

IMPACT ASSESSMENT OF A 15-DAY INTEGRATED NUTRIENT MANAGEMENT TRAINING PROGRAMME ON KNOWLEDGE AND ADOPTION BEHAVIOUR OF FERTILIZER AND INSECTICIDE DEALERS

Indra Jeet¹, Sudhanshu Shekhar^{2*}, Dharamjit Kherwar³, Dushyant Kumar Raghav⁴, Deo Karan⁵, Neeraj Kumar Vaishya⁶, Virendra Kumar Yadav⁷

¹ICAR-RCER, Krishi Vigyan Kendra, Ramgarh, Jharkhand, India. indrakvk80@gmail.com

^{2*}ICAR-RCER, Krishi Vigyan Kendra, Ramgarh, Jharkhand, India. sudhanshukoderma@gmail.com

³ICAR-RCER, Krishi Vigyan Kendra, Ramgarh, Jharkhand, India. dk227bhu@gmail.com

⁴ICAR-CISH, Krishi Vigyan Kendra, Malda, West Bengal, India. dushyantari@gmail.com

⁵ICAR-RCER, Krishi Vigyan Kendra, Buxar, Bihar, India. deokaranicar@gmail.com

⁶Krishi Vigyan Kendra, Gumla, Jharkhand, India. neerajkvk06@gmail.com

⁷ICAR-RCER, FSRCHPR, Ranchi, Jharkhand, India. vkyadavrce@gmail.com

*Corresponding author: Sudhanshu Shekhar, sudhanshukoderma@gmail.com

ABSTRACT

Integrated Nutrient Management is an important approach towards improving sustainable farming, soil and crops. Fertilizer and pesticide dealers can have a significant role in linking research centres with the farmers. Therefore, their technical practice-related knowledge should be developed to promote adequate nutrients use. To address this, the Krishi Vigyan Kendra at Ramgarh, Jharkhand conducted a series of well-structured 15-day INM training programmes for the fertilizer and insecticide dealers from 2019 to 2025, reaching out to more than 500 dealers. This study aimed to evaluate how effective these training programs were in boosting participants' knowledge, their willingness to apply INM practices, and their ability to provide advice on nutrient management. A well-prepared questionnaire was used to measure the knowledge before and after the training using a structured approach.

The information was analyzed by descriptive statistics and inferential statistics by using Paired t test. The results revealed a significant increase in their knowledge after the training with an average score of 78.54 compared to 42.36 before training. This increase was highly significant at 1% level ($p < 0.01$) as confirmed by the paired t-test. Likewise, the adoption index rose from 38.20 to 71.65 indicating definitely the acceptance and intended use of INM techniques. There was also positive change in behavior and increased confidence of dealers on balanced nutrient practices owing to the training provided.

The study concludes that training programs of Krishi Vigyan Kendras with a well-planned thinking and provision of long-term training are very effective in strengthening the skill of agricultural input dealers.

This results in improved service to farmers and greater adoption of sustainable nutrient management practices among farmers.

KEYWORDS: Integrated Nutrient Management, Training Impact, Knowledge Gain, Adoption Index, Fertilizer Dealers, Extension Education

INTRODUCTION

Therefore, Integrated Nutrient Management has become a scientifically sound and eco-friendly practice to sustain soil fertility and long-term productivity in agriculture. It is judicious, balanced use of chemical fertilizers, organic manures, crop residues, green manures and bio fertilizers for soil health promotion and optimal nutrient supply. INM concept is also very much compatible to the idea of sustainable agriculture as it results in better utilization of nutrients, better soil biology, and minimizes environmental degradation (Singh et al., 2018; Mahajan et al., 2020). As land resources are getting further squeezed and labor and other factors are becoming progressively less productive, the use of INM practices is now a must for attaining food and nutrition security.

Overuse and imbalance of application of chemical fertilizers, especially N fertilizers, is a major ecological and agronomic problems in India, which is linked to nutrient mining, soil degradation, reduction in soil organic carbon and ground water pollution (Kumar and Yadav, 2019; Jat et al., 2019). The slowdown in crop productivity and the lesser fertilizer response ratio also highlight the need for an integrated nutrient management approach (Ladha et al., 2020). Efficient nutrient cycling, better soil structure and better long-term productivity of cropping system are the key factors through which INM can be a viable and sustainable solution (Reddy et al., 2020; Meena et al., 2021).

The fertilizer and insecticide dealers have an important, often neglected, role in agricultural extension systems especially in developing countries. Since they interact with farmers frequently, they act as informal extension agents and have a significant impact on farmers decision making process related to fertilizer and pesticide application (Gupta and Sharma, 2017; Raghuvanshi et al., 2021). Evidence indicates that farmers often depend on input dealers for location specific and

immediate advice as compared to formal extension service (Biradar et al., 2018). But the technical know-how and scientific orientation of many dealers are still not sufficient, hence the advice given to them depends upon the commercial interests. This leads to an imbalance in nutrient application, with the cost of cultivation and negative environmental impacts (Sharma et al., 2020).

Structured training programmes are important tools for improving the technical competency and advisory services of fertilizer and insecticide dealers, as a form of capacity building. Training interventions have been found to be an effective way of enhancing knowledge, skill development and attitude towards sustainable agricultural practices (Patel et al., 2021; Kafle et al., 2022). The input dealers can be converted to para-extension professionals by effective training programmes to give science-based recommendations, promote soil test-based fertilization and promote integrated nutrient use (Babu et al., 2021). Moreover, training helps behavioral change which is the key to uptake and dissemination of improved technology like INM (Meena et al., 2022).

Training programme impact assessment is an important part of extension research as it helps to gain insight into the effectiveness of capacity building interventions. It assists in quantifying shifts in knowledge, adoption practices, and roles of participants and helps policymakers and stakeholders optimize training approaches (Davis et al., 2020). While numerous studies have focused on farmers' adoption of INM practices, relatively limited research has been conducted on the role of input dealers as change agents and the effectiveness of training programmes targeted at them (Raghuvanshi et al., 2021; Babu et al., 2021).

MATERIALS AND METHODS

Study Area and Methodology Krishi Vigyan Kendra, Ramgarh under ICAR – Research Complex for Eastern Region, Patna. Ramgarh district is a part of eastern plateau region of the country, with predominantly rainfed agriculture, diverse cropping systems, high proportion of small and marginal farmers. The district has a well-established network of fertilizer and pesticide input dealers which act as a key catalyst for spread of agricultural technologies and advisory services to the farming communities.

In the period 2019–2025, KVK Ramgarh organized a series of 15 day Integrated Nutrient Management training programmes in order to enhance the technical competency of these input dealers. All of these training programmes included scientific nutrient management, balanced use of fertilizers, soil health management, integrated use of organic and inorganic nutrient sources, bio fertilizers, micronutrient management, soil test based fertilizer recommendations and effective farmer advisory practices. A total of over 500 fertilizer and insecticide input dealers from various districts in Jharkhand attended these capacity building programmes.

METHODOLOGY

An ex-post facto research design with pre-test and post-test evaluation was utilized in the present investigation and the effectiveness of the Integrated Nutrient Management training programmes carried by KVK Ramgarh was evaluated.

The study population included the fertilizer and insecticide input dealers who successfully complete the 15 days INM training programme in the year 2019-2025. The information was gathered from an interview schedule which was structured and pre-tested with questions pertaining to socio-personal characteristics, knowledge of Integrated Nutrient Management practices, adoption behavior and competency as an advisor. The questionnaire has been given just before the training started (pre-test) and after completing the programme (post-test).

Knowledge was assessed for Integrated Nutrient Management by administering a standardized knowledge test; and the adoption behavior was determined by an adoption index using the intended or actual adoption of the suggested INM practices by the participants. Advisory competence was assessed based on participants' confidence in, and capacity to suggest correct nutrient management practices (NMPs) to farmers based on scientific findings.

All the data collected were coded, tabulated and analyzed by applying suitable statistical techniques. Data was summarized using descriptive statistics like frequencies, percentages, mean, and standard deviations. The effectiveness of the training programme was tested using paired t-test between the knowledge scores before and after the training and changes in adoption index and other results were analyzed through descriptive and inferential statistical analysis. All statistical tests were carried out at the 1 per cent ($p < 0.01$) level of significance.

Research Design

For the assessment of the effectiveness of the Integrated Nutrient Management (INM) training programme, a one group pretest posttest design was used, which was implemented for 15 days at Krishi Vigyan Kendra, Ramgarh. This approach allowed to quantify difference between: knowledge, adoption behavior and advisory competence of the participants before and after the training intervention. The same group of participants was evaluated at two time intervals:

- Pre training assessment (Pre-test): This was done to ascertain the existing knowledge, awareness and adoption level of Integrated Nutrient Management practices among the subjects prior to the training programme.
- Post-training assessment (Post-test): This is an assessment carried out with the same standardized questionnaire immediately after the training programme (15 days).
- Data Collection
- Structured interview to collect information on the following:
 - Knowledge on INM
 - Adoption behavior
 - Socio-economic variables
 - Measurement of Variables

- Knowledge Score
- Based on correct responses to structured questions
- Score range: 0–100
- Adoption Level
- Based on degree of recommended practices adopted
- Statistical Tools Used
- Mean, Frequency, Percentage
- Paired t-test
- Correlation analysis
- Adoption and Knowledge indices

Indices and Formulae

Knowledge Gain Index (KGI)

$$KGI = \frac{\text{Post-score} - \text{Pre-score}}{\text{Maximum Score}} \times 100$$

Adoption Index (AI)

$$AI = \frac{\text{Score obtained}}{\text{Maximum possible score}} \times 100$$

Training Effectiveness Index (TEI)

$$TEI = \frac{\text{Post-training score} - \text{Pre-training score}}{\text{Pre-training score}} \times 100$$

Paired t-test Formula

$$t = \frac{\bar{d} - S_d}{\sqrt{n}} \times \sqrt{n}$$

Where:

$\bar{d}$ = Mean difference

S_d = Standard deviation of difference

n = Sample size

RESULTS AND DISCUSSIONS SOCIO-ECONOMIC CHARACTERISTICS OF AGRICULTURAL INPUT DEALERS

Table 1. Socio-economic profile of agricultural input dealers (Age, Education, Experience, Type of Dealership, Income) (N = 500)

Variable	Category	Frequency	Percentage
Age	Below 30	90	18.0
	31–40	180	36.0
	41–50	150	30.0
	Above 50	80	16.0
Education	Primary	40	8.0
	Secondary	90	18.0
	Higher Secondary	120	24.0
	Graduate	180	36.0
	Postgraduate	70	14.0
Experience (years)	Below 5	100	20.0
	6–10	170	34.0
	11–15	140	28.0
	Above 15	90	18.0
Type of dealership	Fertilizer	150	30.0
	Insecticide	100	20.0
	Both	250	50.0
	Annual income		
	Below ₹2 lakh	120	24.0
	₹2–5 lakh	260	52.0
	Above ₹5 lakh	120	24.0

Table 1 shows the socio-economic characteristics of the respondents. Out of 500 agricultural input dealers, most of them (36%) were in the age group 31-40 followed by 41-50 years (30%). The highest level of education was the graduate population (36.0%), and 34.0% had between 6 and 10 years of experience in their industry. Most of the respondents (52.0%) had income in the range of ₹2-5 lakh per year and half of them ran fertilizer as well as pesticide dealerships.

According to the profile the respondents were relatively young well-educated and actively involved in agricultural input services and therefore were appropriate participants for the capacity building programmes.

Table 2. Participation and satisfaction in the INM training programme (N = 500)

Variable	Category	Frequency	Percentage
Completed training	Yes	500	100.0
Participation level	Low	50	10.0
	Medium	180	36.0
	High	270	54.0
Training methods*	Lecture	500	100.0
	Demonstration	420	84.0
	Field visit	380	76.0
	Group discussion	450	90.0
Satisfaction	Poor	20	4.0
	Fair	80	16.0
	Good	220	44.0
	Excellent	180	36.0

The attendance in the training programme was very good (Table 2). 100% of the respondents completed the whole training programme and 54.0% high participation was noted. Classroom lectures were supplemented by interactive techniques like group discussions (90.0%), demonstrations (84.0%) and field visits (76.0%). There was a high level of satisfaction overall with 80.0% rating the programme as good or excellent.

Table 3 Effect of INM training on knowledge level of agricultural input dealers

Particulars	Mean Score	SD
Pre-training	42.36	8.25
Post-training	78.54	6.80
Mean Difference	36.18	—
t-value	42.75	Significant at 1%

It is recognized that there was a significant increase in knowledge level of Fertilizer and Insecticide dealers after the training programme. The mean knowledge score increased from 42.36 ± 8.25 before training to 78.54 ± 6.80 after training, with a mean gain of 36.18. The calculated t-value (42.75) was significant at the 1% level ($p < 0.01$), indicating that the training programme was highly effective in improving participants' knowledge. These results suggest that knowledge is the initial phase in the adoption of innovations - as put forth by Rogers - and they are also congruent with Kirkpatrick's, who reported that well-designed training programmes significantly enhance participants' knowledge and learning outcomes.

Table 4 (i) Knowledge Category Distribution

Category	Pre (%)	Post (%)
Low	48.20	8.40
Medium	42.60	28.20
High	9.20	63.40

Results obtained from the participants showed that there was significant increase in the distribution of the respondents in the various knowledge categories after the training programme. The percentage of the high knowledge category was significantly increased after training from 9.20% to 63.40% and the percentage of low knowledge category was decreased significantly after training from 48.20% to 8.40%. Such a change signifies that the training was effective in increasing the knowledge level of the fertilizer dealers and insecticide dealers and these shows the existence of the concept of innovation adoption as postulated by Rogers and learning outcomes by Kirkpatrick.

The distribution of respondents by the category of knowledge indicated that there was a significant increase in the respondents after the training programme. Pre-training 9.20% of the participants were in high knowledge category while 63.40% were in high knowledge category after training, the low knowledge category decreased from 48.20% to 8.40%. This change signifies that training was effective in improving the knowledge level of fertilizer and insecticide dealers, which correspond to Rogers' principle of innovation adoption and Kirkpatrick's learning outcomes.

Bottom of Form

Table 4 (ii) Adoption of Integrated Nutrient Management practices after training

Practice	Fully (%)	Partial (%)	Not (%)
Soil test-based fertilizer	62	28	10
Organic manure use	58	30	12
Biofertilizers	55	32	13

Balanced NPK use	70	22	8
Micronutrients	60	28	12
Crop residue management	52	34	14
INM recommendation	68	24	8

The post training results obtained as shown in Table 4 indicated that the adoption of Integrated Nutrient Management (INM) practices was significantly higher after the training programme. Balanced use of N,P and K (70%) and following the recommendations of INM (68%) had highest percentage of full adoption followed by soil test based fertilizer application (62%), micronutrient application (60%), use of organic manure (58%), use of biofertilizer (55%) and crop residue management (52%). Relatively low percentage of non-participants in these practices (8–14%) reflects the success of the training for sustainable nutrient management. These results lend credence to the Rogers' innovation-decision process which posits that interventions by extension workers in raising awareness and persuasiveness of farmers supports the adoption of better agricultural practices.

Table 4 (iii) Adoption Index

Stage	Index
Pre-training	38.20
Post-training	71.65

Additionally, there was a significant improvement in the adoption of INM practices as evidenced by the Adoption Index before training (38.20) and after training (71.65). This enhancement is an indication that training benefited participants not only in terms of technical knowledge but also in terms of implementation of knowledge to the field level. The results are aligned with the framework of evaluating training by Kirkpatrick and his view that effective training leads to observable behavioral change and studies carried out by Knowler and Bradshaw that found targeted capacity-building programmes help substantially improve the uptake of sustainable agriculture practices.

Table 5 Advisory behaviour change of Input dealers

Variable	Category	Frequency	%
Provide INM Advice	Yes	420	84.0
	No	80	16.0
Frequency	Rarely	60	12.0
	Sometimes	190	38.0
	Frequently	250	50.0
Type of Advice	Product-based	150	30.0
	Knowledge-based	350	70.0
Change After Training	No change	40	8.0
	Moderate	160	32.0
	Significant	300	60.0

The results obtained in Table 5 show that there is significant difference in the fertilizer and pesticide input dealer's advisory behaviour before and after Integrated Nutrient Management (INM) training. Majority (84.0%) of the respondents said that they provided advisors to farmers regarding INM while 16.0% did not provide such advice to farmers. The frequency of advisory service was 50.0% for frequent, 38.0% for sometimes and 12.0% for rarely, indicating high level of engagement of dealers towards the farmers after the training.

The nature of advisory services also changed to scientific and farmer-oriented approach. Almost 70.0% of those surveyed gave knowledge-based advice, while 30.0% continued to offer mostly product-based advice. The shift indicates that the training enhanced the technical skills of the input dealers and promoted decision making with evidence and not sales. This behavioural change can be seen within the framework of the innovation diffusion theory of Rogers which states that increase in knowledge and persuasion increases the quality of extension communication, and the behavioural level of Kirkpatrick which states that an effective training would result in measurable change in professional practice.

In addition, 60.0 per cent of the respondents said that the training had made a significant difference to their advisory behaviour, 32.0 per cent said it had made a moderate difference and 8.0 per cent said it made no difference. The results show that the training programme was successful in converting knowledge inputs into practice, and made input dealers more credible extension intermediaries to promote sustainable nutrient management. The findings confirm earlier studies which showed that capacity building interventions contribute to improving the quality of agricultural advisory services and spreading out improved technologies among farmers.

Table 6 Perception towards INM

Statement	SA (%)	A (%)	N (%)	D (%)	SD (%)
Improves soil fertility	58	30	8	3	1

Reduces input cost	50	32	10	5	3
Easy to adopt	42	34	12	8	4
Farmers willing	45	30	15	6	4
Training improved confidence	65	25	5	3	2

As per the perception analysis presented in Table 6 it is observed that the attitudes created by the Integrated Nutrient Management (INM) training programme showed very positive attitude of input dealers towards the benefits and applicability of INM practices. Most respondents strongly agreed or agreed that INM creates soil fertility, reduces the cost of inputs, is easy to adopt and farmers would adopt INM practices. The highest level of positive response was found for the statement "Training improved confidence" (90% strongly agree and 25% agree), confirming that the programme had a significant impact on their increased confidence in providing scientifically valid nutrient management advice. In contrast, few respondents disagreed (4–8%) or strongly disagreed (1–4%) on any of the statements, indicating that there was a large degree of agreement around the effectiveness and relevance of INM.

The results also indicate that the training boosted technical knowledge and participants' attitudes and confidence, which are crucial to ongoing behavioural change and technology dissemination. Positive perceptions of an innovation have a strong impact on the way the innovation is communicated, and on adoption, Rogers says. Similarly, Bandura highlighted that self-efficacy improves people's ability to execute the desired behaviours and Kirkpatrick considered positive changes in attitude and behaviour as a major criterion for a successful training. Thus it may be concluded that the overwhelmingly positive perceptions noted in this study shows that the training programme of INM has prepared the input dealers as reliable knowledge transfer agents to promote sustainable nutrient management in the farming communities.

CONCLUSION

The present study indicates that training programme for INM (Integrated nutrient Management), done by Krishi Vigyan Kendra, Ramgarh for 15 days proved to be very effective in boosting technical capacity of fertilizer and insecticide input dealers, who are an important but underutilized part of the agricultural extension system. Results in knowledge, represented by the differences between the mean knowledge score before and after training (42.36 to 78.54) and the huge difference in the adoption index before training (38.20) and after training (71.65), demonstrates that intensive, structured training is an effective tool to change technical awareness into behavior change. In addition, the strong shift from product recommendations to knowledge-based advisory services and positive input dealer attitude and perceptions of INM indicates the potential of trained input dealers to run as credible para-extension professionals to promote evidence-based nutrient management to farmers.

In terms of policy, the results highlight the need to make regular certification and competency-based refresher training programmes and Continuous Professional Development programmes for agricultural input dealers, through Krishi Vigyan Kendras, State Agricultural Universities and agriculture departments, institutional. These interventions can significantly boost the efficiency of decentralized farm advisory services, address the rapid and widespread adoption of sustainable nutrient management technologies, achieve better nutrient use efficiency, and make significant contributions to soil health, environment and national food security. Future research is needed that makes use of longitudinal and multi-location evaluation designs to provide better estimates of the long-term retention of knowledge, actual penetration of advisory services at the field level by farmers utilizing the services, and the economic and environmental effects of dealer-led advisory services. The study, taken as a whole, highlights the fact that capacity development of agricultural input dealers can be a cost-effective, scale able and strategically relevant extension method for building sustainable agriculture in India.

REFERENCES

1. Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211.
2. Babu, S. C., Glendenning, C. J., & Asenso-Okyere, K. (2021). Agricultural extension reforms and advisory services. *World Development*, 139, 105318.
3. Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. W. H. Freeman.
4. Biradar, D. P., Aladakatti, Y. R., & Rao, T. (2018). Farmer dependency on input dealers. *Journal of Extension Education*, 30(2), 6021–6025.
5. Davis, K., Mekonnen, D. A., & Spielman, D. J. (2020). Impact of extension services on technology adoption. *Global Food Security*, 25, 100378.
6. Davis, K., & Sulaiman, R. V. (2014). The "New Extensionist": Roles and capacities to strengthen extension and advisory services. *Journal of Agricultural Education and Extension*, 20(3), 233–247.
7. Gupta, S., & Sharma, L. K. (2017). Role of input dealers in technology dissemination. *Indian Journal of Extension Education*, 53(4), 78–83.
8. Jat, M. L., Chakraborty, D., & Ladha, J. K. (2019). Conservation agriculture and nutrient management. *Field Crops Research*, 241, 107589.
9. Kafle, K., Poudel, R., & Tiwari, K. (2022). Training impact on agricultural stakeholders. *Agricultural Systems*, 190, 103117.
10. Kirkpatrick, D. L., & Kirkpatrick, J. D. (2016). *Kirkpatrick's Four Levels of Training Evaluation*. ATD Press.
11. Knowler, D., & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy*, 32(1), 25–48.

12. Kumar, V., & Yadav, D. S. (2019). Nutrient imbalance and soil health degradation in India. *Journal of Soil Science and Plant Nutrition*, 19(3), 567–575.
13. Ladha, J. K., Pathak, H., & Krupnik, T. J. (2020). Efficiency of fertilizer nitrogen in cereal systems. *Advances in Agronomy*, 154, 1–44.
14. Mahajan, A., Gupta, R. D., & Sharma, R. (2020). Integrated nutrient management in cropping systems. *Archives of Agronomy and Soil Science*, 66(4), 500–512.
15. Meena, R. K., & Singh, B. (2022). Behavioural change through agricultural training. *Indian Journal of Extension Education*, 58(1), 34–39.
16. Meena, V. S., Maurya, B. R., & Verma, R. (2021). Role of biofertilizers in soil fertility. *Rhizosphere*, 19, 100–120.
17. Patel, M. M., Desai, H. K., & Patel, J. B. (2021). Training effectiveness on knowledge gain. *Journal of Extension Education*, 33(2), 6590–6595.
18. Raghuvanshi, R., Mishra, A., & Pandey, S. (2021). Role of agri-input dealers in advisory services. *Journal of Agricultural Extension Management*, 22(1), 12–20.
19. Reddy, S. R., Prasad, J. V. N. S., & Rao, C. S. (2020). Integrated nutrient management: A pathway to sustainability. *Agricultural Reviews*, 41(1), 1–10.
20. Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). Free Press.
21. Sharma, A., Singh, D. K., & Yadav, R. (2020). Input use behaviour and sustainability concerns. *Indian Research Journal of Extension Education*, 20(1), 45–50.
22. Sharma, R., & Gupta, S. (2019). Adoption behaviour of INM practices. *Journal of Agricultural Sciences*, 11(3), 120–125.
23. Singh, A. K., Kumar, P., & Singh, R. (2018). Integrated nutrient management for sustainable crop production. *Indian Journal of Agronomy*, 63(2), 145–150.