STUDY ON SUSTAINABLE AGRICULTURE, NITROGEN & FOOD SECURITY

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Abstract

A major global concern for natural resources has become modern agriculture. The burden on soil and water supplies steadily increase population growth and increased demand for agricultural produce. A large number of intensely controlled agriculture systems with high external inputs have a very low resource efficience, especially in nitrogen.A high input and low productivity eventually result in environmental problems, such as soil degradation, eutrophication, contamination of groundwater and ammonia and greenhouse gas emissions.Of course, the shift of existing farm systems into highly resource-efficient, yet environmentally friendly and socially acceptable systems is necessary. Opportunities to improve the efficiency of nitrogen use in crop and agricultural systems are analysed and discussed in this context. The emphasis should be on greater production with less fertiliser N in high-input systems to improve the efficiency of resource use. In low-input systems, further use of N fertiliser may be necessary to increase yield stability. Research at different levels, ranging from single crops to different agricultural systems, is necessary for the development of sustainable agricultural production systems.The Nitrogen supply must be in line with Nitrogen demand not only for individual crops, but as an integrated system for the rotation of crops in order to achieve a higher agricultural productivity N use.To build more environment-friendly agriculture systems, it will be necessary to combine quantitative system analysis, best practices and legislation. Cross-disciplinary research is essential due to the increasing complexity of N management in sustainable agricultural systems.

Key words: Agricultural Biotechnology, Biodiversity, Cropping System,Food Security,Genetically Modified Crops, Legumes, Nitrogen-Use, Sustainability

Introduction

Today, mineral fertilizers including nitrogen (N), as the key tool for maintaining or re-serving soil nutrients and increasing crop yields. The Nitrogen is especially soluble in commercial fertilizers for fast plant uptake and assimilation. Nitrogen can be conveniently used if plants need it most due to the ease of storage and handling. Though manure continues to play an important role, particularly in areas where animals are densely populated, but nowadays the most widely adopted nutrient source for soils are chemical fertilizers.[1]

Worldwide use of the chemical Nitrogen, In 1961 where it is used around 11.6 million tonnes to 104 tonnes in 2006 has therefore increased dramatically. The sum of chemical nitrogen fertilizers added to crops grown by 7.4 times over 40 years, while the average increase in return was only 2.4 times higher. The efficiency of N use, which can be described as the render gathered per unit of the available Nitrogen in soil (sourced with soil + Nitrogen fertilizer) has significantly decreased. This means Nitrogen use efficiency (NUE) is higher because N fertilization is used much smaller at lower crop output levels.NUE is the combination of absorption efficiency, which uses efficiency (yield/absorbed N), and the sum of absorbed N/available quantities of Nitrogen. Genetic heterogeneity is found for a large number of plant species, both for the efficacy of absorption of N and quality of use of N. In addition, interactions between genotype and Nitrogen levels have led to the fact that lower Nitrogen supplies do not necessarily make the most efficient plant species in high N fertilisation.[2]

The burden of land and water supplies is increasing steadily in population growth and the growing demand for farm commodities. Nowadays world agriculture feeds about 7.8 billion people and provides a broad spectrum of additional services, including rural jobs, bioenergy and biodiversity. Every 12 years, the world's population grows by about one billion. The estimated population is around 9.7 billion by 2050 & 11 billion by 2100[3].However, the key issue is not whether we can feed 9 million people by 2050, but can we do so in a sustainable, fair and timely manner, given increasing demand for biofuels and the potential change of climate.Agriculture must meet an increasing demand world-wide for biological commodities like fiber, food, fuel& feed, while also fulfilling very close limitations about product protection, the atmosphere, nature and the countryside.

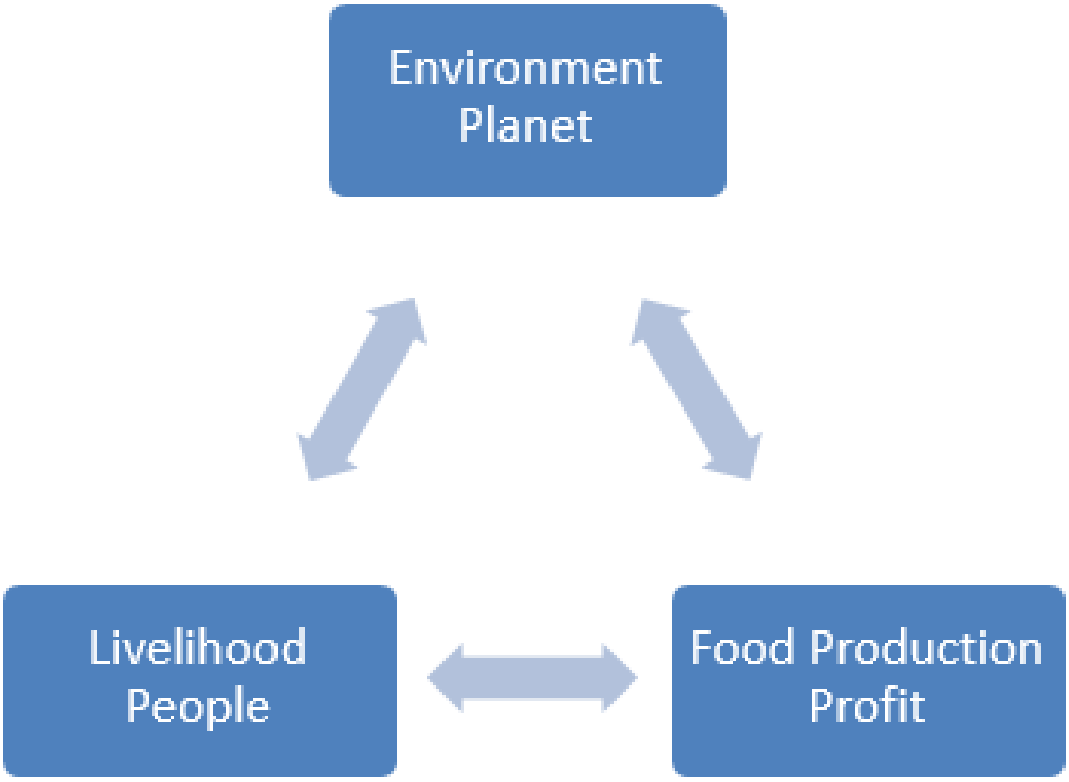

Fig. 1: The 3-P Model for Sustainability of Food Items

The definition of multifunctional land use is currently highly focused by policymakers in the European Union countries. Other business activities such as recreation, regional brand goods and ecological services like land preservation, biodiversity and water harvest, in effect lead to jobs and profits, as well as farming[4]. Sustainability is founded on the idea that we satisfy today's needs without jeopardizing future needs. The three key goals of sustainable agriculture are Profitability, health of the environment and ethical goodness. The conceptual 3-P system is also represented: People, Planet, &Profit as shown in (Fig. 1). In recent decades, improvements in agriculture from profit-oriented to Triple-P, productivity-related activities have been very important to achieve the productivity, quality and efficiency targets.

Literature Review

Scientists & consumers concerned for the widespread adoption of external chemicals like pesticides & nitrogen fertilizers starts decade ago, from 1950s leading to movement seeking alternative agricultural practices [5]. The agricultural research group, in addition to the organic movement, has invested in system growth like: integrated agriculture, low input & sustainable agriculture. The aim is to minimise the impact on environment and improve food quality while maintaining appropriate yields.

The paper of Jennifer A. Anderson et al.[6] summarizes groundbreaking research works and some of modern and evolving biotechnology techniques. This subject illustrates how agricultural biotechnology works in sustainable agriculture and better food safety and can be used to encourage further growth and the use of beneficial genetically modified crops. The introduction of advanced biotechnology and production of GM crop has improved the toolbox of breederand made it possible to drive agriculture quickly in the direction of sustainability. In developing regions, small-scale farmers are profitable more than in developed regions. This technology has a wide and established record for improved production and prosperity. The technologies addressed in the paper are only a few examples of what improves food safety and environmental management. While these technological advances are promising, it is important to recognise that agrobiotechnology is only a set of resources to promote sustainable agriculture and food safety.

Bertrand Hirel et al.[2] discussed approaches that are centered on agriculture research, plant physiology, quantitative genetics, reversing & forward genetics and continuous evolving biological systems in agriculture. Sustainability for long-term can involve a shift, depending on climatic conditions, which ranges from chemical Nitrogen to crop rotations that is legume-based such as continuous deck crops, where in certain parts of the world these can be achieved.All of this would be necessary to improve sustainable development and the management of the environmental burden of agriculture through integrated approach to input, conservation tillage, precision agriculture, cultivation, empowering crop diversity & other best practises for management.

Agricultural Nitrogen Fertilization

Mineral fertilizers are the primary source of N in the developing countries for crops, closely followed by cattle manure. The main source for the symbiotic fixation of Nitrogenis through the nodules of leguminous plants &from the rhizosphere of various trees or plants. There are also N sources on the ground. Minor ones include ammonia, N atmospheric precipitation,different nitrogen oxides, &recyclingwaste sludge that can be spread on cultivated soil amid toxic substances. These vary in significance from country to country. Urea, Anhydrous ammonia, ammonium sulphate & ammonium nitrate are commercial mineral fertilisers widely used on cultivated land. Solution for easy crop assimilation is especially important. Both urea and ammonia: by volatilizing ammonia, or by nitrating or urea rushing after high precipitation and groundwater washing, are converted into nitrate by varying rates depending on the soil nature and climatic conditions.

It does appear, however, that Nitrite production and further nitrite oxidation through nitrite oxidation of microorganisms are influenced by tillage practises or by the functional diversity of automotive nitrified organisms, environmental conditions (structure of abundance and bacterial community) and bacterial ammonia kinetics nitrifying.The nitrification process occurring in soil sustainability therefore has a major influence on the overall inorganic budget for nitrogen.Through the intervention of root or free living microbes, which alter nutrient supply levels and the division of resources between crops and soils. In the field of nutrient inputs, Dung is the second.

Mist's nutrient content varies from country to country, and within the same country from area to region. The system is dependent on the shape and nutrient content of different foodstuffs and animal feed.At least 50 percent of the manure is wasted in storage and transportation & 25% is lost during use. Mineralising of 0.4 percent to 5.8 percent over a time period of 56 days of inorganic Nitrogen was observed in the incubative composted manure study compared to 25.4–39.80 percent of total Nitrogen in poultry manure.Increased soil fertility and an improvement in the structure of the soil that stimulates the microbial soil has also been demonstrated by using manure with a different humification amount.

Further, humid substances have been found to influence nutrient absorption and root architecture and have a substance-like auxin-like action and positive impact on plant physiology. The use of flow-through calorimetry has also been demonstrated to improve the supply of nitrate and to improve its adsorption into humid substances. Excess Nitrogen levels estimated in agriculture can be based on the Nitrogen inputs for agricultural soils and Nitrogen intakes estimates by grass and crops.The surplus Nitrogen is defined as N on the surface of this method of calculation. The surface balance may be used in the context of different environmental situations to illustrate areas that could be affected by n emissions.

Moreover, it can be used to test the effective efficiency of agro-environmental interventions in order to prevent contamination by nitrates over a period of many years. However, surplus measurement cannot be construed as a measure of a Nitrogen loss in the water immediately. All the abovementioned potential losses and the inventory changes in N, particularly in the soil, comprise the balance between input and output systems. Legumes are used for covering crops to suit a wide range of organisms for a particular climate.Legumes are characterised by their distinctive floral structure, pods and the atmospheric N2 nodule fixation capacity of 88% of the plants tested up to now.

Legumes after grasses are only secondary to humans, with a major contribution to grain, pasture, forage and forestry production. As the legumes will symbiotically repair N2, the inputs of N-fertilizers are minimal. If the following cultivated plant has part of this "free" N, rotational use of legumes will significantly reduce the usage of Nitrogen syntheticfertilizers. In addition, legumes can also increase the colonisation and three-part symbiosis of the mycorrhizae of the cultivation roots among AM and N-fixing plants, thus ultimately having a bearing on the host plant.Legumes can be classified tropically and moderately as deck plants or as green manureThe warmed climate or the warmer winter temperatures allow the winter to persist with temperate species and the summer with tropical species.

It is genetic variability intra & inter species that partly why some legumes produce higher and develop more nitrogen.But soil and climatic conditions are the prevailing factors for selecting best-performing legumes.The biochemical quality of plants, for example, has differed between plant species and harvest dates in a recent study, and is reflected in the dynamic of N-mineralisation. A number of papers based on genetically modified crop breeding methods, selection criteria & approaches covered additional changes in pulses that would not only benefit the environment and farmers, but would also benefit the customers of the developed & developing countries.

Several studies concluded that increase NUE in the legumes are rare using quantitative genetic approaches. It appears, however, that for effective N assimilations in the further translocation of seeds both the root and the nodule are essential. N legume production is a major benefit to the cultivation of green manures and plants. The amount of N in the vegetables depends on the crop, the total production of biomass and the percentage of N in the vegetables. The amount of N produced will be reduced by cultural and environmental conditions such as delayed plantations, poor establishment and drought that reduce legume growth. Good nutrient quality, the ideal soil nutrient and soil pH, good node ring and sufficient soil humidity include conditions for good N production. A green-manure N proportion of the total quantity of legume found in the following crop is normally around 40% to 60%.

Interestingly enough, leguminous plants may also substitute for the cotton output of 60% of N chemical fertilizations, although the amount of N available extracted from the coat crop was not in line with the cotton plant requirements. The residue of organic residues from the previous plant, and the rate of application of synthetic N and organic fertigants in the next plant, in turn, is heavily influenced by the NUE. Row and composted manures are both useful in organic crop production. Mist is used properly to balance fertility of soil. In combination with a complete fertility plan that includes plant rotation and N fixing legumes, it can satisfy most of the needs of the N fertiliser acquired.

The time of the N mineralization of the fish crop and the N requirement for the main crop, however, are frequently not synchronised and result in a loss of the Nitrogen part that was saved by the catch crop in the first place.Thus, the estimates for long-term N effects of catching plants must be improved and the sequences optimised to accurately assess the N turnover maintained by nitrate cultivation in soils. The grower therefore must track and study the properties of the manure and/or compost to be used to track the nutrients in the soil. The growers must adjust their rates and select further fertilisers accordingly.Ultimately, without developing system-wide approaches and using and preserving usable agrobiological services to ensure multiple ecosystem services that Green manure will probably not create viable alternatives that lead to the synergy between crops.

Also cereals (ripe, wheat, barley, oats), annual or permanent grass are common in coat plants, as are legumes, ryegrass, warm grass season, including mustard, for example sorghum hybrids and brassicas for coat plants.If both classical and green fungus are required in organic farming for the replacement of chemical N fertilization, plant genetic adaptations and breeding are apparent in order to increase the crop NUE in wheat, for instance. For these alternative agricultural techniques. In the field of organic farming, it will also be necessary to establish biomarkers to determine the NUE potential, as well as to optimize N inputs in crop plants.

1. Legumes role in reducing risk of nitrate leaching:

In India, groundwater pollution caused by nitrate leaching is a relatively new problem. The NO_3-N content of groundwater in regions that have heavy fertilizer and irrigated crop systems applications has been widely published. The NO_3-N content of flax wells at Ludhiana in Punjab increased from 1975 to 1988 from 0.42 to 2.29 mg/l. The choice of appropriate cultivation and management practises will reduce leaching risks and improve N usage productivity.Legumes grown in larger crops can reduce the risk of nitrate leaching. The multiple cultivation of sugar cane, pigeon pea, black gram & maize in parallel (a two cultivated method of different growth habits and low competition) resulted in a low NO_3-N content on the soil compared to single cultivation. Soya bean appears to decrease the concentration of nitrate more than maize in the soil profile.[7]

2. Legumes in NE Indian agriculture:

The importance of legumes is better understood than that of other parts of the world in North-Eastern India, which is fertilizer-consuming (12 kg/ha excl. Manipur), has high organic and acidic soils (Arunachal Pradesh, Assam, Meghalaya, Mizoram, Manipujur, Nage, Sikkim, Tripura). Its capacity is obvious in a large number of cultivated systems in the field, either by N or by leaf dropping. Pigeon pea, cowpea, groundnut, soya bean, peas and rice beans have been estimated to produce respectively 2.0, 1.2, 2.0, 0.5, 0.48 & 1.1 tonne per hectare leaf fall that contributes actively to fertility of soil and to improvement in acidity of soil. The acid soils of Northeast India are widespread in the vegetable herbs, including cowpea, French bees (Phaseolus vulgaris), & lablab beans (Phaseolus lablab).

Legume species	**Protein content in seeds (%)**
Winged bean	40
Rice bean	25
French bean	22.1
Peas	22.5
Broad bean	20-25
Jack bean	27
Pigeon Pea	20.9
Cowpea	20.1

Table 1:Variouslocal LegumesProtein Content [8]

In these legumes mature seeds are eaten as pulses. They are used also as green manure and as a covering for plants.The indigenous leguminous vegetables commonly produced in Tripura, Sikkim, Nagaland, Mizoram, Manipur, Meghalaya, Arunachal Pradesh & Assam are winged beans (Psophocarpus tetragonolobus), the broad bean (Vicia Faba), rice-bean (Vigna Umbellate), jack bean (Canavalia Esiformis), & bakthul bean (Sesbania Grandiflora). These are primarily used as deck plants, as green manure, and as seeds. The superiority according to nutritional value over many more commonly produced pulsations of these indigenous legumes (Table 1). Parkia javanica (tree bean) is north-eastern regional legume that is widely discovered in Manipur and Mizoram with softened, tender and shiny green fruits as they grow in Marseille during April. The excellent source for green manure & fodder is leaves.[7]

3. Role of tree species that fixes nitrogen to support agriculture in hill:

Nitrogen deficiency is a major barrier to increase and maintain productivity in northeastern India, since mountain land use is dangerous and increases the decline. The preservation of soil fertility by reducing land erosion plays a crucial role in fixing nitrogen forests and shrubs. Acacia, Albizia, Calliandra, Dalbergia, Gliricidia, Prosodies, Robinin, Sesbania, Crotalaria, Disodium, Flemingia, Indigofera & Tephrosia are the species of nitrogen fixing trees. For some other plants these trees fix an atmospheric nitrogen in Leguminosae, Ulmaceae & Actinomycetes due to the symbiosis associated with rhizobial bacteria. In nitrogen plants that fix N, namely rhizobium, rhizobic brady and azorhizobium, three genera of rhizobiasis are involved (NFTs).

The microbes symbiont afflicts the tree into the roots of nitrogen-bound trees and promotes it into nodules. The symbiont in the nodule multiplies and sets nitrogen in the atmosphere. By creating a suitable set-up for N fixation and energy, the tree contributes to the symbiosis process by photosynthesizing carbohydrate.This fixed nitrogen is available in a type which can be used by a single plant or in the soil for home animals (by root lixiviation, leaf dropping, dunging or Green dunging) (through fodder). There have also been many non-legumes of economic importance, such as Alnus and Casuarina, which can be nitrogen fixed. Eight species of trees that fixes nitrogen appropriate in Meghalayafor agroforestry systems that were recommended by Dhyani and Chauhan (1990). The paper of das [7] stated that the continuous application of the leaves of leguminous plants in lowland rice fields (10 t/ha in fresh weight) contributed to sustained soil and crop productivity (Table 2).

Table 2:VariousN-Fixing Tree's Leaves effect on the Yield of Lowland Rice.[9]

Treatments	**Grain yield (t/ha)**			**Nutrient composition (%)**		
	2005	2004	2003	K	P	N
Alder	4.67	4.10	3.50	1.37	0.41	2.24
Acacia	5.30	4.66	3.92	1.36	0.43	3.19
Cassia	5.58	4.55	3.99	1.17	0.39	2.50
Erythrina	5.67	4.83	4.48	1.54	0.47	3.24
Parkia	5.23	4.40	4.13	1.52	0.40	2.54
Control	3.35	3.13	2.80	-	-	-
100% NPK through fertilizers	5.13	5.08	4.82	-	-	-
CD (p = 0.05)	0.53	0.46	0.60	-	-	-

4. Leguminous hedgerows and soil fertility:`

The soil fertility and maintenance of the soils in the midhilles of Meghalaya, north-east India has been checked for six separate heedgerow species (Crotolaria tetragona, Cajanus cajan, Desmodium rensonii, Indigofera tinctoria, Flemingia macrophylla, & Tehphrosia candida). The contour bonds were planted for each species on the top terraces with inter-terrace space of 5 metres.Two years after planting the soil contours samples of each species were obtained at different depths of soil. The results show that the chemical properties of soil have a significant impact (Table 3). Far from the initially and control values, The existing NPK status and organic soil carbon content are increased in almost all species. C. macrophylla (19.6 tonne per hectare) and F. macrophylla (4.7 tonne per hectare), the recorded total productivity for pruned biomastic was high.

Table 3:Hedge Species Influences on Soil Chemical Properties (Mean Value, Depth 0–60 Centimetres)[10]

Hedge Species	**Organic carbon (%)**	**Available nutrient (kg/ha)**		
		K	P	N
C. cajan	1.30	154.4	11.16	222.5
D. rensonii	1.67	146.5	13.78	205.66
I. tinctoria	2.33	155.0	13.65	209.97
Control	1.69	149.5	10.97	200.97
Initial	2.34	273.3	13.0	211.2
C. tetragona	2.28	159.4	14.16	216.6
F. macrophylla	1.71	129.2	9.29	256.05
T. candida	2.32	143.8	13.16	175.45

Discussion

During the past two decades, majority of researches to identify NUE's limiting rate steps were undertaken, both in model and in crop organisms, through agronomic, physiological, and genetic studies, in accordance with environmental conditions.NUE has become the second priority for improving abiotic stress in crops, both in the private and public sectors, after drought. For most crops and grains especially the genetic and physiological basis of NUE is decoded with a wide range of methods. These include mutant collections, extensive genetic diversity, recombinant or duplicate haploid (DHL) populations, simple protocols for processing, as well as physiological, biochemical and genomic information for the development of biological systems.Moreover, the commercial research initiative on crops is accompanied by public sector research, in particular the release of rice and maize genome sequences and the growth of wheat, barley and a variety of other cropping sequencing projects.

Conclusion

This paper discussed the synthetic nitrogen use in the agriculture and its side effects. This paper also discussed the legumes which are nitrogen fixing trees to enrich the soil with nitrogen. It further discussed NUE which is dominated by a complex array of interactions between Specific physiological, developmental & environmental organ and tissue factors specific to the genotype of the species. A far greater study of several genotypes that cover the genetic diversity of a crop is therefore important.The Nitrogen utility efficiency & productivity of the plant of organic and mineral plants in combination with the agricultural and physiology approaches can be done using the many techniques available. A gradual shift from the synthetic N into leguminous crop rotations, such as continuous deck crops, depending upon climatic conditions, may be a long-standing sustainability. The future work should be onquantitative framework research, best practices and regulations should be integrated. Interdisciplinary research in sustainable agricultural systems is important because of the growing complexity of management of Nitrogen.

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