Indian Agricultural Research Institute

Jalopchar™ – An Eco-friendly Wastewater Treatment Technology

Dr. Ravinder Kaur

Principal Scientist , Water Technology Centre

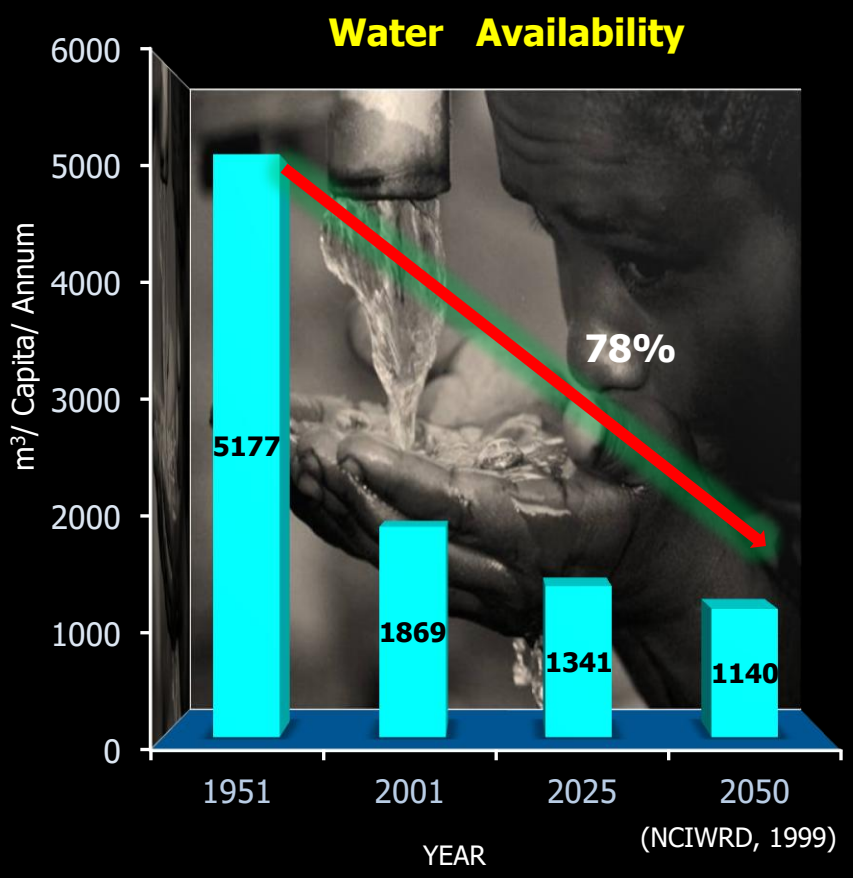
and

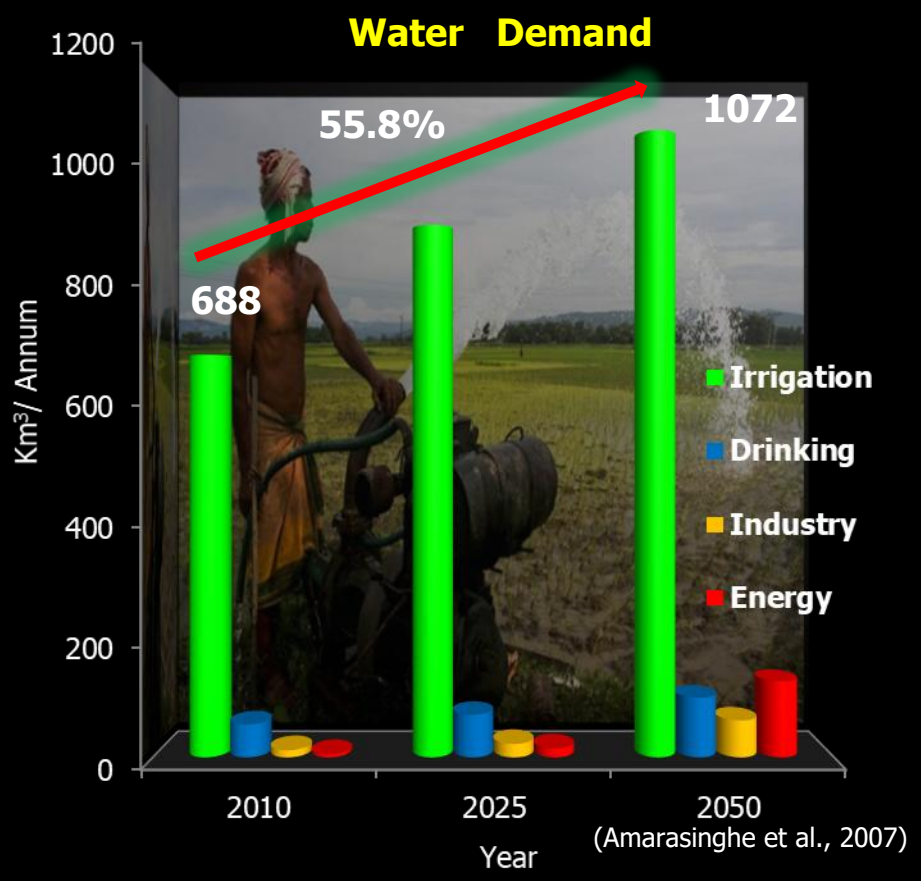
Former Project Director, Water technology Centre & Director (Addnl. Charge)

Indian Agricultural Research Institute-New Delhi

National Challenges

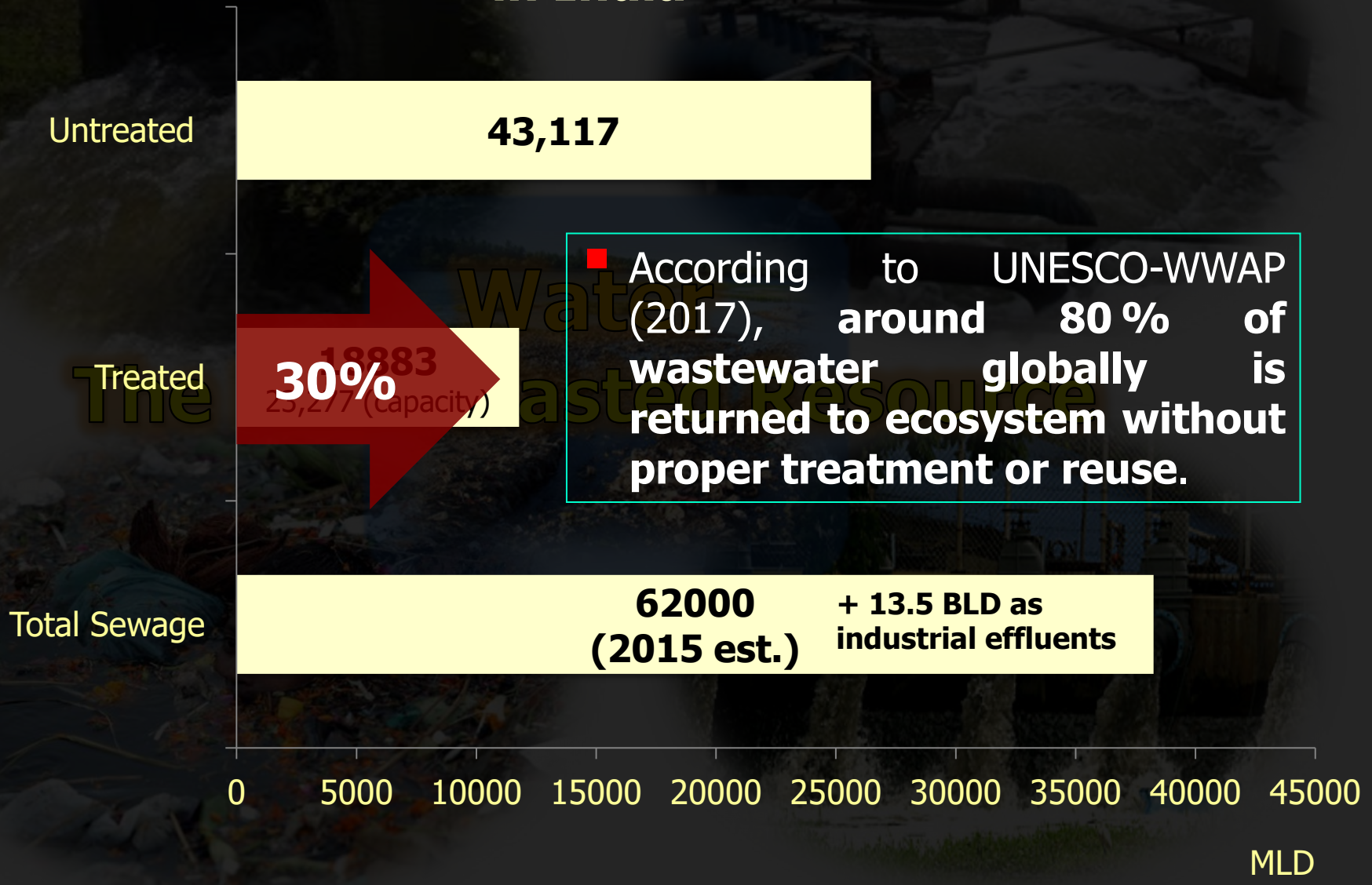
WATER: An essential element for our survival and an important vehicle for economic development





Food production to be increased by 50% by 2025

Wastewater Generation & Treatment in India



- According to UNESCO-WWAP (2017), **around 80 % of wastewater globally is returned to ecosystem without proper treatment or reuse.**


United Nations SDG Goal No.6 mandates to reduce the percentage of untreated wastewater by half while considerably expanding & promoting its recycling & safe reuse (UN-Water, 2016)
Recycle & Reuse of Treated Wastewater
A Viable Option

HIGH ENERGY/ CONSUMABLES

CONVENTIONAL WASTEWATER TREATMENT METHODS

HIGH SKILLED MANPOWER

COSTLY

GENERATE HAZARDOUS SLUDGE

UNSUSTAINABLE

Indian Agricultural Research Institute

Comparative Performance & Economics of Available On-site Wastewater Treatment Technologies in Rural/ Peri-urban Settings

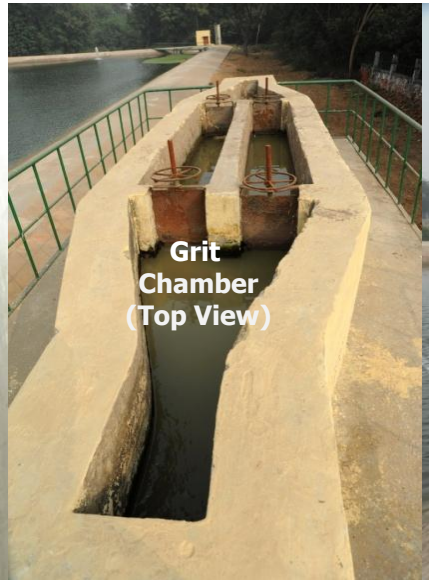
On-site Wastewater management tech.	Performance efficiency	Cost (Rs/ KL)	Remarks
Individual household septic systems			**Annual O&M: Rs 1000-2000/KL; Land demand: 3 to 5 sq. m per household or 10 to 17 sq m/KL**
Septic Tanks	40-50% BOD & 50-70% TSS reduction	Rs. 50,000 per KL	**Require proper septage removal frequency; No economic returns**
Anaerobic baffled reactor	**70% BOD & 50-70% TSS reduction**	20-30% addl.	
Soak pit/ leach pit/ magic pits	40 to 50% BOD & 50 to 70% TSS reduction	Rs 3,000 per household (of 6 to 8 PE) or Rs 7500 to 10,000 per KL	**Often prone to ground water contamination**
Septic tank integrated Anaerobic (natural/ synthetic) Filter based (up flow/ downflow) reactor variants	**BOD, pathogen and TSS removal (~ 70 to 80%)**	**Rs 25,000 to 30,000 per KL**	**Single/ multiple pass filters**: Gravel, sand/soil; peat, textile + external inoculum or organic bed supported hybrid earthworms or Coagulants and aeration system (with 15 to 30 kWh/person/year power requirement) **Unsustainable and expensive due to:** a) Exhaustion of active ion-exchange sites and pollutant leaching, b) additional use of the non-renewable resources/ increased O&M costs, and /or c) non-availability of 24x7 energy supply in the rural / per-urban areas.

Comparative Performance & Economics of Available On-site Wastewater Treatment Technologies in Rural/ Peri-urban Settings

On-site Wastewater management tech.	Performance efficiency	Cost (Rs/ KL)	Remarks
Cluster based Systems Serving Multiple Properties			
Anaerobic lagoons/ Waste Stabilization Ponds	BOD (**lagoons**): 35% BOD (**WSP**): 60-75% **Inefficient biologic/inorganic matter removal** (Sahasranaman and Ganguly, 2018)	**CAPEX**: Rs 1600 to 2600 per KL **Annual O&M:** Rs 650 to 700 per KL	**Covering 72.4% of STPs in Class II towns of India** (CPCB, 2013). Require large land area (2 to 3 sq. m per person or **6.5 to 10 sq. m/KL**), **Higher HRT (3-5 days for anaerobic lagoons to 12 to 15 days for WSP technology),** Periodic de-sludging & maintenance, High evaporation rates
Duckweed based waste water treatment system in conjunction with pisciculture	**Unstained performance** due to Duckweed die-off in cold weather **besides Low pathogen removal**	Comparable	**Widely practiced in Punjab.** Provides economic returns & capable of generating employment opportunities

PANORAMIC View of
JALOPCHAR - AN ENVIRONMENT FRIENDLY WASTEWATER TREATMENT
TECHNOLOGY based FACILITY **(Capacity : 2.2 Million Litres per Day)**
for augmenting irrigation water supplies

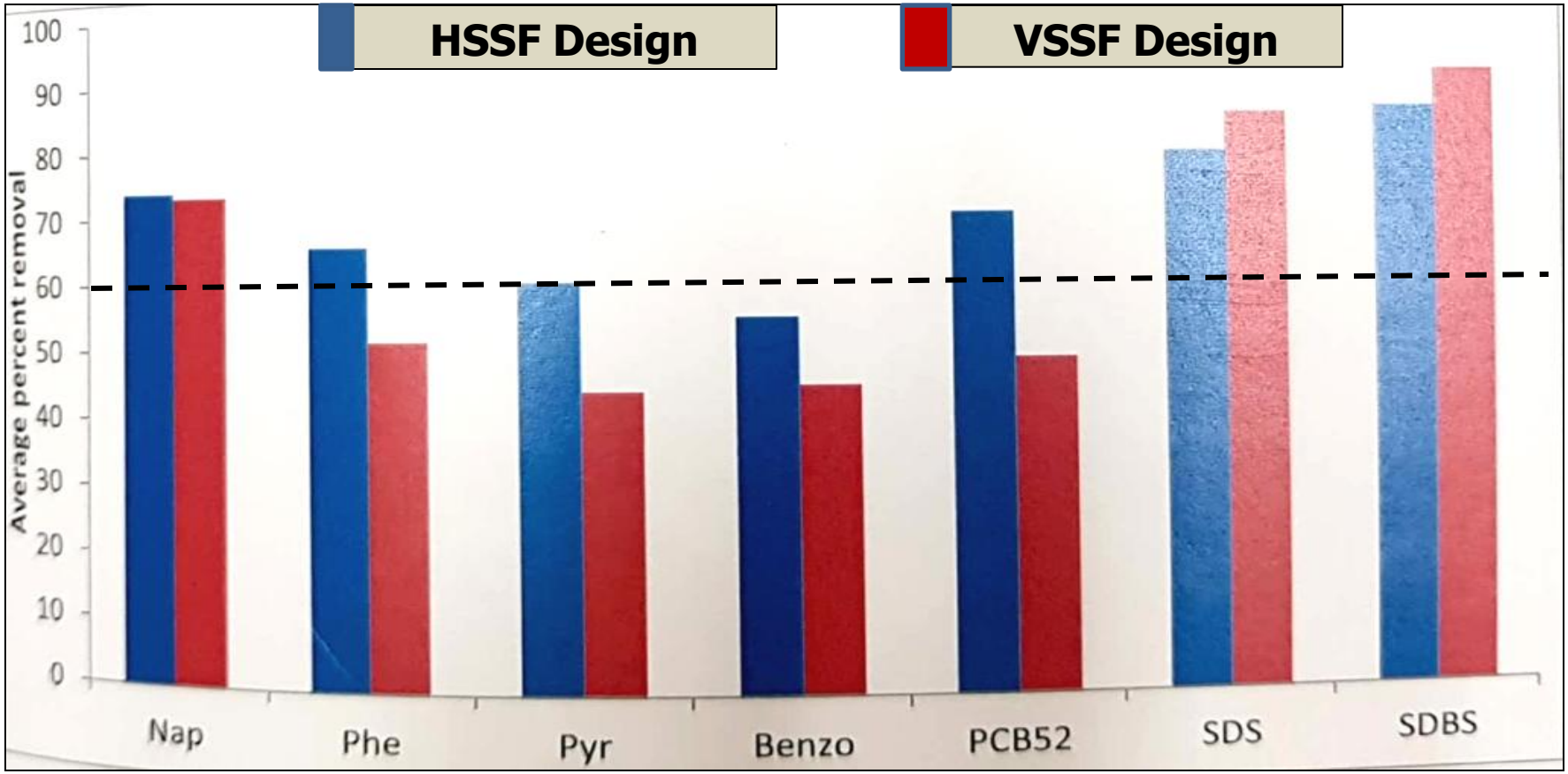
Treatment Process: Plant-native microbe-media interaction



Improved Decentralized Wastewater Treatment Technology

On-site Wastewater management tech.	Performance efficiency	Cost (Rs/ KL)	Remarks
Jalopchar (Plant-Microbe-Media mediated treatment system)	▪ Turbidity (90-99%), Pathogen (99.8-99.9%), BOD (78-88%), Metals (57-100%), Nitrates/ Phosphates (30-57%) ▪ 68-73% Pathogen & Metal free food ▪ Good economic returns/ Value for Land	**CAPEX:** Rs. 5500 to 6500/KL **Annual O&M :** Rs 200 - 250/KL	▪ 80-85% lower capital and O&M expenditure demand than other techs. & 40-55% lower CAPEX than similar techs. ▪ Very scalable (< 1 sq. m/KL or more) ▪ Higher eff. @lower HRTs (<1 day to about 2 days) & simpler, compacter and (~ 66%) lower land demanding engineering design

Removal of Dissolved Organic Contaminants (PAHs, PCBs & Surfactants) through Jalopchar Technology



PAHs: Napthalene, Phenanthrene, Pyrene, Benzo(a)anthracene

PCBs: PCB52, PCB 44

Surfactants: SDS (Sodium Do-decyl Sulphate), SDBS (Sodium Do-decyl Benzene Sulphonate)

ECOLOGICAL FOOTPRINT & SUSTAINABILITY

Implemented Vs. Conventional Solution

Emergy Indices	Implemented Technology	Conventional Technology
Environment Load Ratio	1.37	42.19
Emergy Yield Ratio	0.70	0.01
Renewable Percentage	0.51	0.02
Emergy Sustainability Index	0.54	0.00034

Implemented technology exerts 33 times lesser stress on environment

Implemented technology 70 times more efficient in utilizing purchased resources & 25 times more renewable resource consumptive

Implemented technology 1500 times more sustainable

Impact of Jalopchar treated Vs. untreated wastewaters on vegetables crop yields & heavy metal and pathogen loads

Treatment	Yield							
	Okra (t/ha)	Cabbage (Boll)	Baby corn (t/ha)		Lettuce (t/ha)	Brinjal (t/ha)	Broccoli (t/ha)	Green Onion (t/ha)
			Cob	Stover				
Sewage Water (SW)	15.30	160	28.0	39.30	51.40	93.00	60.00	52.10
Treated Water (TW)	13.60	142	23.1	34.30	42.60	82.75	53.50	47.18
Ground Water (GW)	12.30	138	22.1	31.90	40.00	78.00	53.00	41.40
% Change in TW over SW	-0.11	-0.11	-0.18	-0.13	-0.17	-0.11	-0.11	-0.09
% Change in TW over GW	0.10	0.03	0.04	0.07	0.06	0.06	0.01	0.12

Pollutant	Baby corn				Brinjal				Broccoli				Green Onion			
	GW	SW	TW	% Change in TW over SW	GW	SW	TW	% Change in TW over SW	GW	SW	TW	% Change in TW over SW	GW	SW	TW	% Change in TW over SW
Cu(mg/kg)	28	32	28	**-13**	9.0	11.7	9.9	**-0.15**	9.5	10.8	10.1	**-0.06**	-	-	-	-
Fe(mg/kg)	42	68	49.4	**-27**	94.0	118	101.5	**-0.14**	122	145	126.7	**-0.13**	-	-	-	-
Mn(mg/kg)	18	20	15.8	**-21**	31.8	41.9	34.9	**-0.17**	39.5	47.0	40.3	**-0.14**	-	-	-	-
Zn(mg/kg)	48	58	47.3	**-18**	30.1	40.2	32.8	**-0.18**	34.6	48.0	34.6	**-0.28**	-	-	-	-
Ni (mg/kg)	-	-	-	-	1.5	4.2	2.3	**-0.45**	3.6	5.3	4.0	**-0.25**	1.6	3.2	2.1	**-0.34**
Pb (mg/kg)	2.5	5.5	4.0	**-27**	2.2	4.8	3.1	**-0.35**	5.0	8.8	5.9	**-0.33**	2.1	3.6	2.3	**-0.36**
Total Coliform Count (cfu/g)	$4.3x10^3$	$1.5x10^4$	$4.0x10^3$	**- 73.3**	$2.3x10^2$	$5.4x10^3$	$1.6x10^3$	**-69.5**	63	148	47	**-67.7**	-	-	-	-

Yields : 1 to 12% (w.r.t. GW)
Metal Contamination: -13 to -36%
Pathogen Loads: - 68 to -73 %

Pathogen/ Metal Risk Proof Aquaculture and High Fish Productivity

~3.5 tons/ ha Fish yield with less than 50% feed incorporation

Pathogen and heavy metal loads in Fish-muscle within safe limits

Fish body part / Organ	Heavy metal concentration (ppm)					
	Copper (Cu)	Iron (Fe)	Manganese (Mn)	Zinc (Zn)	Nickel (Ni)	Lead (Pb)
Upper part Muscle	0.09	0.97	0.17	0.54	0.42	0.22
Middle part Muscle	0.09	1.05	0.13	0.58	0.34	0.44
Lower part Muscle	0.14	1.05	0.17	0.68	0.38	0.10
Gills	0.18	2.13	0.95	1.98	0.47	0.48
Lower Gut	0.15	1.92	0.90	0.96	0.35	0.14
Liver	0.18	2.14	0.18	0.87	0.42	0.25
Permissible Limits	30*	100*	1*	100*	70-80**	NA

* as prescribed by FAO/ WHO (1989); ** as prescribed by USFDA (1993)

Other Benefits of Jalopchar Technology

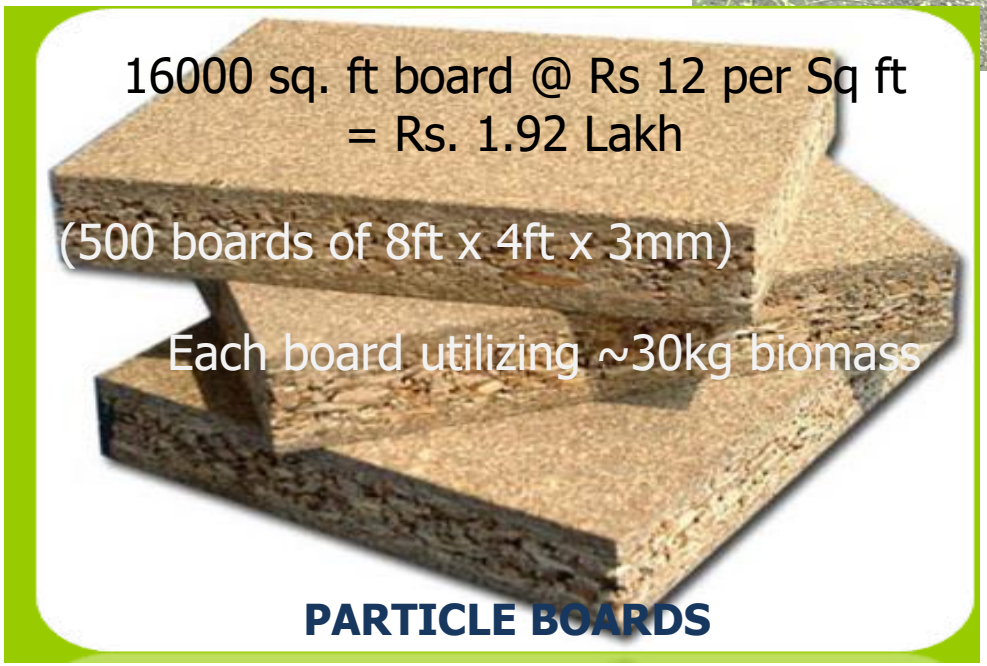
- Zero to < 0.3% energy
- Zero-chemical
- Zero-sludge
- Reduced CAPEX

  ~ Rs. 55 - 65 Lakh/MLD
  (80 – 90 % Civil, 8-15% electrical, 2-5% vegetation)
- 50-65% reduced OPEX

  (just Rs. 0.60 per KL/day)

Integrated Cash from Trash Business models

Transformation of Biomass into Particle Board & Briquettes/ Pellets



PARTICLE BOARDS

ENERGY BRIQUETTES / PELLETS

Recommended for National level adoption and implementation by the Parliamentary Standing Committee on Agriculture

Recommended for its Extension to 420+ Indian Cities by MoUD

PRAVEEN PRAKASH, IAS
Joint Secretary & Mission Director (SBM)
GOVERNMENT OF INDIA
MINISTRY OF URBAN DEVELOPMENT

सत्यमेव जयते

प्रवीण प्रकाश, आई.ए.एस.
संयुक्त सचिव एवं मिशन निदेशक (एस.बी.एम.)
भारत सरकार
शहरी विकास मंत्रालय

D.O. No. Q -16011/01/2007-CPHEEO Dated: 23.3.2017

Subject: **Advisory on a Constructed Wetland based Sewage Treatment System developed by Indian Agricultural Research Institute (IARI), New Delhi-Regarding.**

Sir/Madam,

As you are aware, the Urban Local Bodies (ULBs) are responsible for the containment, collection, treatment and disposal of Sewage as per the effluent discharge standards notified by the State Pollution Control Board (SPCB)/Pollution Control Committee (PCC) and the Central Pollution Control Board (CPCB) under the provisions of Environmental Protection Act, 1986. The existing Sewage Treatment capacity in the country is only about 37 per cent and the rest of the sewage is being discharged with partial/no treatment for which necessary treatment arrangements have to be provided.

One such Sewage Treatment process has been developed by IARI, New Delhi. It is a Low Cost, low energy, and eco-friendly treatment technology based on the wetland processes and found to be very effective for the smaller ULBs generally lacking sewage treatment facility. It is said to require 1.2 to 1.8-acre land (depending upon the site-specific design) for treating one million litres of Sewage per day (1 MLD, about 10,000 population equivalent) with adequate effluent quality for land application (i.e. irrigation) and/or for discharge to water bodies, depending upon the sewage pollutant concentration and the treatment – design of the proposed technology. The technology has less than 1% of the total energy demand of any conventional sewage treatment technology as it requires energy for only lifting the Sewage and the treated effluent, as per the site condition. In terms of standard cost-accounting, the IARI sewage treatment technology is estimated to cost Rs. 0.545 Crore per MLD(million litres per day) of capital cost (CAPEX) and just 60 paise per Kilo litre (KL) for total operational and maintenance cost as it does not require any energy/chemicals for sewage treatment.

I request you to take advantage of this Low Cost, Low Energy and Eco-friendly Sewage Treatment technology developed by IARI. For any support and consultation in setting up such Sewage Treatment System, please contact Dr. (Mrs.) Ravinder Kaur, Project Director (WTC), ICAR-Indian Agricultural Research Institute, New Delhi – 110 012, Telefax: 011-25846790; Mob: 9811041187; Email: pd_wtc@iari.res.in; Website: www.iari.res.in.

With Best Regards,

Yours sincerely,

(Praveen Prakash)

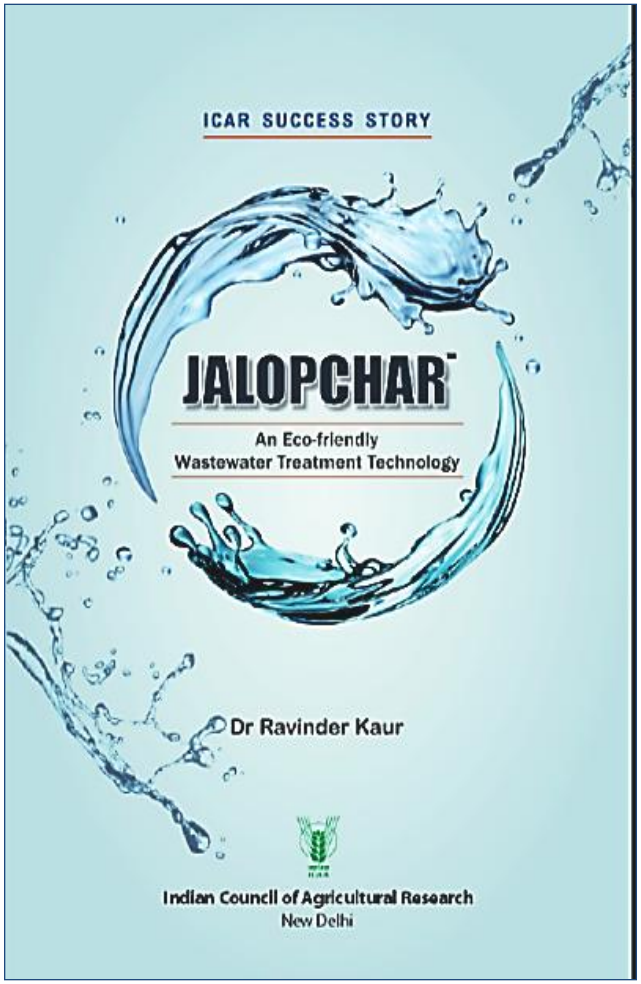
To
Principal Secretary / Secretary,
In-charge of UD/ PHED/Water Supply and Sanitation Departments;
Mission Directors (AMRUT);
Mission Directors (SBM).
} **of All States/UTs, As per List attached**

Copy to:
Joint Secretary & MD, AMRUT, MoUD.
Dr. (Mrs.) Ravinder Kaur, Project Director (WTC), ICAR-Indian Agricultural Research Institute, New Delhi.

Office: 140-C, Nirman Bhawan, New Delhi-110011 ♦ Mob: 9013133636, Phone: 011-23062309, Fax: 23062477
praveenprakashud@gmail.com, praveen.prakash71@nic.in

Jalopchar ™: A Plant-Microbe-Media Interaction based Successful Eco-friendly Wastewater Treatment Technology of ICAR/ IARI

Indian Agricultural Research Institute



Jalopchar™: An eco-friendly wastewater treatment technology released as **ICAR Success Story** by Hon'ble Minister of Agric. & DG, ICAR

Ravinder Kaur (2020) Jalopchar™ - An Eco-friendly Wastewater Treatment Technology. ICAR Success Story, Indian Council of Agricultural Research, pp. 44 (ISBN No. : 978-81-7164-205-2; https://icar.org.in/e-books)

The technology has been **selected as** a "**Good practice example**" under "Safe Use of Wastewater in Agriculture" initiatives by the **United Nation Water**

UNITED NATIONS UNIVERSITY
UNU-FLORES

flores.unu.edu

The Director
Prof. Dr. Reza Ardakanian
UNU-FLORES
United Nations University
Institute for Integrated Management of Material Fluxes and of Resources

Ammonstrasse 74
01067 Dresden, Germany
Tel +49 (0) 351 8921 9372
Fax +49 (0) 351 8921 9389
Email flores@unu.edu

REFERENCE: UNU-FLORES/OD/2016/04 15 January 2016

Workshop on Good Practice Examples and Future Research Needs for Safe Use of Wastewater in Agriculture (SUWA) Organized by UNU-FLORES in Lima, Peru, on 24-25 February 2016

Dear Mrs. Ravinder Kaur,

I am pleased to invite you to the above-mentioned workshop organized by the United Nations University Institute for Integrated Management of Material Fluxes and of Resources (UNU-FLORES). We greatly appreciate your willingness to share your knowledge on the Safe Use of Wastewater in Agriculture in the form of keynotes/presentations/discussions.

CASE 8

Eco-Friendly Wastewater Treatment for Reuse in Agriculture (India)

Ravinder Kaur[1]

Abstract

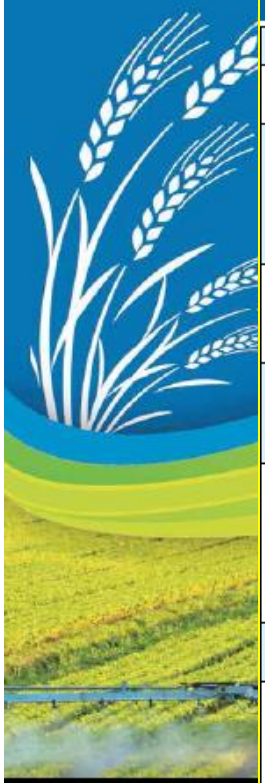
Oxidation ponds or activated sludge processes are the two most commonly deployed wastewater treatment technologies in India. However, these processes are expensive and require complex operations and maintenance. In view of these limitations, constructed wetland technology has been receiving greater attention in recent years. However, the rate of adoption of wetland technology for wastewater treatment in developing countries has been low due a general belief that these technologies have large land area requirements. Batch-fed wetland systems with shorter hydraulic retention times (HRTs) have generally been found to translate into smaller land requirements and

Also **selected as** an **innovation in Indian Agriculture** by the **National Skills Foundation of India**

NSFI National Skills Foundation of India — enabling sustainable livelihoods

Knowledge Partner YES BANK

Innovations in
INDIAN AGRICULTURE
Select Case Studies



Eco Friendly Waste Water Management		
1.	Name of the Innovation	Eco friendly waste water management
2.	Name of the Innovator (Person / Agency)	ICAR-IARI
3.	About the Innovator	The Indian Agricultural Research Institute (IARI) is the country's premier national institute for agricultural research, education and extension. Currently, the Institute has 20 divisions 6 multi-disciplinary centres situated in Delhi and 8 regional stations.
4.	Brief about the challenge the innovation / technology is addressing	Management of waste water/low quality water is essential to reduce pollution. Severe water shortage is the emerging challenge. The demand could be met by enhancing water use efficiency.
5.	How does the innovation / technology addresses the mentioned challenge	The new system reduces metal pollutants besides degrading organic and inorganic pollutants and its energy requirement is less than 1% as it does not require operating aerators.
6.	How is this innovation a better alternative over the current scenario?	✓ Zero chemical application ✓ Zero sludge generation, ✓ 60-65% reduced treatment cost, creation of surface water source enabling managed aquifer recharge ✓ Less than 1% energy requirement.
7.	Who are the beneficiaries of the innovation / technology?	Farmers and society
8.	Contact details for further information	Project Director (WTC) ICAR-IARI New Delhi-110012 Phone: 9811041187 Email: rk132.iari@gmail.com

SKOCH GROUP

SKOCH ORDER-OF-MERIT

AWARDED TO

ICAR- INDIAN AGRICULTURAL RESEARCH INSTITUTE

FOR QUALIFYING AMONGST

TOP-30 TRANSFORMATIONAL INNOVATION PROJECTS IN INDIA

FOR

ECO-FRIENDLY WASTEWATER TREATMENT FOR SAFE RE-USE IN AGRICULTURE

GIVEN ON THIS 20TH DAY OF DECEMBER 2017 AT NEW DELHI

Sameer Kochhar

SAMEER KOCHHAR, CHAIRMAN, SKOCH GROUP

SKOCH GROUP

SKOCH AWARD

PLATINUM

SKOCH TRANSFORMATIONAL INNOVATION AWARD 2017

ICAR - INDIAN AGRICULTURAL RESEARCH INSTITUTE

FOR

ECO-FRIENDLY WASTEWATER TREATMENT FOR SAFE RE-USE IN AGRICULTURE

CONFERRED THIS HIGHEST INDEPENDENT HONOUR IN INDIA ON 21ST DECEMBER 2017 AT NEW DELHI

SKOCH

Sameer Kochhar

SAMEER KOCHHAR
CHAIRMAN, SKOCH GROUP

Jalopchar™ Technology: Scalability & Replicability

Community Scale Urban Wastewater Treatment Facility forr augmenting irrigation water supplies at IARI experimental farm

Capacity: 2.2 Million Liter, Horizontal Sub-Surface Flow (HSSF, Mono-cultured), HRT: 1.53 days, Land demand: 6.45 sq. m/KL

Community Scale Rural High SAR-Saline Sewage Treatment Facility at Pandit Deen Dayal Upadhyay Village, Mathura, UP

Capacity: 75,000 Liter, Design: HSSF, Mixed-cultured, HRT: 1.93 days, Land demand: 12.16 sq. m/KL

All India Women's Conference, Delhi

50,000 liter, VSSF, HRT: 14.8 hr, Land demand: 1.6 sq. m/KL

Rural Household System

Jawahar Navodaya Vidyalaya, Kansiram Ngr., UP

1-Lakh liter, HSSF, HRT: 1.42 days, Land demand: 7.24 sq. m/KL

ICAR-Central Arid Zone Research Institute, Jodhpur

Capacity: 1 Lakh liter, Design: Horizontal Sub-Surface Flow (Mono-cultured), HRT: 1.59 days, Land req: 7.35 sq. m/KL

Combo - Rainwater Harvesting & Wastewater Treatment System for Rainfed Areas

Capacity: 50,000 liters, Vertical Sub-surface Flow (VSSF) HRT: 1 day, Land demand: 2.25 sq. m/KL

Jawahar Navodaya Vidyalaya, Palwal, Haryana

1-Lakh liter, Horizontal Sub-surface Flow, HRT: 1.42 days, Land demand: 7.24 sq. m/KL

Additional Sites Under Commissioning:

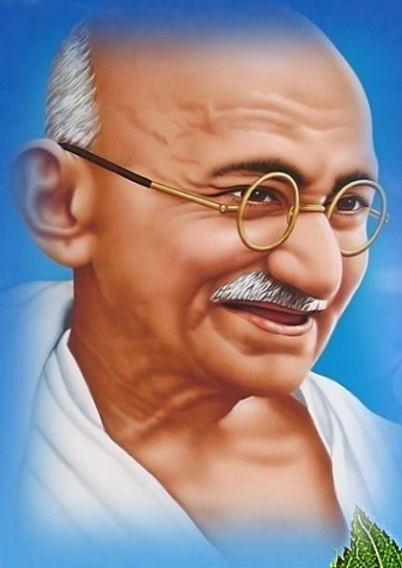
10 MLD @ Kapurthala
For **RailCoach Factory**
(LD:0.821 sq. m. per KL)

450 KLD @ Ghilot, Raj.
For **M/s RK Overseas**
(LD: 2.5 sq. m. per KL)

150 KLD @ Haryana
(Under SAP Program)

100 KLD @ Goa & **Bangalore**
(Under SAP Program)

LD:1.2 to 5.5 sq. m. per KL



THE DIFFERENCE BETWEEN WHAT WE DO

&

WHAT WE ARE CAPABLE OF DOING

WOULD SUFFICE TO SOLVE

MOST OF THE WORLD'S PROBLEMS

Thank You