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NEWS UPDATE

64th Anniversary and Irrigation Day 2073 Celebrated

On April 7th 2017, 64th anniversary of Department of Irrigation (Irrigation Day-2073) was celebrated with organizing various activities. On the occasion of Irrigation day 2073, a special function was organized in the main hall of the department of irrigation.Honorable Irrigation Minister Mr. Deepak Giri, from the seat of the chief guest in his inaugural speech, honored the deed of past and present employees of DoI to bring the irrigation development activities to its present status and also expected its staff would continue to involve in such activities in the future as well. He also mentioned about the necessity of new vision for the development in irrigation sector. Next to him, special guest of the program and the honorable State Minister of Irrigation, Mr Surendra Raj Aacharya expected about the enthusiastic development activities in irrigation sectors in coming days to change the course of enhanced agriculture production as well as economic situation of the nation. On that occasion, Secretary of Ministry of Irrigation, Mr. Ramananda Prasad Yadav in his speech mentioned about speedy development activities in irrigation development works will help to sustain its economic growth through agriculture development situation. On the occasion, Mr. MadhavBelbase, Joint Secretary, Water and Energy Commission Secretariat, Mr. GajadharYadav, Chairman, Federation of Water Users' Associations in Nepal, Former DG of DoI and President of Society of Irrigation Engineers of Nepal (SIREN)Mr. Sharada Prasad Sharma, were also invited as special guests. The program was chaired by Mr. Rajendra Prasad Adhikari, Director General of the department. From the chair, DG MrAdhikari, thanked to chief guest and honorable Irrigation Minister and special guest and honorable State Minister of Irrigation for their presence in the function to make it success. On the occasion, the best performing irrigation system Water User's Association title was awarded to Water User's Association of Argali Irrigation System of Palpa District. MrParshuram Bhattarai, president of the WUA, received the special honor on behalf of the WUA from the honorable Minister. Best performing title among the irrigation division and sub division offices and ongoing projects during last fiscal year were also honored to the respective chiefs and project managers during the occasion. The honorable minister and the honorable state minister also distributed prizes and certificates to the winners of the various extra activities and games organized during the annual celebration.On that occasion, members of parliament, former Director Generals of the department, high ranking officials and Irrigation and Water Resource Experts, Consultants were invited. On the same occasion, life time achievement honor was given to former Director General Mr. Karnadhwaj Adhikari, for his untiring contribution to irrigation development in Nepal. Similarly retired staffs of DoI from the dates of last fiscal year were also honored by the special guests with khada and an appreciation certificate. Likewise, winning trophy of friendly football match was given to Ministry of Irrigation Team. On that occasion a demonstration was also organized on non convention irrigation technology with the coordination of Non Conventional Irrigation Technology Program of DoI. Various firms in Kathmandu Valley and nearby participated in the program. Honorable Minisiter, Mr Giri and Honorable State Minister Mr. Aacharya also observed the stalls and inquire about the new technologies such as micro Irrigation and solar pumps.

A morning procession was also organized in the morning of 7th April, 2017. The high ranking officials from the department of irrigation including the director general participated the procession. The procession bearing placards with irrigation related slogans took course from DoI Building-Harihar Bhawan-Kopundole-Krishnagalli-Pulchowk and ended at DoI premises. Furthermore,blood donation program was also organized on the same occasion in which more than fifty DoI staffs participated. A team of DoI led by DG MrAdhikari also attended the social activity organized at Bhorlet Kulo Irrigation System of Khokana, Lalitpur District in the morning of 6th April.

Highlights of the Issue

Editorial

Gender Equality and Social Inclusion in Irrigation Sector

Gender participation in irrigation activities has not been a new issue in irrigation sector. From last two decades, gender involvement in various construction and rehabilitation of irrigation projects were questioned with the formation of legal institution of Water Users' Association (WUA) for their equal participation in all the processes and activities of construction supervision and quality control so as to maintain the WUA involvement in the construction and rehabilitation of irrigation projects. Involvement of gender and their active participation even in the local level farmer managed irrigation systems for canal operation and maintenance activities to enhance their knowing about canal water sharing, canal operation and maintenance practices hence to empower their participation. From the beginning of last decade, irrigation including other social sector has been made directive to apply the gender responsive budgeting. For achieving this, various programs like workshop, seminars, training and other media to make this aspect to be imposed in annual program and sanction of budget in the related sector by making National Planning Commission and Ministry of Finance more responsible. Now, Gender Equality and Social Inclusion program has effectively been made compulsory for launching new programs and budgeting new projects in the sectors where social activities occur including irrigation.

Recent involvement of stakeholders, water users including gender and socially backward people are being involved in the project and programs related to social mobilization like irrigation sector. But rational and meaningful participation of such people are still negligibly accounted. In future, the GESI involvement in the project implementation and budgeting will be condensed, but for meaningful participation, first more awareness program should be launched at base level. The awareness program should include training activities, workshop, seminar, and inclusion of such subjects in curricular base in schools and educational institutes, with a view to disseminate the idea. In the recent past, Ministry of Irrigation has prepared GESI Guideline to include GESI provisions in the program and project launching in its sub institutions including Department of Irrigation. The guideline also referred to the involvement of proportionate participation of local level gender activists and socially backward and annexed groups for their role in decision making.

Moreover, in the process of construction, rehabilitation and operation-maintenance of irrigation systems from main canal to sub branch and farm ditch level, participation of socially backward people and female members of water users should be enhanced to get involved in the process followed by various activities. Engagement of all representation in such construction/rehabilitation works will lead to the sustainability of the system itself. This is also according to the social welfare activity and is encoded in the spirit of newly promulgated Constitution of Nepal 2072. Such working policy is also mentioned in the revised Irrigation policy 2070 accordingly. ■

TRAININGS/WORKSHOPS/SEMINARS

10th National Irrigation Seminar, 2074 organized

National Irrigation Seminar 2074 was successfully organized at Hotel Country Villa, Nagarkot, Kavre on 18th - 19thJestha, 2074 (June 1st -2nd, 2017) under the banner "*Climate Smart Innovation for Sustainable Irrigation Development*". Honorable Minister Mr. Deepak Giriinaugurated the seminar as a chief guest by watering a plant and lightening Panas. On his inaugural speech, honorable minister Mr. Giri emphasized to speedy completion of irrigation systems under construction and also stressed to build provisional fund for emergency operation and maintenance of irrigation systems. He also wished that the seminar to be utilized as a platform for the exchange of knowledge, experiences and views for the further development of irrigation sector services to be rendered to serve farmers. Mr. Ramananda Prasad Yadav, Secretary, MoI mentioned about the improved situation achieved in agriculture production is mainly due to the major role of irrigation sector development. Director General of Department of Agriculture, Mr. Dilaram Bhandari in his speech indicated importance of irrigation facility to enhance agriculture production with other factors of production like improved seed and fertilizers. He also mentioned about a big role of investment by state in irrigation sector to improve economic situation through agriculture production increment. Mr. Madhav Belbase Joint Secretary, Water and Energy Commission secretariat, DG of Department of Water Induced Disaster Management Mr. Madhukar Rajbhandari, Mr. Jagat Prasad Joshi, Executive Director, Ground Water Development Committee, Mr. Shambhu Prasad Dulal,

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general secretary, National Federation of Water Users' Association of Nepal, Mr. MaheshwarNirshing KC, Director, Central Regional Irrigation Directorate also spoke in the session. During the session, welcome speech was delivered by Deputy Director General Mr. Ashok Singh. Deputy Director General Mr. Bashu Dev Lohanee of DoI expressed brief views on the design of seminar and selection of the papers being presented in the seminar. All other special guests gave important views during their respective speeches. At the end of inaugural session, the director general of DoI Mr. Rajendra Prasad Adhikari mentioned about encouraging current excellent performances of Irrigation Projects under government priorities and its firm continuity in the future. He further mentioned about budget situation of Irrigation sector. Finally he expected the seminar will be beneficial with the papers being presented in the various sessions of the seminar.

After inauguration of the program, Technical session was began. Four Technical Sessions were designed with different sub theme, with three papers in each session. The first technical session entitled with Irrigation Improvement was chaired by former DG of DoI Mr. Sharada Prasad Sharma. He was facilitated with SDE Mr. Indradev Bhatta as rapporteur.The first Paper of the session I was on Murrubidgee Irrigation presented by SDE MrRajendraBir Joshi. Second paper was presented by MrKamal Bhandari on Irrigation Management handover program. The third paper was on Sustainable Irrigation Development Knowledge Development Generation for Karnali River Basin by Dr.Vishnu Prasad Pandey of IWMI.

The second technical session entitled Water Resource Assessment was chaired by former DG of DoiMrRatneswar Lal Kayastha and was assited by Mr Ramesh Raj Sharma as rapporteur. The program of the first day was terminated after the second technical session. During this session first paper was presented by SDE Mr. Ashish Bhadra Khanal on Public Procurement of Large Scale works in DoI. Second paper of the session was presented by Mr. Mitra Baral on Simple statistical tool basin scale flood forecasting. The third paper was on Valuation of water resources for irrigation system presented by MrLaxman Neupane.

The session III continued as the first session of day 2 entitled" Management and Economic Aspect of Irrigation" was chaired by DDG of DoI Mr. Bashu Dev Lohanee. He was assisted by SDE Prem Lasiwa as rapporteur. In the session, the first paper was on Role of Multiple Use Water Services to advance for sustainable development goals by Mr. Rajkumar GC. The second paper was by SDE Mr. Tikaram Baral on Improved water management practices in Kankai Irrigation System. Similarly third paper was on Climate change impact on irrigation systems and adaptation need by Mr. S.B. Thakur. Voluntarily, Irrigation Management Expert Dr. Umesh Parajuli presented a paper on "Climate implication on Irrigation Management Design" at the end of the session.

The fourth session entitled "Different Approaches in Irrigation" was chaired by Water Management Expert Dr. Umesh Nath Parajuli, Dr. Parajuli was assisted by SDE Mr. Rukmagat Khanal as a rapporteur. In the session, first paper was on Smart Irrigation presented by Niranjan Khakural. Second Paper was presented by Mohan Kumar Shakya on Assessing water resources availability in Indrawati river basin and the last paper was presented by Mr. Mahesh Yadav on Teleconnection of global climate modes to wet and dry season discharge.

After the completion of technical session, plenary session was organized on the topic "Past and Future of Irrigation" context in climate change and was facilitated by Deputy Director General of Department of Irrigation Mr. Ashok Singh. Rapporteur for this session was SDE Mr. Dandapani Jaisi. Water Resources Experts Mr. Sharada Prasad Sharma, Professor Dr. Khem Raj Sharma, Irrigation Expert Dr. Umesh Nath Parajuli, and Joint Secretary of Water and Energy Commission Secretariat Mr. Madhav Belbase participated in the plenary session. During the session opinions from the floor also have been discussed. The session was focused on how to proceed irrigation sector through the new federal restructuring.

At the end of the seminar, the closing session was chaired by DG, DoI, Mr. Rajendra Prasad Adhikari. The chief guest of the session Mr. Sharada Prasad Sharma expressed the seminar as very interesting one due to its very fruitful ideas generation, through presented paper in broad aspects. He emphasized on adoption of new technologies in irrigation. Special guests, Joint Secretary Mr. Madhav Belbase, DDG of DWIDM, Mr. Prakash C Pokharel, Executive Director of Ground Water Development Committee, Mr. Jagat Prasad Joshi and representative of NFWUAN, Mr. Shambhu Dulal also made remarks on the seminar and its success and importance indicated in their respective speeches that the ideas generated in the seminar should also be implemented in the field and shared with farmers.

Deputy Director General Mr. Bashu Dev Lohanee, summarized the papers presented in the seminar, highlighting the key issues raised in the seminar. Mr. Krishna Belbase, DDG, DOI expressed vote of thanks to all the participants for their lively discussion with active participation. Further he thanked the organizing committee and all other supporting agencies for the overall management of the seminar.

At the end of the seminar, the director general of DoI offered a token of love to the Chief guest and former DG of DoI Mr. Sharada Prasad Sharma for his continuous support and cooperation from the beginning to the end to make the seminar a success. He also thanked to all the paper presenters for their invaluable contribution to the seminar. With his brief speech DG Mr. Adhikari concluded the program and announced the closing of the seminar.

Technical Staff Training (TST) Organized

Technical Staff Training Program wasbeing carried out since F. Y. 2071/72 (2014/15) till F. Y. 2073/74 (2016/17) by Water Management Section under Irrigation Management Division. Within the period of three fiscal years, 15 irrigation systems of 15 districts were covered

to provide its TST training for the staffs at least once within a year, so as to solve the issues and problems raised regarding technical skills and knowledge regarding implementation of the program.

Consequently, during the last fiscal year (FY 2073/74), TST program has been organized to cover all the fifteen districts to train the technical staffs including Engineers, sub-Engineers, Association Organizers (AOs) from Irrigation office and Subject Matter Specialists (SMS), Junior Technicians (JTs) of District Agriculture Office related districts and Agriculture Technicians from Regional Agriculture Research Stations (RARS).

A three days' Technical Staff Training (TST) was organized by Integrated Crop and Water Management Program (ICWMP) in Birendranagar, Surkhet from 28-30th March, 2017, for its 27 technical staffs working in Dang, Salyan, Banke, Baitadi, Bajhang districts, Mid Western and Far Western Regional offices. Inaugurating the training program, Deputy Director General (DDG) of Department of Irrigation (DoI), on the first day of the program, Senior Divisional Engineer (SDE) Mr. Prem Lasiwa instructed on water management as well as building of irrigation schedules. In the continuation of the program, DDG Lohanee discussed about the importance of good governance in Irrigation Water Users' Association (WUAs), and guidelines of WUAs Establishment. Sr. Scientist Ramnath Jha spoke about the newly developed tillage implements in crop cultivation and water saving techniques during cultivation and its recording technique. On the second day of the program Senior Agri Extension Officer, Mr. MukundaBhusal discussed on seed production of various crops and off-season cultivation of vegetables.

Similarly, a three days' TST has been organized from 2nd-4th, April, 2017 (Chaitra 20 to 22nd , 2073) for its 32 technical staffs working at Chitawan, Dhading, Nuwakot, Nawalparasi, Lamjung, Syngja districts, Central and Western Regional Irrigation Offices at Regional Health Training Hall of Birendranagar Chitawan. Mr. PremLasiwa, Senior Divisional Engineer, briefly discussed on irrigation scheduling and irrigation water management during various crop cultivation. On the second day of TST, SMS, Mr. MukundaBhusal discussed on off-season vegetable cultivation and seed production technology. Similarly, Agriculture Scientist from Nepal Agriculture Research Council Mr. RamnathJha discussed on newly developed farm equipments for tillage, farm mechanization, and water saving technology for crops cultivation.

On consequence, the third TST was organized from May 22nd to 24th, 2017 for 26 technical staffs of Jhapa, Panchthar, Dhankuta, Sindhuli and Eastern Regional Irrigation Directorate at Regional Agriculture Training Centre Hall of Tarahara, Sunsari

During the program, DDG of DoI, MrBashu Dev Lohanee spoke on importance of WUA good governance for the sustainable institutional development of Water Users Association, and ISF collection methods, SDE Prem Lasiwa of ICWM Program, discussed on Water Management in field level and building of Irrigation Schedule, Scientist of NARC, Mr. Jha on the method of application of newly developed farm equipments on crop cultivation. DDG Bashu Dev Lohanee chaired the closing session of the program, and distributed certificates to the participants. All the training events were coordinated by SDE Prem Lasiwa of ICWMP, Jawalakhel.

Workshops on Systems O&M and Sustainable Management Organized

System Management and Training programme of DoI has organizied workshop on System O&M and Sustainable Management at various part of the country regularly for Construction Quality Control and WUA Capacity Build up of Water Users Associations. The workshop particularly focused on their institutional development for sustainable operation and maintenance of irrigation system. In the consequence, three such workshops were organized from May19 toJune 11th 2017. The first workshop was organized on19-20th May, 2017 at Hotel Thakali of Kawasoti in Nawalparasi District for the WUA of Bulingtar Irrigation System and Kansariya Baruwa Irrigation Systems. Altogether 25 participants including 5 women actively participated in the workshop. Resource persons of the workshop were DDG of DoI Mr. Bashu Dev Lohanee, Division Chief Mr. Chudarraj Dhakal, Engineer Mr Sandesh Paudel, Sub Engineer Mr. Prakash Bhattarai, Office Clerk Mr. Hemnath Neupane of Nawalparasi IDD and Senior AO Mr Uttam Dhwaj GC. Prior to workshop, all the participants took part in an observation field visit to nearby irrigation canal construction site.

Similarly, another workshop was organized on same subject at Hotel Tulasi Home of Besishahar in Lamjung District on May 29-30th, 2017 for the water users of Karaputar IS, Rainastar IS, of Lamjung District. In the workshop 25 participants from each WUA including five female participants attended the workshop. Resource persons of the workshop were DDG of DoI, Mr. Bashu Dev Lohanee, Division Chief Mr. Banshidar Koirala, Office Clerk Santa Bahadur Shrestha of IDD Lamjung, WUA President of Rainastar IS Mr. Yubraj Kandel and WUA President of Karapurtar IS, Mr. Khagraj Ghimire. On 31st May, participants took part in field observation tour to nearby canal system.

Third workshop was organized at Hotel Sunrise of Dhampus Kaski, on June 10-11th, 2017 for the water users of Hemja Annapurna IS and Sardi khola Puranchaur IS of Kaski District. The program was attended by altogether 51 participants including 10 female members. The program was conducted with DDG of DoI, Mr. Bashu Dev Lohanee, Regional Director of WRID, Mr. Shisir Koirala, SDE Mr. Tulasi Ram Bhattarai, Engineers Govinda Bhurtel, Gunanidhi Paudel, Senior AO Mr. Man Bahadur Thapa and Computer Operator Hari Prasad Rijal as the resource persons in the workshop. Participants took part in the field observation in the following day of workshop. The workshops were coordinated by Senior Tech Rajendra Kumar Thapa of SMTP.

FEATURE ARTICLES

Aquaponics: A Potential Alternative Agriculture for Urbanized Society

Udhab Raj Khadka, PhD*

Background

The cities are believed to be developed in ancient period after the rise of horticultural and pastoral societies that made possible for people to stay together in one place instead of moving from one place to another in the search for food. With the passage of time and advent of health and sanitation facilities, increased infrastructure and opportunities more people were attracted to those settlement

(the phenomena is still continuing in many developing countries), which ultimately lead to the development of big mega-cities. During 1800, only three percent of the world's population used to live in urban areas, by a century later (1900), it reached to 14 percent and just a half-century later (1950), the world's urban population had doubled to 30 percent (Population Reference Bureau, 2017). Today, more than half the world's population lives in urban areas (Thapa & Murayama, 2009). It has been projected that, by 2030, almost two-third of the world's population will live in urban areas. By 2050, the world's population has further been projected to reach 9.5 billion with three-fourth of them in living urban areas (Goddek et al., 2015). Though, urbanization has positive implication in economic development and innovation, it has several socio-environmental challenges (Sharma et al., 2015). In the present context of growing urban population due to population growth and increased rate of urbanization, it has become a challenge for distributing resources and providing adequate service and facilities to the urban dwellers in many parts of the world. Consequently, the livelihood of urban poor and marginal communities is becoming worse day by day. The urbanization has had important consequences for many aspects of social, political, and economic life (Kleniewski & Thomas, 2011). Yet, the urban population growth rate is higher.

Context of Nepal

Nepal is one of the ten least urbanized countries in the world. However, it is also one of the top ten fastest urbanizing countries (Bakrania, 2015). Despite a low level of urbanization, the annual urban population growth rate is many folds higher than the national population growth rate (1.35%). The percentage of urban population seems to be increased from 3% in 1954 to 14% in 2001, to about 17% in 2011 (Pant, 2011), to 27% by 2014 (CBS, 2014). According to Subedi (2016), with the declaration of 133 new municipalities in 2014 by Government of Nepal, urban population has reached to 38.2% showing growth rate of 11.44% for 2011-2014. With this statistics of urbanization, Nepal ranks second in South Asia. For the period of 2014-2050, Nepal has been projected to remain amongst the top ten fastest urbanizing countries in the world with a projected annual urbanization rate of 1.9% (UN DESA, 2014). Kathmandu Valley, being the capital city and the major administrative hub of the country, is one of the fastest-growing urban areas in South Asia. During the last decade, Kathmandu Valley experienced an average annual growth rate of 4.5% accounting 29% of the total urban population of the country (MoUD, 2015). In the valley, over the period of 22 years (1990-2012), built-up area has increased from 38 km^2 to 119 km^2 with a staggering increase by 211% and agricultural area has decreased from 421 km^2 to 342 km^2, with a decrease by 19%, causing drastic change in valley morphology. Currently, the built-up area and agriculture land area of the valley respectively covers 16% and 47%, and rest is covered by other areas. Within the built-up category, residential area has increased by 331% over the last two decades (1990-2010) (KVDA, 2015). According to 2011 census Kathmandu Valley has 614777 households with population density 20290 persons km^{-2} in compared to average urban density 1381 persons km^{-2} and national average density 180 persons km^{-2} (CBS, 2012). It has been estimated that in each decade (2040 and 2050) approximately 6000 hectare of arable land in the valley will further be converted into built-up area (KVDA, 2015). In this way, with the increased rate of urbanization in the valley, along with the shrinkage of agriculture and forest areas, the water resource related areas such as rivers, flood plains, lakes, ponds and wetlands have also been either substantially reduced or lost leading the valley towards water crisis and ultimately towards vulnerability with respect to food sufficiency. Moreover, in the present scenario of climate change, water sources are depleting and in the other hand, its demand from both domestic and agriculture sector is increasing. Therefore, to feed the future, there seems need of water efficient sustainable alternative agricultural production system to complement the existing conventional production system.

Aquaponics as a possible option

Aquaponics is a kind of food production system which integrates aquaculture (growing fish) and hydroponics (growing plants in soilless condition), where both the agricultural practices mutually benefit from each other in one production unit (Fig. 1). As it uses non-renewable resources and on-farm resources efficiently (Mader, 2012), it has been completely considered as a sustainable agricultural production system (Abdulkhader, 2014; Bethe, 2014; Mader, 2012; Roy et al., 2013; Tyson et al., 2011). The key process of aquaponic system is that waste products of one biological system serves as nutrients to the other biological system and the water is purified and re-used through biological filtration (Bethe, 2014). In this system, the waste excreted by fish into the surrounding water is absorbed by plants as the nutrient, purifying the water, and the water thus purified is used again for fish culture (Abdulkhader, 2014; Bethe, 2014; Tyson et al., 2011). In this way, the process works in cyclic manner simultaneously producing edible fish and vegetable crops in a single unit.

The aquapoinc system controls the discharge of polluted water to the surrounding environment and it has been considered to be effective and efficient in terms of energy consumption. In addition, in this system, the likely pollution caused by the isolated aquaculture is controlled by making nutrient available to the agricultural crops and re-uses water times and again ensuring enhanced production of healthy fish and green vegetable per unit area without using chemical fertilizers and pesticides (Nelson, 2008). This is how, in this system, the likely pollution caused by separate aquaculture and hydroponic is controlled (Hussain et al., 2014).

The system is not restricted to the particular fish and crop varieties; hence, different varieties of green vegetables, condiments and medicinal herbs, and fish can be grown together. Interestingly, and importantly, this system can be used at a small domestic scale just to satisfy ones hobby to the large commercial scale. It can be done in all possible kinds of spaces, like indoor or outdoor, roof tops, floor, veranda, kitchen, garden, etc.

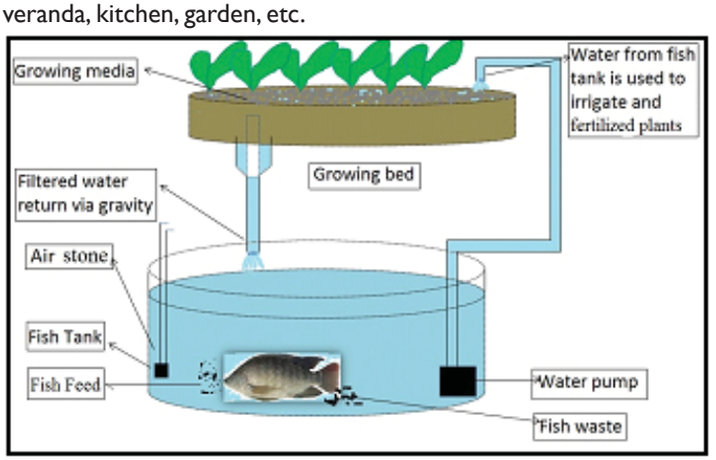

Figure 1 Simple schematic diagram of aquaponic system

Possibility of Aquaponics

In the present context of increased urbanization, there has been a drastic decrease in agricultural land leading to substantial decrease in agriculture production. Thus, search of sustainable alternative agriculture production system has become an urgent need. In the present paper, effort has been given to review the results of aquaponic system experiment carried out in the Kathmandu. For the experimental set up, the researcher had used blue coloured plastic barrels (1 m length and 0.5 m width) for fish culture and crop plant cultivation (Fig. 2). As apparent from figure 2, the two barrels lying towards the bottom had been used for fish culture (fish tank) and two longitudinally cut barrels had been used as growing bed to provide mechanical support for the vegetable crops. In the half cut barrels, hug-plum seeds (the waste material thrown after using the fruit part) had been used as bed material (growing media) which provides support to the vegetable crop as soil does. In the fish tank, 15 catfish having 45 gram weight (3 gram per individual) had been cultured and on the growing bed, 20 days old 11 seedling (weighing 5 gram) of green leafy vegetable (Indian spinach), had been planted. The spinach had been harvested after 40 days which weighed 505 gram with 105 times increase in weight. Likewise, 45 gram catfish, harvested after 90 days of culture, weighed 550 gram (46 gram per individual fish; weight of 12 survived fishes) with 12.22 times increase in weight (Table 1). Himadri and Debajyoti (2012) have reported that the average weight of a fish to be 21.79 gram grown for the time period in cemented tank. Based on the findings of Maharjan (2016), it can be estimated that if only 0.5 m^2 area of rooftop of 614777 households in Kathmandu Valley, with average 195 m^2 roof top areas, are utilized for aquaponics, within 60 days 319.69 tons of spinach and within 90 days 310.46 tons of fish can be produced. Moreover, in this system, production can be taken round the year. This means, the production would be more than four and five times higher for fish and spinach, respectively. This result has indicated the possibility of commercial production of fish and agricultural crops from aquaponic system. However, along with the positive aspects, this system has several challenges as well.

Figure 2 Aquaponic system with growing spinach and fish (Photo Sanu Maharjan)

Table 1 Growth performance of spinach and fish

Growth	Spinach (n = 11)	Catfish (n = 15)
Initial weight (g)	5.0	45.0
Final weight (g)	525.0	550.0*
Net weight gain (g)	529.0	505.0*
Weight gain (times)	105.0	12.2*

*Calculation based on the survived 12 fishes (Source: Maharjan, 2016)

Positive aspects

- In the present context of urbanization and land use change, the water is becoming scarcer. The aquapoinc system is highly efficient in water use.
- The system is based on the re-use principle, thus, it uses waste or useless resources.
- This system is efficient in production as well as environment friendly.
- This system does not use chemical fertilizers and pesticides, thus, the chance of pollution is very less and the produced agricultural products are free from toxic chemical and pesticide residues.
- The system allows simultaneous cultivation of fish and green vegetables in the same space, thus, the per unit area production is higher
- The system is rejoicing like raising pets and maintaining aquarium. But, it satisfies individual's hobby without posing financial burden.
- It is based on green technologies, thus, it does not have environmental implications.
- In this system, one does not has to play with filthy materials like mud, soil, etc.
- This system unknowingly engage individual in physical activities leading to positive health impact.

Challenges associated

- This system is knowledge intensive, i.e. based on principle of different sciences such as environmental science, engineering, water science, biology, biochemistry, biotechnology. Thus, it requires multi-disciplinary knowledge.
- It is considered to be expensive to start-up.
- Selection of appropriate fish and plant species, and determining their numbers and ratio may be challenging.
- Water pH requirement of fish and plant species varies with the species, thus, maintaining balance of pH in water is challenging.
- Likewise, requirement of nitrate nitrogen varies with the fish and plant species, thus, maintaining balance of nitrate is challenging. The higher concentration of nitrate may be harmful for the fish.
- The system requires continued circulation of water between aquaculture (fish tank) and hydroponic (growing bed). Thus, it needs continue supply of energy for running water pump.
- This system requires daily maintenance and care.
- In this system, limited range of temperature is available for fish growth, thus, minor changes in temperature, accidently or by mistake, may damage whole system.

Conclusion

In the present global context of urbanization, Nepal cannot remain unaffected with the process. For the last few decades, particularly after the establishment of democracy, the rate of urbanization has been observed to be highly escalated. Kathmandu Valley, being capital and the only metropolis (until implementation of federal structure) of Nepal, its urbanization rate is obviously higher than other cities. However, due to unorganized rapid rate of urbanization, the shrinkage of forest, water storage area and agricultural land have led the valley towards the state of water crisis and weak food sufficiency. Thus, in order to have ensured water availability and food sufficiency amidst current global as well as local trend of population growth and urbanization, it is essential to search innovative options for resource efficient sustainable agricultural production system by making use of unused spaces, built-up areas including residential areas, and re-use and re-cycling of water resources. The field of aquaponics has grown dramatically towards the commercialization in the past few years; however, there seems information gap on the resource use, cost-benefit analysis of the system. Further, the need of extensive research and developments has been established by the challenges prevailed in the aquapoinc system. In the context

of Kathmandu Valley, although, studies have indicated the potential, there seems need of detailed study on cost-benefit analysis (CBA) and life cycle assessment (LCA) for the commercialization of the aquaponic system.

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Generation of Irrigation Development and Management in Nepal

(Based on Authors 'experience)

✍ **R.R.S.Neupane****

Irrigation development in Nepaldates back from Rana Regimes of Nepal. But systematic planning and development started since 1950 with the establishment of Canal or Irrigation Department. The irrigation development and management characteristics are seen to have been following to adapt trend of population increase and food demand. The characteristic growth of irrigation can be viewedgrouping it into four (4)generations: First generation G-1 (1950 to 1970), Second generation G-2 (!971-1990), Third generation G-3 (1990-2020) and Fourth generation G-4, 2020 onwards. Change drives and important features are briefed below.

G.1-Level of Irrigation Development and Management

During this period basic strategy of irrigation was to abstract river water and divert it to field system. Population was not a severe problem in this period and hence rice production was in surplus. So only main canal and branch canal construction was the major focus of Department Of Irrigation.

Water management control was limited to main canal only and quality of irrigation service to farmers was through field to field without matching demand and supply. So, water productivity was moderately low.

G.2-Level of Irrigation Development and Management

During this period, population increased and so the food demand accordingly and; hence, there was greater pressure to increase water availability to farmers field timely in order to increase the productivity. So, command area development program with tertiary canal extension up to 30 ha 50 ha irrigation block with basic concept of efficient water management was introduced. Irrigation management project (1985-92) laid the basic foundation of participatory irrigation management with users participation. Irrigation policy & regulations were reformed based on user's participation. World Bank and ADB supported NISP and SISP providing financial assistance for participatory irrigation projects. Water control extended up to branch canals and basic management rules & guidelines were developed. WUAs were formed for sharing management responsibility. However, canal system including tertiary canals could not be effectively utilized. Still, field to field irrigation distribution with no irrigation schedule continued lowering water productivity.

G.3-Level of Irrigation Development and Management

During this period, intensive water management with Management

Transfer Approach of irrigation system was introduced because of prevalence of food shortage in Nepal. Irrigation Management Transfer Project, financial by ADB (1995-2000) and Irrigation & Water Resource Management Projects (2008-2018) were introduced to mitigate food imports. The strategy of this management transfer projects was to reduce management cost, rehabilitation of irrigation system for better performance and adopt service oriented water management approach to increase agricultural productivity.

Equitable water allocation and distribution with matched demand and supply from calibrated main canal structures using Canal Operation Plan and Asset Management Plan were the prime effort made to achieve project outcomes.

G.4-Level of Irrigation Development and Management for Future

During this period increased population & also adverse effects of climate change would put more pressure on more food supply. So, strategy for irrigation management & irrigation project development would/should be aligned to service oriented irrigation service with canal networks and control extended down to tertiary & field channel outlet, irrigation management through multi propose WUA-Cooperatives and Irrigation Boards completely and independently operating & maintain their part of irrigation schemes.

For irrigated agricultural sector, climate smart agriculture with medium scale mechanization supported by land development and commercialization (marketing and research) could be the better options.

Summary of the Irrigation Development Generations

Generation of Irrigation	Characteristics	Activities	Irrigation Service
G.1-Level Management	Operation-Un controlled	Main canal and BC gates are opened	Flooded, Field to field irrigation in conventional farming and farm plots
G-2. Level of Management (FMIS-Style)	Proportionate allocation, Demand not assessed, some times rotated	Intake flow estimated/ Judged, off-takes area planned, Area index multiplied by MC -Q l/s	FC to field or Field to field irrigation in conventional farming and farm plots
G-3. Level of Management (IWRMP Style for Large projects- and CMIASP-style for FMIS)	Supply and demand matched, annual intake hydrograph exists, MC off-takes calibrated, MC & BC level COP, AMP exist for O & M control, annual review for update.	Equitable flow allocation, measured flow delivery from MC, proportionate flow sharing in TC & rotated single flow in TC outlets	Outlet users roistered with stream size, duration, depth and frequency in improved farming and farm plots. Minimized field to field irrigation
G-4. Level of Management New thoughts for future management for reducing food imports	Supply and demand matched, annual intake hydrograph exists, MC & BC off-takes calibrated, MC & BC level with AMP and COP exists for operation control, seasonal review and crop planning.	Equitable flow allocation, measured flow delivery from MC and BC, proportionate flow sharing in TC & single flow rotating in TC outlets with scheduled users. Management shared with WUA-Co -operatives and Irrigation Board	Channel to field irrigation and drains, commercial farming with consolidated and planned field plots for medium level mechanization

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FORTHCOMING EVENTS

5th International Conference on Innovation in Environment, Civil, Materials & Architecture Engineering-IECMAE

8th to 9th August 2017, Singapore, **Website:** http://fecae.org/conference/189 , **Contact person:** Conference Secretary: Nikki Taylor, **Organized by:** International Forum on Environment, Civil and Architecture Engineering

International Conference on Biodiversity, Climate Change & Environmental Sciences 2017, 7th to 9th September 2017

Coimbatore, Tamil Nadu, India, **Website:** https://icbce2017.wixsite.com/conference, **Contact person:** Conference Chair,

Organized by: Nirmala College for Women, **Deadline for abstracts/proposals:** 26th August 2017 conference is the premier knowledge building Climate Change event in Canada. **Organized by:** Unique Conferences Canada , **Deadline for abstracts/proposals:** 15th April 2017

5th International Conference on Chemical, Biological, Agricultural & Environmental Sciences (CBAES-2017-Malaysia)

27th to 28th September 2017, Kuala Lumpur, Malaysia, **Website:** http://cbaes.eacbee.org/, **Contact person:** Alissa Matthew ,

Organized by: Emirates Association of Chemical, Biological & Environment Engineers

7th CEBU International Conference on Civil, Agricultural, Biological and Environmental Sciences (CABES-17) Sept. 21-22, 2017 Cebu (Philippines), 21st to 22nd September 2017, Cebu, Philippines, http://cbmsr.org/conference.php?slug=CABES-2017&sid=2&catDid=159, **Contact person:** Simmi Cook, **Organized by:** International Association of Chemical, Biological & Medical Sciences Researchers

Future Drainage & Stormwater Networks Dubai Conference, 2nd to 3rd October 2017, Dubai, United Arab Emirates,

Website: http://www.drainageandstormwaterdubai.com/ , **Contact person:** Lara Makdessi , **Organized by:** Advanced Conferences & Meetings, **Deadline for abstracts/proposals:** 1st October 2017

2017 7th International Conference on Environment and BioScience (ICEBS 2017), 11th to 13th October 2017

Busan, Korea (south), **Website:** http://www.icebs.org/ , **Contact person:** Ms. Iris Tang, **Organized by:** CBEES

Deadline for abstracts/proposals: 5th August 2017

3rd Karachi International Water Conference, 21st to 22nd November 2017, Karachi, Sindh, Pakistan, **Website:** http://waterconference.hisaar.org/, **Contact person:** Daniya Khalid, **Organized by:** Hisaar Foundation

Deadline for abstracts/proposals: 22nd September 2017

Water 2017, London Conference, 21st to 22nd November 2017, London, United Kingdom, **Website:** http://go.evvnt.com/132341-0, **Contact person:** Sales, **Organized by:** Marketforce Business Media

Deadline for abstracts/proposals: 21st November 2017,

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