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Review Article

THE ULTIMATE GREEN IRRIGATION PRACTICE BY INNOVATIVE APPLICATION OF SCIENTIFIC FACTS

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Abstract

Irrigation is an ever used support for crop production by creating externally added moisture supply in the root zone of crops, with or without rainfed supply. But, these results work as white spots, which are short lived and on small areas. There is no universal practice to suite the entire domain of creating such moisture supplementing practice. The present study accomplished a universally applicable practice by innovative application of scientific facts of environmental sciences and environmental engineering and developed the ultimate green irrigation (that does not emit Green House Gases, GHGs). The scientific facts of carbon cycle, nitrogen cycle, phosphorus cycle and sulphur cycle are applied to create such ideal green condition for the plant function and growth. Knowledge intensive technologies of plant nutrient supplementation, raised bed and furrow configuration, precision planting, sprinkler irrigation supplemented with furrow overflow irrigation at the stages of high water demands, weeding, intercultural, crop harvesting and post harvesting cultivation practice that enable successful crops and cropping practices were composed based on sufficient background justifications and substantiated scientific facts of development and effectiveness. The efficacy and utility of the ultimate irrigation practice is established by taking stake of published researches. This unique ultimate green irrigation practice is applicable to all soil, agro-ecological condition and for all crops grown under rainfed as well as with irrigation alone, copes up with poor quality of either water (provided with activated charcoal for biological inactivation of salts and toxic gases) or soil and both. Thus, this study fulfils ever standing global demand of creating breakthrough of universal application in irrigation for maintaining sustainable agriculture, at par with breakthroughs in electronics, communication, biotechnology, geography and printing technology etc.

Key words: Crop production; enhancing nutrient and water use efficiency; furrow irrigation; heavy water demanding crop growth stages; sprinkler irrigation; raised bed and furrow and water management.

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1. Introduction

1.1 Irrigation prospects

Irrigation is an artificial means of building moisture supply in agricultural field with a universal objective to enable plants uptake nutrient and water by absorption through the root hairs. World over researches have been conducted for devising practices for application of irrigation water, assessment of uptake, use efficiency and the resulting benefits, as well developments of salts due to faulty irrigation practices (**Asciandra et. al.1997; Chasak et. al.,2011; Zhong et. al.,2009; Liping et al.,2006**). Invariably, faulty irrigation practices or over irrigations cause development of salinity, alkalinity and many undesirable ionic health hazards viz salinization, sodicity, fluoride, arsenic and selenium etc (**Dhillon and Dhillon**, **2010**; **Guilette, et al., 1998; Jaglan and Qureshi, 1996, Krishnamachari, 1976**). Thus, due to intensive irrigation, fertiliser application and lack of drainage facility (including low lying wetlands) that foster anaerobic decomposition (**Yadav, 2014a**) of wastes and accumulation of salts and toxic gases make irrigation development projects lose their inherent values with time (**Jaglan and Qureshi, 1996, Krishnamachari,1976**). There have been problems due to lack of visualisation of change of scenario of chemistry of irrigated field and rise in ground water table. These issues warrant careful consideration in analysing the situation that develops post irrigation developments.

1.2 Irrigation and salt buildup

Salts form when acid reacts with base to form different types of salts with acidity or alkalinity, it also forms when a reactive metal dissolves in an acid and likewise ammonium salts may be formed by passing ammonia gas through dilute or appropriate acid resulting in formation of ammonium ions (**Horobin, 2003; De, 2010**). The salts of weak oxide exhibit acidity or alkalinity, when they dissolve in water. The salts can be divided as simple salt (that contain single metal ions), double salts (contain two types of metal ions, most important is alum that contains chromium ions (Cr^{3+}) or aluminium ions (Al^{3+}), together with an alkali metal ion, usually sodium or beta sodium. The complex salt is one in which one of ion comprises a metal atom, to one or more other chemical groups such an ion is called complex ion and it remains distinct when the salt dissolves.

The base or acid present in soil has strong tendency to remain in molecular form so its ions tend to rob hydrogen (H^+) or hydroxide (OH^-) from water to form molecular acid and base. The salts build up in irrigation which is essential to produce food with enhanced productivity. However, no endeavours were made to develop irrigation as green technology to reduce the green house gases. Among the six trace gases that cause green house effect, the nitrous oxide (N_2O) is third gas emission, inseries, emanating largely from agriculture field which caused depletion of ozone layer and global warming **(Wuebble,2009, Yadav,2014)**. The poor quality of water and soil inhibit application of irrigation and loss in productivity of fields. Thus, irrigation development accompanied by land improvement and enhancement in productivity suffered set back of developments of toxic salts and gases, which brought deleterious effects on plant productivity, food chain and public health (**Table 1**). Thus, agriculture that goes with strong support of irrigation, be it without supplement of rain as sole moisture build up or as supplementary irrigation, need reconsideration of strategy of bringing good effects. The success of irrigation technologies have been of the local nature and are celebrated as bright spots (**Bosio and Geheb, 2008**). Thus, endless researches are going on and so far no Sun technology of fixed module and universal applications did emerge. The removal of salts and toxic gases and reduction of emission of the GHGs by any means (**Wuebble, 2009, Yadav 2014 a**) would make it sustainable for not merely the bright spots for short times (**Bossio and Geheb, 2008),** but for all time to go for posterity.

Table 1. Soil, water and intensive irrigated agriculture related health hazards.

S.N.	**Location**	**Reference**	**Nature of problem**	**Health hazards**
I. High input conventional farming in lowland condition				
1	Yaqui valley, Mexico	**Guilette et. al. 1998**	Irrigated agriculture, with heavy input of fertiliser and pesticides	High level multiple pesticides in chord of new borne and breast milk of mothers, reduction in learning capacity.
II. Arsenic in Bangladesh and other areas				
2	Bangladesh and surrounding region	**Chapagain and Hoestra, 2008, FAO RAP,2006**	Arsenic causes cancer and reduces life expectancy	Problem of cancer and early death
III. Fluoride in ground water				
3	Irrigation projects in Southern India	**Krishnamachari,1976**	Fluoridised depends on development of sodicity in ground water	Dental and skeletal fluorisis
4	Indra Gandhi Canal, Rajasthan, India	**Jaglan and Qureshi,1996**	Development of sodicity	Dental and skeletal fluorisis
5	Aral basin in **Kazakhstan** and **Uzbekistan**	**Jack et al. 2005**	Spread of sodicity in Pakistan and near Aral basin	Dental and skeletal fluorisis due to excessive fluoride in soil and water
IV. Selenium and selenoisis in alkali soil, Panjab, India				
6	Alkali soil in Punjab, India	Dhillon and Dhillon,2010	Selenium gets mobilised and plants uptake from the alkal soil.	Selenium causes health hazards parallel to the fluoride. **Hira et. al 2004** reported that selenium reaches in animals through fodder, but concentration in ground water was also revealed.
V. Selenium in Sanjaquin valley California				
7	Sanjaquin valley California, USA	**Herbal et. al 2002**	Selenium mobility was observed in California, Janquin valley	Health hazard similar to fluoride
Iodine deficiency in highlands, mountainous area and foot hills, and adverse effect of excess in the coastal areas				
8	Mountainous and	**Audrey et**	Iodine deficiency and	Iodine regulates oxidation in

	foot hills, coastal areas	**al.1994 Food and nutrition encyclopediaC RC Press Inc.USA**	surplus	cells, regulates physical and mental growth function of muscles and tissues, circulatory activity and metabolism of all nutrients.
VI. Fatality in wells in South western part of Uttar Pradesh, India				
9	Fatality in open well at Mathura, India	**Yadav et al. 2008**	Hydrogen sulphide causes fatality in well	High concentration of H_2S caused death of three young men in well with mere 150 cm deep water.
VII. Acidity in lake water				
10	Sangang plain, north east China	**Jingshuang and Xinhua, 2008**	Anaerobic decomposition of dead weeds in lake bottom builds hydrogen sulphide	Ground waters in the downstream side become acidic.

1.3 Universal facts

Research compendium (**Gustafson, 1939/2010**) reveal that plant require 14 elements; may be macro, micro and supporting, absorbed by root hairs where water acts as a universal means of transport of ions. Thus, there is a universal mode of absorption of nutrient from the soil and irrigation is applied to facilitate this physico- chemical process in the biological plant productivity. This fact of absorption by the universal process of absorption has been over looked, and known and existing irrigation practices have been based on mere uniformity of application and irrigation water use efficiencies, which in no way perform the comprehensive function of irrigation. The strategy of use of primary and secondary natural resources, visualised by scientific facts of reactions of the primary resources (**Yadav, 2014d**) is a new insight in the present study. These considerations for green irrigation will bring economy, quality and quantity of productivity and protection of environments. It is a reminding fact that objective of irrigation is same for all sites and crops. Similarly, plants also have a unique way of extracting moisture from soil, through the root hairs, for using it for plant growth and production of desired yields. That means the irrigation specialists should endeavour to create the ideal condition so as to enable the plants to perform their unique and universal functions of absorption of nutrient and water. There is scope to devise a way to create conditions to fulfil the unique needs of moisture build up; be it for sole irrigation or supplementary irrigation. Thus, there is need to devise a unique way of creating the moisture supply by unique and ultimate practice of irrigation.

1.4 Objective

Objective of this study was to develop a Sun technology (a technology that is effective everywhere) by innovative application of scientific facts that will be ultimate irrigation practice for universal applications for crops as sole irrigation or the supplementary irrigation. The development of the ultimate irrigation practice is expected to enhance productivity, withoutcausing development of toxic salts and gases, and protect environment form accumulation of the green house gases (GHGs) *viz* six trace gases; carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chloroflouro carbon (CFCs), per flouro carbon (PFCs) and hexa flouro carbon (CF_6). Thus, this practice would serve as ultimate green irrigation practice that will make irrigated agriculture more sustainable than it is at present.

1.5 Frame work of the research

In agriculture large volume of agricultural waste remain in the fields and undergo decomposition which get converted in to elements such as carbon (C), nitrogen (N), phosphorus (P) etc (**Yadav, 2012**). Their reactions follow good and bad paths to produce useful and harmful products. These reactions are convened in desirable paths by creating conditions for plant growths. In this stride the supply of irrigation water should remain sufficiently aerated. The supporting bed configuration should retain more moisture, decompose to produce humus, apply best composition of organic and inorganic fertilisers, creation of condition for generating secondary natural resources produced by reactions of the primary natural resources, aerobic condition all time and removing salts and toxic gases regularly revolving in the fields, well inter tilled and reduce release of green house gases. Impacts of the ultimate irrigation practice and ecological advantages were assessed.

1.6 Manuscript content

The manuscript contains after introduction, the scenario of irrigation practices in vogue in past and present, method materials consisting of scientific facts, design consideration and the technology module, followed by result and discussion covering almost 10 different aspects concerning the ultimate irrigation practice *viz* accompanying necessary crops and crop cultivation technology, irrigation, product quality, breakthroughs and policy issues etc. The SWOT analysis and the conclusions are presented to complete the aspects of ultimate technology and needed research and development. Thus, this article comprehensively presents the ultimate irrigation practice.

2. Status of Irrigation practices

2.1 Irrigation development in the past

The practice of irrigation followed the practice of agriculture with growth of wisdom and demand for food increased with the increase in the population. Irrigation practices at the field scale have been the flooding, check basin, border irrigation, furrow irrigation, drip irrigation and even subsurface irrigation. These irrigation practices have been based on uniformity of distribution; various aspects of irrigation efficiencies, on the basis of consideration of land configuration, fertiliser application etc and conservation of water (**Israelson and Hanson, 1962**). Sprinkler irrigation or overhead irrigations have been used for uniform application on the undulating topography and soil with high infiltration rate making surface irrigation inefficient. However, the sprinkler irrigation suffer setback of drift losses, resulting in reduction of application efficiency. Likewise drip irrigation and subsurface irrigation systems are pro water conservation practices with some consideration of reduction of evaporation losses and application of fertiliser with irrigation water. The selection of these irrigation practices depends on the wisdom of irrigation practitioners, crops, weather, topographic condition, quality of soil and water as well. There is no consideration of universality of uptake of water by the crop plants. Thus, there exist numerous practices of irrigation under numerous situations caused by combination of these factors. The development of this situation has taken as standard practice and become well known. Now it has become scientifically clear that these irrigation practices were not ideal and it did not consider many scientific facts. The past researches on irrigation have brought good impact on increasing food production. **Table 1** contains the health hazards caused by the irrigation and developments. These problems have been known for almost six to seven decades, but there has been no solution. However, there is ample scope to make irrigation more effective in terms of green development than that of the past. Thus, there is sufficient justification to develop new ultimate irrigation practice of universal application so as to overcome these health hazards causing geo –gentry and social problems.

2.2 Irrigation development in the recent times

In a recent study, (**Etyel et. al., 2013**) entitled increased root zone oxygen by a capillary barrier to bell pepper irrigated with brackish water in an arid region, is note worthy. This study lays major emphasis on the supply of oxygen in the root zone and reports its advantage in production of yield of capsicum. At high root-zone temperatures oxygen flux to the roots was lower than the potential uptake rate and therefore, soil oxygen concentrations were sub-optimal. These conditions led to reduced plant biomass and fruit yield. Fruit yield was found to decrease by 1% for every soil oxygen concentration decrease of 700 ppm. In a fine textured soil, allowing roots to penetrate into the capillary barrier gravel layer increased oxygen concentration in the root zone by 5% and improved biomass and fruit yield by 16% and 18%, respectively. Adequacy of oxygen diffusion in the root zone to explain the scientific fact responsible for increase in the yield is well understood. But, still some important aspects need to be developed. Role of sulphur cycle was used (**Yadav, 2012**) to supplement the scientific fact of utility of sulphur in the plant growth. **Yadav, (2013a,b)** presented a universal green irrigation technology, which was based on application of scientific facts. These facts sufficiently established the level, status and lack of application of the scientific facts, which limit development of innovation of universal applications in irrigation.

Bossio and Geheb, (2008) described isolated short lived successes in land and water management technology for degraded lands as case of bright spots. The bright spots are defined as the management of sociological and biophysical system in such a way as to yield excellent land and water conservation results. Where this happens it is encountering of bright spots. The bright spots glitter like fireflies and remain in existence for short time and another technology may appear and surpass it. These technologies are evaluated for their impact on the production of ecosystem services. The impact of ecosystem services evaluated in terms of eight indicators are: soil quality (SQ), water productivity (WP), low external input (LEI), integrated pest management (IPM),water cycling (WC), biodiversity (BD), carbon sequestration (CS) and social capital (SC) (**Bossio and Geheb, 2008**). These impact indicators are equally applicable for irrigation practices that involve in the ecosystems. Any development to bring the Sun technology should produce the ecosystem services for all time and everywhere. These are the developments in irrigation practices so called generation I (1G). The development of any breakthrough is ever standing requirement in irrigation.

3. Materials and Method

3.1. The scientific facts

There exist many scientific facts which have direct relevance in agriculture. The scientific facts regarding decomposition under varying oxygen supply system disposal of solid and liquid waste, biodiversity, release of green house gases and circulation of water viz hydrology, nutrient supply, nutrient and water uptake, photosynthesis, biological nitrogen fixation etc. These scientific facts should be made use of and any practice so developed should not contradict the scientific facts. Accordingly, in present study the innovative practice of irrigation was developed with thrust and accordance of scientific facts. The scientific facts are briefly described to familiarise the readership.

3.1.1 The Nitrogen cycle

The use of nitrogen cycle has to be made by devising cropping system for paddy culture during the periods land remain under aerobic condition (**Yadav,2014a**).

Atmospheric nitrogen is captured and stored in soil by nitrogen synthesizing bacteria under aerobic condition which is useable by crops. The N is the most important nutrient element and nutrient for plant growth and gets transformed in to various forms in the nitrogen cycle. There are two routes for the N to reach at the terrestrial ecosystems i.e. by microbial fixation bacteria and the thunder and rains. The microbial transformations are organic nitrogen RNO_2, Ammonia NH_3, Ammonium NH_4, Nitrite NO_2, Nitrate NO_3 Nitric acid NO, nitrous oxide N_2O and reformed nitrogen gas $N_{2,}$ that goes back to the atmosphere. With the endeavours of increasing global productivity, the artificial nitrogen is added in addition to the natural build of nitrogen

There are four main ways by which nitrogen can naturally be made available for use in ecosystems. Firstly, by plants themselves, when bacteria, most notably those associated with leguminous (bean or pea) plants, trap nitrogen from the air and combine it with hydrogen to form ammonia (NH_3). Thunder and rains also bring down nitrogen in the nitrate form. The decomposition of plants and animals materials also releases organic nitrogen into the soil as ammonia. Bacteria and fungi in the soil then convert this ammonia into ammonium (NH_4), which can be used by plants. Further chemical reactions by *nitrosomonas* bacteria transform the NH_4 into nitrite -NO_2^- .The nitrobacter bacteria then convert the nitrite NO_2- to NO_3- nitrate. This nitrate is very soluble, and used by plants. The cycle is concluded when denitrifying bacteria in soil convert nitrates in anaerobic soil to either nitrogen gas (N_2) or nitrous oxide (N_2O) and these gasses then return to the atmosphere. In order to reach at scientific interventions in the nitrogen cycle process knowledge would be necessary (**Yadav 2014a , Yadav et. al., 2013**). The land form that maintains nitrogen cycle following good paths of decomposition has to be created in the green irrigation practice.

3.1.2 Phosphorous cycle.

Terrestrial plants absorb inorganic phosphate from the soil and convert these in to organic phosphate. Plant and animal after death return their phosphate by micro organisms to the soil phosphate (**Yadav, 2012; 2014a**), which are finally converted in to humus by the action of soil micro organism. Bulk of the phosphate fixed to or absorbed on soil particles, but part of it is lost by leaching out in to water courses **(De, 2010)** in facilitating profused growth of water weeds.

3.1.3 Sulphur cycle

The decomposition of cellulose reduces to sulphate or sulphide by aerobic and anaerobic condition respectively **(Fig 1).** During the aerobic decomposition the sulphur content of residue gets converted in to sulphate **(Seth et al.2005)**, which is directly taken up by the plants for promoting growth. The sulphur, taken in sulphate form, is a constituent of amino acids such as cysteine, cystine and methionine involved in chlorophyll production, which is required for protein synthesis, plant function and structure. Effect of sulphate is significantly affected by sulphur available doses **(Cimrin et al., 2008).**

On the other hand, the anaerobic reaction occurs under prolonged flooding in lowlands, following irrigation and rain and produces hydrogen sulphide, methane and carbon dioxide. The hydrogen sulphide is inimical to plants. The benefits that results due to operation of sulphur cycle have been realized, but results have hardly been reasoned scientifically. The knowledge of sulphur cycle (**De, 2010, Yadav,2012**) needs additional emphasis in devising practices of universal application of such management of waste and residues in agriculture.

1

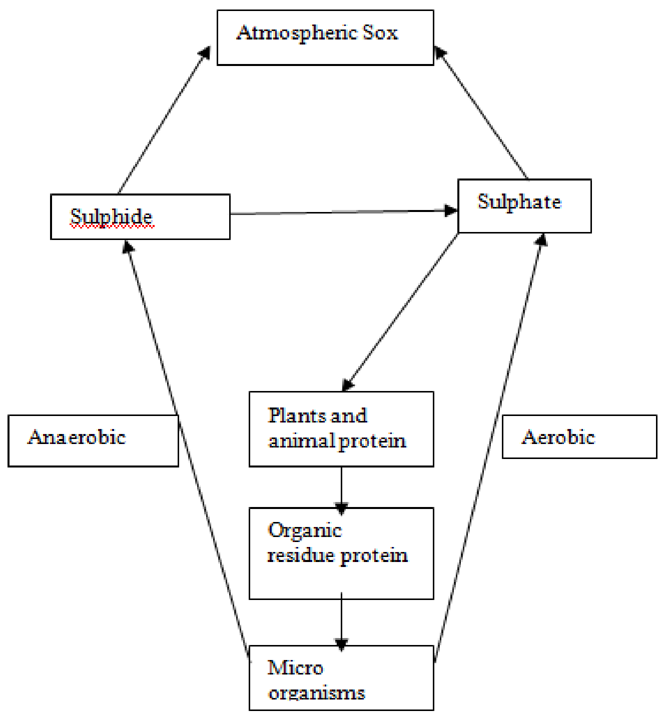


Fig2. Sulphur cycle (After De, 2004)

Fig 1.

A physico-chemical process developed to transform and enhance lingo cellulosic waste in liquid humic extracts: humic-like substances (HLS) (**Ayuso et al.,1996; Eyheraguibel et. al., 2008; Unsal et al 2001)**, showed that HLS do not increase the percentage and rate of germination. But, it enhances the root elongation of seeds, thus treated. Plant growth as well as root, shoot and leaf biomass were positively improved. These effects can be related to the high water and mineral consumption of plants undergoing this treatment of HLS. The high water use efficiency indicated that such plants produce more biomass than non-treated plants for the same consumption of the nutrient solution. Furthermore, the use of HLS induced a flowering precocity and modified root development suggesting a possible interaction of HLS with developmental processes. **Ayuso et.al, (1996)** showed that HLS derived from sewage sludge and other chemical formulation were equally effective. N uptake was better at lower concentration of HLS and P and other micronutrients were enhanced at higher concentration.

The anaerobic decomposition is convened as pre treatment of heavily loaded waste material of sludge or refuge from extensive waste producing industries, a mandatory requirement in many countries, for disposal of industry waste water in to municipal waste water disposal systems (**Vanlier, et al., 2011**). The principle of anaerobic decomposition is utilized in dung gas plants, where methane is produced and recovered for heat energy and digested dung slurry discharged for further uses such as composting and vermin composting. However, due to limitations of burning efficiency of the methane and unpleasant scenes and need of extensive repairs of dung digester plant make the dung gas plants less attractive after some years of use. Plants and animals depend on continuous supply of sulphur for synthesis of some amino acids and proteins. Aerobic decomposition of cellulose by sulphur bacteria produces sulphate. Anaerobic decomposition under polluted condition produces hydrogen sulphide (H_2S), which damage plants and animal cells. In unpolluted water under aerobic condition the sulphur bacteria convert the H_2S in to sulphate for further production of proteins.

The anticipated beneficial effects of recovered material / mass from the waste streams when get converted in the form of anaerobic compost do not bring desired beneficial effects. The situation gets worsened for irrigation with sewage water or salty water or in saline alkali soil bring the bad effect of sewage sickness. The sewage sickness restricts air circulation that produces hydrogen sulphide, known for many harmful effects **(Yadav et. al., 2008).** Sulphur accumulation by anaerobic decomposition of organic wastes left by weeds that grow in wet lands (**De, 2010**) ecosystems and anaerobic decomposition may cause acidity in future **(Jingshuang and Xinhua, 2008).**

3.1.4 Carbon cycle

Carbon cycle is based on the transfer of carbon to biological system and ultimately to geosphere as fossil carbon and fossil fuel (**De, 2010**). Micro organism play important role in carbon cycle mediating significant biochemical reactions.

3.1.5 Oxygen cycle

Oxygen is major component of all living organism. Oxygen is needed by most of plant (**Gustafson, 1939/2010**), animals and microorganisms for aerobic respiration or enzymatic oxidation of organic food which sustain growth and metabolism. It is absorbed from atmosphere by aerobic respiration and released by plants during photosynthesis thereby setting up oxygen cycle.

3.1.6 The hydrologic cycle

The hydrologic cycle is getting vitiated by global warming and climate change, causing extremes of floods and droughts that cause either excess moisture or the severe drought intensive and for longer duration. Great deal of analyses and modelling were done, but so far it has not been possible to precisely forecast the yearly rainfall, feature of year and sequence of rainfall events. The distribution of rainfall events has profound control of operation of the supplementary irrigation, which is a part of cycle of irrigation water application in year round agriculture. A conceptual model supported by example case of rainfall amount, nature of year and the distribution of rainfall events was developed by **Yadav and Saxena (2014),** which will be useful in operation of the supplementary irrigation in question.

3.1.7 Adsorption and absorption principle of environmental engineering

Existence of methane and sulphur dioxide is also toxic gaseous pollutants in liquid or air. There can be suitable manifestation to absorb the methane and hydrogen sulphide gases to reduce burden of releases from the agriculture fields to the atmosphere. Charcoal, which has enhanced surface area due to containing pore spaces, is known to adsorb salt and impurities and absorb toxic gases in liquid or air. Utilizing these characteristics many environmental applications are devised (**De 2010, Yadav, 2014a**).

3.1.8 Substantiation of the gap/ no use of scientific fact in water application

Gustafson (1939/2010) listed fourteen essential elements for plant growth. Nitrogen phosphorus and potash form the macronutrients. Calcium, magnesium, iron and manganese are in another category. The elements sulphur and zinc are considered to be important supplements. However, zinc application received attention more than that of the sulphur (**Yadav et al.,2006**). Agronomist specify the deficiency of sulphur (**Yadav, 2012**), but with little emphasis as important element. As indicated under the subsection sulphur cycle, there was shortfall in the knowledge and thereby no innovative technology of universal application could emerge. These facts were substantiated in detail in another study (**Yadav, 2012**). Because there are different interactions in the sulphur cycle, the net products after decompositions are different. Largely under the low land condition the hydrogen sulphide and methane get produced which deteriorate produce quality and cause fluoride in ground water. The ground water becomes acidic (**Table 1**). On the other hand aerobic decomposition produces sulphate which is used by crops to promote growth and structural tissues. In the recent years studies have shown that substrates of residues increase nitrogen and phosphorus use efficiency at the similar level of consumption of water. **Yadav (2012, 2014a**) presented several means of formulations of organic manure viz NADEP (aerobically decomposed compost), green manuring (GM), NADAPED green manuring (NADEPEDGM) and liquid green manuring (LGM) (**Yadav,2012, 2013b,c**). The cellulose content of the materials will get decomposed to sulphate, hence there will be no extra need for supplementation of sulphur. This gap in knowledge of sulphur cycle in agriculture still prevails and experiments are being carried out on random basis that produces random results. Therefore, it is suggested that in the list of 14 elements (**Table 2**) the <u>priority of sulphur (S) should be brought to the fourth instead of nine</u>. Other elements should also be rearranged by customization for any location. The soil medium acts as habitat where there are living organisms performing biological activities and water helps in biochemical reactions and acts as transport medium. In the process of decomposition and biochemical reactions the salts get produced which need to be removed by suitable mechanism to enable plants get good quality water. Thus, scientific knowledge particularly environmental sciences and engineering enable innovative development to be true for all times. The ultimate irrigation practice is the fore most requirements for sustainable agriculture.

Table 2. Elements needed for plant growth.

S.No	Element	Symbol	Atomic weight	Common valance	Equivalent weight
1	Nitrogen	N	14	3^-	-
2	Phosphorus	P	31	5^+	6.0
3	Potassium	K	39.1	1^+	39.1
4	Calcium	Ca	40.1	2^+	20.0
5	Magnesium	Mg	24.3	2^+	12.2
6	Iron	Fe	55.8	2^+	27.9
7	Manganese	Mn	54.9	2^+	27.5
8	Boron	B	10.8	3^+	3.6
9	Sulphur	S	32.1	2^-	16.0
10	Zinc	Zn	65.4	$^{2+}$	32.7
11	Copper	Cu	63.5	2^+	31.8
12	Hydrogen	H	1.0	1+	1.0
13	Oxygen	O	16.0	2^-	8.0
14	Carbon	C	12.0	4^-	-

Equivalent weight (combining weight) is equal to atomic weight divided by valance (**Hammer and Hammer, 2005**).

3.1.9 Inducement of Sustainability

It is clear that all the essential inputs for the plant growth among 14 essential elements, N, P, S, C, O, and even water supply (**Gustafson, 1939/2010**) maintain a cyclic pattern. In the process of maintaining sustainability it is essential to create a system which supplements all the elements necessary for plant growth to keep the cycle operating continuously as far as possible. Because of many uses and misuses there occur distortions in the process that pollute atmosphere, water and soil medium by formation of toxic salts and gases. **Table 3** contains useful and harmful forms of the products that develop in the process of decompositions in the soil medium, which serves as habitat for the plant growth. So far emphasis had been made on the primary natural resources, but no visualisation emerged for chartering mechanism for development and utilisation of secondary natural resources. This situation remains as a challenge for irrigation engineers and the environment conservationists.

Table 3. Secondary natural resources, product, knowledge status and engineering application

S.N.	Scientific fact	Useful	Harmful	Status of knowledge	Engineering Technology
1	Nitrogen cycle	Nitrate	Nitrite	Known	Mixed, cropping, inter cropping crop rotation, green manuring
2	Phosphorus cycle	Phosphate	Phosphide	Known	Gets fixed in soil, Band placement

3	Potash cycle	Potash	-	-	-
4	Sulphur cycle	Sulphate	Sulphide	Not well known	Conduct aerobic decomposition
5	Absorption	Removal of inimical substances	Pollution, degradation	Not well perceived and applied	Not existing in agriculture, but it can be innovated
6	Adsorption	Removal of inimical substances	Pollution, degradation	Not well perceived and applied	Not existing in agriculture
7	Joint strength	Enhance and produce uniform germination	Strong crust strength restrict germination	Known but way to exercise these facts not popularly used	Weaken strength, enhance joint strength by band placement.

It is necessary to have a mechanism to eradicate, absorb or adsorb the toxic gases and salts to keep the condition controlled and enable the process continue to function always to produce good effects by following right paths of decompositions. It requires to maintain aerobic condition by providing drainage (**Yadav, 2012, 2013a,b, 2014a**), moisture supply and supplement the essential elements. These provisions are universal requirement and creating such landform will serve the universal need and form the ideal landform of universal applications. Creating moisture supply by ideal irrigation practice so as to charter the afore said function of aerobic condition did not come to the visualisation of irrigationists and several inappropriate practices did continue to apply. The research endeavours remain entangled in creating problems and searching for solution. Thus, no universal scientifically correct ultimate irrigation practice could be innovated.

3.2 Design consideration

The foregoing deliberations help devise design specification of development of the ultimate irrigation practice. Among the several mode of application there is no scope for enhancing quality of water that reaches at the ground surface. Any deterioration in quality due to anaerobic decomposition of carbon containing compounds creates biological oxygen demand (BOD). Sprinkler irrigation atomises water that encourages it to acquire oxygen. Hence, irrigation water will have quality character similar to that of green water (ie rain water designated as blue water by **Chapagain and Hoestra, 2010**). In addition to this, specifically required characteristics, sprinkler irrigation is highly suitable for undulating or uneven land surface, uniform distribution, saving in water and maintaining no flooding irrigation.

The climate and weather situation demanding intermittent irrigation can be carried out for deciding operation of sprinkler irrigation as supplementary irrigation and further supplementation by furrow irrigation at the high water demand with some degree of over irrigation to create flooding to touch the apex of the raised bed top surface. Thus, conjunctive use of sprinkler and furrow irrigation should form the ultimate irrigation practice.

For the situation of continuous submergence water ponding of paddy fields should be altered so that the ponded water spread area is reduced to cut down evaporation loss from the liquid water. There should be near saturated condition for wet land agriculture or near field capacity for upland agriculture, which can be maintained by sprinkler irrigation. For fulfilling high water demand at critical stages such as tillering, booting, grain filling etc some additional water should be applied to fulfil the crop water requirement.

Further, when overhead or occasional irrigation is applied a ground condition has to be made to receive and store the irrigation water to the maximum extent that will accomplish the plant water requirement and charter the chemical reactions for decomposition by following the aerobic path of compound elements included in **Table 3**. Manure and fertiliser applications also require careful consideration towards management of nutrients for the crops. The crops and cropping practices form the package to very efficiently utilise water and nutrients at high efficiency.

The plant protection measures, weeding and inter culture operation and post harvesting operations also to be performed for which appropriate moisture conditioning should be created.

3.3 The technology frame work

The agriculture technology for production of crops involves creation of bed configuration for providing required edaphic factors, moisture and nutrient for plant growth, irrigation, precision planting, weeding to cut down robbing of moisture and nutrient, intercultural to keep surface crust broken for exchange of gases, intake of oxygen and breaking capillaries for reducing evaporation from the soil surface, supplementation of oxygen required for maintaining biodiversity respiration, harvesting and post harvesting cultivation to keep cracks in soil filled up to eliminate release of methane. These factors are enumerated in **Table 4** under the racy nature agriculture practice components. The aspects of contribution of factors to the yield and accompanying justification will be taken up in the result and discussion part of the study.

Table 4. Conservative assessment of yield enhancement by racy nature agriculture practices components and their justification

S. No	**Racy nature agriculture practice component**	**Possible increase, %**	**Basis and justification**
1	Aerobically decomposed manure, application	15	Aerobically decomposed cellulose by the sulphur bacteria produce sulphate, directly taken by plants for building body tissues and promoting growth.
2	Ploughing	5	Ploughing creates aeration that convenes aerobic decomposition
3	Formation of raised bed furrow system	10	RBC increase soil depth to larger volume of moisture and air in the root zone. The additional moisture and aeration makes plant growth under both the condition of water logging and

			drought. This situation permits crop diversification in the low lands where only paddy cultivation is possible.
4	Precision sowing	5	The precision sowing enable harness yields from entire space of the field under crop. Both raised bed and furrow can be sown/planted to extract utility high and low moisture and the oxygen supply.
5	Maintenance of optimum plant density	10	Plant density that will be produced by the crop variety and crop should be optimised by generation II (2G) research.
6	Sprinkler irrigation at optimum efficiency	10	Sprinkler irrigation freshens irrigation water by eliminating hydrogen sulphide and methane like harmful gases in water, thus create adequate oxygen supply and save irrigation water
7	Weeding	5	Weeds removal means elimination of loss of nutrient and moisture by unwanted plants that may grow in the crop field along the crops. The Arabic field condition will facilitate walk ability, traffic ability, cutting of weeds by sickles and its reduction by the inter culture operations. In the racy nature agriculture ecological strategy is devised to eliminate the need for weeding.
8	Inter culture	10	The inter-culture again enhances aeration during the crop growing in the field.
9	Subsequent cropping system	5	Subsequent cropping utilises land which emits GHGs contained in soil (at least 10% of total yearly GHGs emission. The subsequent cropping enables function of nutrient cycle under aerobic condition and supplement the soil to be harnessed by the paddy crop.
	Composite enhancement additive index	75	Combined additive effect of all factors enumerated above.
	Multiplicative index	2.047	Combined multiplicative effect of above all factors.

The justifications (**Table 4**) are well internationally accepted by documentations in the form of research publication in world class international journals across the globe (**Yadav, 2012, 2013a,b,c, Yadav,2014a,b,c,d and Yadav and Srivastav,2009, Yadav and Saxena 2014; Yadav et. al.,2013).** However, the optimum practices have not been followed for the lack of a technology capsule which contains every aspect listed in **Table 4**. In the present study this gap of lack of the suitable capsule is fulfilled. The capsule comprises all needed aspect of ultimate irrigation, which cannot be substituted by any other one. Thus, it forms an ultimate irrigation practice.

4. Results and Discussion

Irrigation is applied for raising productivity of crops, hence in this study description is presented in the sequence of the innovative technology for which innovative and ultimate irrigation is accompanying component practice. This characteristic feature requires preparing scientific readership to comprehend the basis and development of ultimate irrigation practice. For this reason, some preparatory facts are presented before coming to the dealings on the innovative ultimate irrigation practice.

4.1 Constituents of technology capsule

The constituents of the racy (alive, smart and enthusiastic), basis substantiated by another study **(Yadav, 2013b, Yadav and Chaudhary, 2014)** nature agriculture are given in **Table 4.** The components warrant some justification and substantiation. The contributions of components to yield are taken based on the observed trends from the past researches. Raised bed and furrow had been a novel technology in India in decades of 1980 and 1990, but lack of scientific knowledge of the sulphur cycle it could not receive necessary provisions of manures and fertilisers (**Brar et al. 2003; Shah et al. 2011; Singh et al 2005; Sigh et. al.1997**), irrigation supplementation (**Yadav, 2013a, Yadav et.al. 1986, Songhao and Xiaomin, 2006**), hence secondary natural resources could not develop (**Yadav, 2014d**) and so were the implement and machineries. These and many issues *viz* lack of ideal practice did not support the raised bed and furrow practice then. The increase in energy input for preparation of raised bed and furrows will get compensated by the use of local materials such as agricultural wastes etc for aerobically decomposed compost. The novel agriculture technology is described in the following.

4.2 The racy nature agriculture

A knowledge intensive green technology for the time sequence and convergence based new alive, smart and enthusiastic (racy) named as, Racy Nature Agriculture was innovated to alleviate the drudgery of the adverse factors in present day agriculture and convene sustainable global food security and protect environment.

The racy nature agriculture comprises best results creating soil habitat, nutrient supplementation and conductance of oxygen, moisture, protection from water logging and keeping condition for aerobic decompositions. All these supplementary conditions are necessary for functioning of nitrogen, phosphorus, potash and sulphur cycles to follow beneficial paths to produce nitrate, phosphate, potash and sulphate under all changing hydrologic conditions. In the development of racy nature agriculture band of best practices supported by the scientific facts were synthesized to form the panacea green technology capsule prescriptive for ameliorating agriculture and environment. The technology comprises raised bed and furrow (**Kenneth,2006, Lauren et ak 2006, Donald and Andrew,2012**) and nutrient supplementation of 25% of N requirement of crop by organic N sources (**Yadav,2012, Yadav et.al., 2013**) such aerobically decomposed compost or aerobically decomposed green manure or liquid green manure [new formations] (**Yadav, 2012**), precision planting, sprinkler irrigation (**Chassak, 2011**, **Ping et al.,2006, Yadav et.al.,1986. 2013a,b**) inducing biological water harvesting and creating condition of green water as rain supplemented with furrow irrigation of high water demand at jointing, heading and flowering (**Prakash et al., 2008**), stages of crops, good drainage during flood and long duration rainfalls (**Yadav, 2014a**),weeding, intercultural, harvesting and post harvesting practices to reduce the emission of green house gases', when land is free of crops. It adopts crops selection that builds nutrient reserve which can be synergically utilised in relay race like situation (**Yadav, 2012**). It promotes productivity with existing situation and conserves resources for posterity. It is a panacea technology suitable for all agro-eco regions, climates, soils, crops and water shortage and poor quality conditions. For example, the racy nature agriculture is applicable even for cactus, a desert nonconventional fruit cultivated in Yemen in Gulf to the other extreme of wettest environment experiencing highest rainfall for paddy crop at *Cherrapunji*, India. It is also equally applicable for controlled environment agriculture such as green houses and poly houses. The technology has capacity to endure adverse impacts of droughts and floods that are likely to become severe due to global warming and climate change in future. The racy nature agriculture focuses and meets world over challenge in the use of natural and fixed resources for agriculture and environment conservation (**Yadav, 2014d**), which have not been found in the existing scientific ventures, except situations of bright spots (**Bossio and Geheb, 2008)**. The technology surpasses by bringing improvement for covering all agriculture domains, instead of that get produced in isolated and short lived bright spots.

The technology capsule components have been validated (**Yadav, 2013b**) for their efficient working. The scientific publications and presentations on the related science and engineering of racy nature agriculture technology capsule have been documented (**Yadav 2012, 2013b, c; 2014c**). Validations of component practices and the composite technology fulfil the validation need of composite technology capsule of nature agriculture. Thus, the technology surpasses and overtakes all known and existing researches and developments in agriculture, food production and environment protection. The racy nature agriculture fulfils and accomplishes challenges related to global agriculture, food, environment and people. It has accomplished more than one and half dozen challenges of natural resources management (NRM). The technology produces ecological benefits of improvement in soil quality (SQ), water productivity (WP), low external input (LEI), integrated pest management (IPM), water cycling (WC), biodiversity (BD), carbon sequestration (CS) and social capital (SC), more than those known for the bright spots.

It is technology of field level application in entire arable area of any watershed to cover any ecosystem accompanying agriculture component in it. The technology will usher global revolution in land and water resources use for bringing food security. Local optimisations of the technology will take care of customization accuracy to account for existing roles of agro-eco-regions, man-machine and socio-economic status. The alteration of decomposition process, arrest of GHGs and heavy metals will reduce GHGs load in atmosphere, reduce load of heavy metals that will reduce global warming and avert climate change by reducing contribution of global warming of nitrous oxide with high warming factor. This aspect, totally new application in agriculture will produce food better than so called organic food. Thus, in lieu of some high profile alighted gentry having access to limited organic food, a better quality and accessible to all and surpassing solution is developed. The lag in the situation and makeup in the shortfall in present day agriculture can be made by recognition of motivational oriental saying i.e. late is better than never. Therefore, it requires to makeup mind, without further delay and come in action for implementation of the racy nature agriculture. The implementation will revamp all to join in mission to create mansion of global sustainable food sufficiency for present and posterity.

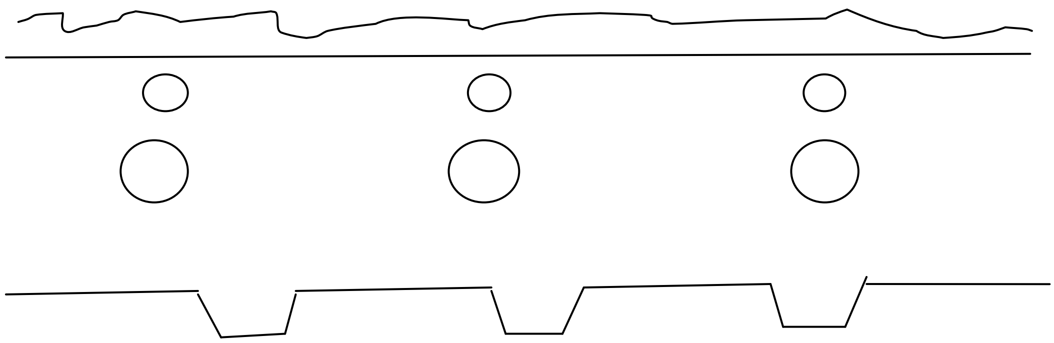
The technology of ultimate irrigation was developed by using the best researches of past studies. When these best researches are composed to form a technology, their efficacy will get enhanced as all of them are complementary to each other and in no way counterproductive or reactionary. Hence, the research of ultimate irrigation is free from the scepticism of discrepancy of field study data. The technology is ready for field application and generate experience on it operational difficulty and modifications. It will inspire the world researchers to carry out their own researches. Thus, tremendous research experience will emerge fast. That will fulfil the target of this research.

4.3 Ultimate irrigation practice

The moisture supply is basic input in agriculture and without it nothing can function. It is supplemented by rain or by irrigation alone. The type of irrigation depends on ground condition. In the previous sub section ideal ground or bed configuration which was devised as best configuration was described to enable visualisation of scientific justification. This ultimate technology is in the form of sprinkler irrigation to make irrigation water green and supplement moisture without causing any flooding that displaces oxygen in soil, the habitat. Further, raised bed and furrow bed configuration permits apply irrigation at time when there is high water demand at crop stages of tillering, heading, and seed formation etc. Thus, sprinkler irrigation accompanied by occasional furrow irrigation forms ultimate irrigation practice to achieve unique objective of universal application. The practice eliminates need of continuous submergence in paddy fields (substantiated by **Yadav 2012, 2013b**) and any other upland crops such as cereals and oil seeds. Further, fact specific description is presented with following **Fig2.**

4.4. The basic module

Clouds and rain

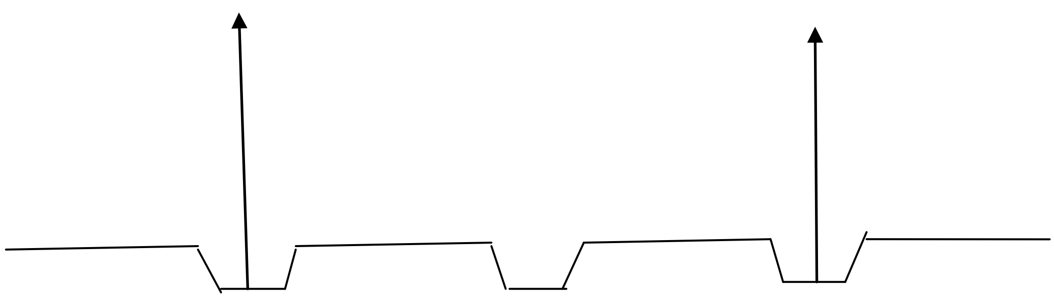


Land formation sectional view

Figure-2a : Land formation of raised bed and furrow for Racy Nature Agriculture under rainfed situation.

[The raised bed- furrow land form supplements adequate oxygen diffusion in the root zone, increased moisture and nutrient reserve for plants under water logged as well as dry condition. Its local customization is to be researched upon.]

Sprinkler irrigation with highest uniform spray irrigation



Land form of raised bed furrow for Racy Nature Agriculture

Figure-2b : Land form of raised bed and furrow and sprinkler irrigation for Racy Nature Agriculture

[The sprinkler spray application of irrigation water will increase oxygen content; it will supplement the raised bed enhanced storage of nutrients and moisture and sufficiently aerated, occasionally saturated and drain off the excess water to keep always convene aerobic decomposition of organic and cellulose. This will supplement plant nutrient by way of enabling sulphur cycle to function. This situation brings good water and air interaction].

The sprinkler irrigation was emphasised in 70s and 80s, but it has no such significance at present. As evident from the **Fig 3**, the sprinkler irrigation has potential for bringing uniform plant growths. Further, fortification in the plant growth can be brought by applying irrigation by furrow irrigation that will boost tillering and grain filling, hence yield will increase. When raised bed and furrow system is created and sprinkler irrigation accompanying with the furrow irrigation applied, it will form accomplishment of the ideal ultimate irrigation practice. That means conjunctive use of furrow irrigation and the well known practice of sprinkler irrigation will bring lateral, vertical and heavy weight growth of crops, all contributing to increase in yields. This universal ultimate irrigation practice will be equally applicable for paddy crop which will eliminate need of continuous submergence. So far researches have emphasised the aerobic rice by intermittently draining the submerged rice field on the plea to provide oxygen circulation. Thus, the ultimate irrigation practice will drastically reduce crop water demand of crops grown under any season of cropping. This ultimate irrigation practice will be a stake for sustainable food under skewed stressful water availability in the future. Thus, the ultimate irrigation practice has global prospective. The new and ultimate irrigation practice innovated in the present study surpasses any kind of irrigation practice known for the present and will remain universally true for all time for all the soil and crops across the globe.

Fig 3. A view of sprinkler irrigated wheat crop in 2013 at Central Institute of Agricultural Engineering farm, Bhopal, India. Note this field was sown on flat bed and irrigated by sprinkler irrigation without the furrow irrigation.

4.5 The cropping pattern for enhanced water and nutrient use efficiency.

The innovative development of scientific fact is applicable to decide the cropping patterns that make best use of nutrient built by the previous crop. This aspect has been manifested as crop rotation or the inter cropping. This aspect is very well exemplified by studies of nitrogen management in wheat by **Bhushan and Prakash 2002, cited in Yadav et al., 2013**. Wheat after leguminous crop of guar saved nitrogen dose of 40 kg/ha. It is, further, displayed by the case study presented in T**able 5.** The cropping pattern of rice-onion-cow pea enabled functioning of sulphur cycle. After rice the residue incorporation and its aerobic decomposition supplements sulphate, which is utilised by cultivation of sulphur loving crop of onion. The leguminous crop of cow pea extracts nutrient from the deeper layer after the shallow soil layer utilising crop of onion. The cow pea fixes nitrogen which is used by the following crop of paddy. Thus, this cropping pattern promotes functioning of nitrogen cycle in the cropping pattern consisting paddy. The nitrogen is essential for building up of essential amino acids and vitamins. These studies have produced example of way of use of cropping pattern in enhancing the productivity. However, there was no consideration of reduction of the GHGs. The cropping pattern charters condition of aerobic cycle that maintains functioning of sulphur cycle, nitrogen cycle and eliminates build-up of nitrous oxide and methane during the summer months. In the rice growing areas of India, Bangladesh and many south east Asian countries growing Boro rice is prevalent practice of growing rice during summer, winter and summer that carry out GHGs emission year round. This practice bothers the environment conservationists who disfavour water conservation with the fear that availability of water will trigger cultivation of many hectares of Boro paddy that will emit more methane than any upland crop such as wheat. There is sufficient justification to stop cultivation of *Boro* rice and grow wheat and pulses as established by the cropping pattern (**Table 5**) and harness benefits of natural resources created by the bio systems. This aspect is a new dimension in development of irrigation practice, which were not visualised by earlier irrigation specialist and irrigation engineers. The benefits are reflected in soil quality, water saving, carbon sequestration and water recycle.

Table 5 Rice based cropping system attributes and productivity that supports functioning of sulphur cycle (**Acharya et al, 2008**).

Treatments	**Yield of rice, Tones/ha**	**Rice equivalent yield, Tones/ha**		**System productivity, Tones/ha**	**Prod efficiency, kg REY/ha/d**
Cropping Sequence		Winter	Summer		
C1 (Rice-Potato-sesame)	4.2	21.5	2.7	28.4	97.5
C2(Rice-rapeseed-groundnut)	4.3	4.9	7.6	16.8	52.8
C3(Rice-Cabbage-Green gram)	4.4	22.8	3.2	30.4	105.6
C4 (Rice-Onion. Cowpea)	4.4	26.7	9.3	40.4	126.5
CD (P=0.05)	0.069	4.132	3.342	7.608	20.82

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4.6 Yearly cropping sequence yield based REY

The uniqueness of the technology is further exemplified by presenting the data on yield increase of annual crops cultivated in different situations and put in different cropping sequences for Punjab, agriculturally blamed for adverse impact of cropping patterns on water scarcity. The composite rice equivalent yield (REY) in different cropping sequences were accounted (**Table 6**) for assessing the potential production of foods. In the table addition of third crop, quite prevalent under intensive agriculture with irrigation will increase nitrogen fixation and enhance the REY. Nevertheless, this component is not included in the data of REY for the sake of keeping the margins of variations at different locations as compensating component for the racy nature agriculture to surpass production everywhere. These values guide one as to which cropping sequence should be followed in a given situation. This will help decide customized management of nature agriculture. The outcome will be more efficient use of resources in agriculture viz increase in food production, conservation of water and reduction of land degradation on various accounts, viz water, wind, chemical, nutrients etc. The REYs will create new niche in food production. The application of technology makes it possible to use any successful cropping sequence under the limited water supply situation. The REY of cereals viz rice and wheat, and maize followed by gram produce same REY, but there is drastic reduction in water consumption in agriculture. Since rice is preferred crop adoption of racy nature agriculture and ultimate irrigation practice will enable produce valuable cereals with limited water supply. The limitation of water availability will increase in the years to come because of global warming and climate change and increase in water demand for diverse uses. Thus, racy nature agriculture will be the only stake for future sustainable food security. The customized data will guide governance to be promoted in different agro-eco regions. Likewise, the quality of the food produced in racy nature agriculture will get identified for geographical indication registry (GIr) and Quality patenting. This will help consumers select most genuine and desirable food for purchase and the produces get remunerative price. This situation will enhance the GDP in agriculture and make agriculture more alive, smart and enthusiastic. The primary productivity will give base for industrialization in agriculture and increase in employment opportunities.

Table 6. Yearly cropping sequences and rice equivalent yields (REYs) for Punjab, India

Items	**Crops**		**Total, q/ha**
Crops	**Rainy season**	**Winter season**	
	Cropping sequence Rice—wheat		
Crops	Rice	Wheat	
Yields Q/ha	114	76	
REY	114	57	171
	Cropping sequence Maize –wheat		
Crops	Maize	Wheat	
Yields, q/ha	91	76	
REY	57	57	114
	Cropping sequence Maize- Mustard		
Crops	Maize	Mustard	
Yields, q/ha	91	36	
REY	57	74	131
	Cropping sequence Soybean –wheat		
Crops	Soybean	Wheat	
Yield, q/ha	50	76	
REY	63	57	120

Cropping sequence Maize- gram			
Crops	Maize	Gram	
Yields, q/ha	91	46	
REY	57	115	172

Price of commodity, Rs/q: Wheat 1200; Rice 1600; Maize 1000; Mustard 3300; Soybean 2000; Gram 4000

4.7 Some yield records.

Although field experiment as treatment of ultimate irrigation practice is not conducted, some known harvested yields are tabulated which are claimed to be big achievement and the implications of the scientific facts are focused.. Take the case of potato; recorded yield was almost one and a half times the general yield. Under the Racy nature agriculture with recommended capsule of practices yield of almost double of the present yield will be possible. There will be saving in the water for irrigation as well. Likewise, the general yield of rice is 60q/ha, which, can be increased to almost double the present yield. However, reported from Bihar, India yield of rice is almost four times the present yield. The reported level was refuted by a Chinese Scientist (**TOI, 2013**) to be overestimated by 120 percent. However, this refutable yield was said to be authenticated by the Government officials. In this situation the Racy nature agriculture is in some way supporting the achievable yield of rice to be double instead of four times. It goes parallel to the estimate made by the Chinese scientist. It was thought that such high yields can be possible where soil condition is good. In the Racy nature agriculture the soil condition is improved by raised bed furrow system which improves nutrient and moisture reserve available for crops. Additionally, nutrient supplementation is created by the scientifically innovative practice of NADEPED GM. Further, implementation of the Racy nature agriculture will help testify to establish and support/ improve the yield level reported by the farmer in Bihar.

The capsule of Racy nature agriculture will be an antidote under all soil, crop, climate, rainfed and irrigated situation. Local customization will indicate scope where improvement in agriculture can be focused. This will open a frontier for scientific resources management. Thus, new niche of productivity plateau can be established for global production. The entire activity will need overhaul to bring the scientific nature agriculture. It is apparent that world food situation will bloom from scenario of gloom. It needs make up of mind to implement in rejuvenating agriculture for global food production.

Table 7. Some recorded yields

Commodity	**Yields, q/ha**				**Reference**
	General	**Recorded**	**Expected under Racy nature agriculture**	**Technology gap/supplementation**	
Potato	200	313	380	NADEPED, irrigation, interculture	*Narsimha* Murthy, K. 2012. Innovative farming gives unexpected high yield Daccan Herald News service, DHNS.
Rice	60	220	114	Do	Indian's harvest claims 120% fake - Claims Chinese scientist. Hindustan Times, Mumbai, Feb 22, 2011
Rice	65	.66kg/m3 water	114	Drip irrigation and SRI	Ramna rao et al., 2013 Drip irrigation system in paddy crop.

4.8 Ultimate irrigation practice as an Innovative Technology

The ultimate irrigation practice is a universal technology of agriculture, which is at par with any breakthrough in other areas of advancement affecting daily life (**Table 8**). It is a breakthrough in irrigation and water use for irrigation. Agriculture is the highest user of water resources. This breakthrough of ultimate irrigation practice is fulfilment of ever standing demand for irrigation. It needs dissemination and training to promote adoption of new ultimate irrigation technology. The scientist in the temperate climatic conditions in China (**Yang et. al. 2005, Zhong and Zhao,1989, Zhang et. al. 2009**) concentrate researches on aerobic rice with insufficient scientific justification. This ultimate practice is a breakthrough for all climate, soil and crops across the globe, where ever supplementary or sole irrigation are being practice for innovative agriculture (**Yadav and Chaudhay, 2014**). The rainwater management by the new approach of the racy nature agriculture supplemented by ultimate irrigation will save nations from hunger and mal nutrition.

The realisation and getting recognition from the public to this breakthrough is likely to go slow as there is always sceptical attitude in agriculture scientists to believe it as there is no apparent visibility of reduction of the GHG. The yield responses are demonstrated and the technology will produce the same quantum of productivity and conserve water. In other words the ultimate irrigation practice will produce same level of yield under the water stress situation. In the other areas of breakthroughs it is the industrial application where research and development and mass manufacture remains under controlled condition with some alighted production houses. In those areas users get turnkey type of result manifestations. In agriculture everyone is doing in his own way as per his justification. Thus, inherent value to this ultimate irrigation practice is likely to not get its due recognition fast and make due contribution. As this is a breakthrough over the existing ones, it should be backed by strong follow up action of training and demonstration. There should be some policy direction to encourage the adoption of ultimate irrigation practice.

Table 8. Technological changes that have affected daily life through rapid pace and un developed areas

S. N.	**Area of advancement**	**Specific area**	**Visible effects**
1	Micro-electronics for information processing	Computer	Computer graphics stopped T.V. goers accept as realistic
		Electronic mail	Displaced postal services
		World Wide Web	Displaced postal services
		Cable T.V.	Displaced T.V. antenna
2	Medical and Biotechnology	Biotechnology research	Development of antibiotics etc
3	Magnetic resonance imaging and fiber optics Technique	To image human anatomy	To make surgical repairs with only minimum amount of cutting of healthy tissues.
4	Cloning of large animals and genetic modification of plants, microbes	Improvement in strains	Offer possibility of enhanced health and well being in future
5	Ancient Babylonia evolved in scriptoria of medieval monasteries	Passed through the invention of printing movable type	Photography, lithography and computer desk top publishing

6	Land and water degradation	Inconsistent, isolated and scanty bright spots advancement	Universally applicable Sun technology has not been visualised and not emerged

Thus, food, environment and health consideration requires research attention to ameliorate this situation for the projected population, where India will be NO. 1, the most populous countryby 2050 (**Raj, 2007**). The worsened situation of land, water and ecosystem services research rely on the research institutes. The researches' successful results are celebrated as bright spots (**Bossio and Geheb, 2008**). Such bright spots are like enlightening by fireflies in isolation, benefiting local areas and short lived. The ultimate irrigation practice a breakthrough presented in this study is a Sun technology of universal application illuminating under all situations and for all crops. This ultimate practice will work under varying soil and water quality characteristics. Towards the quality of food the ultimate irrigation creates new hope to reduce menace of arsenic poison in the food chain (**FAO 2006,Abedin et al.2003, Mehrag ,2004).** The ultimate irrigation and the racy nature agriculture with bio remediation of uptake of arsenic by crops should come in the way to reduce the severity of the poisoning and development of lethal dose **(LD_{50}).**

4.9 Enhancement in nutritional quality of food commodity

Foods particularly the vegetarian foods are derived from the primary products in the regular food chain. When the land, water and environment are polluted by toxic salts, they are likely to be fixed so as not be able to move to the plants. Provision of absorption /adsorption by the activated charcoal in the racy nature agriculture the quality of food will be better than so called organic agriculture. Further, since all decompositions are made to function under aerobic condition, there will be less likely hood of development of methane and hydrogen sulphide; hence there will be no chance of acidity in the food. Since there is a system of sulphate build up in the racy nature agriculture, which is irrigated by ultimate irrigation practice the uptake of nitrogen and phosphorus is likely to get enhanced. The nitrogen and the sulphate constitute the following amino acids which form vital protein for life. The sulphur, taken in sulphate form, is a constituent of amino acids such as cysteine, cystine and methionine involved in chlorophyll production, which is required for protein synthesis, plant function and structure (**Cimrin et al., 2008, Audrey et. al. 1994).** Incorporation of sulphur cycle to function in the ultimate irrigation is a specialised innovative application of the scientific fact. The working of sulphur cycle in the production system promotes N and P use efficiency; hence by the ultimate irrigation practice the quantity and quality of amino acid **eq 1-4** should get fortified. This aspect of food biochemistry fortification is new vision which is visualised as a scientific advantage on the food quality. It needs research endeavour in this area.

Methionine (met): $-CH_2-CH_2-S-CH_3$ (1)

Cystein (cys): $-CH_2=SH$ (2)

Asperagin : $-CH-C=O$ (3)

$\uparrow$

= NH_2

Glutomine ($GluNH_2$): CH_2-CH_2-C=O ↖ =NH_2 (4)

Phosphorus is the second abundant mineral, after amino acid and derived protein from it, in human body in every tissue and cell, generally as salt or ester of mono, di and tri basic phosphoric acid. Phosphorus is involved in wide variety of metabolic functions *e.g*, carbohydrate metabolism and oxidative phosphorylation, which are required to drive many metabolic processes such as active transport, muscle contraction and biosynthesis of fats and macro molecules (nucleic acid and proteins) (**Audrey, et al.1994, Gupta, 2000)**. The importance of phosphorus is tagged to its involvement in the reaction of **energy rich compounds** viz.**ATP** (Adenosine triple phosphate), NADP (Neotinamide Adenosine of hydroxide ion phosphate), **ADP** (Adenosine diphosphate), **AMP(**Adenosine monophosphate), **FAD (**Flavin Adenine nucleotide), **NADH (** added H), **$FADH_2$** (Addition of H_2). Phosphorus is known to help maintain acid –base balance and transfer of fatty acids in the human bodies.

Likewise, the ultimate irrigation practice and inputs in the racy nature agriculture are likely to reduce menaces of fluoride (**Krishnamachari, 1976**), arsenic (**Abedin et al. 2012**) selenium, and sodicity (**Dhillon and Dhillon, 2010**) as well as organically charged compounds of integrated plant production (**Guillette et al.1998**).

4.10 Implication of theory and Practice factor, impact and policy tool

As displayed vide **Fig 4** largely theory displays dominant role in technology application and development of national agriculture. The technology of designer quality production of food is fulfilling need of subsistence, land and water conservation and export promotion as well as reduction of foreign reserve expenditure on importing food (**Thomas et. al., 2011**). The Sun practice of irrigation will produce world level designer quality food, improve ecological services and protect environment. The ultimate irrigation practice is the real example of think global and act local. The global policy will get modified by their impact factor indicating component. Thus, this strategy will bring world agriculture at one platform of quality with respect to nutrition. This Sun irrigation technology fulfils the long standing need and gap of breakthrough in agriculture in food and nutrition, like other areas of technological development affecting the daily life **(Table 7).** Because food and nutrition is the basic primary need, it will acquire the first priority of application, implementation and adoption. The Sun technology having ability to produce balanced nutritional food, will surpass the so called organic food, in the reach of some alighted group to every gentry of globe. These facts need realisation, promotion and adoption by the world food sufficiency thinkers, planners and implementers.

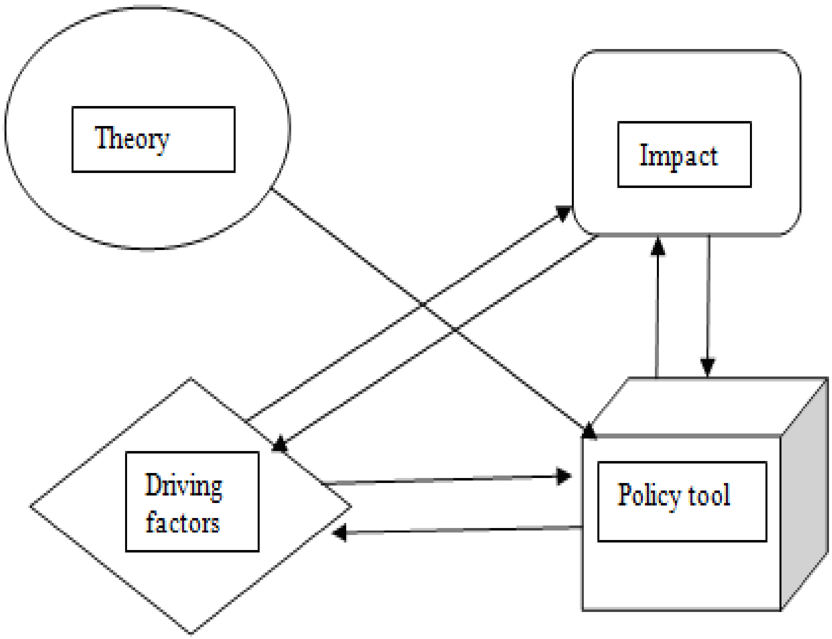

Fig 4. Link network of Theory, Impact, Driving factors and Policy tools

5. SWOT Analysis

The SWOT analyses are carried out to gauge various aspects of study in the following sub heads.

5.1 Strength

The study has high scientific strength. The ultimate irrigation practice is technology of fixed and final module which will remain for application under all conditions of soil, agro-ecosystem involving agriculture land use, rainfed and sole irrigation system. Thus, it is enforcement of quantum mechanics in the vogue science of irrigation. It transforms from vogue irrigation to fixed module irrigation. When same practice is going to be applicable for all sites there is likely hood of emergence of good experience and product. It needs devising suitable mechanism for rating such specialised outcomes of the ultimate irrigation practice.

The ultimate irrigation practice will conserve water and produce high yield with low volume of water. The concepts of ideal ground condition should be created in utilising the ultimate irrigation practice. The racy nature agriculture and ultimate irrigation practice are the green way of creating biodiversity, always emphasised by the ecologist and ecosystem services analysts. Ultimate irrigation practice is a Sun technology of irrigation water management. It provides all opportunities of irrigation practice for which researches have been striving for. This research has provided the globe the last destination where all answers converge with this practice.

4.2 Weakness

The study has no weakness in its conductance. It is an innovative practice of irrigation that facilitates food production to fulfil global food, fodder and fuel demands.

4.3 Opportunity

The unique ultimate irrigation practice builds worldwide unified strength to produce quantity, quality of primary productivity and control GHGs to abet global warming and climate change. The food quality so produced creates opportunity to create a better world (**Sect 4.9**) for food and nutrition than what it is at present. It brings world agriculture to a new generation; which may be different in developed and developing countries. The expenditures on scientific manpower input, resources, budget and time will get saved in searching alternative irrigations. It requires application and brings improvement in the shortfalls in the areas of management in agriculture after the local customisations. It requires experimental studies on optimisation of input factors in any given situation as the module of practice is fixed and there can be nothing other than this.

4.4. Threat

The results of the study are not free from the sceptical attitude of scientific world. This study has strong merit and is based on substantiation of scientific facts. The wisdom demands realisation and acceptance of the facts and promotion of the causes of ultimate irrigation practice to enhance productivity conserve resources and environment for the welfare of human kind.

6. Conclusion and research need

This study developed by innovative application of scientific facts an ultimate irrigation practice, a breakthrough at par with breakthroughs in other fields of science and engineering, which affects daily life. The components of practice are scientifically framed on the scientific justification. The practice has been validated by display of already published researches.

The ultimate irrigation practice produces food quality produce superior to organic farming, making accessible to all gentry of the globe. Further, this ultimate irrigation practice becomes a practice of quantum mechanics; where there is sound and unique justification to bring vague practice of irrigation in wilderness to a fixed module. The unique practice is ready for application for all ecosystems involving agriculture, sites, soils and crops. It needs customisation for local condition and taking necessary measures to revamp productions.

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References

[1] Asciandra G., Cecacanti B., Garcia C 1997 Soil agro-ecological management: fertigation and Vermi compost treatment. Bioresources Technology. 59 (2-3) :199-206.

[2] Chasak, Suthib, Jesda Keawkulyayo C., Roongnapa Korprditskuld, 2011. Water management in raised bed system: A case study from the Cha Phraya delta. Thailand Francois Mellea Thailand. Agricultural Water Management.

[3] Zhong, Leming., Shan Lin., Bouman, BAM. Changying, Xua, Fengtong Wei, Hongbin,Tao, YangXiaoguang, Huaqui wang., Zhao Dule, Klaus Dittert, 2009. Response of aerobic rice growth and grain yield to N fertilizer at two contrasting sites near Beijing China. Field Crop Research. 114, 45-53

[4] Liping, ,Fenge, Bouman B.A.M.,Tuang,T.P., Cabonngon, R.J., Yalong LI., Feng, Yuehua, 2006.Exploring option to grow rice using less water in northern China, using a model approach. I Field experiment and model evaluation. http://www.deepdive.com/LP/elsevier/exploring opportunity to grow rice using less water in northern china-EK8/Z5 quaxu?

[5] Dhillon, K.S. and Dhillon, S.K. 2010. Selenium accumulation insequentiall grown wheat and rice as influenced by gypsum application.in seleniferous soil.Plant and soil nutrition.227(1,2)243-248.

[6] Guilette, E.A., Meza M.M., Aqullar, M.G., Soto, A.D. and Garcia, I.E., 1998.An anthropological approach to evaluation of preschool children exposed to pesticides in Mexico. Environmental Health Prospective. 106(6):347-358.

[7] Jaglan,M.S. and Qureshi, M.H., 1996. Irrigation development and its consequences in arid region in India. Environmental Management.20:323—336.

[8] Krishnamoorty. K.A.V.R., 1976. Further observation on the syndrome of endemic genu valgum of south India. Indian J of Medical Research,649(2)284-291.

[9] Yadav, R.C., 2014. Innovative application of scientific facts for arresting GHG-N2O and improvising lucrative ventures with enhanced land, water and nutrient use efficiency, Journal of Energy and Environment. Photon, 128 :486-520.

[10] Horobin, Wandy (Ed.) 2003. Protein, How it works, Science and Technology, Vol 13 Scavandish Corporation, US.A. pp 1864-1866

[11] De AK, 2010 Environmental Chemistry. (7th Edition). New Age International Publications. New Delhi: 7- 13

[12] Wuebbles D.J., 2009. Nitrous oxide: no laughing matter. Science. 326: 56-57.

[13] Bossio Deborah and Geheb Kim, 2008. Conserving land protecting water: An introduction. In Bossio Deborah and Gehe Kim.2008. Conserving Land Protecting Water Comprehensive Assessment in Agriculture. Series CABI, in association with CGIAR Challenge Program on Water and Foods, International Water Management Institute Sri Lanka, pp XI-XVIII.

[14] Chapagain, A.K., Hoekstra, A.Y. 2010. The Green, Blue and Grey water foot prints of rice. from both Production and consumption perspective. Value of water. UNESCO Research report series No.40.

[15] Jacks, G., Bhattacharya,P, Chaudhury, P and Singh .V.P. 2005.Genesis and control of some F ground water in India. Applied Geochemistry.20(2):221-228.

[16] Heera, C.K.Partal,K. And Dhillon, K. 2004. Dietary selenium intake by men and women in high and low selenium area of Punjab. Public Health Nutrition.,7(1):39-43.

[17] Herbal, M.J.,Johnson T.M Tanji, K.K. Cao, S. And Bullen T.D. 2002. Selenium stable180 take ratio in California. Agricultural Drainage Water System J of Environmental quality.31:1146-1156.

[18] Audrey H,. Einsminger, M.E., Ensminger Jenis E., Konlanola, John and Radson,R.K., 1994 Food and nutrition encyclopedia, CRC Press Inc. USA Pp1740

[19] Yadav, R.C., Srivastav, Paritosh and Dube S.K. 2008. Fatality if well, a main sources of water supply in Braj Kshetra, of Uttar Pradesh, Presented at DST Sponsored National Seminar on Water Treatment Technologies, Hindustan College of Science and Technology, Farah, Mathura, India July 8-9, 2008.

[20] Jingshuang, Liu, Xinhua Li. 2008. Sulphur cycle in typical meadow Calmagrostis ongustifolia wetland ecosystem in the Sangang plain, north east China. Environmental Sciences. (Miscellaneous paper). China. 20(4) :470-475.

[21] Guftafson,A.E,1939/2010.Hand Book of Fertilisers, Their sources, make, effect and use. Third edition, Agro Bios, Jodhpur, India. pp15.

[22] Yadav R.C.2014.Biological phosphorus harvesting for multiple uses:A new scientific vision. International J of Fishery and Aquaculture. OMICS J., USA, In Press.

[23] Yadav, R.C. 2012. Innovative application of scientific facts for nutrient recovery from waste water streams for sustainable agriculture and protection of environment. Hydrology: Current Research. (5): 1000142 (2012).

[24] Israelson Osborn W. and Hanson Vaugen E 1962 Irrigation principle and practices. John Wiley International Ed

[25] Ityel Eviatar , Ben-Gal Alon, Silberbush Moshe, Lazarovitch Naftali. 2013. Increased root zone oxygen by a capillary barrier is beneficial to bell pepper irrigated with brackish water in an arid region. J. Agr. Water Management DOI: 0.1016/..09.018 http://www.agricultural crops.org/magazenes.

[26] Yadav, R.C. 2013. Innovative application of scientific facts for development of universally applicable water technology for enhanced global food production and environment protection. Proceedings of 92 nd Omics Group International Exhibition and Conference on Water Technology, Environmental Technology and Renewable Eenergy. Bombay Exhibition Centre Mumbai India. Feb 13-14.

[27] Yadav, R.C, 2013. Racy nature agriculture versus other like technologies: A technologies contrast. Middle East Journal of Scientific Research, Dubai Published. December,2013.

[28] Yadav, R.C, 2013. Innovative applications for scientific facts for zero methane emission and enhancing productivity of paddy fields for sustainable global food security: A conceptual model. Frontiers of Environmental Sciences and Engineering, USA December

[29] Yadav, R.C, Om Parakash and Deshwal, J.S, 2013. Biotechnology of Intra - Row Banding of Cyno-bacteria Leguminous crops for raising yield plateau of cereals and oilseeds Intern. J Agronomy and Plant Production , 4(12):3330-3336.

[30] Seth, Rashi, Chandra, R. Kumar, Manvendra, Tyagi, A.K. 2005. Utilisation of composted sugar Industry waste (Press-mud) to improve properties of sodic soil for rice cultivation. J. Environmental Science and Engineering. 47 (3): 212—7.

[31] Cimrin, K.M., Yogay, V. Togay, N. Senmiz, F. 2008. Effect of different sulphur and pyrite levels on yield components and nutrient uptakes of lentil (Lens culinaris). Indian. J. Agr. Sciences 78(6):543-

[32] Ayuso M., Hernández, T., Garcia, C., Pascual J.A. 1996 Stimulation of barley growth and nutrient absorption by humic substances originating from various organic materials Original Research Article ioresource Technology, Volume 57, 251-257

[33] Eyheraguibel, B., Silvester, J., Morard P., 2008. Effect of humic substances derived from organic waste enhancement on the growth and mineral nutrition on maize. Bioresources Technology. 99, 4206- 4212.

[34] Unsal Turkan, Sozudogru, Sonay OK. 2001 Description of chemical characteristics of humic substances from different waste materials. Bioresources Technology. 78, 239-242.

[35] Vanlier, J.B., Zeeman Gritje, Huibers Frang, 2011. Anaerobic pre treatment for the decentralized reclamation of domestic waste water stimulating agricultural reuse. P.O Box 8129 6700, E.V. Wageningen, The Netherlands (e mail jules.vanlier@algemeen.mt.wau.nl.)

[36] Yadav, R.C. and Saxena, S.C. 2014. Partial duration series analysis: A conceptual model for forecasting of annual rainfall and sequence of event distribution. Bentham Open Hydrology J, USA,

[37] Yadav,R.P., Aggarwal, R.K., Singh,P.,Arya, S.L.,Tiwari, A.K.,Bhattacharya, A.K.,Prasad, R,and Yadav, M.K., 2006.Effect of supplemental irrigation and integrated nutrient management on wheat (Triticum aestivum) productivity in rainfed Shivalik ecosystem. Inter. J. Tropical Agriculture.24(1,2)257-267.

[38] Hammer Mark, .J, Hammer Mark, Jr, 2005. Water and Waste Water Technology. Printice Hall of India. New Delhi 110001

[39] Yadav, R.C. 2014 Drainage engineering: A savvier for sustainable resources use, protection of environment and professional development. J. Of Civil Engineering, Photan 107:200-213.

[40] Yadav, R. C. 2014. Innovative application of scientific facts for natural resources management. Intern J Agronomy and Plant Production (IJAPP) U.K.accepted.

[41]Yadav, R.C, Srivastava Paritosh, 2009.Innovative applications of scientific facts for nutrient and residue management for sustainable agriculture World Congress on Consevation agriculture, Feb 4-8, New Delhi, India.

[42] Yadav, R.C. and Chaudhary, M.P. 2014.Racy nature A Sun technology towards quantum mechanics in agriculture. World J of Agr Research SciEP, U.K. 2(5) 223-227.

[43] Brar, L.S., Walia U.S., Gill B.S., Jand Seema, 2003. Influence of paddy residue management techniques on bio efficiency of herbicide for control of Phalaris minor in rice wheat system.Indian Journal of Weed Science 35(3and 4):186-189.

[44] Shah, Zahir, Ahmad S., Rashid, Rahma; Hayat Ur.2011.Sustainable rice wheat system through Management of legume: Effect of green manuring legumes on rice yield and soil quality. Pak J of Bot. 43, 1569-1574.

[45] Singh Fateh, Kumar Ravindra, Pal Samir, 2008. Integrated Nutrient Management in rice-wheat cropping system for sustainable productivity. Journal of the Indian Society of Soil Science: 56, 205-208.

[46] Singh, N.T., Joshan P, Gupta, J.P., 1977. Complimentary effect of soil puddling, submergence, and organic matter in rice. J. Agronomy, Am Soc. Agronomy.69, 882-884.

[47] Yad av, Vijay Kumar and Ogunlela V. B. 1986. Partitioning of rain water and its implication on application efficiency of over head irrigation Trans. Desert Tech. 11 (2):91`-97.

[48] Songhao Sping, Xiaomin Mao.2006. Application of simulation based optimization model for winter wheat irrigation scheduling in northern China .Ag Water Manage. 85, 314-322.

[49] Kenneth D. Sayer, 2006. Raised bed cultivation. Encyclopedia of Soil Science. 2006

[50] Lauren ,J.G., Duxbury, J.M., Hossain, M.I., Shah, G., Talukder A.S.M.H.M., Meisner C.A. 2006. Permanent raised bed cultivation improves nitrogen and water in rice wheat cropping system of South Asia. 18 th World Congress of Soil Science. July 9-15. 2006 Phildelphia, Pennsylvania,USA.

[51] Donald Vancooten, Andrew K. Ronald. 2012. Growing rice on raised bed. Ileia.

[52] Lauren, J.G., Pettygrove, G.S., Daxbury, J.M. 1994.Methane emission associated with a green manuring amendment to flooded rice in California. Biogeochemistry.24:5-65

[53] Prakash, Om, Yadav R. C. and Deshwal, J.S. 2008. Effect of simulated droughts at different growth stages of pearl millet crop. Indian J Agr. Sciences.78 (6):

[54] Acharya, Deb Brata, Mondal, S.S., Saha, M., 2008. Production potential and profitability of different rice(Oriza sativa) based cropping systems under irrigated nutrient management condition in Indo - Gangetic plains of West Bengal. Indian J. Agri Sciences 78, 569-72.

[55] TOI Times of India 2013.

[56] Narsimha Murthy, K. 2012. Innovative farming gives unexpected high yield Daccan Herald News service, DHNS.

[57] Hindustan Times 2011. Indian's harvest claims 120% fake – Claims Chinese scientist. Hindustan Times, Mumbai,Feb 22, 2013.

[58] Ramna Rao, K.V.Samaya, Sushila, Keshri Ravis,Chaurasia Lavesh,, Jat Dilip and Patel G.P.2013 Evaluation of paddy irrigation system for paddy crop:A viable alternative to conventional water management practice in paddy cultivation. Proceedings of 92 nd Omics Group International Exhibition and Conference on Water Technology, Environmental Technology and Renewable Eenergy. Bombay Exhibition Centre Mumbai India. Feb 13-14. PP37

[59] Singh Kalyan, Singh S.R., Singh J.K., Rathore, R.S., Singh Shishu Pal and Roy Rina. 2013. Effect of age of seedling and spacing on yield, soil health, digestibility of rice (Oriza sativa) genotypes under system of rice intensification. Indian J Agri. Sci. 83 (5):479-483.

[60] Yang Xiaoguang, BAM., Bouman, Wang Huaqi, Wang Zhimm, Zhao Junfand Chen Bin, 2005 Performance of temperate aerobic rice and different water regimes in China. Agr Water Manage. 74,107-122.

[61] Zhong , J., Zhao, C. 1989. Effect of puddling of paddy soil on crop growth in Taihu lake Region [China]. Actapedologica Sinica. 26(1):42-50.

[62] Raj Felix, Mukharjee Sampat, Mukharjee Millionth, Ghosh Amitava, Nag Rajendra Nath. 2007. Contemporary development economics.- From Adam Smith to Amaratya Sen Second Edition. New Central Book Agency Pvt Ltd.Kolkatta 700009 pp75-76.

[63] FAO RAP, 2006 Arsenic contamination of irrigation water, soil and Crops in Bangladesh: Risk implications for Sustainable agriculture and food safety in Asia. RAP Publication 2006/20 FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS REGIONAL OFFICE FOR ASIA AND THE PACIFIC, Bangkok, 2006

[64] Abedin M.J., Feldmann J., Meharg A.A., 2002. Uptake kinetics of Arsenic species in rice plants. Plant Physiol, 128, 1120-1128.

[65] Meharg A.A. 2004. Arsenic in rice – understanding a new disaster for South-East Asia. Jr Plant Sci,9: 415-417.

[66] Gupta, U.S, 2000. Crop Improvements Vol III- Quality characters. Science publishers Inc Enfield New Hampshire, 03748, United states of America.pp1-1

[67] Ping LU,Yang Li.,Zhang, ShanYou Hua,Han Young.2007.Influence of returning green manure and wheat straw to paddy soil on Soil available N content of rice yield. Chinese Journal of soil Science.

[68] Quanqi, Li, Xunbo Zhou, Yuhai Chen, Songe Yu. 2007 Water consumption characteristics of winter wheat grown using different planting patterns and deficit irrigation regime.

[69] Thomas, Caroline and Evans, Tony: Poverty, Development and Hunger, In Baylish, John, Smith Steve and Oven Patrics, (Editors). 2011. The Globalisation of World Politics: An introduction to world relations, Fifth Eedition, Oxford University Press, 471.