

ICID NEWS

MANAGING WATER FOR SUSTAINABLE AGRICULTURE



MESSAGE FROM THE PRESIDENT

Dear Colleagues,

The United Nation is planning to submit a resolution to the General Assembly in September this year, to adopt “Sustainable Development Goals (SDGs)”, by all member countries for implementation of a sustainable development regime from 2015 beyond. Global food security and poverty eradication are at the top of the SDGs list; wherein water for drinking and sanitation use is lined up next. To fulfill these two and support a number of other SDGs there is a need to increase global food production by 60% by the year 2050. The key elements of augmentation in food production stem from productivity enhancement of both irrigated and rainfed farming. Considering that the future expansion of cropped land may not be promising, the solution lies in exploiting the considerable potential that exist by increasing food production in rainfed agriculture as well as within the existing irrigated area. Using lesser water and thereby increasing the irrigated crop land has the potential to ensure both water and food security at all levels around the world.

ICID, through its technical Working Groups and National Committees, is aiming to contribute effectively to this global endeavor with prospective of reaching to the state of “The World with Secured Food Supply and no Hunger”. In this process, individual – centered irrigation practices, particularly in developing and emerging countries, calls for more attention. At the same time modernization of the existing large and medium irrigation schemes, capacity development, institutional improvement, supporting farmers’ initiatives and rural transformation focusing on irrigation development are the means of materializing action in this direction.

The newly introduced ICID working groups, ‘Modernization and Revitalization of Irrigation Schemes (WG-M&R)’ and ‘Institutional Aspects of Irrigation / Drainage System Management (WG-IOA)’ would provide platforms for the experts from NCs and international organizations to embark on extensive studies and deliberations to find and recommend methods and best practices to revitalize the irrigation schemes neglected up until now. ICID invites NCs, particularly the member countries with vast experience in the operation of large and small irrigation schemes, as well as public and private schemes to join these WGs and share their experiences with the global community.

ICID and its National Committees have demonstrated their commitment to modernization process by organizing sessions and discussions on the role of modernization of irrigation schemes at the recently concluded 7th World

Water Forum in South Korea, April 2015. The deliberations during the Forum, particularly on the role played by storages in mitigating the risk of uncertainty of rains, given the widespread drought conditions prevailing in many parts of the world, requires ICID to reconsider its policy towards means of water storages of all kinds for use in agriculture.

Profitability and long-term sustainability of agriculture sector also depend on its use of energy and how it can make itself green by managing its energy requirements efficiently and by harnessing the renewable sources of energy. A number of policy and field level innovations are being used around the world to harness solar power in conjunction with agricultural practices. A couple of such innovations are presented in this issue of ICID News to initiate the process.

I am sure that this issue of ICID News will provide the readers some of the clues to work towards sustainable agriculture water management. I am hopeful that the readers must be benefitting from our efforts to present the complex scientific issues in simple language in this quarterly ICID News.

Best regards

Dr. Saeed Nairizi

President, ICID



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Inside

Use of Renewable Energy for Irrigation

The challenge of scarcity of resources: Water-food-energy is highly interlinked. Policy and other interventions must take this into account. While, taking an integrated view of these issues is essential but highly complex, individual solutions can pave the way for meeting diverse and opposing objectives. This article brings forth a couple of examples from Spain and India where solar power is helping irrigation and vice-versa to meet this challenge.

In recent years, due to the modernization of irrigation schemes, where old open channel distribution networks have been replaced by new pressurized networks, the overall amount of energy required for the irrigation supply has drastically grown in many countries. The energy and power requirements are around 1000-1500 kWh/ha when water is diverted from rivers or dams, and these values can be much higher where water comes from deep aquifers or it is supplied to steep areas with large differences in elevation from the water source to the supply point.

Due to the increased energy dependence and higher energy costs, since energy prices have followed a growing trend, energy represents an important percentage of the total water costs (around 40%) which has an important impact on farmers' returns. Thus, water and energy use in pressurized irrigation systems cannot be considered independently as energy is becoming a major factor

as important as water availability, rainfall or evapotranspiration. Efficient water and energy use take on greater importance in agriculture due to the widespread tendency of reduced water availability and increasing energy costs, which determine the viability of irrigated agriculture in many areas of the world.

Moreover, the energy used in the pumping stations implies higher GHG (greenhouse gasses) emissions, which increases the carbon footprint of the agricultural sector and involves a significant environmental impact which is particularly important in the current climate change context. This fact highlights the need to improve the efficiency in the water-energy nexus, essential for the economic, social and environmental development of the sector. In the interest of sustainable development and the minimization of climate change impacts, national and international policies are prioritizing the improvement in the use of the natural resources.

Solar Energy for the Irrigation Water Supply in Spain

J.A. Rodríguez-Díaz¹

In Spain, electricity is produced mainly from fossil and minerals fuels, which are non-renewable resources and causes significant environmental impacts. By contrast, renewable energy resources reduce the negative effects on the environment and contribute to the sustainable development of the agricultural sectors. In Southern Spain, the irrigation season is mainly concentrated between March to October. Simultaneously, the PV (Photovoltaic) systems have their peak energy production in these months. Then, solar radiation and evapotranspiration have parallel time distribution curves (monthly and daily), so the peak solar power generated coincide in time with the maximum irrigation water requirements. Consequently, PV systems have potential to be the most suitable renewable source for irrigation, even more when considering that the price of solar panels has dropped dramatically in recent years.

One good example of solar irrigation is the Sun Water Project system developed by IWES (www.iwes.es), a spin-off of the University of Córdoba. The major innovation of this system lies in its capacity to supply energy from solar panels to conventional AC pumps, so there is no need to replace the current pumping system by solar pumps, which usually cost up to four times higher than conventional pumps.



The Sun Water Project system reduces the installation costs significantly and the payback period is between 3 to 6 years depending on the farm size. The system is installed in a variable speed drive, which connects the pumping system and the solar panels to operate the water supply. It can be configured off-grid, independent of the conventional energy supplier grid, or as a grid-tie PV system, connected to the supplier grid so when the electricity generation is not enough, overnight or lower radiation days, and the energy from the main grid can make up the shortfall.

In the 2014 irrigation season, a prototype of the Sun Water Project system was installed in the Villaseca farm (Córdoba, Andalucía) to supply water to a 14 ha citrus field with drip irrigation. The installed power was 14.25 kW with an estimated annual energy production of 24225 kWh. After the first year of operation, the economic savings in energy were 100% since solar panels produced all the energy requirements and no additional energy was purchased from the main grid. The environmental benefits were estimated in 1688 kg CO₂/year by avoiding the use of fossil fuels.

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This experience demonstrates that solar energy is a technically and economically viable alternative, which offers great advantages such as the reduction of energy costs, farmers' profit is decoupled from fluctuations in conventional energy prices and it represents a clean and environmentally

friendly energy source with practically zero CO₂ emissions to the atmosphere. To achieve optimum efficiency, the installation of PV systems must be accompanied by measures aimed at reducing the energy requirements of irrigation systems such as the organization of farmers in irrigation turns (sectoring), detection of critical points, and optimum operation of pumping stations, low energy emitters and better irrigation scheduling.



Solar Plants atop Canals to Save on Land and Water in India

Dr. Mukesh Joshi²

In developing countries with fast population growth, in addition to water, land resources are becoming scarcer. The large surface area required for the installation of solar panels poses a challenge, although the cost of photovoltaic cells is coming down making solar power more economically viable.

As India, a densely populated country moves to ramp up investment in solar power, it is exploring innovative places to install solar plants, including across the top of canals. The 10 MW plant on the outskirts of Vadodara city in India's western state of Gujarat, which began generating power in November, is built across 3.6 km long irrigation canal, and has 33,800 solar panels mounted on steel scaffolding. Connected to the state grid, its output is intended mainly to meet demand from irrigation pumping stations. On a sunny day, the plant generates 50,000 units of electricity (1 unit equals 1 hour of 1,000-watt usage), and is scheduled to produce 16.2 million units in its first year, declining 1 percent annually as the panels degrade.

During the inauguration of the new "canal-top" solar energy plant in January 2015, U.N. Secretary General Ban Ki-moon said that he sees more glittering panels and the future of India and the future of the world. He also said that he sees India's bright creativity, ingenuity and cutting-edge technology. Experts identify two major advantages in building solar plants atop canals viz. efficient and cheap land use, and reduced water evaporation from the channels underneath. Completed in six months, the plant's \$18.3 million cost - including 25 years of operation and maintenance - is recoverable in 13 years, according to Sardar Sarovar Narmada Nigam Ltd (SSNNL), the Gujarat government agency that administers this facility and another smaller one.



The cost of producing 1 unit of electricity at the plant is 6.5 rupees (\$0.105) and SSNNL is entitled to use the same amount of power it feeds into the grid without paying the standard price of Rs.7.5 to Rs.8 per unit. According to Eng. Navin Reddy, Megha Engineering & Infrastructures Limited (MEIL), Hyderabad, which constructed the plant, "Canal-top plants are more expensive to maintain. But the company incorporated side bars on the scaffolding and walkways between the panels so they can be reached easily for maintenance".

The 10 MW plant follows another smaller plant in Gujarat, commissioned in April 2012. Set up along a 750-metre stretch of canal, the 1 MW plant has so far generated

4.35 million units of electricity. The plants are part of the Sardar Sarovar Project, a hydropower and irrigation scheme that aims to water 1.8 million hectares (4.45 million acres) of land in Gujarat and Rajasthan through 75,000 km of canal, which is yet to be completed.

Both the solar power plants are built on branches of the main canal, though which irrigation water runs from a dam on the Narmada River. According to SSNNL, the 10 MW plant has saved on 16 hectares of land, and will potentially prevent 90 million litres of water from evaporating each year.

The 1 MW canal-top plant cost \$2.8 million, according to SSNNL, whereas a 1 MW land-based solar plant costs \$2.3 million. Another problem is that PV panels are usually mounted facing southwards for optimal performance, but a canal might curve and change direction. Using only north-south stretches of water could limit the scale of canal-top plants. Long-term exposure to environmental stresses and ingress of water into the panels could also reduce their performance.



2 Sarovar Narmada Nigam Ltd (SSNNL), Gandhinagar, Gujarat, India E-mail: dr.mbjoshi@gmail.com >

Product Lineup

Maintaining Sub-surface Drainage Systems

Drainage for Sustainability

Increased competition in food producing countries demands maximum effort to achieve high yield against low costs. One of the pre-requisites to achieve this is by well-maintained irrigation and subsurface drainage methods: on the land or in the greenhouse. Reliable water levels in the field can help plants grow even under difficult circumstances.

Drainage problems are serious on about 100-110 million hectares of irrigated land located in the world's semi-arid and arid zones. At present, about 20-30 million hectares of irrigated land are seriously damaged by the build-up of salts and 0.25-0.5 million hectares are estimated to be lost from production every year as a result of salt build-up.

Drainage, by virtue of man-made surface or sub-surface conduits, attempts to create well drained arable lands, preventing salinization of the soils, lowering of groundwater table and removal of accumulated salts or toxic elements.

Regular maintenance keeps your soil healthy

The high investments in equipment demands provision for adequate maintenance. The sub-surface conduits have a tendency to clog for a variety of reasons such as design of the system, materials used for construction, and installation procedures. A predominant phenomenon in clogging of agricultural drainage systems is formation of iron deposits.

For the past 35 years HOMBURG in Holland is the world leading manufacturer for the maintenance of sub-surface drainage systems. The extremely rigid HPE hose is pushed into the drain (up to 500 metres), in combination with the unique low-pressure system (only 10 to 12 bar) making it possible for the specially developed nozzle to clean the drain and remove the dirt. HOMBURG drain cleaners are economical to use, reliable and extremely robust. Their simple operation guarantees a safe and efficient working environment. The patented system cleans without affecting the structure of the soil or the drain.

For more information or free CD-ROM? Check <http://www.drainjetter.com> or send an email to info@homburg-holland.com

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New approach of farm management under surface irrigation to improve water saving and productivity

Prof. Dr. Yousri Ibrahim Atta¹

The WatSave Innovative Water Management Award 2014 was awarded to Dr. Yosri Ibrahim Mohamed Atta (Egypt) for his research work on "Improving growth, yield and water productivity of some maize cultivars by new planting method". Dr. Atta was engaged in a project for investigating the efficiency of an improved technique of planting crops in furrows and ensuring that water application was just sufficient to reach saturation level at top of furrows. This innovative irrigation management method resulted in considerable water saving due to increased irrigation application efficiency, decreased percolation and evaporation losses, and increase in yield at less labour cost.

Introduction

Maize is one of the most important cereal crops in Egypt. The local production of maize does not cover the local consumption. Therefore, great efforts are directed to increase the productivity of the cultivated area by using high yielding cultivars.

Irrigation of maize during growing season using optimum amount of water is important for increasing productivity. Therefore, it is necessary to find out a new planting method and improved irrigation technique to increase the irrigation application efficiency, water saving, field water use efficiency as well as yield and quality.

Description of the Innovation Method

This method depends on reducing irrigated area of furrows by adapting different spacing (80 or 160 cm) apart as shown in Figure 1. Top and bottom of the furrow are named as border and tape respectively. All borders and tapes are named (Strip of furrow). Grains were planted in tapes as per the plant density recommended in one or two rows of plants according to strip width. In first stage irrigation was given enough amounts for saturation effect at borders to fix the dimension of strip. Next irrigations were given for tapes only in addition to a small part on both sides of the furrows as a result of water flow in these tapes. Accordingly, wetted area of the strip is decreased by about 30 to 50 per cent and consequently water saving by

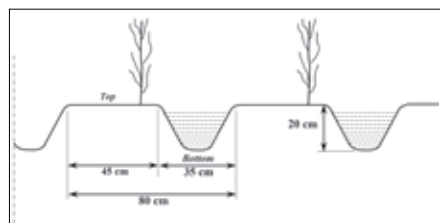


Figure 1. Cross section indicating traditional planting method (Furrow 80 cm width) with one row of plants on top of furrow 22 cm in between to give 57140 plant/ha.



about the same ratio without decreasing the yield. By using this new method, there is an increase in irrigation application efficiency, fertilizers use efficiency, water productivity, and decrease in percolation losses and evaporation.

This innovative method was first implemented in the year 2005 on a small pilot project. It was later introduced in 2007 and being practiced in the local authority of "Governorate of Sharkia" in cooperation with Water Management Research Institute (WMRI). The total cultivated areas using this method is around 50 hectares distributed in different sites.

Farm Management Methods

In treatment A, the traditional method, rows were planted 0.80 m apart with one row of plants on each ridge between furrows with one plant/hill and 0.22 m between plants within the rows to attain recommended plant density, 57143 plants per hectare, (Figure 1). The plots were approximately 20 m long and the furrows were about 0.20 m deep, with closed ends to prevent runoff from the field. When water was applied to treatment A, the application was stopped when the water level in the furrows approached the top of the furrow ridge, which is similar to the typical farmer

practice in the region. To overcome this new farm management treatments were planned to decrease the wetted area and reduce the need for long irrigation time to set-up water from the furrows to the ridges of the borders.

In treatment B, the same plant with distance (0.80 m × 0.22 m) was used to maintain the plant density as in the traditional method except that rows of maize were planted in the bottom of each furrow (Figure 2). The irrigation frequency was similar to the local farming practices, as furrows with 80 cm, with one row of plant, 22 cm

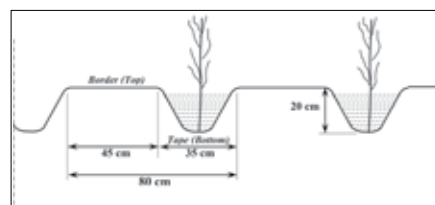


Figure 2. Cross section indicating strips of furrows 80 cm width with one row of plants in bottom of furrow (Tapetape) 22 cm in between to give 57140 plant/ha.

between each plant. Grains were planted in (tapes) using the same plant density of the traditional method.

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Treatment C had a furrow spacing of 1.60m, which is double that of treatments Figure 1 and Figure 2, but there were two rows of maize planted in the bottom of each furrow (Figure 3) with 0.22 m between plants, so that plant density is same in all three treatments. Because the furrow wetted area in treatment C was half of that in treatment B, considerably less water was applied to the same plant density.

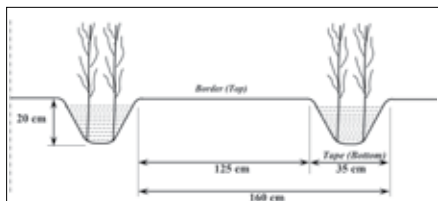


Figure 3. Cross section indicating strips of furrows 160 cm width with two rows of plants in bottom of furrow (Tapetape) 22 cm in between to gave give 57140 plant/ha.

Water relations

Irrigation water applied (IWA)

In total maize plant received 7 irrigations during growing seasons. First irrigation started after 21 days from planting then irrigation interval was every 14 days. After 90 and 95 days from planting in both seasons, the irrigation was stopped.

Water productivity (WP)

Costs were calculated for different planting methods of maize crop. The net return from the new method is higher than the traditional method.

Contribution of the Innovative Method in Water Saving

The planting methods had a significant effect on grain yield/ha. The highest grain yield/ha (6.786 t/ha.) was obtained from

C-treatment, while the lowest was recorded from A-treatment (6.256 t/ha).

Thus, planting maize on strips add new advantages such as:

- Good distribution of plant density;
- Less flooded area;
- Water saving about 30-50%;
- Raising water productivity; and
- Increasing fertilizers use efficiency.

Impact Expansion of the Innovative Method

As a national goal, by applying this innovative method all over Egypt for the maize cropped area can save about 4.0 Milliard Cubic Meter of irrigation water from cultivating million hectare of maize, this amount of water can also serve for horizontal expansion of new lands. ✦

Improved Irrigation Technologies in Paddy Cultivation

Avinash C. Tyagi* and M.L. Baweja**

In the traditional 'shallow flooding' irrigation method for rice production, water is lost to deep percolation, surface runoff and evaporation. Although some of this water can be used downstream, the irrigation infrastructure established to make water available, and the financial resources used therein are put to inefficient use. A number of techniques have been developed to achieve economy in water use in recent years which are briefly introduced in this article.

Irrigated agriculture is the main engine of growth in most developing economies and is likely to play a greater role in stabilization of agricultural production under increasing climate variability and change. However, as the per capita availability of fresh water shrinks the irrigated agriculture has to compete with other water use sectors. The major challenge facing irrigated agriculture today is to produce more food using less water per unit of output i.e. increasing water productivity in irrigated agriculture.

Rice crop is grown on about 150 million ha worldwide and is the most important crop for the countries in the Asian monsoon region. Rice is staple food in all most all countries of Asia and its consumption is substantial in other regions of the world. Asia which produce three-quarters of all rice harvested accounts for about 90% of the world's rice area. Rice accounts for over 39% of the total food grain production in China where out of 113 million ha sown under food crops, 28% are covered by rice.

Asia's food security depends largely on irrigated rice production. More than 30% of Asia's irrigated land accounts for 50% of the total irrigation water withdrawals.



Some studies indicate that in Asia, 17 million ha of irrigated rice areas may experience "physical water scarcity" and 22 million ha may have "economic water scarcity" by 2025.

In order to meet the challenges of growing shortage of availability of water for irrigation many countries have intensified efforts for water saving in rice production. Based on the results of experiments and the experience in adoption the following three main types of water efficient irrigation regimes were found to be contributing to the

sustainable increased water productivity:

- System of Rice Intensification (SRI),
- Combining shallow water layer with wetting and drying (SWD),
- Alternate wetting and drying (AWD), and
- Semi-dry cultivation (SDC).

China has been a pioneer in these efforts. Various water efficient regimes for rice irrigation were tested, applied and extended

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in different regions of the country. More than 10 Water Efficient Irrigation regimes (WEI) for rice have been adopted in China for different conditions of weather, soil topography, rice varieties, and water resources and irrigation projects. Some of these are briefly presented below.

1. System of Rice Intensification (SRI)

Dubbed as a civil-society innovation, the main feature of SRI regarding to water treatment is keeping the soil both moist and aerated so that roots have access to both water and oxygen. SRI method does not require continuous flooding. Irrigation is given to maintain soil moisture near saturation initially and water is let in when surface soil develops hairline cracks. The irrigation intervals, however, vary with soil texture. Soils having low water holding capacity require frequent irrigation. As the soil is not flooded, the roots of the paddy plants grow healthy, deeply in all directions. The root growth is extensive also due to the wide spacing. As the field is intermittently irrigated and dried, the microorganisms grow well which make nutrients available to the plants. This method also helps in better growth and spread of roots. The field should be irrigated again when the soil develops hair line cracks. Depending upon the soil and the environment conditions, the frequency of irrigation should be decided. At the time of weeding operation to avoid shoulder pain, the field should be irrigated to have 2-3 cm of water. After completion of weeding the water should not be let out of the field. After the panicle initiation stage until maturity, one inch of water should be maintained in the field until maturity. The water can be drained after 70 per cent of the grains in the panicle get hardened.

2. Alternate wetting and drying (AWD)

Alternate Wetting and Drying (AWD) is a water-saving technology that farmers can apply to reduce their irrigation water use in rice fields without any decrease in yield. In AWD, irrigation water is applied a few days after the disappearance of the ponded water. Hence, the field is alternately flooded and non-flooded. The number of days of non-flooded soil between irrigations can vary from 1 day to more than 10 days depending on a number of factors such as soil type, weather and crop growth stage.

AWD irrigation technology can improve crop water use efficiency without significant yield reduction. AWD has now spread in many rice producing countries and is hailed as a method which aims at improving

crop water use efficiency by exploiting the plant physiological responses to partial soil drying at the root zone. It involves part of the root system being exposed to drying soil while the remaining part is irrigated normally. The wetted and dried sides of the root system are alternated with a frequency according to soil drying rate and crop water requirement.

A practical way to implement AWD without loss of yield is to monitor the depth of ponded water on the field using a 'field water tube'. After irrigation, the water depth will gradually decrease. When the water level has dropped to about 15 cm below the surface of the soil, irrigation is applied to re-flood the field to a ponded water depth of about 5 cm. From one week before to one week after flowering, the field is kept flooded, topping up to a depth of 5 cm as needed. After flowering, during grain filling and ripening, the water level can be allowed to drop again to 15 cm below the soil surface before re-irrigation. AWD can be started a few weeks (1-2) after transplanting. When many weeds are present, AWD should be postponed for 2-3 weeks to assist suppression of the weeds by the ponded water and improve the efficacy of herbicide.

3. Combining shallow water layer with wetting and drying (SWD)

The basic feature of this new method is that the soil surface is not submerged after the stage of recovering. This technique known as 'Shallowness-Wetness-Drying' (SWD) technique consists of determining the optimal water demand for various growth stages of paddy with respect to different areas, soils and climate conditions. This involves maintaining shallow water layer at transplanting/ recovery stage, just sufficient to keep wet at pre-tillering phase, field drying at post-tillering stage, and again keeping shallow water layer at flowering/emulsifying stages, and finally keeping wet during yellow maturity stage. The research showed that by keeping a shallow water depth of about 15-20 mm for transplant recovery phase, wet or irrigating every 3-5 days during pre-tiller phase, field drying and irrigating every 5-10 days for post tiller phase, again shallow water depth for jointing/flowering/emulsifying phase, and finally keeping wet for yellow maturity phase resulted into 21.1% of water saving and 11.4% of yield increase. This technique improves the water, fertility, aeration, and thermal conditions of the soil, and brings tiller into full play leading to higher yields. It is learnt that this technique was applied at first to an area of 16,000 ha. Which has now expanded to more than 950,000 ha, which is nearly 40% of the total paddy rice area of the province where

this system was adopted. The technique renders tremendous economic, social and environmental benefits.

4. Semi-dry cultivation (SDC)

Semi-dry cultivation or Direct Seeded Rice is the technology which avoids puddling and transplanting processes very similar to wheat and corn cultivation (2) There can be situations when water scarcity may compel the farmers to sow rice in dry soil which is subsequently brought under submerged condition on receipt of rain or canal water. In this method there is a great difference of field water control between SDC and the above-mentioned regimes (SWD and AWD). For SDC, the water depth is maintained only in the revival of green or revival of green to the middle stage of tillering. There is no water depth on paddy field in the other stages in entire growing season. SDC have been adopted in some irrigation districts in the East and South China.

5. Sprinkler Irrigation

An innovation was pioneered in Brazil where Center Pivot Sprinkler System was used for rice cultivation also. Initiating experiments with a 3 ha farm these were further extended to the commercial production in 85 ha. The initial experience with irrigating rice by center pivots has proved that it was possible to produce 1 kg of rice with 683 liters of water – a reduction of 31.7% over that achieved by surface methods. Similar efforts have been made in other South American countries of Argentina and Uruguay. There has been an increase in the area under center pivots but the increase is still lower than expected considering the great potential offered. The possible reasons could be: (i) resistance of some farmers who insist on raising rice according to the traditional method, (ii) lack of commitment of research and development institutes, (iii) unfavorable rice market during the past few years. Generally, the farmers are resistant to change.

The approximate ranges of water savings were as under:

- percolation and seepage losses were decreased by 30-65% in case of SDC, and 20-35% when using SWD and AWD, while the SRI and center pivot system achieve a water saving of up to 50%.
- evapotranspiration was decreased by 3-10% in case of SWD, and by 5-15% in case of AWD and SDC.
- as the rice under SRI, SDC and sprinkler pivots does not have saturated soil conditions, there is reduction of methane (CH₄) emissions.



Non-Point Sources Pollution and Best Management Practices

Anna Tedeschi¹ and Ezee G.C.²

Environmental issues such as climate change, ozone depletion, biodiversity, erosion, deforestation, desertification, and NPS pollution are global concerns. These challenges are exacerbated by the rising trend of the world population and consumption. The most important global issue is satisfying the ever-growing need for natural resources to meet food and living-standard demands, while minimizing adverse impacts on an environment that already show signal of degradation. Acknowledging that agriculture is currently the single greatest contributor of NPS pollutants to soil and subsurface water resources, ICID organized a workshop on ‘Sustainable Management of Tidal Area in the Era of Climatic Change’ during the 22nd ICID Congress to review the issues.



Point source and non-point source pollution (NPS) differ in the scale of the areal extent of their source. NPS is a terrestrial system refers “to those contaminants in surface and subsurface soil and water resources that are diffused, or rather, are spread over large area” (Corwin, 1996). NPS cannot be traced to a point location or source. In contrast, point source pollutants are connected with a point location and are generally highly toxic resulting in acute toxicity. On the other hand the point source pollutants are identifiable and more easily controlled than NPS. Non-point sources pollutants are a consequence of agricultural activities, industrial and urban runoff, mining and forest harvesting activities, path salt runoff, atmospheric deposition, and hydrological modification i.e., diversion, dam, over pumping of groundwater etc. The NPS pollution is of greater environmental concern than point source pollutants because they are ubiquitous and the task of cleanup is costly and nearly impossible to accomplish.

The evaluation of the effect of agricultural management practices on NPS pollution on local, regional, and global scale has become a key component of strategies for achieving sustainable agriculture and mitigating harmful environmental impacts. Decision makers want and need to know in advance the fate and behavior of agrochemicals applied to the soil surface and whether

they pose a threat to soil and groundwater resources in order to develop policies that lead to sustainable agriculture.

This is a challenging requirement as the assessment of NPS pollutants is a complex, multidisciplinary environmental problem that encompasses coupled physical and chemical processes that occur across disparate spatial and temporal scales.

The detrimental environmental health effects of NPS pollutants, even at low concentrations, are chronic rather than acute. Less expensive pollution prevention strategies are preferred that advantageously anticipate and prevent NPS pollution before it occurs and avoid the future need for costly remediation efforts. Therefore, Best Management Practices (BMP) – policies and strategies, are needed to help reducing NPS pollution and thereby ensuring sustainability in food production.

Unexpected technological breakthroughs towards sustainable agriculture are viewed as the most viable means of meeting the food demands of the projected world’s population. The target of sustainable agriculture is predicted on a delicate balance of maximizing crop productivity and maintaining economic stability while minimizing the utilization of finite natural resources and detrimental environmental impacts associated with NPS pollutants. This is a dilemma because on one hand there is the growing pressure of meeting

the food demands of a constantly growing population, but in doing so the likelihood of detrimentally impacting the environment with NPS pollutants seems inevitable.

Conclusion

The related assessment studies are often undertaken on sites of limited extension (from a few hundred square meters to few thousands of square meters) and in the laboratory. It is, therefore, unclear whether these studies do really represent the behaviour of NPS, rather than point source pollution. A particularly relevant issue is whether these studies address the spatial and temporal variability of the sites. In this scenario, a true assessment of the proposed Best Management Practise (BMP), or rather the indirect deduction of a BMP that can be inferred, is not yet possible to draw because it should be confirmed in the long-term evaluation.

Further, it is observed that NPS pollution load is sensitive to climate change parameters thus there is need to develop adaptation measures for reducing the impacts of climate change on NPS pollution based on various climate change scenarios presented by downscaled GCM models.

As a general conclusion, there are a number of potential areas of interest that could be put on table for discussion and to elaborate recommendations for future work necessary to cope with the topics.

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