# Efficient utilization of underground brackish water for sustainable fish culture technology

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ABSTRACT

Haryana st ate bounded by 27°39' to 30°35' N latitude and between 74°28' and 77°36' E longitude, comprises a total geographical area of about 4.4 million ha. Out of this about 2.36 million ha is the net irrigated area. Out of the total surface and underground water potentials of about 1.51 million ha meter (mham) and 1.24 mham, an about 1.05 mham and 0.8mham respectively, have already been exploited. Because of inefficient utilization of surface water resources and available rainfall, there is rapid rise in water table and secondary soil salinization in the Central and south western parts of the Haryana State. This part has saucer type topography, where the quality of under ground water is mostly unsatisfactory for irrigation. In some localities , the water table has reached at critical depth (3mbgl) whereas in certain areas, the water table has touched the ground surface level effecting agricultural productivity badly. In order to have a sustained agriculture in such areas, provision of adequate sub surface drainage to lower water table and to facilitate leaching of salts has been recognized as a basic factor for any long term success in the reclamation and management of saline and water logged soils. But at the same time we have to ensure the economical viability of the drainage system. For sub surface drainage system we have to spend about Rs.25000/- hectare initially and then to operate and maintain it Rs. 5000/- hectare/year have to be spend again. On the other hand if we go for aquaculture in brackish water, we can get an income of Rs.60000-80000/- per hectare/year. Thus keeping in view the economical aspect, the water logged areas with poor productivity can be reclaimed in to carp fish production farms very profitably. This can be very promising in areas where ground water is highly saline and water table is rising at a rapid rate but still below 3mbgl. The average annual rise of water in these areas ranges from 10 to 30 cm which in some pockets is as high as 1m per year. To check water table rise in such areas it is desirable to annually pump out at least 3 to 5 cm saline ground water per unit areas. The farmer should, therefore. be encouraged to adopt either mixed farming (agriculture and fishery) or farmers adopt brackish water fishery which will go a long way in preventing and reclaiming water logging and soil salinization.

**ECONOMICS OF FISH CULTURE IN BRACKISH WATER**

| | | |
|---|---|---|
| Fish production | – | 3000-4000 kg/hectare/year |
| Market price | - | 35 -40 Rs./ kg. |
| Production cost | - | 15 - 20Rs./kg. |
| Net profi | t- | 60000-80000Rs./hectare/year |

Key words: Brackish water, fishery, agriculture, soil salinization.

## 1. INTRODUCTION

With the ever growing menace of population and continuing pressure on agricultural land, it has now become necessary that we must efficiently utilize the available inland underground brackish water to step up the production of protein rich food. Fish culture offers a vast potential of generating large quantities of good quality protein at a low cost besides controlling rise in water table. The underground waters of major part (about 66%) of Haryana are moderately to highly saline. Because of inefficient utilization of surface water resources, there is also a rapid rise in water table and soil salinization in arid and semi arid canal irrigated areas of central and south-western Haryana(Table 2).These underground saline waters are not readily usable for agriculture, industries or for any other purpose, rather pose a serious threat to labile ecosystem. However, these saline water reserves represent a potential opportunity for the development of inland aquaculture. Hence, a survey of the brackish water areas in and around Hisar was made. Water samples les from 8 different inland saline water sources were collected and chemically analyzed for water quality parameters. Water analysis has revealed that with increase in salinity (ppt), water quality parameters like conductivity, pH, sodium, potassium, calcium, magnesium, total hardness, chlorides, bicarbonates and orthophosphate concentration increased, while no variations were observed in the concentration of sulphate. It was further observed that calcium, magnesium and total hardness were very high in comparison with the natural sea water, whereas potassium and chloride contents were low.

## 2. MATERIAL AND METHODS

For economical and most viable use of swampy and water logged areas for aquaculture following criteria must be kept in mind.

### 2.1) **Topography**:

The topography of the site selected should be flat or tilting towards the outlet and earth available from excavation should be sufficient for raising fee pond dykes.

### 2.2) **Ponds:**

Mainly three types of ponds are use for carp culture. These rearing ponds and stocking ponds. As clear from the nomenclature itself, Nursery ponds are used for raising the 2-3 days old fish to 16-17 days old fish. A dependable source of salt free water is required initially for breeding purposes. Rearing pond s are used for raising the fish for 3-4 months and stocking ponds are used for stocking the carp. Fish were maintained in fresh water (0.5-1.5 dS/m) as well as in inland brackish water (12-16 dS/m) fish ponds (10x10x10m) at the fish farm attached to the Department of Soil Sciences, CCS Haryana Agricultrual University, Hisar (Lat. $29^{o}$, 10'N and Long. $75^{o}$, 46'E). As far as the source of fish is concerned, common carp, Cyprinus carpio was made to breed at the farm itself and the fry of major carps were obtained from the Fisheries Department, Haryana Govt. To study the effects of salinity on gonadal activity, monthly samples of Cyprinus carpio as well as of Cirrhinus mrigala were obtained from the field approximately in the middle of each month. A minimum of 6-7 fish of each six were sacrified every month. Water samples were analyzed at different time intervals during the experimental period (APHA,1998; Washington,1984; Boyd, 1990).

**Table 1. Average meteorological data of Hisar for 11 years**

| Month | Pan evaporation (mm) | Rainfall (mm) |
|---|---|---|
| January | 2.9 | 10.2 |
| February | 3.6 | 16.1 |
| March | 5.5 | 14.0 |
| April | 9.7 | 5.6 |
| May | 12.8 | 30.6 |
| June | 12.1 | 37.8 |
| July | 7.4 | 156.8 |
| August | 5.8 | 121.2 |
| September | 6.1 | 42.8 |
| October | 5.5 | 5.1 |
| November | 3.5 | 11.0 |
| December | 2.2 | 5.3 |

To check the survival of common carp and Indian major carps experiments were carried out in stagnant earthen ponds, measuring 10x10x1 m. Ponds were filled with tubewell water- mixed with fresh canal water to obtain the desired salinities. 5 salinities were employed (approx. 1.5, 4.5, 7.5, 11.5 and 14.5 dS/m). Fish seed consisted of four species in the arbitrarily chosen ratio of 1 (catla): 6 (rohu): 2 (Mrigal): 6 (common carp). Fish were stocked at the rate of 10000/ha. To assess the suitability of different organic fertilizers for monoculture of common carp, experiments were carried out in stagnant earthen ponds. Ponds were fertilized with 5 different manure types. These were i) cow dung @ 24 t/ha/yr ii) cow dung @ 20 t/ha/yr iii) Poultry manure @ 1.5 t/ha/yr iv) Duckery @ 6 t/ha/yr v) Sheep/goat manure @ 1.5 t/ha/yr.

## 3. RESULTS AND DISCUSSION

We had measured the different physic-chemical parameter important for aquaculture in different source of saline groundwater situated at university research farms. The degree of variations in different water parameters were observed. The higher salinity was 24.15 ppt whereas lowest was 0.3 ppt measured in source 8 and source 1 respectively.

**Table 2: Physico-chemical characterstics of inland saline groundwater**

| Parameters | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Salinity ppt | 0.3±0.0 | 1.9±0.0 | 2.5±0.0 | 5.9±0.0 | 7.2±0.0 | 9.55±0.03 | 10.3±0.0 | 24.15±0.35 |
| Conductivity mS cm-1 | 1.04±0.0 | 3.8±0.0 | 4.58±0.0 | 10.34±0.0 | 12.83±7.37 | 16.49±0.03 | 17.27±0.03 | 38.55±0.11 |
| pH | 7.6±0.0 | 7.12±0.0 | 7.15±0.0 | 7.2±0.0 | 7.37±0.0 | 7.22±0.02 | 7.38±0.0 | 7.09±0.02 |
| Sodium mg-1 | 20.0±1.65 | 33.3±1.44 | 51.3±1.21 | 114.67±1.09 | 170.67±1.44 | 278.66±2.22 | 250.67±2.22 | 390.0±1.65 |
| Potassium mg-1 | 2.0±0.58 | 5.33±0.27 | 6.8±1.18 | 15.0±0.94 | 17.67±0.23 | 30.4±0.0 | 25.33±0.54 | 40.0±0.94 |
| Calcium mg-1 | 196.21±4.47 | 378.22±19.81 | 462.27±34.31 | 686.86±11.45 | 525.0±14.89 | 420.31±7.43 | 609.0±14.8 | 1082.83±5.25 |
| Magnesium mg-1 | 34.97±13.61 | 52.30±6.48 | 67.91±7.64 | 175.68±11.50 | 826.55±8.21 | 1360.29±12.72 | 933.91±0.43 | 2183.46±114.7 |
| Total hardness mg-1 | 600.0±47.14 | 1100.00±57.73 | 1433.33±54.3 | 2400±47.14 | 4700.0±70.36 | 4625.0±6.95 | 5350.0±35.46 | 11050±134.63 |
| Chlorides mg-1 | 231.93±13.53 | 811.77±35.79 | 1259.67±13.53 | 1838.9±23.43 | 4646.25±123.91 | 4709.1±20.60 | 6038.55±52.89 | 9008.12±20.60 |
| Sulphate mgl-1 | 87.48±12.12 | 92.31±8.7 | 95.8±3.6 | 97.25±0.72 | 97.28±0.13 | 95.68±1.36 | 85.67±8.21 | 93.34±0.55 |
| Carbonate mgl-1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bicarbonates mg l-1 | 195.12±1.21 | 180.62±2.1 | 201.63±1.8 | 198.3±1.6 | 208.16±1.6 | 140.5±0.82 | 156.31±1.61 | 158.0±0.70 |
| Total alkalinity mg l-1 | 195.12±1.21 | 180.62±2.1 | 201.63±1.8 | 198.3±1.6 | 208.16±1.6 | 140.5±0.82 | 156.31±1.61 | 158.0±0.70 |
| Orthophosphate mg l-1 | 0.07±0.02 | 0.07±0.0 | 0.06±0.02 | 0.05±0.01 | 0.04±0.01 | 0.034±0.001 | 0.03±0.0 | 0.092±0.001 |

1-8 different sources of inland saline groundwater.
All values are mean ± S.E. of mean.

**Effect of inland water salinity on gonadal activity in cyprinus carpio.**

Higher salinities do not repress gonadal recrudescence in common carp. GSI's recorded of fish kept in saline waters was higher than of their non-specifics kept in fresh water. Consecutive studies revealed that GSI differences are caused by higher levels of estradiol in female and testosterone in male.

**Table 3: Vitellogenin levels ovarian histology during the annual reproductive cycle in common carp, Cyprinus carpio reared in brackish and fresh water.**

| Name of month | Brackish water | | | | Fresh water | | | |
|---|---|---|---|---|---|---|---|---|
| | Vitellogenin levels ug/ml | | Percentage of oocytes* | | Vitellogenin levels | Percentage of oocytes* | | |
| | plasma | Stage 1 | Stage II | Stage III | ug/ml plasma | Stage I | Stage II | Stage III |
| July | - | 100 | - | - | : - | 100 | - | - |
| Aug | - | 100 | - | - | - | 100 | - | - |
| Sep. | 20.5 ±2.8 | 90.0 ±2.2 | 10.0 ±2.2 | - | - | 100 | - | - |
| Oct. | 20.5 ±3.8 | 87.8 ±0.68 | 9.2 ±0.62 | 3.0 ±0.2 | - | 100 | - | - |
| Nov. | 30.5 ±4.0 | 80.7 ±0.62 | 13.8 ±0.24 | 5.5 ±0.26 | 10.5 ±2.5 | 90.0 ±2.8 | 7.0 ±0.5 | . 3.0±0.0 |
| Dec. | 48.0 ±3.7 | 58.0 ±0.50 | 10.0 ±0.30 | 25.0 ±0.2 | 35.0 ±3.0 | 75.5 ±1.27 | 16.5 ±2.0 | 8.0±0.29 |
| Jan | 30.0 ±5.4 | 70.0 ±1.20 | 18.0 ±0.24 | 12.0 ±0.26 | 25.0 ±2.0 | 82.0 ±1.13 | 14.0 ±1.2 | 4.0±0.39 |
| Feb | 25.0 ±2.2 | 49.1 ±3.0 | 33.0 ±0.62 | 17.9 ±0.24 | 20.0 ±1.5 | 82.1 ±0.38 | 11.4 ±4.8 | 6.5±0.27 |
| Mar | 35.0 ±2.1 | 57.6 ±2.62 | 27.1 ±1.79 | 15.3 ±2.5 | 20.0 ±2.5 | 34.3 ±5.20 | 20.0 ±6.5 | 45.±0.45 |
| Apr | 40.0 ±2.7 | 58.3 ±0.1 | 15.7 ±0.2 | 26.0 ±1.40 | - | 80.2 ±1.85 | 146 ±0.504 | 5.2±0.02 |
| May | 45.0 ±3.9 | 34.2 ±8.2 | 27.3 ±1.2 | 38.0 ±2.2 | 20.0 ±2.7 | 67.3 ±2.12 | 20.7 ±0.50 | 12.0±0.49 |
| June | 30.0 ±2*6 | 30.1 ±2.5 | 15.9 ±1.5 | 54.0 ±2.1 | 22.0 ±2.1 | 40.7 ±2.05 | 5.0 ±0.02 | 54.3±0.29 |

Values in parentheses indicate number of fish
All values are mean ± S.E. of mean.

### 3.1.1 *July - August*

The ovaries during these months under both brackish as well as fresh water conditions remained totally regressed as they contained only oogonia and stage 1 primary oocytes.

### 3.1.2 *September*

A slight but significant increase in ovarian weights was observed during this month in fish kept in brackish water. History revealed that the ovaries also contained few stage II vitellogenic oocytes. Under fresh water conditions, ovaries were still regressed as they contained only oogonia and stage 1 primary oocytes.

### 3.1.3 *October - November*

A further slight rise in ovarian GSI was observed during these months in fish under brackish waters. The slight increase in ovarian weights is perhaps due to the appearance of few yolky (stage III) oocytes along with viteilogenic (stage II) oocytes in the ovaries. Viteilogenic titers rose significantly ( $P< 0.001$) during November.

Ovaries were still regressed under fresh water during October. However, during November ovaries contained few viteilogenic as well as yolky oocytes. Plasma vitellogenin was also detected.

### 3.1.4 *December*

A very significant ($P < 0.01$) increase in ovarian GSI was observed during this month under brackish waters. History revealed that the ovaries contained significantly ( $P< 0.001$) high percentage of yolky oocytes.

Due to intense viteilogenic activity, under fresh water also an appreciable ovarian recrudescence was observed during December. Histology revealed a significant ( $P< 0.005$) increase in the percentage of stage II and stage III oocytes. Alkali-labile protein phosphorus titers also rose considerably.

### 3.1.5 *January - March*

Common carp do not spawn under brackish water conditions even then the ovarian weights fell significantly ($P < 0.001$) during January in comparison to December sampling. Histological observations for the ovaries revealed the presence of both stage II and stage III oocytes albeit in low proportions. Alkali labile protein phosphorus was though detectable, their levels remained low. During February and March low ovarian weights persisted as observed during January.

During January-February a slight decrease in GSI and vitellogenin titers took place in fish sampled from fresh waters. However, during March a significant ( $P< 0.01$) increase in ovarian GSI was observed and the ovaries were fully packed with yolky oocytes (45%).

### 3.1.6 *April - May - June*

With rise in temperature and day length a sharp increase in ovarian weights was noticed during April. A further rise in temperature during May resulted in progressive recrudescence of the ovaries. With the result that the ovarian weights were maximum during June. A similar effect of rising temperature and day length was also reflected on histology of the ovaries. Because of the large size of yolky oocytes during June (mean diameter 940 ± 16.3 urn, range 820-1090 jam), ovaries appeared to be fully packed with yolky oocytes only. Vitellogenin levels fell during June perhaps owing to incorporation as yolk in the oocytes.

**Table 4: Testicular histology during the Annual Reproductive Cycle in common carp reared in brackish and fresh waters**

| Name of the month | Brackish water ……………………. Testicular response ……………………. | | Fresh water ……………………. Testicular response ……………………. | |
|---|---|---|---|---|
| | Spermatogenic Response | Spermatozoa | Spermatogenic response | Spermatozoa |
| July | 1.0±0.00 | - | 1.0±0.00 | - |
| Aug. | 1.0±0.00 | - | 1.0±0.00 | - |
| Sep., | 2.0±0.00 | - | 1.0±0.00 | - |
| Oct., | 3.0±0.00 | 2.0±0.00 | 2.0±0.00 | - |
| Nov., | 4.0±0.00 | 3.0±0.00 | 2.0±0.00 | - |
| Dec., | 4.0±0.00 | 3.0±0.00 | 4.0±0.00 | 3.0±0.00 |
| Jan., | 4.0±0.00 | 3.0±0.00 | 4.0±0.00 | 3.0±0.00 |
| Feb., | 4.0±0.00 | 3.0±0.00 | 4.0±0.00 | 3.0±0.00 |
| Mar. | 4.0±0.00 | 3.0±0.00 | 4.0±0.00 | 3.0±0.00 |
| Apr., | 4.0±0.00 | 3.0±0.00 | 4.0±0.00 | 3.0±0.00 |
| May | 4.0±0.00 | 3.0±0.00 | 4.0±0.00 | 3.0±0.00 |
| June | 4.0±0.00 | 3.0±0.00 | 4.0±0.00 | 3.0±0.00 |

Values in parentheses indicate number of fish
* All values are mean * S.E. of mean.

### 3.2.1 *July-August*

Under brackish waters as well as under fresh waters testes, remained completely regressed and contained only spermatogonial mother cells. Lumen of the seminiferious tubules was narrow and spermatozoa were observed.

### 3.2.2 *September - October*

A rise in testicular GSI was observed during these months both under brackish as well as fresh water conditions. Tests contained spermatogonia and also few spermatocytes.

### 3.2.3 *November*

A little but significant rise in testicular GSI was observed during this month both under fresh as well brackish water conditions. Testes were fully developed with active stages of spermatogenesis including spermatoza. Seminiferous tubules also appeared to be enlarged.

### 3.2.4 *December*

Testes were greatly enlarged under both conditions during this month. Seminiferious tubules were fully distended and packed with active stages of spermatogenesis. Spermatozoa outnumbered all other stages.

### 3.2.5 *January*

A singnificant decrease under both the conditions in testicular GSI was observed during January, however, testes appeared to be active as they contained all stages of spermatogenesis.

### 3.2.6 *February*

An increase in t3esticular GSI during February and an decline during March in ovarian weights was observed.

### 3.2.7 *March*

Another increase in testicular GSI was observed during this month and testes contained active spermatogenesis. The diameter of the seminiferous tubules was also greatly enlarged.

### 3.2.8 *April - May - June*

Though the weights of the testes were low during these months as compared to March, however, active spermatogenesis was observed during this period. Number of spermatozoa was low as compared to the March sampling.

As far as survival of common carp and major carps are concerned, these fresh water fishes can ssurvive and thrice in brackish water prevailing in the region (Garg, 1991).

Some other studies have revealed that carps perform well at salinities upto 8.0 ppt. Higher salinities (>8.0 ppt) appear to repress fish growth (Garg and Sukkel, 1993; Garg, 1996; Garg and Bhatnagar, 1996). Moreover, it is clear from the reproduction experiments that tempo of gonadal recrudescence and body growth is significantly high in brackish water reared fish as compared to fresh water reared fish both in common carp as well as in major carps. The following table 5 shows the relative performance of common carp and Indian major carps grown at different salinities. In this table species are ranked from 1 to 4, with 1 indicating highest growth rate (Sukkel, 1993).

**Monoculture of Common Carp at Two Salinities Using Farm Yard Litters as Fertilizers**

Results of fish production under monoculture are given in table 1. Studies have revealed that highest (4500 kg/ha/yr) fish production under brackish water was observed when poultry manure was used to fertilize fish ponds, followed by cow dung, duckery and sheep-goat litters as fertilizers. These studies indicate that fish culture is feasible in inland brackish waters.

Fresh water fish production under a broad range of climatic conditions in India (Chaudhary and Chakrabarty,1974) and elsewhere (Peakar and Olah,1990) is well documented. Similar fish productions were obtained in our experiments in brackish waters. Therefore, it is recommended to use the brackish ground water for aquaculture, while using the fresh surface canal water for irrigation.

Pumping brackish ground water for aquaculture will reduce water table levels while generating an additional source of income. Today, in Haryana State, fish are sold with a net benefit of Rs. 20 per kg, allowing for a net income of about Rs. 100,000 per hectare per year. With further improvements in management practices and marketing this figure still can increase. Report fish productions front stagnant freshwater ponds in India range between 5,000 and 7,000 kg/ha/yr.

In area with numerous ponds the practice could result in an annual water table reduction of 50 cm/yr. Installing a tile drainage system (Poonia and Rajpal,1987) on 30 ha of land will cost approximately Rs. 30,000/ha. Integrating fish culture within the system would allow to recover the costs over 5-10 yr period. The system looks promising. Besides reducing ground water levels the possibility exists to (a) reclaim land previously lost for agriculture, (b) to reduce salinisation and (c) to raise the average farm income. Some caution, however, is mandatory. Large scale drainage schemes might lead to destabilization of water table and the subsequently sinking of low lying land and aquifers.

**Composite Fish Culture at Different Salinities Using Cow Dung as Fertilizer**

Ponds of 100 $m^2$ each were filled, one month prior to stocking, in triplicate with waters having a salinity of 1.5, 4.5, 7.5, 11.5 and 14.5 dS $m^{-1}$ respectively. One week before stocking, surface breeding aquatic insects were eradicated and large macrophytes were mechanically removed.

Stocking density was 10,000 fish/ha of the species Catla catla, Labeo rohita, Cirrhinus mrigala and Cyprinus carpio at a 1 : 3 : 2 : 4 ratio. Semi-dry cow dung was applied biweekly at a rate of 24,000 kg/ha/yr. Fish were fed every two days at 2 percent body weight with a 1:1 mixture of rice bran and mustard oil cake. Before application the feed was soaked in water overnight and administrated as moist balls between 7.00 and 9.00 a.m, at 2-3 different places for each pond. Feeding rates were adjusted monthly. Biomass data were analyzed by ANOVA. Subsequent analysis with T test revealed that the biomass was equal for all salinities except for the highest (14.5 dS $m^{-1}$), which showed significantly lower biomass than all other treatments. Perhaps due to low prevailing temperature during the experimental period fish growth was moderate. However, with rise in temperature a substantial fish growth was recorded.

Garg and Bhatnagar (2002) showed that fish growth is positively correlated with the trophic status of pond waters. Deacon and Hecht (1999) also observed low growth rate and low feed conversion in juvenile spotted grunter, *Pomadasys commersonii*, at low salinity (5 ppt) than in iso-osmotic or hyper-osmotic (>12 ppt) salinity. Annekutty and vidhyar, (1995) also studied the ecology of brackishwater ponds fertilized with organic and inorganic fertilizers. Partridges and Jenkins (2002); Jana et al. (2006) and Barmen et al. (2005) studied the effect of water salinity on growth performance of different fishes.

**Table 5: Relative performance of common carp and Indian major carps grown at different salinities (in this table species are ranked from 1-4 with 1 indicating the highest growth rate).**

| Species | Salinity (dS/m) | | | | |
|---|---|---|---|---|---|
| | 1 | 4.5 | 7.5 | 11.5 | 14.5 |
| *Cyprinus Carpio* | 4 | 4 | 4 | 4 | 1 |
| *Catla catla* | 1 | 2 | 1 | 2 | 2 |
| *Labeo rohita* | 2 | 1 | 2 | 3 | 4 |
| *Cirrhina Mrigala* | 3 | 3 | 3 | 1 | 3 |

The effect of various organic fertilizers on fish production under brackish water condition shows that highest fish production was obtained in ponds treated with poultry droppings followed by cow dung. However, fish production was lower in ponds treated with duckery and sheep/goat wastes.

Under freshwater (canal control) conditions also highest fish production was recorded in fish pond s treated with poultry droppings, followed by cow dung, duckery and sheep/goat (Table 6). Except for poultry treated ponds, fish production remained a little on the higher side under brackish water ponds in comparison to similarly treated fresh water pond s. An analysis of hydrobiological characteristics indicate that Gross Primary production (GPP) under brackish water conditions was higher in the ponds treated with poultry droppings, followed by cow dung, duckery and sheep/goat.

**Table 6: Effect of different organic wastes on fish production**

| Treatment (tonn/ha/yr) | Source of water | Mean initial weight (g) | No. of fish stocked 100 m2 | Mean av. Weight after 3 months (g) | Gross weight after three months (kg) | Gross fish production ha(kg) |
|---|---|---|---|---|---|---|
| Cow dung (24.0) | BW<br>CW | 23.5<br>24.0 | 50<br>50 | 70.4<br>85.6 | 35.0<br>42.0 | 3500<br>4200 |
| Cow dung (20.0) | BW<br>CW | 20.0<br>17.0 | 50<br>50 | 70.0<br>73.4 | 35.0<br>35.0 | 3500<br>3500 |
| Poultry (1.5) | BW<br>CW | 14.5<br>13.0 | 50<br>50 | 92.0<br>90.0 | 45.0<br>42.0 | 4500<br>4200 |
| Duckery (6.0) | BW<br>CW | 16.5<br>20.0 | 50<br>50 | 74.0<br>81.0 | 34.0<br>37.0 | 3400<br>3700 |
| Sheet/Goat (1.5) | BW<br>CW | 13.2<br>16.6 | 50<br>50 | 63.0<br>67.4 | 34.0<br>34.0 | 3408<br>3400 |

BW= Brackish water; CW= Canal water

Result of these studies indicate the usefulness of poultry, cow dung, sheep/goat excreta in fish culture under brackish water conditions at suitable substitutes for costly feeds and fertilizers being currently in use under intensive fish farming.

## 4. CONCLUSION

Following economical viable production of carp can be obtained

| | | |
|---|---|---|
| a. | Production cost/ha/yr | Rs. |
| 1. | Lease charges for the pond | 10,000 |
| 2. | Various types of Nets and other instruments | 10,000 |
| 3. | Feed and fertilizers | 20,000 |
| 4. | Fish fry | 10,000 |
| 5. | Labour charges + watch and ward | 10,000 |
| | **Total** | **60,000** |

Fish production = 4000 kg/ha/yr

Price of fish = 35 Rs. Per kg.

Total price of 4000 kg fish = 140000 Rs.

**Net profit** = 140000-60000= Rs. 80,000

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