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Integrated Nutrient Management for Food Security and Environmental Quality

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Abstract
One of the most important challenges facing humanity today is to conserve/sustain natural resources, including soil and water, for increasing food production while protecting the environment. Integrated nutrient management (INM) system or integrated nutrient supply (INS) system aims at achieving a harmony in the judicial and efficient use of chemical fertilizers in conjunction. INM addresses environmental consideration by tailoring nutrient application to crop needs and soil conditions in order to eliminate both excessive applications that increase potential loss to water or air and insufficient application that result in soil fertility degradation. Integrated nutrient management holds great promise in meeting the growing nutrient demands of intensive agriculture. It can also help in maintaining production sustainability without deterioration in quality of plants environment
Keywords: Agriculture, Integrated nutrient management, fertilizers

INTRODUCTION

One of the most important challenges facing humanity today is to conserve/sustain natural resources, including soil and water, for increasing food production while protecting the environment. As the world population grows, stress on natural resources increases, making it difficult to maintain food security. Long term food security requires a balance between increasing crop production, maintaining soil health and environmental sustainability. Effective nutrient management has played a major role in accomplishing the enormous increase in food grain production from 52 million tons in 1951-52 to 230 million tons during 2007-08 in India. However, application of imbalanced and/or excessive nutrients led to declining nutrient-use efficiency making fertilizer consumption uneconomical and producing adverse effects on atmosphere (Aulakh and Adhya, 2005) and groundwater quality causing health hazards and climate change (Aulakh *et al.,* 2009).

At present, the issue of soil productivity has become a global concern. According to Brady and Weil (2002), the two major interactive worldwide problems are widespread hunger and malnutrition, and the deterioration of quality of the environment resulting from injudicious attempts made to alleviate hunger and malnutrition. The quality, management and conservation of the world's soils are critical elements in the rectification of the sated problems. The evidence is clear that the soils' natural ability to supply sufficient nutrients has decreased with the higher plant productivity levels associated with increased human demand for food. Of the essential material needs of humankind, the basic requirement is for an adequate supply of air, water and food. People have free access to the air they breathe. However, access to drinking-water and food, while easily obtained for some, is difficult for many. In addition to being physically available, these materials should also be of acceptable quality and continuously.

Can agriculture provide for the food needs of a world population projected to exceed 7.5 billion by the year 2020? Concern is growing that it may not. There are indications that the highly productive fertilizer and seed technologies introduced over the past three decades may be reaching a point of diminishing returns (Bouis, 1993; Cassman et al., 1995; Flinn and De Datta, 1984). Prospects for expanding low-cost irrigation, one of the driving forces behind yield increases, are also becoming more limited (Rosegrant and Svendsen, 1993; Rosegrant, 1997), as are the prospects for converting marginal lands into productive arable land (Bockman et al., 1990; Crosson and Anderson, 1992). Furthermore, new technologies such as genetically engineered, yield-increasing plants are not expected to be major factors in food production increases in developing countries during the next two decades (Cassman, 1994). In developed countries, over application of inorganic and organic fertilizers has led to environmental damage, while in developing countries, population pressures, land constraints, and the decline of traditional soil management practices have led to a decline in the fertility of the soil. The integrated management of plant nutrient resources through soil conservation practices and the widespread and responsible use of organic and inorganic fertilizers offer the opportunity to sustain agriculture over the long-term and to maintain and enhance soil fertility, while minimizing any environmental damage. For Integrated Plant Nutrient Management (IPNM) to be successful at the field level, the farmer must have the knowledge, tools, and support necessary to effectively manage his fields, crops, and soil to their maximum potential. Consumption of water high in nitrate (and nitrite) has been linked to "blue baby syndrome," goiter, birth defects and heart disease, and may be involved in the creation of carcinogenic compounds within the body that can cause stomach, liver and esophageal cancers (Conway and Pretty 1991). Leaching and run-off of nitrogen and phosphorus into rivers, lakes, and inlets, can cause eutrophication an excess accumulation of nutrients in water that promotes algal over-production. This algal over production damages the marine environment as it starves plant and animal aquatic life of both the light necessary for photosynthesis and the oxygen needed to breathe. When in excess to plant needs, nitrogen also escapes into the atmosphere as nitrogen gas and various nitrous oxides. In the upper atmosphere, nitrous oxides react to form acid rain which can be damaging to crops, acidifies soil and water, and contributes to property damage. The basic concept underlying IPNS/INM is the maintenance or adjustment of soil fertility/productivity and of optimal plant nutrient supply for sustaining the desired level of crop productivity (FAO, 1995). The objective is to accomplish this through optimization of the benefits from all possible sources of plant nutrients, including locally available ones, in an integrated manner while ensuring environmental quality. The use of INM increases soil productivity, crop productivity and ensuring food security and environmental quality in sustainable manner.

LITERATUR E REVIEW

Definition of Integrating Nutrient management (INM)

INM system may be defined as 'an intelligent use of optimum combination of organic, inorganic and biological nutrient sources in a specific crop rotation or cropping system to achieve and sustain optimum yield without harming soil ecosystem. Such a package of plant nutrients formulated must be technically sound, economically viable, practically feasible, socially acceptable and environmentally safe. Briefly, INM system is a holistic approach and may be defined as maintenance of soil fertility and plant nutrient supply to an optimum level for sustaining the crop productivity at desired level (Mahajan and Gupta, 2009).

Integrated nutrient management (INM) system or integrated nutrient supply (INS) system aims at achieving a harmony in the judicial and efficient use of chemical fertilizers in conjunction with organic manures, use of well-decomposed crop residues, recyclable waste, green manures, compost including vermicompost, inserting of legumes in cropping systems, use of bio-fertilizers and other locally available nutrient sources for sustaining soil health and amelioration of environment as well as crop productivity on long-term basis (Mahajan and Sharma, 2005). The increase in crop productivity results from the combined effect of chemical and organic manures which also helps in the improvement of physical, chemical and biological properties and consequently the soil organic matter and nutrient status. Thus, INM system holds promise in sustaining higher crop yields besides improving soil health (Kaushal, 2002). The continuous use of high doses of chemical fertilizers is adversely affecting the sustainability of agricultural production and causing environmental pollution (Virmani, 1994).

Component of Integrate Nutrient Management.

Chemical Fertilizer

Fertilizers are an important tool or key input for increased agricultural production in modern era. It is because they are the major contributors for enhancing crop production and maintaining soil productivity. Some of the advantages of chemical fertilizers include: They are easy and quick sources of plant nutrients, contain nutrients in higher and definite concentrations compared to other sources, use of balanced fertilization, however, based on soil test recommendations increases the fertilizer use efficiency and pays back to the farmer more profit per rupee invested, chemical fertilizers are less bulky in nature and can be easily transported and time and labor costs can be saved (Mahajan and Gupta, 2009)

Organic Manures

The manures which are prepared from plant residues and animal remains are referred to as organic manures, and were traditionally and preferentially used in developing countries until the 1960s when chemical fertilizers began to gain popularity. Organic manures are generally of two types; bulky organic manures and concentrated organic manures. The manures that are applied in large quantities and contain low amounts of plant nutrients are known as bulky organic manures such as farmyard manure (FYM), compost (village and town compost), vermicompost, night soil, biogas slurry, sewage and sludge, etc.; concentrated organic manures contain higher percentages of major plant nutrients than bulky organic manures (Mahajan et al., 2002). Organic manures like FYM, compost, vermicompost, green manures, crop residues and bio-fertilizers are important inputs for maintaining soil fertility and ensuring yield stability.

Table 1. Nutrient content of different organic manures (source from Mahajan et al., 2007)

Organic Manure	Nutrient Content %		
	N	P2O5	K2O
A. Bulk manures			
FYM	0.5	0.2	0.5
Farm compost	0.5	0.15	0.5
Town compost	1.4	1.0	1.4
Night soil	5.5	4.0	2.0
Sewage and sludge	3.6	2.0	1.0
Poultry manure	3.03	2.63	1.4
B. Concentrated organic manures			
Fish manure	4-9	3-9	0.3-1.5
Neem cake	5.22	1.08	1.48
Linseed cake	5.56	1.44	1.28
Groundnut cake	7.29	1.53	1.33
Mustard oil cake	5.21	1.84	1.19
Safflower oil cake	7.88	2.20	1.92
Cotton oil cake	6.5	2.89	2.17
Raw bone meal	3-4	20-25	-
Steamed bone meal	1-2	25-30	-
Blood meal	10-12	1-2	1

Green manures

Green manure is the cheapest way to fertilize the cereal crops where sufficient quantity of FYM or compost is not available. The practice of ploughing or intermittently adding un-decomposed green plant material into the soil for the purpose of improving the physical condition and fertility of the soil is called green manuring and the manure obtained by this method is known as green manure (Mahajan et al., 2002). Before the introduction of chemical fertilizers, green manuring was consistently practiced for crops like rice, wheat, etc. For green manuring, generally leguminous crops are preferred because they have an additional advantage of fixing atmospheric N (Gupta et al., 2005). Green manuring, in fact, is the easiest and quickest way of supplying readily decomposable organic matter to soils, and thereby the release of plant nutrients. The magnitude of green manure has been known in periods as far back as 1000 BC because references to the use of stalks and stems of sesame as manure have been found (Gupta and Sharma, 2004). This practice, however, decreased in world after 1960 due to introduction of intensive farming systems and easy availability of chemical fertilizers.

Green manure incorporation adds plenty of fresh biomass and maintains nutrient reserves and physical condition of soil. A green manure crop improves the structure of the subsoil by a deep rooting system and increases the water-holding capacity of the soil. It may also be useful in reclamation of saline, alkaline and sodic soils (Najar and Gupta, 1996). On an average, it generally adds 60–80 kg N ha^{-1} to different crops. Apart from this, green manure crops also provide a shielding action against erosion and leaching.

Vermicomposting

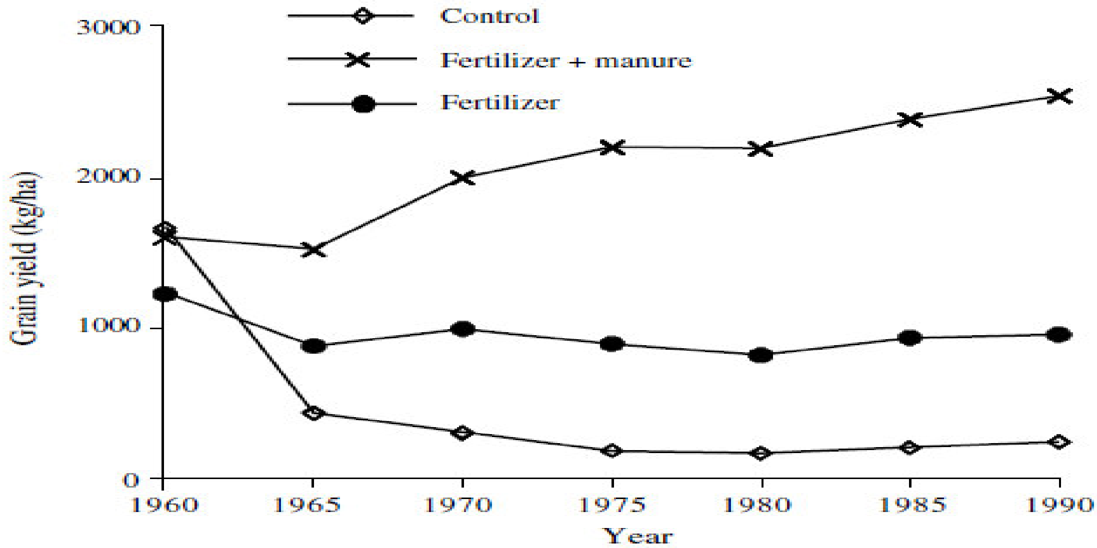
Vermicomposting is derived from the Latin word vermis, meaning worms. Vermicomposting or vermistabilization is a method of making compost using earthworms, which generally thrive well in soil, eat biomass and excrete in digested form, and convert solid wastes of animals and plants into valuable organic manure under aerobic conditions. This organic manure or compost is generally called vermicompost. The art of rearing earthworms is called vermiculture. In other words, the use of earthworms in organic waste management has been termed 'Vermicomposting'. Vermicomposting is, in fact, the process in which earthworms feed on waste organic substances, convert them into compost by passing them through their digestive system and excrete them in a granular form called vermicasts. Thus, vermicompost is a mixture of vermicasts or faecal excretions and organic matter including humus, live earthworms, their cocoon and other organisms.

Table 2. Composition of vermicompost. (Source Mahajan and Gupta, 2009).

Sr. No.	Nutrients	Contents
1	Organic carbon (%)	9.15–17.98
2	Total nitrogen (%)	0.5–1.5
3	Available phosphorous (%)	0.1-0.3
4	Total phosphorous (%)	1.34-2.20
5	Available potassium (%)	0.15-0.56
6	Total potassium (%)	0.40-0.67
7	Available sodium (%)	0.06-0.30
8	Calcium and magnesium (meq/100 g)	22.67–70.00
9	Copper (ppm)	2.0–9.5
10	Iron (ppm)	2.0–9.3
11.	Zinc (ppm)	5.7–11.5
12.)	Available sulphur (ppm)	128.0–546.0

Importance of Integrating Nutrient Management.

Integrated nutrient management (INM) is an option to alleviate soil fertility problem as it utilize available organic and inorganic nutrients for sustainable agricultural production and productivity. Low soil fertility is one of the bottlenecks to sustain agricultural production and productivity in Ethiopia. Anthropogenic factors such as inappropriate land use systems, monocropping, nutrient mining and inadequate supply of nutrients are aggravated the situation. To alleviate the problem, INM is an option as it utilizes available organic and inorganic nutrients to build ecologically sound and economically viable farming system (Gruhn et al., 2000). Agricultural practices that improve soil quality and agricultural sustainability have received much attention from researchers and farmers. The role of organic fertilizers in plant nutrition is now attracting the attention of agriculturists and soil scientists throughout the world. Chemical fertilizers no doubt have boosted the crop growth and yield, but to larger extent they have contributed to soil deterioration. Integration of different sources of nutrients has a promising efficient soil health management and sustained productivity. For example, sorghum grain yields as affected by mineral and organic fertilizers over time. The use of integrated fertilizer and manure increases the production and productivity in sustainable manner.



Source: Bationo et al. (2006)

Increasing Agricultural Production in Sustainable Manner

Integrated nutrient management (INM) is an important component of sustainable agricultural intensification, as well as crop, pest, soil, and water management. INM centers on the management of soils in their capacity to be a storehouse of plant nutrients that are essential for vegetative growth. The goal of INM is to integrate the use of all natural and man-made sources of plant nutrients, so as to increase crop productivity in an efficient and environmentally kind manner, without diminishing the capacity of the soil to be productive for present and future generations. INM incorporates many technologies including soil conservation, nitrogen fixation, and organic and inorganic fertilizer application. Soil conservation practices prevent unnecessary losses of nutrients from the field through wind and water erosion. Organic fertilizers play an important role in the improvement of soil structure and organic matter content. They are also often a good source of the secondary and micro-nutrients necessary for plant growth, and contribute a modest quantity of the primary nutrients (nitrogen, phosphorus, and potassium) to the soil. Nutrient conservation is a critical component of INM. First, practices such as terracing, bund building, alley cropping, and no or low till farming, alter the local physical environment of the field and thereby prevent soil and nutrients from being carried off the field through leaching and erosion. Mulch application, cover crops, inter-cropping, and biological nitrogen-fixation, act as a physical barrier to the destructive effects of wind and water erosion, and help to improve soil characteristics and structure. Organic manures aid in soil conservation as they contribute to improved soil structure, as well as replenish secondary and micro nutrients.

Increasing Soil Fertility/ Productivity

INM increases (robust) soil productivity and health of the soil and enhance soil quality and productivity in more sustainable manner. When soil is fertile; the capacity of soil to retain, cycle and supply essential nutrients for plant growth over extended periods of time (years). Soil fertility relates not only to the nutrient status of the soil, but also to activities of soil organisms, including earthworms or microbes, clay mineral amounts and types, air exchange rates, and other biological, chemical or physical properties and processes. INM reduced N-losses via, Denitrification and nitrate leaching, enhanced nutrient use efficiency and recovery by crops and improvements in soil health and productivity and hence, could sustain high crop yield in various cropping system ensuring long term sustainability of the system. INM can enhance the uptake plant nutrients. For instance, under drought stress conditions, a soil covered with organic matter can hold more soil moisture than a soil that does not have mulch, and this extra moisture may result in improved uptake of applied fertilizer nutrients. Integrated nutrient management can reduce plant requirements for inorganic nitrogen fertilizer, and reduced use of purchased fertilizer nutrients can result in a significant saving of scarce cash resources for small farmers. It also ensures the Conservation and efficient use of native soil nutrients, recycling of organic nutrient flows, Enhancing biological nitrogen fixation and soil biological activity and addition of plant nutrients (Vlaming et al., 1997). The activity of soil organisms is very important for ensuring sufficient nutrient supply to the plant. If microorganisms find suitable conditions for their growth, they can be very efficient in dissolving nutrients and making them available to plants. Moreover, an increase in soil microbial-biomass C and nitrogen (N) is obvious in soils receiving combined application of organic manures and chemical fertilizers compared to soils receiving chemical fertilizers only. Ammonification are higher in soils amended with organic manures with chemical fertilizers, indicating that more active micro flora is associated with integrated system using organic manures and chemical fertilizers together which is important for nutrient cycling. The use of organic fertilizer together with chemical fertilizers, compared to the addition of organic fertilizers alone, has a higher positive effect on microbial biomass and hence soil health (Dutta et al., 2003). The INM changes the chemical and biological properties in soils, it improves the soil organic C, total N, phosphorus (P), and potassium (K) status and microbial biomass (C and N), and soil organic matter (OM) content and long-term soil productivity in the tropics where soil OM content is low. Soil biomass is increased by INM as these amendments supply readily decomposable organic matter in addition to increasing root biomass and root exudates due to greater crop growth (Goyal et al., 1999). Soil organic C and total N are greater in treatments receiving a combination of inorganic fertilizers and organic amendments compared to soils receiving inorganic fertilizers alone. The greatest amounts of both organic C and total N are observed in soils receiving wheat straw and least organic C and total were present in unfertilized soils. The C: N ratio of soil decreases with fertilization.

Environmental Quality.

Maintaining or enhancing the quality of the environment and conserving natural resource. INM addresses environmental consideration by tailoring nutrient application to crop needs and soil conditions in order to eliminate both excessive applications that increase potential loss to water or air and insufficient application that result in soil fertility degradation. within INM fertilizer application are time to optimize nutrient uptake and application methods are designed to minimize possible off site movement of nutrients by optimizing crop nutrient up take. INM is best approach for better utilization of resources and to produce crops with less expenditure. Integrated nutrient management (INM) involves the use of manures, biofertilizers and chemical fertilizers to achieve sustained crop production and maintain better soil health. There is increased emphasis on the impact on the environmental quality due to continuous use of chemical fertilizers. The INM system is an alternative and is characterized by reduced input of chemical fertilizers and combined use of chemical fertilizers with organic materials. For sustainable crop production integrated use of inorganic and organic fertilizers has proved to be highly beneficial (Anderson et al., 2002). Moreover, INM reduces erosion, improves water infiltration, soil aeration and plant root growth, Moreover, it minimizes the risk of downstream flooding (Smaling, 1993). INM practices reduces the emission of green house gases (nitrous and nitric oxides) excessive applications of nitrogen fertilizer results in increased leaching of nitrates into ground water, increasing health risks to new borne infant flows cycled through the return of organic residues as compost, manure and/or mulch have significant implications for conserving soil fauna biodiversity (Smaling, 1993)

Yield Quality

Targeting high yield with a high cropping intensity is the most logical way to raise the total production from the country’s limited resources. Since the nutrient turnover in soil plant system is considerably high in intensive farming, neither the chemical fertilizers nor the organic and biological sources alone can achieve production sustainability. Even with balanced use of chemical fertilizers high yield level could not be maintained over the years because of deterioration in soil physical and biological environments due to low organic matter content in soils. In this context and as a further response to economic depression, and also to conserve and improve soil fertility the concept of INM system has been adopted (Quamruzzaman, 2006). The integrated use of low dose of NP fertilizers with different organic fertilizers such FYM, compost, Cajanus Cajan, and bone meal significantly increased maize grain yield in Bako area (Negassa et al, 2003). It improves stem height, number of leaves, branches and dry matter. Moreover number of flower plant$^{-1,}$ number of fruits plant$^{-1,}$ percentage of fruit set and average fruit weight) of tomato also increases significantly. (Roy, 1986). At the same time the integrated use of inorganic fertilizer and organic manure results in important yield attributes like fruit setting, plant height, number of primary branches per plant, and total soluble solid contents (Patil et al., 2004).

Organic fertilization results in low yields with high vitamin C content, where as mineral fertilization gave higher yields with lower vitamin C content. If organic and mineral fertilizers are used they increase the yield and vitamin C (Dumas et al., 2003). Fruits and vegetables grown with INM treatment have higher levels of cancer-fighting antioxidants, higher mineral levels and higher phytonutrients (plant compounds which can be effective against cancer) than conventionally grown foods (American Chemical Society, 2003). Lycopene has been reported to be a good indicator for fruit maturation. Lycopene contents are highest for INM and lowest for the organic manure only (Lopez et al., 1996). Pimpini et al. (1992) stated that INM results in improved fruit color of processing tomato that is mainly because of Lycopene. Organic manure along with sulfur containing fertilizers gave the highest sweetness, typical tomato flavor, and overall acceptance (Heeb et al., 2005).

Use of Inorganic Fertilizer and its Risk.

Green plants are autotrophic in that they manufacture the carbohydrates, proteins, lipids and other organic compounds they require by photosynthesis. Some plant substances require inorganic elements and compounds for their manufacture. The metallic and non-metallic elements required by plants are obtained by absorption from the soil solution by root hairs. Nitrogen occurs as nitrate ions (NO_3^-), sulphur as sulphate ions ($SO4^{2-}$) and phosphorus as phosphate ions ($PO4^{3-}$) (Anonymous, 2001).

In agriculture, when farmers grow and harvest crops year after year the system may become unbalanced since more nutrients are taken out of the soil than are replaced by normal decay. Thus the soil may become 'exhausted' and infertile. The problem may be alleviated by ploughing in plant remains such as corn crop stubble, by adding fertilizers and by practicing crop rotation. Ploughing improves the drainage, aeration and texture of soil (Anonymous, 2001).

Function of minerals fertilizer in plant.

Table 3. Roles of minerals in plant.

Minerals	Role
Nitrate	Reduced to nitrite by nitrate reductase during amino acid synthesis. Used in the synthesis of proteins, nucleic acids, chlorophyll and many coenzymes.
Phosphate	Component of DNA and RNA and of energy carrying coenzymes, such as ATP. Component of phospholipids found in cell membranes.
Sulphate	Component of sulphur-containing amino acids (e.g. cysteine) and some proteins. Component of coenzyme A. Deficiency causes 'chlorosis' (yellowing of leaves due to a failure in chlorophyll synthesis
Potassium	Required as a cofactor for some photosynthetic enzymes. Deficiency causes yellow and brown leaf margins and premature leaf death.
Magnesium	Component of chlorophyll molecules. Deficiency causes 'chlorosis due to a failure to synthesis chlorophylls. Magnesium pectate is a component of the middle lamella of cell walls

Source bio fertilizer, 2001.

Exclusive use of chemical fertilizers tends to lead to a loss of soil humus and thus soil crumb structure is lost, resulting in poor aeration and drainage. The eventual result is that plant roots cannot absorb oxygen for respiration and so cannot absorb salts efficiently. This result in poor crop growth and low yields. The nitrates that are not absorbed are dissolved in rain water and washed (leached) out of the soil into ponds and lakes, streams and rivers. If excess fertilizer has also been applied, then nitrates from this also leach into waterways. Phosphates may be eroded from soils and reach waterways. This over-fertilization of waterways by nitrates and phosphates is called eutrophication (Anonymous, 2001).

Effect on Agricultural Production and Productivity

The rates of grain cereal production yield in the past 10-20 years have showed that markedly decreases. Agricultural inputs such as nitrogen (N) and phosphorus (P) have continues to increases. For instance, in Chinese grain yield increases by 10% from 1996 to 2005, where the use of mineral fertilizer increases by 51% (Cassman et al., 2010). There is no doubt that the Green Revolution in the world during the late 1960s brought self-sufficiency in food grain production, mainly through the increase in rice and wheat crop yields the two main crops which play an important role in the world for food security point of view. However, the excessive use of fertilizers and pesticides, and the neglect of organic manures for these crops, has resulted in the deterioration of physical, chemical and biological health of the rice and wheat-growing soils. Owing to the deterioration of the health of these soils, the productivity of the rice–wheat cropping system has now either got reduced or in some places has become constant for the last decade. Plant nutrients are often supplied to agricultural system in the form of chemical fertilizer. Nitrogen, phosphorus, and potassium are three primary nutrients may be used to promote plant growth and development. When commercial fertilizer are applied at the rates that exceed the plants ability to remove the nutrients at a given growth stage fertilizer runoff occur; this runoff may be harm full to near water. N recovery efficiency for cereal production (rice, wheat, sorghum, millet, barley, maize, oat. and rye is approximately 33%. This means that large amount of N is lost in the soil–plant system.

Effect on Environmental Quality and Ecosystems.

Inorganic fertilizers are not without their share of problems. The over-supply of nutrients from inorganic and organic sources in excess of plant needs and in the absence of a mechanism to bind the nutrients to the soil, can lead to environmental contamination. Soil nitrate concentrations in excess of plant absorption needs, for example, allow the soluble nitrate to be carried away in ground water to contaminate surface waters and underground aquifers. Consumption of water high in nitrate (and nitrite) has been linked to "blue baby syndrome," goiter, birth defects and heart disease, and may be involved in the creation of carcinogenic compounds within the body that can cause stomach, liver and esophageal cancers (Conway and Pretty 1991). Leaching and run-off of nitrogen and phosphorus into rivers, lakes, and inlets, can cause eutrophication. Over accumulation of nutrients in water that promotes alga over production. This algal over-production damages the marine environment (ecosystem) as it starves plant and animal aquatic life of both the light necessary for photosynthesis and the oxygen needed to breathe. When in excess to plant needs, nitrogen also escapes into the atmosphere as nitrogen gas and various nitrous oxides. In the upper atmosphere, nitrous oxides react to form acid rain which can be damaging to crops, acidifies soil and water, and contributes to property damage. Large amounts of fertilizer, however, either escape into the atmosphere, leach to groundwater, or run off the land to create an excess of nutrients in the environment. Other major sources of excess nutrients result from the burning of fossil fuels, fiber production, and nutrients in wastewater produced by humans, livestock, aquaculture and industry.

Effect on Climate Change

Fertilizers are not directly toxic either to wild animals and plants or to us. Under certain conditions, though, they play an important role in chemical reactions in the environment that result in significant pollution. Excess nutrients causes air pollution, water, soil and marine degradation, loss of biodiversity and fish, destruction of ozone and provide additional global warming potential. Toxic algal blooms and hypoxic (lack of oxygen) zones undermine coastal ecosystems and their contribution to meeting climate change. 50% of N losses from applied fertilizers are caused by leaching, Denitrification of nitrate, and volatilization of ammonia, reducing the efficiency with which they are used as well as exacerbating environmental problems in the hydrosphere, troposphere, and stratosphere. N loss in the tropics is about 56% of the N fertilizer applied. This high N loss not only increases cost of crop production but also creates the problem of environmental pollution. This high N loss not only increases cost of crop production but also creates the problem of environmental pollution (Gruhn et al., 1995).

Cause of Overuse and Misuse of Inorganic Fertilizer.

Managing nutrients efficiently is relevant to food and energy security, water quality and availability, biodiversity and fisheries, and climate change. It is estimated that the food security of half of the world's population is dependent on fertilizer use. But much of the fertilizer is not actually utilized by the crops to the cost of farmers and the environment. Human activities produce around 120 m tones of reactive nitrogen each year, but only a third is used by the target plants. Some 20 m tones of phosphorous are mined every year and nearly half enters the world's oceans - 8 times the natural rate of input. At the same time some areas suffer from nutrient shortages. In sub Saharan Africa agriculture is the primary industry but it has the lowest fertilizer application rate in the world, accounting for 1% of global use of synthetic fertilizer, with its consequent impact on food production. Many of the world's freshwater lakes, streams, and reservoirs suffer from eutrophication (excess nutrients). Millions of people depend on wells for their water where nitrate levels are well above recommended levels. In developing countries an estimated 90% of wastewater, a major source of excess nutrients, harmful to health and ecosystems, is discharged as untreated into waterways and coastal areas. Nitrous oxide is a powerful greenhouse gas estimated to be responsible on current levels for about 10% of the net anthropogenic global warming potential from such gases. There are a number of contextual issues on inorganic fertilizer use. First, the food security of one half of the world's population rests on the application of nitrogen and phosphorous fertilizers. Secondly, nearly one billion people are affected by insufficient food production, a major factor being a shortage of the nutrients from fertilizers. In sub-Saharan Africa, agriculture is the region's primary industry, but it has the lowest fertilizer application rate in the world, accounting for 1% of global use of synthetic fertilizer on some estimates.

Precautions while Applying INM

The concern of INM grown in recent years; that the uses of fertilizer, particularly inorganic fertilizers, can lead to serious environmental consequences. Environmental contamination of this type, however, is largely a problem in the developed world and a few regions of the developing world. As fertilizers make up a small share of the total production costs in many developed countries, farmers often apply fertilizer in excess of recommended levels in order to ensure high yields. Over application of inorganic and organic fertilizers is estimated to have boosted nutrient capacity in the soil by about 2,000 kilograms of nitrogen, 700 kilograms of phosphorus, and 1,000 kilograms of potassium per hectare of arable land in Europe and North America during the past 30 years (World Bank, 1996). Such oversupply of nutrients can lead to environmental contamination, which often has negative consequences for humans and animals. Over application of nitrogen, for example, allows the nutrient to be carried away in groundwater and to contaminate surface water and underground aquifers. Ingestion of nitrate can be toxic to humans and animals when it transformed within the body into nitrite, which affects the oxygen-carrying ability of red blood cells. Evidence also suggests that nitrite and the carcinogenic compounds it can create may also lead to goiter, birth defects, heart disease, and stomach, liver, and esophagus cancers (Conway and Pretty, 1991).

Constraints in Dissemination and Implementation of INM.

The low efficiency of the extension services also contributed substantially to the low contribution rate of science and technology to agricultural development (Fan and Youhuan, 1999). Low levels of education and insufficient trainings to improve agricultural knowledge of farmers in developing countries are another constraint for extension of nutrient management technology. Though about 70–80 percent of farmers do not know that fertilizer application rates should accord with soil fertility and target yield levels, also most of them did not know how to determine the fertilizer rate and application time satisfactorily. Improvement of education (formal or informal) and updated technology training to farmers will make an important contribution to improve the provision of agricultural technical extension programmers (He, 2000).Common constraints encountered by the farmers in adoption of INM technology are follows.

- Non availability of FYM
- Difficulties growing green manure crops.
- Non availability of bio fertilizer.
- Non availability of soil testing facilities.
- High cost of chemical fertilizers
- Non availability of water
- Lack of knowledge and poor advisory services.
- Soil conditions
- Lack improved varieties.

CONCLUSION AND RECOMMENDATION

Integrated nutrient management holds great promise in meeting the growing nutrient demands of intensive agriculture. It can also help in maintaining production sustainability without deterioration in quality of plants environment. The benefit of integrated nutrient management increases water holding capacity of the soil, amount of nutrients in the soil, make soil resistance to diseases and make soil the soil able to withstands drought. also play great role in sustainable agriculture , i.e. use of modern practices to meet present and future food and fiber needs without in way damaging the basic resources such as soil and water for future use. The goals of integrated management are;

- ➢ To maintain soil productivity
- ➢ To ensure productive and sustainable agriculture.
- ➢ To reduce expenditure on costs of purchased inputs by using farm manure and crop residues etc.
- ➢ To utilize the potential benefit of green manure, leguminous crops and bio fertilizers.
- ➢ To prevent degradation of environment
- ➢ To meet the social and economical aspiration of the farmers without harming the natural resource base of agricultural production.

Food security and environmental quality is current issues of the world. World population increases from time to time, especially developing countries it shows the great progress; this population pressure causes the ecosystem murderer and environmental disturbance. They results food insecurity and the living things the ecosystem are harmed (affected). Action should be taken to fight against food insecurity and environmental quality; these include combination of different disciplines. Nothing alone did not have given any change in the ecosystem. The combination of nutrient management (integrated nutrient management) which enhance the food security and environmental quality in sustainable manner.

Therefore, the following things are recommenced for the study.

- Using the combination of inorganic and organic fertilizers.
- Using correct time of application and method of application of both inorganic and organic fertilizer.
- Management of crop residues on farm in order to maintain soil fertility.
- The rate of uptake of inorganic nutrients from the soil would be balanced by the rate of return of in organic nutrient to the soil.

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