

# Eco-Zero Weeding-A Usable Science for Harnessing Multiple Benefits

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## Research Article

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## ABSTRACT

An innovation of Eco-Zero weeding agriculture was developed and substantiated by experimental results on garlic and onion and had been applied for wheat production and several publications were brought in. Subsequent studies brought this innovation as true science-based, whereas all other existing and methods under research for weed management were not true science-based. With this science, weed management has become very simple, practical and even involves practically no monetary input. The eco zero weeding agriculture will be a simultaneous ongoing process that will refine the environment with agriculture. Thus, the science of eco zero weeding has emerged as a simple, practical and feasible measure to reduce GHG N<sub>2</sub>O and fulfilled the cherished dream of the renowned scientist. eco-zero weeding agriculture enhances crop yields, increases farmer's net income, improves soil health, beneficial to the environment, stabilizes market prices and brings contentment in gentry and peace. A new nature-based agriculture system is also innovated where the eco-zero weeding will remain as an integral supporting practice to bring global food and agri system for all time and induce global peace.

## INTRODUCTION

An infestation of weed in agriculture crop is a universal problem that robs resources viz nutrient, moisture, solar radiation and exhibit competition with crops. It reduces crop yield from 24% to 43% against fully weeded crops [1]. Thus, weeding is a necessary investment in agriculture that involves cost of cultivation thereby reduction in net benefits to the farmers' income as well as some risks of life. The curative measures involve weeding by manual, chemical and mechanical means. Institutions are investing a lot of scientific time, and resources on research on these measures of weedicide spray, developing machine which reduces the application of chemical weedicides. Solar energy experts have relied on solar panel equipped Geographical Positioning System (GPS) operated weeder. Some European countries have developed such equipment and making a marketing strategy for global marketing for making big business. These measures have a lot of limitations viz creating incomplete weed removal, involving high cost and technological expertise, bring several adverse impacts in environmental pollution and humiliating disparity of affordable economy and create demand of international donor organizations. This situation creates a scene of disparity between rich and poor, forfeiture of the right of equality, whereas these days everyone is talking of equality of resources and opportunities [2,3]. The present situation is counteracting the popular demand of people that means that whatever measures so far developed towards weed management are not truly scientific. Therefore, it revealed the pending need for the development of a science-based measure for weed management.

Eco-zero weeding became a true scientific innovation that eliminates all aforesaid limitations [2,3]. In the development of eco-zero weeding as a science, a scientific theme was conceived and substantiated by experimental results. The eco

zero weeding was basically developed as an innovative application of nitrogen cycle management. It implies that weeds are suppressed by creating an ecology of N fixing crop along with the main crop and in open spaces between rows. There might remain some weeds, but dynamic nitrogen fixed by the N fixing plants bring unimaginable enhancement in yield, whatever weeds remain in the field and resulting crop loss gets overshadowed by the huge increase in yield. Experiments were conducted to optimize the rates of sowing of the leguminous crops in cereals, oilseeds or even in long duration pulse crops. The maximum seed rates of sowing of the leguminous crop for eco-creating crop canopy was found to be <55% of the rate of sole seeding [4]. The documentation in the form of research articles and reports were carried out as revealed by references. As it is visible the research articles on experimental studies, eco-zero weeding, how the eco-zero weeding is science and it can replace all other methods of weed management have been published [2-6]. This study presents an elaboration of potential areas [2,4] and allied benefits the eco zero weeding can bring.

## MATERIALS AND METHOD

### Perception of New Idea of Eco-Zero Weeding and Its Development

Although sufficient details of concept of eco-zero weeding and how it is a science has been elaborated in the introduction part of the study, in order to make readership for widespread grasp and understand, and as a supplement to conventional way of giving work details in method and materials, briefly write up is included in the following:

During the course of review literature on intercropping I came across an article [1] and perceived that legumes or any crop that fix nitrogen (N) by cyanobacteria can be made use of suppressing weeds that will reduce the dominance of weed and resulting yield loss. So far the only the practice of intercropping had been developed. In the development of weed management practice, further innovation was that as N is fixed by the crop the enhancement in yield can be optimized. In this hypothesis, it was not aimed at making weeds zero, instead of to produce maximized yield from the N fixation. In this strategy, although some weeds might exist that will cause some loss, that maximization will compensate that loss and there will be no need of weeding i.e. it will be eco-zero weeding for weed management as a science, which will be further substantiated with data for which salient experimental details are described.

With this perception and hypothesis, a field experiment was conducted to determine enhancement in yields of garlic at Dr. Rajendra Prasad Agricultural University Research farm at Tirhut College of Agriculture, during the rainy season on onion and winter season on garlic in the year 2016-17. The treatments in the experimental study were:



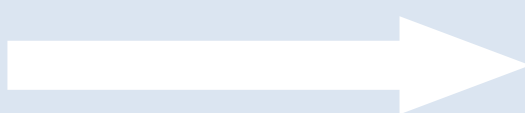
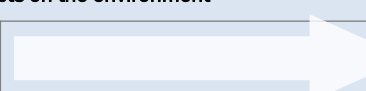
- T<sub>W0</sub>, fully weeded (control 1)
- T<sub>WF No</sub>, fully no weeding and no N fixation (Control 2)
- T<sub>WF N25%</sub>, fully no weeding+25% N fixing crop viz lentil pulsed seed sown
- T<sub>WF N50%</sub>, fully no weeding+50% seed lentil sown
- T<sub>WF N75%</sub>, fully No weeding+75% seed rate lentil sown
- T<sub>WF N100%</sub>, fully No weeding+100%seed rate lentil sown


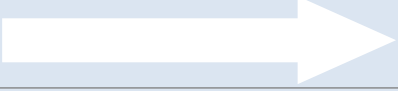
The sowing of lentil seeds at corresponding seed rates were done in uniformly sown garlic kernels in plots at 15 cm apart rows and 10 cm plant to plant spacing, i.e. total garlic plant population corresponding to plants/ha, uniformly by hand broadcasting and given slight covering by shallow raking. The garlic crop was given fertilizers and irrigation etc. as per recommended practice by the horticulture department of the University. Except for the treatment at S.N 1 T<sub>W0</sub> which was weeded manually. At the harvest, all plot yield of garlic were recorded uniformly and data were converted in yield per plot yield, q/ha. Detailed experimental data processing is available in the study [3]. Thus, the entire concept of eco-zero weeding was developed. The yield data so obtained were optimized by polynomial regression analysis. The optimum yield of garlic and optimum lentil seed rates were computed. A detailed description is available in the study [4].

### Harnessing Multiple Benefits

**Table 1** gives a detailed description of areas of benefits viz: Beneficial effect on agricultural crops; Beneficial effect on land resources; reduction in energy input; effect on economic gains; beneficial effects on the environment; benefits to individual farmers and farming communities and aiding to public governance. Over and above all it is non-monetary input involving scientific technology. Several publications [2,4,6] support this incredible genius innovation, where the scientific wisdom has been brought at the world scale, replacing alternative agriculture practices of weed management viz. either manual or mechanical or even weedicides have been tried and practiced producing a lot of side adverse effects [2,4-7].

**Table 1.** Reduction in crop yield losses, enhancements in unimaginable yields and harnessing many other benefits from maneuverable eco-zero weeding agriculture.

The extent of reduction in loss	Nature of loss	Adverse function	Eco zero weeding	Positive function	Beneficial effects	Extent of benefits
(1)	(2)	(3)	(4)	(5)	(6)	(7)
-	-	-	0	+	+	+
<b>Beneficial effect on agricultural crops</b>						
Extent	Reduction in crop losses	Reduction in weed growth	Supressed weed stunted growth	Reduction in weeds	Reduction of crop yield loss	Extent
-43	Wheat	<b>No weeding</b>	Eco zero weeding	Nitrogen fixation and eco zero weeding	Wheat	-31 (i) -12(ii)
-36	Mustard				Mustard	-28(i) -16(ii)
-24	Linseed				Linseed	-14(i) -7(ii)
<b>Beneficial effect on land resources</b>						
			Increase in LER	LER Increased, economic return, crop quality improved		
			Increase in N fixation	Increase in protein uptake		
			Eliminate Earth overshoot	Overcomes earth overshoot		
			Reduction in land degradation	Increased soil health fosters high yield of subsequent crops		
<b>Reduction in energy input</b>						
			Reduction in tillage	The number of ploughing reduced, secondary tillage eliminated.		
			Eliminates drudgery of weeding	Will enhance the efficiency of zero tillage		
<b>Effect on economic gains</b>						
			Energy saving	Cost of tillage and other cultivation reduced		
			Time-saving, high output of crop and better quality	Increased in commodity and quality will enhance economic gain		
<b>Beneficial effects on the environment</b>						
+N <sub>2</sub> O GHG emission			Reduction of Nitrous oxide N <sub>2</sub> O	GHG N <sub>2</sub> O emission reduced, ozone depletion risk reduced, acid rain		

		problem reduced, greenhouse gas effect reduced.
<b>Benefits to individual farmers and farming communities</b>		
	Assured sustainable and enhance yield	Better economic gain and gainful agriculture, increase in happiness, stable mind, etc. no revert to suicide
<b>Aiding to public governance</b>		
	Better and effective governance	Satisfied hunger-free gentry, progressive outlook, and riot free country
<b>Note:</b> Arrows signify that benefits will occur, but their quantification has to be monitored		

Since eco-zero weeding is a new science-based innovation still people and concern departments of research have not given a year to it. But in the world development on machinery development is making tall claims of a solar panel equipped weeder, which has a lot of limitations and its adaptability and efficiency [2]. The study dealt with on proving eco-zero enumerated in **Table 2** and different articles cited have sufficiently substantiated the science of eco-zero weeding. Hence with clear and doubt free scientific development has to be looked for harnessing the multiple benefits which have been enumerated in **Table 3**.

**Table 2.** Chronological development on scientific articles published on eco-zero weeding.

Ref. No	Aspect of study	Outcome	Remarks
4	Field experimentation on weed management by Eco- Zero Weeding for garlic crop	It revealed all facts of eco-zero weeding concept, experimental data and relevant results of esteem values	A new science-based innovative solution developed for the universal long-standing problem of weed management.
6	Eco-zero weeding on the yield of onion was corroborative study	Since onion and garlic have similar growth habit and crop canopy a corroborative study revealed very relevant scientific facts	Cultivation of onion is more profitable than garlic. Efficiency on nutrient especially macronutrients play an important role in producing yields.
3	Eco-Zero as panacea shrine for agriculture	The article dealt with the fact that Eco-zero weeding is a panacea for agriculture	It applauded the contribution of eco-zero weeding in enhancing yield, eliminating drudgery in agriculture and as new scientific discovery.
2	Eco-zero weeding a wow scientific innovation	This study displayed utility, novelty and supremacy of science of eco-zero weeding	It redundant all mechanical weed management including manual weeding and proved all time effectively working eco-zero weeding science technology.
This study	Use of eco-zero-weeding science for harnessing multiple benefits	This study enables harnessing tangible and non-tangible benefits from eco-zero weeding science	A great deal of multiple benefits can be harnessed from this non-monetary science-based measure for bringing social, economic, environmental, sociopolitical governance.

**Table 3.** Crisp details of data on an experimental study on eco-zero weeding.

Treatments	Composition	Garlic yield, q/ha	Maximized yield* q/ha	Gross income Rs/ha	Net income, Rs/ha
TWO	Fully weeded manually	35.5	36	106500	103500
T <sub>WF</sub> NO	Full weed no N fixation	55.5	56	166500	166500
T <sub>WF</sub> N <sub>25%</sub>	Full weed, N 25%	114	114	342000	341366
T <sub>WF</sub> N <sub>50%</sub>	Full weed, N 50%	125	125	375000	374312
T <sub>WF</sub> N <sub>75%</sub>	Full weed, N 75%	78.5	79	Yield declined	-

$T_{WF} N_{100\%}$	Full weed, N 100%	71	71	Yield declined	-
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## RESULTS

### Yield Response

The yield response is presented in **Table 3** give an appraisal of experimental details and optimization of yield and corresponding seed rate. The garlic onion is close-growing crops for which manual weeding is carried out. Eco-zero weeding is the most ideal weed management science-based practice, which eliminates any manual weeding. There might be or someone may try to develop a machine that will add up with the huge cost, involve carbon footprint. This aspect has been fully dealt with the study<sup>[2,8]</sup>. As stated earlier sufficient no of research articles are published which are enumerated in **Table 2**. The data in the table reveal some important conclusion viz (i) Fully weeded control produced minimum yield. (ii) presence of weeds also fixes N, hence yield of garlic became more than that with fully weeded control. Maintenance of eco with different seed rate produced more yield than both the two control. There was a tendency of a maximum which was assessed by regression analysis of polynomial regression analysis. Since the study was conducted on the basis of innovative application principle of the nitrogen cycle, the inferences will be of universal application. The maximum yield producing will be between 52-55% of sole seed rate for eco establishment. The slight variations in the maximum value can be fixed by customization i.e. local research. There might be some variation due to solar variation and type of vegetation, can be fixed by customization research.

**Data after maximization by polynomial study:** Cost of lentil seed was Rs 50, Seed rate of lentil as a sole crop is 25 kg/ha. The sale price of garlic was Rs 30/kg. During those time 1 US\$=INR 65.

$T_{WF}$  validation, utility, and applications have passed FN<sub>100%</sub>

Treatments with full weeds N fix 100%

## THE CORRECTNESS OF SCIENCE AND TITLE ECO-ZERO WEEDING AGRICULTURE

The science of eco-zero weeding and its several applications with respect to relevance, efficacy, efficiency, impact, and sustainability have been accepted by different evaluators hence, it has proven its worthiness (**Table 2**). It is proven scientific innovation of immense values. Therefore, the concept and title of science are highly relevant beyond doubt. This study has produced an intellectual property for the nation India in particular and entire world in general. This scientific innovation as brought out in this article makes unique development applicable for agriculture, environment, and land conservation by restoring the nutrient status of soil, environment and social well-being. It is expected that these details will enable readers to comprehend that eco-zero weeding is the very right title for the weed management by ecological principle at any specific point of time i.e. stage of the crop. The incorporation of another aspect i.e. time it will form ecosystems. Thus, eco zero weeding is the best to approach for the management of weeds either on principle of ecology or that for ecosystem consideration. This aspect is very appropriate for the terrestrial ecosystem, where biological nitrogen fixation can be enhanced by cyanobacteria crop under arable condition. Eco zero weeding makes it clear that irrigation and nutrient can be fortified to enhance yield and dynamic N fixation, which is used producing the main crop. Since it is based on the innovative application of the N cycle, the geographical location seems to play a role in types of weed. This study has opened a new direction for weed management which will inspire researchers to conduct further study and bring refinements with respect weed type. Therefore, it is sufficient to understand that readers will comprehend and for further part of the present study.

### Enumeration of Multiple Benefits of Immense Values

**Benefit to agriculture:** Various aspects enumerated about the maneuverable eco-zero weeding agriculture (**Table 3**) support positive aspects of the new innovative technology. Eco-zero weeding is also known to fix nitrogen, it enhances residual N after harvest of the crop as revealed by a review of the research article<sup>[1]</sup>. The good effects of leaving residual fertility especially N after harvest of the crop will be stronger than what has been realized with intercropping alone. Thus the science of Eco-zero weeding will go on keeping good soil health, thereby eliminating the danger of land degradation due to nutrient deficiency. This effect of land improvement will be accumulating year after year and time will come that farmers will be able to reduce the rate of N application that will enhance the net benefits to farmers. Further, enhancement in yield will enhance Land Equivalent Ratio (LER), that is to say, the reduction in an area with increased vertical productivity will be able to feed the increasing population.

It has no disadvantage or any limitation. In agriculture, the eco zero weeding not only eliminates/suppresses weeds or reduce crop yield losses but also enhances yields to an unimaginable level. The presence of nitrogen-fixing crops supplements the effects of intercropping that is well known in agriculture as a measure for enhancing equivalent crop yield. The most lucrative feature of intercropping, as well as the eco-zero weeding agriculture besides enhancement in

yield, has been the suppression of the release of GHG nitrous oxide ( $N_2O$ ). The simultaneous buildup of dynamic N fixed by the legume crop and utilization of it in photosynthesis keeps N reserve in soil profile low during nitrification and denitrification during which the release of GHG  $N_2O$  is low.

**A simple way for the establishment of eco-zero weeding:** Establishment of eco-zero weeding agriculture involves sowing of eco creating crop with the main crop simultaneously or even before, this requires the minimum energy input for its establishment. It involves broadcasting of eco producing pulse crop at 50% of seed rate of sowing the particular crop as sole cropping, which is practically a nonmonetary input for eco-zero weeding practice. In contrast to this, it eliminates the need for weeding and intercultural i.e. secondary tillage and saves a lot of energy input in agriculture and eliminates carbon footprint. The inter-culture operation involves some tilling and loosens soil during heavy rainstorms get washed off in sheet and rill erosion, i.e. an initial process of land degradation and gully formation. Thus, this is also a strong aspect in favor of eco-zero weeding agriculture i.e. eliminating land degradation.

**Increase in farmer's income:** Effect of eco-zero-weeding on economic gain brings direct benefit as the cost involved in weeding is eliminated that will add to a net benefit. Further increase in yield due to N fixation will bring additional income.

As regards to benefits to individual farmers and farming community, stable productivity will bring stability in market price. The farmers will be able to produce pulses for household consumption as a result of compulsory diversification in small or large holding agriculture. Thus, there will be a low dependency on market-based food commodity. Farmers will escape sharp rises in the price of pulses and cereals. It requires the availability of small storage vessels and pulses preservation techniques to avoid insect losses of pulses during the storage time.

**Food sufficiency induces contentment in gentry:** When productivity is maintained and everyone is able to produce diversified products to have contentment and contented gentry<sup>[9]</sup>, there will be less heart burning and the emergence of unpleasant ideas in good gentry. A nature-based agriculture innovation<sup>[10]</sup> is presented to lead all agricultural systems for which efforts are on to lead the visionary system to 2050 and beyond. The nation will move towards prosperity and peace. This will facilitate socio-political governance and the emergence of a peaceful world.

**A simple way of environment protection by reducing the emission of GHG  $N_2O$ :** Agriculture is known to be the main source of release of GHG  $N_2O$ . The most important and prominent aspect is that the eco-zero weeding agriculture is a non-monetary input technology to bring improvement in any land limiting agrarian country without any extra budget and special skilled input of manpower and machinery. Thus, the eco zero weeding agriculture will be simultaneous ongoing processes that will refine the environment with agriculture. Wubble<sup>[8]</sup> did caution on the severity of the nitrous oxide and had expressed hope for coming off a day with research to combat the GHG  $N_2O$ . Thus, the science of eco zero weeding has emerged as a simple, practical and feasible measure to reduce GHG  $N_2O$  and fulfilled the cherished dream of the renowned scientist. This conclusion brought by research on intercropping<sup>[9]</sup> was declared as the winner of the World Academic Championship in Chemical Research 2017. The eco-zero weeding agriculture will find extensive application in cereals, oilseeds and even pulses of long duration for eliminating the problem of weeding have potential to cover all areas under agriculture, hence it will be still a strongest effect bringing measures in making shortfall of pulses and reducing the GHG  $N_2O$ .

## DISCUSSION

A brief discussion is presented to fortify and ratify the issues that figured on eco-zero weeding

### Concept and Naming of Eco-Zero Weeding

The concept and eco zero weeding are ideally dealt with as revealed by different publications cited on this topic. Ecologist specifies eco-balance and same is maintained in eco-Zero weeding as it is established that it is not aimed at creating zero weeds, but carrying out no weeding. The entire or to say even more than weeding benefits harvested. The inoculation of legume crop will enhance N fixation which will enhance the yield of crops further. Irrigation such as sprinkler or furrow irrigation will foster microbiological activity that will enhance the yield of the crop which will enhance the efficiency of eco-zero weeding.

### Sufficiency of Research

This is entirely a new innovative scientific research to solve the universal problem of weeds. The study has opened a new dimension for solving costly, laborious and tiring work in the sunny open sky. This eco-zero weeding once established it will continue to overcome crop loss and further fortify yield enhancement which no other practice of weed management does. Chemical weedicides spray pollute environment and machinery emit environment polluting gas.

### **Eco-Zero Weeding Highly Suitable for Land Limiting Condition**

Eco zero weeding is scale independent which is applicable for all sizes of fields, be it small or large. It requires further research and development for making it mechanized.

### **SWOT Analyses**

Since it is a science-based practice it has no any flaw, it has high strength, It has no any weakness, it creates tremendous opportunity and also does not bring any threat, Thus it is true scientific innovation of tremendous values.

### **Eco-Zero Weeding an Intellectual Property Bring National Prosperity**

Eco Zero weeding is an intellectual property, which is capable of building national prosperity.

## **CONCLUSION**

An innovation of Eco-Zero weeding agriculture was developed and substantiated, and subsequent studies brought this innovation as true science-based, whereas all other existing and methods under research for weed management were not true science-based. With this science of eco-zero weeding weed management has become very simple, practical and even involves practically no monetary input. This eco-zero weeding agriculture, besides enhancing crop yields, increases farmers' net income, improves soil health, reduces runoff, remain beneficial to the environment, stabilizes market prices and brings contentment in gentry and global peace.

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