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22710

FINAL REPORT ON

IRRIGATION USING TREATED TANNERY EFFLUENT

Contract: US/RAS/92/120/ .Amendment B

CONDUCTED BY

RANIPET SIDCO FINISHED LEATHER EFFLUENT TREAMENT CO. LTD

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TABLE OF CONTENTS

LIST OF SYMBOLS & ABBREVIATIONS

BDL	:	Below Detectable Limit
BOD_5	:	Biochemical Oxygen Demand, 5 days
^oC	:	Degree Celsius
CETP	:	Common Effluent Treatment Plant
Cl	:	Chlorides
cm	:	Centimeter
COD	:	Chemical Oxygen Demand
DO	:	Dissolved Oxygen
d	:	Day
dia	:	Diameter
EC	:	Electrical Conductivity
h	:	Hour(s)
ha	:	Hectare
HD	:	High density
HP	:	Horse power
ILIFO	:	Indian Leather Industry Foundation
INR	:	Indian Rupees
kg	:	Kilogram
kg/ac	:	Kilogram per acre
kW	:	KiloWatt
l	:	Litre
l/s	:	Litres per second
m	:	Meter
m^2	:	Square meter
m^3	:	Cubic meter (1000 litres)
mg/l	:	Milligrams per litre
no.	:	Number
pH	:	Negative logarithm of hydrogen ion concentration
PVC	:	Poly Vinyl Chloride
s	:	Seconds
SIDCO	:	Small Industries Development Corporation
t	:	Tonne (1000 kg)
TOC	:	Total Organic Carbon
TDS	:	Total dissolved solids
TSS	:	Total suspended solids
UNIDO	:	United Nations Industrial Development Organisation
V	:	Volt
W	:	Watt
w/w	:	Weight/ weight
μ	:	Micron

EXECUTIVE SUMMARY

To tackle the problem of disposal of treated effluent and sludge from the CETP, SIDCO CETP, Ranipet has taken up two projects with assistance from UNIDO.

The first of these, named as the 'mini forest project', launched after a series of experiments with irrigation of trees using the treated effluent from the CETP was commissioned in January 2000. It comprises of 8.9 acres of land, divided into 11 blocks. The low saline treated effluent has been used in rehabilitation of the degraded land in raising trees numbering about 22,000. The trees namely:

Acacia mangium, Enealyphis terrestis, Casuarina equisetifolia, Azardichta indica, Pongamia pinnata, Tectona grandis, Terminalia arjuna, Dendrocalamus strictus, Melia agadirach, Thespesia populnea

These trees are grown intermingled in all the blocks. A road runs in the center of park and also contains a park with a lawn and flower beds

The peizometers for collection of ground water samples were installed in certain locations in the mini forest to ascertain the quality of the ground water on a regular basis.

The location of the peizometers were: near the trench 6 feet, Near the trench 40 feet, Ridges & furrows 6 feed, Ridges & Furrows 40 feet, Park Area 6 feet, Park Area 40 feet, Pond Area 40 feet,

The ground water was analysed for the parameters as follows: pH, EC, TDS, Chlorides, Sulphates, Total hardness, Calcium hardness, Magnesium hardness, Calcium ,Magnesium

Apart from ground water, soil samples at different depth and growth parameters were also tested. The growth parameters were taken to establish the height and girth variations of different trees for the application of treated effluent irrigation. Among the trees Eucalyptus and Casuarina are on par with each other with the growth parameters regarding height and firth followed by Mangium and Bamboo. The salinity was high in some spots of the field eg. Blocks F, G and J. The growth of the trees varies widely with the other blocks. Reclaimation measures are being undertaken with the incorporation of chemicals such as gypsum, biofertilizers etc.

The salinity status of ground waters is subject to variation during different seasons of the year, which depends upon the quantum of its use and gradual variation in recharge potential and continued contact of recharge waters with minerals at lower depths after the cessation of the monsoon. The sum total of these charges would determine the salt balance and sodic effects on soils irrigated by these waters.

During the hot summer months, the salinity status of the ground waters is high and after the monsoon it becomes low. Due to the excessive evaporation the water is raised to the surface by capillary action causing salt encrustation on the surface area and increasing the salt contact of the underground waters. The TDS, Chlorides and total hardness increases to a peak in the summer months of April – May.

The salts dissolved in irrigation water would accumulate linearly in the soil with member of irrigations over the years depend upon the several factors, the most important being annual rainfall. The soluble salts and exchangeable sodium which are introduced with the irrigation water during the summer season in the soil profile are reduced in the rainy season. The leaching of the salts depends upon the accumulated salinity and the amount of rainfall. The annual rainfall received in Ranipet amount to 650 mm – 750 mm concentrated mostly from September – December (North East monsoon) when the TDS, Chlorides and hardness of the ground water reduces. The profile salts are leached down very efficiently, rendering soil at 0 – 40 cm depth in the surface as non – saline.

The project provided valuable information regarding the suitability of utilising low saline treated effluent from tannery CETPs and achieved the following objectives:

- Utilisation of substantial quantity of treated effluent from the CETP
- Rehabilitation of the land, degraded due to previous discharge of untreated effluents.
- Growing up trees, with some economic potential.

The second project was involving composting of the sludge generated in the CETP, mixed with suitable amendments and improved aeration using earth worms. Two sets of trials were taken up and later a full vermi-composting trial with guidance from the International expert of UNIDO too was taken up.

The earlier earth-worm assisted trials were organised in shallow heaps, allowing conventional process of composting to set up for a period of 4-5 weeks and then inoculating the heaps with earthworms, which is believed to help improve air movement within the composting pile and thereby avoiding the requirement of periodical turn-over. The trials indicate that the procedure, though longer than the conventional composting, need lower amount of amendments to achieve a satisfactory product.

However, it was recognised that this procedure is somewhat unconventional and hardly resembles the common vermi-composting techniques. Later under the guidance of the international expert, a proper vermi-composting trial was organised and the results were found to be satisfactory.

The compost produced is generally used within the mini project in the CETP. Some quantity has been sold to plantation companies and it is expected that if the chromium content in the compost could be brought down further, marketing of the product compost in a commercial manner could be taken up.

1. INTRODUCTION

The CETP-SIDCO treats effluent from 86 tanneries in the Sipcot industrial area of Ranipet. These tanneries process semi processed hides and skins to finished leather.

The treated effluent of CETP generally contains TDS at a level of < 4500 mg/l and chlorides, < 900 mg/l. Though these levels are higher than those prescribed by the TNPCB for irrigation (2100 mg/l TDS and 600 mg/l chlorides), with the concurrence of the Board, it was decided by UNIDO to evaluate the feasibility of utilising such effluent for irrigation of inedible plants.

Accordingly, experiments were planned in the CETP in a methodical manner and it was decided in the beginning that the project would have adequate time for studying ill effects, if any, on soil and ground water.

Initially a trial plot of 400 m^2 was developed in April 1997, just to assess the survival of different plants in the saline treated effluent. This experiment established that the treated effluent did not affect the survival or growth of selected plants. On the contrary, it seemed to help. The trees grown included *silk cotton*, *eucalyptus* and *casuarina*. Following encouraging results from this experiment, another experiment was implemented in a larger plot of 800 m^2 area in which eight varieties of plants were tried. Also various combinations of feeding pattern including 100% treated effluent, treated effluent and ground water in the ratio of 50:50, ground water alone, treated effluent with sludge, fresh water with composted sludge etc. were tested. The results established the feasibility of using treated effluent for irrigation. The growth of trees was impressive.

As mentioned above, the early experiments were mainly to establish the survival of plants when irrigated by saline effluent and were not monitored for other parameters. Based on the experience gained, a third experiment with the support of Indian Leather Industry Foundation (ILIFO) and technical guidance of UNIDO was taken up. In this project, *Acacia mangium,* which was growing very well in the treated effluent as observed in the earlier experiment, was selected for plantation. An area of 1600 m^2 behind the CETP, adjacent to the experimental plot No. 2 (800 m^2 area), was chosen.

Encouraged by the positive results of these experiments, the CETP sought technical assistance of UNIDO for development of a low lying, degraded land, adjacent to its premises, measuring 3.55 hectares, into a mini forest, using treated effluent for irrigation. SIPCOT, a state government industrial promotion organisation and owner of the land, also expressed its willingness to provide the land, free of rental, for use by the project.

Specific objectives of the project were:

- To rehabilitate the apparently degraded land by converting it into a mini forest.
- To utilise the treated effluent as much as possible to minimise environmental impact outside the irrigated plot.
- To test and confirm the survival of the different varieties of plants irrigated by the treated tannery effluent and compare their growth rates.
- To test and confirm the extent of ground water and soil contamination due to continuous irrigation by treated tannery effluent.
- To achieve progressively zero discharge status for the CETP.

- To recover revenue from the land considered degraded and unusable.

The earlier irrigation trials also established the fact that application of sludge does not have any adverse effect on the growth of the plants. Accordingly, simultaneous with the above trials, attempts to utilise the sludge by composting it too had been taken up and following trials, a shed with 100 m^2 area was constructed and trials were conducted. Later with assistance from UNIDO, another shed of same area with 6 heaps of composting too was implemented. Objectives of these experiments were:

- To condition the sludge with some amount of composting taking place, in a most simple manner, to make it fit for use as a soil conditioner.
- To obtain sufficient quantity of material to supplement the requirement of fresh compost in the miniforest project.
- To attempt the conventional vermi-composting in pilot scale.

2. MINIF FOREST PROJECT DEVELOPMENT

M/s. Archana Agrotech Pvt. Ltd, Chennai was entrusted by the CETP with the job of surveying the proposed area and preparing a detailed design for irrigation of the area. After surveying the entire area for contour levels etc. The company made a design of the project site, which included the contour map, scheme of plantation and piping details.

The basic design consisted of dividing the entire plot into 11 sections and planting of different varieties of trees, intermingled. Plantation of different varieties of trees had been planned in such a way that the low-lying areas were planted with those varieties, which could withstand comparatively high salinity. The area was to be developed into ridges and furrows.

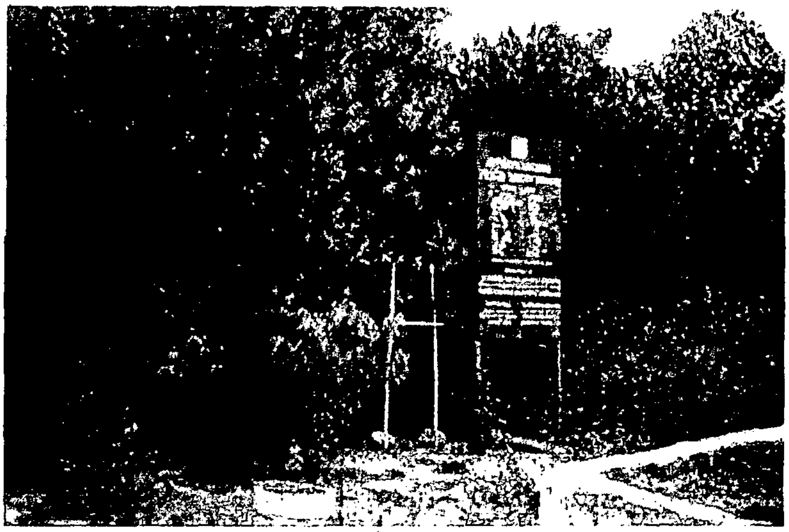
In the middle of the site, a central park of about 0.5 acre had been envisaged. This park was to be planted with grass and flowering shrubs.

A pond of about 10 m diameter at the end of the irrigation plot was planned, mainly to collect surface run-offs. Lotus was to be planted in the pond.

A road was to be formed from the entrance till the end of the plot cutting through the forest in the middle. Avenue trees were to be planted on either side of the road.

The condition of the area, which is today, a mini forest and where the untreated effluent used to accumulate earlier is shown in pic.1. The front side of the mini forest after the development is shown in pic. 2.

Pic.1: Degraded land



Pic.2: A view of the mini forest in June 2001

The following arrangement was made for transport and distribution of treated effluent:

A collection sump of 5.0 m x 5.0 m x 2.5 m was constructed for collection of treated effluent by gravity. The treated effluent collected was pumped to the irrigation plot using a centrifugal pump of 3.75 kW capacity through 90 mm distribution lines. The collection tank was provided with suitable arrangement to let out the effluent through the normal discharge line, if the collected treated effluent was not needed for irrigation.

The earthwork and levelling was started by the third week of December 1998 and plantation began by the third week of January 1999. Some very low lying areas were filled up with fresh soil.

Regular irrigation of the plants was started in some sections by the beginning of February 1999. Initially around 250 m^3/d of treated effluent was utilised for irrigation and the volume was increased steadily as more sections were planted with saplings.

3. MONITORING OF MINIFOREST

Before developing the area samples of ground water and soil were collected for obtaining baseline data. Treated effluent was analysed on a daily basis. A detailed monitoring schedule followed by the subcontractor is given below:

- The treated effluent used for irrigation was analysed for all the parameters specified by the TNPCB viz., pH, Total dissolved solids, Chlorides, Sulphates, EC, BOD @ 20° C, COD, (on a daily basis) Total chromium, Percent sodium, Total Kjeldahl Nitrogen, Nitrates as NO_3, Phosphates as PO_4 (on a weekly basis)
- Soil samples inside and outside the mini forest, once in three months, at 6 points & at the surface, 0.3 m & 0.6 m in each point, total 18 samples, for parameters such as pH, N kg/ ac, P_2O_5 kg/ac, K_2O kg/ac and Cr kg/ac.

- Ground water samples, twice a month, at two depths (6 ft and 40 ft, Number of sampling points: 4 – 8 samples). Parameters checked in ground water samples were pH, TDS, Chlorides, Sulphates, BOD_5, Total chromium and Percent sodium
- Other parameters such as the volume of treated effluent admitted, growth factors such as height and girth of trees, meteorological data such as humidity, rainfall, temperature etc. were regularly monitored & recorded.

4. PROJECT INFORMATION

4.1 Number of saplings planted

As the area available for plantation was less than 3.6 hectares, the distance between saplings was kept low. Altogether around 25,000 saplings were planted in the area.

4.2. Irrigation pattern

Originally the entire effluent admitted to the mini forest was fed through pumping from the treated effluent collection sump. The valves in the branches were opened to admit treated effluent into each bay for about 45 minutes every day. Control valves were kept open and closed in such a way that any time during the day, at least 35% of the lines were open.

Later, to increase the feed, a separate earthenware pipeline (200 mm) was laid to admit effluent through gravity. This line has been operational since January 2001.

4.3. Effluent used for irrigation

The volume of treated effluent used for irrigation is given in figure 1:

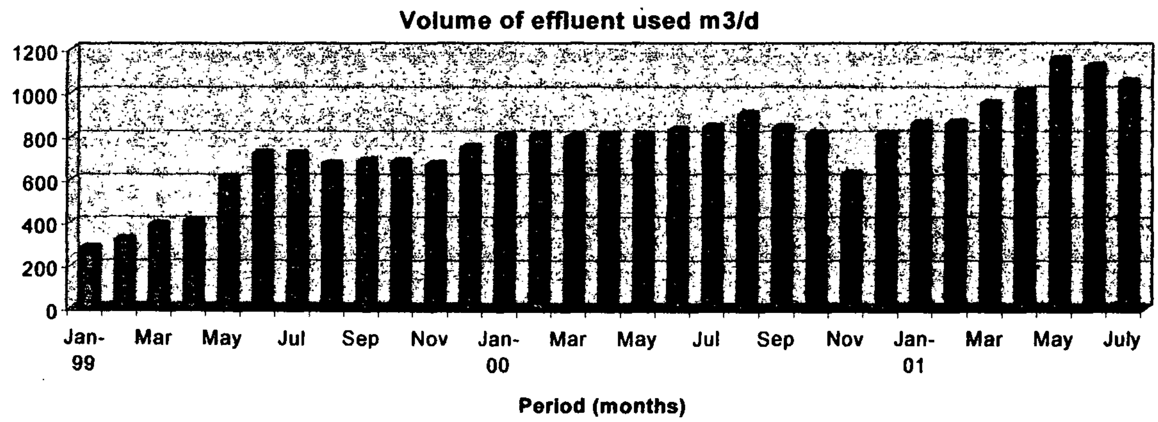


Fig.1: Volume of effluent used in miniforest m^3/day

4.4. Survival of plants

All plants survived & grew well except for *Eucalyptus* and *Casuarina* in the early stages. This was because these saplings were procured as naked seedlings. Replanting these varieties was carried out with saplings of average height of (30 cms) in poly bags. The survival rate, as of June 2001, is given in Table 2:

Table 2: Survival of plants as of June 2001

Tree variety	Nos. originally planted	Nos. replanted	Nos. survived and grown as on 30 Nov 2001
Mangium	5914	2210	5874
Pungam	803	155	789
Neem	1200	360	1182
Casuarina	9230	6200	9023
Eucalyptus	5446	2200	5324
Terminalia arjuna	500	220	500
Bamboo	1030	50	1005
	24123	11395	23,697

Note: Additionally 504 numbers of teak were planted along the boundary and approximately 420 numbers were replanted and the number of trees surviving as of 1 June 2001 was 705.

5. RESULTS OBTAINED

5.1 Growth of plants

The height (cm) of plants, planted during January 1999, as in June 2001 is given in table 3.

Table 3: Height (cm) of plants : Mar 1999- June 2001

Months	*Mangium*	*Eucalyptus*	*Casuarina*	*Neem*	*Pungam*	*Terminalia*	*Bamboo*
Mar-99	142	72.7	41	43.3	37.9	40.3	36
April	146	99	53.9	68.9	56	45.6	48.5
May	153	101.4	60.9	86.2	59	61.1	51
June	156	108.8	65	97.3	59.8	79	52
July	163	122	73.3	175	60.4	107	71
August	173	144.9	78.7	201	64.6	136	109
September	184.8	157.5	102.2	211	73.7	156	129
October	202	167.1	129.4	216	87.9	190	166
November	229	184	151.8	227	97	198	199
December	230	205	162	231	98.9	199	208
Jan-00	238	234	187	233	99.2	203	215
February	276	298	252	240	100.8	211	221
March	315	301	317	246	118	218	227
April	354	358	384	262	123	232	232
May	393	416	443	277	126	246	236
June	432	474	512	298	128	259	250
July	471	531	577	308	130	262	282

August	510	589	600	323	133	274	305
September	522	595	612	332	138	275	309
October	527	599	618	332	141	282	312
November	535	611	632	339	152	294	325
December	538	614	639	341	156	299	329
January-01	541	617	643	345	162	301	333
February	544	616	648	348	163	302	336
March	546	621	652	349	167	304	334
April	547	623	655	355	169	308	337
May	552	626	662	352	171	311	338
June	558	627	663	358	174	313	341
July	738	743	684	381	191	324	364
August	746	751	696	396	205	336	372
September	762	762	712	408	217	347	397
October	780	770	728	415	228	351	408
November	786	785	739	423	232	368	419

The girth (cms) of these plants in June 2001 is given in Table 4:

Table 4: Girth (cm) of plants: Mar 1999- June 2001

Months	*Mangium*	*Eucalyptus*	*Casuarina*	*Neem*	*Pungam*	*Terminalia*	*Bamboo*
Mar-99	3.2	1.8	1.2	2.7	2	1.3	2.6
April	3.3	2.8	2.1	4.3	2.6	2.7	4.3
May	4	3.1	2.4	4.4	3	3.4	5
June	4.2	3.3	3.7	5.3	3.7	4	7.4
July	5.3	3.6	3.8	7.1	3.8	5.6	9.8
August	6.5	5	3.9	8.3	3.9	7.3	11
September	7.9	6.2	4	9.1	4	9	16
October	9.5	7.3	4.8	9.7	4.6	11.5	16.2
November	10.9	8.3	5.6	10.1	4.9	12.2	16.5
December	12.1	9.3	6.5	11.2	5.2	12.7	18
Jan-00	13.3	10.3	7.4	11.7	5.8	13	19.5
February	14.6	12.3	8.5	12.3	6.2	13.8	20
March	15.7	12.7	9.9	14.2	6.7	14.1	22.5
April	16.7	12.9	10.4	14.6	7.2	14.5	23
May	17.5	13.7	11	14.8	7.6	15	24
June	18.2	15	11.5	15.3	8	15.5	25
July	18.7	15.6	12.3	16	8.4	16.4	26.5
August	19.2	15.8	13	17.5	8.8	17	27.5
September	19.8	16.1	13.2	17.9	8.9	17.3	29
October	20.4	16.9	13.6	18.3	9.1	18.4	29.8
November	21.1	17.8	14.2	19.3	9.9	19.1	30.3
December	21.7	18.1	14.9	19.9	10.2	19.7	30.9
January-01	21.8	18.2	14.9	19.8	10.4	19.8	31.2
February	21.9	18.4	15.0	20.1	10.7	19.8	31.4
March	22.1	18.7	15.1	20.2	10.8	20.2	31.4
April	22.3	18.9	15.3	20.5	11.2	20.6	31.8

May	22.6	19.1	15.5	20.8	11.2	20.9	32.1
June	23.4	19.3	15.7	21.3	11.2	21.3	32.3
July	24.1	19.7	16.9	21.7	12.6	22.7	33.5
August	24.7	20.6	17.3	21.9	12.9	23.2	33.8
September	25.3	21.5	17.5	22.5	13.2	23.8	34.0
October	26.1	21.8	18.2	22.8	13.9	24.1	34.6
November	26.8	22.3	18.7	23.4	14.2	24.6	34.9

The height of plants planted in January 2000 as of June 2001 is in table 5:

Table 5: Height (cm) of trees April 2000 – June 2001

Months	*Mangium*	*Eucalyptus*	*Casuarina*	*Neem*	*Pungam*	*Terminalia*	*Bamboo*
April	219	144	254	161	102	172	232
May	224	148	265	174	104	176	268
June	227	152	275	179	108	183	277
July	240	157	284	184	112	190	284
August	256	164	296	189	117	195	296
September	265	167	301	191	119	199	298
October	267	171	302	192	121	201	301
November	269	173	303	196	123	204	305
December	271	178	311	205	128	212	311
January-01	273	179	312	206	130	214	315
February	275	182	314	211	133	218	319
March	277	185	316	215	138	219	324
April	282	189	323	218	142	222	326
May	289	191	324	221	145	225	331
June	291	195	329	223	149	227	336
July	312	208	354	236	154	238	342
August	330	217	371	254	168	249	361
September	357	229	386	279	182	257	370
October	372	237	395	291	190	271	384
Nove,ber	396	249	408	304	205	289	393

The girth of these plants is in table 6:

Table 6: Girth (cm) of trees April 2000-June 2001

Months	*Mangium*	*Eucalyptus*	*Casuarina*	*Neem*	*Pungam*	*Terminalia*	*Bamboo*
April	9.5	5.9	13.7	10.4	6.5	19.9	7.2
May	9.7	6.4	14.1	11	6.9	20.3	7.6
June	10.2	6.8	15	11.5	7.2	22.1	8.2
July	11.3	7.1	16	12.2	8.4	23.5	8.6
August	11.9	7.8	16.4	12.6	9	24	9
September	12.1	7.9	16.9	12.8	9.2	24.2	9.3
October	12.3	8.1	17.4	13.5	9.9	25.3	10.1
November	12.9	8.8	17.9	14.1	10.2	25.9	10.3
December	13.1	9	18.1	14.2	10.3	26.1	10.6

January 01	13.4	9.2	18.2	14.3	10.7	26.2	10.7
February	13.7	9.3	18.3	14.5	11.1	26.4	10.8
March	13.9	9.3	18.5	14.6	11.2	26.5	10.9
April	14.1	9.5	18.7	14.9	11.3	26.9	11.1
May	14.3	9.8	18.7	15.1	11.5	27	11.2
June	15.1	9.9	18.9	15.1	11.5	27.1	11.3
July	16.7	10.3	19.5	15.3	12.3	27.8	11.6
August	17.0	10.8	19.9	15.7	12.8	28.1	11.9
September	17.4	11.1	20.1	16.2	13.3	28.5	12.3
October	17.8	11.7	20.6	16.9	13.7	29.1	12.5
November	18.2	12.0	20.9	17.2	14.0	29.6	12.9

5.2 Ground water analysis

The variation in the values of TDS, chlorides & sulphates observed in the ground water in the mini forest project (4 sampling points, at two depths at each point) are presented schematically in the figures 2, 3 & 4:

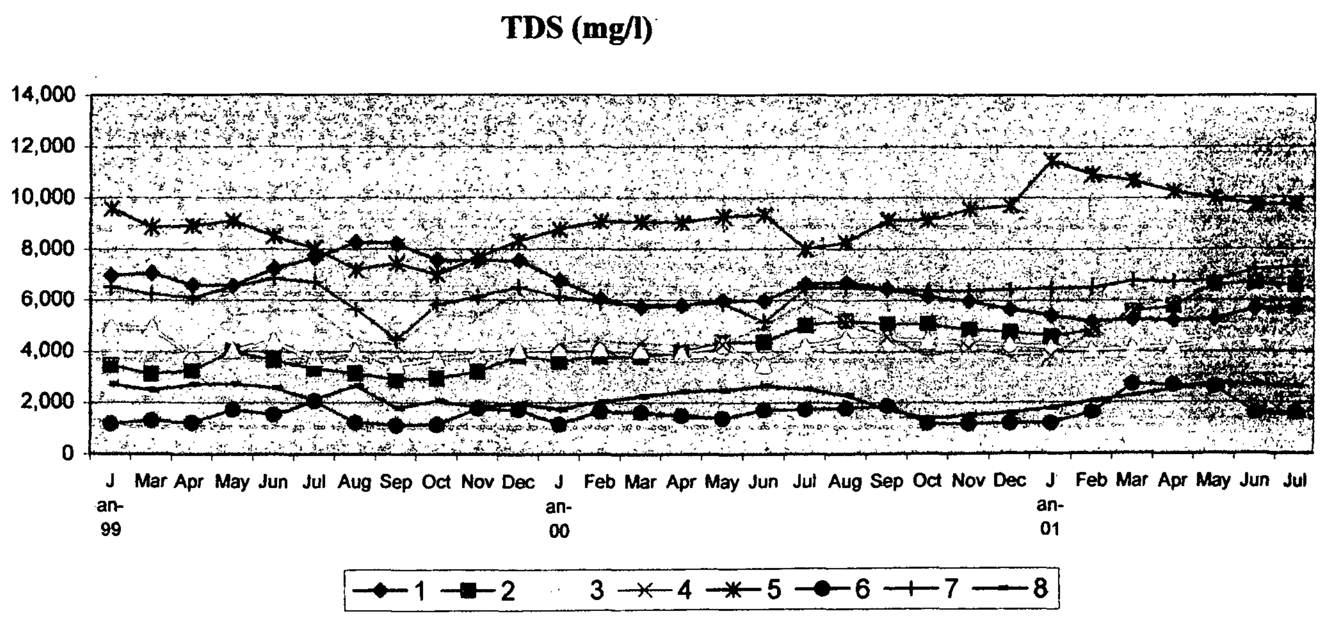


Figure 2: TDS variations in the ground water

Chlorides (mg/l)

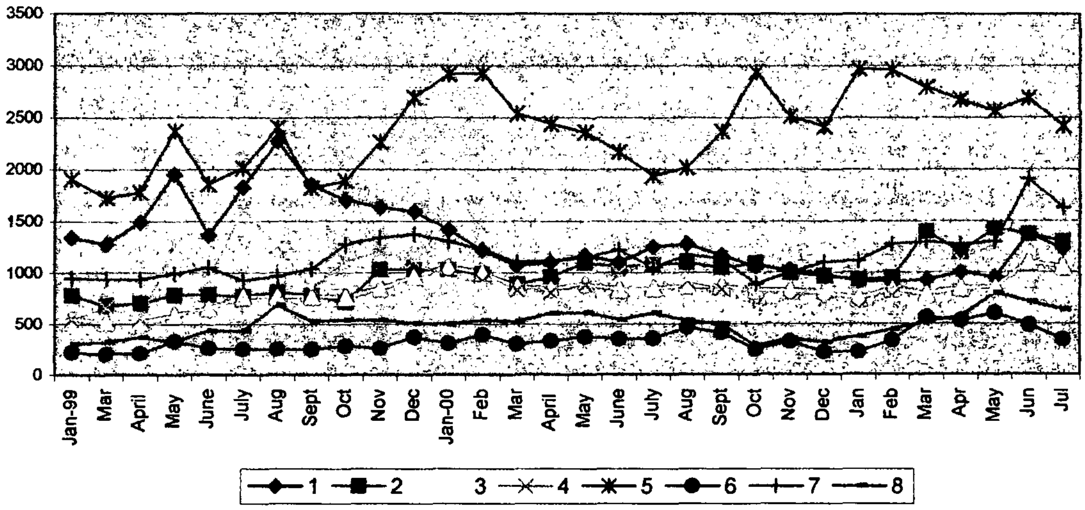


Figure 3: Variation of Chlorides in the ground water

Sulphates (mg/l)

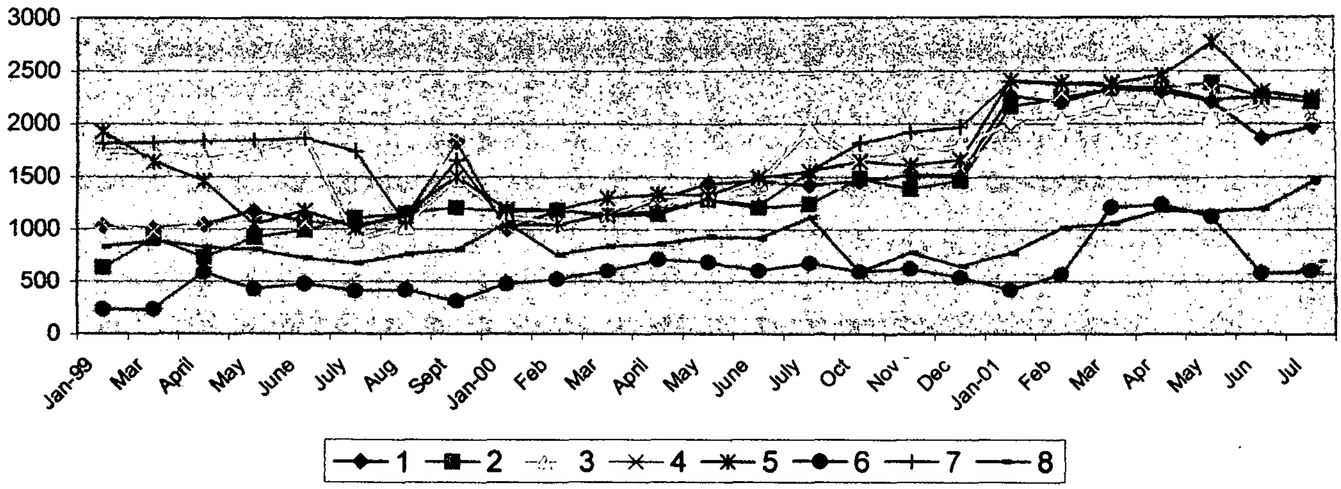


Figure 4: Variation of Sulphates in the ground water

5.3 Soil analysis

The soil analysis values obtained from various sections of the mini forest during the beginning (Feb 99) and during May 2001 are given in table 7:

Table 7: Soil analysis value

Block (Inside the irrigation plot)	February 1999				May 2001		
	Sample collection point	Electrical conductivity micro-siemens/sec	Soil organic matter	Nitrogen kg/acre	Electrical conductivity micro-siemens/sec	Soil organic matter	Nitrogen kg/ acre
A Block	a. Surface	0.98	0.97%	70	0.48	0.06%	55
	b. 0.3 m	0.53	0.09%	126	0.52	0.19%	108
	c. 0.6 m	0.86	0.31%	84	0.55	0.22%	48
B Block	a. Surface	0.87	0.56%	168	1.1	0.51%	41
	b. 0.3 m	1.08	0.20%	112	0.49	0.48%	114
	c. 0.6 m	0.86	0.26%	98	0.67	0.29%	59
C Block	a. Surface	2.51	0.67%	224	0.98	0.38%	61
	b. 0.3 m	0.91	0.08%	154	0.79	0.26%	102
	c. 0.6 m	1.65	0.10%	126	0.64	0.28%	162
I Block	a. Surface	1.07	0.33%	252	1.85	0.24%	59
	b. 0.3 m	0.88	0.44%	196	1.16	0.08%	104
	c. 0.6 m	1.81	0.13%	140	0.98	0.05%	101
Just outside the irrigation plot	a. Surface	0.35	0.51%	238	0.33	0.22%	154
	b. 0.3 m	0.27	0.32%	182	0.46	0.19%	142
	c. 0.6 m	0.72	0.24%	140	0.48	0.17%	99
50 m away from the plot	a. Surface	0.45	0.63%	266	0.52	0.45%	72
	b. 0.3 m	0.38	0.13%	196	0.43	0.11%	125
	c. 0.6 m	0.25	0.04%	182	0.38	0.18%	89

6. EVALUATION OF RESULTS

During the 2 years of continued monitoring of the mini forest irrigated by treated effluent, the following observations are made:

- The growth rate of trees generally seemed to be good indicating that there was no adverse effect on their growth due to irrigation by treated effluent. However, in certain pockets where the soil was in a much degraded state (particularly with respect to soil salinity), the growth rate was not satisfactory.
- The variation of ground water characteristics indicated that no significant addition to contaminants in ground water had occurred during this period. However, continued monitoring is called for.
- No adverse change in the soil characteristics was observed.

7. STATUS AND FUTURE

7.1 Present status

The current status of the miniforest project is as follows:

- The mini forest has been successfully established in the degraded & unused land.
- This objective has been achieved. About 70% of the effluent treated by the CETP is used for irrigation.
- The survival and growth of selected inedible plant species have been confirmed. Reasonably reliable figures of rates of growth of different species obtained.
- Data collected so far indicates no such danger, but to establish the same, continued monitoring for a longer period is recommended.
- Though the actual realisation of commercial benefits is yet to take place, the commercial potential of the mini forest is well recognized.

7.2 Future

Following future actions are proposed in this regard:

- Continue operation of the miniforest project.
- optimising the volume of effluent used for irrigation based on the mass balance
- Continued monitoring for a longer period.

8. COST AND BENEFITS

8.1 Investment cost

The total investment cost of the mini forest project was INR 0.55 million (US $ 12,500) the break up of which is given below:

Item	Cost (INR)	Cost (US $)
Land levelling filling etc.	150,000	3,409.09
Plantation including cost of plants	90,000	2,045.45
Piping	125,000	2,840.91
Collection sump and pump	85,000	1,931.82
Monitoring instruments	100,000	2,272.73
Total	550,000	12500.00

Note: Land cost excluded

8.2 Operational cost

Labour	
No. of workers employed for the maintenance of the mini forest	14
Daily wage provided to the labour	INR 60/head
Total labour cost	INR 840/d = INR 25,200/month (30 days)
Power	
Total working hours	7 h/d, 26.25 kWh/d
Total power cost	26.25 kWh/day = INR105/d (INR 3150/ month)
Others	
Miscellaneous including manure for trees	INR 100/d or INR 3000/month
Monitoring cost (30 effluent samples, 36 ground water samples and 9 soil samples)	INR 5,850 / month
Total cost	INR 37,200 / month.

8.3 Benefits

Following are considered to be the benefits of the project:

- Disposal problem of treated effluent resolved to a major extent.
- The unused, degraded land was rehabilitated.
- The area was made green with positive environmental appeal.
- Good timber value from trees grown is expected.

9. VERMI COMPOSTING TRIALS

The CETPs face great difficulty in allotting space for storage of the sludge which amounts to large quantities. Sludge storage system (secure landfill) suggested by NEERI could not serve the purpose of long time storage because of enormous cost involved in forming the structure and space unavailability for the huge amount of sludge generated daily. Hence vermi-composting of sludge is the only way to convert the solid waste to more nutritive one applicable to plants.

Ranipet Sidco Finished Leather Effluent Treatment Plant in Ranipet is designed to treat 2500m^3/day of raw effluent from 86 tanneries located in the Sipcot Industrial Area of Ranipet. All the tanneries process wet blue/EI to finished leather and the effluent is therefore of low salinity mostly contributed by sulphates. The chrome level in the sludge from the CETP is very low as all the tanneries process from semi-finished to finished leather, Wetblue hides and skins. It was therefore considered feasible by the CETP that the sludge could be composed and used as manure, particularly for non edible crops.

The sludge from the CETP contains good organic matter content (upto 45% volatile matter) and low chromium and hence considered as a good choice for composting.

Vermi-composting is the process by which the earthworms are engaged in the composting process. Earthworms facilitate conversion of organic material present in the sludge into available form which would be readily absorbed by plants. The movement of worms increases the pores of the sludge heap and hence the air transfer rate (indispensable for maintaining aerobic condition in compost heap). The earthworms at the end of the process are seived and reused for next round of composting.

The benefits of composting are:

- Supplements humus content and thereby improves the structure of the soil.
- Enhances the water holding capacity of the soil.
- Provides plant growth hormones.

Trials so far carried out by the CETP

R.S.F.L.E.T.CO.LTD (SIDCO CETP), initiated the composting activities way back in 1997 in small experimental pits with the financial assistance of ILIFO and technical assistance of UNIDO-Repo, Chennai. Initially a pit of 6.2m x 1m x 0.5m was made on 9th September 1997. The capacity of the pit was 1 tonne. 3000 numbers of earthworms (***Eudrilus euginae***) were introduced into the pit containing sludge and cowdung. The composting process was over in 66 days. The available nutrients (N-P-K) of the sludge increased two folds.

Based on the encouraging results shown by the vermi- composting process and lower duration period for vermi-composting, a permanent arrangement for composting of sludge was commissioned in August 2000. A shed of approximately 100 sq.m. area (size 10 m x 10 m) was constructed. The floor was evacuated as individual trenches of size 8 m (length) and 1 m (width) to a depth of 1 m. Six such trenches were formed with a gap of 0.5 m in between. The sides had a gap of 0.75 m from the compost pit. The floor of excavated area was levelled and applied concrete. The depth of the composting heaps was 800cms. It consists of 6 heaps of 4 tonnes each. 3 cycles have been completed and the harvested product the vermi-compost is applied to the MINI FOREST containing tree species grown with treated tannery effluent.

The treated tannery sludge mixed with cowdung alone serve as the control. The different additives used like cowdung and paddy straw. The leaf litter was collected from the MINI

FOREST to add organic carbon content to the composting process. Two replications were followed in each of the treatments. Sludge with the moisture content of about 65% was used in the composting process.

The duration of the cycles are about 78-115days. Approximately 20,000 earthworms were inoculated in the heaps, which at the end of composting were seived and reused in the next cycle.

OBSERVATIONS

Temperature:

Temperature is a reflection of microbial activity during composting. The temperature of the vermicompost remains low initially and increases gradually to a high of 41°C. It remains at this level with minor fluctuations for some days and then gradually decreases to a constant state near ambient. The point at which temperature approaches ambient is considered the state of stability of the product.

pH

Changes in pH noted to occur during the composting process therefore have been considered as a possible indicator of biological activity. Generally it was noted that the pH drops during the early stages of composting to 5.5 - 6.0 and then increases to a range of 6.5 to 7.5

C:N ratio

C:N ratio plays an important role in the composting process. Carbon makes up a large and definite proportion of organic matter. Organic residues (leaf litter and straw) carry large amounts of Organic carbon (40% and 32%) and small amounts of total nitrogen. C:N ratio is wide as 33:1. The heterotropic flora bacteria, fungi and actinomycetes acts rapidly, yielding carbon dioxide in large quantities. As decay of the microbes occurs the C:N ratio decreases to 11:1. As the carbon content is higher in the leaf litter and straw they rapidly decompose yielding a nutrient rich vermi-compost.

Quantity of the compost

The yield of fine compost obtained was seived through a fine mesh of size 2-3mm. The yield of vermi-compost was over 92%.

Application of vermi-compost as manure

As the vermicompost sludge contains 1.30% Nitrogen, 0.5% Phosphorus and 0.06% Potassium trials were conducted in SIDCO.CETP to find the possibilities of using it as a manure for tree crops. The growth parameters were recorded. The results showed that vermi-compost sludge along with treated effluent had the higher growth rate compared to the Control.

FINDINGS

- Vermi-composting with leaf litter admixture produced higher yield.
- Leaf litter is observed to be the better admixture and efforts to increase the quantity of leaf litter and to reduce cow dung could be made to make the process more cost effective.
- The quality of the vermicompost is better than conventional system of composting.
- Vermi-compost due to the nutritional status could be effectively used as a manure for non-edible tree species.
- Applying vermi-compost to trees improves soil structure, aggregation, humus and moisture holding capability of the soil.

TABLE - 1

QUANTITY OF SLUDGE AND ADMIXTURES

Heap No.	Material	Quantity(Kg)	Total (Kg)
1	Sludge	4052	4750
	Cowdung	600	
	Leaf litter	100	
2	Sludge	4200	4900
	Cowdung	600	
	Leaf litter	100	
3	Sludge	4000	4740
	Cowdung	720	
	Straw	20	
4	Sludge	4000	4740
	Cowdung	720	
	Straw	20	
5	Sludge	4000	4840
	Cowdung	840	
6	Sludge	4000	4820
	Cowdung	820	

TABLE – 2

Moisture content of the vermi-heaps

Heap No.	Material	Moisture%
1	Sludge+Cowdung & Leaf litter	70%
2	Sludge+Cowdung & Leaf litter	75%
3	Sludge+Cowdung & Straw	65%
4	Sludge+Cowdung & Straw	64%
5	Sludge+Cowdung	64%
6	Sludge+Cowdung	62%

TABLE – 3

YIELD OF VERMI-COMPOST

Heap No.	Quantity of sludge	First round		Second round	
	&admixtures	Yield (Kg)	% Yield	Yield (Kg)	% Yield
1	4752	4398	92.6	4320	90.9
2	4900	4230	86.3	4315	88.1
3	4740	4240	89.5	4225	89.1
4	4740	4380	92.4	4310	90.9
5	4840	4115	85	4085	84.4
6	4820	4075	84.5	4110	85.3

TABLE – 4

NUTRITIONAL VALUE OF HARVESTED COMPOST

Heap No.	Nitrogen w/w	Phosphorus w/w	Potassium w/w
1	1.4	0.56	0.07
2	1.2	0.4	0.08
3	1.4	0.44	0.08
4	1.3	0.44	0.07
5	1.2	0.52	0.06
6	1.3	0.53	0.05

TABLE – 5

Chromium content of Vermi-compost

Heap No.	Material	Chromium mg/l
1	Sludge+Cowdung & Leaf litter	2650
2	Sludge+Cowdung & Leaf litter	2500
3	Sludge+Cowdung & Straw	2750
4	Sludge+Cowdung & Straw	2340
5	Sludge+Cowdung	2400
6	Sludge+Cowdung	2680

VERMI COMPOSTING TRIAL AS SUGGESTED BY Mr. BOWDEN

As suggested by Mr. Bowden a trial was laid for vermi composting of bio-sludge. The trial was carried out in the existing vermi-compost shed – unit I, which was identified as cool and dark place, suitable for breeding and activity of earthworms. The trial was initiated on July 14th 2001, on the visit of Mr. Bowden to SIDCO CETP.

Initially an area of 1.08 m^2 was earmarked. Wood chips of 30 – 45 cm of length was cut and loaded to make 1 foot height. This enables good drainage and aeration for breeding of earthworms. Later a thin layer of vermi compost along with 5 kg of earthworm was loaded on the pile of wood chips. 10 litres of bio-sludge (from the secondary clarifier) which is more organic in nature and neglible toxic heavy metals was added to the earthworms. The fresh bio-sludge contained 95 – 96% moisture. The top layer was given good aeration by placing a thin jute bag held by wooden sticks in order to avoid the jute bad directly in touch with the top layer.

The casts were seen on the top indicating the consumption of the bio-sludge by earthworms. Fresh loading of bio-sludge took place at an average frequency of 3 – 5 days interval. Totally the bio-sludge loading was upto the height of 1.5 – 2 feet level. Later the vermi compost was harvested and packed. The earthworms were counted periodically which bound to increase as the time of the process progressed. While harvesting it is found that the earthworms multiplied to 2 to 3 times of the initial number of earthworms.

10. CONCLUSION

10.1 Miniforest project

- The project established that effluent generated by tanneries processing semi processed hides and skins to finished leather can be profitably used for irrigation of inedible plants with positive results.
- The saline resistant species identified include *1. Pongamia pinnata, 2. Azadirachta indica, 3.Casuarina equisetifolia,, 4. Tectona grandis, 5. Acacia arabica, 6. Eucalyptus tereticornis, 7.Dendrocalamus strictus and 8. Acacia mangium*
- The advantages of the project are: (a) containing ill effects from low saline tannery effluent (b) greening the otherwise arid lands (c) converting the waste water into a valuable resource and thus saving good water normally used for irrigation (d) rehabilitation of degraded land and (e) generating revenue for tanneries and ETP.
- The obvious limitations are: (a) this practice is currently recommended only for effluent from semi processed to finished leather processing units (b) potential of ground water/soil contamination in case of overloading (c) requirement of sufficient vacant land and (d) inadequate information on optimum feeding rate.
- It is yet not possible to conclusively define the volume of wastewater that can be used to irrigate one hectare of land, with a given plant density. However, based on the observations made so far, it may be tentatively stated that with a plant density of 2500 per acre, it is safe to use about 90 m3 per acre for irrigation, without any adverse impact on soil or groundwater. However, it must be stated that continuous monitoring should be done of soil & groundwater & if any increasing trend in TDS or chlorides were seen, the volume of effluent used for irrigation should be suitably modulated.

10.2 Vermi-composting trials

- The trials established the technical feasibility of the composting, with air movement assisted by worms, in producing reasonably good quality end product.
- The advantages of the technique tried here vis-à-vis other conventional type composting was the lower requirement of amendments and high yield and relatively simple nature of the process.
- The major limitations noted were the extended duration of the process and in the specific case of SIDCO, the high level of chromium in the end product.
- Though no concrete external markets were developed for the composted sludge has been found out yet, efforts are on to market the product after reducing the chrome (specific selection of the sludge with low chrome, e.g. with secondary sludge) content in the sludge. However, at present, the product developed is almost completely utilised in the miniforest.
- New trials with the 'real' vermi-composting as per the guidance of Mr. Bowden was found to be quite encouraging and more trials in this direction is being planned.