UNIVERSITY OF GHANA

STUDIES ON THE GROWTH PATTERN OF THE PENAEID SHRIMP *PENAEUS NOTIALIS (PEREZ-FARFANTE)* IN PONDS MANURED WITH CHICKEN DROPPINGS.

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DECLARATION

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DEDICATION

This work is dedicated to my loving and caring parents and to my dearest friends, Burghard and Helgah Sievers of Germany, who have laid the foundation of this work by doing all they could to see my dreams of having a degree come true. At the time others were retreating they solidly stood by me, damn the cost. With nostalgia, I say, it is for them I was able to undertake this programme of study.

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ABSTRACT

A study was conducted on the growth pattern of the penaeid shrimp, *Penaeus notialis,* in earthen ponds at the Volta Estuary of Ghana. The ponds were treated with chicken manure at the rate of 0 kg/ha (control), 100 kg/ha, 200 kg/ha, and 300 kg/ha respectively. The culture period was divided into two phases; the first phase covered a period of 90 days and the second phase took 180 days.

Growth rates established at the end of the 90 days of culture were 0.04 – 0.13 g/day that resulted in the yield of 128.03 kg/ha, 138.00 kg/ha, 168.88 kg/ha and 243.60 kg/ha in the 0 kg/ha, 100 kg/ha, 200 kg/ha and 300 kg/ha manure treatments respectively. The growth rates at the end of 180 days of culture were 0.04 – 0.07 g/day that resulted in yield of 258.72 kg/ha, 261.05 kg/ha, and 327.18 kg/ha in the 0 kg/ha, 100 kg/ha and 200 kg/ha treatments respectively. Analysis of Length-weight relationship showed isometric growth during the second half (91 to 180 days) of culture whilst the growth during the first 90 days was not isometric in all the treatments. Regression of total length on Carapace length; Body weight on Carapace length and Body weight on Total length showed strong correlation for both 90 and 180 days of culture periods. Productivity test showed nearly uniform primary production in all the ponds with 100 kg/ha treatments registering the highest value of 3.53 mg/l and 300 kg/ha treatments the lowest value at 1.45 mg/l

The results indicated that *P. notialis* would not be ready for harvest during the first 90 days of growth; at least 5 months of growth is required to attain marketable size. Chicken manure could be used at 200 kg/ha and 300 kg/ha rates, an illustration that shrimp culture development and production in Ghana has a great potential.

CHAPTER 1.0. INTRODUCTION.

1.1. BACKGROUND.

Fishing is one of the major activities that provides food, employment and other economic benefits to those engaged in it. The living aquatic resources, although renewable, are not infinite and need to be properly managed if their contribution to the nutritional and social well being of the growing world population is to be sustained. However, clear signs of over-exploitation of important fish stocks, modification of ecosystems, significant economic losses and international conflicts on management and trade threaten the long-term sustainability of fisheries and its contribution to food supply (FAO, 1995a). According to FAO report (2000), increases in the world marine and inland capture fisheries production declined from 6% to 2% per year in the 1970s and then fell to zero in the 1990s.

In view of the stagnant production from capture fisheries, aquaculture seems to be the solution to anticipated future supply shortages; it is rated as the fastest growing food production systems in the world, (Csavas, 1994; FAO, 2000). Aquaculture production grew by about 5% per year between 1950 and 1969 and 8% per year from 1970s to 1980s and further increased to 10% per year in 1990s (Prein and Ofori, 1996a; FAO, 2000). The expectations from aquaculture to increase its contribution to the world's production of aquatic food are very high with increasing demand for fish and fisheries products. It is also hoped that aquaculture will continue to strengthen its contribution to food security and poverty alleviation in many developing countries (FAO, 1997). The appropriate technological development through adaptive research is therefore paramount to make aquaculture play this all-important role. Together with the resources and patterns involved, aquaculture offers options for diversification of food production and income generation in the rural and peri-urban areas.

One aspect of aquaculture that has a growing potential interest and of recent times made aquaculture popular and worthy of investment is shrimp farming. Shrimp farming has not only had a major impact on increased production and export for some countries, but also on price structure and buying pattern in the major markets of the world. Most of farmed shrimp producing areas are in tropical and developing countries where climate, land values and labour costs make the business more economical and feasible.

In terms of value, shrimp is the most important seafood product traded internationally (Chauvin, 1986; FAO, 1998), accounting for some 20% of total value of internationally traded fishery products FAO (2000). Over one quarter of the shrimp traded internationally comes from aquaculture, (27 – 29%), (FAO, 1998). This was however not enough to keep up with the growing demand for shrimp, the report indicated. There is also increasing emphasis on the nutritional benefits of eating seafoods. Riding the crest of this new wave in dining preferences is the premium seafood – the shrimp (Chauvin, 1986). Shrimp culture is therefore a very lucrative venture not only in producing shrimps for self-consumption and local markets, but also for export. By its nature, shrimp farming is mainly carried out in tropical countries, while the market for shrimp is concentrated in the temperate developed countries (Neiland *et al.* (1997).

Shrimp farming provides employment not only in developing exporting countries but also in developed importing ones (Singh, 1997). Conservative estimates indicated that the shrimp culture sector employs directly more than one million persons globally (FAO, 1998). According to Kongkeo (1995), the total number of people employed in the industry in Thailand was more than 150,000 with 97,000 directly involved in the farming.

Singh and Brenner (1995) however estimated a total of 114,000 people directly engaged in the farms; Sirrirattrakul (1998) put the average number of persons per farm at not less than 2.9 to 3.2 in Thailand. In Ecuador, about 1,567 firms were involved in shrimp farming and associated businesses employing about 195,000 people in 1992 whilst about 17,000 part-time workers were engaged in catching wild post larvae (Robadue, 1995). In Sri Lanka, a rough estimated figure was around 20,000 people directly engaged in shrimp farming (Siriwardena, 1997). A survey of around 5,000 diverse shrimp farms in Asia showed that intensive shrimp farming provided an average of 558 person-days/ha/year of labour. Even the less labour-intensive traditional/extensive farming systems gave 192 person-days/ha/year (Singh, 1997). Unfortunately, apart from trials and experimental shrimp culture practices, Africa as at the moment has no record on farmed shrimp production. This calls for vigorous intensification on research into shrimp culture not only for commercial production, but also to identify culture practices that are environmentally friendly and suitable to our economy.

The global shrimp industry has experienced phenomenal growth over the years, this rapid growth however began to slow down in the 1990s due to lack of knowledge about farming techniques, poor farm management practices, degradation of the environmental and water qualities leading to uncontrolled shrimp diseases. These developments have contributed immensely to raise doubts on the sustainability of the industry. The solution to these problems probably lies in the need to properly identify and promote systems and practices that will lead to the development of shrimp farming without adverse social or environmental impact, or at worst a substantial reduction of the magnitude of these negative impacts. A report by World Bank *et el.* (1991), indicated that numerous aquaculture ventures in Africa failed because they were not integrated into the rural and agriculture economy surrounding them. For successful integration, fish farms must have among other things, readily available agriculture by-products for direct feeding or wastes for fertilization.

JUSTIFICATION.

The FAO Code of Conduct for Responsible Fisheries (CCRF), adopted in 1995 as a global intergovernmental consensus on promotion of sustainable fisheries and aquaculture developments, enjoins states and communities to conserve the aquatic ecosystems in their use of living aquatic resources. They are to consider aquaculture as a means to promote diversification of income and diet with responsible use of resources without any significant adverse effect on the environment and local communities. The aquacultural practices so selected should aim at supporting the rural communities, producer organizations and fish farmers. They should be such that they will enhance the active participation of the local communities and involve efforts, which will improve selection and use of appropriate feeds, feed additives, fertilizers and manures.

Fertilization generally induces fast growth of farmed organisms. Research results have proved that organic fertilizers (manures) are more effective, more economical and more environmentally friendly than inorganic (chemical) fertilizers in enhancing biogenic capacity of fishponds. Among the organic fertilizers researched into in aquaculture, chicken-manure is rated as the best (Rappaport et al., 1977; Tacon, 1987 among others Appendix III). The recycling of organic manures in fish ponds for natural productivity is therefore important for sustainable aquaculture and to reduce expenditure or cost on feeds and chemical fertilizers which form more than 50% of the total input cost in shrimp culture. The type of fertilizers and the quantity to be used however differs considerably from region to region and even between farms. It is therefore crucial for any farmer to determine the appropriate regime that addresses the particular situation. Chicken manure, a part from its effectiveness in inducing the growth of fish feed organisms in ponds, it is also readily available in all parts of Ghana and easy to handle and apply.

The use of inorganic fertilizers to induce natural productivity in shrimp ponds has been established with good results. These inorganic fertilizers are however expensive. The over-reliance on these fertilizers in aquaculture projects usually increases the operational cost and therefore discourages potential investors from investing in otherwise, profitable shrimp farming venture. It has also been established that inorganic fertilizers and composite supplementary feeds rich in protein are the major sources of phosphorus and nitrogen in waste-water from shrimp ponds that lead to organic load and eutrophication in water bodies and environmental degradation.

1.2. OBJECTIVES

The primary objective of this study is to demonstrate the use of organic manure as viable alternative to inorganic fertilizers in enhancing the biogenic potential of shrimp-cultured ponds with the view to reducing the cost of raising shrimps and to attract the participation of the rural coastal communities.

The specific objectives include the following:

- to study the effect of chicken manure on the growth of *P. notialis*.
- to assess the growth pattern of the shrimp at different rates of chicken dropping as manure in ponds.
- to establish the fact that without the use of inorganic fertilizers and excessive use of composite supplementary feed with food additives, *P. notialis* could be raised in ponds to appreciable growth in weight.

- to determine the manuring rate of chicken manure that would give appreciable yield without adverse water quality.

The study was therefore formulated under the alternative hypothesis (Ha) that "there are significant differences at 0.05 level of significance in growth pattern of *P. notialis* at different rates of manuring with time in ponds as against the Null hypothesis (Ho) that manuring at different rates with chicken droppings does not have any significant differences in the growth of shrimps with time in ponds".

"The real challenge to the shrimp culture industry is to succeed as is the case in the poultry and animal husbandry industries – that is to make this luxury shrimp-food, an everyday food item someday, when the ordinary man on the street can come home any night and dine on a dish of clean, uncontaminated, nutritious and tasty shrimp, and enjoy his gourmet meal like kings used to do in their royal palace, then the world's shrimp culture industries will have reached the summit of their achievement" (Liao, 1990).

CHAPTER 2.0. LITERATURE REVIEW.

2.1. CULTURE-BASED FISHERIES

2. I.I. Aquaculture Development in the World.

Aquaculture is believed to have originated from China around 1100 BC and the first cultured fish was believed to have been the common carp (*Cyprino carpio*) DFID (2003). The advances in development of aquaculture can however be traced down to the past three decades during which aquaculture has developed to become the fastest growing food production sector in the World (Csavas, 1994; Gupta and Dey 1999; FAO, 2000; Pedini, 2000), with the annual growth rate increasing from 5 percent in 1990-91 to around 14% in 1994-95 (FAO, 1997; DFID, 2003;). Recent development in the field of aquaculture, especially the culture of high valued species like shrimp has popularised aquaculture especially among entrepreneurs and exporters in particular. It has expanded, diversified, intensified and technologically advanced over the years. The result of a study by Pedini (2000), on the growth of this lucrative venture showed global growth rate of 10.2% from 1984 to 1997 as against the 14% reported by FAO (1997) and DFID (2003).

Aquaculture consists of a broad spectrum of systems, practices and operations ranging from simple backyard; small-household pond systems to large-scale highly intensive commercially oriented practices (Jia *et al.* 2001). Depending upon the level of intensification and the extent of input used aquaculture practices are broadly categorised under:

- Extensive system; - largely depends on a single input, the seed with little or no other extraneous material inputs. The system therefore depends on natural food produced in the system or brought in by water flow.

- Semi-intensive system; - the system depends largely on natural food produced *in-situ* enhanced by liming, fertilization and supplementary feeds which may form up to 50-70% of the cost of production, it is characterised by high stocking density.
- Intensive system; -characterised with high inputs – high outputs, large investment and adequate managerial skill. Depends largely on complete and commercially available feeds, oxygenation, water exchange or circulation and so on.

Much of the reported increase in aquaculture production however come from small-scale producers in Developing Low-Income Food Deficit Countries (LIFDCs), where the demand for aquatic products is high and expected to continue increasing (Gupta and Dey, 1999; FAO, 2000 and Jia *et al.* 2001).

According to FAO (2000) world marine and inland capture fisheries production increased on average of 6%/year, trebling from 18 million tonnes in 1950 to 56 million tonnes in 1969. It then declined to 2%/yr from 1970 to 1980s and fell off to zero in 1990s. This according to the report is due to the fact that most world fishing areas have reached their maximum potential for capture fishery production with majority of fish stocks being fully exploited. It is therefore very unlikely that capture fisheries can match up with increasing demand for fisheries products. Aquaculture production on the other hand increased from about 5%/yr between 1950 and 1969, and by 8%/yr from 1970 to 1980; it further increased to 10%/yr in 1990 (FAO, 2000).

Aquaculture potential contribution to local food security and livelihoods can therefore be very significant especially in remote and resource-poor areas. To attain its full potential to contribute to human development and social empowerment, the aquaculture sector may require new approaches. These could vary with countries and the challenge, nonetheless, is to develop approaches that are realistic and achievable in the context of pertaining social, economic, environmental and political circumstances. Such approaches should not only focus on increasing production, but also on producing a product that is affordable, acceptable, environmentally friendly and accessible to all sectors of society (Jia *et al.* 2001).

FAO (2000) and DFID (2003) reported that aquaculture provides a quarter (26.3%) of the world fish production. Its contribution towards animal protein resources is therefore crucial. DFID (2003) reported that fish supplies 30% of total animal protein in diets in Asia, 20% in Africa, 10% in Latin America and West Europe, and 7% in North America. In Ghana, the report indicated that fish accounts for 60% of the population's protein intake. Duthie (1994) reported that according to FAO records of 1989, the per capita consumption was 30kg/yr. A study by Nketsia-Tabiri (1993) also showed that the consumption preference for fish in Ghana is 82% compared to livestock and poultry products.

Like all aquaculture practices, large scale and especially intensive shrimp culture will result in negative environmental impacts such as wetland destruction, eutrophication, oxygen depletion and pollution of surrounding water bodies (Braaten *et al.,* 1988; Folke and Kautsky, 1989). The need for investigation into environmentally friendly way of farmed shrimp production is therefore crucial for sustainability of the industry. For example Limsuwan (1999) reported that in Thailand, the leading producer of farm raised shrimps for the past seven years with mean production level reaching 210,000 metric tons experienced an outbreak of diseases such as Lumniscent bacteria (*Vibrio harveyii*), yellowhead, white spot syndrome virus (*Monodon baculovirus*, MBV) and hepatopancreatic parvolike Virus (HPV). This had caused severe loses which were estimated up to 170,000 metric tons in 1999.

It has also been reported that the failure in shrimp culture business was caused by environmental in-balance; this assertion was proved right when efforts through environmentally oriented shrimp culture in producing countries helped to offset the problems (Rosenberry, 2000). ASICo (2000) attributed the slow down in the phenomenal growth of shrimp culture over the past twenty-two years to lack of knowledge about the appropriate farming techniques, poor farm management practices, degradation of water quality and shrimp disease as a result of environmental stress. This underscores the significance of the current work. Clearly if aquaculture is to be sustained in the long term and play its crucial role in food security, it is imperative that donors, developmental agencies and governments, wherever possible and economically feasible, promote the culture of species with herbivorous and/or omnivorous feeding habit, which are not dependent upon the use of high-quality protein-rich feed inputs, and are able to make maximum benefit from natural food organisms and simple farm-made supplementary feed inputs (Tacon, 1994).

The shrimp culture industry, just like other aquaculture ventures again faces two fundamental issues that need to be resolved to sustain this multi-billion dollar industry. These are "*ecological foot print*" of aquaculture and the "*fish meal trap*". Ecological foot print concept defines the minimum area that productive ecosystem requires to sustain a specific amount of inputs and to assimilate waste output from aquaculture system in question. Larsson, *et al.* (1994) for instance indicated that for every farmed hectare of a semi-intensive system producing about 4,000 kg of shrimp/ha/year could have assimilative capacity of between 38 and 186 hectares of ecosystem per year. The fishmeal trap denotes the demand and stress put on fisheries resources by manufacture of feeds for aquaculture and the culture of land animals. According FAO (2000) the amount of world fish production reduced to fishmeal and oil from 1994 to 1999 was more than 20% per year. It is even expected that the amount will increase in the subsequent years, creating a "fish meal trap". For Asia alone it is projected that 776,000 tons of aquatic feeds would be required in the future for aqua feeds (New and Wijkstrom, 1990).

2.1.2 Aquaculture Potential in Africa.

Kapetsky, (1994) showed that some 9.2 million km^2, (equivalent to 31%) of the African surface area is suitable for warm water fish farming at subsistence level and 3.9 million km^2 (about 13% of land surface area in Africa) is potentially suitable for commercial fish farming. Out of 48 countries studied 40 including Ghana possess land suitable for subsistence and commercial fish farming. His result further stated that about 35% of the surface area is apt for two crops/year with good growth, about 19% for two crops/yr with fair growth and nearly 27% for one crop/yr.

In terms of water availability about 34% of the continent has optimum amount of rainfall, perennial streams and rivers at relatively high to moderate density accounting for about 10% of the total surface area. Results of the study conducted by Aguilar – Manjarrez and Nath (1998) to reassess fish farming, potential in Africa also indicated that 37% of the African surface area has some potential for small-scale fish farming for the Nile tilapia (*Oreochromis niloticus*), African catfish (*Clarias gariepinus*) and common carp (*Cyprinus carpio*). They indicated that 11 countries studied have over 50% of areas suitable for small-scale farming and 16 countries have over 50% of their national areas suitable for commercial farming for the three species.

2.1.3. **Aquaculture Potential in Ghana.**

In an article entitled "Ghana's fisheries resources" published by the Daily Graphic of 1st and 26th November, 1994, Duthie quoted one T. R. Brained as saying that some "African nations, of which Ghana is one, are endowed with considerable fishery resources". According to her, Ghana has such enormous fishery resources capable of producing fisheries surplus in large quantities for both local and export markets. Ghana is extremely well watered; the 550km stretch of coastline of Ghana coupled with the 200 Exclusive Economic Zone (EEZ) limit provide a continental area of 24,300 km^2. The Volta Lake, rivers, lagoons streams, lakes, ponds/dugouts, reservoirs and pools of water with their catchments provide 237,870 km^2 out of 238,537 km^2 of the total surface area of Ghana. An indication of almost every town or village (human settlement) having access to some amount of water (Duthie, 1994).

Still in Ghana, Prein and Ofori (1996b) reported that the Department of fisheries had 16 sites for hatcheries with total area of 35 hectares of grow out or demonstration ponds, but only 4 out of the 16 were operational as at 1996. Universities and Research Institutions also provided total area of 14 ha. Mensah (1979) and Weigel (1985) identified 50 lagoons along the coast of Ghana. The aquaculture potential for Ghana in and around the lagoons has been pointed out by several researchers, (Rabanal, 1995; Pauly, 1975; 1976). Their report indicated the possibility of the culture of endemic brackish water species like black chin Tilapia *(Sarotherodon melanotheron,* Mugil sp. and *P. notialis* Prein and Ofori (1996a) reported of the attempt to introduce an exotic prawn (*Penaeus monodom*) for commercial scale production in Ghana in the recent past.

The vast water bodies of Ghana can be put under: Lagoons, Bays and Estuaries, Rivers, Lakes, Small water bodies, Flood Plains and Swamps (Prein and Ofori 1996b) in which the following traditional aquaculture systems had been in practice for generations:

I. Acadja or brushparks in lagoons and reservoirs.
II. Hatsis (fish holes) and whedos (mini dams) in coastal Lagoons
III. Afani or freshwater clams (*Egeria radiata*) culture in lower Volta River.

The modern form of aquaculture was however introduced around 1956 with the advent of ponds (earthen and concrete) fish culture (Prein and Ofori, 1996a).

The role of culture-based fisheries to boost the animal protein source and the determination of the government of Ghana to promote aquaculture to supplement fish production from capture fishery has been expressed at different fora by Government officials. A research into aquaculture practices using available agricultural by-products is therefore necessary for its development to position it to effectively play the desperately needed role in fish food production.

2.2. BIOLOGY AND ECOLOGY OF PENAEID SHRIMPS

Shrimps and prawns constitute a large group of crustaceans with extended abdomen (or" tail") varying in size from microscopic to about 35cm body length (measured dorsally from the posterior orbital margin to the end of the tail excluding the rostrum and the appendages) (Chan, 1998).

Taxonomically, shrimps and prawns belong to the "swimming group" of decapod crustaceans in the sub-order *Macrura natantia*. They differ from the lobsters (sub-order *Pleocynata* (*Macrura reptantia*) by having the body generally more laterally compressed; the *pleopods* (abdominal appendages) are well developed. The thoracic sternum (i.e. ventral part of the thoracic body segments between the legs) is often narrow and not easy to observe. The first abdominal pleura (or lateral plate) are well developed, and the *telson* usually tapers distally (Chan, 1998).

The term "shrimp and prawn" have no definite reference to any known taxonomic groups. Although the term "shrimps sometimes is applied to small species while "prawn" is more often used for larger forms, there is no clear distinction between both terms and their usage is often confused or even reversed in different countries or regions (Chan, 1998).

Although nearly 3,047 shrimp species are known (Chan, 1998), only a little over 300 species are of economic interest and of these about 100 species comprise most of the annual world-wide catches usually reported by FAO (Fischer *et al.*, 1981; Cervigon, *et al.* 1993; and Chan, 1998). Shrimps are widely distributed, occurring in marine, brackish and freshwaters from the equator to the Polar Regions. The majority of the marine species occupy shallow or moderately deep waters, some are also found at depths of nearly 5,700 metres. Most of the commercial species are however taken on the continental shelves of depths less than 100 metres. Five deepwater species are exploited in the Eastern Central Atlantic fishing area commercially by travellers at depths ranging from 250 to 800 metres (Fischer *et al.*, 1981). Many shrimps nonetheless, are pelagic but the majority by far are benthic, living on a large variety of bottoms such as rock, mud peat, sand, fragments of shell or mixture of these materials. Some species are also found in coral reefs and a few live in sponges and other invertebrates (Fischer *et al.*, 1981; Cervigon *et al.*, 1993). Most of the commercial species in the Eastern Central Atlantic belong to four Penaeidean families: *Solenoceridae*, *Aristeidae*, *Penaeidae* and *Sicyoniidae*, and six Caridean ones: *Nematocarinidae*, *Pasiphaeidae*, *Palaemonidae*, *Happolytidae*, *Panadalidae* and *Crangonidae* (Fischer *et al.*, 1981). Penaeidae species are generally of moderate to large size and often occur in large quantities in shallow waters along the continental shelf on trawable bottoms, and are therefore fished extensively by trawls, seines, set nets, traps and artisanal gears (Fischer *et al.*, 1981and Chan, 1998). Gross, (1973) and Edwards, (1978), also identified the following species along the coast of West Africa (a section of the East Central Atlantic Fishing Area): *Penaeus notialis, Parapenaeopsis atlantica, Penaeus caliderniensis, Penaeus vannamei, Pepaeus_styliostris, Pemaeus brevirostris and Penaeus occidentalis.*

Along the 550km stretch of the coastline of Ghana, species reported by the Marine Fisheries Research Division of MOFA, Tema, that are fished in the area include: *P. notialis*, *P. duorarum*, *P.brasillerisis*, *P. karatherus*, *P. trisulcathus*, *P. caramote*, *Parapenaeus longirostris*, *Paranaeopsis atlantica* and *P. monodon.* Out of these *P. notialis*, *P. keratherus, Parapenaeopsis atlantica* and *Parapenaeus longirostris* are caught in commercial quantities (Marine Research, MOFA, unpublished data). A study by Nunoo (1998), also indicated that *P. atlatlantica, P. kerathurus, P. longirostris and P. notialis* were landed at Keta, Ada and Adjoa fishing grounds of Ghana.

In terms of population dynamics, penaeid shrimps are fast growing and generally live only about a year, rarely two or three years. They have high mortality rates and due to this, determination of the best size at which to capture shrimps are critically sensitive to determination of mortality and growth rates. It is therefore not clear how stock size or the environment in spite of intense fishing for shrimps affects recruitment. There exist as a result, a dilemma as to whether high levels of fishing efforts generate population instabilities or push shrimp populations precipitously close to being in danger of collapse (Penn, 1984).

The behaviour of commercially important *Penaeus* species has been extensively reported (Hughes, 1969; Kutty and Murugopoopathy, 1968; Fuss and Green, 1966; Racek, 1959), and is generally grouped into three categories as follows.

i. Strongly nocturnal but often inactive or buried at night. Always buried during the day *(e.g. P. duorarum*).

ii. Generally nocturnal and continuously active at night, buried during the day but with a tendency to occasionally emerge (e.g. *P. aztecus*).

iii. Rarely buried and almost continuously active (e. g. *P setiferus*).

This behavioral pattern appears to be adaptations to the habitats occupied by the adults. For example:

TYPE 1 SPECIES:

These are usually fished over sandy-hard substrata, which are most often associated with relatively clear water habitats. In these habitats, the advantages of well developed borrowing behaviour which leaves the animals usually exposed to predation only at night with only a minimum time required for feeding exist, e.g. *Penaeus duorarum, Penaeus. notialis* (Williams, 1958)

TYPE 2 SPECIES.

These species are commonly associated with softer silty-substrata e.g. *Penaeus aztecus.* (Williams, 1958) *Penaeus esculentus* (Hall and Penn, 1975). Such silty habitats are generally associated with more turbid waters than the sandy substratum of type 1 species. One other feature noted with the type 2 sp. is their camouflage coloration pattern, which the juveniles at least use in association with vegetative cover to avoid predation e.g. *Penaeus aztecus* (Williams, 1958) Penaeus *esculentus* (Yong and Carpenter, 1977).

TYPE 3 SPECIES.

The group include *Penaeus setiferus* (Neal, 1975); *Penaeus. merguiensis* (Munro, 1975) and are exclusively found in areas where rivers discharge into the sea, which are usually characterised by soft mud bottoms and high turbidity. Some species in the group for example *Penaeus merguiensis* typically form schools, which in themselves generate intense localised turbidity. The schooling with its associated turbidity tends to occur at times of slack water in the tidal cycle especially during neap tides (Munro, 1975), when turbidity falls to a minimum. This behaviour may therefore be of survival value to this non-burrowing species in minimising predation at times of reduced turbidity.

These behavioural strategies of penaeid shrimps may cause differing levels of vulnerability to fishing gear and stock aggregation which are major factors affecting catchability (Caddy, 1979). The catchability can therefore be considered as grading from low for type 1 species to high in type 3 species and extremely high for those of type 3 species which school, since their presence and path can easily be detected and traced by fishermen. These patterns may also suggest the degree to which the stock of each group can be reduced before catch rates become uneconomical and fishing ceases.

Penaeid shrimps as from evidences available are omnivores, feeding on varying proportions of sediments, detritus, algae and benthic organisms. They are often fished alongside with bottom fishes which represent a diverse assemblage of trophic types ranging from herbivores through carnivores. Since shrimps are omnivores they may form prey to bottom fish species with which they interact (Sheridan *et al.,* 1984). Perhaps shrimps may only feed on disabled, dying or dead fishes.

It has however not yet been established to what extent shrimp stocks are affected by the attack by the bottom fishes. Stomach content analysis by Yanez-Arancibia *et al.* (1976) on *Galeichthys caenilescens* showed that this catfish preyed mainly upon fishes and crabs with only 7%, on average, by volume of the stomach content made up of *Penaeus* species. Bell *et al.* (1978) also analysed the stomach content of Australian Scorpaenid (*Centropoqon anstralis*) in sea grass meadow inhabited by shrimps and found only 4.3% frequency of occurrence of *Penaeus* species in their stomach. It was also noted that fish predators mostly feed on small non-commercial species whereas the larger commercial shrimps do not feature significantly in their diets (Kakuda and Matsumoto, 1978; Kasoda, 1977). Information of larger predators on both penaeid shrimps and bottom fishes is however, quite limited (Bass *et al.*, 1973).

2.3. SHRIMP CULTURE PRACTICES

2.3.1 Developmental History

Shrimp farming traces its origin to Southeast Asia where for centuries farmers had raised incidental crops of wild shrimp in tidal fish ponds (Rosenberry, 1991; 1994). By this, seeds for rearing came along with the tide. This was improved into conscious seed collection in the 1970s and the supply of hatchery-produced post larvae in the 1980s. Production of farmed shrimps grew thereafter exponentially, and marine-shrimp farming became one of the most outstanding success stories in the modern history of aquaculture (Czavas, 1995).

Successful large-scale shrimp farming is relatively new. A Japanese scientist achieved the first success in spawning and partial rearing in 1934 with kuruma shrimp, *Penaeus japonicus.* He strove to perfect his techniques until 1959, when he set up a pilot hatchery and a farm. This was followed by about 20 other operators using his techniques to produce about 4 000 tons of shrimp annually from 8 500 ha of water surface in 1967, (Bardach *et al.*, 1972). Other reports of FAO (1985) gave the estimates of cultured shrimp production as 30 000 tones of shrimp as a by-product of extended milkfish or mullet pond in the middle of 1970s in several Asian countries. Following the demonstrated economic viability of shrimp farming, improved technology and more sophisticated farms are developed. Semi-intensive and intensive systems with feed supplement and hatchery reared post larvae are common and far out-produce the extensive pond rearing system, (Sirirattrakul, 1998). Rosenberry, (2000) reported that about 376 000 shrimp farms were estimated world wide covering about 3 million acres. Most of these located in tropical developing countries where climate, land values and labour costs make the business more economically feasible.

It was estimated that farm raised shrimps in 1999 was 814 250 metric tonnes (nearly 1.8 billion pounds), a 10% increase over the previous year's production (Rosenberry, 2000). Farm raised shrimp production has so advanced that it has been suggested that productions of the major-farmed species, if compared with the same species of capture fisheries, the contribution from culture would be considerably higher (Yap 2000). About 21 species of the penaeid shrimps have so far been identified to be of culture potential worldwide (Pillay, 1993; Swift, 1993; Arrignon *et al*, 1994). The 6 major farm-raised shrimp species and their proportions of contribution are: *P. monodon*- 52%; P. *vanamei* - 17.99%; *P. chinensis* - 11%; *P. merguiensis* - 5.5%; *P. indicus* - 0.5%; P *japonicus* - 0.3% and 12.71% for the rest (FAO, 1999)

Sixty-three (63) countries are listed as being producers of farm raised shrimp species world wide from 1984 to 1997 (FAO, 1999). This number however, dwindled as the years went by. In 1987 nine countries had no records on farmed shrimp production, and by 1997 only 29 countries had any record, while new recruits were emerging. In terms of regions, Southeast Asia leads in farmed shrimp production, contributing up to 53.7% of the world total production. Considering all Asia as a region, their contributions add up to 78% of the world-farmed shrimp production while America as a region contributes 21% with Latin America being the major contributor. The remaining 1% forms the contribution from the other regions. By country, Thailand is the leading producer since 1993. It produced up to 215,000mt in 1997 (FAO 1999) and 210,000mt in 1998 (Limsuwan, 1999). In the Americas, the producing countries are all part of Latin America, producing up to 1,200mt in 1997 (FAO, 1999).

There are considerable similarities in the culture techniques for the various penaeid shrimp species, but some specific requirements and limitations exist due to environmental requirements, breeding and feeding behaviour as well as compatibility with other species. The general requirement for water salinity varies from 10-40‰; temperature, 10-37^{0}C, (Pillay, 1993; Chanratchakool *et al.*, 1995 and Saha *et al.,* 1999); the character of substrate in the culture facilities; feed quality and response to high-density culture vary within some ranges (Pillay, 1993; Arringnon *et al.*, 1994). Penaeid shrimps, however, have some specific requirements and limitations at species level. Among the species so far studied, the tiger shrimp *P. monodon* is the fastest growing species in captivity. It is euryhaline and can tolerate almost fresh-water conditions even though 10-25‰ is considered optimum, it can tolerate temperatures below 12^{0}C with upper limit of tolerance around 37.5^{0}C (Pillay, 1993; Saha *et al.*, 1999). *Penaeus indicus* and *Penaeus mergiuiensis* have very similar habits but in aquaculture the former species exhibits preference for sandy substrates and the later muddy ones. Both species require high salinities (20-30‰) for good growth and cannot tolerate salinities out-side the range of 5-40‰. The lethal temperature is above 34^{0}C (Saha *et al.*, 1999). The important water quality parameters are not the lethal levels or LC_{50}, but the lower levels, which prevent optimal growth, (Chanratchakool *et al.*, 1995).

The species under study, *P. notialis,* is usually fished over sandy-hard substrata associated with relatively clear water habitats. In these habitats, they develop burrowing behaviour which leaves the animal usually exposed to predation only at night with only a minimum time required for feeding, (Nunoo, 1998; Penn, 1984; Williams, 1958). Research is yet to be carried out to establish conditions for fast growth of the species under culture in Ghana and West Africa as whole where the *P. notiails is* most abundant.

2.3.2. **Shrimp Culture; African Experience.**

Current efforts in establishing shrimp farming in Africa, according to Pillay (1993), mainly involved the culture of *P. indicus* on the East Coast and *P notialis* on the West Coast, where species are endemic. Prein and Ofori (1996a) however, reported of the attempt to culture an exotic species *P. monodon* in Ghana. Work of Darpaah, (1998) also indicated the culture penitential of *P notialis* and *P kerathurus* at the Volta Estuary of Ghana. His work was followed by Akorlor (unpublished), who worked on formulating suitable feed for *P notialis*. So far attempts remained at experimental level with very encouraging results. Rabanal (1995) in his consultative report on the feasibility of brackish water culture development recommended *Penaeus notialis* and *Parapaeniopsis atlanticus* and some species of finfish as prospective candidates for culture around the Volta Estuary. In other parts of West African Coast, La Cote d'Ivoire, for example Brulhet (1997) reported of a successful attempt made on hatchery production of *Penaeus japonicus* to post larval stage, the grow-out stage rather failed. In Nigeria, another attempt was made in culture of *P. notialis* in early 1960s; this project was however cut short by the Civil War in 1966 (Swift, 1993). Egypt is emerging as the pioneer in commercial production of farm-raised penaeid shrimps in Africa with the production of *P. semisulcatus at* estimated amount of 60mt in 2001. Seven hatcheries have so far been established with yearly production capacity around 500 million post-larvae (Izzat, 2003).

2.4. FERTILIZATION AND LIVE FISH FOOD PRODUCTION IN REARING PONDS.

Feed constitutes the major cost of semi-intensive and intensive aquaculture production, constituting as much as 50 to 70% of the operational cost. It therefore deserves a great attention for the fact that both overfeeding and underfeeding lead to stagnant growth if not catastrophe and financial losses. Three groups of feed are mainly used in shrimp farms; - natural feed, wet feed and processed feed (FAO/UNDP, 1980).

- *Natural feed:* - These are fish food organisms that naturally grow in shrimp ponds and are mainly the blue green algae with the associated zooplankton and benthos.
- *Wet feed:* - They are unprocessed supplementary feeds including fresh fish, blood meals, slaughter house waste, mussels, oysters and so on. They are not recommended for semi-intensive and intensive systems. This is because water quality is badly affected creating unhealthy environment; they are inconsistence in quality and nutritionally unbalanced. Their availability depends only on season and other environmental factors, they have very short shelf-life or cannot be stored at all (Hardy, 1980; Lovell,1980 and Pillay, 1993;)
- *Processed feed*: - This type of feed is recommended for semi-intensive and intensive systems, they can be nutritionally balanced and promote good growth, with enhanced economic benefits. They also ensure slow leaching of nutrients and water stability enabling the farmed animals to eat well to satiation; can be available in different shapes and sizes for various developmental stages of

shrimps. They normally have long shelf-life (Hardy, 1980; Lovell, 1980).

Despite the suitability of processed feeds in semi-intensive and intensive systems, too much reliance on it adds up to the cost of production resulting in high prices of the farmed products. Mukhi *et al.* (2001) indicated that supplementary feeds are responsible for the high load of nitrogen and phosphorus in wastewater from shrimp ponds and that the uneaten feed contributes a major share (30-40%) of nitrogen pollution. Live foods on the order hand offer favourable hygienic conditions. Live foods play important role in aquaculture; they are generally rich in essential nutrients (Pillay, 1993). An evaluation by Nayer *et al.* (1998), of some common live food organisms show that they are suitable in meeting the nutritional demands of culture organisms. The protein content of live feeds on the average is in the range of 16 – 70% of dry matter (both fauna and flora). The calorific value falls within 1.6 – 5.7 kcal/g of dry matter. They are also rich in vitamins and minerals. Some of them especially the ciliates feed on the organic matter thus reducing the organic load in the environment. They are more acceptable to the culture animals and help restore water quality as compared to processed feeds (Huet, 1994; Mukhi *et al.,* 2001),

The ability of aquatic system to produce live feeds depends on its biogenic capacity. The biogenic capacity of aquatic system denotes the nutritive value of the water to provide feed and other essential parameters to enhance growth of fish and other higher animals in the system (Huet, 1994). Fertility of aquatic system just as land is improved by means of fertilization. Fertilization is the simplest and the most economic means of increasing fish production in ponds. It assures hygienic conditions of the pond and intensification of production devoid of dietary diseases (Huet, 1994). The aim of fertilization therefore is to aid the production of natural (live) food present in the system.

McIntire and Boyd, (1962) counted less than 1,000,000 of various species of phytoplankton per litre in unfertilized ponds whilst more than 10,000,000 per litre were counted in fertilized ponds. Hepher (1962) had chlorophyll a concentration in unfertilized ponds varied from 8.8 to 115.5µg/l as against 103.4 to 212.3 5µg/l from ponds fertilized with nitrogen and phosphorus. Hall *et al.* (1970) also reported the following average concentrations of chlorophyll a: unfertilized ponds gave 2.9µg/l and 55.5µg/l for fertilized ponds. As much as 20 to 130µg/l of chlorophyll a was determined in ponds fertilized with nitrogen and phosphorus whilst only 5 to 30µg/l was from unfertilized ponds, according to Boyd (1973). Hall et al. (1970) reported that primary production was 10 - 15 times greater in fertilized ponds than in unfertilized ponds.

Zooplankton appears to increase in direct proportion to that of phytoplankton. This is illustrated in the following examples: 484 crustaceans per litre and 1,826 rotifers per litre were counted from waters fertilized with phosphorus whilst only 263 crustaceans and 686 rotifers were counted from the same volume of water from unfertilised ponds (Wiebe, 1929). McIntire and Boyd (1962) reported that fertilization with nitrogen and phosphorus resulted in large increases in crustaceans and rotifers. At the peak density of their three years' work, 136,000 rotifers and 1,000 crustaceans per litre were counted in fertilized ponds whilst only 10,000 rotifers and 100 crustaceans were counted from control-unfertilised ponds. Hall *et al.* (1970) reported of 150µg/l biomass of zooplankton in unfertilised ponds as against 881µg/l in ponds treated with nitrogen and phosphorus fertilizers. The annual average production level was given as 2,767µg/l in unfertilised ponds and 7,447µg/l in fertilised ponds. On close studies of the ponds they reported that fertilization increased production level but had little effect on the community composition of the zooplankton. This is therefore in agreement with the assertion of Boyd (1973; 1984). Dickson and Effort (1972) reported that fertilization does not generate new plankton species but rather the previously dormant and rare species rapidly increase after fertilization to form algal bloom, resulting in the reduction in their diversity. The diversity is particularly low in ponds with dense blue-green algae.

Reported results of work on organic and inorganic fertilizers indicated that organic fertilizers, especially livestock droppings are more effective in generation of live food organisms than the inorganic fertilizers. The result of studies conducted by Wade and Stirling (1999b) showed that ponds treated with chicken manure and Cow dung combined gave the highest number of different species and biomass of benthos as compared to unfertilized ponds and ponds treated with inorganic fertilizers.

Ball (1949), for instance counted 245 benthic organisms/m^2 in unfertilized ponds and 694 organisms/m^2 in fertilized ponds. Boyd (1984) reported of 371 benthic organis/m^2 in unfertilized ponds and 640 organisms/m^2 in fertilized ponds. McIntire and Boyd (1962) discovered that fertilization with nitrogen and phosphorus fertilizers increased the biomass of benthic fish food organisms 7.6 times in one pond and 19.5 times in another pond as compared to those from unfertilized ponds.

Considering the favourable characteristics of live fish food, both to the cultured animals and the environment, not forgetting cost effectiveness in its use in aquaculture, it would be most appropriate for aquaculturist to continue with research into the use of live fish food in the husbandry of aquatic animals so as to reduce over reliance on processed feeds. It is in light of this that the current work was decided no the use of organic fertilizer, chicken manure in particular out of the numerous materials including inorganic fertilizers, based on its superiority over these other materials (Woynarovich, 1980; Boyd, 1984; Green *et al.*, 1989; Delincé, 1992; Cruz, 1997). Study conducted by Rapapport, *et* *al.* (1977), using inorganic fertilizer, organic fertilizers and control unfertilised ponds to generate natural fish food in ponds indicated that chicken manure ranks the best in generation of natural food. Work of Rappaport and Sariq (1978), further demonstrated that chicken manure as compared with cow dung increased fish production by 11% and 21% in the case of the control unfertilised pond. Feed Conversion Ratio (FCR) decreased by 12% in chicken manure and 6% in cow dung as compared to the control unfertilised pond (the FCR ratio measures the degree of digestibility of food item and the ease at which it is assimilated by the organism; the lower the figure the better).

Analysis of cow dung and chicken manures indicated that they contain net metabolizable energy in the ratio of 2,510 to 3,347 kJ/kg and 3,766 to 5,021 kJ/kg respectively. Chicken manure contain up to 25% N-protein whilst cow dung contains 10 -15% Delincé (1992). Msiska (1981) and Schroeder (1980) also reported that chicken manure contains 14.2 ± 4.0% gross proteins. Chicken droppings were therefore used in the current work as manure to enhance the biogenetic capacity of the ponds based on its good qualities.

Despite the favourable production of natural fish food initiated by the use of chicken droppings in fishponds, the indiscriminate use of manures as a whole may lead to disastrous loss of culture animals instead of improving productivity in the pond. This calls for the determination and use of appropriate dosage to keep physico-chemical parameters of the pond within the acceptable range required for survival and growth of the animals (Wade and Stirling, 1999a). This underscored the objectives of the work.

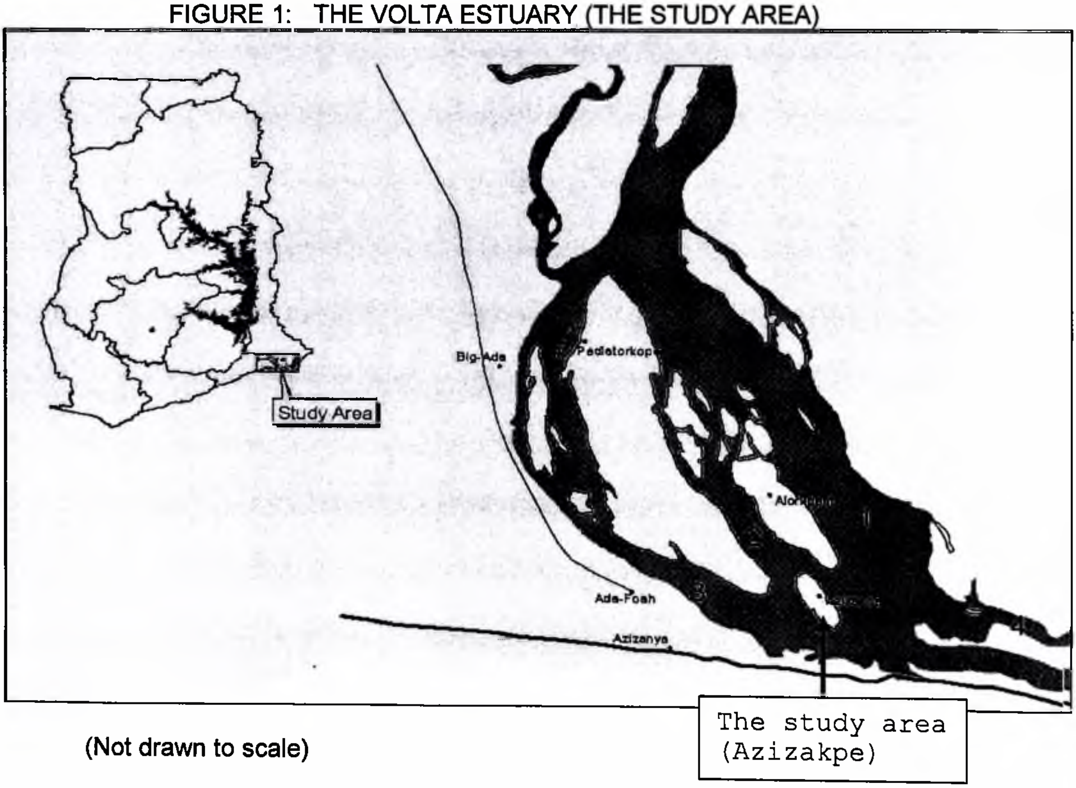
The current work *"Studies on growth pattern of Penaeid shrimp Penaeus notialis in ponds manured with chicken droppings"* is aimed at enhancing the biogenic capacity of shrimp ponds in a bid to determine the best manuring regime for adequate generation of fish-food organisms for fast growth of *P. notialis* that is most suitable for sound water quality and less negative environmental impact. This is against the background that phosphorus and nitrogen constitute the major source of organic load in shrimp ponds and are comparatively in greater proportions in composite feeds and inorganic fertilizers (Mukhi *et al.*, 2001).

CHAPTER 3.0. MATERIALS AND METHOD

3.1. SITE SELECTION

In principle, site selection for aquacultural activities basically depends on some essential conditions and facilities determined by the culture system in question. For a site to be suitable for a particular culture system, availability and access to the requisite facilities and conditions become the determinants. Penaeid shrimp culture is essentially brackish water or marine aquaculture. The selected site for the current project was therefore a Demonstration Shrimp Farm, funded by the Directorate of Fisheries of Ministry of food and Agriculture, and located at Azizakpe, one of the islands in the Volta Estuary, Ada-Foah (Fig. 1).

FIGURE 1: THE VOLTA ESTUARY (THE STUDY AREA)



(Not drawn to scale)

The selected site consisted of 6 earthen ponds (Plate A) ; a mini-laboratory, a store and three small concrete tanks (acclimatization tanks).

Four out of the six experimental ponds were used, each pond measured $172m^2$ and 0.58m deep.

PLATE A. LAY OUT OF EXPERIMENTAL PONDS

The ponds were fitted with outlet PVC pipes, which drained them into a perimeter canal that enclosed the ponds (Plate B). The perimeter canal in turn drained into a creek at the lower reaches of the estuary by means of valve system made from PVC pipes that controlled the flow of water in the canal.

PLATE B. PART OF THE DRAINAGE SYSTEM

The water supply system was made up of a 40m long PVC pipe that was placed into the estuarine water and connected onto a 5.5 HP Water Pumping Machine, with delivery volume of 930 litres of water per minute, at the bank. A 10m long PVC pipe linked the pumping machine to a supply canal into which inlet pipes from the ponds were opened. With this arrangement, water was pumped into the supply canal and distributed into the ponds via their inlet pipes which were securely covered at the side opened into the supply canal with 500μm mesh size equadorial netting material.

3.2. POND PREPARATION

Weeding was carried out with cutlass to clear the area surrounding the ponds and the dykes of vegetative cover. The water in the perimeter canal was drained intermittently through the valves during the low tides (Appendix I). Debris, rooted plants and excessive mud were removed from the perimeter canal to speed up the flow of water in the canal when the ponds were being drained.

The outlet pipes in the ponds were opened to let the water out of the ponds into the canal during low tides (Appendix 1). The bottom of the ponds was prepared by dredging the degraded mud and excessive organic load accumulated from the previous production cycles with water pumping machine, shovels and rakes. Tree stumps, rooted plants and other debris were removed with the aid of hoes, cutlass, spade, shovels, rake and other earth moving tools. The dykes were rehabilitated by closing all identified leakages and re-fixing of faulty pipes in the ponds. The pond bottoms and the slopes of the dykes were realigned to get the suitable gradient for good drainage. The pond bottoms were flushed several times by filling the ponds with water to a depth of 10 -20 cm, the water was allowed to remain in the ponds for 2 – 3 days before being drained out. The pond bottoms were solar dried for a week before lime application.

The pH of the soil in the ponds was determined by taking soil samples to the depth of 1 -2 cm from the surface at six different spots, making up about 3 cm^3 in each pond. The soil samples so taken were divided into three equal parts and placed in three test tubes per pond. Equal amount of distilled water was added to each of the soil samples in the test tubes and left over night. The supernatant water was tested for pH using Hatch Water Testing Kit manufactured by Hatch Company, Loveland CO, United States of America. The results of the tests are in Table 1.

TABLE 1: PH AND LIMING RATES IN THE PONDS

Pond	Soil pH (mean)	Liming rate (kg/ha)	Quantity of lime (kg)
1	7.5	1000	19.2
2	7.5	1000	19.2
3	6.5	1500	28.7
4	6.5	1500	28.7

The ponds were limed, with Calcium Oxide (CaO) produced at site by burning shells of *Egeria radiata* (Plate C), at rates according to Huet (1964); Boyd (1984) and Delincé (1992).

PLATE C: A SET OF FUEL WOOD AND PILE OF *EGERIA RADIATA* SHELLS.

Despite the favourable pH of the soil in the ponds (Table 1), liming was necessary in order to disinfect and improve the general soil quality. Liming was done by spreading granulated CaO (less than 1mm grain size) on the entire bottom and inner surfaces of dykes of the ponds according to Huet and Timmermans (1970).

POND FILLING AND MANURING

All the pipes leading into and out of the ponds were securely screened with 500µm mesh size Equadorial netting material to shield off eggs and larvae of other aquatic organisms. Water was pumped into the ponds from the intake point up to stocking capacity (about 45cm deep) after Pillay (1993) and Chanratchakool, *et al.* (1995) and manured.

The ponds were manured with sun dried chicken droppings collected from a small-scale-holder poultry farm at Sogakofe, Johnson Farms. The chicken droppings collected were sun-dried to evaporate excessive nitrogenous products and to make handling easier. They were sorted out of sand, stones, feathers and other debris before being measured according to predetermined rates (Table 2) using a 5kg capacity weighing scale manufactured by Premier Household Co., Glasgow, UK.

TABLE 2: MANURING RATES

POND	RATE (kg/ha)	QUANTITY (kg)
1	100	1.72
2	200	3.46
3	300	5.19
4	0	0

The manuring rate constituted the main factor (treatments) under study. The required amount of manure for each pond was divided into two and applied on two occasions at a week interval to avoid sudden algal bloom that might create DO deficiency problem (Boyd, 1974; Rappaport *et al.*, 1977; Cruz 1997; Wade and Stirling, 1999a). The chicken droppings were soaked in an equal volume of water for at least 24 hours ASEAN (1978).

The mixture obtained was spread evenly over the surface of the water in the ponds according to ASEAN (1978) and Chanratchakool *et al.* (1995). This method was preferred to heaping the manure at a spot in a fenced structure or spreading the dried manure in powdered form over the bottom of the pond FAO (1994).

3.3. SEED COLLECTION.

The seeds for stocking were obtained from the wild. With the aid of local fishermen, the seeds were collected from inshore waters of the estuary over a night, from 1900 hours to 0430 hours GMT the following day. The timing was such that the spring tides coincided with total darkness when there were no moons

With a crew of three, made up of two local fishermen and the candidate in a canoe, the seeds were collected with a draw-net of mesh size of 12mm at diagonal stretch. The harvested seeds were sorted out with the aid of two transparent glass containers of 100 × 60 × 60 cm^3 and a 12-Volt lamp to separate the *P. notialis* from other species - *Macrobrancium*, *Callinectics* species and a variety of finfish that were harvested together with the *P. notialis* species. The selected shrimp species were transported to the shore after a sizable number of between 400 to 600 individuals were obtained. At the shore, they were quickly put into concrete tanks, which were well prepared - cleaned, limed and filled with water from the estuary. The average parameters of the seeds selected were; Carapace Length (CL) 0.70cm; Total Length (TL) 4.43cm and Body Weight (Wt) 0.43g.

SEED ACCLIMATIZATION AND STOCKING.

The seeds were acclimatized over a four-day period in the concrete tanks without feeding. During this time the water in the tanks was gradually brought to similar conditions of the one in the control pond (0 kg/ha). This was done by changing the water in the tanks with the pond water at the rate of 10-20 %/day by volume. This is essential not to expose the animals to drastic environmental changes that may result in high mortality. About 94% survival rate was obtained in this way.

At the end of the acclimatization period, the acclimatized shrimp juveniles were removed from the tanks through PVC pipes connected to the tanks into plastic buckets and stocked into the ponds at the rate of 3.78/m^2, that gave a total of 650 juveniles per pond.

3.4. WATER QUALITY PARAMETERS.

Dissolved Oxygen, (DO); pH; Salinity; Water level and Secchi disc readings were taken on daily basis; Pond bottom condition, productivity test and Ammonium Nitrogen (NH_3-N) were assessed every three weeks. Water was flushed every two weeks and fertilization was carried out, as and when it was necessary. This was indicted by secchi disc readings observed. The following activities were carried out on routine basis:

- Dissolved Oxygen and Temperature were taken twice a day at 0830 and 1630 hours GMT after Boyd (1984); Pillay (1993) and Chanratchakool, *et al.* (1995) with DO-probe; model 55/12 FT SN manufactured by Spring Instrument Co. Inc. of United States of America.
- pH was taken using Hatch Water Testing Kit manufactured by Hatch Company, Loveland, CO, United States of America.
- Salinity was taken once a day with Refractometer; model S-IO 2412-W04

manufactured by Oatago Co. of Japan.

- Water Levels were taken with graduated wooden pole placed at six different spots in each pond and the average depth of water determined for the daily measurement.
- The transparency of water was taken with a metal disc of 12cm in diameter painted in white and black to which a 6metre long thread was attached (Secchi disc).
- Pond bottom condition was assessed with a PVC pipe fitted with a piston that was used to take sample of the clay from the bottom of the ponds every three weeks.
- NH_3-N was estimated with the aid of Hatch Water Testing Kit, manufacture by Hatch Company, Loveland, CO of USA

Water exchange was done by pumping water from the estuary into the supply canal during high tides when the salt water incursion was high. From the supply canal, the water was distributed into the ponds through their inlet pipes. Flushing the water in rearing ponds did not only increase DO content, but also flushed out or dilute any toxic materials before their concentrations reached harmful proportions.

PRODUCTIVITY ESTIMATION

Productivity test was conducted to determine the rate of oxygen fixation in photosynthesis as a measure of primary production in the ponds. An experimental set up of three dark bottles and three light ones was put up in each pond. The bottles were placed 5 to 10 cm bellow the surface of the water and allowed to incubate for six hours. The average oxygen content in both set of black and light bottles in each pond was determined after the incubation period and the necessary calculations made to determine the productivity in each pond.

GROWTH SCHEDULE

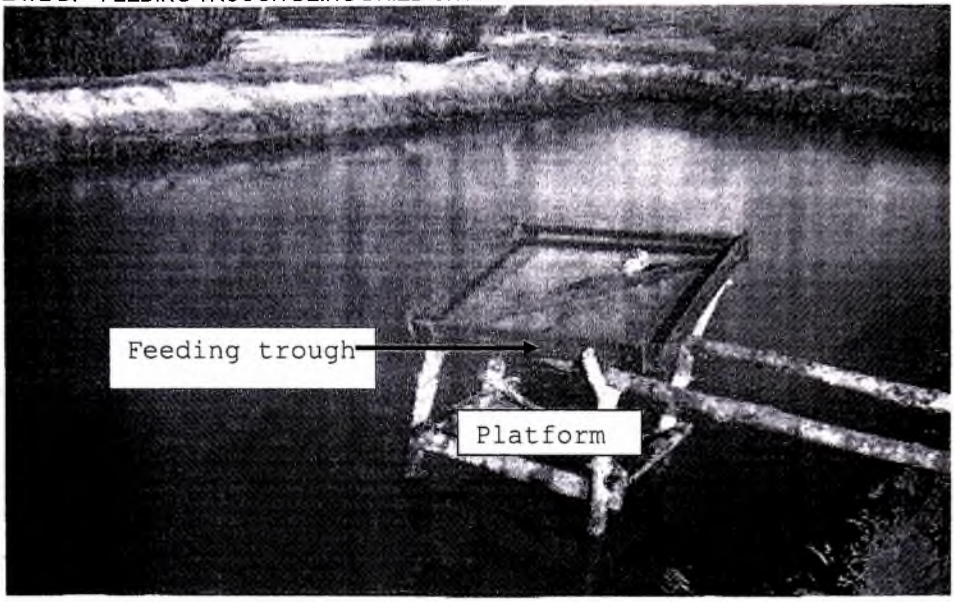
The total culture period of 180 days was divided into two stages: the first 90 days involving four treatments of chicken manure: - the control- 0kg/ha, 100kg/ha, 200kg/ha and 300kg/ha. The second stage that spanned through the 180 days involved three treatments: - the control- 0kg/ha, 100kg/ha and 200kg/ha.

3.5. SUPPLEMENTRY FEEDING.

The animals were fed once a day (Arrignon et al., 1994 and Saha, *et al.*, 1999) between 1730 – 1830 hours GMT. The feed was administered to the shrimps at 10 % body weight and gradually reduced to 2% body weight (ASEAN, 1978 and Rosenberry, 2000). The supplementary feed was formulated at 20% protein level containing Wheat bran - 65%; Cornmeal - 33%; Fishmeal – 2% Cassava Starch (binding agent) - 5%; Soybeans oil - 5% (Chow *et al.*, 1980) and Hardy, 1980). The feed was formulated using the Square-method according to Hardy (1980); Lovell (1980) and Fegan (1992).

The feed was given to the animal in feed troughs made from wooden frames and mosquito netting material (Plate D). This method was adopted to prevent water pollution and reduce organic load that might be caused by uneaten feed in the ponds. The feed trays were also used to assess the feeding behaviour and health of the shrimps by observing the amount of food left in the trays after placing the food in the ponds for three to four hours.

PLATE D: FEEDING TROUGH BEING DRIED ON A PLATFORM.



Samples of the shrimps were also taken using the feed trays at early stages of culture for growth assessment. To avoid excessive wading and disturbing the water during feeding and sampling, stands were erected close to the dykes with wood that served as platform for these activities. This method was adopted after ASEAN (1978) and Chanratchakool *et al.* (1995).

3.6. MEASUREMENT OF GROWTH PARAMETERS

Sample size of 50 individual shrimps were taken every 21 days using the feed trays. During the sampling, parameters monitored were length, weight, survival rates and health conditions. The length measurements taken with the aid of a 30 cm long rule to the accuracy of 0.1 of centimetre. The measurements taken include:

- CL (Carapace Length) – The distance between the post-orbital margin and the medial posterior border of the carapace (Fig 2).
- TL. (Total Length): - The distance between the tip of the rostrum and the tip of the telson with the abdomen extended in straight line (Fig. 2).

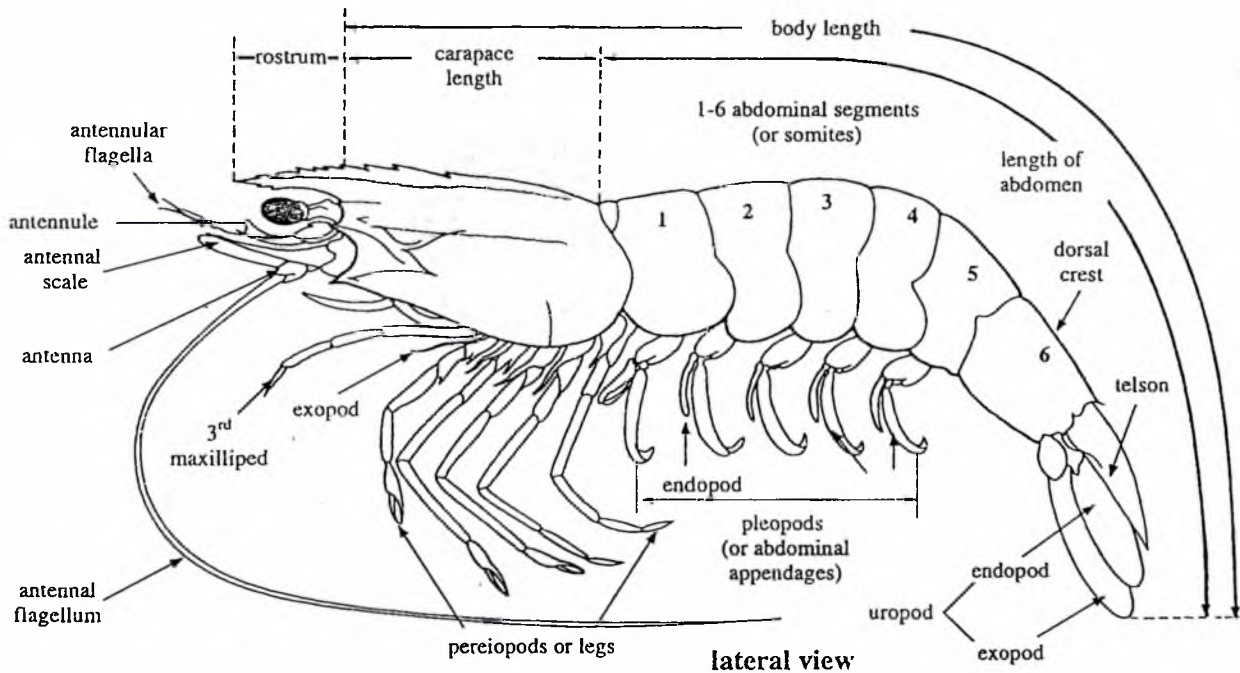
The Body Weight (Wt): - Weight of the shrimp in grammes was taken to the accuracy of 0.1 gramme with a 1200g capacity Electronic Scale manufactured by Watgtech Electronic Co. of Japan.

A typical shrimp and the linear measurements can be seen in Figure 2.

PREVATION OF COMPETITORS AND POSSIBLE ENEMIES (PESTS) OF SHRIMPS

The outlet and inlet pipes were carefully screened with 500µm mesh size Equadorial netting material to prevent eggs, larvae and juveniles of fin fish and crabs from entering into the ponds. The pond bottoms were exposed to the sun for a week to get ride of any pool of water and destroy all aquatic organisms. Calcium Oxide was used as lime to disinfect the dykes and the bottom of the ponds. Occasional drawing of net in the ponds was also done to remove any fish or crabs per adventure entered the ponds while trap was used to get ride of land crabs that borrowed along the dykes.

FIGURE 2: MORPHOLOGY AND BODY MEASUREMENT OF A TYPICAL PENAEID SHRIMP



CHAPTER 4.0. RESULTS

4.1. WATER PARAMETERS.

Mean values of water quality parameters taken prior to stocking are indicated in Table 3 below:

TABLE 3: WATER QUALITY PARAMETERS PRIOR TO STOCKING

Parameters	Treatment:- Kilogramme chicken droppings per hectare (kg/ha)				
	0kg/ha	100kg/ha	200kg/ha	300kg/ha	Deviations
DO (mg/l)	5.8	6.3	7.1	6.0	± 0.47
Secchi depth (cm)	30.5	28.4	28.1	27.7	± 2.5
Water level (cm)	44.0	46.2	43.7	46.6	± 4.6
Salinity (‰)	12	12	12	12	± 4
PH	7.5	6.5	6.5	7.5	± 0.13
Temperature (°C)	28.8	28.5	28.7	27.9	± 2.39
NH_3-N	0.1	0.1	0.1	0.1	± 0.5

The effectiveness of the method adopted in manure application (dissolution of the manure in water before application) was testified by the time taken for phytoplankton to develop after fertilizer application. Within four days after the application of the manure there were signs of phytoplankton, making seeding the water in the ponds (introducing water from external source in which the phytoplankton productivity already exist into the pond), unnecessary. This is because seeding is sometimes necessitated by the delay in phytoplankton development. The amount of the phytoplankton formed seemed to increase with increasing amount of manure used as indicated by lower secchi disc readings (Table 3).

The DO values however seemed not to follow any trend (Table 3). The lowest was observed in the control (0 kg/ha treatment) followed by the 300 kg/ha treatment whilst the highest value was observed in the 200 kg/ha treatment followed by 100 kg/treatment.

TABLE 4. RANGE VALUES OF WATER QUALITY PARAMETERS DURING THE CULTURE PERIOD

Parameter	Treatment:- Kilogramme chicken droppings per hectare (kg/ha)			
	0kg/ha	100kg/ha	200kg/ha	300kg/ha
DO (mg/l) am	2.24 – 3.74	3.08 – 3.70	4.02 – 4.10	3.26 – 3.70
pm	7.51 – 9.26	7.62 – 10.70	8.22 – 10.64	7.75 – 10.20
Temperature am	25.7 – 28.00	20.2 – 26.40	24.7 – 27.60	25.6 – 27.90
(°C) pm	31 – 35.10	30.2 – 35.50	31.3 – 35.30	30.2 – 35.30
Salinity (‰)	10 - 24	10 – 27	10 – 25	10 – 24
pH	6.5 – 9.7	5.5 – 9.5	6.5 – 9.5	6.5 – 9.5
Secchi depth (cm)	28 – 33	26 – 30	26 – 28	24 – 28
Water level (cm)	29 – 40	32 - 42	34 - 45	36 - 47
NH_3-N	0.1 – 1.3	0.1 -1.9	0.1 – 2.6	0.1 – 3.1

From Table 4, DO was generally low in the mornings, which ranged from 2.24 to 4.10mg/l with the highest recorded value in the pond receiving 200 kg/ha chicken droppings followed by 100 kg/ha, 300 kg/ha and 0 kg/ha. The same trend was observed in the values observed in the afternoons, but then the DO values observed were high (7.51 – 10.70mg/l). Apart from the control, (0 kg/ha pond), all the ponds showed varying degrees of shades of green, brown and red colouration at different times of the day. The highest changes in colour occurred in the pond receiving the 300 kg/ha manure treatment with the control (0 kg/ha) being the least.

pH fluctuated within 5.5 – 9.7 (Table 4) and seemed to be almost uniform in the various ponds. Salinity varied from 10 to 27‰, the range was however kept within 16 – 20‰ most of the time by flushing the water during high tides when the salinity was high in the estuary (about 28 - 31‰). The NH_3-N level was higher in the pond with 300 kg/ha treatment followed by 200 kg/ha and 100 kg/ha, with the control giving the lowest value. Values recorded towards the end of the culture period were generally higher than those recorded at the initial stages of work. Remarkably higher values were observed within 2-3 days following additional manuring.

The observed secchi disc readings were 28 – 31 cm at the early part of culture, this was reduced to (24 – 28 cm) towards the end of the culture period. There was foaming action observed especially in the afternoons in all the ponds apart from the control (0kg/ha). This action, which was most predominant in the pond receiving 300 kg/ha treatment, seemed to precipitate excessive organic matter from beneath and cause it to float on top of the water. They were removed with the aid of hand-net. This reaction might be attributed to the action of the lime applied during the pond preparation. Primary productivity was highest in 100 kg/ha treatment and lowest in 300 kg/ha treatment (Table 5)

TABLE 5: AVERAGE PRODUCTIVITY VALUES

Condition	Treatment:- Kilogramme chicken droppings per hectare (kg/ha)			
	0kg/ha	100kg/ha	200kg/ha	300kg/ha
Light Bottle (O_L)	8.73	8.89	9.05	7.67
Dark Bottle (O_D)`	5.88	5.36	7.17	6.22
Productivity ($O_L - O_D$) (mg/l)	2.85	3.53	1.88	1.45

4.2. GROWTH PARAMETERS AND TREND.

Within the first 90 days of culture, the average total length of the shrimps with the corresponding weights were 8.11cm: 3.83g; 8.93 cm: 4.45g; 9.52cm: 5.88g and 11.11cm: 11.12g in 0 kg/ha, 100 kg/ha, 200 kg/ha and 300 kg/ha treatments respectively (Table 6 and Appendix V). An indication of nearly 2:1 ratio for total length to weights in the 0 kg/ha, 100 kg/ha and 200 kg/ha treatments, but 1:1 in 300 kg/ha treatment. The growth rates (weight in grammes/day) during the period were 0.04, 0.05, 0.06 and 0.13 in the 0 kg/ha, 100 kg/ha, 200 kg/ha and 300 kg/ha respectively with appreciably good survival rates (Figures 3 & 4; Table 6 & Appendix V). This gave production at the end of the first 90 days of culture as128.03 kg/ha, 138.90 kg/ha, 168.88 kg/ha and 243.60 kg/ha in 0 kg/ha, 100 kg/ha, 200 kg/ha and 300 kg/ha respectively (Table 7). The water in the pond treated with 300 kg/ha manure turned brown with rapid reduction in dissolved oxygen values followed by high mortality, over 70% mortality, after the 90 days of culture.

At the end of the 180 days of culture, the highest increment in Total length and Body weight of the shrimps were observed in the pond with 200 kg/ha manure treatment followed by 100 kg/ha treatment and then the control (Table 6). The survival rate was good varying from 60 to 70 and production from 258.72 to 327.19 kg/ha with growth rate varying from 0.05 to 0.07 g/day (Table 7). Illustration of growth rates for total length and body weight are in Figures 3 & 4. Some jumpers of *P. notialis* with average body weight, 18.5g; Total length, 14cm and Carapace length, 3cm were encountered at the end of the culture period in the pond receiving the 200 kg/ha treatment.

CL:- Carapace Length (cm)
Wt:- Body Weight (g)

TABLE 6: GROWTH TREND OF CARAPACE LENGTH (CL), TOTAL LENGTH (TL) AND BODY WEIGHT (Wt) OF P. NOTIALIS.

		TREATMENT :- Kilogramme chicken droppings per hector (kg/ha)											
DATE	No of	(0kg/ha)			(100kg/ha)			(200kg/ha)			(300kg/ha)		
yr. 2002	Days	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g
1st Apr.	0	0.70	4.43	0.43	0.70	4.34	0.43	0.70	4.34	0.43	0.70	4.43	0.43
22nd Apr.	21	0.94	5.89	0.92	0.96	5.93	0.98	0.98	6.04	1.00	1.01	6.12	1.39
13th May	42	1.06	6.08	1.95	1.11	6.3	2.02	1.13	7.03	2.53	1.18	7.91	3.79
3rd Jun.	63	1.45	7.79	3.00	1.54	8.49	4.13	1.72	9.03	5.06	1.79	9.88	7.65
24th Jun.	84	2.03	8.11	3.83	2.24	8.93	4.45	2.40	9.52	5.88	2.58	11.11	11.12
15th Jul.	105	2.41	9.53	5.23	2.44	9.60	5.69	2.76	10.35	7.73			
5th Aug.	126	2.62	10.35	6.94	2.75	10.51	7.62	3.00	10.59	10.45			
26th Aug.	147	2.81	10.76	7.81	2.9	11.09	8.19	3.53	13.09	11.99			
16th Sep.	168	2.86	11.38	9.31	2.99	11.49	9.71	3.74	13.60	12.91			
7th Oct.	189	2.94	11.86	9.78	3.15	12.04	10.16	3.81	14.08	14.43			

TL:- Total Length (cm)
CL:- Carapace Length (cm)
Wt- Body Weight (g)

Table 7 GORWTH PARAMETERS OF PENAEUS NOTIALIS

Treatement	0kg/ha	100kg/ha	200kg/ha	300kg/ha
Survival Rate at 90th day (%)	88	82	76	58
Survival Rate at 180th day (%)	70	68	60	....
Production at 90th day of culture (kg/ha)	128.03	138.90	168.88	243.60
Production at 180th day of culture (kg/ha)	258.72	261.05	327.19	....
Growth rate at 90th day (g/day)	0.04	0.05	0.06	0.13
Growth rate at 180th day (g/day)	0.05	0.05	0.07	....

Fig. 3. Growth Rate of Total Length of *P. notialis*

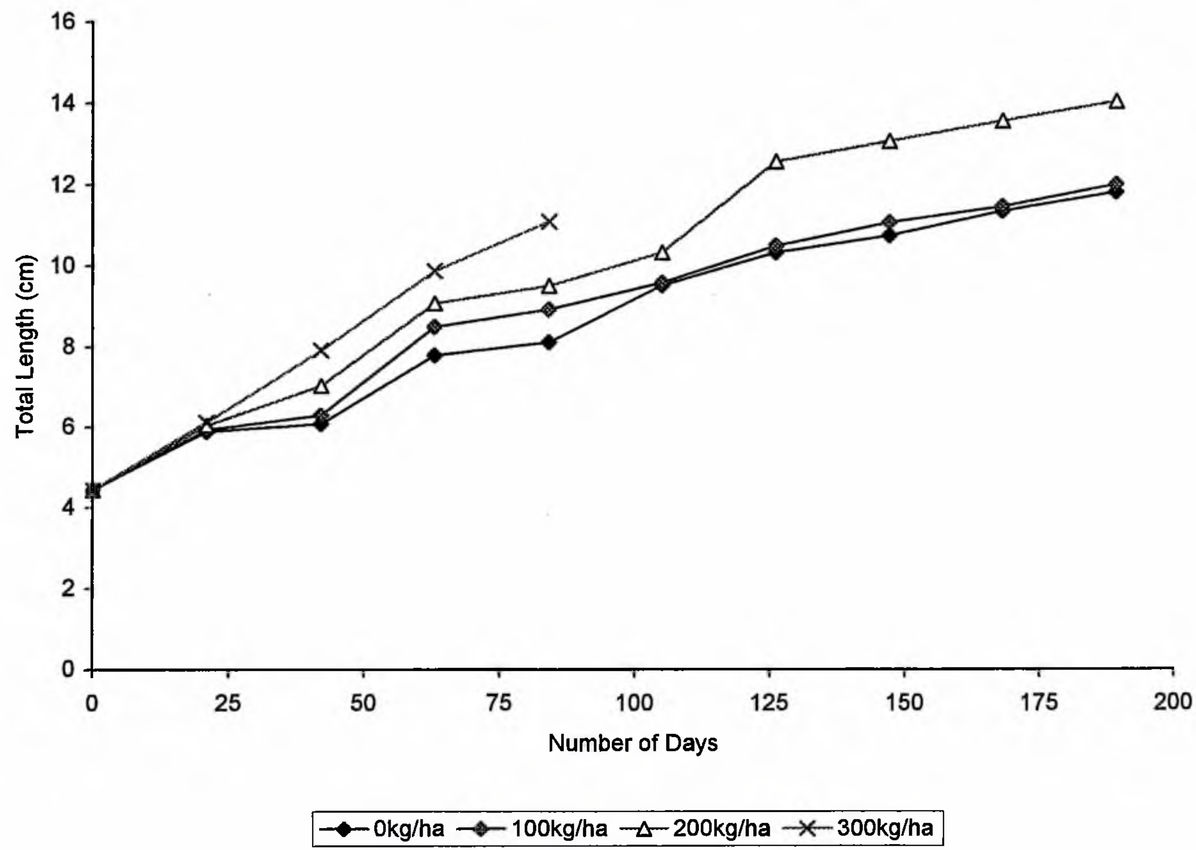
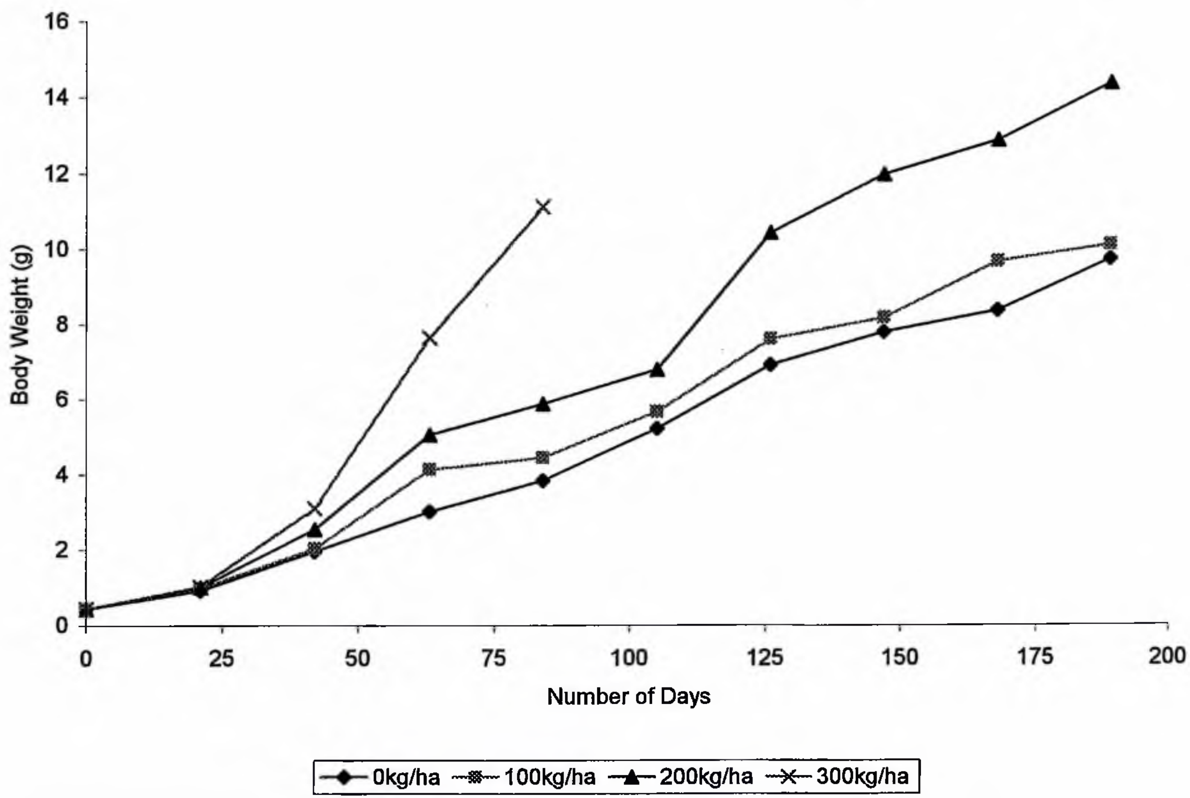


Fig. 4. Growth Rate of Body Weight of *P. notialis*



The major pests of the shrimp observed were the swimming crabs, *Callinectes sp; Cardiosoma* sp; *Tilapia* and *Hemichromis* sp, which probably not only preyed on the shrimps, but also competed with the shrimps for food and other materials required for growth. The burrowing characteristics of the *Cardiosoma sp* were observed to be the major source of leakages and weakening of the dykes.

4.3. STATISTICAL ANALYSIS

A two-way analysis of variance (ANOVA), without replicates was used for the analysis of data after Bailey (1995) and Ayertey (1998). The result from the data was fed into a computer simulation (Microsoft Excel) programme for analysis (Tables 8 to 11).

TABLE 8. ANOVA FOR TOTAL LENGTH DURING THE FIRST 90 DAYS OF CULTURE.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Treatment	25.0404	3	8.34679	14.6106	0.00083	3.86254
Total Length	14.0592	3	4.68641	8.20329	0.00608	3.86254
Error	5.14156	9	0.57128			
Total	44.2411	15				

From Table 8, F values for Treatment (Rows) and Total length (Columns) are greater than F critical values and P 0.05 > P – values. The Ha is therefore accepted for both Treatments and Total Length.

TABLE 9. ANOVA FOR TOTAL LENGTH DURING THE 180 DAYS OF CULTURE.

Source of Variation	SS	df	MS	F	P-value	F crit
Treatment	147.423	8	18.4279	98.8662	3.74E-12	2.59109
Total Length	12.9566	2	6.47829	34.7562	1.50E-06	3.63372
Error	2.98228	16	0.18639			
Total	163.362	26				

From Table 9, F values for Treatment (Rows) and Total length (Columns) are greater than F critical values and P 0.05 > P – values. The Ha is accepted for both Treatments and Total Length.

TABLE 10. ANOVA FOR BODY WEIGHT DURING THE FIRST 90 DAYS OF CULTURE.

Source of Variation	SS	df	MS	F	P-value	F crit
Treatment	70.1673	3	23.3891	10.4574	0.00273	3.86254
Body Weight	25.4231	3	8.47437	3.78892	0.05233	3.86254
Error	20.1296	9	2.23662			
Total	115.72	15				

From Table 10, F values for Treatment (Rows) are greater than F critical values and P 0.05 > P – values. For the Body Weight (columns), the F values less than F critical and P 0.05 values less than P-values. The Ha is therefore rejected for Body Weight but accepted for treatments.

TABLE 11. ANOVA FOR BODY WEINGHT DURING THE 180 DAYS OF CULTURE

Source of Variation	SS	df	MS	F	P-value	F crit
Treatment	336.309	8	42.0386	50.3787	6.72E-10	2.59109
Body Weight	31.0395	2	15.5197	18.5987	6.70E-05	3.63372
Error	13.3512	16	0.83445			
Total	380.7	26				

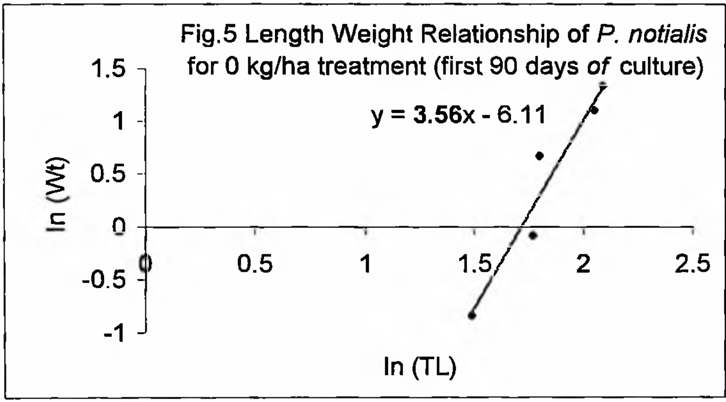
From Table 11, F values for Treatment (Rows) and Body Weight (Columns) are greater than F critical values and P 0.05 > P – values. The Ha is accepted for both Treatments and Body Weight.

Length-Weight relationship for both 90 and 180 days of culture periods were determined as indicated in:

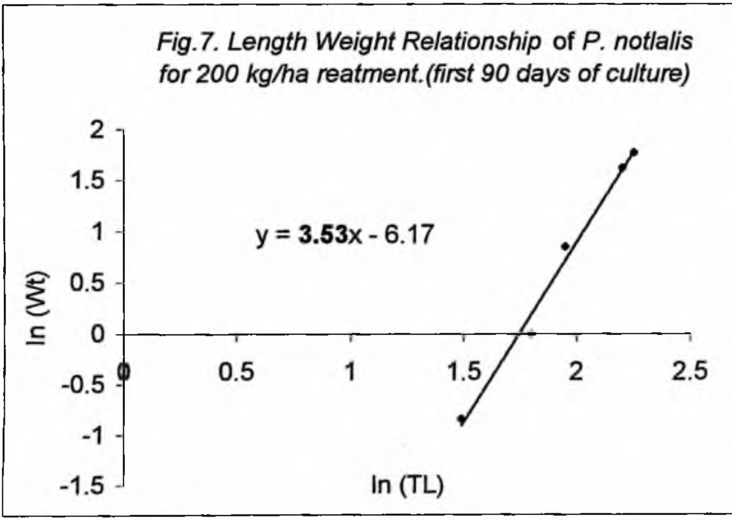
- Figures 5 to 8 for the 90-day period of culture
- Figures 9 to 11 for the 180-day period of culture.

The graphs were developed using the table in Appendix IV.

The gradient "b" values for the first 90 days of culture are; 3.56, 3.40, 3.53, 3.56 for 0 kg/ha, 100 kg/ha, 200 kg/ha and 300 kg/ha treatments respectively (Fig. 5 – 8). And for the 180 days culture, the "b" values are: 3.11, 3.16, and 3.12 for 0 kg/ha, 100 kg/ha and 200 kg/ha treatments respectively (Fig. 9 – 11). The "b' values for 90 days of culture are generally greater than 3 and those for the 180 days of culture are very close to 3.

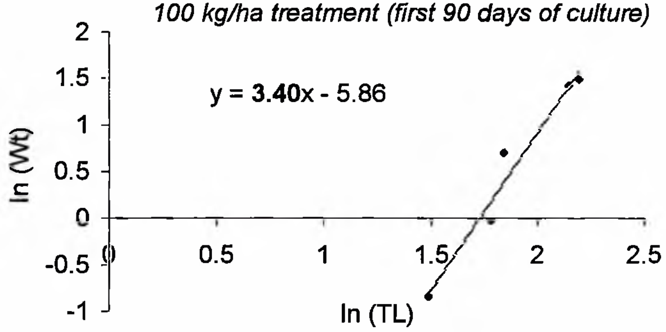


$W = 0.0022L^{3.56}$



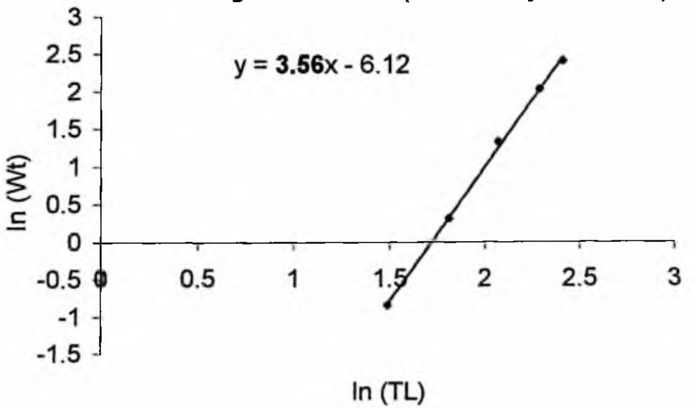
$W = 0.0021L^{3.53}$

Fig. 6 Length Weight Relationship of P. notialis for 100 kg/ha treatment (first 90 days of culture)



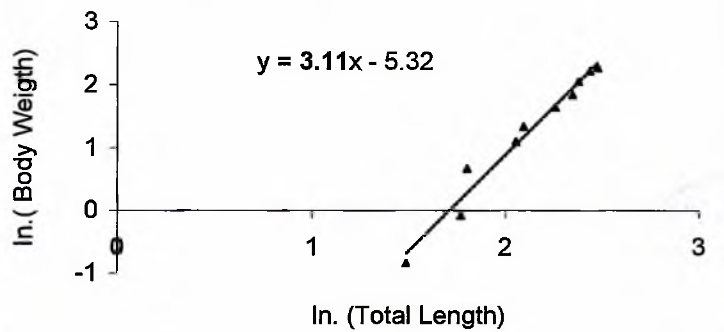
$W = 0.0029L^{3.40}$

Fig. 8 Length Weight Relationship of P. notlalis for 300 kg/ha treatment (first 90 days of culture)



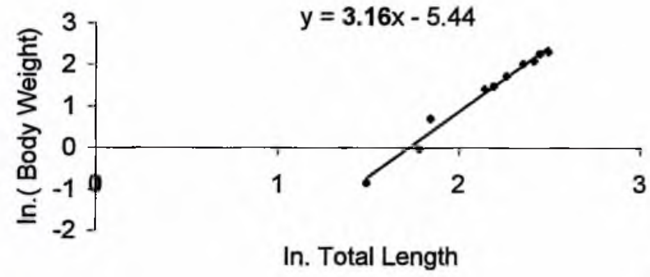
$W= 0.0029L^{3.56}$

Fig.9 Total Length Body Weight Relationship of *P. notialis* for 0kg/ha treatment for 180 days of culture



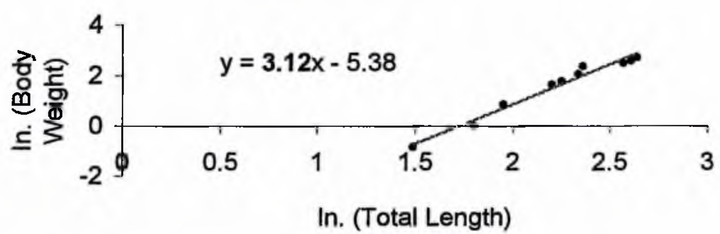
$W = 0.0049L^{3.1}$

Fig. 10. Total Length Body Weight Relationship of *P. notialis* for 100kg/ha treatment for 180 days of culture



$W = 0.0043L^{3.2}$

Fig 11. Total Length Body Weight Relationship of *P. notialis* for 200kg/ha Treatment for 180 days of culture.



$W = 0.0046L^{3.1}$

Regressional analyses performed are; regressing Total Length on Carapace Length; Body Weight on Carapace Length and Body Weight on Total length for the first 90 days of culture involving all the four treatments shown in Figures 12 – 23 and for 180 days of culture involving three treatments in Figures 24 – 32.

Regressing Total length on Carapace length, the "b" values are close to three during both 90 and 180 days of culture (Fig. 12 – 15 and 24 – 26 respectively). The same trend occurred in regressing Body Weight on Carapace length for both 90 and 180 days of culture (Fig. 16 – 19 and 27 – 29 respectively). For regressing Body Weight on Total length however, the "b" values for the 90 days of culture ranged from 0.90 – 1.60 (Fig. 20 – 23) and from 1.31 – 1.51 for the 180 days of culture (Fig. 30 – 32).

The R^2 values for Total length on Carapace length varies between 0.87 and 0.88, (Fig. 12 – 15); 0.87 – 0.98 for Body Weight on Carapace length (Fig. 16 – 19) and 0.92 - 0.96 for Body Weight on Total length (Fig. 20 – 23) during the 90 days of culture. Values for the R^2 during the 180 days of culture are: between 0.96 and 0.97 for Total length on Carapace length (Fig. 24 – 26); 0.94 – 0.97 for Body Weight on Carapace length (27 – 29) and 0.96 for the three treatments for Body Weight on Total length (Fig. 30 – 32).

In Figures 12 – 15 with R^2 values of 0.87 – 0.88 suggested that 87 – 88 % growth in Total Length was due to growth in Carapace length and 87 – 98 % variation in body weight was due to changes in Carapace Length (Fig. 16 – 19). The same argument holds for 0.92 – 0.96 (Fig. 20 – 23); 0.96 – 0.97 (Fig. 24 – 26); 0.94 – 0.97 (Fig. 27 – 29) and 0.96 (Fig. 30 – 32).

Fig. 12. Regression of Total Length on Caraoace Length for 0kg/ha treatment for the first 90 days of culture

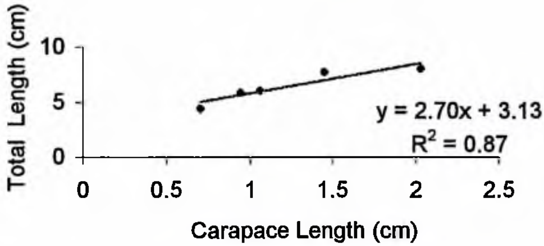
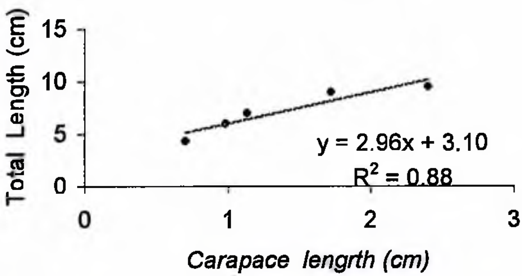


Fig. 14. Regression of Total length on Carapace length for 200kg/ha treatment for the first 90 days of culture.



Fjig.13 Re gression of Total length on Carapace length for 100kg/lha treatment for the first 90 days of culture

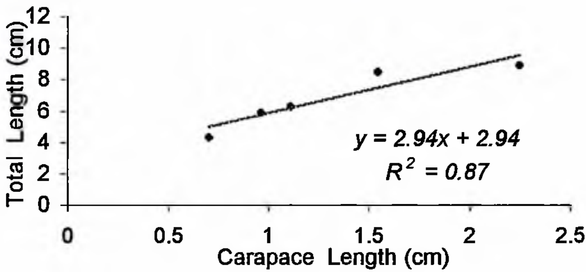


Fig. 15. Regression of Total length on Carapace length for 300kg/ha treatment for the first 90 days of culture

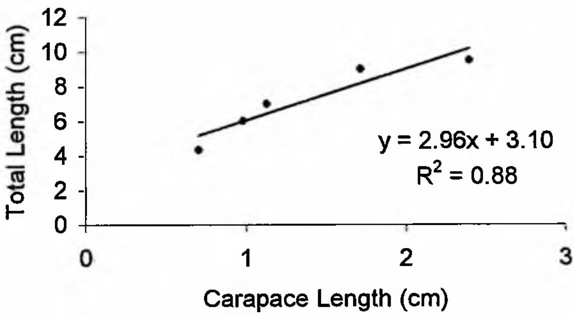


Fig. 16. Regression of Body Weight on Carapace length for 0kg/ha treatment for the first 90days of culture.

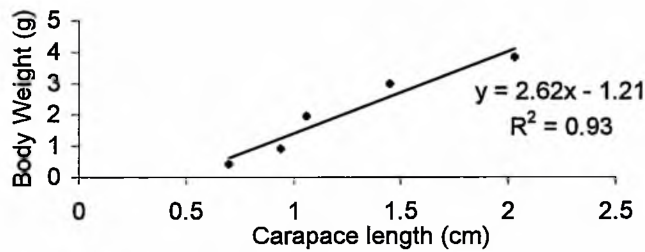


Fig. 18. Regression of Body Weight on Carapace length for 200kg/ha treatment for the first 90 days of culture

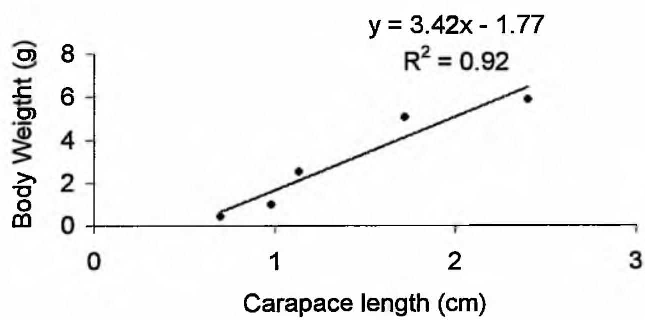


Fig. 17. Regression of Body Weight on carapace length for 100kg/ha for the first 90 days of culture

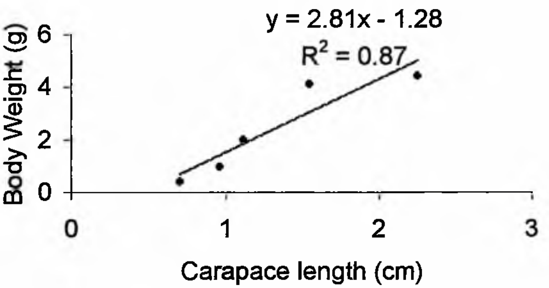


Fig. 19. Regression of Body Weight on Carapacce length for 300kg/ha treatment for the first 90 days of culture

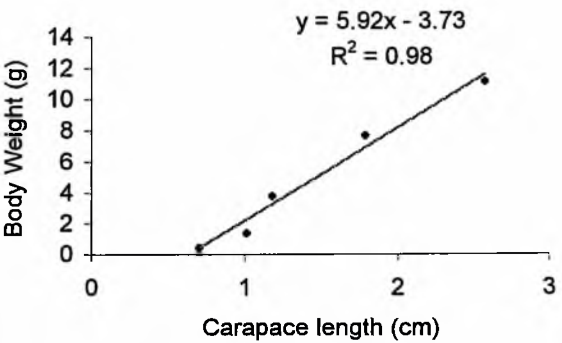


Fig. 20. Regression of Body Weight on Total length for 0kg/ha treatment for the first 90 days of culture

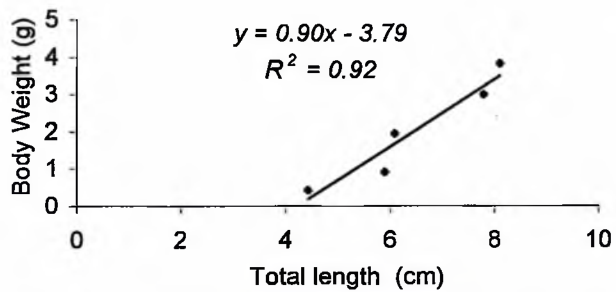


Fig. 21. Regression of Body Weigth on Total length for 100kg/ha treatment for the first 90 days of culture

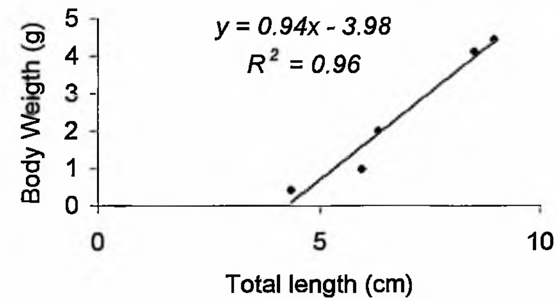


Fig. 22. Regression of Body Weight on Total length for 200kg/ha treatment for the first 90 days of culture

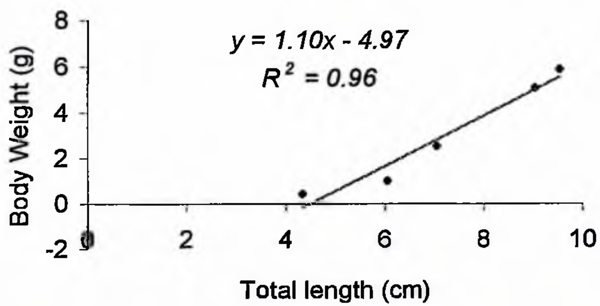


Fig. 23. Regression of Body Weight on Total lengrh for 300kg/ha for the first 90 days of culture

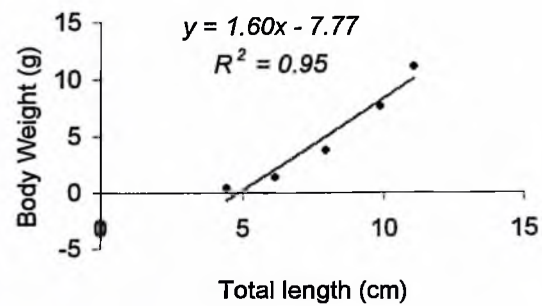


Fig. 24 Regression of Total length on Carapace length for 0kg/ha treatment for 180 days of culture

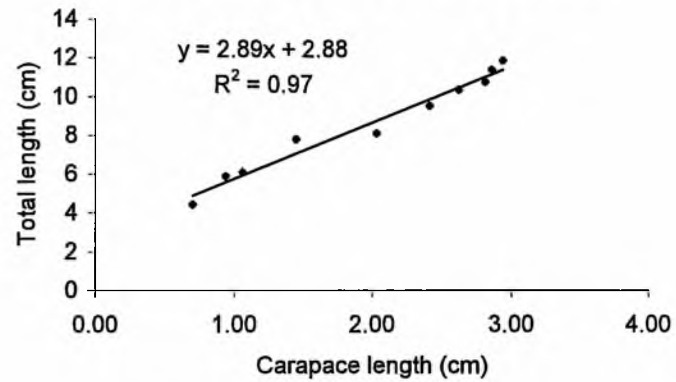


Fig. 25 Regression of Total length on Carapace length for 100kg/ha treatment for 180 days of culture

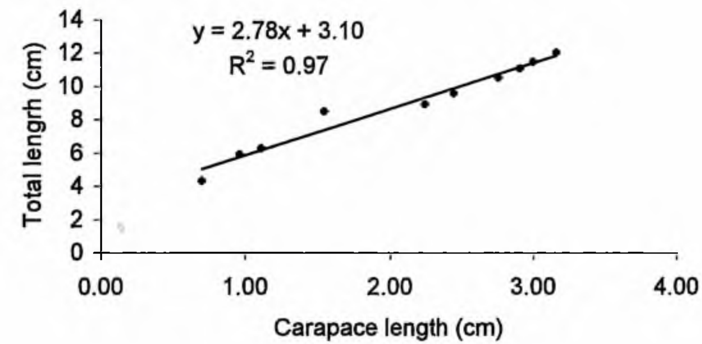


Fig. 26. Regression of Total length on Carapace length for 300kg/ha treatment for 180 days of culture

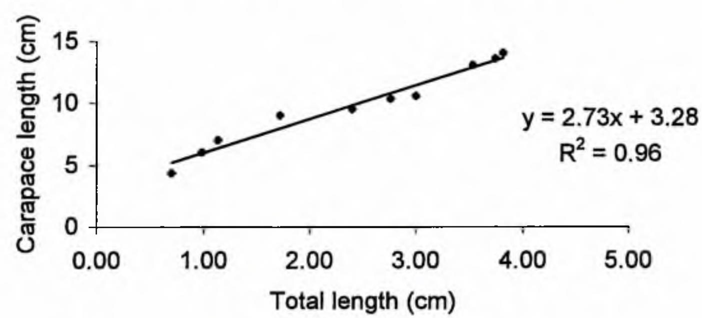


Fig. 27. Regression of Body Weight on Carapace length for 0kg/ha treatment for 180 days of culture

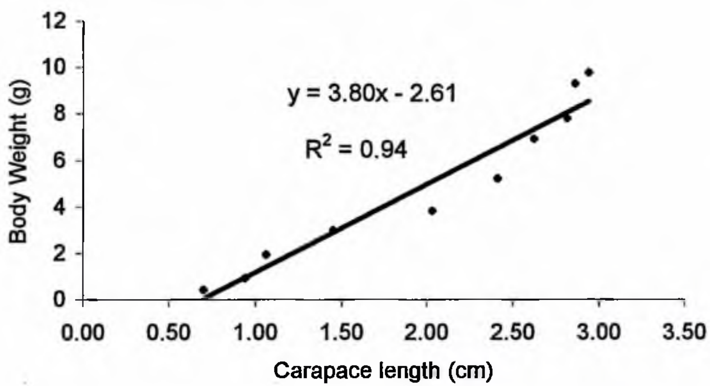


Fig. 28. Regression of Body Weight on Carapace length for 100kg/ha treatment for 180 days of culture

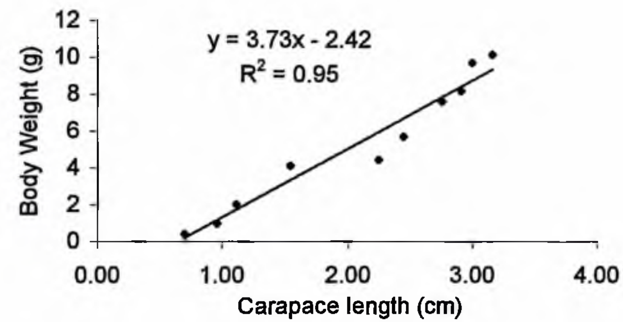


Fig. 29. Regression of Body Weight on Carapace length for 200kg/ha treatment for 180 days of culture

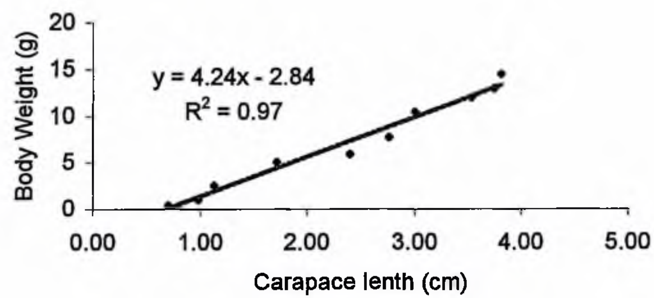


fig. 30 Regression of Body Weight on Total length for 0kg/ha treatment for 180 days of culture

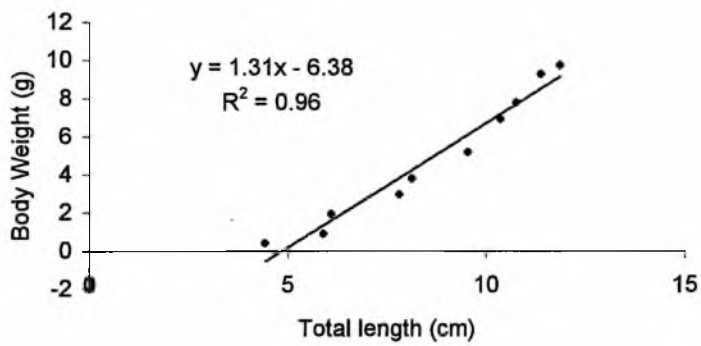


Fig. 31. Regression of Body Weight on Total length for 100kg/ha treatment for 180 days of culture

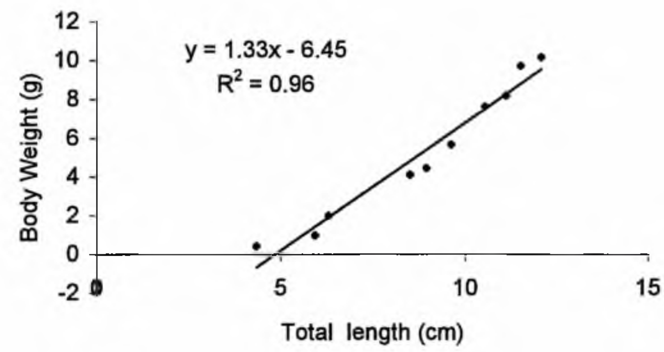
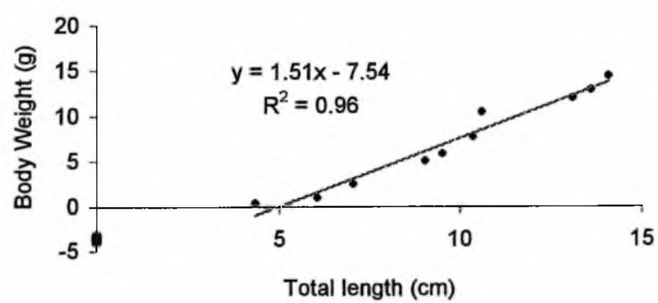


Fig. 32. Regression of Body Weight on Total length for 200kg.ha for 18 0 days of culture



CHAPTER 5.0. DISCUSSION.

Water quality parameters before stocking and through out the work were within the range reported by Boyd, 1984 and Chanratchakoo et al 1995. This showed that the treatments did not have any negative effect on water quality and on the growth of *P. notialis.* The heavy mortality of shrimps that occurred in the pond treated with 300 kg/ha manure after 90 days of culture could be attributed to the efficiency of chicken manure as source of nutrients (Appendix III), and the call for its judicious use for good results. This underscored the fact that misuse of manure could lead to devastating consequences. It is however believed that the 300 kg/ha chicken manure could be used effectively to achieve good growth of *P. notialis* with much more frequent flushing of the water rather than the average frequency of two weeks used in the current work; high water levels up to 1.0 – 1.2 metres rather than the average depth of 45cm used or by mechanically aerating the water in the pond.

The fact that plankton and other fish food organisms in the water play important role in aquaculture and that they are generally rich in essential nutrients (Pillay, 1993; Huet, 1994 and Nayer *et at.*, 1998) and are suitable in meeting the nutritional demands of culture organisms, (Nayer *et al.*, 1998; Wade and Stirling, 1999b), were attested to in this work. This was because no Vitamin or Mineral supplements were added to the supplementary feed given to the shrimp to attain the observed growth.

The differences in the recorded production values by the various treatments (Table 7) may be an indication of the extent of performance of the various treatments of the chicken manure in enhancing the biogenic capacity (the ability of aquaculture facility to generate natural productivity) of the various ponds. This was because fish production is closely linked to primary production. Measurement of fish production in fertilized ponds could therefore be used as indices for the potential of the pond to produce live food (Almazan and Boyd, 1978).

However in the words of Mortimer (1954), "for the fish farmer, the best index of the efficacy of fertilizer treatment is not the effect on plankton, benthos or rooted vegetation, but in the increase of fish crop over and above natural productivity". The fact therefore that there were differences in growth response, little though they may be, to the various treatments proved that varying amounts of live fish food were generated in the ponds that varied directly proportional to manuring rates. This is an answer to the objectives of this work, that is to say, there were differences in growth response of penaeid shrimp *P. notialis* in the ponds to varying manuring rates, and that the differences increased with increasing manuring rates, with 200 kg/ha being the best performer regarding the water quality parameters.

The work showed that chicken manure when well managed could be used in generation of live food in culture of shrimps and finfish without necessarily using food additives in supplementary feeds as indicated by Rappaport, 1977 (Appendix III). The current work contrasts favourably with the pioneering work of Dapaah (1998) in which about 14 g of body weights of *P. notialis* was achieved in 20 weeks, at the same site and facilities. The only difference in his work and the current one is that he used chemical fertilizers and fed the animals with the flesh of oysters (*Ostrea tulipa).*

The production at the end of 90 days in the controlled pond was 128.03 kg/ha; that from 100 kg/ha manure application was 138.00 kg/ha; 200 kg/ha gave 168.88 kg/ha and 300 kg/ha yielded 243.60 kg/ha. The yield of 300 kg/ha over the control-unfertilized pond was 115.57 kg/ha, but the yield of 300 kg/ha over the 200 kg/ha was only 74.72kg/ha, whilst the yield of 200 kg/ha over 100kg/ha was 29.98kg/ha and that of 100 kg/ha over the control was 10.87 kg/ha (Table 7). Similar trend could be seen at end of the 180 days of culture where the yield in 0 kg/ha, 100 kg/ha and 200 kg/ha treatments were 258.72kg/ha, 261.05kg/ha and 327.18kg/ha respectively (Table 7). Here the yield of 200 kg/ha over 0 kg/ha was 68.46kg whilst it was 66.13kg/ha over the 100kg/ha, and that of 100kg/ha over 0 kg/ha was 2.33kg. The observed trend can be compared with the work of Hickling (1962). This confirmed the fact that "When a single factor is limiting in the growth of a crop, the increase in the growth with each equal and successive addition of the growth factor is progressively smaller" (Tisdale and Nelson, 1959). This is a clear indication that merely increasing the fertilizer (growth factor) does not result in increased yield that would give proportionate revenue. Increasing the growth factor would rather lead to losses. This is because increasing the growth factor would increase the cost of production without the corresponding financial returns. As stated by Hepher (1958), fertilizers are valuable resources and should be used conservatively to provide good fishing rather than wasted in trying to achieve greater fish production with increasing amount. The result of the current work indicated that although there was progression in the growth with increasing manuring rate, the increment over successive addition of manure did not result in any attractive yield increment that could give good economic dividend. This observation gave credence to the research. That is, to determine the best manuring rate based on the growth pattern of the shrimp induced by the varying manuring rates. The need for the use of the required amount of manure to achieve good production of *P. notialis* is therefore paramount and this is what the current work was set to establish.

Mean values of results of productivity test conducted, Table 5, showed that natural productivity did not increase with increasing manuring rates. From the mean values; 2.85 mg/l for 0 kg/ha treatment, 3.53 mg/l for 100 kg/ha, 1.88 mg/l for 200 kg/ha and 1.45 mg/l for 300 kg/ha at the end of the work even showed that the highest value was observed in the 100 kg/ha treatment and decreased with increasing manuring rate. The observation is in line with the work of Govind *et al.* (1978); Dhawan and Kour (2002). The result of the productivity test also showed that although the net oxygen values (Table 5) was highest in the 100 kg/ha pond the oxygen taken in respiration (dark bottles) and gross oxygen fixed in photosynthesis were highest in the 200 kg/ha pond. This could be explained that the 200 kg/ha treatment generated and maintained the largest amount of plankton (live food).

The comparatively high production of the control, 0 kg/ha treatment, may be due to the fact that mud absorbs excess nutrients in ponds according to Hepher (1958); Kimel and Lind (1970) and Latterel *et al.* (1971). Sediments are therefore believed to be responsible for the abundant growth of phytoplankton in unfertilized ponds (Hepher (1966). This was confirmed by other reports that phosphate from sediments was responsible for phytoplankton growth during the period when dissolved phosphate was not adequate to support the observed rate of growth (Pomeroy *et al.*, 1956; Regotzkie and Pomeroy, 1957; Rytheer *et al.*, 1958). It was also indicated that mud was not only a source of good growth of planktonic algae in laboratory culture but also that the density of algae increased with increasing concentrations of phosphate in the mud (Golterman *et al.*, 1969; Chion and Boyd, 1974;).

Despite the fact that sediment seemed to be the reservoir for phosphate in unfertilized ponds, the amount of phosphate released in water of fertilized ponds were 4.5 to 5.5 times greater than that from the mud (Hepher, 1966). There is therefore the need to frequently add phosphorus to ponds to maintain high primary productivity.

The analysis of Variance pointed to the fact that fertilization is crucial in pond production of *P. notialis.* This was indicated by significant differences established by the analysis (Tables 8 to 11). The lack of significant differences indicated in Table 10 for Body weight, established the fact that harvesting of *P. notialis* within 90 days of growth using the treatments in this work is not profitable. Although there were significant differences in the blocking indicating growth with each successive samplings, the growth was however not significant. The analysis of Variance results also proved that the treatments were suitable for good growth since there were increases in growth with each successive day.

The gradient, "b" values in the Length-Weight relationship for the various treatments indicated that in the first 90 days of culture, the shrimps were not growing isometrically. The animals might have been diverting most of the food energy into skeletal development (frame) rather than increases in weight. This confirmed the result of the Variance analysis; while there were significant differences in Total length, there were no significant differences in Body weight for the first 90 days (Table 10). The regressional analysis indicated that for every unit growth of Total length, Body Weight increased only by 0.90units in the control, 0.94 in the 100kg/ha treatment pond, 1.10 in the 200kg/ha treatment pond and 1.6 in the 300kg/ha pond. An indication that the animals were growing faster in length than in weight for the first 90 days The isometric growth indicated by the values for "b" during the second phase of the 180 days of culture (from 91 – 180th day) is a true reflection of the results of the Variance analysis. This means that *P. notialis*, by the treatments in the current work needs more than 90 days of growth to register any appreciable corresponding growth in weight as compared to the growth in total length.

The results of the Weight – Length relationship and that of Variance analysis could suggest that during the first 90 days of growth, the *P. notialis* were diverting the food energy into building new tissues rather than increment in existing tissues. Increment in tissues might occur after 90 days of growth.

The R^2 values in both culture periods varied from 0.87 to 0.97 with the lower values from the 90 days of culture indicating high correlation for regressing Total length on Carapace length, Body weight on Carapace length and Body weight on Total length during both culture periods (Fig. 12 to 23 for 90 days of culture and Fig. 24 to 32 for 180 days of culture).

CHAPTER 6.0. CONCLUSION AND RECOMMENDATIONS

6.1. CONCLUSION

The method used in the application of manure proved to be effective in prompt growth of plankton that did not necessitate seeding of the water in the ponds. The manure treatments generally did not in any way affect water quality negatively. The pH, dissolved oxygen, secchi disc readings and other water quality parameters were within the acceptable range for such culture system. The high survival rates of the cultured animals recorded throughout the period also indicated the positive impact of the treatments on the growth environment.

The net dissolved oxygen did not increase with manuring rate. Secchi disc readings however indicated that the amount of plankton increased with increasing manuring rate. This was further illustrated by the productivity test in which the 200 kg/ha manure treatment registered the highest amount of respiratory oxygen (dark bottle) and the oxygen fixed in photosynthesis (light bottle). This was not however true for the 300 kg/ha manure treatment, a situation that could be attributed to some other factors, perhaps lower water volume and longer period of water flushing adopted in the current work, which might have resulted in substantial death of plankton culminating in the deficiency of the dissolved oxygen and the observed heavy mortality rate after the 90 days culture.

The fact that fertilization is crucial in enhancing the growth of shrimps was indicated by the significant differences established by the analysis variance in growth of the shrimps in the control (0 kg/ha manure) pond compared with others. The precipitation observed suggested the importance of the use of lime to get ride of excessive organic matter in the ponds. The varying colouration in the ponds could testify to the fact that phytoplankton shows varying colours and degrees of a particular colour not only at different weathers but also during different times of the day. This might indicate the type of phytoplankton that formed the majority at the time in question.

Growth of *P. notialis* during both culture periods increased with increasing manuring rate. The highest growth rate and production, at the end of 90 days of culture, were observed in the pond treated with 300 kg/ha manure and the lowest in the 0 kg/ha manure treatment (control) pond; the total length to body weight ratio was 2:1 in 0 kg/ha, 100 kg/ha and 200 kg/ha manure treatments as compared to 1:1 in the 300 kg/ha manure treatment.

At the end of the 180 days of culture that comprised of 0 kg/ha, 100 kg/ha and 200 kg/ha treatments, the highest growth rate and production were observed in the 200 kg/ha treatment. The Length – Weight analysis of the cultured shrimps showed that isometric growth generally occurred after 90 days of growth.

The result of the current work indicated that although there was progression in the growth with increasing manuring rate, the increment over successive addition of manure did not result in any attractive yield increment. The need for the use of the required amount of manure to achieve good production of *P. notialis* devoid of waste was therefore established.

The best manuring rate of chicken manure to obtain fast growth was 200 kg/ha without considerable problem with water quality. For the fact that the highest growth was observed in 300 kg/ha manure treatment pond for the first 90 days, its use for a longer period would require much more attention to water quality and perhaps higher water levels (volume) with more frequent and regular water flushing to achieve the desired growth of shrimps. The use of 100 kg/ha of chicken droppings however would require much more use of supplementary feed to achieve fast growth. The decision, nonetheless, on the manuring rate of chicken manure should be governed by the pond history and the set production target.

P. notialis could reach marketable size after five to six months of growth. The first three months would be used for tissue building (skeletal development). The animal would therefore not be ready for harvesting for food in the first three months of growth.

Perhaps, the significance of this work lies in the fact that researchers all over the world are busy trying to find alternative ways of making sufficient amount of live fish food available to aquaculture animals to replace the use of Brine shrimp (*Artemia salina*), which received world wide acceptance but quite expensive especially to our present economy. Elsewhere, the alternative live food " the green water" is cultured separately and fed to the animals, this is to ensure good water quality in the grow out ponds. The current work therefore indicated that farmed shrimps could be produced in Ghana without much complexities and high production cost in five to six months.

6.2. RECOMMENDATION

- There should be further work on manuring farmed shrimp ponds with chicken manure at closer rates of 100 kg/ha, 150 kg/ha, 200 kg/ha, 250 kg/ha and 300 kg/ha as furtherance of the current work.
- Work should also be directed into eradication of shrimp enemies/competitors; the crabs and finfish, which may not necessarily prey on the shrimps, but compete with the shrimps for the available resources thereby reducing the over all yield.
- Work on establishing hatchery production of *P. notialis* fingerlings would be essential for commercial production of the shrimps.
- Research into the breeding and grow out of *P. monodon* believed to be the fastest growing species would be steps in the right direction to boost farmed shrimp production in the country.
- The Government of Ghana could support researchers and farmers to venture into shrimp production that has a great potential for local and foreign markets.

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APPENDICES:

APPENDIX I. TIDAL BEHAVIOUR IN 2002

MONTH	Highest tide (m)			Lowest tide (m)		
	Day	Time	Height	Day	Time	Height
January	Thu 31.	1820	1.74	Wed. 30	1056	0.09
February	Thu. 28	1707	1.86	Thu. 28	1036	0.10
March	Fri. 29	1639	1.94	Fri. 1	1119	0.15
April	Fri. 26	0309	1.90	Sat. 27	2224	0.21
May	Sat. 25	1501	1.74	Sun. 26	2204	0.16
June	Mon. 10	1515	1.50	Mon. 24	2149	0.13
July	Mon. 15	0757	1.48	Thu. 11	2250	0.06
August	Sun. 11	0551	1.62	Fri. 9	1012	0.03
September	Mon.19	0520	1.81	Sat. 7	2210	0.11
October	Mon. 7	0407	1.97	Sun. 6	0936	0.24
November	Tue. 5	0337	1.99	Wed. 6	1038	0.23
December	Tue. 3	0234	1.85	Thu. 5	1022	0.20

Adopted from GPHA, (2002)

APPENDIX II. WATER QUALITY PARAMETERS.

Water Parameters for Successful Culture of *P. monodon*

Water Parameter	Optimum level	Comments
PH	7.5 to 8.5	Daily fluctuation < 0.5
Salinity	10 to 30 ppt	Daily fluctuation < 5 ppt
Dissolved oxygen	5 to 6 ppm	Not less than 4ppm
Alkalinity	> 80 ppm (as $CaCO_3$)	Dependent on pH fluctuation
Secchi disk reading	30 t0 40 cm	-------
H_2S	< 0.03	More toxic at low pH
Unionized Ammonia	< 0.1	More toxic at high pH and temperature

(After Chanratchakoo *et al.*, 1995;

Observations that may be made in Shrimp Cultured Pond

Stage of culture	Observation	Action
Early, < 60 days post stocking	Water transparency > 80 cm	Seed plankton, exchange water, Fertilise water 10 to 30 kg/ha, add limestone or dolomite 100 to 300 kg/ha
	pH < 7.5	Exchange water, add hydrated limestone , 50 to 100 kg/ha
	PH > 8.5	Exchange water, add limestone or dolomite, 100 to 300 kg/ha
	PH fluctuation	Exchange water, if > 0.5 add limestone or dolomite, 100 to 300 kg/ha
	Routine	Add limestone or dolomite, 100 to 300 kg/ha twice a week
Later > 60 days post stocking	Water transparency > 50 cm	Exchange water, add limestone or dolomite, 100 to 300kg/ha
	Bubbles on the surface	Exchange water, add limestone or dolomite, 100 to 300kg/ha
	PH < 7.5, or PH > 8.5	Exchange water, add limestone or dolomite, 100 to 300kg/ha
	PH fluctuation	Exchange water, if > 0.5 add limestone or dolomite, 100 to 300kg/ha
	Routine	Add limestone or dolomite, 100 t0 300 kg/ha once a week

After Chanratchakoo *et al.*, 1995; Boyd, 1984.

APENDIX III. QUALITIES OF CHICKEN DROPPINGS AS MANURE

Varying amount of *chironomid* larvae in mud of ponds receiving different types of manures as compared with inorganic fertilizers and control ponds.

Treatment	Phytoplankton (No./ml)	Chironomid larvae (No/m^2)
Chicken droppings	16,300	340
Liquid manure	5,600	82
Corral Manure	3,000	38
Chemical fertilizer	4,60	43
Control	2,500	59

(Rappaport *et al.*, 1977)

NUTRIENT CONTENT OF DROPPINGS OF SOME SELECTED ANIMALS

Manure source	DM (%)	N (%)	P (%)	K (%)	OM (%)	N:P ratio	C:N ratio
Chicken	60-70	3.8	1.9	1.8	41.0	2.0	9.0
Duck	80	2.2	1.1	1.2	39.0	1.9	10.0
Pig	73.0	2.8	1.4	1.2	29.0	2.1	13.0
Cattle	76	1.9	1.4	1.4	34.0	3.4	19.0

Source : adapted from Tacon (1987)

Appendix IV: In (Wt) and In (TL) data

Length and Body Weight Relationship for 90 days of culture

Treatment :- Kilogramme chicken droppings per hectare															
0kg/ha				100kg/ha				200kg/ha				300kg/ha			
TL	In TL	wt	In Wt	TL	In TL	Wt	In Wt	TL	In TL	Wt	In Wt	TL	In TL	Wt	In Wt
4.43	1.49	0.43	-0.84	4.43	1.49	0.43	-0.84	4.43	1.49	0.43	-0.84	4.43	1.49	0.43	-0.8
5.89	1.77	0.92	-0.08	5.93	1.78	0.98	-0.02	6.04	1.8	1	0	6.12	1.81	1.37	0.31
6.08	1.8	1.96	0.67	6.63	1.84	2.02	0.7	7.03	1.95	2.53	0.85	7.91	2.07	3.79	1.33
7.79	2.05	3	1.1	8.49	2.14	4.13	1.42	9.03	2.2	5.06	1.62	9.88	2.29	7.65	2.03
8.11	2.09	3.83	1.34	8.93	2.19	4.45	1.49	9.52	2.25	5.88	1.77	11.1	2.41	11.1	2.41

Total Length and Body Weight Relationship for 180 days of culture.

Treatment :- Kilogramme chicken droppings per hectare											
0kg/ha				100kg/ha				200kg/ha			
TL	In TL	wt	In Wt	TL	In TL	Wt	In Wt	TL	In TL	Wt	In Wt
4.43	1.49	0.43	-0.84	4.43	1.49	0.43	-0.84	4.43	1.49	0.43	-0.84
5.89	1.77	0.92	-0.08	5.93	1.78	0.98	-0.02	6.04	1.80	1.00	0.00
6.08	1.80	1.96	0.67	6.63	1.84	2.02	0.70	7.03	1.95	2.53	0.85
7.79	2.05	3.00	1.10	8.49	2.14	4.13	1.42	9.03	2.20	5.06	1.62
8.11	2.09	3.83	1.34	8.93	2.19	4.45	1.49	9.52	2.25	5.88	1.77
9.93	2.25	5.23	1.65	9.60	2.26	5.69	1.74	10.35	2.34	7.73	2.05
10.35	2.34	6.94	1.85	10.51	2.35	7.62	2.03	10.59	2.36	10.45	2.35
10.75	2.37	7.81	2.06	11.09	2.41	8.19	2.10	13.09	2.57	11.99	2.48
11.38	2.43	9.31	2.23	11.49	2.44	9.71	2.27	13.6	2.61	12.91	2.56
11.86	2.47	9.78	2.28	12.04	2.49	10.16	2.32	14.08	2.64	14.43	2.69

Appendix V **RAW DATA**

APRIL 1, 2002, Data on juveniles stocked

Treatment: - Kilogramme chicken droppings per hector (kg/ha)

	(100kg/ha)			(200kg/ha)			(300kg/ha)			(0kg/ha)		
	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g
1	0.8	4.5	0.5	0.8	4.4	0.5	0.7	4.3	0.5	0.6	4.0	0.5
2	0.8	4.4	0.5	0.7	4.3	0.4	0.8	4.5	0.5	0.6	4.2	0.5
3	0.7	4.4	0.4	0.7	4.3	0.4	0.8	4.5	0.5	0.7	4.4	0.5
4	0.8	4.5	0.5	0.7	4.2	0.5	0.7	4.4	0.4	0.7	4.4	0.4
5	0.8	4.5	0.5	0.6	4.5	0.5	0.8	4.4	0.4	0.7	4.4	0.4
6	0.8	4.4	0.5	0.8	4.5	0.4	0.8	4.4	0.4	0.6	4.0	0.4
7	0.7	4.3	0.4	0.7	4.5	0.5	0.7	4.3	0.4	0.8	4.4	0.4
8	0.8	4.4	0.4	0.6	4.2	0.4	0.7	4.4	0.5	0.6	4.0	0.5
9	0.8	4.4	0.4	0.6	4.1	0.4	0.8	4.5	0.5	0.7	4.4	0.5
10	0.6	4.5	0.5	0.8	4.4	0.5	0.7	4.4	0.5	0.7	4.4	0.5
11	0.7	4.5	0.5	0.7	4.5	0.5	0.7	4.4	0.5	0.7	4.2	0.5
12	0.6	4.5	0.5	0.7	4.5	0.5	0.8	4.5	0.5	0.7	4.4	0.5
13	0.8	4.5	0.5	0.7	4.4	0.5	0.7	4.4	0.5	0.7	4.4	0.5
14	0.8	4.5	0.5	0.8	4.3	0.4	0.8	4.5	0.5	0.7	4.4	0.5
15	0.8	4.5	0.5	0.8	4.4	0.4	0.7	4.3	0.5	0.6	4.5	0.5
16	0.8	4.5	0.5	0.8	4.4	0.4	0.7	4.4	0.5	0.7	4.4	0.5
17	0.7	4.5	0.4	0.6	4.5	0.5	0.7	4.4	0.5	0.7	4.4	0.5
18	0.6	4.1	0.4	0.6	4.5	0.5	0.8	4.4	0.4	0.8	4.4	0.5
19	0.8	4.5	0.5	0.8	4.5	0.5	0.8	4.5	0.5	0.7	4.5	0.5
20	0.6	4.0	0.3	0.8	4.5	0.5	0.7	4.4	0.5	0.8	4.4	0.5
21	0.8	4.5	0.5	0.7	4.5	0.5	0.7	4.4	0.5	0.7	4.4	0.5
22	0.8	4.4	0.4	0.7	4.5	0.5	0.7	4.3	0.4	0.6	4.0	0.5
23	0.7	4.4	0.4	0.7	4.4	0.4	0.6	4.4	0.4	0.6	4.3	0.5
24	0.6	4.0	0.5	0.7	4.4	0.4	0.7	4.4	0.4	0.7	4.5	0.5
25	0.7	4.3	0.4	0.7	4.5	0.5	0.8	4.4	0.5	0.8	4.5	0.5
26	0.6	4.4	0.4	0.6	4.5	0.5	0.7	4.3	0.5	0.7	4.5	0.5
27	0.6	4.1	0.3	0.7	4.1	0.4	0.7	4.3	0.5	0.7	4.2	0.5
28	0.6	4.2	0.4	0.7	4.5	0.5	0.8	4.4	0.5	0.8	4.4	0.5
29	0.8	4.4	0.4	0.6	4.0	0.3	0.7	4.5	0.5	0.8	4.4	0.4
29	0.6	4.0	0.4	0.8	4.5	0.5	0.7	4.4	0.4	0.7	4.4	0.5
30	0.6	4.0	0.5	0.8	4.5	0.5	0.7	4.4	0.4	0.8	4.5	0.5
31	0.6	4.0	0.3	0.7	4.5	0.5	0.7	4.4	0.4	0.8	4.5	0.5
32	0.7	4.5	0.4	0.6	4.1	0.5	0.7	4.4	0.5	0.8	4.5	0.4
33	0.6	4.0	0.3	0.6	4.0	0.3	0.4	4.4	0.5	0.8	4.5	0.4
34	0.6	4.0	0.4	0.6	4.1	0.4	0.7	4.4	0.5	0.7	4.4	0.4
35	0.7	4.4	0.4	0.7	4.0	0.4	0.7	4.5	0.5	0.6	4.0	0.3
36	0.7	4.4	0.4	0.7	4.2	0.4	0.7	4.4	0.4	0.7	4.4	0.5
37	0.8	4.3	0.4	0.7	4.3	0.4	0.7	4.4	0.4	0.7	4.4	0.5
39	0.7	4.5	0.5	0.7	4.5	0.5	0.7	4.4	0.4	0.7	4.3	0.4
38	0.6	4.5	0.5	0.7	4.4	0.4	0.6	4.0	0.5	0.7	4.4	0.4
39	0.7	4.5	0.5	0.7	4.5	0.4	0.7	4.3	0.4	0.7	4.3	0.4
40	0.7	4.5	0.5	0.7	4.5	0.4	0.7	4.3	0.4	0.7	4.5	0.4
41	0.7	4.5	0.5	0.7	4.5	0.5	0.6	4.0	0.4	0.7	4.5	0.4
42	0.6	4.1	0.5	0.7	4.4	0.3	0.7	4.4	0.4	0.7	4.5	0.5
43	0.7	4.4	0.5	0.7	4.4	0.5	0.6	4.1	0.4	0.7	4.3	0.5
44	0.7	4.4	0.5	0.7	4.4	0.4	0.6	4.0	0.3	0.8	4.5	0.5
45	0.8	4.3	0.5	0.7	4.2	0.4	0.7	4.4	0.5	0.7	4.2	0.5
46	0.7	4.3	0.4	0.7	4.2	0.5	0.6	4.0	0.4	0.7	4.4	0.5
47	0.6	4.1	0.4	0.7	4.1	0.4	0.7	4.1	0.5	0.6	4.1	0.4
48	0.6	4.5	0.5	0.7	4.0	0.4	0.6	4.3	0.4	0.6	4.0	0.3
49	0.6	4.1	0.3	0.6	4.1	0.4	0.6	4.0	0.3	0.6	4.0	0.3
50	0.7	4.2	0.5	0.6	4.0	0.4	0.6	4.0	0.4	0.7	4.2	0.5
Ave	0.70	4.34	0.43	0.70	4.34	0.43	0.70	4.34	0.43	0.70	4.34	0.43

Sampling on 22 April, 2002, 23 days from the of stocking

Treatment: - Kilogramme chicken droppings per hector (kg/ha)

	(100kg/ha)			(200kg/ha)			(300kg/ha)			(0kg/ha)		
	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g
1	1.0	5.6	0.6	1.0	5.8	1.0	1.0	6.1	1.3	0.8	6.0	1.0
2	1.0	5.6	0.9	1.0	6.0	0.9	1.0	6.2	1.3	0.9	6.0	1.0
3	0.9	5.8	1.0	1.0	6.2	1.0	1.0	6.1	1.2	1.0	6.0	1.0
4	1.0	5.8	1.1	1.1	6.2	1.0	1.0	6.1	1.4	1.0	6.1	1.0
5	0.9	6.0	0.9	1.0	6.2	0.9	1.0	5.8	1.1	1.0	5.6	1.0
6	1.0	6.0	1.1	0.9	6.7	0.8	1.0	5.7	1.4	1.0	5.7	1.0
7	1.0	6.0	1.0	0.9	6.0	0.9	1.0	5.9	1.3	1.0	5.6	1.0
8	1.0	6.0	1.0	1.0	5.9	1.0	1.0	6.0	1.5	1.0	5.8	1.0
9	1.0	5.8	0.6	1.0	6.0	1.0	1.0	6.0	1.3	1.0	5.9	1.0
10	1.0	5.7	1.0	1.0	6.0	1.0	1.0	6.2	1.2	1.0	6.1	1.0
11	1.0	5.6	1.0	1.0	6.0	1.0	1.0	6.3	1.4	1.0	5.7	1.0
12	1.0	6.0	1.1	0.9	6.0	1.0	1.0	6.1	1.4	1.0	6.0	0.9
13	1.0	6.0	1.0	1.0	6.0	1.0	1.0	6.1	1.3	1.0	6.0	1.0
14	1.0	6.0	1.0	1.0	6.0	1.0	1.0	6.2	1.3	0.9	5.8	1.0
15	1.0	5.7	1.0	1.0	6.2	1.0	1.0	6.2	1.4	0.9	6.1	1.0
16	1.0	6.0	0.8	1.0	6.0	1.0	1.0	6.4	1.6	0.8	6.0	1.0
17	0.9	6.2	1.0	1.0	6.0	1.0	1.9	6.4	1.3	1.0	6.0	0.9
18	1.0	6.0	0.9	1.0	6.0	1.0	0.9	6.3	1.4	0.8	5.6	0.9
19	0.9	6.0	0.9	0.9	6.0	1.0	1.1	6.2	1.5	1.0	6.1	1.0
20	1.0	5.8	1.1	1.0	6.0	1.0	1.1	6.1	1.2	1.0	6.0	1.0
21	1.0	6.0	1.9	1.0	6.0	1.0	1.0	6.2	1.4	1.0	6.0	0.7
22	0.9	6.0	1.0	1.0	6.0	1.0	1.0	6.1	1.3	1.0	6.0	0.8
23	1.0	6.0	1.0	1.0	5.8	1.0	1.0	6.0	1.4	1.0	6.1	0.9
24	1.0	6.0	1.0	1.0	6.0	0.9	1.0	6.5	1.4	1.0	5.6	1.0
25	1.0	6.0	1.0	1.0	6.0	1.0	1.0	6.1	1.4	1.0	5.6	0.5
26	1.0	5.9	1.0	0.9	6.3	1.0	1.0	6.1	1.4	1.0	6.0	0.7
27	1.0	6.0	1.0	1.0	6.0	1.0	1.0	6.5	1.4	0.9	5.7	0.8
28	1.0	6.0	1.0	1.0	6.1	0.9	0.9	6.2	1.5	1.0	6.0	0.8
29	1.0	6.2	1.0	1.0	6.0	0.9	1.0	6.1	1.6	0.9	6.0	0.6
29	1.0	5.6	0.9	1.0	6.0	0.9	1.0	6.2	1.6	1.0	6.0	0.7
30	1.0	6.0	0.9	1.0	6.0	1.0	1.0	6.2	1.6	0.8	6.0	0.8
31	1.0	6.0	0.9	1.0	6.1	1.1	1.0	6.3	1.6	0.8	5.7	0.8
32	1.0	5.7	0.9	1.0	5.8	1.0	1.0	6.4	1.6	0.9	6.0	1.0
33	0.9	6.0	0.9	1.0	6.3	1.0	0.9	6.0	1.4	1.0	6.0	1.0
34	1.0	6.0	0.9	0.9	6.2	1.0	0.9	5.8	1.3	1.0	5.7	0.8
35	1.0	6.0	1.0	0.9	6.0	1.0	1.0	5.7	1.3	0.8	6.0	0.9
36	0.9	5.7	1.0	0.9	5.7	1.0	1.0	5.8	1.4	1.0	6.0	1.0
37	0.9	6.0	0.9	1.0	5.7	1.0	1.0	6.1	1.4	0.8	6.0	1.0
39	1.0	6.0	1.0	1.0	6.0	1.1	1.0	6.1	1.4	1.0	6.0	1.0
38	1.0	6.0	1.0	0.9	6.0	1.1	1.0	6.0	1.4	1.0	6.0	1.0
39	0.8	6.2	1.0	0.9	5.9	1.0	0.9	6.0	1.4	1.0	6.0	1.0
40	1.0	6.0	1.0	1.0	5.9	1.0	1.0	6.1	1.4	0.9	6.0	1.0
41	0.8	5.8	1.0	1.0	6.0	1.0	1.0	6.0	1.4	1.0	5.6	1.0
42	0.9	5.8	1.0	1.0	6.0	1.0	1.0	6.1	1.3	1.0	5.6	1.0
43	1.0	6.0	0.8	1.0	6.0	1.0	1.0	6.1	1.4	1.0	6.0	1.0
44	0.9	6.0	1.9	1.0	6.2	1.1	1.0	6.0	1.4	0.9	5.7	0.8
45	0.9	6.0	1.0	1.0	6.2	1.1	1.0	6.0	1.4	0.9	5.6	1.0
46	0.9	6.0	0.9	1.0	6.3	1.1	1.0	6.3	1.3	0.8	6.0	1.0
47	0.9	6.0	0.9	1.0	6.2	1.1	1.0	6.4	1.4	0.9	5.7	0.8
48	0.9	6.0	0.9	1.0	6.2	1.1	1.0	6.4	1.4	0.9	5.7	0.9
49	0.9	6.0	0.8	1.0	6.2	1.1	1.0	6.0	1.3	0.9	6.0	0.9
50	0.9	6.0	0.8	1.0	6.0	1.0	1.0	6.1	1.4	0.9	6.0	0.9
Ave	0.96	5.93	0.98	0.98	6.04	1.00	1.01	6.12	1.39	0.94	5.89	0.92

Sampling on May, 13 2002, 42 days from stocking

Treatment: - Kilogramme chicken droppings per hector (kg/ha)

	(100kg/ha)			(200kg/ha)			(300kg/ha)			(0kg/ha)		
	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g
1	1.0	6.4	2.0	1.3	6.7	2.1	1.2	7.6	3.4	1.1	6.1	1.9
2	1.0	6.3	2.0	1.1	7.1	2.4	1.2	7.9	4.2	1.1	6.0	1.9
3	1.0	6.4	2.0	1.1	7.2	2.3	1.3	7.9	3.6	1.1	6.1	1.7
4	1.2	6.2	2.0	1.2	7.3	2.3	1.3	7.5	3.7	1.1	6.1	1.7
5	1.2	6.1	2.0	1.1	6.6	2.7	1.3	7.5	3.5	1.1	6.1	1.8
6	1.0	6.3	1.9	1.1	6.8	2.7	1.3	7.6	3.7	1.1	6.2	2.0
7	1.3	6.0	2.0	1.1	6.7	2.5	1.4	7.8	3.6	1.1	6.2	2.0
8	1.0	6.0	2.1	1.0	7.0	2.5	1.1	7.9	3.5	1.1	6.4	1.9
9	1.2	6.0	1.8	1.0	7.0	2.8	1.1	7.9	3.5	1.0	6.0	1.9
10	1.2	6.4	1.6	1.0	7.0	2.8	1.3	7.8	3.6	1.1	6.0	2.0
11	1.3	6.5	1.6	1.1	7.0	2.6	1.2	7.8	3.6	1.0	6.0	1.9
12	1.0	6.4	1.9	1.1	7.0	2.9	1.2	7.9	3.6	1.1	6.0	2.0
13	1.0	6.5	1.5	1.1	7.0	2.8	1.3	7.8	3.6	1.0	6.0	2.0
14	1.0	6.5	1.8	1.0	6.6	2.4	1.2	7.9	3.6	1.1	6.2	2.1
15	1.0	6.3	2.0	1.0	7.2	2.7	1.3	8.1	3.6	1.1	6.2	2.2
16	1.3	6.4	2.0	1.0	7.2	2.7	1.2	8.2	3.8	1.1	6.1	1.8
17	1.4	6.0	2.0	1.0	7.1	2.9	1.3	7.9	3.7	1.0	6.16	1.9
18	1.0	6.0	2.0	1.0	7.0	2.4	1.2	7.8	3.7	1.1	6.0	2.4
19	1.0	6.5	1.8	1.0	7.0	2.3	1.3	8.1	4.3	1.1	6.4	2.0
20	1.0	6.5	2.0	1.0	7.2	2.2	1.2	8.2	3.7	1.1	6.4	2.0
21	1.3	6.4	2.1	1.0	7.4	2.5	1.3	8.0	3.7	1.1	6.3	2.1
22	1.4	6.0	2.3	1.0	7.3	2.6	1.4	8.0	3.6	1.1	6.0	2.0
23	1.3	6.5	2.1	1.0	7.0	2.4	1.2	8.0	3.6	1.1	6.0	1.8
24	1.3	6.0	2.0	1.0	7.0	2.3	1.3	8.2	3.8	1.0	6.0	1.8
25	1.0	6.0	1.9	1.2	7.0	2.3	1.2	7.8	3.6	1.1	6.0	2.0
26	1.2	6.0	2.0	1.0	7.0	2.3	1.4	7.8	3.7	1.1	6.0	2.0
27	1.0	6.5	2.0	1.0	7.0	2.4	1.3	7.5	3.8	1.1	6.0	2.1
28	1.2	6.5	2.0	1.0	7.0	2.5	1.3	7.5	3.7	1.1	6.0	1.8
29	1.0	6.5	2.0	1.0	7.0	2.6	1.2	7.4	3.6	1.1	6.0	1.8
29	1.0	6.3	2.2	1.1	7.0	2.7	1.4	7.6	3.7	1.1	6.0	2.0
30	1.3	6.4	2.2	1.2	7.2	2.4	1.2	8.1	3.8	1.1	6.0	2.1
31	1.0	6.0	2.2	1.5	7.0	2.8	1.1	8.1	3.8	1.0	6.0	2.1
32	1.0	6.2	2.2	1.2	7.0	2.4	1.1	8.2	3.6	1.0	6.0	2.0
33	1.1	6.0	2.0	1.2	7.0	2.8	1.1	8.0	3.6	1.0	6.0	2.1
34	1.0	6.0	2.0	1.2	7.5	2.4	1.0	8.2	3.8	1.0	6.0	2.1
35	1.3	6.0	2.0	1.0	7.0	2.4	1.0	8.1	3.8	1.0	6.1	2.0
36	1.2	6.5	2.2	1.2	7.2	2.2	1.2	8.0	3.8	1.0	5.7	2.0
37	1.2	6.4	2.0	1.2	7.0	2.4	1.1	8.1	3.7	1.0	5.7	2.1
39	1.3	6.3	2.0	1.2	7.0	2.4	1.1	8.0	3.8	1.0	5.7	2.1
38	1.0	6.4	1.9	1.2	7.0	2.4	1.0	8.0	4.2	1.0	5.8	2.1
39	1.0	6.4	2.0	1.3	7.0	2.5	1.0	8.0	4.4	1.0	6.0	2.1
40	1.2	6.4	2.0	1.3	7.1	2.6	1.0	8.1	4.4	1.0	6.0	2.0
41	1.2	6.0	2.0	1.1	7.0	2.4	1.0	8.2	4.5	1.0	6.1	2.0
42	1.0	6.6	2.0	1.3	7.0	2.4	1.0	8.1	4.6	1.0	5.9	1.9
43	1.0	6.7	2.0	1.2	7.0	2.9	1.0	7.9	4.2	1.0	6.0	1.9
44	1.0	6.4	2.0	1.3	7.2	2.8	1.1	7.9	3.6	1.1	6.0	1.8
45	1.0	6.4	2.2	1.1	7.0	2.8	1.1	7.8	3.6	1.1	6.4	1.9
46	1.0	6.3	2.3	1.2	7.0	2.9	1.2	7.7	3.5	1.1	6.4	1.8
47	1.0	6.2	2.3	1.3	7.0	2.8	1.0	8.0	3.5	1.1	6.4	1.6
48	1.3	6.6	2.2	1.2	7.0	2.3	1.0	8.0	4.1	1.1	6.4	1.8
49	1.0	6.4	2.2	1.2	6.9	2.4	1.0	8.0	4.1	1.0	6.4	1.8
50	1.0	6.5	2.3	1.3	6.8	2.5	1.0	8.1	4.3	1.0	6.4	1.8
Ave	1.11	6.30	2.02	1.13	7.03	2.53	1.18	7.91	3.79	1.06	6.08	1.95

Sampling on June 3, 2002, 63 days from stocking

Treatment: - Kilogramme chicken droppings per hector (kg/ha)

	(100kg/ha)			(200kg/ha)			(300kg/ha)			(0kg/ha)		
	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g
1	1.4	9.0	4.0	1.4	8.5	5.0	1.7	9.9	7.8	1.5	7.5	3.0
2	1.4	8.5	3.8	1.5	9.4	5.0	1.8	9.9	7.8	1.4	7.5	2.0
3	1.6	9.0	4.1	1.5	9.1	4.9	1.8	9.7	7.8	1.3	8.0	2.4
4	1.5	8.4	3.7	1.7	9.2	5.2	1.6	9.5	7.2	1.3	7.5	2.8
5	1.4	8.5	3.4	1.8	9.0	5.0	1.7	9.7	7.2	1.3	8.5	4.2
6	1.5	9.0	4.2	1.7	9.0	5.0	1.8	9.7	7.8	1.5	8.2	3.5
7	1.6	9.0	3.8	1.8	9.3	5.0	1.7	9.8	7.9	1.4	7.8	3.0
8	1.8	8.5	4.0	1.8	9.2	4.8	1.8	9.7	7.9	1.5	8.6	4.0
9	1.6	8.5	3.7	1.6	9.2	5.2	1.7	9.7	7.8	1.3	8.0	3.4
10	1.6	9.0	4.4	1.5	9.2	5.0	1.6	9.8	7.8	1.4	8.0	2.7
11	1.8	8.5	3.2	1.7	9.2	5.0	1.6	9.9	7.8	1.3	7.5	2.6
12	1.5	9.1	3.3	1.9	9.5	5.4	1.7	9.7	7.6	1.3	7.5	2.7
13	1.3	8.5	3.7	1.6	9.1	4.5	1.8	9.9	7.4	1.2	8.0	3.0
14	1.7	8.5	4.8	1.7	9.0	5.0	1.8	10.0	7.7	1.3	7.0	2.5
15	1.6	8.8	5.0	1.8	9.5	5.0	1.8	9.8	7.8	1.3	8.0	3.7
16	1.4	8.4	4.5	1.9	9.4	6.0	1.8	9.8	7.7	1.3	7.8	3.0
17	1.4	8.5	4.4	1.7	9.2	5.0	1.8	9.9	7.6	1.3	8.0	3.0
18	1.6	8.3	4.5	1.4	9.0	4.8	1.8	9.8	7.6	1.4	8.0	2.7
19	1.5	8.2	3.6	1.6	9.0	4.8	1.8	9.9	7.8	1.6	8.0	3.5
20	1.5	8.4	3.8	1.7	9.4	5.4	1.8	9.9	7.7	1.4	7.6	3.0
21	1.7	8.5	4.0	1.8	9.4	6.0	1.8	10.1	7.7	1.3	7.5	2.9
22	1.8	9.0	4.6	1.8	9.0	4.8	2.0	10.1	7.8	1.5	7.3	2.8
23	1.7	8.5	4.2	1.7	9.3	4.3	2.0	10.2	7.7	1.4	7.5	2.9
24	1.8	8.4	4.0	1.7	10.0	5.3	1.9	9.9	7.6	1.6	6.8	2.5
25	1.7	8.2	3.8	1.8	10.0	5.3	1.9	9.0	7.4	1.3	8.1	3.7
26	1.3	8.4	4.0	1.6	9.3	5.0	1.8	9.9	7.7	1.5	7.6	3.1
27	1.5	8.2	5.7	1.6	9.2	5.0	1.8	10.0	7.6	1.5	7.8	3.4
28	1.4	9.0	5.0	1.7	9.4	5.4	1.7	9.6	7.6	1.5	7.5	3.0
29	1.4	9.0	5.0	1.8	9.3	4.8	1.8	10.1	7.6	1.6	7.9	2.8
29	1.3	9.0	4.6	1.6	9.2	4.6	1.8	9.8	7.6	1.6	7.3	3.2
30	1.5	8.5	4.0	1.7	9.2	4.8	1.9	9.9	7.7	1.6	7.6	2.4
31	1.5	8.5	4.7	1.7	9.4	4.8	1.7	9.7	7.6	1.6	8.2	3.5
32	1.4	8.5	4.2	1.7	9.3	5.0	1.9	10.1	7.6	1.7	7.5	2.4
33	1.6	8.5	4.0	1.8	9.0	4.9	1.8	9.9	7.7	1.5	8.0	3.0
34	1.6	8.4	4.6	1.8	9.0	5.0	1.7	10.2	7.7	1.3	7.7	2.7
35	1.4	8.4	4.0	1.6	9.0	4.8	1.9	10.2	7.6	1.5	7.6	2.4
36	1.5	8.4	4.0	1.8	9.0	4.8	1.8	9.9	7.6	1.3	8.5	3.0
37	1.6	8.6	4.2	1.8	8.9	4.6	1.9	9.9	7.6	1.4	7.8	2.7
39	1.4	8.1	4.0	1.7	8.7	4.6	1.8	10.1	7.6	1.5	8.5	3.6
38	1.4	8.4	4.0	1.8	8.8	5.0	1.9	10.1	7.5	1.4	7.5	2.7
39	1.5	8.1	4.0	1.9	9.0	5.6	1.7	10.2	7.6	1.5	7.7	3.2
40	1.6	8.4	4.0	1.9	9.2	5.0	1.7	10.0	7.7	1.4	7.7	3.2
41	1.5	8.2	4.0	1.8	9.2	5.0	1.8	10.0	7.7	1.4	8.4	3.7
42	1.6	8.5	4.0	1.9	9.0	5.9	1.7	9.9	7.6	1.4	7.8	3.0
43	1.5	8.3	4.0	1.9	8.7	5.0	1.9	9.9	7.6	1.4	8.0	3.1
44	1.5	8.2	4.0	1.8	8.6	5.0	1.8	9.8	7.6	1.5	7.6	3.0
45	1.5	8.1	4.0	1.9	8.4	5.1	1.8	9.8	7.6	1.4	8.0	3.2
46	1.5	8.1	4.0	1.8	8.6	5.0	1.7	9.5	7.6	1.4	8.0	3.0
47	1.6	8.1	4.0	1.8	8.4	5.1	1.7	9.7	7.6	1.5	7.8	2.8
48	1.7	8.1	4.0	1.6	8.6	5.4	1.8	10.0	7.7	1.5	7.5	2.6
49	1.6	8.2	4.1	1.7	8.4	5.5	1.9	10.0	7.7	1.5	7.7	2.8
50	1.6	8.1	4.0	1.7	8.5	5.6	1.9	10.0	7.6	2.8	7.8	3.0
Ave	1.54	8.49	4.13	1.72	9.08	5.06	1.79	9.88	7.65	1.45	7.79	3.00

Sampling on June 24, 2002, 84 days from the day of stocking

	Treatment: - Kilogramme chicken droppings per hector (kg/ha)											
	(100kg/ha)			(200kg/ha)			(300kg/ha)			(0kg/ha)		
	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g
1	2.4	10.5	4.7	2.4	9.8	6.0	2.7	11.3	11.6	2.0	8.2	4.0
2	2.5	8.4	3.8	2.4	9.5	5.3	2.7	11.2	11.4	2.0	8.1	3.8
3	2.4	9.0	4.7	2.2	9.2	5.5	2.6	11.1	11,3	2.0	8.0	3.8
4	2.3	9.0	4.2	2.5	9.2	5.9	2.7	11.3	11.3	2.0	8.3	3.8
5	2.3	8.5	4.0	2.6	10.0	6.2	2.6	11.3	11.3	2.0	8.0	3.7
6	2.3	8.5	4.6	2.5	9.5	5.6	2.6	11.2	11.1	2.0	8.2	3.7
7	2.2	8.5	3.9	2.4	9.5	6.2	2.7	11.4	11.0	2.0	8.0	3.7
8	2.3	8.5	3.8	2.3	9.5	6.3	2.6	11.0	11.1	2.0	8.4	3.5
9	2.2	9.0	4.4	2.5	9.5	5.7	2.6	11.3	11.0	2.0	8.5	3.9
10	2.3	9.0	4.9	2.5	9.5	5.4	2.6	11.3	11.4	2.0	8.1	3.7
11	2.4	9.0	4.7	2.3	9.2	5.7	2.6	11.2	11.4	2.0	8.2	3.7
12	2.2	9.0	4.3	2.4	9.3	5.7	2.5	11.2	11.3	2.0	8.2	3.8
13	2.3	9.0	4.2	2.3	10.0	6.1	2.6	11.2	11.3	2.3	8.3	4.0
14	0.2	9.0	4.6	2.5	9.4	5.4	2.4	11.2	11.3	2.0	8.1	3.7
15	2.3	8.2	4.3	2.5	9.5	5.8	2.5	11.2	11.1	2.0	8.1	3.8
16	2.3	9.5	4.2	2.5	9.5	5.3	2.5	11.1	10.6	2.0	8.0	3.7
17	2.2	9.0	4.4	2.6	10.0	6	2.6	11.3	11.1	2.2	8.0	3.8
18	2.2	9.0	4.3	2.5	9.0	5.5	2.6	11.2	11.0	2.0	8.0	3.8
19	2.2	9.0	5.0	2.4	9.4	5.7	2.5	11.2	11.4	2.2	8.4	3.7
20	2.3	9.0	4.9	2.5	9.4	5.7	2.5	11.3	11.4	2.3	8.4	4.0
21	2.3	8.5	4.7	2.5	9.6	5.8	2.6	11.0	11.3	2.0	8.2	3.8
22	2.3	8.5	4.3	2.5	9.5	5.8	2.6	11.3	11.2	2.0	8.0	3.8
23	2.3	8.5	4.1	2.3	9.4	6.2	2.6	11.3	10.6	2.0	8.0	4.0
24	2.3	8.5	4.1	2.4	9.5	6.0	2.2	10.9	11.0	2.0	8.0	3.6
25	2.2	8.5	4.8	2.4	9.8	6.1	2.5	10.6	10.8	2.0	8.4	3.6
26	2.2	8.5	4.4	2.3	9.7	6.1	2.6	11.3	10.8	2.0	8.0	3.9
27	2.3	8.5	4.2	2.3	9.8	6.1	2.5	11.0	10.9	2.0	8.0	4.2
28	2.3	8.8	3.4	2.3	9.8	6.1	2.6	11.0	10.8	2.0	8.0	4.1
29	2.4	8.9	4.8	2.4	9.8	6.0	2.7	10.8	10.7	2.0	8.2	4.2
29	2.3	9.0	4.7	2.5	9.8	5.9	2.6	11.1	11.4	2.0	8.1	4.0
30	2.3	10.0	5.2	2.4	9.4	5.8	2.6	10.6	10.9	2.0	8.2	4.1
31	2.4	10.0	5.0	2.4	9.4	5.8	2.6	10.9	10.7	2.0	8.2	3.8
32	2.3	9.8	4.9	2.5	9.2	5.8	2.5	11.3	11.4	2.0	8.1	4.0
33	2.2	10.0	5.0	2.5	9.2	5.8	2.6	11.2	10.8	2.0	8.1	3.8
34	2.3	9.8	4.9	2.4	9.2	5.8	2.5	10.7	10.8	2.0	8.1	3.7
35	2.2	9.0	4.8	2.2	9.5	6.2	2.5	11.2	11.3	2.0	8.3	3.7
36	2.3	8.8	4.5	2.4	9.5	6.0	2.7	11.2	11.1	2.0	8.3	4.1
37	2.3	8.7	4.4	2.4	9.5	6.1	2.7	10.9	10.9	2.0	8.0	4.0
39	2.2	8.6	4.8	2.4	9.5	5.8	2.5	10.8	11.1	2.0	8.0	3.8
38	2.3	8.7	4.4	2.4	9.6	6.0	2.6	10.8	11.0	2.0	8.0	3.8
39	2.2	9.0	4.4	2.4	9.5	6.1	2.6	11.1	11.4	2.0	8.0	3.6
40	2.4	9.1	4.5	2.3	9.6	6.1	2.7	11.3	11.3	2.0	8.0	3.8
41	2.4	8.7	4.0	2.2	9.5	6.1	2.6	11.0	10.9	2.3	8.0	4.0
42	2.2	8.6	4.1	2.5	9.7	6.0	2.6	11.0	11.3	2.0	8.0	3.8
43	2.2	8.8	4.3	2.4	9.5	6.0	2.6	10.8	10.7	2.3	8.0	4.0
44	2.2	8.7	4.3	2.2	9.5	6.0	2.5	11.2	10.8	2.0	8.0	3.6
45	2.2	8.8	4.4	2.4	9.4	5.8	2.6	11.2	11.1	2.0	8.0	3.8
46	2.2	8.7	4.5	2.4	9.4	6.0	2.6	11.1	11.4	2.0	8.0	4.3
47	2.2	8.6	4.4	2.4	9.5	6.1	2.5	11.1	11.4	2.0	8.0	3.7
48	2.2	8.4	4.2	2.5	9.6	6.2	2.5	11.0	11.4	2.0	8.0	3.4
49	2.3	8.5	4.4	2.2	9.5	5.6	2.6	11.3	11.3	2.0	8.0	3.8
50	2.2	10.0	4.5	2.4	9.6	5.6	2.5	11.3	11.3	2.0	8.0	4.0
Avg	2.24	8.93	4.45	2.40	9.52	5.88	2.58	11.11	11.12	2.03	8.11	3.83

Sampling on July, 15 2002 105 days from the day of stocking

	Treatment :- Kilogramme chicken droppings per hector								
	(100kg/ha)			(200kg/ha)			(0kg/ha)		
	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/	Wt/g
1	2.5	10.5	5.4	2.5	10.0	7.7	2.2	10	5.0
2	2.5	10.5	6.6	3.0	10.5	7.7	2.3	10	5.1
3	2.4	9.5	6.0	3.0	10.1	7.6	2.3	9	5.1
4	2.5	9.5	5.7	3.0	11.0	7.8	2.5	10	5.7
5	2.5	9.0	5.4	3.0	10.4	7.8	2.5	10	5.9
6	2.5	9.5	5.6	3.0	10.4	7.6	2.3	9	4.7
7	2.5	9.5	5.9	3.0	10.2	7.6	2.5	10	5.2
8	2.5	9.5	5.8	3.0	10.7	7.7	2.5	9	5.0
9	2.4	10.0	5.9	3.0	10.8	7.6	3.3	9	5.0
10	2.4	9.5	5.6	3.0	10.1	7.7	2.4	10	5.1
11	2.5	10.0	5.7	3.0	10.2	7.7	2.4	10	5.1
12	2.5	10.5	5.7	3.0	11.0	8.2	2.4	10	5.2
13	2.5	9.6	5.6	2.8	10.3	7.8	2.2	10	5.4
14	2.5	9.5	5.3	2.7	10.5	7.8	2.2	10	5.3
15	2.5	9.7	5.3	2.7	10.5	8.1	2.4	10	5.5
16	2.5	10.0	6.2	2.6	10.0	7.7	2.5	10	5.6
17	2.5	9.8	5.8	3.0	11.0	7.8	2.2	10	5.0
18	2.6	9.5	5.2	3.6	10.5	7.6	2.5	10	5.0
19	2.7	9.6	5.6	2.6	10.5	7.7	2.4	10	5.0
20	2.5	9.5	5.4	2.6	10.5	7.7	2.4	9	5.0
21	2.4	9.5	6.7	2.5	10.3	7.8	2.3	9	5.2
22	2.6	9.4	6.5	2.4	10.2	7.8	2.4	10	5.1
23	2.7	9.5	5.7	2.5	10.0	8.1	2.5	10	5.2
24	2.3	9.4	5.3	2.5	10.0	8.5	2.4	10	5.1
25	2.5	10.0	6.0	2.6	10.0	7.7	2.5	10	5.2
26	2.4	9.6	5.8	2.7	10.4	7.7	2.4	10	5.0
27	2.4	9.5	5.4	2.8	10.5	7.7	2.3	9	5.4
28	2.2	10.1	5.9	2.8	10.0	7.8	2.4	10	5.3
29	2.3	10.0	5.8	2.6	10.2	7.8	2.5	10	5.1
30	2.4	9.5	5.6	2.7	10.4	7.8	2.4	10	5.1
31	2.4	9.5	5.6	2.7	10.8	7.7	2.4	10	5.3
32	2.5	9.5	5.6	2.8	10.2	7.7	2.4	10	5.6
33	2.2	9.5	5.7	2.8	10.2	7.7	2.5	9	5.3
34	2.4	9.4	5.6	2.8	10.8	7.6	2.4	9	5.2
35	2.4	9.3	5.5	2.8	10.7	7.8	2.2	9	5.0
36	2.4	9.6	5.6	2.7	10.1	7.6	2.3	9	5.3
37	2.4	9.5	5.5	2.5	10.1	7.8	2.4	9	5.3
38	2.3	9.6	5.7	2.7	10.0	7.5	2.2	9	5.2
39	2.3	9.4	5.3	2.7	10.0	7.5	2.5	10	5.3
40	2.4	9.5	5.4	2.6	10.0	7.5	2.3	9	5.1
41	2.3	9.6	5.4	2.8	10.0	7.8	2.4	10	5.4
42	2.4	9.7	5.8	2.7	10.0	7.6	2.5	10	5.4
43	2.4	9.8	5.8	2.6	10.0	7.7	2.3	10	5.4
44	2.4	5.8	5.8	2.7	10.6	7.6	2.3	10	5.3
45	2.4	9.7	5.8	2.6	10.0	7.6	2.5	10	5.3
46	2.4	9.7	5.6	2.8	10.8	7.6	2.3	10	5.3
47	2.4	9.7	5.5	2.7	10.6	7.6	2.6	10	5.4
48	2.4	9.8	5.6	2.6	10.8	7.8	2.5	10	5.4
49	2.4	9.8	5.6	2.6	10.2	7.7	2.5	10	5.2
50	2.4	9.8	5.6	2.6	10.0	7.7	2.6	10	5.4
AVE.	2.44	9.60	5.69	2.76	10.35	7.73	2.41	10	5.23

Sampling on August 5, 126 days from the day of stocking

Treatment :- Kilogramme chicken droppings per hector

	(100kg/ha)			(200kg/ha)			(0kg/ha)		
	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g
1	2.6	10.8	7.6	3.1	13.0	12.0	2.5	10.7	7.5
2	2.6	10.8	7.7	3.0	12.2	9.7	2.6	10.9	7.7
3	2.7	10.4	6.5	2.9	12.4	10.0	2.6	11.0	7.0
4	3.8	10.2	7.6	3.2	12.6	10.2	2.8	10.2	6.8
5	2.8	11.0	7.0	3.1	13.0	10.0	2.7	10.1	6.8
6	2.8	10.2	6.6	2.9	12.9	10.3	2.8	10.8	7.2
7	2.8	10.4	7.0	3.1	12.9	10.7	2.6	10.8	7.0
8	2.8	10.0	7.6	3.1	12.9	11.0	2.7	10.3	7.2
9	2.5	10.9	8.3	3.0	13.0	12.0	2.5	10.1	6.8
10	2.7	10.7	8.3	3.1	12.5	10.6	2.6	10.4	7.3
11	2.6	10.3	7.4	2.9	12.2	10.0	2.3	11.0	7.3
12	2.8	10.8	6.4	2.9	12.1	9.5	2.6	11.0	7.5
13	2.7	11.0	6.4	2.8	12.2	9.4	2.5	11.1	7.2
14	2.8	10.1	7.5	3.0	12.6	10.4	2.6	10.2	7.0
15	2.8	10.2	7.5	2.9	12.8	10.4	2.6	10.1	6.5
16	2.6	10.4	7.5	2.9	12.2	9.9	2.6	10.7	7.3
17	2.6	10.0	7.8	2.8	12.6	10.1	2.5	10.7	7.2
18	2.7	10.0	7.8	2.9	12.5	10.3	2.4	11.0	7.0
19	2.8	10.2	8.0	3.1	12.3	10.2	2.6	10.2	6.8
20	2.7	10.1	8.2	3.1	12.8	11.0	2.6	10.3	6.7
21	2.5	10.1	8.0	3.1	12.5	10.1	2.7	10.2	6.6
22	2.7	10.0	8.4	3.1	13.1	12.0	2.7	10.2	6.8
23	2.6	10.2	8.4	3.1	13.0	11.4	2.6	10.7	7.2
24	2.6	10.1	7.6	3.1	13.0	11.0	2.6	10.1	6.4
25	2.7	10.6	7.6	3.0	12.3	9.8	2.6	10.0	6.7
26	2.8	10.8	7.8	3.0	12.8	11.0	2.6	10.0	6.8
27	2.7	10.4	7.8	2.8	12.8	12.0	2.5	10.0	6.6
28	2.8	10.6	7.6	3.1	12.6	12.0	2.7	10.0	6.6
29	2.8	11.1	7.2	3.0	12.5	11.0	2.6	10.0	6.8
30	2.7	10.5	7.2	3.0	12.3	10.6	2.6	10.2	6.6
31	2.6	10.1	7.5	3.0	12.3	10.2	2.8	10.0	6.5
32	2.7	10.3	7.8	3.0	12.3	10.2	2.7	10.1	6.8
33	2.7	10.4	7.5	3.0	13.0	11.1	2.8	10.0	6.4
34	2.8	10.2	7.6	3.0	12.7	10.0	2.7	10.5	7.2
35	2.8	10.4	7.7	3.0	12.7	10.0	2.6	10.5	7.3
36	2.8	10.8	7.8	3.0	12.5	10.0	2.6	10.6	7.4
37	2.7	10.8	7.9	3.0	12.7	10.0	2.8	10.4	7.5
38	2.8	10.4	7.8	3.0	12.6	10.0	2.7	10.0	7.0
39	2.7	10.6	7.8	3.0	12.4	10.0	2.6	10.0	6.4
40	2.6	10.8	7.8	3.0	12.3	10.0	2.6	10.0	6.6
41	2.8	10.4	8.0	3.0	12.5	10.4	2.5	10.0	6.4
42	2.8	10.5	7.4	3.0	12.1	9.6	2.5	10.0	6.4
43	2.9	10.2	7.5	3.0	12.4	10.0	2.6	10.1	7.1
44	2.8	11.0	7.9	3.0	12.5	10.2	2.7	10.1	6.4
45	2.8	11.0	7.7	3.0	12.3	10.0	2.6	10.0	6.4
46	2.8	11.0	8.0	3.0	12.4	10.0	2.6	10.0	6.4
47	2.8	11.0	7.9	3.0	12.8	10.4	2.6	10.0	6.6
48	2.8	10.7	7.8	3.0	12.8	10.4	2.7	10.8	7.8
49	2.8	11.0	7.6	2.9	13.0	10.8	2.7	10.6	7.7
50	2.8	11.0	7.9	3.0	12.5	10.4	2.6	10.8	7.7
AVE.	2.75	10.51	7.62	3.00	12.59	10.45	2.62	10.35	6.94

Sampling on August 26, 2000, 147 days from the day of stocking

	Treatment :- Kilogramme chicken droppings per hector								
	(100kg/ha)			(200kg/ha)			(0kg/ha)		
	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g
1	2.8	11.0	8.0	3.4	13.0	12.0	3.2	11.0	7.4
2	2.9	11.0	8.0	3.5	13.0	11.8	3.1	11.0	7.2
3	2.9	11.1	8.2	3.4	13.2	11.0	2.8	10.6	7.2
4	2.9	11.1	8.2	3.5	13.2	11.0	2.6	10.6	7.5
5	2.9	11.2	8.2	3.6	13.0	11.4	2.6	10.8	7.3
6	2.9	11.2	8.2	3.6	12.8	11.0	2.7	10.6	7.3
7	2.9	10.8	8.2	3.4	12.9	11.0	2.7	10.3	7.2
8	2.9	11.1	8	3.6	13.0	12.0	2.8	10.4	7.4
9	2.8	11.2	8.2	3.4	13.0	12.8	2.8	10.8	7.8
10	3.0	11.4	8.4	3.5	13.0	12.4	2.8	10.5	7.7
11	2.9	11.2	8.3	3.3	13.4	12.6	2.8	10.5	7.7
12	2.9	11.4	8.6	3.4	13.4	12.2	2.8	10.6	7.7
13	2.9	11.0	8.1	3.3	13.0	12.2	2.7	10.7	7.8
14	2.9	11.0	8.1	3.4	13.2	11.0	2.7	10.4	7.1
15	2.9	11.1	8.1	3.5	13.2	11.8	2.7	10.8	7.9
16	2.6	11.1	8.1	3.4	13.2	11.6	2.7	10.8	7.9
17	2.8	11.2	8.1	3.5	13.0	11.6	2.6	10.8	7.9
18	2.8	11.1	8.2	3.6	13.0	11.6	2.8	10.5	7.8
19	2.8	11.0	8.1	3.5	13.0	11.6	2.7	10.5	7.7
20	2.9	11.2	8.2	3.6	13.0	11.6	2.8	10.6	8.0
21	3.0	11.0	8.2	3.7	12.8	11.9	3.4	11.0	8.2
22	3.0	11.0	8.1	3.6	13.0	11.8	2.6	10.9	8.0
23	2.9	11.0	8.1	3.6	13.2	12.0	2.8	10.9	8.0
24	3.1	10.7	7.8	3.6	13.2	12.0	2.6	10.8	8.0
25	3.0	11.0	8.0	3.6	12.9	12.3	2.7	10.9	7.9
26	3.0	10.9	8.0	3.6	13.0	12.1	2.7	10.8	7.9
27	3.0	10.9	8.0	3.7	13.0	12.3	2.7	10.8	7.9
28	3.0	11.0	8.0	3.6	13.1	12.1	2.8	10.7	7.9
29	2.8	11.0	8.4	3.6	13.1	12.1	3.1	11.0	8.2
30	3.1	11.0	8.1	3.6	12.9	12.1	3.0	11.0	8.2
31	2.9	11.0	8.2	3.6	13.2	12.4	3.0	11.0	8.1
32	3.1	11.0	8.2	3.6	13.2	11.2	2.6	10.9	8.1
33	2.8	11.3	8.4	3.4	13.2	12.2	3.2	11.0	8.0
34	2.8	11.2	8.2	3.6	13.2	12.2	3.2	11.0	8.0
35	3.1	11.2	8.3	3.5	13.0	12.4	3.2	11.2	8.2
36	3.1	11.0	8.2	3.6	13.0	12.4	2.8	10.9	8.0
37	2.8	11.2	8.4	3.6	13.0	12.4	2.7	10.9	8.0
38	3.1	11.0	8.3	3.5	13.0	12.2	2.8	10.9	8.0
39	2.8	11.2	8.4	3.6	13.0	12.1	2.7	10.6	7.8
40	3.1	11.3	8.2	3.5	13.4	12.4	2.8	10.4	7.8
41	2.9	11.3	8.4	3.6	13.2	12.1	2.8	10.9	8.0
42	2.9	11.2	8.2	3.6	13.2	12.6	2.8	10.8	8.0
43	2.8	11.2	8.2	3.4	13.2	12.4	2.8	10.8	8.0
44	2.8	11.0	8.4	3.5	13.2	12.4	3.2	11.0	8.1
45	2.8	11.2	8.4	3.6	13.1	12.4	2.7	10.8	8.1
46	2.8	11.2	8.3	3.6	13.1	12.6	2.8	10.8	7.9
47	2.8	11.2	8.4	3.6	13.3	12.2	2.6	10.7	8.0
48	2.9	11.0	8.0	3.4	13.0	12.2	2.7	10.5	7.6
49	2.8	11.0	8.1	3.6	13.2	12.0	2.8	10.6	7.5
50	2.8	11.0	8.2	3.6	13.2	12.0	2.6	10.6	7.5
AVE.	2.90	11.09	8.19	3.53	13.09	11.99	2.81	10.76	7.81

Sampling on September 16, 2000, 168 days from the day of stocking

	Treatment :- Kilogramme chicken droppings per hector								
	(100kg/ha)			(200kg/ha)			(0kg/ha)		
	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g
1	3	11.8	9.5	3.8	13.6	12.6	2.8	11.5	9.4
2	3	11.8	9.8	3.7	13.8	12.3	2.8	11.5	9.5
3	3	11.8	9.9	3.8	14.1	13.5	2.9	11.0	9.3
4	3	11.4	9.8	3.8	13.7	12.6	2.9	11.6	9.6
5	3	11.4	9.6	3.6	13.7	12.8	2.8	11.4	9.7
6	3	11.4	10.1	3.7	13.8	13.6	3.1	11.2	9.2
7	3	11.5	9.6	3.8	13.9	12.6	3.1	11.3	9.4
8	3	11.7	8.9	3.8	13.8	13.6	3.1	11.3	9.3
9	3	11.7	9.3	3.6	13.6	12.4	2.8	11.3	9.4
10	3	11.6	9.5	3.8	13.7	12.6	2.9	11.3	9.3
11	3	11.5	9.8	3.7	13.6	12.6	3.0	11.2	9.3
12	3	11.3	9.2	3.7	13.6	13.6	3.0	11.2	9.4
13	3	11.5	8.9	3.8	13.1	13.4	3.0	11.2	9.5
14	3	11.4	9.7	3.7	13.4	14.2	3.6	11.3	9.4
15	3	11.5	9.9	3.7	13.6	12.8	3.0	11.3	9.2
16	2.9	11.5	9.8	3.4	13.4	13.3	3.8	11.4	9.3
17	3	11.5	9.8	3.4	13.8	13.2	2.7	11.3	9.2
18	3	11.3	10.0	3.7	13.6	13.5	2.7	11.3	9.2
19	3	11.3	9.7	3.8	13.5	13.2	3.1	11.0	9.1
20	2.8	11.6	9.8	3.4	13.5	12.6	3.1	11.0	9.3
21	3	11.5	9.8	3.8	13.6	12.6	3.1	11.0	9.4
22	3	11.2	9.8	3.7	13.5	12.6	2.8	11.5	9.6
23	3	11.3	9.9	3.7	13.3	12.5	2.6	11.5	9.6
24	3	11.6	9.8	3.8	13.2	12.4	2.6	11.8	9.5
25	3	11.7	9.7	3.7	13.2	12.4	2.6	11.5	9.7
26	3	11.7	9.8	3.8	13.2	12.4	2.5	11.4	9.6
27	3	11.8	9.7	3.6	13.8	12.4	2.6	11.3	9.6
28	3	11.6	9.8	3.8	13.6	12.3	2.7	11.3	9.5
29	3	11.5	9.8	3.8	13.6	12.8	2.8	11.4	9.5
30	3	11.6	9.8	3.7	13.6	12.9	2.7	11.3	9.5
31	3	11.4	9.8	3.8	13.6	13.2	2.8	11.3	9.4
32	3	11.6	9.8	3.8	14.1	12.8	2.8	11.3	9.6
33	3	11.7	9.8	3.8	13.6	12.8	2.8	11.1	9.2
34	3	11.5	9.8	3.8	13.6	12.6	2.7	11.3	9.5
35	3	11.5	10	3.8	13.6	12.8	2.8	11.4	9.6
36	3	11.4	9.6	3.8	13.7	12.9	2.8	11.2	9.4
37	3	11.4	9.6	3.8	13.8	12.7	2.7	11.0	9.2
38	3	11.5	9.8	3.8	13.6	12.9	2.8	11.0	9.2
39	3	11.5	10.1	3.8	13.6	13.7	2.8	11.0	9.4
40	3	11.5	9.6	3.7	13.6	14.2	2.9	11.0	9.2
41	3	11.7	9.7	3.8	13.5	13.2	2.7	11.0	9.3
42	3	11.4	9.6	3.8	13.6	12.7	2.8	11.0	9.4
43	3	11.2	9.5	3.7	13.6	12.8	2.7	10.9	9.5
44	3	11.2	9.8	3.8	13.6	12.6	2.8	10.8	9.4
45	3	11.6	9.6	3.8	13.6	12.8	2.7	19.8	9.3
46	3	11.4	9.6	3.8	13.5	12.9	2.8	10.9	9.3
47	3	11.6	9.6	3.8	13.6	12.8	2.8	11.0	9.4
48	3	11.6	9.9	3.9	13.6	13.4	2.8	11.0	9.3
49	3	11.6	9.8	3.8	13.5	12.6	2.8	10.8	9.2
50	2.8	11.5	9.8	3.8	13.5	12.7	2.8	10.8	9.4
AVE.	2.99	11.52	9.71	3.74	13.60	12.91	2.86	11.38	9.39

Sampling on October 7, 2000, 189 days from the day of stocking

Treatment :- Kilogramme chicken droppings per hector

	(100kg/ha)			(200kg/ha)			(0kg/ha)		
	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g	CL/cm	TL/cm	Wt/g
1	3.1	12.1	10.2	3.9	14.3	14.2	3.1	11.8	10.1
2	3.1	12.0	10.0	3.9	14.3	14.4	2.9	11.9	10
3	3.0	12.0	10.2	3.8	14.2	14.6	3.0	11.6	10
4	3.0	12.0	10.5	3.8	14.1	14.6	2.9	11.9	9.8
5	3.1	11.8	9.8	3.6	13.6	13.8	2.8	11.7	9.7
6	3.0	11.6	9.9	3.9	13.7	14.2	3.0	11.9	9.9
7	3.1	12.0	10.0	3.8	14.2	14.6	3.0	11.8	9.8
8	2.9	12.0	10.1	3.8	14.3	14.7	3.0	11.9	9.8
9	3.2	11.9	10.0	3.8	14.2	14.3	3.0	11.9	10
10	3.2	12.0	10.0	3.6	14.3	15.3	3.0	11.9	10
11	3.0	12.0	10.3	3.6	14.3	14.9	2.8	11.9	9.8
12	3.0	12.0	10.0	3.8	14.5	14.6	2.9	11.9	9.9
13	3.2	11.9	11.0	3.9	13.4	14.0	2.9	11.8	9.7
14	3.3	11.9	9.9	3.7	14.3	14.6	2.8	11.9	9.8
15	3.3	11.9	10.1	3.8	14.6	14.7	2.9	11.9	9.7
16	3.3	12.0	9.9	3.9	14.3	14.8	2.9	11.8	9.8
17	3.2	12.0	9.8	3.9	14.4	14.6	3.0	11.9	9.9
18	3.2	12.2	10.2	3.7	13.7	13.9	3.0	11.7	9.8
19	3.3	12.3	10.0	3.8	13.6	13.4	3.0	11.6	9.8
20	3.3	11.9	10.0	3.8	13.6	14.4	3.0	11.9	9.6
21	3.2	12.3	10.4	3.9	14.5	14.3	3.1	11.6	9.6
22	3.2	11.8	10.6	3.9	13.8	13.8	3.1	11.8	9.6
23	3.2	12.2	10.4	3.9	14.0	14.1	2.9	12.1	9.8
24	3.4	12.2	10.2	3.9	13.6	14.1	2.8	11.9	9.7
25	3.4	12.1	10.2	3.9	14.2	14.6	2.8	11.6	9.7
26	3.3	12.0	10.3	3.6	13.6	13.9	2.9	11.9	10.1
27	3.2	12.0	10.2	3.7	14.1	14.3	2.9	12.0	9.3
28	3.1	12.0	10.2	3.8	14.1	14.6	2.8	11.5	9.8
29	3.1	12.3	10.2	3.8	14.1	14.4	2.9	11.8	9.9
30	3.2	12.0	10.2	3.8	14.3	14.6	2.9	12.1	9.7
31	3.1	12.3	10.1	3.8	14.4	15.1	3.1	12.0	9.8
32	3.0	12.0	10.1	3.9	14.3	14.8	3.1	11.9	9.7
33	3.0	12.2	10.2	3.8	13.3	13.5	2.9	11.9	9.8
34	3.0	12.0	10.2	3.7	14.4	14.8	2.8	11.9	9.9
35	3.2	12.0	10.2	3.7	14.1	14.8	2.8	11.9	9.8
36	3.0	12.3	10.1	3.9	14.2	14.4	2.9	11.9	9.8
37	3.2	12.1	10.1	3.9	13.9	14.4	2.9	12.0	9.6
38	3.1	12.0	10.2	3.9	14.1	14.6	3.0	11.8	9.6
39	3.1	12.1	10.2	3.9	13.9	14.7	2.9	11.8	9.6
40	3.0	12.2	10.1	3.6	14.3	14.5	2.8	12.0	9.8
41	3.0	12.0	10.0	3.9	14.1	14.6	3.0	11.6	9.8
42	3.3	12.0	10.1	3.8	14.4	14.7	3.0	12.1	9.8
43	3.3	12.0	10.4	3.9	14.2	15.0	3.0	11.9	9.9
44	3.3	12.0	10.0	3.8	13.9	14.2	3.0	12.1	9.8
45	3.3	12.3	10.5	3.9	14.0	14.5	2.9	11.8	9.8
46	3.1	12.2	10.2	3.9	13.8	13.6	2.8	11.8	9.6
47	3.2	12.0	10.1	3.7	14.0	14.5	3.0	11.9	9.6
48	3.0	12.0	10.1	3.8	14.0	14.7	3.0	11.9	9.6
49	3.0	12.0	10.1	3.8	14.1	14.3	3.0	11.9	9.8
50	3.0	12.0	10.1	3.9	14.2	14.5	2.9	11.9	9.8
AVE.	3.15	12.04	10.16	3.81	14.08	14.43	2.94	11.86	9.78