Innovative Application of Scientific facts and Irrational Mechanics to Develop Green Chemistry Endowed Racy Nature Sustainable Agriculture

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Abstract

Food policy formulators' world over worry on keeping pace with world food production to feed likely buildup of nine billion population and protection of environment. The objective of this study was to develop an innovative alive, smart and enthusiastic (racy) nature agriculture for enhancing sustainable food productivity. Innovative application of scientific facts for inducement of green chemistry involvement in agriculture and quantum mechanics to operate on right path to produce useful secondary natural resources was devised. The knowledge intensive racy nature agriculture technology comprises year round schedule of operations for production of crops by selecting most appropriate cropping pattern, application of manure, fertilizers, carrying out land formation, precision sowing, application of ultimate green irrigation, conductance of toil free eco agriculture, inter-culture, harvesting and post harvesting cultivation to enhance crop yield and reduction of GHGs, a necessary requirement for endowment of green chemistry for sustainable productivity. This racy nature agriculture involves many non monetary inputs in agriculture. The validation of increase in yield and development of green chemistry was sufficiently accomplished and documented. The racy nature agriculture is quantum mechanics involving fixed module technology suitable for all crops, soils, ecosystem, both irrigated and rainfed agriculture. The racy nature agriculture technology eliminates all wildernesses in agriculture and brings it at right fixed paths of green chemistry involved with irroatational mechanics is capable to bring sustainable productivity under all situations and sites. It needs optimization of doses of inputs and carryout customization to bring scientific management to make up shortfall at local conditions. Thus, implementation of racy nature agriculture will alleviate world over worry of grim food situation and development of bad environment. The racy nature agriculture will be saviour for global agriculture by fulfilling challenges of green chemistry for sustainable food production and protection of environment for present and the posterity.

Keywords

Aerobic and anaerobic decomposition, Eutrophfication, Food security, green chemistry, Nature agriculture, post sowing cultivation, raised bed and furrow, Sulphur cycle, Toil free zero weeding ecology and ultimate irrigation practice

1.Introduction

Food is the basic physiological necessity of all human. While developing countries are striving hard to produce food to feed their nation, the developed countries are attempting to accomplish physical quality of living (PQLI). The large global population in the countries will increase to a new large number by the year 2050.The increase will change the sequential orders of thickly populated countries in year 2003 to a different order of population of sequences. India will be the 1st and Ethiopia the 10^{th} most thickly populated country of the world by 2050 [1]**.** Thus, food requirement scenario will increase dramatically in different countries of the world.

The primary productivity processes are universal. However, depending on wisdom of the people and agro-eco compulsions render the food production practices and technologies take different forms. This fact has created more bad impact than good in the agriculture by doing, learning and redoing. Now it has become matter of great concern [2]. No innovation could come as a Sun technology to prevail as revolution in agriculture. Of course, the green revolution as a result of improved crop varieties brought first green revolution in India in particular and rest part of world in general. The world over intensive land modification, irrigation, fertilizers and intensive plant protection measures induced various setbacks that brought deleterious effects on the food and food chain implicating global scenario of health hazards[3-9]. Development of fluoride in ground water, sodication, selenoisis, arsenic development etc caused poison accumulation in human bodies, causing cancer induced deaths, dental scaries and skeletal defects in people [3-9]. In a different study this author dealt with global scenario of gray and black chemistry making food chain bad to worst [**10**]. The situations create worry on food situation and development of bad environmental condition.

The plants require 14 element for growth and creating production **[11,12],** that becomes primary productivity which serves as primary food chain and later get transformed in to secondary food chains and food web. In agriculture depending on water and interactions chemical reactions develop which cause bad and good paths of decompositions. The vast waste material such as residues comprising nitrogen, phosphorus, potash, calcium, magnesium and sulphur undergo decomposition. The gray and black chemistry [13] induce grim situation on food production and worsening of environment. The gray and black chemistry induced emission of green house gases (GHGs) that induced climate change. The adverse effect of climate change has been confirmed by studies reported in Germany[13] **.** The adverse impact of climate change is accumulating and causing global worry. It demands development of green chemistry to facilitate production and protection of environment.

The decomposition processes can be reversed to follow route that produce beneficial products useable for plant growths. The processes which eliminate emission of GHGs are categorized as green chemistry. The green chemistry involves building process, and is always desirable to overcome the gray and black chemistry. The primary productivity should be poised to contain high carbohydrate, proteins, vitamins and minerals. Therefore, the development should make proactive consideration of building green chemistry to enhance this quality of primary productivity which serves as base for primary consumers and industrial raw materials. Development of this strategy will enable create innovation in agriculture and environment. The objective of the present study was to develop green chemistry of reactions involved in agricultural production processes and acquire challenges of green chemistry in augmenting productivity and protection of

environment, not for merely cases by chance, but for certainty to keep it revolving to maintain the sustainability for everywhere and all the times.

2. Materials and Method

In order to deal with green chemistry, it is imperative to review the essential elements for plant growth. For such reference included here is Table from **[11, 12].** The plants require these 14 essential elements in a specific ionized form by the root hairs [13].

2.1. The green chemistry

In the product preparations water and environment interactions promote and modify endowments of transformations. The essential nutrients classified as macro, micro and oxygen and water. The chemistry transforms the elements in different compounds. In this study different elements were analyzed to produce green and eliminate gray and black chemistry. The various cycles of elements such as N, P, K, S and C cycles are analyzed about where and how gray or black/green chemistry develop by water and environment and it can be transformed in to green chemistry. Water acts as transport medium. The development of ideally required green chemistry is presented in results and discussion.

Table 1. 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 [12]..

2.2 Universal fact of plant nutrition

The well known scientific fact is that plants absorb nutrients by absorption and transfer from soil to the roots through root hairs [13]. Water works as carrier of nutrients. Oxygen is used for respiration of organisms in soil and conductance of aerobic decomposition [14-16]. The element is promptly used in formation of different compound by supplementing electrons. This phenomenon is universally true for all the plant species who conduct primary productivity. In spite of different situations plant follow their own set pattern of uptake of nutrients to perform their growths and produce yields. Depending

on the efficiency of utilization of the nutrients supplemented by human efforts enhancement in the productivity is achieved. There are always endeavors to create conditions closest possible to the situation required for the plant growths.

2.3 Removal /elimination of inimical products developing in gray or black chemistry.

In spite of best effort there will occur gray or black chemistry which will produce inimical toxic salt or toxic gases that will counter act the beneficial effects of the green chemistry. Therefore, a new mechanism is enforced in the process of the innovative technology to accomplish all time green chemistry challenge for sustainable productivity. These measures will be presented in the research and development part of the study.

2.4 The irrotational mechanics

Whatever best function is devised in the green chemistry should always follow irrotational pattern of revolving for all the times. This is a quantum mechanics of irrotaional flow for maintaining [17] sustainable productivity. The irrotational cycle is maintained for the endowment of inbuilt sustainability. Different nutrients' chemistry should continue indefinitely. Components of the desired green chemistry may change in time domain, but their function should not get altered in different locations. That means irrotational mechanics function should continue. More elaborative description will be dealt with in result and discussion part of the study.

2.5Design specifications

In order to meet the specific functional criteria for accomplishing the challenges of green chemistry supporting the sustainable enhanced product design specifications were evolved and prescribed. In this endeavour soil is accepted as an habitat and the quantity of the elements needed for plant growth should be sufficiently maintained by creating suitable agricultural practice to produce products in the form in which plants accept it. This aspect was described in detail by the author in his earlier studies **[18-19].** The knowledge and lessons learnt in agriculture by the past researches were used in developing specifications and bringing water and environment interactions to fortify functionality of green chemistry and keep it revolving within the seasons of the year suitable for different crops, ropping systems for agriculture in different seasons dynamics maintained by irrotational mechanics. This is implied that such specifications can be applied to produce plant productivity under open field as well as under controlled environment agriculture such as in poly and green house etc. The trees be in horticulture or forest start from the small seeds and grow in to tall trees do follow the universal pattern of nutrient uptake. Hence, this strategy will be equally workable for agi horti, horticulture and forestry developments.

2.6 The Technology module

A technology module which fulfills all the desirable features specified in the design consideration was developed in [18-19]. In this study more refinements and green chemistry and irrotational dynamics [17] in creating and maintaining the green chemistry are fortified. Thus, the present study makes more scientific and mechanics dominated technology of green nature agriculture. The detailed descriptions will be dealt with in the research and development part of the study.

3. Results

Any chemical reaction that emits green house gas is considered to be the gray and black chemistry. The emission of CO_2, CH_4, N_2O, CFC, PFC and SF_6 , which are trace gases and cause green house effect and induce climate change are involved in development of either gray or black chemistry. In any production process of ecosystems such types of reactions occur and produce bad (gray or black chemistry). In the present research all efforts were centered to accomplish challenges of green chemistry necessary for bringing sustainable production and environment protection [20].

3.1 The green chemistry

The reference is to be made those chemical reactions which do not emit any green house gas to the atmosphere, a necessary condition that does not promote global warming and climate changes, is classified as green chemistry. The green chemistry involved in all the 14 elements covering wide spectrum are described in the following.

3.1.1 Nitrogen cycle

In the study it is not the merely elements that support plant growth (**Table 1**), but the entire cycle of its revolving with the time, year round (**Fig 1**) is considered. Discretization of the Nitrogen cycle components was made to eliminate gray or black chemistry that operates in the cycle. Atmosphere contains almost four fifth of total gases. Nitrogen gas reacts with water under different environments and produces different products. The products produce good and bad products under influence of water and environment interactions (**Table 2**). There are only two ways of nitrogen to reach from the atmosphere to the ground. The most prominent is the nitrogen fixation by nitrogen bacteria. The green products are the ammonium and nitrate which are readily absorbed by plants. The harmful products are nitrogen oxide and nitrous oxide which cause GHG N_2O that emanate from agriculture and cause depletion of ozone layer. **Wuebull [20]** expressed worry some situation and expected some scientific development to have control of the N_2O. Studies[21-23] devised by innovative application of scientific facts of the nitrogen cycle showed ways to keep the minimum balance of N in soil profile to keep emission low by application of suitable cropping patterns. This has been unique development in the green chemistry of nitrogen management in agriculture, grassland, and forestry. The study created all necessary condition to charter the green chemistry in nitrogen cycle [15, 21-24]. Further, innovative research on biological nitrogen harvesting from non conventional sources [23] is another development on green chemistry of nitrogen.

The crops and cropping patterns which promote green chemistry operation of nitrogen cycle were chartered and post sowing cultural operations have been devised to keep the green chemistry to function year round. Thus, wilderness in practice of post harvest tillage in agriculture will end up by this scientific foundation that will hold well under all the global situations (**Table 2**)

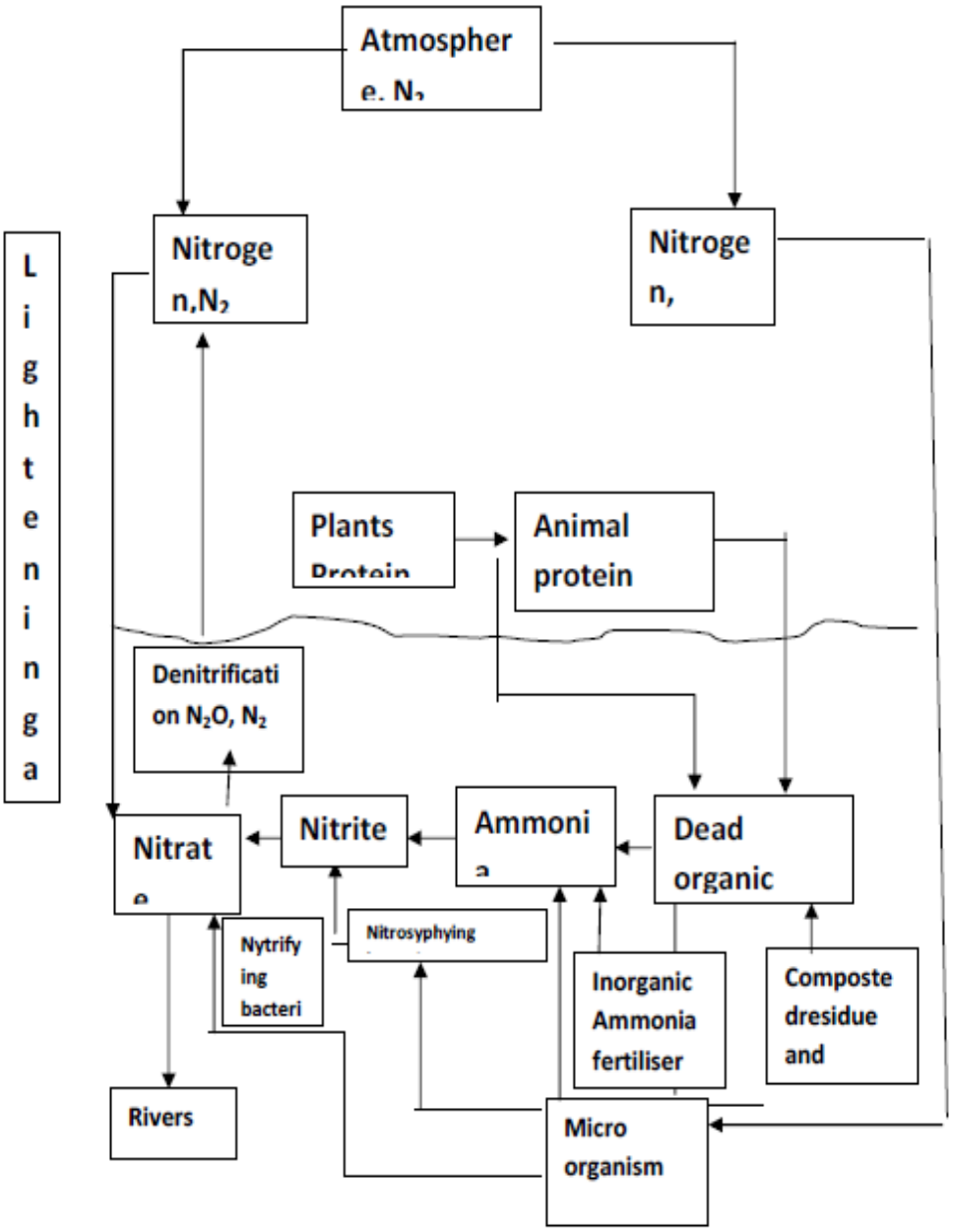


Fig 1. Nitrogen cyle after **[25]** and update by author

3.1.2 Phosphorus Cycle

Phosphorus is present in all the cells and promote energy building compound in the crop produce. Phosphorus competes with Arsenic and inhibits its intake in the food chain. Presence of phosphorus promotes nitrogen use efficiency even at same level of water consumption. Phosphorus dissolves in water and its concentration causes eutrophication in the water bodies.

Plants absorb phosphorus from the soil, as primary producer are consumed by animals as primary consumers. The dead organic residues are acted upon by by microorganisms, which produces soil phosphates. The soil phosphates are absorbed by plants and part of it gets washed away in runoff water. Phosphorus and nitrogen produce eutrophication in the water bodies.

3.1.3Potash cycle

It is a major nutrient for plant growth. In comparison of the N, P, K the requirement is considered to in proportion of 4: 2:1 ::N:P;K. further the K is stable in soil hence it cyclic variation is of lesser importance in green chemistry.

3.1.4 Calcium

Calcium raises soils low pH to bring soil salinity.

3.1.5 Magnesium, Iron and Manganese

These are micronutrients which keep balance in the chemistry of the nutrition.

3.1.6 Sulphur Cycle.

Sulphur cycle operates on decomposition of cellulose by sulphur bacteria. It follows route of aerobic and anaerobic decomposition (**Fig 2**)[25]. Under the aerobic condition the sulphur cycle produces sulphate which is used by the plant s in synthesizing the chlorophyll and building of tissues. Conversely, under the aerobic condition the decomposition produces hydrogen sulphide, which is poisonous gas and brings inimical effects on the plants. The hydrogen sulphide is highly dissolvable in water and moves with it. Several cases of fatality in water wells were reported by [26,27]**.**

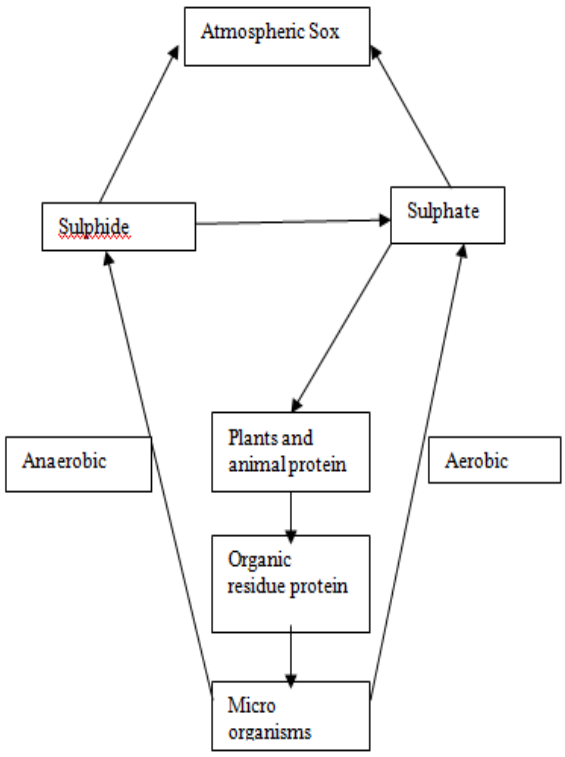


Fig2. Sulphur cycle (After De, 2004)

3.1.7 Zinc

Zinc is micro nutrient involved in maintaining balance reactions. Its excess produces toxicity in the plant and human cells

3.1.8 Copper,

Copper also a micronutrient keeps the reaction balanced. Being a heavy metal it also causes toxicity in in the cells.

3.1.9 Hydrogen

The element hydrogen is very important in creating green, gray and black chemistry in forming useful and harmful products.

3.1.10 Carbon

The carbon is present in atmosphere as CO_2 part of it is dissolved in surface water and ground water.as HCO_3.Major portion is dissolved in sea and ocean water, where it is fixed as carbonate mineral at the ocean bottom. Major portion of the carbon is fixed by the green plant in photosynthesis in production of carbohydrate (CH_2O) Another fraction ion is fixed in coal, lignite and petroleum and natural gas.

Transfer of carbon in the biological system and in turn in the geosphere is formed as humus Detailed description of carbon cycle is dealt with in [25]

3.1.11 Oxygen

Oxygen is needed by most of plants and animals including human for aerobic respiration or enzymatic respiration of organic foods..Oxygen is released by photosynthesis thereby setting the oxygen cycle. Oxygen largely contributes to the processes on the earth.

The first and foremost desirable green chemistry is the photosynthesis which absorbs CO_2 and releases O_2. Other reactions which produce both the good and bad products (confronting gray or black chemistry) should be altered to bring the beneficial products [26- 27]. **Table 2** contains such reactions with respect to different elements in the plant nutrition system and the products as well as the suitable management practices for meeting the green chemistry challenge to bring sustainable production.

Table 2 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	Phosphate	Phosphide	Known	Gets fixed in

	cycle				soil, Band placement
3	Potash cycle	Potash	-	-	-
4	Sulphur cycle	Sulphate	Sulphide	Not well known	Conduct aerobic decomposition
	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 widely applied.	Low strength of seedling emergence get enhanced by collective strength of band placement.

3.2 Measures to overcome the toxic heavy metal and toxic gases generated in the production process.

It needs to be clarified that because agriculture domain is an open ended; there will involve some part of gray or black chemistry to function. Thus, it is implied that there will exist some toxic heavy metals and toxic gases. These toxic substances always bring inimical effects. This has been the situation and reduction in irrecoverable makeup in yield of crops in spite of many efforts.

Development of gray and black chemistry in very essential component of agriculture is presented in **Table 3**. Aerobic decomposed NADEP compost produces N less than that by the vermin composting, .but produces highest content of P and K. The development of toxic heavy metal in different method of decomposition produces the lowest content of heavy metal of Fe, Mn and Zn except enhancement in copper Cu and Zn. It means the organic farming utilizing organic manures cannot be cent percent free from heavy toxic metals and toxic gases.

The toxic metals and the toxic gases and chlorinated toxic organics can be reduced by inactivation by application of activated charcoals as depicted by data in **Table 6**. The bio inactivation remediation is workable for all cases of poor quality of soil, water and environment. Thus, challenge of the toxic heavy metal and toxic gases can be fulfilled by simple remedial measures of soil management amendment.

Table 3. Gray and black chemistry involved in organic manure; elemental composition of organic manures, average values

Organic manures	**GHG emission chemistry**	**Macronutrients**			**Some selected heavy metals**			
		N	P	K	Fe	Mn	Cu	Zn
		% wet weight basis			Mg/kg dry weight basis			
Farm yard manure	CO_2 and CH_4, gray and black	0.54	0.31	0.51	440	155	10	78
NADEP	CO_2 Gray	0.93	0.52	1.15	215	96	25	56
Vermin compost	CO_2 Gray	1.36	0.48	0.65	619	245	16	45

The chemical analysis data based on reference [28]**.**

Note: There was no visualization of building of S sulphur in the organic manures, supporting lack of visualization of working of sulphur cycle.

Table 4. Removal of some toxic chlorinated organic by activated charcoal treatment [25]

Compound	**Concentration, µg/**		
	Initial	**After**	**Removal efficiency, %**
Aldrin	48	<1.0	99^+
Dieldrin	19	0.05	99^+
Endrin	62	0.05	99^+
DDT	41	0.1	99^+
Arochlor1942 (PCB)	45	<0.5	99^+

3.3The irrotational mechanics

As brought earlier, Fig 3 displays that the green chemistry of the cycles of the elements constituting the nutrients should be able to revolve throughout the season. However, the revolving pattern should only follow irrotational dynamics ie it should follow path of green chemistry and produce good products useful for the plant growth [17]. As depicted in **Fig 3,** very visible and common example is of giant wheel operating in fairs etc for amusement ride of children and youngsters. The rotating wheel makes irrotational revolution keeping the riders in same upright

position at different locations in the circulating path. Contrary to this, water currents in rivers at the curvature makes rotational dynamics and produces secondary currents making top water layer strike the concave bank and bottom water current thrown out at the convex bank. The rotational dynamics in the river current results in erosion at the inner concave bank and deposition of sediment at the inner convex bank. These facts sufficiently justify the utility of irrotational dynamics of the cyclic revolution of the nutritional elements for sustainable productivity. Any green chemistry involving dynamics should meet this year round necessary condition for development of sustainable productivity. The revolving wheel can be inclined to some degree, if need be, while keeping its irrotational dynamics.

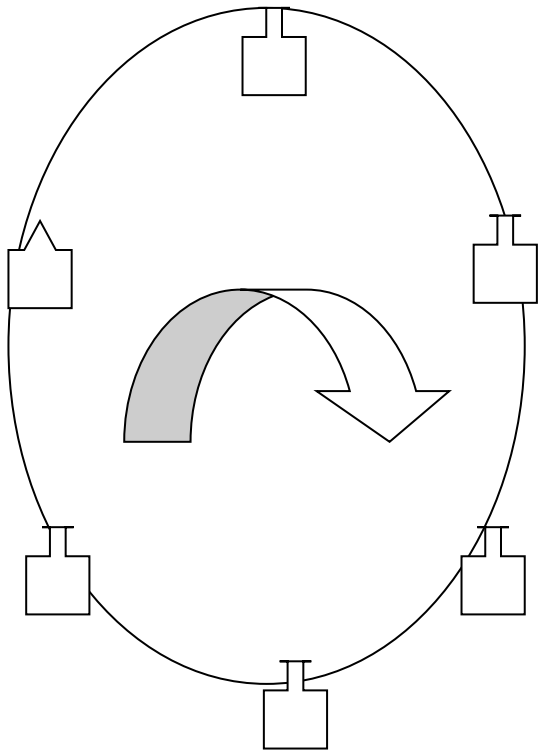


Fig 3. New irrotational quantum mechanics of green chemistry endowment in in racy nature agriculture

The ideal requirement is the best known and developed situation which conduct green chemistry should always remain in function in situation under all changing scenario of climate, both exogenic and endogenic, biological alteration or

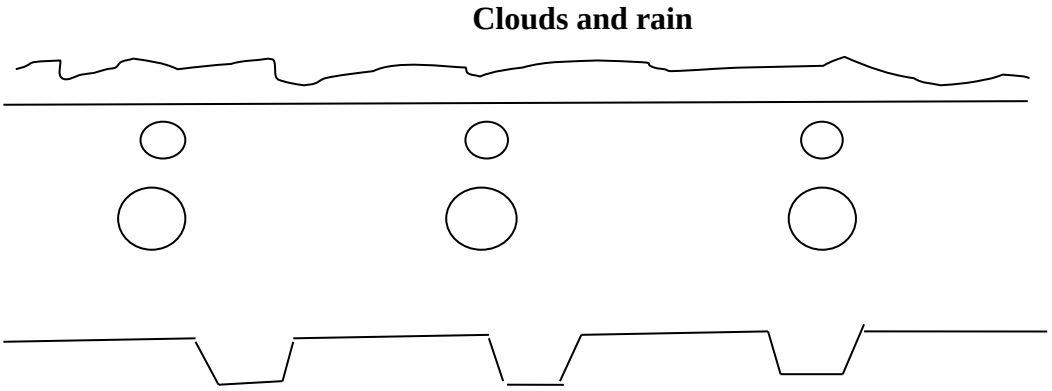
supplementation etc. These aspects will be presented in detail in the following section of results and discussion.

3.4 The racy nature agriculture technology

3.4.1 The technology

Considering application of the prescribed specification an innovative technology named as racy (smart, alive and enthusiastic) nature agriculture was developed, which fulfills all aspirations of the green chemistry [29-31] challenge for sustainable productivity. The basic physical appearance of the technology is displayed in **Fig 4**. It comprises raised bed and furrow which changes in hydrologic response to provide well drained moist condition and sufficiently aerated to keep the green chemistry to function for all times of the cropping season. In addition to earlier known practice of raised bed and furrows, the green chemistry, not visualized before, is now endowed in the technology [18,19, 29-31]. The cropping patterns, precision planting, intercultural and ecosystem for zero weeding [27-28], harvesting and postharvest practices are innovatively devised. The technology is suitable for all crops, cropping patterns, both irrigated and rainfed situations. It is equally suitable for poly houses and controlled environmental condition.

3.4.2Technology module

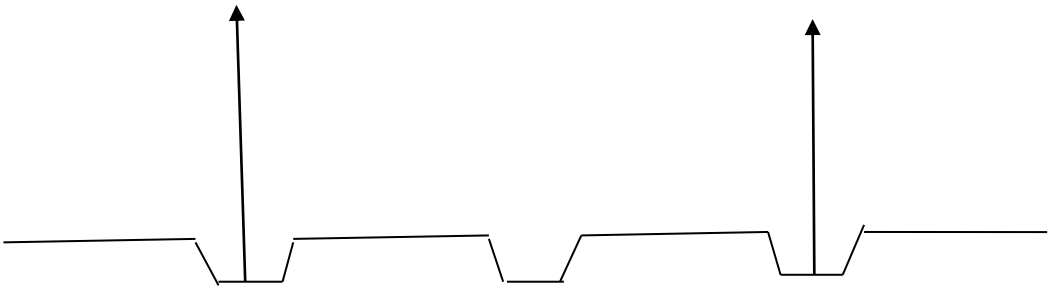


Land formation sectional view

Figure-4a : Land formation of raised bed and furrow for Racy Nature Agriculture underrainfed 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-4b : 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 contribution of different practices constituting the technology as well as the composite effects, are summarized in **Table 5**. The individual component practices have capacity to enhance yield in range of 5-15%. The composite effects comes out to be almost bringing the double the present harvested yields.

Table 5. Conservative assessment of yield enhancement by racy nature agriculture practices components and their justification

S. No	Racy nature agriculture	Possible increase,	Basis and justification

	practice component	**%**	
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	Application of activated charcoal for bio remediation	Improved quality	Hard metals such as iron, zink, manganese, and copper etc get reduced by the NADEP compost application. Further, these toxic metals, toxic gases and chlorinated organics get absorbed by charcoal application in the Practice.
5	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.
6	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.
7	Establishing zero weeding pulse based ecology	5	Weeds removal is removal of nutrient and moisture by unwanted plants that may grow in the crop field
8	Ultimate irrigation	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
9	Weeding	-	No weeding is required. Effect of pulse based ecology is indicated under S.No.7.
10	Inter culture	10	The inter-culture again enhances aeration during the crop growing in the field.
11	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.
12	Composite enhancement additive index	75	Combined additive effect of all factors enumerated above.

	Multiplicative index	2.047	Combined multiplicative effect of above all factors.
	Average	1.8985	(1.75+2.047)/2=1.8985

3.4.3. TECHNOLOGY Characteristics and status

- It is a scientific principles based innovative technology for enhancing agricultural productivity in vogue.
- This is water and environment interactions based knowledge intensive technology convergence research innovative use as convergence of breakthroughs.
- The technology uses aerobic decomposition process permits crop diversification and eliminates release of methane, and enhance water and nutrient use efficiency. Application of activated charcoal enables absorb gases and adsorb heavy metals that will further reduce GHGs load and clear environment of polluting gases and heavy metal pollutants.
- The technology has fixed module, without scope for deviation, ie introduction of irrotational quantum mechanics in production of agricultural crops and protection of environment.

3.4.4 Technology capability towards fulfilment of challenges

- The RACY NATURE AGRICULTURE is endowed with green chemistry and sufficiently meets all challenges for sustainable productivity.
- The RACY NATURE AGRICULTURE has capacity to endure to withstand the global warming and climate change.
- This is universally applicable for all ecosystems, soils, crops, water qualities and irrigated as well as rain fed agriculture production.
- The RACY NATUREAGRICULTURE enables devise technological innovations for creating livelihood (Jeevika), by making flexible multi story use of space and time by enabling crop diversifications.
- Additionally, it inherits compensating resilience to follow up, even on middle paths of partial application of the technology, to enable all stakeholders to join and become part of mission of racy nature agriculture to build global mansion of sustainable food security.
- The transformation of RACY NATUREAGRICULTURE will enable introduce service sector that will generate permanent season bound specialised job works. [**32]**. This will promote extension of new agriculture system and increase in the GDP in agriculture, which occupies major share and controls national economies.

3.4.5 Validation of the technology

- **Crops and Cropping patterns**

In the green chemistry based yearly cropping patterns some nutrient mineral cycle do function. Thus, the cropping pattern should be designed in such a way that during its growth period concern nutrient cycle should function. This fact is substantiated by

presenting data in **Table 6**. Crop rotation, nitrogen cycle, nitrogen and sulphur cycle and sulphur cycle followed by nitrogen cycle could be different options. In the treatment C4 cropping pattern rice-onion-cowpea, the sulphur cycle worked on abundant rice residues and produced sulphate, which was efficiently utilized by onion crop. Following this, cowpea was raised that fixed nitrogen to be utilized by following crop of rice. In this treatment sale of cowpea pods also produced high economic return that enabled high rice equivalent yield. This fact is further substantiated by treatment C3- rice- cabbage- green gram, where green gram further added nitrogen, to be used by the rice crop. Thus it is evident that creation of functioning of nitrogen and sulphur cycle appear to be the most effective in maintaining crop yield during the crop year and in subsequent years.

The example crops referred to in **Table 6** were grown on the flat bed configurations and not on raised bed and furrow land formations. The raised bed and furrow land formations provide, border effect, enhanced soil depth, more moisture storage and functioning of green chemistry for longer duration than those with flat bed. Thus, multiple benefits will culminate in enhancing harvest index of crops. It will result in better utilization of resources in agriculture, where resources constraints are emerging and environmental degradations occurring.

Table 6 Rice based cropping system attributes and productivity that supports functioning of different nutrient elements cycle.

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

Yield data extracted from [33].

- **Yearly Yield enhancement and water conservation**

The concept of prompting of functioning of nutrient element cycle in any cropping system of region can be ascertained by yield responses of crops in different sequences for

the entire year. This fact is substantiated by taking crop yields of established cropping pattern and some alternative cropping pattern in resources constraint viz water in the state of Punjab. Due to rice wheat cropping pattern the ground water depth had been at alarming rate that caused political conceren for agriculture. The data presented in **Table 7** substantiate that rice wheat is the most remunerative and stable cropping pattern in Punjab. Rice is cultivated during rainy season when water availability is more; though distribution patter is unpredictable. The wheat crop is grown during winter when water demand is low due to low evaporative demands. But, even under these situations wide spread withdrawal of ground water had caused alarming concern of fall in ground water depth. Different methods of rice cultivations are being resorted to with a view to reducing water demand for rice. At most alternate wetting and drawing practice of rice irrigation have been practiced. This author has developed an ultimate green irrigation practice [28] which fulfills all necessary requirement of green chemistry and saves water. The sprinkler irrigation is applied for uniform saturation of soil profile and during high water demand at crop stage of tillering, year head emerging stage by over flooding the furrows. Thus, high yield can be harvested at low water consumption [34-35].

The water need for irrigation can be reduced by changing wheat crop with mustard or gram. By changing crop of rainy season viz maize followed by gram will produce REY at par with that of rice –wheat (**Table 7**). There will be tremendous reduction in water demand for agriculture. In the maize- gram cropping pattern both the cycles of sulphur and nitrogen work synergic ally. The racy nature agriculture will be highly successful crop management practice for Punjab with regard to saving in water. In earlier researches scientist found encouraging responses of raised bed and furrow, but they could not make sustainable as the concept of green chemistry was not endowed in it. This research has demonstrated ways and simple means to acquire it.

The fact of sprinkler irrigation on wheat raised on flat bed is depicted by uniform crop under sprinkler irrigation (**Fig 5**). The raised bed and furrow land form will equip the soil with more moisture, nutrient and perform green chemistry for longer duration than a flat bed. Further, furrow over irrigation at time of high water demand will become ultimate irrigation that will conserve water and produce high harvest index. Utility of raised bed and furrow, NADEPED composting and ultimate irrigation which are devised and substantiated in the present study fortify the cliam of achieving high yield and conserving water and nutrients by application of innovative technology of racy nature agriculture.

Table 7. Yearly cropping sequences and rice equivalent yields (REYs) for Punjab, India

Items	Crops		TotalREY, 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

Fig 5. 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. The raised bed and furrow planting and overflow furrow irrigation at the critical irrigation stages will enhance the harvest index of crop, which will make the ultimate green irrigation practice.

3.5 Improvement in quality

The yield of cereal crops largely contains nitrogen proportional to the harvest index. The nitrogen content gets converted in to essential amino acids, which later form the protein in human body. Because the racy nature technology uses NADEP (aerobically decomposed compost) which produces sulphate, readily absorbed by plants, enhances the sulphur content of the yield]36-38]. The sulphur contents form the energy compound, thus, quality of food is enhanced by the green chemistry endowment in the racy nature agriculture [34, 36-38,].

Further, in the arsenic dominant soil and water or in both, the sulphate becomes competing element against arsenic uptake by plants [34-38]. This is scientific interpretation and experimental substantiations have not been established. However, this opens an avenue for research for the scientific community. In the racy nature agriculture technology use of activated charcoal brings bio-inactivation of heavy metals and toxic gases, thus, up take is reduced. All these measures improve the quality of food products produced by the green chemistry involving racy nature agriculture.

3.6 Reduction in GHG releases

The racy nature agriculture comprises practices which largely operate under aerobic condition created by well drainage maintained in soil. Oxygen content is enhanced that enhances biological respiration and aerobic reactions as described in **Table 2**.These facts have been substantiated in detail by this author's studies [15,16,39-43].The substantiation was done by making contrast of production technologies against racy nature agriculture.[10].

3.7 Sustainability

The racy nature agriculture comprises all necessary measures to endow the green chemistry and activated charcoal to bio inactivate toxic substances. The raised bed and furrow created opportunity for storage of more moisture and nutrient than the flat bed and in turn keep green chemistry to function for longer times. Thus, racy nature agriculture technology is resilient to both drought and flooded situation. The innovative application of NADEP compost produces sulphate necessary for chlorophyll formation and promotion of plant tissues. The ultimate irrigation practice conserves more water and keeps the gray and black chemistry at bare minimum level. Maintaining a pulse crop based ecology eliminates need of weeding. Thus, the racy nature agriculture is endowed with nitrogen and sulphur cycles, which act synergically and bring high harvest index under all adverse situations. The residual nitrogen is more which ensure reduction of land degradation by nutritional deficiency. The management of nitrogen cycle demand keeping land under some suitable leguminous crop during fallow or intervening periods between crops, keep nitrogen fixation and eliminate nitrogen losses by nitrate leaching and formation of nitrous oxides. Thus, summer ploughing is replaced by pulse crop. It is estimated that almost 10% of total GHG emission occurs during the post harvest period.

The new concept of irrotational dynamics entails that whatever best action is designed for one time keeps on revolving for all times as depicted by **Fig 3** and description there in. Utility of raised bed and furrows is already explained above. Thus,

the racy nature technology will be the best technology that accomplishes challenges of green chemistry and sustainable productivity. It has capacity to enhance the yield level by providing scientific basis. It provides an opportunity to bring makeup for any shortfall by scientific management in agriculture. Thus, racy nature agriculture has become a Sun technology[10,18,19] and the present study). It is the technology for present and posterity. It will eliminate worries for producing food for 9 billion forecasted population. The fact of its universalisation is established by this authors another study [10]. These facts describe the **repeatability** and scalability of the technology.

3.8 The timeline of the racy nature agriculture

The time line of this research started in year 1992 when this author devised a process for eradication of poisonous gas in columnar situation like open wells, which was patented in India in year 2010 [46]. The process and method was again presented for combating acid rains and for countering global warming and reverting climate change in year 2012. A study on recovery of nutrient from the waste water stream was made during that year [15,16] in which many scientific facts and new innovations were brought in. These studies dealt with chemistry of emissions of green house gases and control measures[14-15, 35,40]. Reduction of zero methane emission from paddy fields was attempted and scientific article was published in Dec issue of frontiers of environmental sciences and engineering [16]. The control measure of the nitrogen cycle management was developed in year 2013-2014[19],. During this period new concept of racy nature agriculture was evolved [18] and its universalisation as a Sun technology was disseminated by publication [19]. Following these, many refinements in innovative components such as practice for designer quality rice, ultimate green irrigation practice and toil free eco system for zero weeding have been developed and publications released [(**Yadav, 2014c, 2015a,b, 2015c, e,f,g,h**) Recently, study was completed on implications of geology, geographical settings and water and environmental interaction on food chains on health hazard. The racy nature technology encompassing green chemistry and sustainable developments was demonstrated to overcome to rescue such health hazards[10]. Since in this technology quantum mechanics and universalisation have been brought in, the vogue science of agriculture has been fixed in a mode which will perform well in all the situations of cropping systems and both rainfed and irrigated agriculture. For different locations the technology inputs (vide **Table 5**) need customization by optimization. Thus, the racy nature agriculture is a universally applicable technology accomplishing challenges of green chemistry and sustainable productivity.

4. Discussion

Worsening situation of resources viz land, water, precipitation and environmental condition cause worry for thinkers of food sufficiency for increasing global population [2]. Among several factors the chemistry of reactions and question of sustainability became major concern. In the production systems some good and waste products develop which undergo different chemical reactions that produce detrititious food chains to become source for the environmental nuisance. The good products get utilized in creating primary produces which are consumed by the primary consumers. The dynamics of increasing population and consumption in quantity and quality are becoming issue for sustainability of production and protection of environment. The global warming and climate change are being realized in forms of extremes of occurrences of floods and droughts, rise and fall in extreme temperature and wind blows, on settings of monsoon etc. These environmental factors disturb time of occurrence of seasons on productivity

and processing of agriculture and horticultural crops. The renewable resource of water for agriculture in general is getting scarce and in general fail to follow its established season. Lately challenges of green chemistry and sustainable productivity have been carved with great expectations of development of innovative measures/practices/ product to overcome the situation described aforesaid.

In the present study these important aspects have been dealt with and substantial progresses made. The aspects of green chemistry and gray or black chemistry[14,15,25,40] that occur in the agricultural production systems and the factors of sustainability are treated with. By innovative application of scientific facts a technology designated as racy (smart, alive and enthusiastic) has been developed. The technology components were selected based on the results of earlier researches. The technology of racy nature agriculture comprises raised be and furrow, selection of crops and cropping practices, manures, fertilizers, precision sowing/planting, cultivation and weeding, harvesting and practices for post harvest cultivation. The land formation practice of raised bed and furrows were studied and applied by earlier researchers [40-41] where in major thrust was on crop diversification. However, the aspects of green/ gray and black chemistry was not analyzed then. These practices did not justify for adoption and it remained largely at the research institutions. In the present study the green chemistry producing processes are endowed to produce high quantity and quality of foods. The technology validations have been substantiated. Its productivity and environmental protection capability were contrasted. Many innovative refinements viz ultimate irrigation practice [34] zero methane rice production technology [16], designer rice production [35] technology and zero weeding toil free eco agriculture have been developed[36-38]. The racy nature agriculture technology is a Sun technology having a fixed mode and universal applicability. It involves cyclic irrotaional mechanics[17] of season variation and keeps revolving working of Nitrogen, sulphur, water and oxygen for almost all times to create green chemistry. The technology also comprises measures to inactivate the toxic heavy metals and toxic gases so as not to move in the food chain. Thus, quality and quantity of production eliminates health hazardous products. The technology now at the most needs customization at local condition (**Fig 6**) by optimization of necessary inputs of production systems. Any shortfall can be made up by scientific management.

Detailed justification and descriptions of the technology have been devised and documented. The timeline of progressive developments are also indicated and substantiated. The technology is ready for universal application and optimization for its efficacy at global scale. Only one technology module will be able to produce food of excellent quality, which can be patented and geographical registry (GIr) identified. This will help the producers and consumers get right price and genuine products. This fact will fulfill the needs of industrialized country striving for physical quality of living (PQLI) and for developing country sustainable productivity of quantity and quality foods for present and posterity.

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 was developed in the present study.

*Information extracted from [39].

The racy nature agriculture is a technology at par with innovative technology which affect daily life of people (**Table 8**). Since food is the first priority, it will be commodity of first attention in any given situation. The racy nature technology is scientific principle based and policy issues can be framed. Further local changes can be resorted to by customization as depicted by **Fig 6** on interaction of technology, policy and impact. Thus, the racy nature agriculture set a new pattern of green chemistry and sustainable agriculture at global scenario. Many of the measures are monetary inputs and the technology is input sensitive so advantages of this research can be derived in proportion to component application under various resources con

straints.

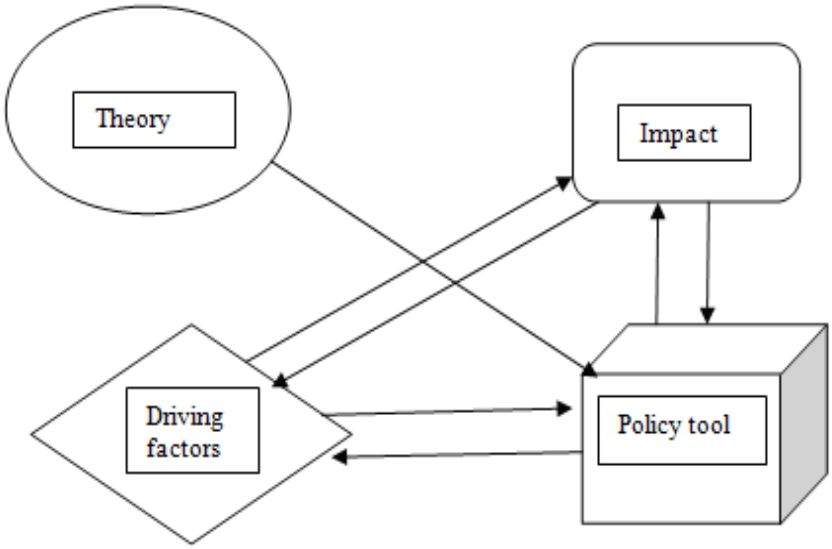


Fig 4. Link network of Theory, Impact, Driving factors and Policy tools

Fig 6

7.Conclusion

In the present study bench mark of green chemistry and sustainability undertaken since 1992 is presented. Based on innovative application of scientific facts and irrotational quantum mechanics a technology named as racy (smart, alive and enthusiastic) nature agriculture endowed with green chemistry of major essential elements viz N, S, O and C was developed. Its validation and substantiations revealed that this technology has capability to meet challenges of green chemistry and sustainable productivity to acquire raised and quality production for the present and posterity. It is ready for adoption and implementation and makeup of any shortfall by customization can be acquired by optimization of components. It is finally concluded endowment of N, S, O and C cycle should always be incorporated to manage agriculture production to acquire high quantity and good quality of crops constituting the food chains.

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Reference

[1] Thomas, Croline and Evans, Tony (2011). 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.

[2] Bossio Deborah and Geheb Kim, 2008. Conserving land protecting water: An introduction. In Bossio Deborah and Geheb 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.

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

[4] 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.

[5] 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.

[6] 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.

[7] 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.

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

[9] Krishnamoorty. K.A.V.R., 1976. Further observations on the syndrome of endemic genu valgum of south India. Indian J of Medical Research, 6(2)284-291.

[10] Yadav, R.C. (2015). Geology and Geographical Implications on Food Related Health Hazards and their Remedial Measures. 8th WSEA conference on geology and geography. Salerno University, Italy, ,June, 28-30,2013

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

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

[13] Ehlers, Wilfried, Goss, Michael, 2003 Water dynamics in plant production. CABI Pub ication, Walling Ford, U.K. 2003.

[14] 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.

[15] 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).

[16] 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

[17] Ramamurtham, S 2008. Hydraulics, Fluid Mechanics and Fluid Machines. Dhanpat Rai Publishing Company, New Delhi, 110002. Pp 254.

[18] Yadav RC,2013. Racy nature agriculture versus other like technologies: A technologies contrast. American Eurasian j agric and environment Sci..13(10).1412-1439. Doi10.5829/idosi aejaes. 13.10.11253l

[19] Yadav RC. and Chaudhary, MP.(2014) Racy nature. A Sun technology towards quantum mechanics in agriculture. World J of Agr Research SciEP, U.K. 2014;2(5): 223-227.

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

[21] Yadav, R.C., 2014. Innovative application of scientific facts for arresting GHG-N_2O and improvising lucrative ventures with enhanced land, water and nutrient use efficiency, Journal of Energy and Environment. Photon, 128 :486-520.

[22] Yadav, R.C. 2015.Support of drainage for management of nitrogen cycle in Africa Irrig Drainage System Engrg. USA3:128.

[23] Yadav, R.C. (2015) New Ecology for Eradicating GHG- Nitrous oxide (N_2O).Oen internation j Ecosystems.1(1):1-2.

[24] Yadav, R.C.(2014). Biological Nitrogen harvesting from aquatic ecosystems- A new scientific vision. Fish Aquac J. 5(3)

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

[26]Yadav, R.C. Dube, S.K. and Srivastav, Paritosh.(2008).Fatality in water well, the main source of water supplyin the Brij Kshetra of North India in . National Seminar on House Hold Water Supply Water Technology HSTC, Mathura, India.

[27] 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.

[28] Biswas, H. Dev Narayan, and Lakaria Brij Lal. 2012. Effect of integrated nutrient management on soil properties and performance of aonla (Emblica officinalia Gaertn) based agri horti system in Bundle Khand region. Indian J of Soil Conservation. 40

[29] 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.

[30] 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.

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

[32] Yadav, R.C.,Yadav, Jaya (2013)Development of business out sourcing (BPO)in agriculture for sustainable productivity and environment protection .IJMSEM taylor and francis publishing Co. London. Published on line. 12 Aug 2013.

[33]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.

[34]Yadav, R.C.2014 Innovative application of scientific facts for production of designer quality rice. Intern J. on Advancement in Research and Technology. 3(10)150-189.

[35]Yadav R.C. 2015. The ultimate green irrigation practice by innovative application of scientific facts World J Agronomy, Food Sci. and Technology.2(1):1-30

[36]Yadav, R.C. 2015. Innovative application of scientific facts for devising maneuverable zero weeding and GHG emission ecology for enhancing productivity of cereals, oilseeds and pulses. accepted Journal of Agriculture, Photan, (Accepted)

[37]Yadav, R.C. 2015.Toil free eco agriculture for bringing sufficiency of bread, dhal and onion,for good public Governance. Danish j. Agri and AnimalSci. (In Press)

[38]Yadav RC .2015f Biological Phosphorus Harvesting for Multiple Uses - A New Scientific Vision. J Aquac Mar Biol 2(2): 00022. DOI: 10.15406/jamb.2015.02.00022

[39] Horobin, Wandy (Ed.) (2003). Protein How it works, Science and Technology, Vol 13 Scavandish Corporation, US.A. pp 1864-1866 (2): 141-146.

[40] Davis, M and Cornwell,D.A.(1997).Introduction to environmental Engineering.McGra Hill Book series. Inc.33-36

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

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

[43] 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

[44] Yadav, R.C. 2012. Physically based geo engineering measures to counter global warming . Hydrology Current Research USA.3(5):1000142

[45]Yadav, R.C. 2012.Eradication of Acid Rain Physically Based process and Product Hydrology Current Rsearch.1(20:100042.

[46].Yadav, R. C.(2010)A process for eradication of polluting gas.filed. Indian Council of Agricultural Research. 12/11/2002 granted 25/2/2010