Farmers' Perspective on Integrated Nutrient Management in Sugarcane

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ABSTRACT

Integrated nutrient management is the maintenance of soil fertility and plant nutrient supply at an optimum level to sustain the desired crop productivity. Though integrated nutrient management has been considered a broad based remedy against soil fertility decline, the management practices advocated by scientists, however, have been lot more ignored by the farmers when compared to control of insect pests and diseases. Hence, this study was purposively carried out in Sakthi Sugars, Tamil Nadu as they have been advocating nutrient management practices and the mill had also been supplying micronutrients, compost and biofertilizers to the cane growers. The operational area of the mill comprises five divisions from which 150 cane growers were selected at random for conducting the study. The yield data was recorded from the individual farms and the sociological appraisal was done through personal interview. It was found that all the respondents applied chemical fertilizers apart from application of farm yard manure, bio fertilizer, and micronutrient application in correct dosage. Almost half of them applied either farm yard manure or Sakthi bio compost @5-15 t/ac and 30% of them applied green manures like sun hemp or daincha as in situ *application. Every farmer had some reason or other for adopting nutrient management practices* viz., *to get more yield and thereby increase in net profit, increase the soil health, improve the physical condition of soil and reduction in fertilizer cost. Yield analysis indicated that nearly three fourth of the respondents got 25% more yield and 23% of the respondents got 50% more yield due to adoption of nutrient management practices as compared to the average yield of normal practice. However, there are some restrictions in farmers adopting nutrient management practices and it includes high fertilizer cost, non-availability of inputs in time, lack of awareness about micronutrients, lack of knowledge about bio-fertilizers & trash mulching, lack of availability of farm yard manure and if available high cost of the manure and lack of availability of good quality bio-fertilizers. Nevertheless, it was seen that nutrient management practices resulted in increased productivity with reduction of total fertilizer cost.*

Key words: *Farmers perception; Sugarcane; Integrated nutrient management; Advantages; Economics;*

Agriculture invariably removes plant nutrients from the soil and these have to be replenished. While recycling and transfer of nutrients from non-crop areas, crop residues and animal manures can partially make up for exports of mineral nutrients by harvested products, application of mineral fertilizers is essential to meet crop requirements and to increase crop production in many farming situations. Nutrient management is one of the major issues of concern for the farmers throughout the world. Sugarcane growers in particular, need to pay attention to this issue as few crops put such heavy demand on soil resources, as sugarcane (*Hartemink and Wood, 2000)*.

The concept of integrated soil and nutrient management implies practices such as appropriate crop rotations, cover crops, use of manure, crop residues and fertilizers, conservation and no-tillage, moisture management etc (*Gopalasundaram et al., 2012)*. Integrated nutrient management (INM) approach improves and sustains soil fertility and provides a sound basis for crop production systems to meet the changing needs through optimization of the benefits from all possible sources of plant nutrients in an integrated manner *(FAO, 2011)*.

There are scientific studies conducted in research stations which state that adoption of INM practices leads

to higher yield and net returns and reduced cost of cultivation. Though nutrient management is an issue of concern for cane growers as the crop puts a heavy demand on soil resources, adoption of INM practices is still a reservation and the present study attempts to gain insights into this fast spreading technology. The primary objectives of the study are to study the profile of farmers adopting integrated nutrient management practices, factors for adoption of INM practices, to study the advantages of INM practices, to analyze the constraints in adoption and to work out the economics involved in adopting INM practices compared to control.

METHODOLOGY

The study was conducted by using descriptive type of research design applying ex-post facto approach and the respondents were selected among farmers adopting integrated nutrient management practices. Sakthi Sugars Ltd., is a leading private sugar mill in Tamil Nadu state in South India and is a pioneer in introducing recent scientific technologies in cane cultivation. The study was purposively carried out in Sakthi Sugars as they have been advocating INM practices and the mill had also been supplying micronutrients, compost and biofertilizers (solid and liquid formulations) to the cane growers. The average cane yield recorded in the reserved area of the sugar mill during 2011-12 was 107.5 t/ha which was on par with the state average yield of 105 t/ha. The operational area of the mill includes Erode and Tirupur districts with three zones of operation. This comprises five divisions from which 150 cane growers were selected – Avalpoondurai (52), Modakurichi (28), Erode (26), Ganapathypalayam (19) and Chennimalai (25) at random for conducting the study.

The yield data was recorded by purposive interview schedule from the individual farms and the sociological appraisal was done through personal interview. Their responses were tabulated and the data were analyzed using mean and percentage analysis as the statistical tools to analyze the collected data.

RESULTS AND DISCUSSION

The present study focused on the profile of farmers adopting INM practices, the adoption level, advantages in adoption, constraints faced and the economics involved in following INM practices. The details are discussed below:

Demographic profile of farmers: Demographic profile of the participants of the study indicated that they were mostly middle aged (35-50 years) (50.0%) to old aged (more than 50 years) (43.3%), literate with secondary education (30%) to graduate level (16.6%). All of them had agriculture as their main occupation with 50 per cent having more than 25 years of farming experience and 23.2 per cent had more than 20 years of experience in cane cultivation. Majority of them (83.3%) owned more than 5 acres of land.

The mass media channels utilized by the farmers include television (farm programs), radio, newspaper (news related to agriculture, development programs, farmers fair etc) and farm magazines. Only 21.33 per cent of the respondents had access to all the mass media channels, while remaining 78.67 per cent of the respondents had access to only selected mass media channels.

Social participation in the study includes membership/ office bearers in co-operative sugar mill, agricultural credit society, village panchayat, farmers association, farmers' discussion group and self help group. The medium farmers had higher social participation (52%) followed by large farmers (34%) and medium farmers (14%).

The study also revealed that 82.67 per cent of the respondents contacted sugar factory extension personnel and the rest (17.33%) sought other sources like neighbours, relatives, family members and friends.

Crop rotation followed by the farmers was sugarcane plant - ratoon followed by paddy, maize, turmeric, banana, tapioca or vegetables.

Adoption level of INM practices: The basic concept underlying integrated nutrient management is the maintenance or adjustment of soil fertility and of plant nutrition at an optimum level for sustaining the desired crop productivity through optimization of the benefits from all possible sources of plant nutrients in an integrated manner (*Gopalasundaram, 2008).*

The various components of INM as adopted by the respondents include application of farm yard manure, green manure, bio-fertilizer, micro-nutrients, chemical fertilizer, trash mulching / trash composting and vermicomposting (Table 1).

Application of chemical fertilizer: It is evident from Table 1, that all the respondents were applying chemical fertilizers apart from application of farm yard manure,

Table 1. Adoption of various INM practices (N=150)

INM practices	No.	%	Rank
Application of farm yard manure	77	51.3	VI
Green manuring using Sunnhemp	46	30.7	VIII
Application of bio fertilizer	95	63.3	V
Micronutrient application	128	85.3	II
Application of chemical fertilizer only	150	100	I
Trash mulching in furrows	113	75.3	IV
Application of Sakthi special	127	83.3	III
Trash composting	44	29.3	IX
Application of FYM / Sakthi compost	75	50.0	VII
Vermicomposting	32	21.3	X

green manuring, bio-fertilizer, and micronutrient application. The average of the chemical fertilizers used by the respondents is given below:

Urea: 66 per cent respondents applied urea @300kg/ ac and 34 per cent of the respondents applied urea @250-300kg/ac.

Di Ammonium Phosphate: 76 per cent of the respondents applied DAP @100-150 kg/ac and 24 per cent of respondents did not apply DAP due to high cost

Potash: All respondents applied potash @ 50-150kg/ac

Complex fertilizers (20: 20: 0: 13): 73 per cent of the respondents applied Complex @100-150kg/ac and 27 per cent of respondents did not apply complex fertilizers.

DAP is applied as basal fertilizers after forming ridges and furrows. Complex, urea and potash fertilizers are applied as top dressing. Though the amount applied varied, they still have knowledge about the importance of fertilizers.

Application of FYM/ Compost: Among the respondents, 50% were applying either FYM or Sakthi bio compost @5-15 tonnes/ac. Farm yard manure is taken from their own farms or very rarely procured from nearby farms. Sakthi biocompost is available at the rate of Rs. 140 per tonne and is being supplied by the mill itself.

Green manuring: Nearly 30% of the respondents were applying green manures like sun hemp / daincha as *in situ* application. The green manure crops seed is sown before planting and allowed to grow up to 40 days in the field and incorporated by using gauge wheel or rotavator. After that cane planting was taken up. This increases the nitrogen content of the soil and makes the crop grow lush green. Farmers who apply green manures reduce up to 10% of nitrogenous fertilizers application during top dressing. This also helps to sustain the physical condition of the soil.

Application of biofertilizer: Around 63% of the respondents were applying bio fertilizer in the liquid form. The liquid bio-fertilizer like Azospirillum, and phospobacteria were mostly used along with FYM. 500 ml of liquid bio fertilizer is mixed with 200 kg of FYM and kept overnight and applied next day in the base of the clump on 40th day and again on 70th day after cane planting. Liquid biofertilizer is available @ Rs 385 per litre from International Panacea Ltd. and is made available to the growers through the sugar mill.

Micronutrient application: Almost 83% of the respondents were applying Micronutrients (Sakthi special) as basal along with FYM. This is one of the important reasons for getting more average yield compared to other factories (43 t/ac). Sakthi special is a micronutrient formulation consisting of iron (4.75%), zinc (6.00%), magnesium (1.25%), manganese (0.35%), copper (0.20%) and boron (0.20%). 40 kg of micronutrients mixture (Sakthi special) is mixed with 200 kg of FYM and applied as basal during planting. This supplies almost all the nutrients for the germinating bud and helps in making the crop grow with vigour.

Trash mulching: Among the respondents, 73% were practicing trash mulching after detrashing and applying as *in situ* in the field itself. Detrashing is done during the 5th month of the crop by almost all the farmers in the study area and 27 per cent of them use it as fodder for cattle. Less than 50 per cent of them detrashed during 7th month as recommended. The trash is left in the alternate furrow under normal irrigation and if it is drip irrigated field it is left in all the furrows.

Effect of INM on cane yield: Cane yield is a function of many direct and indirect factors; the direct factors being stalk population per unit area and single cane weight. The indirect factors include genetic potential of the variety, soil factors, nutrient use efficiency, planting pattern etc (*RajulaShanthy and Muthuswamy, 2012).*

The harvest data of the participants (Fig. 1) revealed that the range in increase in cane yield due to adoption of INM practices was 1.0 to 38.7 t/ha. Nearly 43 per cent of the respondents could obtain an increase in cane yield of 10-20 t/ha due to the adoption of INM practices in time. Another 21.33 per cent could get an additional yield of 20-30 t/ha whereas 22.33 per cent

got up to 10 tons additional cane yield due to INM practices. The data also indicates that a meager of 10 per cent got a quantum jump of 30-40 tons more yield. However, the variation in yield increase is highly location specific and depends on the soil and other crop management practices followed by the farmers.

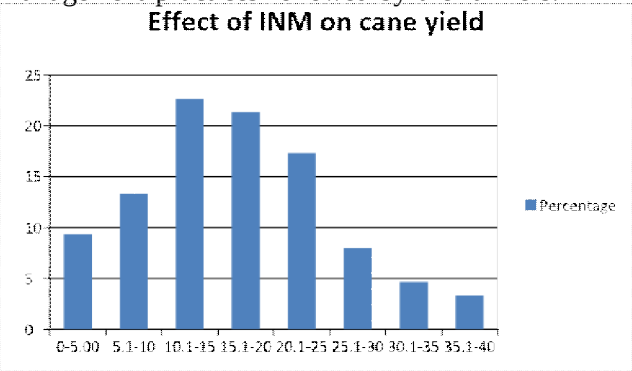

Fig.1 . Effect of INM on cane yield

The results are in line with the findings of *Manimaran, 2009* that wider row spacing of 120 cm row spacing with cross planting method along with successive intercropping (blackgram followed by sunnhemp) and application of recommended dose of fertilizers (275:62.5:112.5 kg NPK /ha) along with *Acetobacter* @10 kg/ha and foliar spraying of micronutrient mixture (1% at 45 and 75 DAP) recorded the highest single cane weight, cane and sugar yield.

Table 2. Performance of sugarcane technologies

Technology demonstrated	Cane yield (t/ha)		Difference in yield (t/ha)
	IP	FP	
Alternate furrow trash mulching	167.90	156.80	11.10
Bio-fertilizer	169.21	160.30	8.91
Integrated nutrient management	176.40	159.70	16.70
Integrated nutrient management	161.13	151.15	9.98
Bio-fertilizer application	134.00	125.08	8.92
Bio-fertilizer application	102.50	100.00	2.50
Bio-fertilizer application	146.50	136.55	9.95
Bio-fertilizer application	137.50	132.50	5.00

Performance of INM in Frontline Demonstrations: Sugarcane Breeding Institute, Coimbatore has been conducting FLD since 2001-02 in Coimbatore, Erode and Tirupur districts in Tamil Nadu. The results of the demonstrations conducted on INM are given in Table 2. Farmers' Practice (FP) may be read in general as narrow spacing of 90 cm with the variety Co86032 without the technology under demonstration.

There was considerable improvement in yield in all the demonstration plots over the farmers' practice. Since the demonstrations are conducted in farmers' fields they serve as a motivation for the farmers in the neighbourhood as well. While demonstrating the technologies in the farmers' fields, the factors contributing to higher crop production and field constraints of production were also studied to get feedback information *(Rajula Shanthy, 2011).*

INM Technology Assessment and Refinement: The results of experiments conducted in farmers' fields by Sugarcane Breeding Institute as part of Institute Village Linkage Programme (*Thiagarajan and Rajula Shanthy, 2004)* are given hereunder (Tables 3&4).

Table 3. Refining bio-fertilizer application in sugarcane

Practice	Bio-fertilizer*
Yield improvement	7.74% (over farmers' practice)
CB ratio	2.4

**Bio-fertilizer:* Phosphobacteria @ 10 kg/ha and Azospirillum @ 5 kg/ha on 30 days after planting, and 5 kg Azospirillum on 60 days after planting.

Table 4. Assessing performance of sugarcane with green manure

Practice	Green Manure*
Yield improvement	5.95%
CB ratio	2.63

***Green Manure:* Intercropping with sunhemp and *in situ* ploughing before flowering

Outreach initiatives: The results of such experiments are being disseminated through training programs for farmers and cane development personnel, farmers' mela, extension literature etc. Sugarcane Breeding Institute has also prepared video films on INM practices, bio-fertilizers and organic recycling which are being distributed to the end users.

Advantages of adopting integrated nutrient management practices: For any new innovation, there are some advantages and disadvantages during and after adoption. If the farmers perceived that the advantages of the new technology are more than its disadvantages, then it leads to adoption of that technology. So, the study on advantages and constraints are very important in the survey of any new technology. The survey indicated that every farmer had some reason or other for adopting INM practices (Table 5).

Table 5. Advantages of integrated nutrient management practices

Advantages	No.	%	Rank
Increase in cane yield	150	100	I
Increase in net profit	150	100	I
Improvement in soil health	140	93.3	II
Increase in cane weight	140	93.3	II
Increase in cane length	125	83.3	III
Organics microbial population	120	80.0	IV
Reduction in fertilizer cost	120	80.0	IV
Reduction of weeds	120	80.0	IV
Possibility of multi-ratooning	115	76.6	V
Increased fertilizer use efficiency	115	76.6	V
Labour saving	105	70.0	VI
Stabilization of productivity	90	60.0	VII
Additional income by intercropping	55	36.6	VIII

The advantages realized by the respondents are discussed in their order of importance as expressed by them.

Increase in cane yield and net profit: All the respondents indicated that due to adoption of INM practices the cane yield was increased and thereby net profit was increased. When the farmers had farm yard manure from their own farms, the cost incurred was very less. *Babu et al., 2007* reported that an additional cane yield of 14-27 t/ha was realized with different organic manures plus inorganic fertilizers over inorganic fertilizers alone.

Improvement in soil health and cane weight: Nearly 93 per cent of the respondents indicated that due to adoption of INM practices the soil health was improved and also cane weight was more. Application of farm yard manure, biocompost and biofertilizers creates a conducive environment for the development of soil flora and soil fauna and this makes the soil healthy. Increase in cane weight could be the probable reason for increased cane yield. *Gana, 2008* reported that in Nigeria, the best sugarcane growth and yield were obtained from the plots incorporated with cowdung at 10 t/ha and also supplemented with inorganic fertilizer at 120 N-60P2O5-90k2O per hectare.

Increase in cane length: Application of nutrients in adequate quantities increased the cane length as well and this was realized by 83 per cent of the respondents. Increased cane length gives the crop a better field stand and it adds to the cane weight also.

Organics improve microbial population: Almost 80 per cent of the respondents indicated that due to adoption increased and reduced the fertilizer cost.

Reduction in fertilizer cost: In fields where farm yard manure, biofertilizers and Sakthi special are applied, the farmers reduce urea application by 10-15 per cent. This results in the cost of fertilizers.

Reduction of weeds: Due to adoption of INM practices the weed population was also reduced. This is especially true with trash mulching.

Increased fertilizer use efficiency: Almost 76 per cent of the respondents indicated that due to adoption of INM practices the fertilizer use efficiency was increased.

Possibility of multi-ratooning: Since the soil health is maintained, there is also a possibility of multiratooning without much reduction in the yield.

Other advantages: Adoption of INM practices stabilizes the productivity by way of increasing soil health. Sowing of pulses as intercrop not only increases soil health but also provide additional income the farmers. Intercropping also reduces weed infestation considerably.

Table 6. Constraints in INM

Constraints	No.	%	Rank
High fertilizer cost	145	96.6	I
Timely application is not possible	141	94.0	II
Lack of knowledge in micronutrients	133	88.7	III
Application of green manure *in situ* is cumbersome	128	85.3	IV
Lack of availability of fertilizer in time	124	82.7	V
Less awareness about micronutrients	119	79.3	VI
Laborious work	115	76.6	VII
Lack of knowledge about biofertilizer	113	75.3	VIII
Lack of availability of FYM	108	72.0	IX
Non availability of quality biofertilizer	103	68.7	X
Green manure is costly	72	48.0	XI
Yield not up to expected level	44	29.3	XII
Lack of knowledge about trash composting	40	26.6	XIII
No constraints	12	6.6	XIV

Constraints faced by farmers in adopting integrated nutrient management: A main part of this survey was to find the constraints faced by the respondents due to the adoption of INM practices (Table 6). The perception of the individual on INM was measured in all possible dimensions. To introduce any new technology into a social system, the technology must perform well than the already existing technology in the system. The system members must observe its performance directly in their

own situation and evaluate them in terms of their own reference. It the members of the system are convinced with the performance of new technology, and also if the calculated negative factor percentage (constraints) is less than the positive factor percentage (advantages), then the technology can be easily diffused among the members of a social system.

Farmers come across a number of constraints in adopting integrated nutrient management practices and are discussed in theirs order of importance.

High fertilizer cost: Due to the increasing fertilizer cost, 96% of the respondents faced problems in adopting INM practices. With every passing year, there is escalation in the prices of fertilizers.

Timely application is not possible: Nearly 93 per cent of the respondents faced the problem of timely application of fertilizer. This was mainly due to non availability of inputs at the right time.

Application of green manure in situ is cumbersome: About 87 per cent of the respondents felt that due to lack of availability of fertilizer, it could not be applied in time. Application of green manure *in situ* is cumbersome because it has to be sown before planting and after 45 days it has to be incorporated in the soil and it also involves laborious work.

Less awareness about micronutrients: Majority of the respondents felt that they don't have enough knowledge about the quantity of micronutrients to be applied. Around 80 per cent of the respondents had less awareness about micronutrients and the contents therein of the micronutrients mixture and its function. This needs further extension efforts to popularize the INM technologies.

Lack of knowledge about biofertilizer and laborious work: Around 76% of the respondents were not having much knowledge about biofertilizer usage and its function and also felt it was more laborious work. Though biofertilizers are in vogue for quite some time, the application of this technology is yet to gain momentum. Farmers have not yet realized the full benefit of this technology.

Lack of availability of FYM: At least 73 per cent of the respondents faced non availability of FYM but managed with bio compost. The population of cattle is on the decline in rural areas and hence the unavailability of farm yard manure.

Non availability of good quality biofertilizer: Though biofertilizer is a promising technology, there are not many firms who are into production of biofertilizers. Even the firms who produce biofertilizers are not much bothered about the quality and hence 70 per cent of respondents felt that good quality biofertilizer was not available in time.

Yield not up to expected level: More than one fourth (29%) of the respondents reported that there was not much increase in cane yield due to the application of various nutrient formulations.

Lack of knowledge about trash composting: Trash composting is yet another fast disseminating technology; however, they lack complete knowledge about the procedure of trash composting.

Economics involved in INM: Relative economic advantage is an important criterion for adoption of any new technology. The economics involved was worked out with adoption of INM practices compared to conventional farmers practice. Nearly three fourth (73%) of the respondents got only 25 per cent more yield due to adoption of INM as compared to average yield of normal practice. Almost 23% of the respondents got 50% more yield in comparison to average yield of normal practice.

Overall yield analysis :

Av. yield obtained by respondents		
Through conventional management	:	99.23 t/ha
Average yield after adopting INM	:	120.63 t/ha
Yield increase	:	21.40 t/ha
% of yield increase due to INM	:	21.5%
Quick review of economics		
Cost of cultivation without INM	:	Rs.133655/ha
Cost of cultivation with INM	:	Rs.143155/ha
Addl. yield expected on an average	:	20 t/ha
Value of additional yield after deducting harvest charges (Rs. 500 /t)	:	Rs.30000/ha
Addl. expenses after adopting INM	:	Rs.9500/ha
Total Addl. income (after INM)	:	Rs.20500/ha

The study indicated that the respondents could obtain up to 21.5 per cent increase in cane yield due to the adoption of INM practices. The farmers practicing integrated nutrient management practices could get an additional income of Rs.20500/ha with minimum additional expenditure increasing the net return of the farm. Hence adoption of integrated nutrient management has relative advantage over the existing farmers' practice.

Table 7. Test of comparison using paired 't' test

Criteria	Conve-ntional method	With INM practices	df	SE of differ-ence	't'
Mean	99.23	120.63			
SD	8.976	10.774	149	0.925	8.5228
SEm	1.639	1.967			
N	150	150			

Paired t test results: Paired 't' test was done to find the significance in variation of the yield levels with and without adopting integrated nutrient management practices (Table 7). The paired t-test is used to compare the values of means from two related samples, for example in a 'before and after' scenario. The t ratio for a paired t test is the mean of the differences between each set of pairs divided by the standard error of the differences. The two-tailed P value here is less than 0.0001. By conventional criteria, this difference is considered to be statistically significant. Confidence interval: The mean of group one minus group two equals -7.880; 95 per cent confidence interval of this difference: from -9.771 to -5.989. At 95 per cent confidence interval of this difference, the 't' value is 8.5228 at df = 149 with standard error of difference = 0.925.

With the adoption of INM practices, there is a definite scope for reduction in cost of cultivation specifically towards fertilizers and additional income due to increase in cane yield.

CONCLUSION

INM is an age old practice but its importance was not very much realized in the pre-green revolution era due to low nutrient demands of the subsistence agriculture. Though INM has been considered a broad based remedy against soil fertility decline, the management practices advocated by scientists, however, have been lot more ignored by the farmers when compared to control of insect pests and diseases. In an extension perspective, such differences in perception between the users of the soil and the experts are generally common. Nevertheless, in the present study, it was seen that adoption of integrated nutrient management practices resulted in reduction of total fertilizer cost with increased productivity and thereby additional income to the practicing farmers.

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