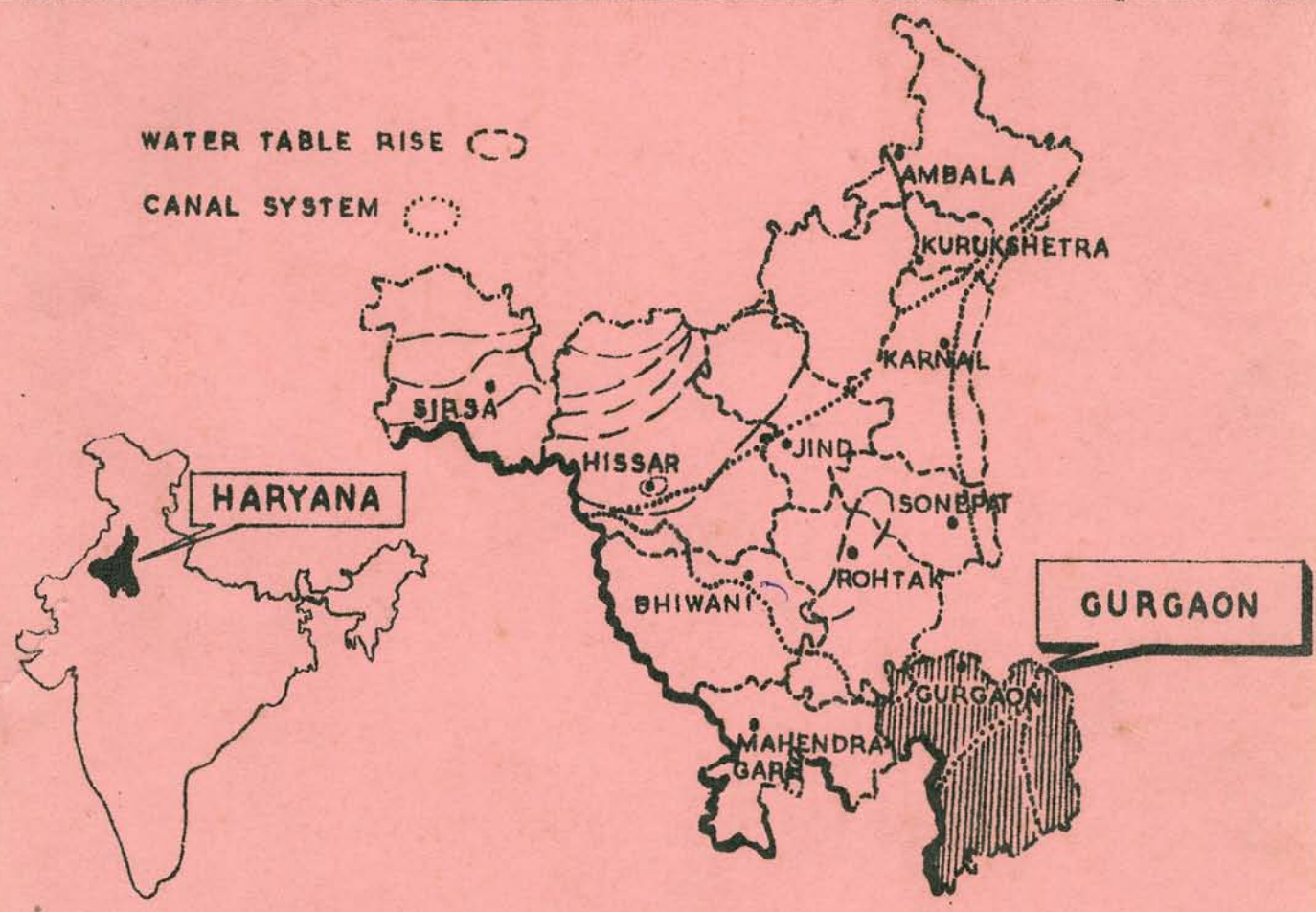


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FEASIBILITY SURVEY REPORT ON UTILISATION OF SALINE GROUND WATER OF GURGAON DISTRICT FOR AQUACULTURE



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PREFACE

As per decision taken at a meeting on 29 March 1981 in Gurgaon District presided over by the Hon'ble Minister for Agriculture, Government of India and on specific instructions from Dr. O.P. Gautam, Director General, Indian Council of Agricultural Research, the CIFRI took up a preliminary survey of water, soil and biota of ponds, wells etc. in Gurgaon District with a view to exploring the suitability of utilising saline ground water for aquaculture. The team comprising scientists Sarbashri G. N. Saha, K.L. Shah, and S.C. Thakurta, covered all the six blocks, collected as many as 21 samples of pond and well waters, 14 samples of pond soils and 13 samples of plankton and benthos. On the basis of this survey and detailed discussion held with local officials the present report was drawn up which highlights distinctive ecological features of the stretches covered besides focussing constraints as well as scope for development of aquaculture in this area. The team has received willing assistance and cooperation from the local officials which is gratefully acknowledged here. Special words of thanks in this connection are also due to Dr. D.K. Kaushik, Director of Fisheries, Government of Haryana, Shri D.V. Khanna, Deputy Director of Fisheries, Government of Haryana, Shri S.P. Chowdhuri, Fisheries Development Officer, Gurgaon, and Shri V.S. Vishnoi, Hydrologist, Ground water Cell, Agriculture Department, Haryana. The report carries suitable recommendations that have been drawn up on the basis of data collected during present survey as well as past work by State Geo-hydrologists.



A.V. Natarajan
Director

10.6.1981

FEASIBILITY SURVEY REPORT ON UTILISATION OF SALINE GROUND
WATER OF GURGAON DISTRICT FOR AQUACULTURE

Introduction

Haryana is a small semi arid State in northern India and is situated between latitudes $27^{\circ}39'$ to $30^{\circ}55'$ N and longitudes $74^{\circ}27.8'$ to $77^{\circ}36.5'$. It has an area of 44222 km^2 . The State lies almost in the Indo-Gangetic alluvial plain of northern India. In the extreme north there is small area of tertiary sedimentary rocks which form the Siwalik Hills and in the south the precambrian quartzite ridges of the Aravalli Hills. The sand dunes on the west and south-west form the exterior of Thar desert. Most of the plain lies at elevation of 200-300 m.s.l.

The occurrence of saline ground water mineralisation is more marked in the central and western parts of Haryana. Saline aquifers are met in parts of Haryana, Rajasthan and Gujarat and since these States are being water deficient, the use of saline ground water becomes important. In Haryana there is a typical problem of rise of saline ground water table in canal command areas due to the non flushing of the interior drainage. No extensive canal system exists in saline areas, but in northern areas of the State fresh ground water aquifers occur below the saline aquifers. The salinity hazards are assuming serious proportions due to inadequate drainage. With a view to utilising the saline ground waters for aquaculture, a short survey of the Gurgaon District was conducted, the results of which are presented in the following pages.

Location

Gurgaon District is situated on the south-east corner of Haryana State. It is one of the largest districts and has an area of 4889 km^2 with a population of 840817 (1980). It lies between $27^{\circ}28'$ south to $28^{\circ}-33'-30''$ north latitude and $76^{\circ}41'$ west to $77^{\circ}-32'-30''$ east longitude. It is bordered by the Union territory of Delhi and Rohtak district in its

north, Mahendragarh district in the west and Alwar and Bharatpur districts (Rajasthan) in the south. It comprises 6 blocks—Gurgaon, Sohna, Nuh, Pataudi, Punhana, and Ferozpur Zhirka.

Physical feature

There is a slope in the land from west to east in Gurgaon district. On the northern side there is a vast area of low lying basin (Sultanpur lake) which is a natural bird sanctuary and for which a tourist complex has been developed. The basin had almost dried up. The most part of Ferozpur Zhirka is valley between the two ranges of Aravalli. On the eastern side, there lies the Gurgaon canal supplying water to Punhana, Nuh, and Sohna blocks. The water bearing strata varies from 3 - 74 metres. It is generally shallow in Nuh and Ferozpur Zhirka and deep in Gurgaon.

Climate

The climate of Gurgaon is semi-arid. The annual rainfall of the district during the years 1978, 1979 and 1980 was 728.33 mm, 300.82 mm and 455.7 mm respectively, the last two consecutive years being drought years. July, August and September are the main rainy months, of which August receives bulk of the rain. November, December, March and April have least rainfall and these months are practically dry. The relative humidity is generally high (72-85%) during the monsoon and it ranges from 67-72% during the winter season. The average maximum and minimum temperatures of the district are 46.5°C and 0.6°C respectively. The highest temperature is recorded in May (47.0°C). Fluctuations of temperature take place when dust storms are followed by light showers. The climate is extreme, hottest during summer and coldest during winter.

Soils

The soils of Gurgaon district are mainly of sandy loam, and loamy in texture. The soils of Ferozpur Zhirka, major parts of Punhana, Nuh and south-western portions of Sohna and Gurgaon blocks are loamy sand and well drained. However, central parts of Ferozpur Zhirka and Nuh have heavier textured soils showing imperfect drainage in some places.

Ground water qualities

The ground waters of Gurgaon district have been categorised into 5 types, viz. (i) Good waters ($EC \times 10^6 / 2000$),

SAR ≤ 10 and RSC < 2.5 (ii) Normal waters ($EC \times 10^6 = 2000-4000$, SAR ≤ 10 , RSC < 2.5 .) (iii) Sodic waters ($EC \times 10^6 < 4000$, SAR > 10 and RSC > 2.5) (iv) marginal saline waters ($EC \times 10^6 = 4000-8000$, SAR < 10 and RSC absent and (v) Saline-sodic waters ($EC \times 10^6 > 4000$, SAR > 10 and RSC > 2.5).

Report shows that 28% of ground waters in the district on an average are good, 12 percent normal, 15 percent sodic, 12 percent marginally saline and 33% saline sodic waters, i.e. of poor quality for crops.

Most of the subsoil waters of Sohna, Nuh, and Ferozpur Zhirka blocks adjoining the foothills of Aravalli ranges are good to normal quality. But the central part of the above blocks are predominantly brackish. Besides, the soils are heavy in texture with clay loam at lower depth with impeded drainage and waters are hazardous to crops.

The blocks which are badly affected with salts are presented in the table below:

* HIGHLY SALINE GROUND WATERS OF THREE BLOCKS OF GURGAON DISTRICT			
Block	Village	Electrical conductivity (micro mho/cm) $\times 10^6$	pH
Nuh	Akaira	34500	7.5
	Bainsi	24400	7.7
	Bhangka	23400	9.5
	Dhaudhuka	43500	7.2
	Ferozpur Nimak	1600-47500	7.2-8.5
	Ghasera	1050-39000	6.8-8.7
	Indri	1700-11000	7.8-9.2
	Kotlu	1800	8.6
Ferozpur Zhirka	Dhanwa	18500	8.3
	Hasanpur-Nuh	15000	7.7
	Kankar Kheri	26500	7.4
	Sukhpur	17500	7.9
	Kameda	2000	8.3
Gurgaon	Basai	11500	8.2
	Bhanwapur	10800	7.7

Source: Quality of ground waters of Haryana (1972) by H.R. Manchanda, Haryana Agricultural University, Hissar.

*Source: Data supplied by the Hydrologist, Groundwater Cell, Agricultural Department Haryana.

Of the above blocks, the ground water in most of the areas of Nuh is highly saline.

Most of the waters of Sohna and Pataudi blocks have high residual sodium carbonate which is harmful to crops. Use of gypsum with the irrigation waters is recommended so as to amend sodium hazard.

Observation during the survey

During the survey white patches of salt incrustations in the fields of Sohna, Nuh, and Gurgaon on both sides of the road were observed. Most of the ponds were dry excepting those which were canal fed at Sohna, Nuh, Punhana and Ferozpur Zhirka. No saline water-logged area was encountered in the district during the survey. The village ponds, which have been renovated under food for work programme are managed by the Panchayats. The pond waters are used for domestic purposes as well as for bathing of cattles. In most cases, wells are present by the side of the pond. During summer, waters of some wells become saline and during monsoon these turn fresh when the pond is full with rain water. When well waters in summer become more saline, these are not generally used for drinking purposes.

Most of the ponds are seasonal and accumulated rain water is the main source of fish culture. The State Department of Fisheries has got one seed farm at Dum Dama in Sohna block. Construction of more seed farms during the plan period has been envisaged.

A hot spring within the town area of Sohna exists. The water temperature is about 55°C and the water source is abundant.

Shallow brine wells*

It was interesting to note a few brine wells in Sultanpur village. It is reported that there are about 350 abandoned brine wells in Farrukhnagar-Garhi area of Gurgaon district, of which 250 wells exist in these four isolated brine tracts of the area viz. (i) Sultanpur (ii) Mubarakpur-Bassirpur, (iii) Sadhrana and (iv) Kaliawas-Ikbalpur. These wells are of 3 to 4 m in diameter and 1.8 to 4.5 m deep. In nineteenth century salt industries flourished in this area. A large quantity of salt was extracted from these wells till the first quarter of twentieth century. Later, these industries were closed down as because the cost of salt extraction from these wells became uneconomical and competition faced from the salt industry of Sambhar Lake.

The ground water brine contains Sodium and Chloride as the most important ions. The concentration of sodium ranges from 4750 to 7875 ppm, magnesium from 335 to 1248 ppm, calcium from 160 to 720 ppm. The pH values of brine varies from 7.7 to 8.2. The density of brine varies from 1 to 3.5°Be .

Ground water brine occurs at very shallow depth ranging from 1.8 to 4.5 m below ground.

The chemical composition of groundwater of this area could be compared to the chemical composition of sea water except that the intensity of concentration of individual constituent varies. The brine does not contain bromine and iodine.

Of late, Industries Department, Government of Haryana, has revived the project of salt extraction on experimental basis from the wells at Sultanpur village one-and-a-half years ago.

Chemical parameters of pond and well waters

Analysis of pond and well waters are presented in the Table 1 and Table 2 respectively.

Pond water

It is seen from the Table 1 that water temperature varied from 28.0 - 35.0°C with air temperature ranging from 34.0-43.0°C. The reaction of water was fairly alkaline with pH varying 7.6 - 8.6.

Electrical conductivity in these pond waters was comparatively higher (756 - 4410 micro mho/cm) as compared to fresh water ponds (150-660 micro mho/cm) which indicated higher concentration of salts in Gurgaon waters. It is also quite evident from the salinity values of pond waters in Dhanwapur, Sultanpur, Indri II and Rawasan (1.98, 1.20, 1.60 and 1.50 ppt. respectively). Alkalinity of water was on the higher side (> 200 ppm) excepting in few places. A very high value of alkalinity 878 ppm was recorded in Dhanwapur followed by 584 ppm in Ghasera. Magnesium content of waters (40-196 ppm) was much higher than calcium (5.0-74.0 ppm). Ammonical nitrogen concentration of waters excepting a few was found unusually

*Source : Chemical nature of shallow ground water brine in the alluvial tract of the Farukhnagar area of district Gurgaon, Haryana by B.S. Tanwar.

high which was not generally encountered in unpolluted fresh waters. These high values of ammonical nitrogen would be inimical to fish in cases where the water pH is high. These waters were also rich in nitrate (0.04-3.0 ppm) and phosphate (0.08-0.90 ppm) excepting a few places.

Well waters

The pH of well waters was fairly alkaline (7.6 - 8.2). The well waters in Dhanwapur and Ferozpur Nimak were fairly saline showing Ec value more than 8000 micro mho/cm. The brine well at Sultanpur had high Ec value 31500 micro mho/cm with corresponding salinity 41.0 ppt. Excepting Sultanpur brine, the alkalinity of waters in all other wells was very high (> 250 ppm). Magnesium content of waters (100-1800.0 ppm) was many times higher than calcium (16.0 - 750.0 ppm) as compared to pond waters. In contrast, the concentration of nitrates was higher than ammonical nitrogen in well waters, excepting that in Farrukhnagar and Sultanpur. The concentration of phosphate of well waters was comparatively less than that in most of the pond waters. The details are presented in Table 2.

Characteristics of pond soils

The data of soil analysis are presented in Table 3. The pond soils were sandy loam to loamy in texture. The soil pH ranged from 7.2-8.0 with higher values in Gurgaon blocks. From the Ec values, it was noticed that the pond soil in Laphuri is saline showing conductivity of 5670 micro mho/cm. Ec values of the rest of the pond soils though less than 4000 micro mho/cm. showing non-saline characteristics of soils, but some of these values were quite high as in Indri I and Indri II (3654 and 2016 micro mho/cm) and in Ghasera (2016 micro mho/cm). The soils were rich in available phosphorus and the values recorded were above 6 mg P₂O₅/100 gm soil. Available nitrogen in comparison was of poor to medium range of productive level (6.16 - 37.70 mgN/100 gm soil). Correspondingly the soils were also poor in organic matter (0.21-0.51% carbon.).

Plankton and Bottom biota

Analysis of plankton samples collected from ponds of Gurgaon has been presented in Table 4. Heavy blooms of Microcystis aeruginosa and M. flos-aquae were observed in ponds/Gurgaon block. Blooms of Spirulina sp. and Anabaenopsis / of sp. were observed in Punhana and Nuh blocks. Gyrosigma sp. and Navicula sp. were encountered from the brine well and Sultanpur pond respectively.

Spirulina sp. and Gyrosigma sp. have been reported to be brackishwater forms which are tolerant to fluctuating salinities. The presence of these two forms in these inland saline tracts is quite interesting.

Zooplankton was dominant in rest of the ponds and represented by species of Euglena, Trachelomonas and Phacus; Rotifers by three species of Brachionus, Filina, Testudinella sp. Asplanchna sp. and Keratella sp.; Cladocera by species of Daphnia, Moina and Ceriodaphnia and copepods by species of Diaptomus and Cyclops.

The bottoms biota was extremely poor. It was represented by Chironomid larvae, oligochaetes and gastropods only at four stations. The data is presented in the same Table.

Inferences

Based on the preliminary survey, available literature, and information collected from different sources, the inferences drawn are given below:

1. The ecology, topography, edaphic factors, and water qualities of Gurgaon district are quite different from those that exist in coastal region used for brackish-water fish culture.
2. In coastal areas brackishwaters are abundantly available through tides for flooding the ponds, while in Gurgaon the supply source will be saline ground water aquifers. The adequacy of this source for the large scale farming needs further investigation.
3. Both in pond and well waters of Gurgaon, cation magnesium is much higher in concentration than calcium, specially in the latter. In case of anions chlorine is more than bicarbonate. This phenomenon indicates the saline characteristics of waters during the summer. In general, calcium and bicarbonate are more than magnesium and chlorine respectively in freshwaters.
4. Since the soil in Gurgaon is of lighter texture (sandy loam to loam), the seepage loss of water would be higher unless the water table is close to the surface.

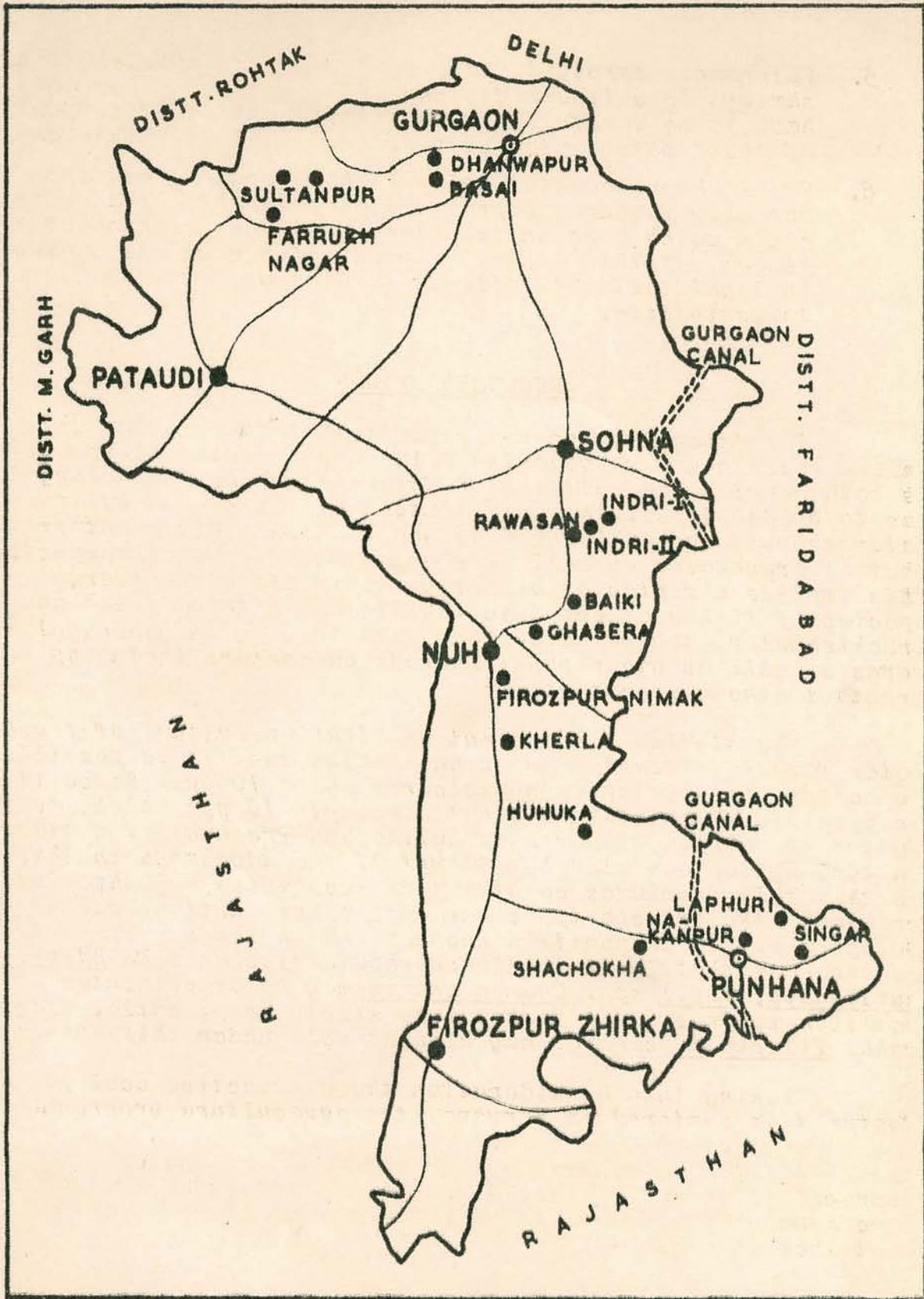
5. Tolerance, survival and growth of brackishwater fishes/shrimps in saline-sodic and sodic waters of Gurgaon have to be carefully assessed since the salt composition of these waters will vary from coastal brackishwater.
6. Fairly heavy coastal soils rich in organic matter normally favour the production of benthic blue green algae which form an important food for brackishwater fishes. Whether a similar production could be achieved in light textured soils as in Gurgaon requires investigation.

RECOMMENDATIONS

The foregoing account reveals that the problem of inland brackishwater aquaculture in Gurgaon using saline water is both complex and challenging for which a new technology has to be developed. The salt content of the ground saline water encountered in Gurgaon is qualitatively different from that of freshwater as well as coastal water in many respects. This implies a series of experimental trials with diverse species of fishes of economic importance, both of fresh and brackishwater, to evaluate their adaptability in osmoregulatory terms as well as other physiological parameters including growth to the new ecotope.

The studies carried out by CIFRI on culture of freshwater fishes in coastal areas have shown that it is possible to culture freshwater economic carps up to 10 ppt. Since it is possible to maintain the salinity upto 10 ppt and below in Gurgaon by conjunctive use of saline and freshwater, similar culture system can also be attempted. The advantage in this is that this precludes coastal fish seed which may throw up problems like transport, higher cost of production, market etc. Going by biotic communities encountered in the survey it is recommended that initially brackishwater fishes like Etrophus suratensis, Mugil spp. Chanos chanos may be experimented in addition to freshwater fishes like silver carp, catla, mrigal, rohu. Tilapia mossambica may also do well under this eco-system.

Taking into consideration the distinctive ecological features encountered in Haryana, the aquaculture programme needs to be purposefully supported by ecological studies to facilitate development of a sound aquaculture system appropriate to arid zone. As such it is suggested that an Arid Zone Aquaculture Research Centre be set up at Gurgaon to meet these objectives.



MAP OF GURGAON DISTRICT HARYANA SHOWING DIFFERENT STATIONS VISITED AND SAMPLES COLLECTED DURING SURVEY

TABLE 1 : PHYSICO-CHEMICAL PARAMETERS OF POND WATERS OF GURGAON DISTRICT
(as ppm)

AIR TEMPERATURE 34.0 - 43.0°C

Village	Water temp. °C	Conductivity BC x10 ⁶	pH	Total alkalinity CaCO ₃	Calcium (Ca)	Magnesium (Mg)	Salinity (Ppt.)	Chloride (Cl)	Ammoniacal Nitrogen (NH ₄ -N)	Nitrate nitrogen (NO ₃ -N)	Phosphate P ₂ O ₅	D.O.
Dhanwapur	35.0	4410	8.3	878.0	18.0	128.0	1.98	1100	5.0	2.0	0.8	10.0
Sultanpur	28.0	3780	8.6	150.0	5.0	48.0	1.20	700	1.5	1.0	0.20	5.6
Indri I	32.0	1260	7.6	250.0	8.0	76.0	0.54	300	2.0	0.50	0.60	8.0
Indri II	29.0	3150	7.8	140.0	10.6	170.0	1.60	900	Traces	Traces	0.08	8.0
Rawason	30.0	2520	8.0	190.0	38.0	130.0	1.50	800	3.0	0.70	0.9	5.2
Baiki	31.0	945	8.0	268.0	14.0	56.0	0.28	100	Traces	3.0	0.12	4.4
Ghasera	29.0	2520	8.4	584.0	74.0	196.0	0.90	500	3.0	0.80	0.60	5.0
Kherla	28.0	1890	8.2	340.0	48.0	90.0	0.54	300	2.0	0.06	0.60	4.6
Shachokha	29.0	1701	8.0	216.0	40.0	56.0	0.18	100	1.0	Traces	0.40	6.0
Nekanpur	30.0	756	7.8	200.0	30.0	40.0	0.09	50	2.0	0.04	0.30	8.0
Laphuri	29.5	1890	8.0	290.0	52.0	80.0	0.54	300	1.8	0.50	0.70	5.0
Shingar	28.5	2520	8.0	360.0	34.0	148.0	0.72	400	3.5	0.12	0.16	6.4
Huhuka	30.0	756	7.8	170.0	20.0	48.0	1.50	800	0.04	1.0	0.12	5.8

TABLE 2 : WATER QUALITIES OF WELLS OF GURGAON DISTRICT

(As ppm)

Village	Conductivity (EC x10 ⁶)	pH	Total alkali- nity	Calcium (Ca)	Magnesium (Mg)	Salini- ty (ppt)	Chloride (Cl)	Ammonical Nitrogen (NH ₄ -N)	Nitr- ate Nitro- gen (NO ₃ -N)	Phos- phate (P ₂ O ₅)
2	3	4	5	6	7	8	9	10		12
Dhanwapur	10710	7.8	260.0	260.0	789.0	7.02	3900	0.15	1.5	0.08
Basai	1764	7.6	270.0	16.0	180.0	0.72	400	0.6	0.9	0.08
Sultanpur (brine well)	31500	7.8	140.0	750.0	1800.0	41.10	24500	0.02	0.02	0.16
Farrukh- nagar	3780	8.0	472.0	20.0	240.0	1.8	100	5.0	0.12	0.15
Indri	1260	8.2	400.0	30.0	100.0	0.54	300	0.6	3.0	0.04
Ferozpur Nimak	8190	8.0	440.0	176.0	420.0	4.3	2400	0.18	0.6	0.04
Shahchokha	1890	8.2	450.0	26.0	114.0	0.54	300	0.20	2.0	0.20
Singar	3780	8.0	500.0	26.0	288.0	1.8	100	0.28	0.7	0.20