003**), as well as to insure a good performance and safe products. (**Loganathan, et al., 2008**).

Therefore, the present work aims to achieve the following objectives:

1.1 Main objective:

To investigate the performance of small ruminants grazed on pastures treated with each of compost, farm yard manure, chemical fertilizer and sewage water.

1.2 Specific objectives were to determine the effect of each fertilizer and sewage water on:

- i. The levels of some toxic and trace metals in water, soil, plant and animal.
- ii. Ewes fertility and milk quality
- iii. Growth performance of lambs.

Review of Literature

Types of Fertilizers:

Fertilizers are broadly classified into Organic and Inorganic/Chemical fertilizers.

Organic fertilizers:

Things like manure, slurry, worm castings, peat moss, seaweed, sewage and guano are good examples of organic fertilizers. **(Herter et al., 2003)**. Apart from these naturally occurring minerals like sulfate of potash, limestone and rock phosphate are also considered very good Organic Fertilizers. **(Gardening.Ygoy.com 2007)**. Organic Fertilizers are the most convenient forms of fertilizers. They are safe and easily available. The organic produce industry is gaining popularity with consumers because of the perception for healthier foods and the environmental benefits of this agricultural practice **(Hargreaves, et al., 2008)**.

Advantages of Organic Fertilizers:

Manure application resulted in lower nematode and soil borne fungal disease pressure compared to commercial fertilizer, possibly contributing to an 8% yield advantage for manure compared to fertilizer. **(Newton et al., 2000; 2001)**. Efficient production of forage, using animal manure, strengthens the economic position for ruminant production and limits the potential negative impact of animal agriculture on the environment. **(Newton, et al., 2003)**. Silage yield was increased most years by the application of manure compared to commercial N fertilizer.

(Ferguson et al. 2005). Organic fertilizers improve the structure of the soil, retain soil moisture, release nitrogen slowly and consistently, mobilize existing soil nutrients, do not harm the plants like some chemical fertilizers and less subject to leaching **(Gardening.Ygoy.com 2007)**

Disadvantages of Organic Fertilizers

Mixed waste compost contains higher percentages of impurities and contaminants such as heavy metals and organic pollutants than compost from source-separated organic waste **(Hogg et al., 2002)**. Heavy metals are frequently found in compost **(Zethner et al., 2000; Marb et al., 2001; Hogg et al., 2002; Herter et al., 2003)** Often Organic fertilizers, especially those that contain animal feces are contaminated with pathogens. They should be properly composted to reduce the risk of pathogens. The composition of organic fertilizers is variable thus it becomes a very dilute and inaccurate source of nutrients compared to inorganic type of fertilizers. For profitable yields, significantly large amounts of fertilizers should be used to cope up with nutrient requirements. **(Gardening.Ygoy.com 2007)**. Compost additions to agricultural and other soils, with background concentrations of heavy metals, raise the soil content and the availability of heavy metals for transfer into crop plants. **(Smith , 2008)**

Inorganic/ Chemical fertilizers

Inorganic or chemical fertilizers are primarily derived from chemical compounds such as ammonium nitrate, ammonium phosphates and potassium chloride. Mined rock phosphate and limestone are examples of inorganic fertilizers. **(Gardening.Ygoy.com 2007)**

Advantages of Inorganic Fertilizers

Inorganic fertilizers provide higher and accurate amount of nitrogen that promotes protein and chlorophyll and encourages growth of stems and leaves. Potassium from potash fosters causes protein development and thickens stems and leaves. Release of nitrogen is rapid from inorganic fertilizers, they provide an accurate source of nutrients, provides higher amount of phosphorus which results in more flowers, larger fruits, and healthier roots and tubers. (**Gardening.Ygoy.com 2007**).

Li, et al., (2008) stated that the application of limestone increased grain yield by 12.5-16.5 fold, and decreased Cu and Cd concentrations in grains by 23.0%-50.4%. They also found that the application of calcium magnesium phosphate, calcium silicate, pig manure, and peat also increased the grain yield by 0.3-15.3 fold, and effectively decreased the Cu and Cd concentrations in grain. Cd concentration in grain was slightly reduced in the treatments of Chinese milk vetch and zinc sulfate.

Disadvantages of Inorganic Fertilizers

Application of fertilizer and sewage sludge to farm land, may lead to contamination of soils with cadmium and other heavy metals, and to increase their uptake by crops and vegetables grown for human consumption. The uptake process of soil cadmium by plants is enhanced at low pH (**Järup et al., 1998**). Inorganic fertilizers if used carelessly can burn plants and distort the quality of soil leading to cadmium poisoning. Using Inorganic fertilizers would mean that strict watering schedules have to be adopted in order to retain the soil moisture. Inorganic fertilizers are made up of elements like potassium and

phosphorus that come from mines or saline lakes thus from limited resources. **(Gardening.Ygoy.com 2007).** **Cakmak, et al.,**

(2010) stated that Long-term application of phosphorus fertilizers may eventually result in excess and/or toxic accumulations of trace elements and microelements in soil.

Effect of fertilization on some soil chemical properties:

Chemical features of soil.

Compost application is generally perceived to be beneficial to the soil and crops because of improved soil structure, increased cation exchange and water holding capacity, and the addition of plant nutrients **(Kerner et al., 2000)**. **Mosquera-Losada, et al., (2001)** stated that the use of municipal sewage sludge as a fertilizer could be a more adequate means of disposal of this residue than to transport it to the dump, they suggested that the improvement of soil fertility due to organic fertilizer application and sowing a mixture of cocksfoot (*Dactylis glomerata*) and clover (*Trifolium repens*) increased the production and quality of pasture, Since the nutrient content of compost is relatively low, considerable quantities (8–10 Mg dry wt./ha/yr) are required to obtain a sufficient fertilizing effect **(Herter et al., 2003; Timmermann et al., 2003)**. Even higher amounts are applied if the compost is used as a soil conditioner. Consequently, the input of organic pollution to the soil via compost application may be equal to or even higher than that introduced by aerial deposition or the application of other organic fertilizers such as sewage sludge or manure **(Herter et al., 2003)**. Compost can also have a positive effect on physical, chemical, and biological soil parameters **(Brändli. et al. 2005)**. **Bol, et al., (2005)** examined long-term effects of animal

manure and mineral fertilizer on soil organic matter quality and turnover. They found that the total soil N content for animal manure > minerals fertilizer > untreated treatment

Heavy metals content in soil:-

Canet, et al., (1998) stated that the use of sludges and compost led to an increase of heavy metal contents in soil. Excess concentrations of some heavy metals in soils such as Cd and Ni have caused the disruption of natural aquatic and terrestrial ecosystems (**Gardea-Torresdey et al., 1996**). **Parkpian, et al., (2003)** stated that long term simultaneous application of fertilizer and manure showed higher metal accumulation in the soil and plants. The risk of compost pollution by organic pollutants remains even if separately collected organic waste is composted, because of aerial deposition or accidental [e.g., via the increasingly ubiquitous plastic debris (**Thompson et al., 2004**) and deliberate input (e.g., pesticide application) of such chemicals to organic materials (**Brändli, et al., 2005**).

Lead in soil:

El-Gala et al., (1990) stated that acetic acid extractable pb in surface soils (0 – 30 cm depth) of Ismailia ranged from 0.2 to 2.2 mg kg⁻¹ soil. **Shahin and Abdel Hamid (1993)** reported values for DTPA extractable Pb content range from 0.2 to 0.4 mg kg of soil with an average of 0.3 mg kg⁻¹ for a large number of Egyptian soils. In some contaminated soils of Egypt, **Hegazy (1993)** mentioned that available amount of pb extracted by DTPA ranged from 2.0 to 4.6 mg kg⁻¹ with an average 3.6 mg kg⁻¹ in Helwan soils irrigated with industrial sewage water. **EL- Shikha (1994)** found that DTPA extractable Pb content

ranged from 6.15 to 20.80 mg kg⁻¹ in surface soils (0 - 15 cm depth) and from 2.15 to 7.15 mg kg⁻¹ in subsurface soils (15 – 30 cm depth) in Kafr El- Zayat soils affected by emission of supper phosphate factory. **Aboulroos et al., (1996)** stated that available Pb content extractable by DTPA ranged from 0.51 to 2.88 mg kg⁻¹ with an average of 1.19 mg kg⁻¹ in 82 soil sample collected from different location in Egypt. **Hassan (1997)** observed that available contents of Pb extracted by DTPA were 10.8 and 9.59 mg kg⁻¹ in cultivated surface soils irrigated with sewage water of Shebin El- Qanater collector and Mostorod collector, respectively. **Malak et al., (2007)** investigated the effect of different fertilizers on the heavy metals in soil in Egypt. They found that the highest Pb content of the soil was obtained by 100% mineral fertilizer treatment, and the lowest Pb content of the soil was recorded by 50% of mineral fertilizer treatments. They stated that Pb contents were higher than adequate amount (4.5 ppm) according to **Follet and Lindsay (1970)**. They found that the available Pb are lower than the critical level (100 to 400 mg Kg) mentioned by **Kabata- Pendias and Pendias, (2000)**, while it is in range of common concentration (0.10 to 20 µg/g) and lower than maximum tolerable concentration (100 µg/g) according to **Ewers (1991)**. And their results are in range of international criteria (0.5 to 135 mg Kg⁻¹) reported by **Souza et al., (1996)**, and more than the background level of extractable Pb in nonpolluted soils of Egypt (1.17 to 1.61 µg/g) mentioned by **Aboulroos et al (1996)**. **Atafar, et al., (2010)** stated that Cd, and Pb concentrations were increased in the cultivated soils due to fertilizer application.

Cadmium

El-Gala et al., (1990) reported that acetic acid extractable Cd content ranged from 0.012 to 0.026 mg kg⁻¹ in Ismailia Governorate surface soils. **Sharaf (1991)** found that available Cd value were 0.11 and 0.17 mg kg⁻¹ in lacustrine and alluvial soils of Egypt respectively. **Badawy (1992)** showed that DTPA extractable Cd content ranged from 0.024 to 0.057 with a mean of 0.036 mg kg⁻¹ in El- Sharkia soils, while it ranged from 0.015 to 0.037 mg kg⁻¹ with a mean of 0.027 mg kg⁻¹ and 0.024 to 0.04mg kg⁻¹ with a mean of 0.03 mg kg⁻¹ in kafer El- Sheikh and El- Menofia soils, respectively. **El- Shikha (1994)** found that DTPA extractable Cd content ranged from 2.3 to 11.95 in contaminated surface soils (0 - 30 cm) at Kafr El- Zayat which are affected by super phosphate factory, while at subsurface layers (30 – 60 cm) it ranged from 0.28 to 3.35mg kg⁻¹ . **Aboulroos et al., (1996)** stated that DTPA extractable Cd content ranged from none detected to 0.06 mg kg⁻¹ with an average of 0.018 mg kg⁻¹ in cultivated surface soils of Egypt. **Rabie et.al., (1996)** mentioned that total DTPA extractable Cd content range from 0.33 to 0.38 mg kg⁻¹ with an average of 0.35 mg kg⁻¹ in El- Saff soils irrigated with outlet pipes from iron and steel factory directly. **Matter (1999)** recorded that total Cd ranged from 1.9 to 4.8 mg kg⁻¹ and DTPA extractable Cd content ranged from 0.07 to 0.11 mg kg⁻¹ with an average of 0.087 mg kg⁻¹ in soils at Shoubra El- Kheima affected by industrial emissions.

Cobalt

Rashad et al., (1995) reported that DTPA extractable Co content ranged from 0.04 to 0.11 mg kg⁻¹ with an average of 0.07 mg kg⁻¹ in