Proceedings of Workshop on "Increasing Water Use Efficiency in Agriculture" held on 26th & 27th November 2019 in Scope Complex, New Delhi

Introduction:

National Water Mission (NWM) organized a workshop on "Increasing water use efficiency in Agriculture" on 26th (AN) and 27th November 2019 in Scope Complex, CGO Complex, Pragati Vihar, New Delhi. The inaugural session of the workshop was held on 26th November, 2019 (afternoon) followed by 2 hour session by Dr. Walter Jehne who is internationally acclaimed soil micro-biologist from Australia. Technical sessions on Crop Economics, Crop Diversification and Integrated approach for increasing Water Use Efficiency were held on 27th November, 2019 where prominent speakers expressed their views on the relevant subjects.

Inaugural session (26th November 2019):

- **G. Asok Kumar**, **Additional Secretary and Mission Director, National Water Mission (NWM),** welcomed the delegates and all participants. He introduced the audience about the objectives of NWM and took a quick rundown of all the key activities coming under the purview of the Mission. Noting some of the concerns that India is facing, such as low water use efficiency, fragmented and unreliable data, poor participation of grassroots stakeholders and inept adaptive resilience, he added key action avenues through which NWM is undertaking detailed scoping of these issues and scripting integrated and novel strategies for allaying the aforesaid concerns.

- He placed a warranted attention towards the issue of poor crop planning and briefed the audience of the *'Sahi Fasal'* concept which was kick-started from a workshop organized by NWM in Amritsar on 14th of November 2019 on the said concept. Although Punjab has seen burgeoning prosperity owing to practicing a system of intensive wheat-paddy cultivation, he continued, the State has been witnessing an alarming drawdown of ground water, including water quality related issues. In this regard, NWM has become cognizant of the urgency to revamp the extant model of crop production in India, and has, therefore, initiated this campaign to leverage expert knowledge and engagement with key stakeholders.

- He introduced the key speakers to the audience and invited **Mr. T. Vijay Kumar, (Retired IAS)** to steer forward the discussions.

- Shri Kumar placed on records his sincere appreciation towards National Water Mission for organizing the event and expressed happiness towards the efforts of NWM in knitting together a diverse set of stakeholders and argued that such cross-sectoral engagements holds key for introducing sustainable reforms in this country.

- He explicated the concept of zero budget natural farming and asserted the paramount role that farmers can play through management of land and related resources in meeting the sustainable targets in near future.

- Thereafter, he requested the audience to **join Dr. Walter Jehne, Founder, Healthy Soils Australia** into a fascinating journey of water and soil.

- Dr. Walter began his talk by charting out a categorical perspective of the global water crisis. Noting that, with ever increasing population, and the corollary stress it will put on our

already crumbling food production economy, there is an urgent need to revisit our current water management paradigm. He added that managing social stability in times to come will predicate upon provisioning of safe and reliable water related services. He observed that there is no dearth of availability of water on our planet but how we manage this resource for our common good becomes more important. He thereafter introduced the concept of pedogenesis which he described as an 'historical natural process of soil formation', for informing audience on the basic principles governing land-water-food-ecology nexus relationship.

- He explained, 420 million years ago, the earth saw explosion of eukaryotic multicellular organisms competing for nutrients leached out by inert rocks present on the lands. Pioneering organisms, such as fungi, had major competitive advantage as they were able to colonize and solubilize nutrients from rocks. Interestingly, in order to survive, this race saw a mutualistic or symbiotic relationship being entrenched between algae and fungi to produce lichens which continued colonizing rocks and survived as the first life forms on land and further 'caused something profound'. This lead to the formation of Earth's Soil Carbon Sponge which is 60% void and can hold water.

- He expounded that what ensues was the birth of hydrogeology. Soil, thereafter, with its enhanced capacity to infiltrate and retain rain water, accelerated plant growth, evolving from lichens to varied forms, viz. mosses, ferns, gymnosperms, angiosperms and grasses, in short successions. Plant life, in short, colonized the whole 14 billion hectare of land surface underpinning the Earth's bio-productive and resilient ecosystems.

- He further explained how our ability to manage ground water is basically reliant on the health of this soil carbon sponge. He asserted that our only point of leverage over nature, in general, lies on our ability to manage this sponge. Through an example of a hydrograph, he articulated how the composition of soil in terms of its carbon content can directly alter the distribution and flow of water over and below land surface. He lamented that with our current engineering-construction approach we have significantly altered the land use composition of earth, and thereby modifying the hydrological cycle and, furthermore, in corollary, have turned almost 5 billion hectares of land into a desert. We have designed in drought by building concrete and letting rain water runoff without percolating and sitting inside the soil. He stressed that, this is the most significant crisis that we all will face in the next decades or so. Alternatively, by mimicking the ecological processes, we can increase the share of rain water that infiltrates the soil and, in doing so, extend the longevity of terrestrial vegetation, including food production. He explained that this can produce almost 2000% growth response rate and is key for our planet's survival.

- He further captured the idea of water use efficiency by explicating the fate of 100 rain drops in Australia. As the water falls on the land, he added, 12 ends up in stream and only 2 drops get stored in the dams. The corollary is that Australia's whole industrial economy, or for that matter any economy, is dependent on that 2 drops of water for meeting its varied needs. Amongst the rest of the rain drops that had fallen on land, 50 drops get lost either through evaporation or by running off into the ocean. According to him, this is a 'scandalous loss' and much of it can be attributed to the spree of dam construction in the early 19th century. He explained that the future resiliency of our economy and life on Earth depends only on our ability to rebuild the soil carbon sponge.

- He stressed upon the need to account for water vapor present in the air to capture the full scope of meeting water use efficiency targets. He cited examples of ecosystems, such as Cacti in Arizona and red wood forest in California, which can harvest moisture directly from the air to meet their growth needs. He posed a stimulating question requiring us to ascertain means by which our agro-ecosystems can also mimic natural processes to harvest additional water from air.

- On similar lines, he presented the case of Andhra Pradesh where farmers are spearheading the application of efficient water harvesting measures to turn their dry lands into productive and resilient ecosystems. The farmers recorded 12-15 thousand tons of biomass per hectare with only 1000 tons of water becoming available from the rain. He elucidated the processes - the role of bio-stimulant in nudging the fungi to take up water present in films around the soil particles even below wilting point and the microbial respiration which in combination with the breaking down of organic matter produced water (1 gram of organic matter producing 6 gram of water). He asserted how this is opening up a whole new paradigm of farming in the marginal arid regions of the world, including India, as long as we have the right microbial stimulating processes and carbon sponge.

- Cognizant of the rapid urbanization that the world is facing and the ensuing pressure on our food production systems, Dr. Walter proposes the idea of wicking bags that can have cross-cutting benefits securing nutritional integrity, wastewater recycling and organic matter reuse. He presented a detailed operational arrangement of the wicking bag to make aware the audience of the varied processes involved in its design, management and use. He asserted that this will be the new frontier for urban agriculture in the decades to come.

- He provided a snapshot of 'Biodome' technology currently in vogue in remote areas of Australia to manage urban waste-water produced therein. Wetland plants are grown in shipping containers and these managed system of plants support growth of microorganisms in their root zones. Once the effluent is allowed to pass through the container, nutrients are taken up by the plants. As an additional gain, highly nutritious stock feed retreated every few weeks is given to animals in the pasture lands, thus, connecting city to hinterland nutrient cycle. This checks nutrients from polluting the rivers and lakes and is rather harvested back to increase agricultural productivity. Effluent water, on the other hand, is used for non-potable purposes. He explored ideas to harvest potable water by condensing water transpired by plants. Transpired water is capture by condenser and can be stored in dam or tank for non-potable usage.

- This was followed by an address of **Shri Ashok Dalwai, CEO, National Rainfed Area Authority** who narrated the telling trends from the agriculture sector as they relate to the inefficient practices of water resources management. He pointed out that there is an urgent need to reconcile the three competing goals in this sector, relating to: 1. meeting nutritional needs of people; 2.ensuring remunerative returns to the farmers; and 3. respecting the ecological integrity of our bio-physical environment.

- He added an historical perspective as to the challenges faced by the post-independent agriculture reformists in the country. He continued that gripped with the daunting task of ensuring food security in India, a system of intensive wheat-paddy cultivation was introduced alongside a host of policy reforms, viz. procurement support, remunerative pricing, input subsidies, technological extensions etc. He further explained that how this push towards

intensive farming added pressure on the available water resources of the country and heralded an era of menacing groundwater over-exploitation by this sector.

- Shri Dalwai expressed the need for a timely intervention that would bring in its ambit the entire gamut of issues as they relate to agriculture, viz. rationalizing input use based on data; lowering cost of production, transferring remunerative prices to farmers, ecological based cropping and meeting nutritional needs of people.

- His critical reflection towards farmers being rational economic agents who thinks in terms of marginal utility was well founded given the case of rice-paddy cultivation in northern India. Owing to government policies and support ecosystem, the northern states of India, particularly Punjab, has become mired in an ever complex nexuses of food-energy-water-livelihood. He articulated that the Government on account of its ability to reorient existing structure of incentives, can nudge farmers to make the necessary shift towards alternative cropping patterns, based on scientific data and evidence.

- The individual presentations/talks were followed by question and answer session where key ideas mooted ranged from financial viability of nature based waste-water management in urban areas, moisture management as a panacea for agriculture development and identifying means for operationalizing the idea of bio-stimulant based agriculture in India. Session ended with vote of thanks to the Chair and delegates .

- The session ended with **Mr. S.K. Arora , Advisor (C&M) , NWM** , thanking all the speakers with a token of appreciation. The day ended with a high tea.

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Technical Sessions on 27th November 2019

Session 2: Crop Economics

- The day started with a welcome to the participants on the second day of the workshop on 27th November 2019 by highlighting the key points of speech given by Dr. Walter Jehne on the previous day. Shri G Asok Kumar, Mission Director, NWM welcomed the participants and the speakers of the session and re-emphasized the points made by Dr. Walter Jehne that storing water in the soil in the form of soil moisture is more cost effective to farmers than building concrete structures like dams. National Water Mission is also working to conserve water in ways that can be retained and sustained for the future generations. The 'Sahi Fasal' campaign emphasizes on increasing the water use efficiency in agriculture by producing "Sahi Fasal" in every sense which has nutritional value, is economically remunerative and uses water efficiently. Currently crops like paddy are not grown as per the agro climatic zones of the nation; there is a misalignment in the cropping pattern which leads to unsustainable water management practices. The Sahi Fasal campaign was kick started in Amritsar which saw the enthusiastic participation of 850 farmers. They were shocked to know that the groundwater in their district has fallen 25 meters below the groundwater level and is one of the over-exploited blocks of the states with respect to groundwater development. They cited that paddy has better procurement system than any other crop in the state and they are growing paddy due to its economic profitability. So through this campaign , NWM is striving to bring policy change in the market system of the country that will allow farmers to grow crops that are as per the agro climatic condition of the state and

are at the same time economically profitable to the farmers. Mission Director welcomed the first speaker to floor.

- The first speaker of session was **Shri R. Balasubramanian, Professor of Agricultural Economics of Tamil Nadu Agricultural University**. His presentation was on Economics of crop production and water saving in agriculture. He begun by explaining the different types of water footprint (green, blue and grey) and the water footprint of crops across the world emphasizing that India has the highest water foot print . He then presented a picture of problems prevailing in India's water sector ranging from groundwater exploitation, marginal price of water, resource subsidy, inequality in resource distribution etc. After which he spoke on the cropping misalignment of paddy in the state of Punjab emphasizing of the negative effect the growth of paddy with respect to groundwater level of the state. He then compared the different kinds of paddy cultivation with respect of water usage and yield. Studies have showed that System of Rice Intensification (SRI) technique uses less water and has good yield when compared to conventional way of growing rice. He recommended that public infrastructure investments and regulatory reform to support farmers in technology adoption to realize rice yield increase. For instance, frequent power shortage need to be addressed to enable farmers to practice in-time irrigation. In addition, to generate economic incentives to save water, volumetric pricing of water is necessary. He numerated that drip irrigation and adoption of drip and sprinkler irrigation has the potential to reduce excessive extraction of groundwater by two thirds.

- However, under realistic assumptions about farmers' irrigation choices, half of these reductions are lost due to the expansion of irrigated area. He recommended that the control on total water use, improvement in water use efficiency and control on water pollution are the key factors in augmentation of water resources. He ended his presentation by recommending the use of behavioral economics. Nudges like information on environmental and health damages can initiate social comparison which will motivate others to comply with rules that can help in saving water.

- The next speaker was **Shri P.C. Bodh, Adviser, Directorate of Economics & Statistics, Ministry of Agriculture, Government of India** who spoke on Increasing Water Use Efficiency and Crop Economics: Issues & Solutions. He started with explaining the concept of crop economics and the ways it is measured. He emphasized that in states like Punjab, irrigation charges are a small component of the total cost of cultivation as electricity is subsidized. This has led groundwater exploitation in that region. He spoke on how farmers in the plateau region of the country are falling in the debt-trap bore-well economics as these are drought prone area. Thus release of correct information like aquifer maps should be made available to the farmers for better management of the local water resources of the area. He emphasized that Professional Decision-Enabling on ground-realities, not corruption-oriented subsidy solutions should be adopted by the Government.

- The last speaker of the session was **Ms. Shailja** who spoke on behalf of Shri Parthsarthi, Agricultural Principal Secretary, Government of Telengana. The topic was on "Agriculture Investment Support Scheme" ("Rythu Bandhu"). The scheme is implemented in the state of Telangana by Government of Telangana. Land owners are entitled to get INR 4,000 per acre per season. The thought behind the scheme was to relieve the farmers from debt burden

and not allowing them to fall in the debt trap again. Rythu Bandhu Scheme is proposed by Government of Telangana for providing Investment Support Agriculture and Horticulture crops by way of grant of Rs. 4,000/- per acre per farmer each season for purchase of inputs like seeds, fertilizers, pesticides, labor and other investments of farmer's choice for the crop season. The benefit extended under the scheme is not a subsidy but a financial tool to plan agricultural activity. This type of scheme is universally called decoupled income support programs, where payments to farmers are not linked to current production decisions. Similar schemes are ongoing in Odisha and West Bengal which has helped farmers to break poverty cycle and plan their agricultural activity sustainably. .

- The session ended with Mission Director summarizing the key points of the all three speakers and presenting them mementos as a token of appreciation.

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Session 3: Crop Diversification

- The first speaker of the session was **Dr. Dinesh Kumar, Principal Scientist, Indian Agricultural Research Institute, New Delhi.** He began his talk by explaining the types of cropping pattern followed in the country. It was seen that throughout the country mono-cropping pattern is followed such as rice-wheat, rice-rice, cotton-wheat etc which is detrimental to the soil health, water quality and promotes weed growth. Therefore, crop diversification was suggested to enhance the overall quality of agricultural produce and manage water & land resources in a sustainable way. Though factors like soil and climate, socio-economic factors, crop varieties etc play an important role in crop diversification, but availability of water resources is also a vital factor. He then explained the how water scarcity affects crop production like development of soil salinity, loss of nutrients, decreased crop growth etc. Thereafter, he spoke on the large quantum of water usage required for rice production highlighting that irrigated rice receives about 34-43% of the total world's irrigation water. Crop rotation, intercropping, production of legumes should be taken up for increasing sustainability in agriculture. He ended his presentation by suggesting crops like pigeon pea, soybean, Dhaincha as options that can be grown to diversify crop produce.

- The next presentation was on **Making farming water smart & climate resilient** given by **Shri Crispino Lobo, Managing Trustee, Watershed Organisation Trust.** He started his talk by presenting the problems in the water sector and suggesting that water budgeting is the key to manage water resources. Water budgeting helps in gaining an understanding of the total water availability, a community's existing needs and requirements of water, planning of agriculture based on water availability, promoting equitable sharing of water and making judicious decisions on ground water withdrawals. Therefore, he introduced the audience with the concept of Water Stewardship. The 'water stewardship' approach goes beyond considering water users as passive beneficiaries or target groups; on the contrary, all water users are considered 'water managers'. Since they own and share the common resource, they collectively need to assume the responsibility of adopting effective water management practices. Institutions at the local level are required to understand, plan and manage the use of water in their village. He ended the presentation by emphasizing on the need of sharing weather advisory data with the farmers leading to Climate Smart Small Holder Precision Farming.

- The last speaker was **Prof. Kanda, IAS (Retired), Government of India** who was not able to attend the workshop due to personnel reasons, had sent his thoughts which were narrated by Shri Gopal. He talked about the importance of health of natural resources like water and soil and that increased production and enhanced productivity do not always reflect healthy farming systems. Climate change, uneconomic use of land and water, cultivation of highly water consuming crops have resulted in a fall in fertility of soil, soil erosion and depletion of water table. He emphasized the need for paradigm shift from the current supply dominated mode to a demand driven mode. Diversification of agriculture is an alternate way not only for the regeneration and conversation of land but also for enhancing its productivity and at the same time conserving water. Crop diversification in India means a shift from traditionally grown less remunerative crops to more remunerative crops. It needs to be a function of factors such as geo-climatic, socio-economic conditions and technological development in a region. He ended his speech by reiterating that decision support systems, governmental policies, geographic information system etc will also aid in crop diversification.

- The session ended with the, Mission Director summarizing the key points and thanking the speakers with a token of appreciation.

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Session 4: Integrated approaches towards WUE in Agriculture

- **Dr. D.V. Raidu, (IAS retired)** described the current scale of crisis facing the agriculture sector and highlighted some key areas of concerns viz. on-farm practices, farmers' income, state's regulatory policies and depleting natural resources. He guided audience to reflect upon the magnitude of this crisis by sharing an example of declining crop yield per unit of fertilizer used over the last 5 years. He cited immobilization of nutrients, leaching of nutrients with water and fixation of nutrients in soils as the principle reasons behind low nutrient use efficiency in Indian agriculture farms.

- He presented the concept of Zero Budget Natural Farming (ZBNF) and highlighted some of its key pillars viz. restructuring of incentives to nudge adoption of right behaviors by stakeholders, partnership driven approaches towards planning and management, microbial inoculum for increasing soil's health, etcetera. He described ZBNF to be well poised for introducing resilient capacity in Indian agriculture system and also to reconcile the competing ambitions of farmers, consumers, ecosystems and posterity. He also presented the key technological framework guiding this approach, viz. a) designing with nature; b) setting up community champions; c) knowledge centric approach; d) experimental approach towards learning; e) mixing technology with traditional wisdom; and f) understanding pest life cycle for distinguishing between harmful and negative pests.

- Dr Raidu enunciated the concept of regenerative agriculture whereby pest management, nutrient integrity, carbon sequestration and drought proofing all combines as a result of enhanced land management measures such as using crop residue as mulching, microbial seed coating and planting perennial crops for reducing evaporation losses. He laid special attention to the importance of mulching for reducing evaporation losses, regulating heat content in the soil, releasing nutrients by decomposition and Non-pesticidal Management (NPM) for eliminating the use of toxins for pest control.

- He provided a snapshot of innovative farming practices under Andhra Pradesh ZBNF (APZBNF) that seek to diversify the farmers income portfolio while benefiting the natural environment. These examples included SRI, Integrated farming systems, seed banking, nutri gardening and tree based farming.

- He further shared APZBNF has been instrumental in alleviating poverty and integrating youth through targeted initiatives. For tapping the demographic dividend, he added, a 5-year model is planned where counseling, training and exposure visits are roped in for propping up youth participating in APZBNF. He also gave a summary of a special plan under APZBNF to lift 3 lakh landless farm workers out of poverty by securing market, regulatory and technological leverages.

- He concluded by highlighting some of the key impacts of APZBNF which included increased farmer income by reduction in cost of cultivation. He requested participants to ponder on means to upscale this idea for benefiting farmers across the country.

- The next speaker, **Dr. Alok Sikka,** Representative – India, International Water Management Institute provided an overview of trends in Indian irrigation system, which saw a massive decline in surface water based irrigation, and conversely, a rapid uptake of ground water as a key source for meeting agriculture production needs. For example, number of tube wells increased from 11.4 million in 1986-87 to about 24 million presently. Further, estimates put groundwater use for more than 60% of the total net irrigated area in country. He added, the system is inextricably intertwined in the intricacies of depleting surface water irrigation systems, subsidized energy provision, excessive groundwater dependence and green house emissions.

- He propounded for an integrated approach that encourages coordinated development of land, water and related resources and includes systematic interventions cutting across the dimensions of policy, technology, agronomy and resource conservation. He further enunciated that specific measures such as micro-irrigation, canal management system, decision support system (ICT technologies and models) and participatory approaches towards irrigation water management can systematically introduce sustainable irrigation systems and optimize famers' pecuniary returns. He presented a case of Narmada Canal Project, Rajasthan to establish integration of above said measures in planned manner can lead to water savings of about 40-45%.

- Dr. Sikka stressed upon the usage of water productivity. He described that improving PWP can aggravate conditions in water scarce basins and the need is, therefore, to increase EWP to target increase in income, resilience, water use efficiency and accelerated economic growth.

- He provided 4 pathways to increase water productivity which included increase yield per unit of water consumed, reduce non-beneficial depletion, tap uncommitted flows, re-allocate and co-manage water among users.

- Dr. Sikka elucidated the comparative productivity gains that can be secured by implementation of innovative cropping practices by citing examples viz. dry direct seeding of rice, water smart resource conservation technologies, alternative wetting and drying, raised beds for rice-wheat systems, aerobic rice planting, channel to field irrigation, hydrogel-technology and laser land leveling.

- He cited examples from Indian context looking at the institutional and legal aspect of irrigation management. These include an act launched in 2009 in Punjab restricting early sowing of paddy and an institutional model from Bihar that strives to include women and ostracized communities

for their holistic development. He concluded his talk by urging for a) coordinated approach towards land and water management; b) modernization of canals; c) strengthening capacity of key stakeholders; and d) adopting right mix of incentives for nudging appropriate behaviors.

- **Dr. P. Nandakumaran, Member, CGWB** was the third and final speaker of this session. He underscored the importance of ground water in meeting irrigation and drinking needs of the country. He stressed upon the key role that efficient groundwater management will play in buffering the impact of climate change and drought shocks. Further, he highlighted the challenges related to management of ground water as they relate to the incorporation of analytics on spatial and temporal variability of resource availability in the decision making process. He presented stark differences in terms of per capita availability of water between 1951 and present.

- He highlighted that India is the largest consumer of ground water. He informed that the share of water use in agriculture sector is 89%, which is 20 percentage point above the world average. He also highlighted the significant role groundwater is playing in meeting the irrigation needs of the country in terms of percentage share of irrigated area under-ground water irrigation.

- He explained the key challenges facing ground water management, including low yields, water logging, saline water intrusion and contamination from geogenic and anthropogenic sources. As per the Dynamic Ground Water Resources (2017) report, 17% of total assessed units in India are over-exploited, 18.6% are either critical or in semi-critical stage and1.5% are facing salinity related issues. Not only the number of over-exploitation units has increased by a margin of 41 percentage points between 2004 and 2017, the report also informed that 61% of monitoring wells recorded a decline in ground water levels. He thereafter cited reasons explicating such dismal state of affair, viz. limited awareness, poor crop plantation choice and practices, low water use efficiency, disoriented incentives promoting overexploitation, etc.

- Dr. Nandakumaran expounded key measures for curbing the threat of groundwater exploitation, covering both demand side and supply solutions available, and further elaborated the distribution of roles and responsibilities amongst key stakeholders. He highlighted key initiatives regarding ground water conservation as being implemented by some of the states.

- He concluded by identifying key levers which can help allay ground water problem in the country. Some of these includes enabling & empowering communities to manage their ground water, improving on farm efficiencies, changing cropping patterns, understanding the dynamic relationship between ground water and surface water and adopting plans for effective and coordinated utilization of the two resources.

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