# Effect of Integrated Nutrient Management on Growth, Yield, Nutrient Uptake, ~~NUE~~ Nutrient uptake efficiency and Economics of Baby Corn (*Zea Mays*. L): A Review


## ABSTRACT

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After rice and wheat, maize (*Zea mays* L.) is the third most significant cereal crop and has the biggest potential for output. One new trend in the food processing industry's efforts to diversify and add value to maize is the farming of baby maize, or maize grown for vegetables. A young, unfertilized, dehusked maize ear that has just started to multiply is called baby corn (the baby phase of the maize cob). It is usually harvested when the silk is between two and three cm long, two to three days following silking. Depending on the agro-climatic circumstances, baby maize can be grown three to four times a year after maturing for 60 to 75 days. As a *pre-kharif* crop with a brief growing phase, baby maize provides a distinct benefit by making use of fields that would otherwise stay fallow during the periods when rice and wheat are turning over. Higher earnings can be made from the early harvest and selling of baby maize ears. Additionally, untranslocated photosynthates remaining in the green stover can be used as a good source of nutrient-rich green fodder for live stock, which boosts the production of dairy products and meat.

As the crop with the highest nutritional content, baby maize needs exceptionally high-quality nutrients to be used efficiently and to increase yield. Although the production of baby corn can be increased by applying artificial fertiliser, doing so will eventually compromise the sustainability of the expanding field. Furthermore, farmers' financial stability and soil health can be preserved by replacing a portion of chemical fertilisers with organic sources of nutrients. However, the replacement of 25% and 50% of the nitrogen with organic sources (FYM/~~Vermicpompost~~Vermicompost/Poultry Manure) had a greater positive impact on the production of baby maize, the yield of fodder, the quality and economics of the nutrient uptake, and the soil fertility status.


## INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop next to rice and wheat and has the highest production potential among the cereals. For diversification and value addition of maize as well as growth of food processing industries, recent development is of growing maize as 'baby corn'. Depending on the cultivar grown, baby maize is the ear of maize (*Zea mays* L.) harvested young, particularly when the silk has not emerged or has not been fertilised. Baby corn ears that have been dehusked are consumed both raw and cooked. It is possible to cultivate many crops of baby maize in a year in peri-urban or adjacent areas of cities, which would increase the farmers' revenue Citation. Furthermore, following harvesting, the immature plants can be fed to calves as they provide green, soft, succulent, nutrient-dense, and appetising feed that is easier for farm animals to digest. Thus, it will assist in bringing in additional revenue for the farmers. In addition to supporting the dairy industry and crop diversification, baby corn creates jobs and adds value because it's used in the production of several value-added products and in the making of various recipes, such as soups, pickles, cutlets and deep-fried baby corn with meat, rice and other vegetables.

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Because baby maize has a high planting density and is a nutrient-exhaustive crop, it is crucial to maintain soil productivity and heavy yields through the use of integrated nutrient management (INM) Citation. In addition to increasing the supply and availability of soil nutrients to the crop and boosting the activity of beneficial soil microorganisms due to the availability of more organic matter content, the implementation of integrated nutrient management (INM) practices in the field will lower production costs and increase farmers' economic yield. This will sustain soil fertility and productivity.

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Use of various feeding forms and amounts has a significant impact on baby maize yield and quality. Since baby maize is a labor-intensive crop, managing its nutrients needs a lot of attention (Naveen and Saikia, 2020). The growth performance and yield of baby maize are significantly impacted by the amount of applied inorganic fertiliser, such as urea, SSP, and MoP, and organic manure, such as cowdung, vermi-compost, and poultry manure (Mahmood *et al*., 2017). Given the current energy crisis, high inorganic fertiliser prices, and risky effects on environmental health in addition to raising production costs, it is imperative that fertilisers be used sparingly.

Using organic manure will preserve the sustainability of the environment. Adoption of INM will lower production costs, boost farmers' profits, and improve crop availability and supply of nutrients from the soil through enhanced activity of beneficial soil microorganisms due to an increase in soil's organic matter content.

## EFFECT OF ORGANIC MANURE:

A detailed understanding of the pattern of nutrient release from organic sources is crucial to prevent nutrient stress since nutrient release and crop demand synchronisation are crucial to organic management. Therefore, in addition to improving soil health overall, the development and application of effective nutrient management techniques are essential for the successful production of organic baby corn and for enhancing the quality and yield of the final product. One of the key elements in increased production is optimal plant geometry, which promotes greater photosynthate synthesis by efficiently harvesting as much solar energy as possible and using subsurface resources. According to (Saif *et al*. 2003), planting patterns for baby maize have a major impact on both growth and yield characteristics.

Integrating Farm Yard Manure (FYM) with conventional fertilisers has been shown to greatly boost maize output (Sharma and Gupta, 1998). A significant place is held by FYM among the organic manures. The FYM appears to work directly by boosting crop production through the cellular permeability, respiratory process acceleration, or growth hormone action. Through biological breakdown, it provides the plant with N, P, and K in forms that are accessible to it; correspondingly, it includes 0.50, 0.17, and 0.55 percent of N, P, and K(Citation). The main advantages of applying FYM are the accumulation of secondary and micronutrients, balancing the harmful impacts of soil salinity, acidity, and alkalinity, and enhancing soil health components. The application of FYM increases the N fertilizer's use efficiency. Long-term tests incorporating different food and fodder crop sequences and inorganic and inorganic sources of nitrogen have revealed that substituting 50% of mineral fertilizer-N by FYM in different agro-eco areas sustains production (Yadav *et al,* 2001).

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Vermicompost is becoming more and more popular as a source of organic manure for crop production because of its increased nutritional content, quicker mineralization, and acceptability. It has been claimed that vermicompost increases soil quality, improves soil physical, chemical, and biological qualities, and yields exceptionally high crop productivity. Scientific research has demonstrated that vermicompost is an incredibly nutrient-dense, potent plant growth stimulant and protector. Additionally, it makes additional fertilisers in the soil more effective. According to Sinha and Herat (2002), vermicompost typically includes 0.80 to 1.10% N, 0.40 to 0.80% $P_2O_5$, and 0.80 to 0.98% $K_2O$.

Poultry manure can play a significant role in promoting the growth and health of maize plants due to its nutrient content. Poultry manure is a rich source of organic matter and essential nutrients, including nitrogen, phosphorus, potassium, and various ~~micronutrients~~micronutrients (Source). Here are some of the roles of poultry manure in maize cultivation:

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1. **Nutrient Supply:** Poultry manure is a valuable source of essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K), which are crucial for the overall growth and development of maize plants. These nutrients support processes like photosynthesis, energy transfer, and root development.

2. **Organic Matter:** Poultry manure adds organic matter to the soil, improving its structure, water retention, and aeration. The organic matter also enhances microbial activity in the soil, promoting nutrient cycling and making nutrients more accessible to maize plants.

3. **Improving Soil Fertility:** The continuous application of poultry manure can improve soil fertility over time. It helps replenish nutrient levels in the soil, reducing the need for synthetic fertilizers. This can contribute to sustainable and environmentally friendly farming practices.

4. **Enhanced Water Retention:** The organic matter in poultry manure improves the water-holding capacity of the soil. This is beneficial for maize plants, especially during periods of drought, as it helps the soil retain moisture, ensuring a more consistent water supply for the plants.

5. **pH Regulation:** Poultry manure can help regulate soil pH. While it is slightly acidic, the buffering capacity of organic matter in the manure can help maintain a more neutral pH in the soil. Maize plants typically prefer slightly acidic to neutral soil conditions.

6. **Microbial Activity:** Poultry manure provides a habitat for beneficial microorganisms in the soil. These microbes contribute to the breakdown of organic matter, nutrient cycling, and the formation of symbiotic relationships with plant roots, promoting overall soil health.

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Global interest in alternative agricultural practices has been sparked by growing knowledge of the health and environmental risks linked to the extensive use of chemical inputs. On the other hand, organic farming is the most effective and a good management strategy for guaranteeing the health of the agro-ecosystem, ~~taking into account~~considering issues with soil biological activity, biological cycles, and biodiversity (FAO, 1999). Crop production's increased use of inorganic fertilisers is linked to the quality and health of the soil (Yadav, 2003). People's interest in organic farming has increased due to growing awareness of crop quality and soil health (Sharma *et al*., 2008). Maintaining soil fertility and achieving maximum crop yields with the best possible input levels need the balanced application of nutrients from organic sources such as farm yard manure, chicken manure, vermicompost, green manuring, neem cake and biofertilizers (Dahiphale *et al*, 2003). When organic matter is added to soil, there is a noticeable and large build-up of organic carbon. Additionally, organic manures leave behind a sufficient ~~amount~~number of residues for the crop that comes after it in the sequence (Singh *et al*, 1996; Baruah *et al*, 1999).

## EFFECT OF INORGANIC FERTILIZERS

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Nitrogen is the most crucial ingredient in maize cultivated to produce baby maize. It is an essential component of protein molecules, alkaloids, nucleotides, enzymes, chlorophyll, and other substances. It also plays a crucial function in the growth and development of plants. Being a component of phosphatases, sugar, ADP, and ATP, phosphorus is essential for energy transformations and plays a part in the fundamental processes of photosynthesis. Potassium is necessary for the synthesis of carbohydrates as well as for ~~defence~~defense against illness and ~~unfavourable~~unfavorable weather. It is essential for the development of plant parts' growth and reproductive processes as well as for improving the uptake and utilisation of phosphorus and nitrogen. The cytoplasm, which controls the osmotic potential of glycophytic plant species' cells and tissues, is where potassium cations are most prevalent.

## EFFECT OF ~~INM~~ Integrated Nutrient Management

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Using inorganic fertilisers raises production costs and has negative consequences on the environment's health in addition to helping to produce the most baby maize possible. Therefore, the environmental sustainability will be preserved for future generations by the prudent use of nutrients from various sources such as chemical, organic, and biofertilizers (Dadarwal *et al*., 2009). By implementing INM principles in the field, farmers will experience economic sustainability and a decrease in production costs. Because there is more organic matter in the soil, it also improves the crop's supply and availability of nutrients and raises the activity of helpful soil microbes. muriate of potash, Urea, calcium ammonium nitrate, ~~zinc ,~~zinc, diammonium phosphate, sulphate, and so forth are examples of chemical fertilisers. Farm yard manure (FYM), poultry manure (PM), compost, goat manure, green manure, and so forth are examples of organic sources. Phosphate-soluble bacteria, Azolla, biospirillum, and biopotash are examples of biofertilizers. Farmers' economic production is increased by INM methods, which also improve crop nutrient availability and increase the amount of organic matter in the soil, which in turn stimulates the activity of beneficial soil microorganisms.

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## EFFECT OF INM ON GROWTH ATTRIBUTES

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According to Dhake *et al*. (2016), the largest plant height (222.30 cm) was seen at harvest when the nitrogen level of N4 (200 kg $ha^{-1}$) was recorded. At 30 DAS (9.89) and harvest (13.46), the plant with the greatest number of leaves ($plant^{-1}$) had the same amount of nitrogen. According to Snehaa *et al*. (2017), during the summer and kharif seasons, greater values of plant height (61.4 and 64.7 cm), LAI (3.6 and 4.1), and DMP (850.3 and 920.7 kg $ha^{-1}$) were observed when the recommended dose of inorganic fertiliser ($T_1$) (150:60:40 kg $ha^{-1}$ NPK) was applied. Vermicompost ~~@~~ at 5t $ha^{-1}$ was shown to have the highest values of growth parameters, such as plant height (59.6 and 62.21 cm), LAI (3.5 and 3.8), and DMP (812.3 and 893.5 kg $ha^{-1}$) among the various organic sources ($T_3$). Mahapatra *et al*. (2012–2013) found that plants treated with a combination of 75% RDF + 2.5 t vermicompost combined with biofertilizers had the maximum plant height and number of leaves per plant. When bio-fertilizers were combined with 75% RDF and 2.5 t vermicompost per hectare, the LAI and dry matter production were measured. According to Gurmeet *et al*.'s (2015) analysis, treatment $T_3$ (5 ~~tonnes~~tons of FYM plus 100 kg of organic N ha-1) significantly increased plant height compared to all other treatments at 15 and 20 DAS. In 2012, Barod *et al*. conducted a field study at IARI in New Delhi to examine the effects of various nutrient sources on baby maize yield and economics. They found that using organic manures increased the growth parameters of root dry weight, leaf area index (LAI), and root volume more than using inorganic fertilisers. In the eastern Himalayan region of Arunachal Pradesh, Choudhary and Kumar (2013) found that vermicompost was associated with higher growth parameters such as plant height, number of leaves, leaf area, leaf area index, and dry matter accumulation. Poultry manure was found to be the second most popular organic nutrient source. In a study regarding the way nutrient management affects infant maize growth and yield, Aravinth *et al*. (2011) found that taller plants (180 cm), higher LAI (3.51), and more dry matter (7107 kg $ha^{-1}$) were achieved with prescribed fertiliser + vermicompost concentrations of 5 t $ha^{-1}$. Applying 75% (NPK) + FYM (4.5 t $ha^{-1}$) + Biofertilizer (Azotobacter + Phosphate solubilizing bacteria (PSB)) significantly shortened the time it took for plants to reach the tasseling, silking, and milky stages, as well as several other growth characteristics like plant height, leaf area index, dry matter, crop growth rate, and relative growth rate, according to research done in a field experiment by Rasool *et al*. (2015). Meena *et al*. (2012) conducted research at IARI on the effects of nutrient sources on the growth, productivity, and economics of the baby corn, potato, and mung bean cropping system. They found that the highest growth parameters, such as plant height (151.8 cm), LAI (4.02), and dry matter (67.7 g plant-1), were recorded when using N90 P20 K25 + bio-compost equivalent to 30 kg N $ha^{-1}$. In Naira, Andhra Pradesh, Keerthi *et al*. (2013) investigated the impact of nutrient management techniques on sweet corn. The maximum growth metrics were reported at 20, 35, and 50 DAS when 180-7560 kg NPK ha-1 + vermi-wash was applied. This was comparable to 180-7560 kg NPK $ha^{-1}$ + vermicompost.

## EFFECT OF INM ON YIELD ATTRIBUTES AND YIELD

Maximum girth of a cob (3.61 cm), maximum length of a cob (8.00 cm), maximum weight of a cob with husk (48.30 gm), and maximum weight of a cob without husk (8.50 gm) were recorded with treatment $T_{13}$ NPK Zn (100% RDN + fish amino acid (0.5%) at 20 DAS and 35 DAS, according to Andhale *et al*. (2015). Dhake & Associates (2016) they stated that the $N_4$ (200 kg $ha^{-1}$) nitrogen level considerably raised the number of cobs per plant (3.07). With the application of 200 kg of nitrogen, the largest cob length (9.03 cm) and diameter (1.48 cm) were also recorded. The weight of the cob, both with and without husk, was notably highest at nitrogen level $N_4$ (200 kg $ha^{-1}$) at 49.85 g and 9.53 g, respectively. Level $N_4$ (200 kg $ha^{-1}$) also had a substantial impact on cob yield per plant (30.12 g), cob production per plot (1.68 kg), and cob output per hectare (62.45 q) without husk. The application of 100% recommended dose of nitrogen as inorganic + vermicompost @ 5 t $ha^{-1}$ + 3 sprays of 3% panchagavya positively influenced the yield parameters, namely cob length (22.43 cm), cob diameter (5.32 cm), number of cobs per plant in baby maize (2.81), cob yield (6845 k $ha^{-1}$), and stover yield (21.00 t $ha^{-1}$) This information was reported by Stalin P. and B. Priyanka in 2019. $T_1$ (150:60:40 kg $ha^{-1}$NPK) recorded the highest values of yield attributes, such as the number of cobs, cob length, cob girth, cob weight, cob yield, and fodder for the summer and *kharif* seasons, among the various treatments, according to Snehaa *et al*. (2017). This was comparable to $T_3$ (vermicompost @ 5 t $ha^{-1}$). According to Kabir *et al*. (2018), $N_2$ (75% N from urea + 25% N from cowdung) had the greatest number of cob $plant^{-1}$ (1.502), followed by $N_4$ (1.335) (75% N from urea + 25% N from chicken manure). According to Dinesh *et al*. (2019), applying 75% RDN using poultry manure and 25% RDN with chemical fertiliser ($T_7$) resulted in a higher number of cobs—2.67 cobs per plant—than expected. This treatment yielded a similar number of cobs as the application of 50% RDN through poultry manure + 50% RDN through chemical fertiliser ($T_8$) and 25% RDN through poultry manure + 75% RDN through chemical fertiliser

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($T_9$). According to Walia and Patidhar (2019), the treatment with 50% N from FYM + 50% N from inorganic fertilisers ($T_1$) had the highest yield attribute, including cob length, cob girth, number of grains per cob, 100 grain weight, grain yield, and stover yield. According to Mahapatra *et al*. (2018), the application of 75% RDF plus organic manure as vermicompost at 2.5 t ha$^{-1}$ in combination with bio fertilisers significantly increased the yield attributes, such as the number of cobs plant$^{-1}$ (2.82), baby corn length (9.28 cm), baby corn girth (4.99 cm), and baby corn weight (8.45 g). In a study on how nutrient management affects baby corn growth and yield, Aravinth *et al*. (2011) found that applying the recommended dose of NPK + vermicompost ~~@~~ at 5 t ha$^{-1}$ resulted in more cobs plants$^{-1}$, longer, wider, heavier and higher baby corn yield than recommended NPK alone.

Vermicompost was found to be the most effective among the several forms of organic manures in an experiment to examine the impact of organic manures on infant maize output in Uttarakhand. The highest baby maize yield was achieved by applying vermicompost (1.92 kg bed$^{-1}$) + bio spirillum + (10 ml kg$^{-1}$ of seed) + biophos (10 ml kg$^{-1}$ of seed) + bio potash (10 ml kg$^{-1}$ of seed) (Ranjan *et al*., 2013). In the eastern Himalayan region of Arunachal Pradesh, Choudhary and Kumar (2013) conducted a study on maize production, economics, and soil productivity under various organic source of nutrients. They found that yield was attributed to characters such as the number of cob plants per plant, the number of grain rows per plant, the diameter and length of the cob, test weight, shelling percentage, and yield. Using a field experiment on baby corn in clayey soil, Shivran *et al*. (2015) found that the maximum yields of green cob (2414 kg ha$^{-1}$) and green fodder (19389 kg ha$^{-1}$) were obtained when 75% of the N was applied through fertiliser and 25% using vermicompost.

## EFFECT OF INM ON NUTRIENT UPTAKE

According to Bharathi *et al.* (2020), different nutrient management strategies affected nitrogen uptake during each of the three crop growth stages under investigation. The N uptake by plants was significantly higher in 100% N with 12.5 t ha-1 of FYM ($T_{12}$) at the 30, 60, and harvest stages. This was comparable to 25% N as poultry manure + 75% N as inorganic ($T_3$) and 25% N as goat dung + 75% N as inorganic ($T_4$). At all three stages of sweet corn growth, the 50% N as biogas slurry + 50% N as inorganic ($T_{10}$) combination showed the lowest uptake of N. In a field experiment conducted in Tirupati, Tamil Nadu, Kumar *et al*. (2009) investigated the effects of integrated nitrogen management on the yield, nitrogen uptake, and soil fertility status of baby maize. They found that the highest nitrogen uptake was achieved when 100% N was applied by fertiliser. In a field study with baby maize grown in clayey soil, Shivran *et al*. (2015) found that applying 150–75 kg N-$P_2O_5$ ha$^{-1}$ increased the amount of N, P, and K absorbed by cob and fodder throughout harvest and increased the amount of N and P that was accessible in the soil following harvest. In experiments conducted on baby maize, Sharma and Banik (2014) of the Indian Statistical Institute, Kolkata, found that the crop considerably acquired a maximum of 68 kg N, 11 kg P, and 84 kg K ha$^{-1}$ with 150% RDF. According to a study conducted by Sobhana *et al*. (2012) at IARI, New Delhi, on plant population and nutrient requirements for infant maize hybrids, the maximum uptake of N, P, and K was observed with each increase in NPK level. With each increase in nutrient level from the control to the highest dose (N187.5 P32.75 K62.5 kg ha-1), the K uptake improved considerably. The P content of baby maize, husk and fodder increased with each increment in NPK levels from the control to the highest level of nutrients, i.e., N187.5 P32.75, K62.5 kg ha$^{-1}$. However, after application of N150 P26.2 K.50 kg ha$^{-1}$, N concentrations in fodder and K contents in baby corn husk and fodder were the highest. According to Aravinth *et al.* (2011), the highest nutrient removal of 164.5 kg N, 22.9 kg P, and 184.5 kg K ha$^{-1}$ was recorded in the combined application of recommended NPK+ vermicompost @ 5 t ha$^{-1}$, which was comparable with recommended NPK + FYM @ 12.5 t ha$^{-1}$. This field experiment was conducted in Chidambaram, Tamil Nadu, and examined the yield and nutrient uptake of baby maize. According to the Indian Statistical Institute in Kolkata, West Bengal, the results of a field study on the application of chemical fertiliser, arbuscular mycorrhiza (AM), and Azospirillum to baby maize showed that maximum nutrient uptake was recorded by 100% RDF (150: 60: ~~60:~~60: N: P2O5: K2O kg ha$^{-1}$) + AM + Azospirillum. The same treatment resulted in the highest residual soil fertility in terms of NPK (Sharma and Banik, 2014). In a field experiment conducted in Varansi, Uttar Pradesh, Singh *et al*. (2010) found that sources of N and fertility levels had a substantial impact on nutrient intake. The administration of 100% N using an inorganic fertiliser source resulted in noticeably higher nutrient uptake than integrated nutrient management techniques. After baby corn was harvested, the available N, P, and K status of the soil was significantly increased by applying 75% NPK + 2.25 t vermicompost ha$^{-1}$ along with biofertilizer, according to a field experiment by Dadarwal *et al*. (2009) in Udaipur, Rajasthan, to assess the impact of integrated nutrient management on baby corn. Keerthi *et al*. (2013) reported that the application of 180-75-60 kg NPK ha$^{-1}$ + vermin wash at 20, 35, and 50 DAS recorded the highest values for NPK uptake, which was

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comparable to 180-75-60 kg NPK $ha^{-1}$ + vermicompost. One effective method for managing nutrients in the environmental balance is integrated nutrient management, according to the findings of an agronomic field trial carried out at the University of Agriculture Faisalabad, Pakistan (Ali *et al*., 2012).
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## EFFECT OF INM ON SOIL MICRO FLORA

An experiment was conducted at Horticultural College and Research Institute, Tamil Nadu Agricultural University, by Muthu ~~Kumar~~ and Ponnuswami (2014) Periyakulam to elucidate the effect of different irrigation regimes and organic manures on rhizosphere microbial population of noni (Morinda citrifolia). Among the different treatment combinations, $M_2S_4$ (100% WRc through drip irrigation+ 50% farmyard manure+ 50% vermicompost) registered the highest rhizosphere bacteria, fungi, actinomycetes, Azotobacter, Azospirillum and phosphobacteria population.

Microbial populations were determined in this study, and results showed that Intercropping of baby corn with clusterbean ($M_1$) recorded significantly higher number of bacterial CFU (13.46 X $10^7$). Significantly higher number of fungal colonies (24.22 X $10^3$) were observed in sole baby corn and significantly higher actinomycetes population (65.00 X $10^4$) in baby corn + okra system ($M_2$). Among nitrogen management practices application of 50% RDN through goat manure + 50% RDN through poultry manure ($S_3$) recorded significantly higher microbial ~~population.(~~population (Rekha et al.,2017).



## EFFECT OF INM ON NUTRIENT USE ~~EFFICIENCIES( NUEs~~EFFICIENCIES(NUEs) OF BABY CORN

Huang *et al*., (2018) found that to enhance both maize productivity and the environment, more effective N fertilizer use is required.

With reports averaging 33% of fertilizer nitrogen (N) recovered by the crop, the NUE for world cereal production is poor (Raun and Johnson 1999).

In maize just 30–50% of applied nitrogen fertilizers (Smil 2002; Ladha *et al*., 2005) and 45% of applied phosphorus fertilizers (Smil 2000) are estimated to be used for crops today.

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It is appropriate to revise the dose of fertilizer as N 210 kg $ha^{-1}$ and $K_2O$ 80 kg $ha^{-1}$ were optimum for higher maize production with grain yield of 10.95 t $ha^{-1}$ and ~~10.54 ton~~10.54-ton $ha^{-1}$, respectively in silty clay loam soil condition of mid hill of Nepal. The use of higher rate of inorganic P and K fertilizer improved the efficiencies of N by the maize and the case was also valid for efficiencies of P and K. N 150 kg ha-1 resulted the highest $PFP_N$, $PNB_N$, $IE_N$ and $PE_N$ whereas N 210 kg $ha^{-1}$ showed the higher $AE_N$ and $RE_N$. These findings can help to direct the use of chemical fertilizers in maize-based cropping systems thereby maintaining nutrient use efficiency. (Rawal *et al*., 2021)

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## EFFECT OF INM ON ECONOMICS

According to Dhake *et al.* (2016), the benefit-cost (B:C) ratio for baby maize cultivation shows that the treatment combination $N_4K_1$ (200 kg $ha^{-1}$ + 25 kg $ha^{-1}$) had the highest benefit:cost ratio (1: 2.56), followed by N4K3 (200 kg $ha^{-1}$ + 75 kg $ha^{-1}$) (1: 2.47) and $N_4K_2$ (200 kg $ha^{-1}$ + 50 kg $ha^{-1}$) (1: 2.44). Stalin P. and B. Priyanka (2019) reported that of the different treatments applied, the treatment with the highest gross and net return of Rs. 47400 and Rs. 98287, respectively, and the least amount of nutrient uptake was observed in the control treatment. The treatment with 100% recommended dose of nitrogen as inorganic + Vermicompost ~~@~~ at 5 t $ha^{-1}$ + 3 sprays of 3% panchagavya ($T_{12}$) was found to be effective. In the end, the control treatment showed the lowest return per rupee invested of 1.5, with the least gross and net returns of Rs. 58885 and Rs. 26845. Mahapatra *et al*. (2018) found that the combined application of 75% RDF+2.5 t vermi-~~-~~compost+mixed bio fertilisers produced the highest gross return of 115550 $ha^{-1}$ and net return of 77921 $ha^{-1}$. RDF had the highest B:C ratio, followed by mixed biofertilizers and 75% RDF+FYM ~~@~~ at5.0 t ha-1. Application of RDF + vermicompost ~~@~~ at 5 t $ha^{-1}$ + seed treatment with Azotobacter and PSB recorded considerably greater gross returns, net returns, and B:C ratio of wheat above control, according to Verma *et al*. (2015) from a field trial in Kanpur (U.P.). In an experiment conducted at ANGRAU, Hyderabad, Rani *et al*. (2011) found that when the crop received the necessary amount of N through fertiliser (90 kg N/ha), it produced more baby corn green ear yield and green fodder yield (16.95 t ha$^{-1}$), which resulted in higher net returns (33,127 ha$^{-1}$) and a ~~benefit:cost~~benefit: cost ratio (2.3). In a field study using baby corn grown in clayey soil, Shivran *et al*. (2015) found that applying 120–60 kg N-$P_2O_5$ ha$^{-1}$ had the highest net returns (26502 ha$^{-1}$) and B:C ratio (2.22). In a study conducted in Rajendranagar, Hyderabad, Prathyusha and Hemalatha (2013) found that the harvest index was considerably greater at 120 kg N ha$^{-1}$.

## CONCLUSION

Therefore, it can be concluded that utilising different nutrient sources—including inorganic, organic, and biofertilizers~~—~~recorded greater growth, yield, and economics than using only chemical fertilisers. The careless application of chemical fertilisers is contributing to environmental degradation, soil erosion, and acidification in addition to the growing global food insecurity. The majority of the researchers had all recommended an alternative method for managing soil that is sustainable, environmentally friendly, economical, and improves soil fertility, productivity, nutrient uptake, and status while lessening the negative environmental effects of inorganic fertilisers is the integrated natural manure (INM). The availability of nutrients in the soil as well as microbial activity both are greatly increased by the Integrated Nutrient Management system. By keeping the pH stable and raising gross return, INM improves the physiochemical state of the soil. Therefore, an option that is flexible in minimising the usage of chemical sources of nutrients while maximising their effectiveness and the financial reward to farmers is integrated nutrient management, or INM. However, the economics, baby maize yield, fodder production, and enhanced soil fertility status were all better when 25% of the nitrogen was replaced with organic sources, such as FYM or vermicompost, in addition to biofertilizers.

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