Tropical Agricultural Research Vol. 15: 242-255 (2003)

# Effect of Chicken Manure and Cow Dung on Water Quality, Pond Productivity, and Growth and Survival of Goldfish (*Carassius auratus*) Fry

A.G.L.A.S. Kumara, U. Edirisinghe[1], C.M.B. Dematawewa[1]

Postgraduate Institute of Agriculture,
University of Peradeniya,
Peradeniya, Sri Lanka.

*ABSTRACT. Ornamental fish sector is a high income generating venture when economic return per fish is considered. In addition, successful fish culture depends upon eco-friendly and economically viable systems. This study was conducted to determine the effect of chicken manure and cow dung as pond manure on physico-chemical and biological parameters of water(Experiment I), and on the growth and survival of goldfish fry up to Day 60 (Experiment II). In experiment I, outdoor cement tanks ($1 m^2$) were fertilized with either chicken manure or cow dung at the rate of 1000 kg $ha^{-1}$ (dry weight basis), after mixing the respective manure with dolomite at 19:1 ratio. As physico-chemical parameters, temperature, pH, DO, BOD, secchi-disc visibility, $NO_3^-N$ and Water Soluble Phosphates were measured every fourth day. As biological parameters, phytoplankton and zooplankton densities were measured from random samples collected in two-day intervals. Both phytoplankton and zooplankton densities were significantly higher ($p<0.05$) in chicken manure treatment than in cow dung treatment and control (tanks without manure treatment). Manure dosages did not adversely affect any of the water quality parameters measured. In experiment II, goldfish fry were introduced to tanks 14 days after manuring at a stocking density of 50 fry $m^{-2}$. A separate set of fry was raised in tanks with a standard formulated feed for comparison. On Day 10, 20, 30, 40 and 50, growth parameters (live weight, total length, growth rate, specific growth rate and condition factor) of a random sample of fry from each replicate were measured. On Day-60, all survivors were used for growth measurement. At the end of the experiment, all growth parameters and survival percentage were found to be significantly higher ($p<0.05$) in fry that were raised in chicken manure and formulated feed compared to those in cow dung treatment. This suggested that goldfish fry could be successfully cultured using chicken manure instead of using formulated feed. The cost benefit analysis of feeding regimes showed that usage of chicken manure which is a by product could produce higher profit than conventional standard formulated feed in outdoor goldfish fry culture.*

## INTRODUCTION

Successful fish culture depends upon eco-friendly and economically and socially viable systems. The recycling of organic animal wastes for fish culture leads to cleaning of the environment and providing additional economical benefits. The use of animal dung in fish culture for natural fish production is important to reduce the usage of costly feeds and inorganic fertilizer that form more than 50% of the total input cost (Dhawan and Kaur, 2002). However, determination of proper manuring rates is

[1] Department of Animal Science, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.

essential if maximum fish yields are to be attained. Therefore, it is necessary to estimate the standard doses of these wastes which would keep the physico-chemical parameters of pond water in a favourable range required for the survival and growth of fish.

Research on the use of animal wastes as fertilizer in aquaculture ponds has been conducted in various parts of the world. Many studies have been conducted on the utilization of animal dung for fish culture; particularly farmyard manure, cow dung, poultry waste and biogas slurry, which are suitable substitutes for costly feeds and fertilizer (Schroeder, 1980; Dhawan and Toor, 1989). MegGeachin and Stickney (1982) revealed that between 70 and 140 kg $ha^{-1}day^{-1}$ of dry poultry manure would produce good growth in *O. aurea*. Fagbenro and Sydenham (1988) reported good growth and survival of the walking catfish *Claria ishariensis* in ponds fertilized with 90 kg $ha^{-1}day^{-1}$ of dry poultry sweeping (30 to 40 % manure). Chicken manure is richer in nutrients for production than cattle manure (Schroeder, 1978; 1980).

Goldfish (*Carassius auratus*) is one of the most popular fresh water ornamental fish in the world as well as in Sri Lanka. It is an omnivorous fish which eats all invertebrates and zooplankton that are found in natural waters. In artificial environments, feeds used for goldfish post-larvae rearing are *Artemia,* tubifex, mosquito larvae, daphnia and high quality granulated or pelleted feeds (Harvath and Seagrave, 1992).

Feeding of fish has become one of the critical management practices of today, as it seems to be having a great impact on the growth rate and the survival rate of fish. Feed cost is considered to be the highest recurrent cost in aquaculture, often ranging from 30 % to 60 % depending on the intensity of culture practices involving higher stocking densities and intensive feeding (De Silva and Anderson, 1995). Therefore, it is important to find out low cost ingredients in order to reduce farm operation cost. Treating outdoor ponds with chicken manure seems to be an inexpensive alternative to formulated feeds.

Therefore, the objectives of this study were: 1) to find out the effect of chicken manure and cow dung on biological and physico-chemical parameters of water; 2) to compare the effect of chicken manure, cow dung and formulated feed on the growth and survival of goldfish fry; and 3) to compare the profitability of using chicken manure and cow dung with that of feeding formulated feed during the goldfish fry culture.

## MATERIALS AND METHODS

### Preparation of tanks

Experiments were conducted in outdoor concrete tanks of 1 $m^2$ (1 m x 1 m) having a depth of 0.7 m at the Department of Animal Science, University of Peradeniya. Experimental tanks were covered with nets to prevent the entering of predators (specially, birds). They were cleaned thoroughly and kept for two days to dry and filled with tap water and kept for 48 hours to remove chlorine. Each tank was well aerated.

## Manuring of tanks

Selected six outdoor cement tanks were fertilized with chicken manure or cow dung. Initially, manure was mixed with dolomite at a ratio of 19:1 and applied as the basal fertilizer at a rate of 1000 kg/ha (dry weight basis). Supplementary application rate was 100 kg $ha^{-1}$ $week^{-1}$. After manuring, ponds were kept for a two-week period without any disturbance. Each tank was aerated. All the cement tanks were treated with kerosene oil at the rate of 2 ml $m^{-2}$ a day before the introduction of fish as a precautionary measure against predatory air breathing insects and repeated at every two week interval.

## Preparation of a formulated feed

A granulated feed was prepared using low cost ingredients. Ingredients used were tilapia meal (25 %), shrimp head meal (17 %), swine liver (9 %), wheat flour (17 %), soy meal (17 %), rice bran (12 %), coconut oil (0.5%), cod liver oil (1%), vitamin and mineral pre-mixture (1%) and yeast (0.5 %). The formulated feed mixture was prepared as pellets. The pellets were oven dried at 60°C, until a constant weight is reached. Then, the pellets were ground to powder form and used as a feed for larvae.

## Experimental set-up

Experiment I

First experiment was conducted to study the changes in biological parameters and physico-chemical parameters of water in cement tanks with the application of chicken manure and cow dung up to 18 days. Chicken manure, cow dung, and the control (without fertilizer) were the three treatments (with three replicates) compared in nine outdoor cement tanks. As biological parameters, phytoplankton and zooplankton were randomly sampled at every 2-day interval. Physico-chemical parameters, viz., temperature, pH, DO (dissolved oxygen), BOD (biological oxygen demand), secchi-disc visibility, $NO_3$-N, WSP (water soluble phosphates) were measured every fourth day, between 05:00 and 06:00 h.

Experiment II

Second experiment was conducted to study the effect of chicken manure, cow dung and formulated feed on the growth and survival of goldfish fry. The three treatments (with three replicates) were chicken manure, cow dung and formulated feed. Selected outdoor tanks were fertilized as described above. After manuring, tanks were kept for a two-week period without any disturbance and with aeration. Goldfish fry (21- day old) were used for this experiment. At stocking, live weight and total length of each fry was measured. Fry were stocked at a density of 50 fry $m^{-2}$. Formulated feed was added to the control treatment at 10 % of the body weight, three times $day^{-1}$.

For growth measurements, fry were randomly sampled from each replicate on Day 10, 20, 30, 40 50 and 60. Live weight (g) and total length (cm) of individual fish were measured. The number of dead fish was counted daily. At the end of the experiment all the survived fish were counted and individual live weight and total length were determined. Percentage survival was calculated using the following formula:

$$\text{Survival \%} = \frac{\text{Number of fish survived during the culture period}}{\text{Number of fish introduced}} \times 100$$

Growth Rate (GR) at each growth stage of fry was determined as follows:

$$GR = \left\{\frac{\text{Final weight (g)} - \text{Initial weight (g)}}{\text{Time (days)}}\right\} \times 100$$

Specific Growth Rate (SGR) was determined as Elangovan and Shim (2000).

$$SGR = \left\{\frac{\ln \text{Final Weight (g)} - \ln \text{Initial Weight (g)}}{\text{Time (days)}}\right\} \times 100$$

Condition Factor (CF) was determined as follows.

$$\text{Condition Factor (CF)} = \frac{W}{L^3} \times 100$$

W = Weight (g)

L = Length (cm)

### Water quality measurements

Changes in physico-chemical parameters of the water in each replicate were monitored regularly. Temperature ($^{O}C$), DO (mg $l^{-1}$) and pH were measured using an electronic probe (Digital DO/ Temperature Meter, Model UC-12, Central Kagaku, Co. Ltd., Japan). BOD was analyzed as according to APHA (1989). Ammonia (mg $l^{-1}$), phosphorous (mg $l^{-1}$) and nitrate (mg $l^{-1}$) contents were measured using Hatch Portable Data logging Spectrophotometer (model DR/2010). Visibility of water was measured using a secchi-disc.

### Plankton density measurements

A 15 l sample of water was collected from each replicate at 2-day intervals and filtered through 15 μm plankton net. The filtrate collected in the net-tube was fixed with 10% formaline and distilled water was added up to 10 ml. Plankton was counted in each treatment tank using a Sedgwick-Rafter cell. Each plankton colony was counted as one specimen and total number of plankton in a litre of tank water was estimated.

### Proximate analysis

Both manure types and formulated feed used have been analyzed for proximate composition by standard techniques (AOAC., 1980). Crude protein content was analyzed by the micro-kjeldhal method and crude fat by Soxlet extraction. Crude fibre content was estimated by the fibre extraction apparatus. Mineral content of the manure types and the formulated feed ($Ca^{2+}$, $Na^{+}$, $K^{+}$ and $PO_4^{3-}$) was estimated by an Atomic Absorption Spectrophotometer.

### Statistical analysis

One-way Analysis of Variance was used to determine the differences among chicken manure, cow dung and control with respect to plankton density (zooplankton and phytoplankton), and physico-chemical parameters. The differences in growth measurements (live weight, total length, GR, SGR and percentage survival) between chicken manure, cow dung and formulated feed treated tanks were also determined by using one-way Analysis of Variance procedure. Duncan's New Multiple Range Test was used to compare the differences among the means of treatments.

### Economic analysis

Partial budget analysis was made on the results to compare the profitability of different treatments. The expenses considered were the cost for feed and labour incurred during the period of experiment. The income was expected to be realized by selling the fish at the end of experiment. Input and output prices were based on current market prices.

## RESULTS AND DISCUSSION

### Physico-chemical parameters

### Water temperature

During the experimental period, water temperature ranged from $20^0$C to $28^0$C. The mean water temperature in chicken manure and cow dung treated tanks were significantly higher ($p<0.05$) than that of the control treatment (Table 1). This may be due to occurrence of higher biological activity in fertilizer tanks compared to the control. According to Flaig (1984), main constituents of organic compounds are liberated by microbial activity during the formation and dynamics of soil organic matter. Increase in temperature has also been observed by Fortes *et al.* (1986) in ponds treated with chicken manure and formulated feeds. Edirisinghe (1989) has reported that temperature increase was directly proportional to the amount of duck litter applied as a basal fertilizer. Higher temperature values may help to increase the growth rate of natural feeds in fertilized tanks. Natural feeds are adequately produced from manure when the water temperature is above $18^0$C (Schroeder, 1980).

### pH value

pH value varied from 7.0 to 8.5, and significantly higher ($p<0.05$) mean pH was recorded in both manure types than the control (Table 1). In these experiments, dolomite was added with chicken manure and cow dung in order to buffer the pH. Therefore, pH values in chicken manure and cow dung did not show any significant difference ($p>0.05$). However, pH values in fertilized tanks slightly increased 10 days after the addition of fertilizer. That may be due to the rapid growth of plankton after 10 days in fertilized tanks. Early morning pH values increased during the growing season of plankton as reported by Boyd (1984), due to rapid removal of carbon dioxide.

### Dissolved Oxygen and Biological Oxygen Demand

Dissolved Oxygen (DO) in the tanks ranged from 2.7 to 6.4 mg $l^{-1}$ during the study period (Table 1). Significantly higher ($p<0.05$) DO was recorded from the control treatment than both manure treatments. Biological Oxygen Demand (BOD) ranged from 0.08 to 4.3 mg $l^{-1}$ and significantly higher ($p<0.05$) than in manure treated tanks than in the control. DO also get removed from water as a result of certain inorganic chemical reactions (Chemical Oxygen Demand) and due to the decomposition of organic matter by microorganisms. The requirement for oxygen by the latter process plus that associated with plant and animal respiration comprise the BOD (Stickney, 1994).

**Table 1. Changes in physico-chemical parameters of water in chicken manure, cow dung and control treatments.**

| Parameter [1] | | Treatment [2] | | |
|---|---|---|---|---|
| | | Chicken manure | Cow dung | Control |
| Temperature (°C) | Mean ± SD | 26.4 $^a$ ± .28 | 26.0 $^a$ ±0.39 | 21.8 $^b$ ±0.21 |
| | Range | (24 - 27) | (23 - 28) | (20 - 23) |
| pH | Mean ± SD | 7.97 $^a$ ±0.07 | 7.9 $^a$ ±0.05 | 7.26 $^b$ ±0.02 |
| | Range | (7.2 – 8.4) | (7.3 – 8.5) | (7.0 – 7.6 ) |
| DO (mg/l) | Mean ± SD | 3.65 $^b$ ±0.04 | 3.67 $^b$ ±0.03 | 5.95 $^a$ ±0.18 |
| | Range | (2.8 – 5.1) | (2.7 – 5.0) | (5.4 – 6.4) |
| BOD (mg/l) | Mean ± SD | 2.54 $^a$ ±0.19 | 2.22 $^a$ ±0.34 | 0.14 $^b$ ±0.02 |
| | Range | (0.2 – 4.3) | (0.1 – 3.5) | (0.08 – 0.3) |
| Secchi disc visibility (cm) | Mean ± SD | 25.9 $^c$ ±2.4 | 31.7 $^b$ ±1.54 | 44.2 $^a$ ±0.58 |
| | Range | (15 – 42) | (24 – 42) | (39 – 42) |
| $NO_3^-N$ | Mean ± SD | 1.49 $^a$ ±0.17 | 1.19 $^b$ ±0.08 | 0.602 $^c$ ±0.12 |
| | Range | (0.85 – 2.42) | (0.72 – 1.72) | (0.01 – 1.15) |
| WSP | Mean ± SD | 2.40 $^a$ ±0.25 | 1.91 $^b$ ±0.18 | 0.58 $^c$ ±0.09 |
| | Range | (0.82 – 3.95) | (0.62 – 2.81) | (0.04 – 1.10) |

[1]DO – Dissolved Oxygen. BOD – Biological Oxygen Demand, $NO_3^-N$- Nitrate Nitrogen, WSP – Water Soluble Phosphates.

[2]Within rows, the means not sharing a common superscript are significantly different ($p<0.05$). Within parentheses are the respective ranges.

#### Secchi-disc Visibility

The secchi-disc visibility varied from 15 to 42 cm with significantly lower ($p<0.05$) secchi-disc values recorded from chicken manure treatment (Table 1). On the other hand, secchi-disc visibility was highest ($p<0.05$) in the control treatment where it was 100 % transparent even on the Day-18. Secchi-disc visibility is accepted as a reliable tool in estimating plankton abundance in fish ponds (Almazen and Boyd, 1978).

#### Nitrate, nitrite and water soluble phosphates

Nitrate nitrogen in the ponds varied from 0.01 to 2.02 mg $l^{-1}$ (Table 1). Chicken manure treatment showed the highest ($p<0.05$) nitrate-nitrogen content. The water soluble phosphate (WSP) values varied from 0.04 to 3.95 mg $l^{-1}$, with chicken manure treatment recording the highest ($p<0.05$) values (Table 1). Nitrate and phosphorus are among the essential nutrients for both plants and animals. These nutrients are required to promote primary production in pond water. Phosphorus is the first limiting nutrient in natural fresh water, while nitrogen may be the limiting nutrient in the marine environment (Stickney, 1994).

Physico-chemical parameters of water play a significant role in the biology and physiology of fish. In the present study, the physico-chemical parameters of water in chicken manure, cow dung and control group ranged within the favourable limits required for carp as defined by Jhingran (1991).

### Biological parameters

### Phytoplankton growth

Phytoplankton numbers in the ponds were expressed in millions $l^{-1}$ (Table 2). Total phytoplankton number ranged from 0.001 to 132.81. The highest ($P<0.05$) mean value was recorded in chicken manure treatments (Table 2). Bacillariophyceae (Bc) varied from 0.0004 to 74.52. A significantly higher ($P<0.05$) mean value of Bc was recorded in chicken manure compared to cow dung and control treatment. Cyanophyceae (Cy) ranged from 0.0002 to 32.63 (Table 2), with chicken manure treatment recording the highest plankton number ($p<0.05$). In addition, chlorophyceae (Ch) varied from 0.0001 to 38.24, with highest mean levels recorded in cow dung treatment ($p<0.05$). Plankton growth is influenced by the amount of nutrients in the water. WSP and $NO_3^-N$ were significantly highest in chicken manure treatment and lowest in the control ($p<0.05$). High levels of nutrients released from animal wastes can support the extensive growth of phytoplankton blooms and lead to high levels of secondary productivity in the form of zooplankton and benthos (Stickney, 1994). In this experiment, among phytoplankton, bacillariophyceae was the dominant group in the chicken manure treatment and chlorophyceae was poorly represented even in the control treatment.

### Zooplankton growth

Total zooplankton number varied from 25 to 4645 $l^{-1}$ (Table 2). Zooplankton density was observed to be numerically high in chicken manure treatment than in cow dung and control ($p<0.05$). Rotifer, copepod and cladecera density varied from 25-2083, 20-1275 and 6–531 $l^{-1}$ respectively. All these groups were present most abundantly in chicken manure treated ponds ($p<0.05$). Kapur and Lal (1986) have shown that zooplankton density can be increased on organic wastes bypassing the primary production. Among zooplankton, rotifers were the dominant group in chicken manure treatment and cladocera group was the lowest even in the control. In the cow dung treatment, copepoda was the dominant group and cladocera was poorly represented.

In chicken manure and cow dung treated tanks, plankton number increased gradually with time since application, reached maximum and then reduced. In cow dung treated tanks, plankton growth initiated 4 days after stocking fertilizer, reached the maximum plankton number by Day 12 and reduced afterwards. On the other hand, plankton growth in chicken manure increased after 6 days and came to the maximum level on Day 14. Edirisinghe (1989) reported a similar pattern of plankton growth in ponds treated with duck litter.

### Growth and Survival of goldfish fry

The performance of chicken manure and cow dung treatments were compared with standard formulated feed with respect to growth and survival of fish (Fig. 1). Survival rates of fish during the fry stage were not significantly different ($p<0.05$) among the treatments. However, mean percentage survival for all treatments at the end of experiment was above 85 %. Though non-significant, fertilized tanks recorded high survival rates than those with formulated feed. These results indicate that chicken manure and cow dung treatments are as good as formulated feeds with respect to survival. Mortality occurred mainly due to predator attacks in manured tanks, similar to those reported by Sumith Kumara *et al.* (2002).

**Table 2. Differences in biological parameters of water in chicken manure and cow dung treated ponds and the control.**

| Parameter[1] | | Treatment[2] | | |
|---|---|---|---|---|
| | | Chicken manure | Cow dung | Control |
| Tp*(10⁶/l) | Mean ± SD | 47.36ᵃ ± 7.59 | 35.23ᵇ ± 4.97 | 0.69ᶜ ± 0.01 |
| | Range | (0.01 – 132.8) | (0.04 – 75.1) | (0.001 – 1.89) |
| Bc*(10⁶/l) | Mean ± SD | 26.71ᵃ ± 4.09 | 12.94ᵇ ± 1.55 | 0.52ᶜ ± 0.05 |
| | Range | (0.021-74.52) | (0.03 – 23.61) | (0.0004 - 0.81) |
| Cy*(10⁶/l) | Mean ± SD | 14.87ᵃ ± 2.18 | 5.01ᵇ ± 0.76 | 0.08ᶜ ± 0.03 |
| | Range | (0.01 – 32.63) | (0.015 – 12.82) | 0.0002 – 0.59) |
| Ch*(10⁶/l) | Mean ± SD | 5.769ᵇ ± 0.83 | 17.25ᵃ ± 2.15 | 0.09ᶜ ± 0.0 |
| | Range | 0.003 – 13.32) | (0.01 – 38.24) | (0.0001– 0.31) |
| Tz** (No/l) | Mean ± SD | 1846.6ᵃ ± 408 | 1073.3ᵇ ± 178.9 | 228.6ᶜ ± 49.7 |
| | Range | (425 – 4645) | (215 – 1997) | (25 – 500) |
| Ro**(No/l) | Mean ± SD | 1054.9ᵃ ± 125.8 | 428.3ᵇ ± 32.67 | 109ᶜ ± 11.49 |
| | Range | (252 – 2785) | (110.2 – 744.1) | (28 – 238) |
| Co**(No/l) | Mean ± SD | 582.1ᵃ ± 48.9 | 551.4ᵇ ± 46.31 | 91.0ᶜ ± 9.36 |
| | Range | (184.2 – 1275) | (123.12 – 920.12 | (20 – 179.08) |
| Cl**(No/l) | Mean ± SD | 209.60ᵃ ± 28.6 | 93.96ᵇ ± 15.7 | 27.18ᶜ ± 12.0 |
| | Range | (47.1 – 531) | (40.11 – 354) | (6 – 63) |

Tp- Total phytoplankton, Bc- Bacillariophyceae, Cy- Cyanophyceae, Ch- Chlorophyceae, Tz- Total zooplankton, Ro- Rotifers, Co- Copepoda, Cl- Cladocera
[2]Within rows, means not sharing a common superscript are significantly different ($p<0.05$)
*Values are No. x $10^6$/l
**Values are No./l

At the stage of stocking the fish were similar in mean live weight and total length. However, at the end of the experiment, Mean live weight and total length of fish were significantly different among the treatments ($p<0.05$) (Table 3). Chicken manure showed high performance similar to formulated feed. However, performance of fish under cow dung treatment was low ($p<0.05$). Similar results were found with respect of specific growth rate and condition factor. From the onset of the experiment chicken manure out performed cow dung treatment (Fig. 2). Ponds with chicken manure had significantly higher ($p<0.05$) plankton growth (phytoplankton and zooplankton) than those with cow dung (Table 2). That may be the reason for higher growth of goldfish fry recorded from chicken manure treatment than cow dung treatment. Michale (1988) reported that phytoplankton supply oxygen to the pond water and encourage the growth of zooplankton, which is an excellent feed for the goldfish. Chakrabarti and Hettiarachchi (1982) showed that excellent growth of common carp fry fed on plankton was attributed to high dietary value and energy content in planktons and enhancement of water quality due to plankton activities. According to Jana (1998), artificially grown plankton can be used as fry feeds due to their high dietary value, enzyme content and least water pollution. Planktons were proven to be a rich source of protein often containing 40% to 60% on dry matter basis

(De Silva and Anderson, 1995). Amarasinghe (1985), showed that the amount of plankton consumed by carp fry increased gradually with the increase in the body weight, which indicates the contribution of plankton as a feed. Proximate analysis conducted on chicken manure, cow dung and the formulated feed showed that formulated feed is much superior in protein and fat content than the manures (Table 4). However, formulated feed is directly consumed by the fish while manures are left in the tanks for planktons to grow on and produce proteins. Mineral content is an important factor for plankton growth (Schroeder, 1980). Table 4 shows that chicken manure is richer in minerals. This may be the reason for high plankton growth and consequently superior performance of fish in chicken manure treated tanks.

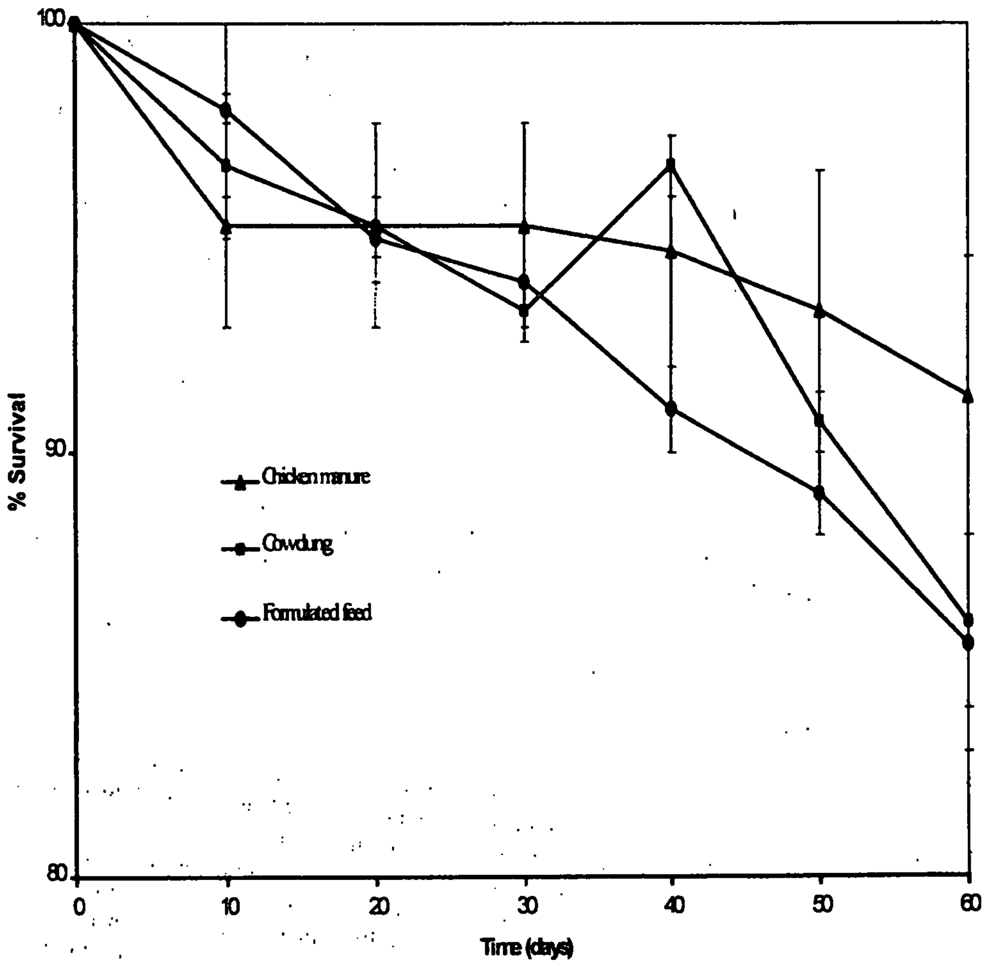


**Fig. 1. Percentage survival (Mean ± S.E.M.) of goldfish fry cultured with chicken manure, cow dung and formulated feed during the experimental period.**

Table 3. **Growth performance of goldfish fry cultured with chicken manure, cow dung and formulated feed treatments[1].**

| Parameter[1] | Treatment (Mean ± SD)[2] Chicken manure | Cow dung | Formulated feed |
|---|---|---|---|
| At stocking | | | |
| MLW (g) | $2.0^a \pm 0.13$ | $2.0^a \pm 0.07$ | $2.0^a \pm 0.1$ |
| MTL (cm) | $0.193^a \pm 0.04$ | $0.191^a \pm 0.02$ | $0.191^a \pm 0.03$ |
| At harvesting | | | |
| MLW (g) | $5.56^a \pm 0.06$ | $3.64^b \pm 0.21$ | $5.27^a \pm 0.04$ |
| MTL (cm) | $6.6^a \pm 0.3$ | $6.0^b \pm 0.13$ | $6.6^a \pm 0.2$ |
| MWG (g) | $5.36^a \pm 0.02$ | $3.45^b \pm 0.23$ | $5.08^a \pm 0.02$ |
| GR (g/day$^{-1}$) | $8.94^a \pm 0.04$ | $5.75^b \pm 0.33$ | $8.47^a \pm 0.02$ |
| SGR (%/day$^{-1}$) | $5.68^a \pm .0.37$ | $4.53^b \pm 0.15$ | $5.54^a \pm 0.2$ |
| CF (%) | $1.91^a \pm 0.08$ | $1.61^b \pm 0.03$ | $1.84^a \pm 0.15$ |
| Survival (%) | $91.3^a \pm 3.27$ | $86^a \pm 2.0$ | $85.5^a \pm 2.5$ |

[1] MLW = Mean Live Weight, MTL = Mean Total Length, MWG = Mean Weight Gain, GR = Growth Rate, SGR =Specific Growth Rate and CF = Condition Factor.
[2] Within rows, means not sharing a common superscript are significantly different ($p<0.05$).

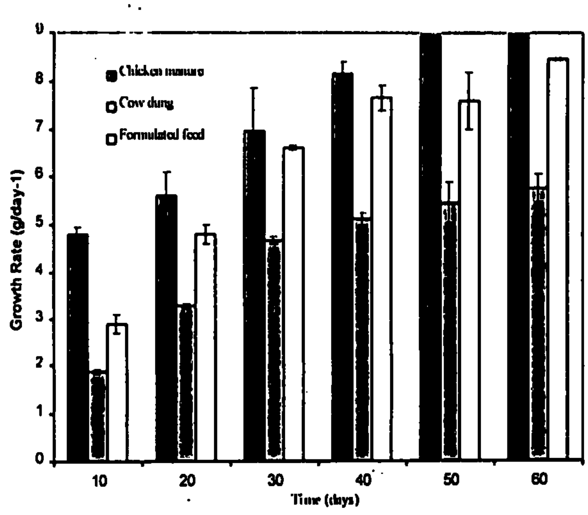


Fig 2. **Growth Rate (Mean ± S.E.M.) of goldfish fry cultured with chicken manure, cow dung and formulated feed during the experimental period.**

## Economics of feed

Results of the partial budget analysis on the three treatments are given in Table 5. Formulated feed, through provides high performance, is very costly compared to the alternatives. Due to bulky nature, manures are associated with high labour cost. However, overall cost of formulated feed was very high, confirming a major problem existing in the industry. Survival rate under manures were slightly higher. Improvement in condition factor was considered in pricing of fish. Thus income from chicken manure was clearly higher than that from formulated feed. Profit from cow dung treatment was comparable to that standard formulated feeds.

**Table 4. Proximate composition (% dry matter basis) of feeding materials.**

| Feeds | Chicken manure | Cow dung | Formulated feed |
|---|---|---|---|
| % Crude protein | 22 | 12.5 | 53.6 |
| % Fat (ether extract) | 1.8 | 2.1 | 9.94 |
| % Crude fibre | 17.8 | 29.8 | 5.13 |
| % Ash | 25.1 | 12.9 | 12.3 |
| % Moisture | 12.4 | 10.5 | 6.4 |
| Minerals (ppt) | | | |
| $K^+$ | 17.15 | 8.34 | 10.72 |
| $Na^+$ | 5.12 | 2.4 | 14.68 |
| Ca | 2.35 | 0.63 | 1.71 |
| $PO_4^{3-}$ | 1.9 | 0.35 | 1.01 |

Being an economic enterprise, success of fish farming is ultimately decided by the profit margin. Less expensive alternative natural feeds plus high survival and growth rate should be the primary consideration. Chicken manure is a cheaper by product of poultry industry, which is freely available in Sri Lanka. Transport which requires higher number of labour days for manure the tanks and the difficulty to use in indoor tanks are among the problem associated with the one of poultry manure. Formulated feed showed higher income than the cow dung treatment only because of higher growth rate (Table 5).

**Table 5. Partial budget for goldfish fry cultured with chicken manure, cow dung and formulated feed on 100 fish basis.**

| | Chicken manure | Cow dung | Formulated feed |
|---|---|---|---|
| a) Expenditure | | | |
| 1) Feed cost | | | |
| Average weight of feed and manure (g/100 fish) | | | |
| Chicken manure | 2000g | - | - |
| Cow dung | - | 2000g | - |
| Formulated feed | - | - | 4000g |
| Dolomite | 100g | 100g | - |
| Total feed cost (Rs) | 10.00 | 10.00 | 320.00 |
| 2) Labour cost (Rs) | 10.00 | 10.00 | 6.00 |
| Total cost (Rs) | 20.00 | 20.00 | 326.00 |
| b) Income (Rs) | | | |
| No. of fish survived | 91 | 86 | 85 |
| Price per fish (Rs) | 30.00 | 25.00 | 30.00 |
| Total income (Rs) | 2730.00 | 2150.00 | 2550.00 |
| c) Total profit (Rs) | 2710.00 | 2130.00 | 2224.00 |
| Profit per fish (Rs) | 27.10 | 21.30 | 22.24 |

Further improvement of growth by cow dung is difficult without mixing it with a rich source of nutrients. These results strongly suggest that chicken manure can be used to minimize the cost of production and increase profitability of goldfish fry culture.

## CONCLUSIONS

The results of this experiment indicate that chicken manure promotes plankton growth more than cow dung partly due to superior nutrient content. In addition, the current rate of chicken manure and cow dung usage (1000 kg $ha^{-1}$ on dry matter basis) can be used effectively in outdoor cement tanks without any deterioration of water quality. Chicken manure and the standard formulated feed use resulted in similar growth performance and survival in goldfish fry. However, the cost benefit analysis of feeding regimes showed that chicken manure is the cheapest option that maximizes profit in goldfish fry culture among the three alternatives compared.

## ACKNOWLEDGEMENTS

Authors are thankful for CARP (Grant No. 12/391/289) for financial assistance.

## REFERENCES

Almazen, G. and Boyd, C.E. (1978). Plankton production and tilapia yield in pond. Aquaculture, 15: 75-77.

Amarasinghe, U.S. (1985). Studies on the exploitation of minor cyprinids in Parakrama samudraya; a man made lake in Sri Lanka, using gillnets. National Aquatic Resources Research and Development Agency (NARA) (Sri Lanka) 32: 11-23.

AOAC. (1980). Official Methods of Analysis, 13th Edition, Association of Official Analytical Chemists, Washington DC, USA.

APHA. (1989). Standard methods for the examination of water and waste water. 17th Edition, American Public Health Association, Washington, D.C.

Boyd, C.E. (1984). Water Quality Management of Pond Fish Culture. Elservier, Amsterdam, The Netherlands.

Chakrabarti, R.D. and Hettiarachchi, A. (1982). Effects of raising fish in private ponds in the Polonnaruwa District. J. Inland Fish., 1: 115-118.

De Silva, S.S. and Anderson, A.T. (1995). Fish Nutrition in Aquaculture. Chapman and Hall Press, London.

Dhawan, A. and Kaur, S. (2002). Pig Dung as Pond Manure: Effect on Water Quality, Pond Productivity and Growth of Carps in Polyculture System. ICLARM Quarterly, 25:11-14.

Dhawan, A. and Toor, E. (1989). Impact of organic manure and supplementary diet on plankton production and fish growth and fecundity of Indian major carp, *Cirrhma mrigala* in fish ponds. Biol. Waste, 29:289-298.

Edirisinghe, U. (1989). Some Aspects of Duck-Bighead Carp-Common Carp-Nile Tilapia Intergrated Farming. unpublished PhD Thesis, Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka.

Elangovan, A. and Shim, K.F. (2000). The influnce of replacing fish meal partially in the diet with soybean meal on growth and body composition of juvenile tin barb. Aquaculture, 189: 133-144.

Fagbenro, O.A. and Sydenham, D.H.J. (1988). Evaluation of *Clarias isheriensis* (Syndenham) under semi-intensive management in ponds. Aquaculture, 74: 287-291.

Flaig, W. (1984). Soil organic matter as a source of nutrients. *In* : Organic matter and rice. International Rice Research Institute, Los Banos, Lguna, Philippines.

Fortes, R.D., Corre, V.L.J.R. and Pudadera, E. (1986). Effects of fertilizer and feeds as nutrient source on *Oreochromis niloticus* production in Philliphins brackish water ponds. In. Maclean, J.L., Dizon, L.B. and Hosillos, L.V. (eds.), The First Asian Fisheries Forum, Asian Fisheries Society, Manila, Philippines.

Harvath, L. and Seagrave, G.T.C. (1992). Carp and Pond Fish Culture. John Wiley and Sons, Inc., New York.

Jana, B.B. (1998). Efficiency of artificial plankton diet on growth of common carp fry. Journal of Aquaculture in Tropics, 13: (4) 225-260.

Jhingram, V.G. (1991). Fish and Fisheries of India. Hindustan Publishing Corporation, Delhi.

Kapur, K. and Lal, K.K. (1986). The chemical quality of waste treated waters and its relation with patterns of zooplankton population. *In* Maclean, J.L., Dizon, L.B. and Hosillos, L.V. (eds.), The First Asian Fisheries Forum, Asian Fisheries Society, Manila, Philippines. pp. 129-132

MegGeachin, R.B. and Stickney, R.R. (1982). Manuring rates for production of blue tilapia in simulated sewage lagoons receiving laying hen waste. Prog. Fish Cult., 44: 25-28.

Michale, V.K. (1988). Carp farming. Fishing News Book Ltd, England.

Schroeder, G.L. (1978). Autotropic and heterotropic production of microorganisms in intensively manured fish ponds and related fish yields. Aquaculture, 14: 303-325.

Schroeder, G.L. (1980). Fish farming in manure loaded ponds. *In* ICLARM-SEARCA Conf. Agr. Aquac. Farm. System, Manila, Philippines. pp73-86.

Stickney, R.R. (1994). Principles of Aquaculture, John Wiley and Sons, Inc., 605 Third Avenue, New York, USA.

Sumith Kumara, A.G.L.A., Edirisinghe, U., Dematawewa, C.M.B. and Perera, K.A. (2002). Determination of Compensatory Growth in Goldfish (*Carassius auratus)* Fry. Trop. Agric. Res., 14: 60-70.