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Nanotechnology of Fostering Soil Sulphur Cation Exchange Capacity (CEC) for Combating Desertification

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***Abstract* – Mostly macro nutrients viz N, P, K are being applied which bring some adverse impact under inadequacy of support of micro nutrients. It requires strong miracle like technological intervention for combating desertification. Some fragmented efforts must had been made and benefits realized, but no innovative development could come to combat desertification. In order to overcome this bad situation, it requires quick revamping of the nutrient status for building the desirable feature of productive capacity. Aspect building cation exchange capacity of soil to improve productive capacity were known in soil science, but hardly any study can be named to have attempted on this front. In this stride an innovative measure is explored. The objective of the present study was to build CEC of soil through fortification of micronutrient sulphur (S) through a nanotechnology and bring quick solution of combating desertification. Relevant past researches were adopted to exemplify support of the CEC buildup by functioning of sulphur cycle. Thus a new nanotechnology, fully supported by theory and substantiated by experimentally proven results, becomes exact and perfect technological solution of revamping CEC for combating desertification. The nanotechnology is the most effective, easy to organizing to create very relevant, effective, efficient impact creating and sustainable practice to combat desertification and restoration of land degradation for eliminating worry of desertification at global scale. This nanotechnology becomes an intellectual property for bringing global prosperity, food sufficiency, creating pleasant livable environment and socio-political governance in counties world over.**

***Keywords* – CEC, Desertification, Food Security, Global Warming and Climate Change, Productivity and Sulphur Cycle.**

I. Introduction

Agriculture is primary activity for producing food for global gentry. The science of agriculture had been based on doing and learning lessons that make it suffer of location specific development. This became justification for large scale research experimentation by varying experience that resulted in contrasting success and failure of results. Any success story on socio agriculture were declared as white spots by Scientists of International Water Management Institute (IWMI) [1]. The study was fully revamped by sulphur cycle, which was substantiated by review of world agriculture, which revealed a general lack of application of sulphur cycle. This insufficiency of knowledge of sulphur cycle produced very good and bad impression on the effects and as a reason why no innovative technology could emerge. The situation of black box scenario prevailed in agriculture management and the white spots became short lived and over shadowed by another white spot technology, like intermittent lights produced by fire flies. A sun technology of smart, alive and enthusiastic (RACY) nature quantum (a fixed mode) agriculture was developed [2]-[3]. The quantum agriculture was based on innovative application of sulphur cycle that enabled development of several innovative practices of agriculture with full justification and definite results. This quantum agriculture became a scientific agriculture enabling development of exact practice and requiring local verification of doses of the treatments constituting the innovative practices. The recent research by Yadav and Ambeker [4] substantiated this aspect for enhancing nutrient and water use efficiency for paddy cultivation. The sulphur cycle implicating water and environment interaction is documented in the text book [5].

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Soil is accepted as habitat for plant, necessary nutrients and water. Their exact scientific manoeuvre and management is required for function of practices in agriculture [6]. Among several micro nutrients [7], [8]; deficiency of sulphur is realized and chemical sulphur is applied. There had been adverse impacts of such applied sulphur under varying interaction of water and environment, hence no desired benefits of input in agriculture were harnessed and problem got compounded year after. This trend became cause of genesis of *desertification*. United Nations committee on combating desertification (UNCCD -COP- 14) held recently in Noida, NCR Delhi made frightening statistics of devastating situations. In their final resolution declaration came with fixed gigantic targets for combating desertification. Forest green cover is the sole stake for combating the desertification. However, there is persistence of lack of strong exact and perfect technological solution; hence the set targets is not likely to be achieved. Objective of the present study was to devise exact and effective technology for combating the desertification.

In the COP 14 conference a new insight appeared that soil has lost its productive capacity and has become mere dust due to lack on nutrients. In this context feature of cation exchange capacity appeared, however there had been hardly any study to build such productive capacity of soil based on CEC. Taking this as a beginning point a new nanotechnology, fully supported by theory and substantiated by experimental results, was formed as an exact and perfect technological solution.

II. Materials and Method

2.1.1. *The Sulphur Cycle*

The sulphur cycle displays processes involved in decomposition of cellulose which is a crude form of protein, in to sulphate or sulphide depending on the oxygen supply [5] in the medium of decomposition. Plants and animal residues and organic residue protein are acted upon sulphur bacteria and under the prevailing condition of aerobic or anaerobic sulphate or sulphides are produced. Under unpolluted water condition the sulphide is converted in to sulphate again [5]. Sulphate is used by plants in producing chlorophyll, building tissues [6], [7], [8] and enhancing harvest index.

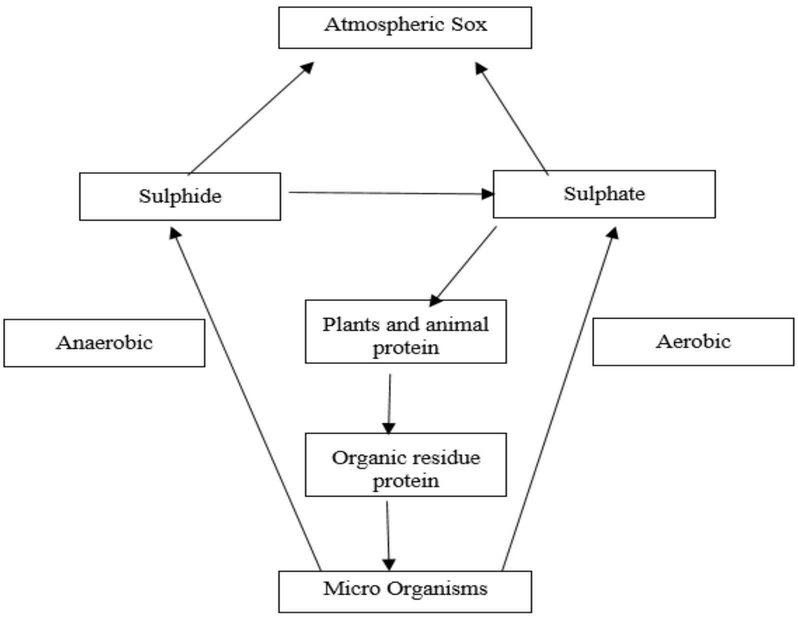

Fig. 2. Sulphure cycle (After De, 2004).

2.1.2 *Sources for Supplementation*

The sulphur had been considered as micro nutrients, hence the development of sole fertilizer for S came in for use in the fag end of 20th century. Thus although requirement is low but it is costly. As cation exchange capacity is also getting reduced the yield levels are coming down. The use of farm yard manure is highly popular, although style of preparation of FYM is not so precisely and carefully done. Earlier studies had revealed a general lack of knowledge of sulphur cycle, thus hardly any method has been available to supplemet the S [14] there had been no significant research and development on indigenous or organic source of S. this situation will be further elaborated in result part of study.

The cattle population is getting down that means there is no sufficient supply of cow dung. An aerobic decomposition of trashes and some cow dung are placed in 15 cm layers in air circulating chambers for decomposition. Some researches have been by non-governmental organizations (NGO). There is no evidence of existence of knowledge about the availability of S. In that case knowledge about FYM have been applied and the further clarification will be taken in result part of the study.

2.2.1 *Experiment Results Validating Efficacy of S in Enhancing Crop Yields expt I*

The various nitrogen sources used were: urea, ammonium sulfate, calcium ammonium nitrate (CAN) and ammonium nitrate (AN) [21]. Nitrogen was applied @ 100 kg/ha in two splits (half at transplanting and half at booting stage). Basal dose of P and K was applied each @50 kg/ha as single super-phosphate and potassium sulfate, before transplanting the nursery plants of rice variety IR-6. Application of $ZnSO_4$ @ 10 kg/ha was added in the following sequence: T1 100 kg N/ha as urea, with no zinc, T2 100 kg N/ha as urea with 10 kg $ZnSO_4$/ha. T3 100 kg N/ha as ammonium sulfate, with no zinc. T4 100 kg N/ha as ammonium sulfate, with 10kg $ZnSO_4$/ha. T5 100 kg N/ha as calcium ammonium nitrate (CAN), with no zinc. T6 100 kg N/ha as calcium ammonium nitrate (CAN), with 10 kg $ZnSO_4$/ha T7 100 kg N/ha as ammonium nitrate (AN).

2.2.2 *List of S Loving Crops*

Sulphur loving crops viz onion, garlic and chilly etc. require high doses of sulphur, horticultural crops viz garlic and onion also require sulphur. Other sulphur loving crops are rape seed and mustard. Now days almost all crops are responding to sulphur application in enhancing yield. Therefore, application of sulphur is becomes a method of revamping productivity of soil.

2.2.3 *Method of Study*

First theory of sulphur caycle [5] was presented, which had been a gap in knowledge, this theory was proven by using previous research [12], [13] data formed highly convincing Fig 3, meaningful results were drawn. Their implications were presented in making conclusion from the present study.

III. Results

The knowledge of sulphur cycle is enforced to build the CEC of soil by the second element S with - ve ions (Table 1). Earlier study had developed method for building N. This study is devoted on building second element S in the array of the plant nutrients [14-[16].

3.1 *Elements of Plant Nutrients*

Table 1. Elements needed for plant growth, [7],[8] and periodic table affecting plant growth and desertification.

S. No.	Element	Symbol	Atomic weight	Common valance	Equivalent weight	Factors for maneuvering desertification
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^-	3.0	*
16	Cobalt	Co	60	3	20.0	
17	Chromium	Cr	58			X
18	Iodine	I	53	1^-	53.0	*
19	Molybdenum	Mo	42			
20	Selenium	Se	79	2^-	39.0	Selenium produces negative effect on food chain
21	Clay (montmorillonite)			1^-		*
22	Organic matter (humic substance)					*
	Productive factor	7				1:3+
	Desertification factors	15				3+:1

* Periodic table gives a straight answer to the ionic charge, name, and mass of each element in the table.

* Equivalent weight (combining weight) is equal to atomic weight divided by valance [9]. X disputed, as the European Union does not recognize chromium as an essential nutrient) elements presented in table 1, which constitute essential macro and micro elements for plant growth.

Review of elements presented in Table 1, which constitute essential macro and micro elements for plant growth to produce food for global gentry reveals elements are charged with + (positive) and – (negative) charges, which involve making compounds. It is clear that the elements with negative charges are 7, which form the cation exchangeable capacity and that with positive charge 15. The resulting pros and con situations are also depicted in the Table 1. Thus, there are limited ways by which the CEC can be revamped. The cation exchange functioning is also depicted vide Fig. 2. The exchange of ions are depicted that they continuously go on changing and reforming. - negative charge elements attract + charge one and enable plants to absorb nutrients in + charged ones. Thus, elements which are –vely charged are fortified to produce more plant nutrient absorption. This cation exchange capacity is adopted as nanotechnology for further study.

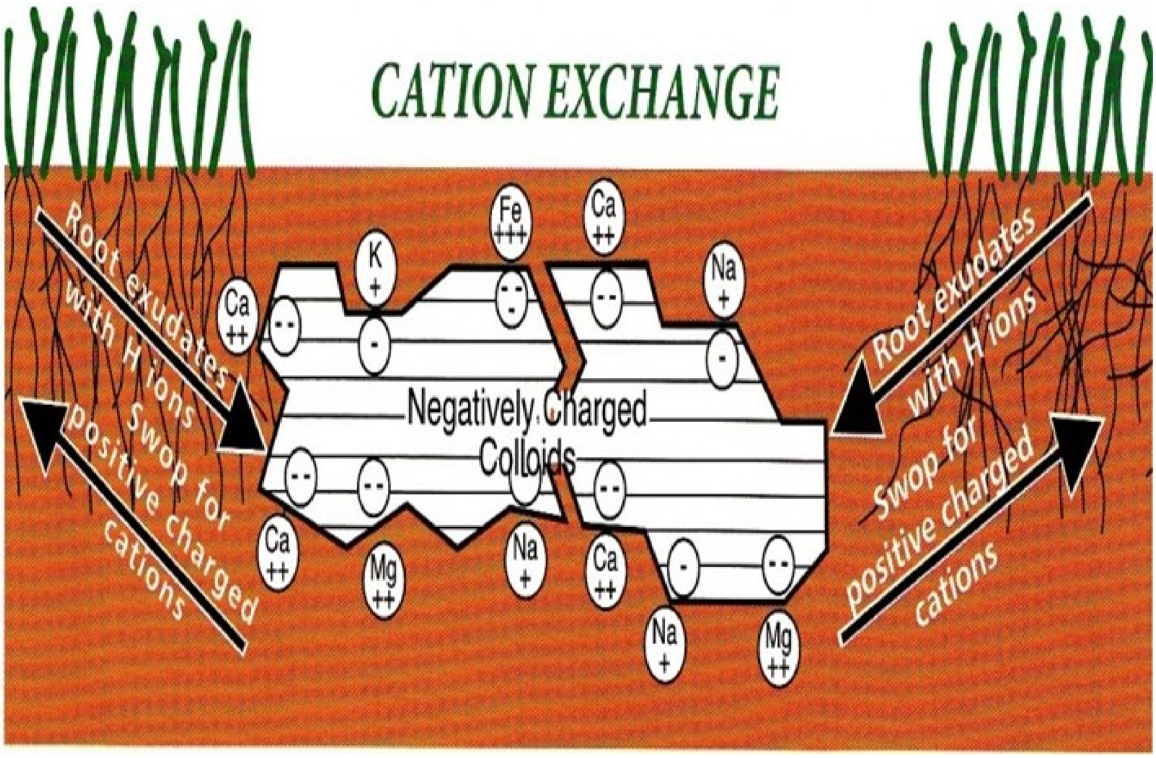

Fig. 2. Cation exchange capacity and plant uptake of nutrients.

3.2 *Experimental Validation of theory of Building CEC through S*

A study conducted with distilled irrigated plants [12], [13] where different doses of, N, S, and Zn S were referred and analyzed and presented in Fig. 3. The treatments 2 and 4 are very promising implicating efficacy and suitability of S in building CEC for enhancing uptake of other nutrients for increasing productivity, grain, straw ratio viz. the harvest index

Inference s from the study were:

- Urea as N source is the best suited for paddy because of its split application eliminates loss of N by deep percolation.
- For paddy Zn should be applied as basal dose in combination with the nitrogenous fertilizer.
- Zn use efficiency is more for wheat than for paddy. It will be better to apply Zn for wheat and get advantage of residual Zinc in paddy field. It is implied that supplementation of NADEP composting will add some Zinc that will fulfill need of Zn for paddy and there may be no need to apply Zinc for paddy in wetland condition.

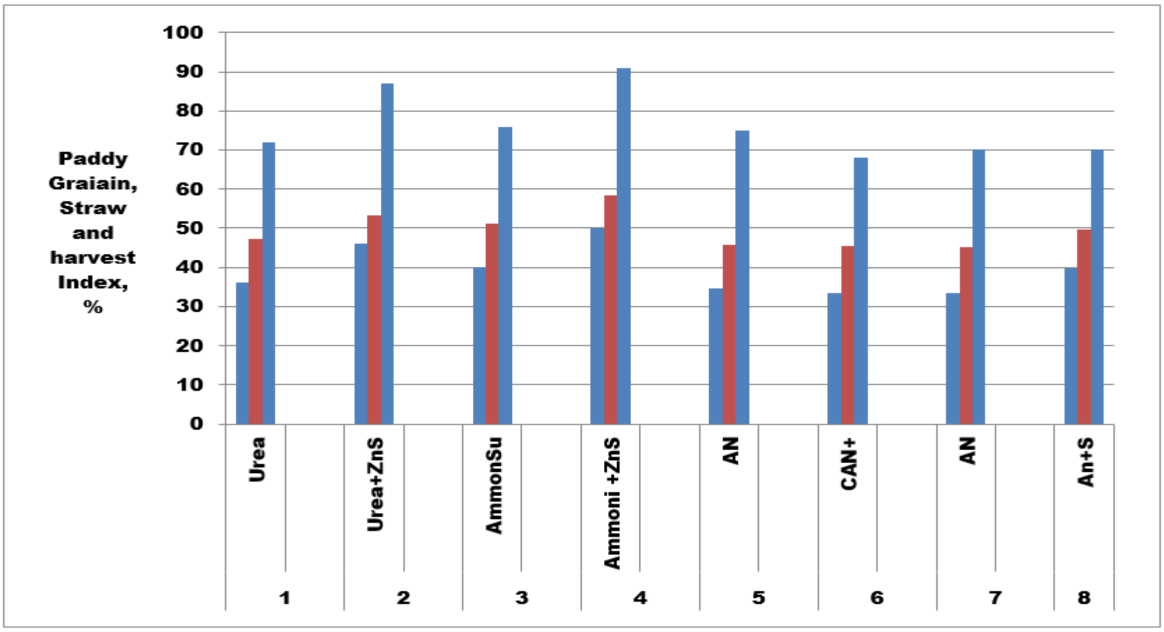

Fig. 3. Effect of S supplementation with N and Zn on grain, straw and harvest index of paddy Note 1.
Paddy grain 1, Paddy straw 2, Harvest index, grain : straw ratio 3.

- Means sharing the same letter (s) are statistically non-significant at < 0.05 probability. All N sources were applied 100kgN/ha, all plots were irrigated by distilled water Zn S : Zinc sulphate.

3.3 *Sulphur Loving Crops and Yield Reduction Due to Deficiency of S*

Among agriculture crops oilseed and mustard is highly sulphur loving crops. There is wide spread awareness developing that sulphur deficiency in the northeren states of U.P, Rajasthan and Haryana. However it has been causing yield reduction, but there has been no awareness of method of building S through soil corrections. The costly input of elemental sulphur is being resorted to which remain effective for crops for which it is applied. Further, there is lack of method of building N, which being a major plant nutrients are not getting up lifted, hence the enhancement in yield due to effects of S is not so prominently visible. As established in the experimental result presented, the S CEC will foster building of element uptake Zn and N. There are other factors which play their role in enhancing CEC of soil as revealed in Fig 2. The strategy here is to develop effective feasible measure to build S based CEC.

3.4 *Aerobically Decomposition of Cellulose and Organic Matter*

Knowledge of sulphur cycle (Fig 1) gudes to prepare aerobically composted manure, using low volume of Cow dung which is getting insufficient to fulfill demand of FYM. Agricultural crop residues and wastes and evil waste water stream derived slurry can be equally used for the organic manure. So far no scientific or commercial venture have come and entire knowledge remained on previous practice of doing and learning. This aerobically composted manure is popularly called as NADEP. The N, P, K and some heavy metals have been analyzed in comparison with FYM and the vermin composting. The FYM is indigenous Indian version of composting, Vermi composting is based on the British biological science advancement and aerobic compost had been practiced in the USA. However, in none of the situation there had been study on finding development of sulphate. The study is creating backing of S based on the sulphur cycle. Therefore earlier statement on lack of knowledge on S building method is again fortified and substantiated in the present study.

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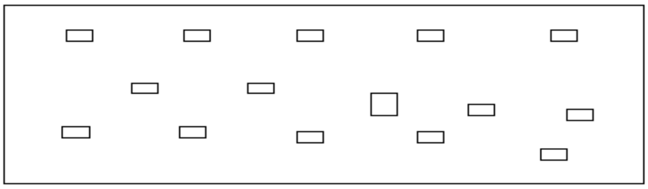
Table 3. Gray and black chemistry involved in organic manure; elemental composition of organic manures, average values.

Organic manures	GHG emission chemistry	Macronutrients			Some selected heavy metals				Content of S*
		N	P	K	Fe	Mn	Cu	Zn	S
		% wet weight basis			Mg/kg dry weight basis				Whether Ma or Mi ???
Farm yard manure	CO_2 and CH_4, gray and black	0.54	0.31	0.51	440	155	10	78	No data on S
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	

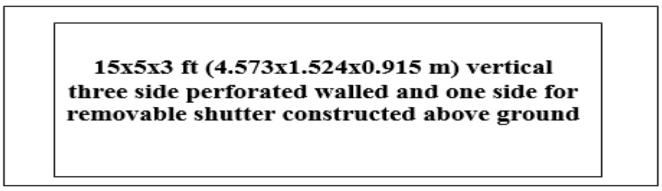
Chemical analysis data based on reference [14] [bswa].

Note: *There was no visualization of building of S (sulphur) in the organic manures, supporting lack of visualization of working of sulphur cycle. Hence, no innovative developments on S and CEC have been in existence. This aspect had been substantiated in another earlier study [11]. The classification of the S under either Macro or Micro nutrient and order of priority is to be thought over and substantiated.

The application of NADEP in place of FYM has been found better than FYM. This study provides scientific backing to NADEP composting which is better than FYM and vermin composting efficiency by S. The NADEP is better option in terms of material requirement for preparation, low care and reduced emission of GHG (Table 3). Further, improvement made [11] in this practice of NADEP composting is presented in the following.



Elevation



Plan view of NADEP Chamber.

Fig. 4. Common design dimension of NADEP Composting chamber of about 5.38 m3 nearly 5000kg.

(Note-The filled chamber is provided thatched cover and maintained moist by space for occasional sprinkling of water)

3.4.1. *NADEP Green Manuring (NGM)*

Recent study on NADEP based compost and Farm yard manure, Green manuring and poultry manuring, constituting different organic farming treatments for growing finger millet in Karnataka was presented in national seminar in Maharashtra. Among the several combinations the combination of compost of NADEP and green manure supplementation of combined 100kg N/ha produced the maximum yield of finger millet and highest agronomical factors. However, the green manuring takes one season and field get occupied in decomposition. The exsitu preparation of NADEPED Green manuring appears highly feasible. This aspect is fully supported by findings in Fig 3 that S and N combination forms the highest biomass yield and harvest index. The setup displayed in Fig 4 is equally useable in preparation of NADEPED GM simultaneously by filling half with green manure crop chaffed and dry stubble with fraction of cow dung or even slurry derived from the waste water stream [11]. This combination of compost will constitute the best combination. Theoretical concept on decomposition of green manure produce and dry residue favours fast decomposition. However, it needs experimental assessment of performance in decomposition and its efficacy in enhancing growth and harvest index of crop. But this will become flexible and usable and feasible practice for building S based CEC for restoring productive capacity of desert lands.

3.4.2 *New Nutrient Rich NADEP Compost*

Further, advancement in composting can be created by harvesting of dairy barn, sheep pen and poultry house as well hog house dropping and urine and decomposition in the NADEP stubble in filled which create hell of problem of air pollution. It may be mentioned that paddy straw, which is harvested and burnt at site in piles or as stubble in field can be stored in a special pyramid ed storage bin and the material may be used as cattle, fooder or bedding material, which can be used for making the ideal compost. If suitable kiln is used it can be converted in biochar, without causing air pollution. The quality of NADEP compost prepared with urine and dung/droppings will be better than other types of materials used in NADEP Preparation. This bill be an ideal approach in restoring productivity of desert soil. This will be very strong and easy task in arresting desertification.

3.4.3 *Liquid LGM*

Liquid GM prepared [11] with N enriched leafy material will become good source of arial spray of crop that will enhance chlorophyll development and fostering of photosynthesis. Some innovative research practices were developed for fortification of source as well as sink is described in detail. Thus N and S supplementing measure will enhance CEC of deserts lands.

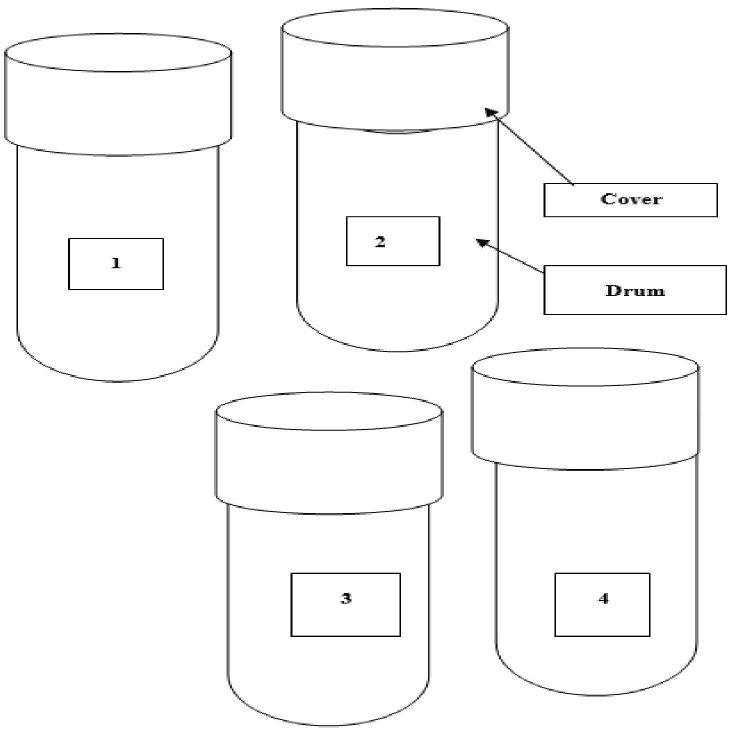


Fig. 5. Setup of 250 l drum setup for liquid green manuring 1000 litres.
(Note: The Covers of the liquid drums are lined with charcoal powder coated replaceable textile clothes).

The covering lids will be lined with charcoal coated tectile to absorb methane gas and eliminate any fowl smell that may emanate from liquid GM. Yhus, the liquid GM is good and alternative/ additional source for enhancing CEC of desert soil. The crop may be green gram or black gram of lucena which an be chopped and filled in drum. The green material will be submerged in water. It will decompose fast.

The LGM can be grounded, filtered and sprayed in desirable concentration.

3.5 *Enhancement in Quality of Food Commodity Due to S*

The food commodity quality enhancing chemistry had been described in authors other study on development of ultimate green irrigation practice [15], [16], [17]. These food qualities are preferred by body physique conscious gymnausts and sports persons.

3.6. *Novel Launch of CEC Building Project*

Encouraged by the innovations and realities [18], [19], the enhancing production through application of technology for preparing organic S is sufficiently developed [9] and the present study. The innovative technology is the prime factor in building CEC of S. the technology factors are further characterized in stage three of the Fig 6. These features are better use, intensification and diversification. The technology presented here for CEC buildup through the S viz NADEP composting is fulfilling all the tree features of an ideal technology in the domain. The supporting technology of supplementing N [20] [21]] are also very simple, feasible, easily organizable and fulfilling the three required character as in case of S.

Further improvement in the quality of NADEP composting by harvesting dung and urine with paddy stuff bedding is a new innovation. It is going to solve dual problem of biomass burning that causes air pollution and secondly it will produce good quality manure viz NADEP rich in S. It is expected that NADEP supplements and its further improvement will go long way in enhancing CEC of S.

The group job action in restoring CEC based capacity will be based on individual participatory action. Because study [13]. Both the CEC involve actions of farmers.' by himself and for them himself. Therefore, once knowledge imparted to the farmers will prompt them to do all the needful tasks to derive maximum benefit from the CEC building by S.

Since this nanotechnology involves use of it is developed with locally available material there is no critical implication of cost factors. At the most the filling of NADEP will require some give and take collective participation. This requirement will get fulfilled by the short training of the groups involved in agriculture with the benefits of NADEP composting. The Madhya Pradesh Farmers have been practicing this method and getting benefits, although there is no scientific backing of theory of sulphur cycle (Fig 1) and nutrient content analysis Table 3.

There is no convergence of services as in Fig 6, except its knowledge through extension departmental training. The required training can impart skill of the filling and upkeep of NADEP composting.

The NADEP CEC building is so prominent and its benefits are so large that it becomes a technology of auto adoption. This is an addition to an exemplary case of eco–zero weeding [23] for creating auto adoption of innovations.

Therefore all aspects of implementation NADEP CEC building are very effectively implementable and adopta-

-ble.

3.7. *Enhancing Auto Adoption of the S based Nanotechnology of CEC*

The nanotechnology uses a very efficient, feasible, efficient technology and produces practical visible featured results that make it become an exemplary case of auto adoption. This advancement has been added as a new wing in the patternised production function [2], [3], [20]. Thus, this S based CEC build up will get adopted by the land users [21] that will bring benefits to them, society, markets and public Governance. This will aid creating pollution free environment, elimination of open agricultural biomass burning, becoming new source at unimagined situations. Thus S based nanotechnology gets qualified to be classed under wow innovations that changed life of the people [15].

3.8 *The CEC Based Nanotechnology*

This nanotechnology is the most effective, easy and organizing to create very relevant, effective, efficient impact creating sustainable practice to combat desertification and eliminate land degradation for eliminating worry of desertification at global scale. The manuscript presents the sulphur cycle. Experimental results fortifying working of sulpur cycle, constituting practice of CEC building and resulting benefits. Large scale application module is also presented for application of the innovating technology and by peoples participation and overcoming desertification. Thus in conclusion the nanotechnology becoming exact and perfect solution and peoples' individual participator action as solution for combating desertification in quickly in easy way.

4. *SWOT Analysis*

The strength weakness opportunity and threat analysis is very pertinent and relevant aspect in focusing any innovative technology. In this regard building of CEC through S is equally new innovation; hence following section is devoted on the SWOTH analysis.

4.1 *Strength*

The CEC buildup by S is second factor in long list of macro and micro nutrients. The first factor is N which is macro nutrient, and had already been covered in previous study [23], but this important factor S had been kept under the category of micro nutrient and even after many other micro nutrients. Since there was no visualization as depicted in Table 3. This was a missing hence no innovation in soil conservation practices emerged. This lapse resulted in lot of agriculture productivity loss and cause of nutritionally deficient land degradation. There had been unaccountable tremendous economic loss not in Indian agriculture, but world agriculture at large [11]. Thus it is proven to be a new innovative practice how to easily build with naturally abundant materials vix crop residues, slurry derived from waste water streams and even with low quantity of cow dung available with farmers. Thus it is boon innovation for rural development. It has very high strength as it has its scientific backing of sulphur cycle. The method of building and using of abundant materials serves two purposes, first being important plant nutrient and secondly it uses waste which support national mission on sanitation. Therefore, this S has tremendous strength in its role in building soil productive capacity as CEC factor, duly accomplished in the study. This nanotechnology will get voluntarily adopted by the land users, ie cultivators [20]-[22].

4.2 *Weakness*

Since it is developed based on scientific principle of sulphur cycle (Fig1 and Fig 2), it is using waste materials i.e. it is converting waste to gold, there is no weakness. There is no weakness of S either in its utility part or practice for preparation.

4.3 *Opportunity*

The element S provides opportunity of fulfilling gap of nutrient in soil for plant growth and it will eliminate productivity loss and building of desert soil fertile. Thus it will very efficiently fulfills cherished desire of UNCCD COP -14 conference. The technology of CEC building is practically non-monetary input demanding. The S will be useable in making a universally applicable organic fertilizer. Some such efforts creating struvite have severe limitations of its use and they are not useable for agriculture. The sulphur cycle process builds internal heat and all pathogenic bacteria get finished and such manure will be highly useful in agriculture. This development will provide vast opportunity for overcoming open biomass burning of crop residues viz paddy and wheat residue and threshed stalks of wheat. It provides opportunity of creating good quality food commodity and food chain.

4.4 *Threat*

There is practically no threat so far known hence S use is free of any threat.

4.5 *REEIS Analysis*

The development of use of S as CEC building element is theoretically correct and highly relevant and sustainable [23] in combating desertification. Earlier deficiency of S had been known and focus for this deficiency and decrease in yield of rapeseed and mustard, which is grown as main crop in bordering districts Bharatpur in Rajasthan and Hisar in Haryana near the thar desert were made. Thus this building of CEC through S is highly relevant innovation in combating desertification. Building of S through the process of NADEP composting is very simple. Thus it forms a simple way of combating desertification. This study has brought the difficult task in to simple form by innovative method of producing growth in productivity. It is highly efficient in enhancing harvest index of crop at same level of use of water. It will be an aspect to be paid attention to in coping with scarcity of ware for producing food for the gentry.

The S is important micro nutrient, it is very effective element in combating desertification through CEC. The NADEP is applied annually at rate nearly 2.5-5 tonnes/ha, it produces sustainable increase in yield. The innovative development is highly efficient. Hence, the S nutrient managing practice brings sustainability in agriculture.

4.6 *Justification of Large no of References of the Author in the mss.*

The author has been writing and publishing articles on S since year 2012[11]. It was established that S was not considered with sufficient scientific backing in agriculture, and when its need emerged, it was given low weightage compared to the other micro elements. Some studies which reported results of S are [10] - [13]. The author's researches are innovative hence they supplementing statements were brought out in the mss. These references became supporting fact and valid reason of many references of the author. The recent publications [24]--[26] support it make a wow technology [18]. This also becomes intellectual property for combating desertification occurring in global scenario.

IV. Conclusion

Land desertification is wide spread problem limiting productivity. United Nations Committee on combating de-

-sertification carried out deliberations and displayed frightening statistics of global land desertification. In the COPE -14 conference huge targets were fixed, but there had been no technological effective intervention. In the present study a S based CEC was developed and named as S based nanotechnology for combating desertification. Theory of working of sulphur cycle was demonstrated to supporting well and based on confirming experimental results different brands of aerobically decomposed compost (NADEPs) were developed. It was substantiated for different characters and up scaling for combating certification was elaborated. This nanotechnology is simple, feasible, quickly responding and enabling fast recovery of desert lands. This nanotechnology is intellectual property for bringing global prosperity and solving problem of desertification.

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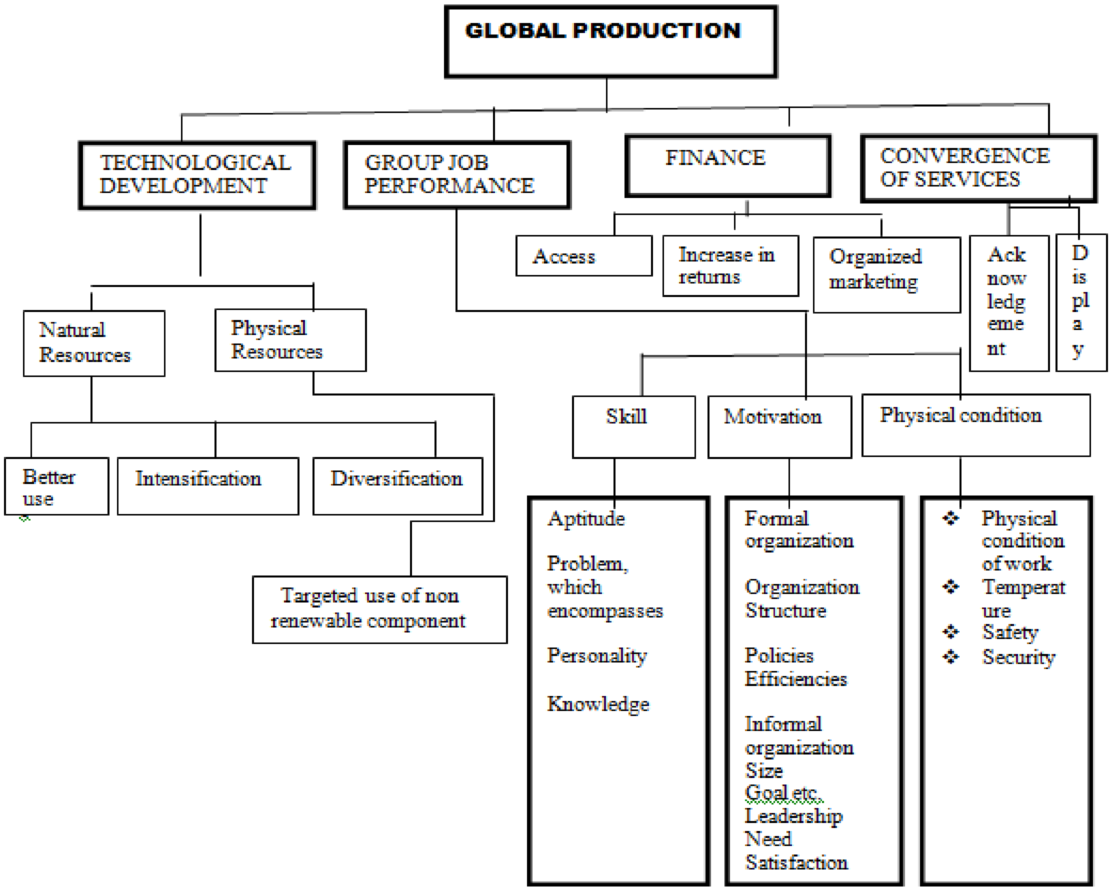

Fig. 6. Production function involving CEC. Build up.

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AUTHOR'S PROFILE

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Dr R.C. Yadav, Ram Charan Yadav completed his B.Sc. Agri. Engg. and Tech from the then UPAU, Pantnagar in 1968 and M. Tech in Soil and Water Conservation Engineering from IIT, Khaaragpur in 1970. After working for 22 year he again started Ph.D. studies and completed his Ph.D. in Water Resources, Civil and Environmental Engg. from IIT, Mumbai in July1997.He joined fist service as Jr. Research Engineer at Experimental Research Station, University of Udaipur in 1971, then as Assistant Professor in College of Engg. in the same University. He then joined at Central Arid Zone Research Institute Jodhpur in May 1972. He worked as Engineer de Etta in Ministry of Hydraulics, Land Improve--ment and Environment, Government of Algeria on Foreign Assignment for two years from Nov. 1977, then Joined as Lecturer in Ahmadu Bello University, Kaduna State, Northern Nigeria. He again returned to ICAR in 1985 and continued as Senior scientist at CSWCRTI, Research Centre, Agra. He became Principal Scientist in 1998 and then as Head of the Research Centre Agra from Nov 2001-Sept 2006. He worked for short term assignments in ASRB post retirement. He took assignments as Professor in UPTech University colleges in 2008 and Foreign Universities in Eritrea in May 2009-Sept 2011 and worked in Ethiopia from Nov 2011 till July 2014. During his working in Eritrea and Ethiopia, he developed many innovative applications of scientific facts. Based on his updates he wrote several innovative technologies on food and nutrition. It was noticed that all subjects viz human health, dairy, agriculture sanitation and environmental based entrepreneurship can be created with indigenous resources. It came to his mind to write a compendium of innovative technologies of universal applications. He used his researches in developing this book. Dr. Yadav brought several refinements in use of conservation structure and watershed management and associated technologies during his service in ICAR and he pursued his researches and created several innovative researches viz smart, alive and enthusiastic (RACY) nature agriculture. He created innovations on nitrogen cycle management and developed innovative practice of nutrient, weed management under nomenclature of zero weeding agriculture, Super-micro irrigation as superior replacement of drip irrigation and biotechnology of crop stand establishment for crop production. He received UNESO grant for his B. Tech student Project in Ahamadu Bello University in Nigeria, ICAR Pandit Jawahar Lal Nehru Award in 1999 for Outstanding PhD Thesis work at IIT, Bombay. He received Engineering Research Fund Award for social welfare research and Thomas Edison Award 2012. Professor Yadav was awarded World Academic Championship in Chemical Research 2017, World Academic Championship in Biological Sciences in 2018 and again World Academic Championship in Agricultural Sciences, 2018 for his research articles published in renowned international journals of reputations. Professor Yadav has developed Agriculture System for Vision Agriculture 2050, which will become new stake for developing World Food sustainable Sufficiency.