NEWSLETTER

ISSUE 1 - MARCH 2014

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EDITORIAL

Dear Readers

We are pleased to present you the first edition of the "Water4Crops" Newsletter. **'Water4Crops'** is the acronym for **"Integrating Bio-treated Wastewater Reuse and Valorization with Enhanced Water Use Efficiency to Support the Green Economy in Europe and India"**. Water4Crops is an Euro-India coordinated research project, co-funded by the Department of Biotechnology, Government of India and the European Commission, addressing a crucial issue facing the world - **Water and wastewater reuse and management**.

In order to have a reasonable size, the present issue provides actual information on the project progress, research findings and observations made especially at its Indian case study sites. The next issue, instead, will be focused mainly on the European case studies. Other upcoming project events and announcements are also provided in the sections below.

The objective of the newsletter is to open the project to public and private stakeholders, diffusing our scientific research results with a problem-solving approach, and contemporarily stimulating a discussion with the enlarged audience of the end users by informing them on critical problems of waste water management.

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This issue contains excerpts from an insightful interview given by the project's European Coordinator, Dr Antonio Lopez to the UK research media where Dr Lopez explains how both the European and Indian consortiums are devising solutions to enable sustainable reuse of wastewater and efficient water use in agriculture. Subsequent sections will present the project research activities happening at ICRISAT, TERI, NEERI, IRSA-Italy, etc, who are partners in the project. The project's flagship event, first "INNOVA Platform" meeting's outcomes are also presented in this issue. Such meeting brought together external industry stakeholders, SMEs, end users and policy makers to discuss the pros and cons of the technologies being investigated in the project.

We hope you will enjoy reading this first issue. You are welcome to have a closer look into the works of Water4Crops at our web portal, www.water4crops.org.

Yours

Water4Crops Team

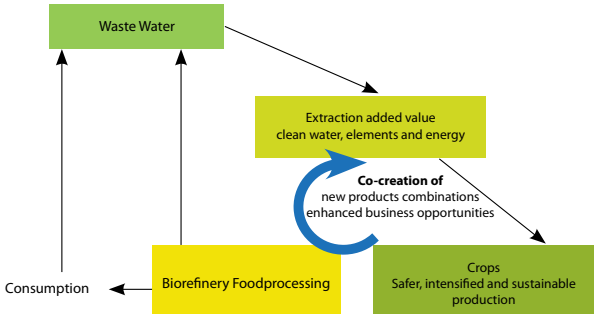
Water4Crops – An ambitious joint initiative of Europe and India

Through Water4Crops, an Indo-European consortium of 14 Indian and 22 European organizations belonging to different categories, including research institutions, university departments, large and small industries and consultants, **explores the possible opportunities of wastewater reuse in agriculture, both in Indian and in European context. Water4Crops commenced in 2012, and will run until the end of 2016.**

The overall strategy of Water4Crops is to advance individual key technologies and methodologies, both in Europe and in India, within the two Pillars "Innovative Biotechnological Waste Water Treatments for Improved Water Recycling in Agriculture" and "Improved Water Use Efficiency through Agronomics, Plant Breeding and locally adapted Irrigation Technologies and Techniques".

Water4Crops adopts a unique EU-India co-creation process which would integrate the role of co-learning, enabling links between traditional and industrial agri-production system and better utilization of market opportunities, thus boosting business development in the field of bio-treatment, wastewater reuse, and agricultural innovations to reduce the water footprint and opening-up various avenues for up-scaling processes.

The core **Principle** of the project is to develop an innovative, modular biotechnological process dedicated to fully exploit the use of water and its content of the organic carbon and nutrients leading to an **innovation triangle** with **creation of extra added value compounds** (organic acids, alcohols, PHA …) besides nutrients, **water** and **energy** as last recovery in a cascade approach. While nutrients and water will go back to the land and create opportunities to increase crop yield and allow new crops to grow spreading harvest period and processing times, the new crops and higher yields will bring in more activities like food processing and bio-refinery. The co-creation of these new product combinations will lead to enhanced business opportunities. This Principle is summed up diagrammatically here.



The project employs another unique concept called '**EU-India Mirror Case Concept**' which involves twinning, and integration of results of two successful 'mirror' case studies in Europe and in India. The Mirror cases will act as 'reflectors' reflecting a) business point of views/demands to the technology developers, b) achievements from individual technology development leading to identification of new solutions and new local business opportunities, c) the experience gained in India and in Europe in their respective case studies.

The mirror cases chosen are the **Emilia Romagna Region (Italy)**, and the **Greater Hyderabad Region (Andhra Pradesh State, India)**. Both regions offer high potential for application of innovative technologies and research outcomes for increasing and diversifying agricultural production.

For more details on project strategy, principle and mirror case concept, you can visit the project website or download the project brochure at http://www.water4crops.org/downloads/

Water saving and reuse for a greener economy

DR ANTONIO LOPEZ works at the Water Research Institute (IRSA) of the Italian National Research Council (CNR) since 1982

Excerpts of interview with Prof. Antonio Lopez, Coordinator of Water4Crops EU consortium providing an insight into Water4Crops project devising solutions to enable sustainable reuse of wastewater and efficient water use in agriculture [1]

As one of the largest current Indo-European projects, how are you coordinating Water4Crops (W4Cs) to ensure that its objectives are carried out effectively?

The key factor in ensuring the effective coordination of the two W4Cs projects is the simplicity and the similarity of their structures. The projects mirror one another with an identical structure in terms of both work packages (WPs) and topics. This means that the partners of each twinned WP speaks the same language and has shared competencies, which facilitates their organization and the project as a whole. Periodic WP meetings and joint project meetings are specifically scheduled to help coordinators monitor developments and, in some cases, adjust activities.

Could you discuss the main challenges presented by the two project locations and the ways in which W4Cs will overcome them?

The main challenges are rooted in the differing economies and educational systems of the regions. The average Indian income is lower than that of Europe, as is the level of the technological development, particularly in agriculture. Although continuously decreasing, such differences are still significant. Our research has been designed with such differences in mind, thus ensuring we are not aiming towards unrealistic goals. Within the agricultural sector – where the results of our work can be most easily implemented – the two issues we are facing are limited fresh water resources and the excessive use of water for irrigation due to the overestimation of crop water requirements. We are aiming to utilize non-conventional water resources by developing innovative sustainable techniques to treat wastewater, so that it can be safely used in agricultural production while safeguarding the environment.

This could save huge amounts of fresh water resources for drinking and domestic use. In terms of using natural resources more efficiently, we are developing new techniques that precisely measure the amount of water that the plant and soil require. By doing so, we are able to obtain a maximum yield so that excessive use of such limited water resources may be avoided. Using new technologies to determine exactly when and the extent to which we should irrigate will enable us to produce more crops per drop and unit area.

How would you define your approach and what makes it so innovative?

In practice, we apply a modular multistep approach that brings together wastewater treatment and reuse with its valorization by recovering compounds of high or moderate value. First, organic products originally occurring in the wastewater are converted into valuable products, such as organic acids or bio plastics, through dedicated biotechnological processes. After their separation, a final treatment is applied to obtain high quality irrigation water containing fertilizing matter such as the nutrients commonly occurring in wastewater. The novelty of the approach mainly lies in the maximal recovery of chemicals and nutrients.

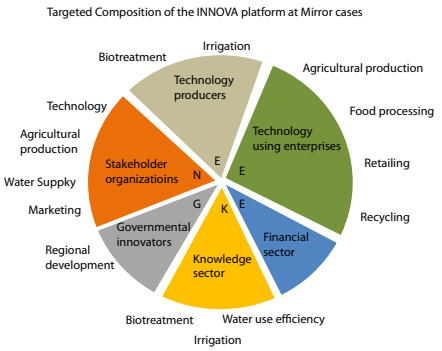
What practical solutions will be in effect by the project's completion in 2016?

By 2016, we plan to have developed the following solutions

- Alternative combinations of biotreatment, recycling of high value elements and bioproducts, leading to better commercialization of biotechnology and agricultural products in Europe and India as a basis for green growth
- Best practices for improving water use efficiency in agriculture through agronomics, plant breeding and locally adapted new irrigation technologies, and accurate crop water requirement measurement techniques
- Enhanced involvement among stakeholders (technology producers, technology users, retailers and regulators) for exploiting the outputs of the projects as means towards food and water security, and enabling mutual steps towards a green economy in Europe and India.

[1] Water saving and reuse for a greener economy, International Innovation magazine, December 2013, pp 112-114(ISSN 2051-8544).

EU- India developing solutions together through “The INNOVA Platform”



To enable successful market uptake of Water4Crops technologies, the project is acutely aware of the need to collaborate with a range of stakeholders. Without the capacity for social changes – for example, in user practices, regulations and industrial networks – any technological developments as a result of Water4Crops’ work would be effectively redundant, a fate that the team is keen to avoid. The **INNOVA stakeholder platform** was established to close this gap, and lies at the heart of Water4Crops. The INNOVA platform will be the main tool to facilitate the co-creation process. Through the platform, the researchers are able to connect and communicate with a suite of key contacts with expertise in a range of relevant sectors, including technology use, marketing and policy. During the course of the project, three major INNOVA meetings are planned, with the aim of encouraging researchers and stakeholders to share their experiences to date, discuss and work towards solutions to any particular challenges, and identify any further opportunities to boost green growth as part of the project.

Business opportunities, regulations and legislations discussed at Water4Crops First EU INNOVA Platform Meeting @ Bari, Italy

The first Water4Crops INNOVA platform meeting took place on 5th December 2013 in Bari, Italy. The meeting brought together 35 experts in the field of wastewater treatment and water use efficiency from Italy, France, Germany, Netherlands, United Kingdom, Greece and Belgium. These experts were challenged to explore business opportunities for the new technologies in the domains of waste water reuse and valorization, and water use efficiency that are being developed in Water 4Crops. The meeting facilitated discussions between researchers, potential users of the new technologies and marketing experts. Amongst the participants, experts from the AutoritàIdrica Pugliese (It), Acquedotto Pugliese (It), Sabmiller (India) and the Gesellschaft für Internationale Zusammenarbeit (GIZ, DE) represented different user groups. Marketing and business development specialists from LeAF (NL) and the Social Innovation Foundation (NL) also attended the meeting.

BUSINESS OPPORTUNITIES

Researchers used an elevator pitch to present and ‘sell’ the technologies they are developing. Lively discussions emerged in which the relevance of technology for users, (cost) effectiveness and other issues related to applicability and market uptake were addressed. One of the conclusions was that although there is still a long way to go, **more than 50% of the Water4Crops technologies have market uptake potential**.

Jack Crielaard of Social Innovation Foundation challenged the participants to look at business development in a different way. He prompted the gathering to consider the total availability of resources in a region as a starting point for social innovation, and to organize innovation as a co-creation process involving multi stakeholder networks.

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REGULATION AND LEGISLATION

The researchers in Water4crops face the dilemma to create business opportunities for waste water treatment technologies and reuse in a context of 'regulations' for the reuse of treated wastewater, as they are either very strict, for e.g. in Italy or still largely absent, like in India. Participants explored possibilities to use lessons from the Water4Crops project to positively influence future discussions on regulation and legislation at the national and European level.

The 1st EU INNOVA Platform meeting was experienced as very useful and inspiring. While the 1st Indian INNOVA platform meeting will be organized in India during 2014 "touching" the same topics (business opportunities, regulations and legislations) with external Indian stakeholders, the 2nd EU INNOVA Platform meeting will focus on costs and benefits of the technologies.

If you are interested in knowing more about the INNOVA Platform meeting outcomes, and are interested in being part of or contributing to these discussions you can write to us at info@water4crops.org.

Dr. R. Ragab, EU partner from Centre for Ecology and Hydrology, CEH, UK

SALTMED 2013 - An integrated management tool for Water, Crop, Soil and N-Fertilizers

(An Innovative Technology developed under Water4Crops)

Dr. R. Ragab, EU partner from Centre for Ecology and Hydrology, CEH, UK, has developed a very useful tool which helps in agriculture resources management as well as in predicting the impact of future climate change on food production and on the environment. The model has been supported by SALTMED, SAFIR, SWUP-MED and Water4Crops EU funded projects.

The SALTMED model has been developed as a generic model that can be used for a variety of irrigation systems, soil types, soil stratifications, crops and trees, water application strategies (deficit irrigation, Partial Root drying, PRD, subsurface), different nitrogen applications (fertigation, chemical or organic or crop residues incorporated in the soil) and different water qualities (fresh, wastewater, or saline, brackish, drainage water), drainage systems and shallow groundwater presence. The model can run simultaneously with up to 20 different fields or treatments and produces daily output files and figures. The daily output includes: soil moisture salinity and nitrogen profiles, plant water uptake/transpiration, soil evaporation, crop water requirement, nitrate and salinity leaching, nitrogen dynamics (mineralization, nitrification, and denitrification), nitrogen uptake, Relative yield, dry matter and yield and groundwater level. The model has a database for soils and crops parameters and is friendly and easy to use.

For further details on the SALTMED Model and Dr Ragab's contacts details please visit http://www.water4crops.org/saltmed-2013-integrated-management-tool-water-crop-soil-n-fertilizers/

Developing Decentralized Wastewater Treatment System as a Rural Business Model - ICRISAT, India

Use of wastewater in agriculture in rural as well as peri-urban areas in India is not uncommon. Almost 90% of total water supplied for domestic use generates wastewater which could be diverted for agriculture purpose. Safe use of wastewater could be a potential source of water in agriculture especially for vegetable growers in peri-urban areas. These areas have large employment opportunity for female and male laborers to cultivate crops, vegetables, flowers, fodders that can be sold in nearby markets or for their livestock use.

There are however number of limitations for wastewater treatment and reuse in agriculture such as mismatch between demand and water supply; salinity, treatment capacity and over nutrient application, etc. Moreover use of untreated wastewater in irrigation also may degrade groundwater system, accumulate salts in soils and create bad odour and further degrade other ecosystem services like downstream water quality etc.

Decentralized Wastewater Treatment (DWT) system developed at ICRISAT Campus, Hyderabad is believed to address number of these problems and water scarcity issues at local scale. At ICRISAT campus, Hyderabad domestic wastewater is received from a community outside the campus. This wastewater is being diverted through a series of settling tanks to a small lake. These tanks and lake is a habitat to several migratory birds and generates number of ecosystem services (regulating and cultural services). In coming wastewater is polluting surface water bodies in ICRISAT.

ICRISAT Water4crops team proposed to develop a DWT system to reduce pollutant load from this wastewater and reuse the treated wastewater for agriculture. The DWT system comprising a wastewater holding tank, constructed wetlands, and treated water storage tank is being constructed at ICRISAT (Figure 1).

Figure1. Photographs of constructed wetlands (inset) and treated water storage tank being constructed at ICRISAT, Patancheru site, Hyderabad, India

Similar DWT system is developed at University of Agricultural Sciences, Dharwad (UASD). At UASD, the source of domestic wastewater is effluent from campus residential area and hostels. The rationale behind developing DWT is - water scarcity, farmers and consumers getting adversely affected by direct use of wastewater in agriculture, environment pollution by disposal of untreated wastewater, and lack of sewage treatment plants in several localities.

Wastewater treatment should be linked with integrated watershed development program at field and community scale (500-1000 ha). Implementing several agricultural water management interventions at one hand would enhance the water resources availability, and wastewater treatment on the other hand reduces total water demand (as the demand management approach). A multitude of resources and processes that are part of natural ecosystems can be strengthened by such initiatives. Coupling wastewater treatment along with IWRM (Integrated Water Resource Management) is not only helpful in enhancing crop production and income of small holder farmers but also in improving water quality of groundwater wells and downstream water bodies including better soil quality through C sequestration.

ICRISAT is in the process of developing the 'sites of learning' in two model watersheds (Kolar and Bellary district of Karnataka) showing decentralized wastewater treatment and its use in agriculture.

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Figure 2: Wastewater collection pond and wastewater irrigated field at Muduvatti village from Kolar district of Karnataka, India

Read more about ICRISAT's Integrated Watershed Management Programme in Kolar District, and on what parameters that have analyzed the characteristics of the collected wastewater samples at http://www.water4crops.org/developing-decentralized-wastewater-treatment-system-rural-business-model-icrisat-india/

Benchmark characterization of wastewater and soil at Dharwad, India

The average availability of water is reducing steadily with the growing population and it is estimated that by 2020, India will become a water stressed nation. Hence use of non-conventional sources of water is inevitable to meet the future challenges of scarce water resource in terms of sustainability, food security, income security and environmental safety.

The rapid expansion of cities and domestic water supply, quantity of grey/wastewater is increasing in the same proportion. An overall analysis of water resources indicate that in coming years, there will be a twin edged problem to deal with reduced fresh water availability and increased wastewater generation due to increased population and industrialization.

Farmers in peri-urban areas use untreated sewage water for crop production. The adverse effects of untreated sewage water have been overlooked. Hence there is a need to create awareness among users and to compare the same with treated waste water in crop production. Even the 12th five year plan document says that economic growth of 8 to 9 per cent is only possible if water requirements of the expanding population can be met. Thus the present investigation on use of treated wastewater in crop production would improve crop productivity by reducing direct contamination with food crops.

Under Water4Crops Project, University of Agricultural Sciences, Dharwad, has identified the following experimental sites - Ugar Khurd (Distillery), University campus and Dharwad (Mavanur, Katnur and Gabbur), where wastewater has been in continuous use for several years. Wastewater and soil samples were collected and analysed for different physical, chemical and biological properties.

SEWAGE WATER: The pH of sewage water was slightly alkaline and remained largely unaffected over time and was slightly saline. The sewage water of UAS, Dharwad recorded slightly higher salinity ovewr the sewage water collected at three villages near Hubli. Total solids were relatively higher at Gabbur and lower at Katnur. But, irrespective of location, total solids were higher during July-August possibly due to mixing of sewage water with rain water. Same trend was observed with respect to total suspended solids. Total dissolved solids did not show such trend. High levels of phosphates were observed, irrespective of place and time of sampling. Total N in sewage water increased during summer and decreased during rainy season (July and August months) may be due to dilution effect.

Besides, higher bacterial populations were observed in the month of August and September in all the four locations. **Thus during**

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rainy season due to low salinity level, the waste water may be judiciously used with proper treatment.

Plate 1: View of land affected by continuous application of spentwash for > 20 years

The electrical conductivity (EC) of soils was slightly higher in soils sampled close to the stream (50 m) at Gabbur than those sampled away at all depths. Despite long term irrigation with sewage water, the EC build up was not appreciable at all three depths in all villages. At all the three villages they remained relatively lower in the surface and increased with soil depth. The EC remained nearly uniform in majority of the cases except for a slight increase at the surface layer in sites closer to the stream at Gabbur. **This indicates that extensive use of sewage water with such properties can be safely practiced in crop production.**

INDUSTRIAL WASTE WATER: Continuous application of spentwash for varied periods at large had no effect on soil pH at various depths. However, increased frequency of application of spentwash resulted in relatively lower pH values, the lowest pH (7.87) being recorded under continuous application of spentwash for > 20 years. Application of spentwash for 15 to 20 years showed no significant effect on soil salinity. However, application of spentwash for more than 20 years resulted in accumulation of salt. The salt accumulation was more at the surface and decreased with depth. (plate. 1)

Continuous application of spentwash resulted in higher organic carbon status in soils. The organic carbon was low in the untreated control which increased to 4.78 g/kg due to continuous application of spentwash for 5-10 years, which further increased to 6.40, 7.20 and 7.74 g kg-1 due to continuous application of spent for 10-15 years, 15-20 years and > 20 years, respectively. Hence the trails have been initiated at Ugar khurd to find out suitable agronomic and bioculture practices to improve soil fertility and productivity of affected soils.

The Table on chemical composition of sewage water is available at the link: http://www.water4crops.org/benchmark-characterization-wastewater-soil-dharwad/

Bioremediation of degraded land & Utilization of waste sugarcane bagasse ash TERI, New Delhi

Figure 1: Photos of different sites subjected to biomethanated spent wash application

Biomethanated spent wash (partially treated distillery wastewater) is often used to irrigate agricultural land. Over time, this leads to land degradation due to salinity build-up. To address this issue, bioremediation i.e. use of microbes for clean-up is being examined by TERI under the Water4Crops project. Sites at Ugar Sugar, Belgaum that have been subjected to biomethanated spent wash application for different durations (5-10 years, 10-15 years and > 15 years) (Figure 1) were selected. Bacteria associated with sugarcane crop grown in alkaline soil conditions have been isolated. Some of the microorganisms produce organic acids during their metabolic processes that can reduce rhizospheric alkalinity. Estimation of chemical properties of soil and biochemical characterization of isolates is on-going.

Utilization of waste sugarcane Bagasse ash: Bagasse, the residue generated by crushing of sugarcane, is used as a fuel in sugar factories. The resulting ash is rich in unburnt carbon due to incomplete combustion. This carbon is separated by simple techniques like sieving and is being studied as an adsorbent for

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contaminants in wastewater (Figure 2). The properties of the unburnt carbon can be improved by removal of residual ash and steam activation. Humic acid is similar to colour causing compounds in distillery wastewater and hence adsorption of humic acid was studied. Removal of humic acid with modified carbon was about 38%. Studies to further improve the adsorbent properties are underway.

Figure 2 (a) Unburnt carbon separated from bagasse ash (b) Scanning electron micrograph of unburnt carbon (c) Unburnt carbon after deashing

Bio-treatment of distillery wastewater and reuse in integrated agro-aqua farming systems- MSSRF, India

Distillery spent wash is the dark black coloured residual liquid generated during alcohol production from sugarcane molasses. During the course of alcohol production, for each liter of alcohol ~12-15L of effluent is generated. In India there are ~319 distilleries generating ~40.4 billion litres of distillery effluent annually. Despite stringent standards imposed the partially treated or untreated effluent is discharged into water bodies or used for irrigation purpose which leads to high environmental hazard. The characterization of the distillery effluent indicates that the Biochemical oxygen demand (BOD 5200 ppm), Chemical oxygen demand (COD 56,285 ppm), total solids (TS -68,000 ppm) are very high, in addition to the presence of high concentration of sulphates, phosphates and phenolic compounds even after anaerobic digestion. The dark colour of the distillery effluent is due to the presence of a complex polymer namely melanoidin which is a major source of soil and water pollution and needs to be treated before discharging into the environment. In addition, the untreated distillery effluent when discharged into the agriculture land inhibits seed germination and depletes the native vegetation, and in the aquatic bodies it leads to eutrophication, decreases photosynthetic activity and damages the fauna and flora. Though conventional treatment processes such as activated sludge and activated carbon absorption methods are available it has its own drawbacks mainly sludge disposal. Hence to overcome the negative feature of the effluent, a combination of the bio and phytoremediation methods is being adopted for treatment of the distillery effluent.

One of MSSRF's activities under the Water4Crops project is focusing on Biotreatment of distillery and sugar effluents discharged from KCP Sugar Industries located in Vuyyuru (L1) and Lakshmipuram (L2) of Krishna district, Andhra Pradesh. In this process the anaerobically treated molasses spent wash is subjected to Bio and Phytoremediation. Potential decolourising bacteria isolated from the waste water were multiplied and used for decolourization of the effluent. The microbial pretreated waste water was passed through individual filter tanks containing seeds of Strychnos potatorum (clearing nut) and charcoal. These three sequential treatments would mediate the degradation of high organic and inorganic pollutants and contribute to 25% colour reduction in addition to reducing BOD, COD and TSS. This pretreated effluent is further subjected to phytoremediation in an Engineered Constructed Wetland (ECWL) which contains common wetland plants Typha and Phargmites cummunis harbouring rhizosphere bacterial communities. Both the plant and the rhizosphere communities mediate declourization and detoxification of the effluent by utilizing the organic and inorganic substance as energy source. The sequential treatment of the distillery effluent with bacterial consortia, followed by treatment with S. potatorum; biochar and CWLS would enhance water qualities to suit the irrigation standards.

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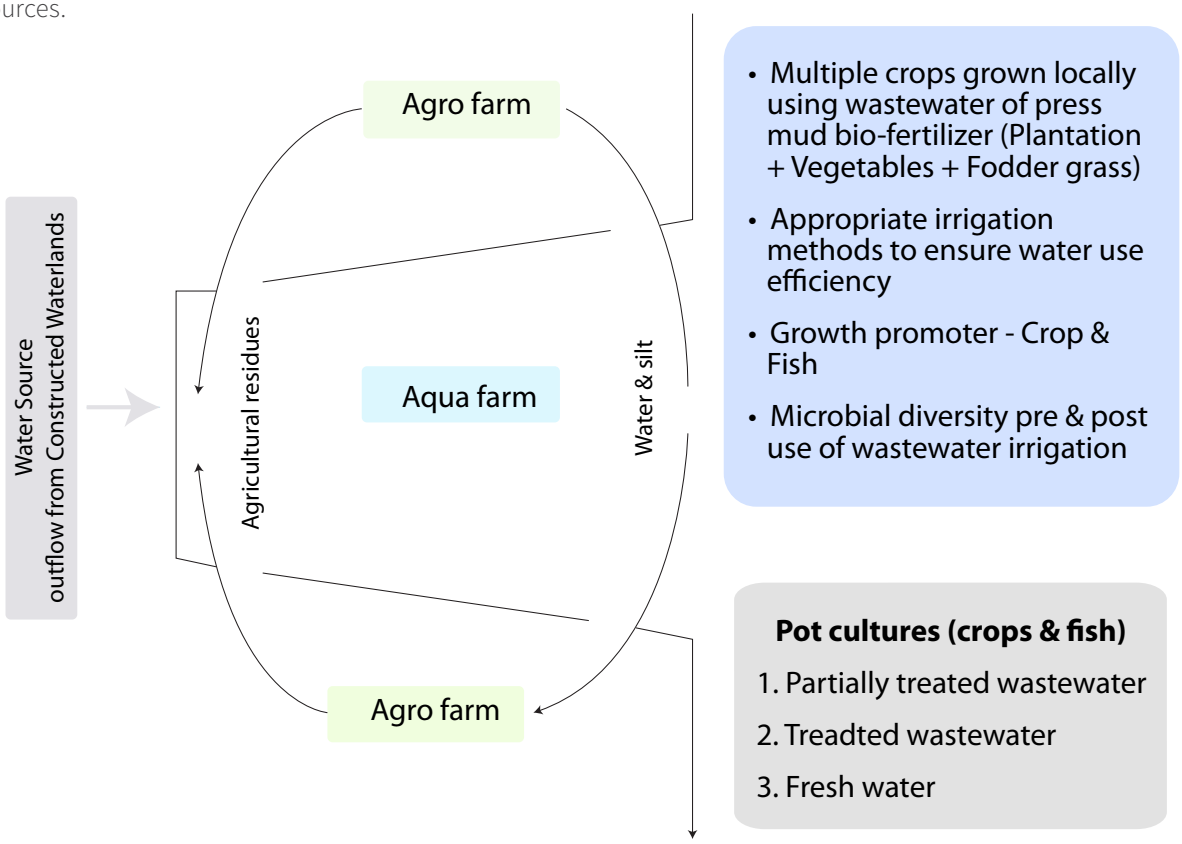
AN INTEGRATED AGRO-AQUA FARMING SYSTEM IS TO LINK AQUACULTURE TO CONVENTIONAL FARMING SYSTEMS.

The development of such systems has been driven by different needs including a desire to improve food security on small, subsistence family farms and or to minimize pollution and use valuable resources (such as water) more efficiently and effectively. From the Water4Crops perspective, the advantages of integrated agro-aqua farming system include increasing farm productivity and profitability without any net increase in water consumption by diversifying crops including aquatic species. In this context the aqua pond is considered as a tertiary treatment process followed by CWL which would reduce the COD, BOD, TSS, TDS to a considerable amount. And the nitrogenous waste from aqua pond can be reused as nitrogen source for crop cultivation otherwise reuse of on farm resources.



Framework for Integrated Agro-Aqua Farming System

The multiple uses of farm water resources for aquaculture can result in many environmental benefits. As aquaculture predominantly does not consume much water, rather "borrows" it for "temporary" use, this practice is integrated into a farming system before the water is used for its primary purpose, such as irrigating crops or pastures. In this way, nutrients are also added in organic form to the water before irrigation, which may subsequently reduce the need for additional inorganic fertilizer application. The multiple use of water in itself will mean that the farm is more efficient in terms of the value of production per unit of water used, and more environmentally sustainable.

Thus productive use of treated distillery wastewater through Water4Crops project will be demonstrated in an integrated manner by establishing an agro and aqua farming system.

The treated waste water from the CWL flows into the aqua pond where the resilient species namely Tilapia (*Oreochromis niloticus*) will be cultured. Water from fish pond will be used to irrigate the agro farming systems with the native crop species. The native crop spp. grown in and around the industrial area for farming system was identified in a participatory manner in consultation with the farmers.

Building Efficient Irrigation Systems, Strategies and Improved Agronomic Practices, Jain Irrigation Systems Ltd. Jalgaon, India

The wastewater from industries varies so greatly in both flow and pollution strength. So, it is impossible to assign fixed values to their constituents. In general, industrial wastewaters may contain suspended, colloidal and dissolved (mineral and organic) solids. In addition, they may be either excessively acid or alkaline and may contain high or low concentrations of coloured matter. These wastes may contain inert, organic or toxic materials and possibly pathogenic bacteria. It may be necessary to pre-treat the wastes prior to release to the agriculture or municipal system.

"**There is more to Jain Irrigation than irrigation**," because it has world class food processing facilities for dehydration of onion, vegetable and production of fruit purees, concentrates and pulp. These plants are ISO 9001 & HACCP certified and Meet International FDA statute requirements. Both the industries are separate and 105 tonnes of fruits & vegetables (onion) are processed daily. Large amount of water is used for washing, grading, peeling and processing. The annual average availability of treated waste water generated from fruit processing is 200000cu.m and from onion dehydration plant is about 150000cu.m. Our aim is to save every single drop of water be it from industry or from agriculture. In Water4Crops Jain Irrigation Systems has an important objective of "Increasing water use efficiency through efficient irrigation systems, strategies and improved agronomic practices".

Laboratory test/analysis is conducted developing clog-free emitter for processed water from both onion and fruit processing industries. Testing protocol is developed for testing clogging resistance of emitters either to let pass or to prevent entry of solid particles of a given size, with a view to approach the minimum size of the internal aperture within emitter which further helps in the selection of system filtration size. **Six different varieties of emitters have been tested till today of both type pressure compensating (PC) and Non Pressure compensating (NPC). PC Emitters have shown effective results as compared with NPC. The clogging resistance of PC emitter is higher than that of NPC.**

Fig: Emitter clogging setup

Fully automatic Drip irrigation Model – for three different water sources – Fruit, Onion & Bore well)

Water analysis is done to trace out (detect) the type of impurity responsible for clogging after every one month. List of parameters are analyzed at our laboratory; pH (7-9), EC (1-3ms/cm), TDS (1000 - 4000 ppm), BOD (100-400) , COD (100-300), Carbonates & Bicarbonates (50-100), Chlorides(50-100), Sulphates(50-100), Sodium (100-400), Potassium(50-200) , Calcium (50-100), Magnesium(10-50), Arsenic(NIL), Iron (0.1-0.5), Lead, Cadmium, Zinc, Pathogenic microbes, Nitrates, Physical impurities.

Field tests we do include soil analysis and the list of parameters tested in our laboratory are: Micro nutrient & Macro Nutrients, Sand (%), Silt(%), Clay(%), Bulk Density, Soil texture & Soil Microbes. like Micro nutrient & Macro Nutrients, Sand, Soil texture, Soil Microbes. This could also help in selecting the fertilizer & pesticide dose/ Irrigation scheduling & other crop & farm treatments.

Experimental setup is designed to fulfill the objective of this activity. And trails are carried out on two different crops – Maize & Banana. Three water sources (Fruit, Onion & Bore well) have been used to know the effect on drip system, crop as well as on soil. Trails are replicated five times to minimize the error and to achieve good results on two different crops Maize and Banana.

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Crop is responding well for all the water sources since the date of sowing two months ago. But it is noticed that fruit water has good effect on maize than the fresh & onion water. The Plant height, Number of leaves, Vegetative Growth is found to be good in Fruit water under NPC dripper than that of PC. And the **System** is responding well to fresh water followed by fruit. The frequency of cleaning sand filter and disc is more in case of onion than that of Fruit.

To read more about this activity please visit: http://www.water4crops.org/building-efficient-irrigation-systems-strategies-improved-agronomic-practices-jain-irrigation-systems-ltd-jalgaon-india/

'Phytosystems for Wastewater Treatment and Reuse in Agriculture'

Water4Crops Workshop organized by CSIR-NEERI, INDIA

CSIR-National Environmental Engineering Research Institute, a premier institute in the field of environmental protection in India and Water4Crops Indian consortium partner has the objective of treating the industrial and domestic wastewater with biotechnological methods and to provide safe water for crop irrigation. In this context, CSIR-NEERI is working on improvising the existing constructed wetland technology for better treatment of wastewater.

Figure 1: Pilot scale engineered constructed wetland system at CSIR-NEERI campus.

A series of pilot scale experiments are being conducted on the engineered constructed wetland systems by varying the substrate composition, retention time and loading rate to improve its treatment efficiency. The objective is to control the onset of clogging in the wetlands, to study the reaction kinetics occurring in the system and to control the pathogenicity of the treated wastewater.

Figure 2: Degraded land at Pandharkawada village due to the application of domestic wastewater

Apart from this, CSIR-NEERI is also working on reclamation of the degraded lands due to the prolonged application of municipal wastewater for crop irrigation. In this regard a social initiative was taken up by CSIR-NEERI and conducted a workshop entitled "**Phytosystems for Wastewater Treatment and Reuse in Agriculture**" in October 2013 where it involved the stakeholders such as farmers, municipal authorities and governing agencies to get a deep insight of the problems experienced by the farmers. Subsequently, they have adopted a village Pandharkawada, near Nagpur, to reclaim the degraded land into cultivable agricultural fields.

More information about Phytosystems for wastewater treatment and workshop themes are available at http://www.water4crops.org/wp-content/uploads/2013/10/20131009_NEERI_Workshop_Brochure.pdf

Water4Crops events

The Water4Crops EU and Indian consortiums have met three times since the beginning of the project to discuss the progress and bottlenecks in project activities at both ends. The 2 Kick-off meetings at Europe and India followed by the Year 1 EU Project meeting and subsequent 1st EU Innova Platform meetings have proven to be good platforms for the research and industry partners from both the consortiums to share the know-how, experiences and technology updates in the project.
The details of the project events are given below. To view the event galleries please visit Water4Crops news and events page at: http://www.water4crops.org/category/water4crops-news/

Water4Crops EU Kick off meeting, 30-31 October 2012, Rome, Italy

Water4Crops EU Kick Off meeting was held from 30-31st October 2012, Rome, Italy and was attended by EU consortium partners and 8 delegations from INDIA representing the consortium of W4Cs-India project. Both The Coordinators from EU and India presented the overview of water4crops project. Considering that the kickoff was the first time that W4Cs-EU partners physically met the Indian colleagues, in addition to the usual scope of a kickoff meeting, the main objectives of the presentations gave an exhaustive picture of the activities planned, the goals and the mutual integration within W4Cs-EU and with W4Cs-India.

Water4Crops Indian Kick off meeting, 28-30 January 2013 at ICRISAT, Hyderabad

Water4Crops India Kick Off meeting was held from 28-30 January 2013 at ICRISAT, Hyderabad and was attended by DBT director in-charge of the project, Dr Shailja Gupta, and Indian and European consortium partners. During the Inaugural Session, on 29th January 2013, Dr. William D. Dar, Director General, ICRISAT stressed the importance of treating and recycling of wastewater for agricultural use for improving the livelihoods. Drs. Suhas P Wani and Antonio Lopez coordinators of the India and EU projects described the salient objectives, strategies, expected outputs and novelties in the projects.

Following the Inaugural Session, a well-attended Press Conference was addressed by Drs. W.D. Dar, Suhas P Wani, Antonio Lopez, Meenakshi Sharma and Shailja V Gupta, Director, DBT, providing important insights about the project to the media.

EU INDIA 1st Joint Meeting, 3-5 2013, Bari, Italy

On December 3rd-5th 2013, the first Joint Meeting of the Water4Crops (W4C) project was held at CIHEAM Bari. An Indian delegation of nine partners representing the Indian consortium and all 22 European partners attended the meeting, for a total of about 60 participants.

During the opening session, Dr. Nicola Lamaddalena welcomed participants and presented the main activities of CIHEAM Institute. Afterwards, Dr. Suhas P. Wani (ICRISAT, India) and Dr. Antonio Lopez (IRSA-CNR, Italy), coordinators of the India and EU projects, respectively, presented an overview and new strategies of Indian and European W4C projects. Subsequently, the Joint Meeting officially started with the technical presentations. In the course of three days intermediate results of work packages (WP) 1-7 were presented and intensively discussed. Future plans were made to increase the mutual integration within W4C-EU and with W4C-India. The Joint Meeting was closed on December 5th 2013 with a concluding session. With the exchange of activities and enhancement of the interaction between the EU and Indian W4C partners being the objectives of the W4C Joint Meeting, latter can be called successful.

Upcoming Events

4th IWA/WEF Wastewater Treatment Modelling Seminar 2014
30 March - 2 April 2014 Spa, Belgium
http://www.biomath.ugent.be/WWTmod2014/

Industrial Technologies 2014
9-11 April 2014 - Athens/Greek
www.industrialtechnologies2014.eu

Aquatech India 2014
6-8 May 2014, New Delhi, India
http://www.aquatechtrade.com/india/Pages/homepage.aspx

World Water Week
31 August – 5 September 2014, Stockholm, Sweden
http://www.worldwaterweek.org/

Watertech India 2014
10-12th September, 2014, New Delhi, India
http://www.watertechindia.com/

Wastetech India 2014
10-12th September, 2014, New Delhi, India
http://www.wastetech-india.com/

IwA world water congress & Exhibition
21-26 September 2014 – Lisbon/Portugal
www.iwa2014lisbon.org

IFAT India 2014
9-11 October 2014, Mumbai, India
http://www.ifat-india.com/

Partners

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