Agricultural water is one of the most critical components of food safety during production. Water has the potential to transmit both chemical and biological hazards to fresh produce, as used for irrigation of crops, and/or during post-harvest operations. At any of these points, the use of contaminated agricultural water (AW) could potentially pose food safety hazards. Hence, effective water management strategies are necessary in improving and maintaining AW quality to ensure safe food production as well as for the sustainability of water resources.

World food demand is increasing, driven by population increases and growing incomes, and changing lifestyle to meet this demand. Additional food production required to meet this increasing demand comes from intensification, not from expansion of area for agriculture. In Asia, it is projected that 80% of food production increase will come from irrigated agriculture. This is a highly water-intensive activity, accounting for three-quarters of world water withdrawals from both surface water and groundwater. The agriculture sector in Asia is expected to compete fiercely for finite water resource with domestic, industrial and other sectors, thereby putting an even heavier burden on an already strained natural resource.

Compounding this problem is the degradation of water quality. In the Asian region, water quality is deteriorating fast due to increasing population pressure, rapid urbanization and industrialization, and inadequate sanitation facilities, with water resources being contaminated by a variety of hazardous chemicals and virulent pathogens. These pollutants have been caused mainly by untreated human and animal waste, garbage, and industrial waste. Untreated sewage and garbage are intentionally and/or unintentionally drained into open ditches, streams and other waterways, resulting in the pollution of freshwater reservoirs such as rivers and lakes.

Irrigated agriculture can also be a pollution source. For instance, irrigated agriculture is the main source of nitrate pollution of groundwater and surface water. Chemical fertilizers and pesticides are polluting both water and the atmosphere, and nitrate and phosphate enrichment causes eutrophication in various water bodies. Buildup of salts through irrigation with degraded water affects as much as 20% of the total irrigated area. Thus, high quality water is bound to become a scarce commodity in many areas of the region.

Study meeting on agricultural water quality
Farmers in developing Asian countries can not help but use whatever water they can obtain, often using highly polluted water for irrigation, washing and processing of produce. When polluted water is repeatedly used for irrigation of crops, and/or used during post-harvest operations, there is a great risk for the produce becoming seriously contaminated by various hazardous chemicals and virulent pathogens. This puts the health of the consumers as well as the farmers themselves at risk.

Against this backdrop, FFTC in cooperation with the Asian Productivity Organization (APO) and the Council of Agriculture (COA), Taiwan ROC, organized the study meeting on Monitoring and Management of Agricultural Water Quality for Green Food Production held in Jhongli, Taiwan on September 29-October 3, 2008. Co-organized by the Agricultural Engineering Research Center (AERC) and the China Productivity Center (CPC), Taiwan ROC, the study meeting primarily aimed to examine the current status of agricultural water (AW) quality in the Asian region and its relation to the safety of agricultural produce for human consumption.

During the study meeting, 30 participants from 11 countries (India, Indonesia, Iran, Japan, Korea, Malaysia, Philippines, Taiwan ROC, Thailand, Sri Lanka, and Vietnam) as well as 30 local participants shared and exchanged promising technologies and innovative practices for the effective monitoring and management of AW quality. Specifically, they deliberated on the status of AW availability and quality, and regulations and standards of...
AW quality in the Asian region; newly-developed technologies/innovations in monitoring systems for AW quality; technologies for AW conservation, pollution prevention, and remediation of polluted AW, and institutional and policy arrangements; technologies for recycling wastewater as a reliable source of irrigation water; relationship between AW quality and food safety for green food production; and developing guidelines for the minimum requirement of AW quality for small- and medium-scale Asian farmers.

**Tools and technologies for monitoring and managing AW quality**

By 2025, it is projected that most countries will face severe water scarcity, and will lose some more from waste water by way of domestic, industrial and other activities. At present, many Asian countries face the problem of water scarcity aggravated by water pollution and contamination. And one vital solution to this problem is the monitoring and management to maintain the quality of irrigation water, as well as the development of technologies for its reuse.

As identified during the study meeting, some of the parameters for quality monitoring and management of agricultural water are salinity, water infiltration rate, specific ion and heavy metal toxicity, and excessive nutrients that reduce crop yield, quality and marketability.

Some suggested tools and technologies for monitoring as identified by the participants include: establishment of monitoring network system, along with guidelines and standards for monitoring like BOD/COD (biological and chemical oxygen demand); development of water database such as the hydrological information system (HIS), with feedback/assessment mechanism; promotion of people’s participation during sample collection and analysis and other public awareness campaigns; and capacity building on data collection and analysis.

Meanwhile, some of the management options for water quality improvement based on the results of water quality monitoring are: treatment (physical, chemical, biological), sediment removal, aeration, dilution, filtration, and change of canal alignment; and strategies such as land preparation, irrigation and drainage control, fertilizer and pesticide management, and recycling of irrigation water.

**Regulations and standards for monitoring and managing water quality**

While most member countries have existing regulations and standards for monitoring and managing water quality, governments must provide the...
necessary budget support to ensure compliance and implementation of AW quality standards. Enforcement of those standards, while delegated to environment control agencies, must be closely coordinated with other implementing agencies and all stakeholders for effective compliance.

Policy and institutional strategies must also be in place for the effective implementation of regulations and standards through appropriate irrigation technologies and practices like pressurized irrigation system and hydro-flumes; and programs to raise public awareness on water conservation and water quality management as it relates to food safety and environmental sustainability.

**Toward sustainable water management**

In the context of rapid demographic growth, increased competition for water, and greater attention to environmental issues, water for food production remains a core issue that can no longer be tackled through a narrow sectoral approach. Among the many challenges that the agriculture sector faces include:

- Producing safe food of better quality, while using less water per unit of output;
- Providing rural people with resources and opportunities for healthy and productive lives;
- Applying clean technologies to ensure agricultural water sustainability; and
- Contributing in a productive way to the local and national economy.

The sustainability of agricultural water for green food production in the Asian region can be intensified through strong policy support from the government; water conservation and quality awareness campaign; participation of farmers' association and rural institutions in water governance; and financial and technical assistance to environment control agencies.

Most importantly, every country in the region must have a strong political will to put into action agricultural and rural development policies that will accelerate changes in irrigation governance, as well as adequate water laws and institutional capacities in support of the needs of the people for safe and quality food and the sustainability of water resources.
Study Meeting on Monitoring and Management of Agricultural Water Quality for Green Food Production in the Asia-Pacific Region

Held in AERC, Jhongli, Taiwan ROC, September 29 - October 3, 2008
No. of participating countries: 10 (India, Indonesia, Iran, Korea, Malaysia, Philippines, Sri Lanka, Taiwan ROC, Thailand, Vietnam)
No. of papers presented: 15
No. of participants: 24 international participants, 5 resource speakers, and about 30 local participants/observers

Co-sponsors: Asian Productivity Organization (APO), Japan; Council of Agriculture (COA), Taiwan ROC; China Productivity Center (CPC), Taiwan ROC; Agricultural Engineering Research Center (AERC), Taiwan ROC

List of papers

Resource papers
1. Predicting river water quality in rural area using a watershed scale model
   - Sunao Itahashi, National Institute for Agro-Environmental Sciences (NIAES), Tsukuba, Japan
2. Current situation of agricultural irrigation water operation and management in Taiwan
   - Ming-Hwa Tsai and Po-Hua Lin, Department of Irrigation and Engineering, Council of Agriculture (COA), Taiwan ROC

3. Establishment and extension of information system for irrigation water quality monitoring and management
   - Chih-Hung Tan, Agricultural Engineering Research Center (AERC), Taiwan ROC

4. Monitoring and managing quality of agricultural water in Korea: current status and future outlook, technologies and approaches for effective monitoring and management of agricultural water quality
   - Mi Hyun Park, Korea Rural Community & Agricultural Corporation, Korea

5. Automatic monitoring and maintenance of irrigation water quality in Taoyuan Irrigation Association
   - Chien-Kuo Chen, Taoyuan Irrigation Association, Taiwan ROC
Country reports

6. Taiwan ROC
   - Wen-Pin Shu, Tamkang University; Chou-Ping Liang, Department of Irrigation and Engineering, COA; Wei-Ting Sun, COA; Yu-Hsiueh Liu, AERC-COA; Yung-Tsung Liao, AERC-COA; Jen-Hung Tseng, Water Resources Agency, Ministry of Economic Affairs

7. India
   - U.S. Kradam, Department of Irrigation and Drainage Engineering; Ashish Pandey, Indian Institute of Technology Roorkee; Natarajan Pratap, National Productivity Council

8. Indonesia
   - Nora H. Pandjaitan, Bogor Agricultural University; and Muhammad Samsul Huda, Ministry of Agriculture

9. Iran
   - Nader Abbasi, Iranian Agricultural Engineering Research Institute

10. Korea
    - Young D. Kim, Korea Rural Community and Agriculture Corporation

11. Malaysia
    - Tan Yu Wai, Ministry of Natural Resources and Environment; and Fred Lew Leong Poh, Malaysia Productivity Corporation

12. Philippines
    - Evangeline B. Sibayan, Philippine Rice Research Institute; and Reynaldo Baloloy, National Irrigation Administration

13. Sri Lanka
    - W.P.D. Rajamanthri, North Western Provincial Engineering Department; and K.A. Nandasiri, Provincial Ministry of Land Agriculture and Animal Production Activities - North Western Province

14. Thailand
    - S. Kownarumit, Department of Science Service; T. Suthavatin, Metropolitan Waterworks Authority; and C. Chompradist, Royal Irrigation Department

15. Vietnam
    - Nguyen Van Dung, Hanoi University of Agriculture; and Ngo Phuc Dao, Ha Tinh Province, Standardization Metrology Quality Division

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