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IMPACT OF THE DAESI PROGRAMME ON AGRI-INPUT DEALERS: A KIRKPATRICK MODEL OF EVALUATION THROUGH PCA

E. Ravi Goud[1], G. Dhanalaksmi[2] and K. Raghavendra Chowdary[3]

1 Scientist (Agril. Extn.), KVK, Yagantipalle, Nandyal-518 124
2 Sr. Scientist& Head, KVK, Yagantipalle, Nandyal-518 124
3 Sr. Scientist & Head, KVK, Banavasi, Kurnool-518 360
Email : eravigoud068@gmail.com

ABSTRACT

The present study was conducted to assess the impact of the Diploma course in Agricultural Extension Services for Input Dealers (DAESI) programme by using the Kirkpatrick four-level evaluation model, supplemented with Principal Component Analysis (PCA) to capture the multidimensional relations of training outcomes. A Longitudinal Ex-post facto evaluation designwas adopted, and all 40 trained agri-input dealers from Kurnool district of Andhra Pradesh were included in the study. Data were collected across four levels reaction, learning, behaviour, and results using structured schedules. Mean Percent Scores (MPS) and level-wise indices were computed, and a composite impact index was derived by assigning appropriate weights to each level. Descriptive statistics and PCA were used for analysis. The results revealed that the DAESI programme had a positive impact, with a composite impact index of 82.70. Among the four levels, learning recorded the highest index (86.38), followed by reaction (84.04), behaviour (80.13), and results (79.85), indicating strong knowledge and skill acquisition with relatively moderate translation into field-level outcomes. PCA identified three principal components with eigenvalues greater than one, explaining 70.55 per cent of the total variance. The components represented programme delivery and advisory effectiveness (38.72%), skill-driven business improvement (16.59%), and knowledge acquisition (15.24%). The biplot analysis indicated strong associations between skill enhancement and business improvement, as well as between advisory services, behavioural change, and input adoption. The study concludes that the DAESI programme effectively enhances the technical competence and professional orientation of agri-input dealers. However, the comparatively lower performance at the results level highlights the need for strengthened post-training support and institutional linkages to maximize long-term impact.

Keywords: *DAESI programme, Kirkpatrick model, training evaluation, principal component analysis, agri-input dealers.*

INTRODUCTION

Indian agriculture continues to play a pivotal role in the national economy, contributing about 16 per cent to the country's GDP in FY-2024 and supporting the livelihoods of more than half of the rural population in India. Despite notable achievement in food grain production crossing 320 million tonnes in recent years, productivity growth in several major crops has begun to plateau, while the cost of cultivation has steadily increased (Economic Survey, 2023, FAOSTAT, 2023). Rising input prices, erratic pest and disease outbreaks, climate variability, and imbalanced fertilizer use have significantly affected farm profitability (Birthal, *et al*., 2015, Directorate of Economics & Statistics, 2023).

The public agricultural extension system in India, which traditionally played a central role in technology dissemination, is increasingly constrained by limited manpower, inadequate resources, and expanding extension worker to farmer ratios. As a result, its outreach and effectiveness at the grassroots level have diminished over time (Babu, *et. al.,* 2012; Glendenning, *et.al.,* 2010). Latest estimates suggest that extension worker to farmer ratio in the country is less than 1:5000, which is much lower than in developed countries (Roy Burman et. al. 2021). This has led to the emergence of pluralistic extension systems, where private sector actors, particularly agri-input dealers, have become key sources of farm advisory services (Anderson & Feder, 2007; Birner *et al.,* 2009; Harikrishna et al., 2021). Agri input dealers are local private vendors who sell vital agricultural inputs- seeds, fertilizers, pesticides, farm machineries and also provides extension services to farmers. (Kumar et. al. 2020; Saklani et. al. 2025)

India has about 2.82 lakh practicing Agri-input dealers constitute one of the most accessible and frequently consulted sources of information for the farmers. Studies

indicated that 60-70 per cent of small and marginal farmers depend on local input retailers for recommendations on seeds, fertilizers, and pesticides (Ali *et. al.*, 2018, MANAGE, 2018). However, a significant proportion of these dealers lack formal agricultural education or structured extension training. Consequently, advisory services are often influenced by commercial considerations, leading to over-prescription of agro-chemicals, inappropriate dosage recommendations, and limited promotion of integrated nutrient and pest management practices. Such practices not only escalate the cost of cultivation but also contribute to pest resistance, soil health deterioration, and environmental concerns (Shetty *et al.,* 2019).

Escalating expenditure on plant protection is particularly concerning. In crops like cotton and vegetables, pesticide costs alone may account for 10-20 per cent of total cultivation expenses, often driven by prophylactic spraying and brand-driven marketing rather than need-based advisories (FAO, 2021; Peshin & Dhawan, 2009). Similarly, imbalanced fertilizer use-especially excessive nitrogen application has widened the N:P:K ratio beyond recommended levels (e.g., 7:3:1 against the ideal 4:2:1 in several states), adversely affecting yields and input use efficiency (Fertilizer Association of India, 2022; Jat *et al.,* 2018). These trends highlight the critical need for scientifically informed and ethically responsible advisory services at the last-mile interface.

Recognizing this gap, the National Institute of Agricultural Extension Management (MANAGE), under the Ministry of Agriculture & Farmers Welfare, Government of India, launched the Diploma in Agricultural Extension Services for Input Dealers (DAESI) in 2003. The programme is implemented through SAMETIs and a network of Nodal Training Institutes at district level namely Krishi Vigyan Kendras, State Agricultural Universities, District Agricultural Training Centres. The programme aims to enhance the technical competence, legal awareness, ethical standards, and extension skills of agri-input dealers through a structured one-year diploma. By equipping dealers with knowledge on crop production, integrated pest and nutrient management, soil health, seed quality, and relevant agricultural legislation, DAESI seeks to transform input retailers from mere product sellers into para-extension professionals contributing to sustainable agriculture (Davis *et al*., 2019)

Given the increasing importance of capacity-building initiatives, DAESI plays a critical role in enhancing advisory quality, promoting scientific input use, and supporting sustainable agricultural intensification. However, systematic evaluation of such programmes is essential to assess their effectiveness and impact on knowledge enhancement, behavioural change, and field-level outcomes (Kemekar and Salunkhe, 2024). Evaluation not only helps in understanding the extent to which training objectives are achieved but also provides insights for improving programme design, delivery, and policy decisions (Kirkpatrick & Kirkpatrick, 2006). Among various evaluation frameworks, the Kirkpatrick Model is widely recognized for its comprehensive and structured approach, encompassing four levels: Reaction (participant satisfaction), Learning (knowledge gain), Behaviour (application of learning), and Results (outcomes/ impact).

Thus, using Kirkpatrick's four-level training evaluation model and Principal Component Analysis to comprehend multidimensional training outcomes and their interrelationships, the current study attempts to assess the impact of the DAESI program on agri-input dealers conducted by KVK, one of the NTI of the program. In particular, it assesses how the program affects dealers' expertise, professional practices, advice behavior, and perceived results in terms of farmer satisfaction and input usage rationalization. It is anticipated that the results would shed light on how to enhance pluralistic extension systems, improve training design, and promote sustainable agricultural development.

OBJECTIVE

To assess the impact of DAESI programme on competencies of input dealers by using the Kirkpatrick four-level evaluation model, and supplemented with Principal Component Analysis (PCA) to capture the multidimensional training outcomes.

METHODOLOGY

The study employed a Longitudinal Ex-post facto Evaluation Design (Kerlinger, 1986) integrating both immediate post-training assessment and ex-post facto evaluation to capture short-term and long-term impacts of the DAESI programme conducted by the Krishi Vigyan Kendra Yagantipalle during the year 2020.

Sampling procedure

The study was conducted during the period 2020-2024 in Kurnool district, of Andhra Pradesh, onfirst batch of DAESI agri-input dealers who had successfully completed the diploma course. All the 40 trained dealers were included the study. A census (complete enumeration) approach was adopted to ensure comprehensive coverage and to avoid sampling bias.

Evaluation framework

The impact of the training programme was

evaluated using the Kirkpatrick Model of Training Evaluation (Kirkpatrick, 1994) which enabled a comprehensive assessment of both immediate and long-term impacts of the DAESI programme and comprises four hierarchical levels:

Table 1: Kirkpatricks evaluation model for the DAESI Programme

Levels	Outcomes	Measurement instruments
Reaction	Training content relevance, Trainer effectiveness, Training materials, Practical exposure, Overall satisfaction	Questionnaire
Learning	**Knowledge:** Crop production practices, Pest and disease management, Fertilizer recommendations, Seed quality standards: **Skill:** Diagnostic ability, Advisory skills, Input recommendation skills, Field problem-solving	Questionnaire and group discussion
Behaviour	Change in advisory practices, Confidence in farmer interaction, Ethical input recommendation, Professional orientation	Questionnaire and group discussion
Results	Increase in customer base, Business turnover/improvement, Number of new advisories provided	Questionnaire

Data collection

Data were collected at different time intervals corresponding to each level of evaluation to capture both short-term and long-term effects of the training.

- **Level I (Reaction):** Data were collected immediately after completion of the training using a structured questionnaire consisting of 12 feedback statements.
- **Level II (Learning):** Knowledge gain was assessed using pre- and post-training tests, along with structured schedules comprising 14 knowledge statements and 16 skill statements measured on a five-point Likert scale.
- **Level III (Behaviour):**Behavioural changes were assessed two years after training using indicators related to business ethics, confidence, and professional orientation.
- **Level IV (Results):** Data on advisory services, input supply, and business performance were collected two years after training to capture long-term outcomes.

Measurement and index construction

Responses were recorded on a five-point Likert scale (Likert, R. 1932) and converted into Mean Percent Scores (MPS) for uniformity. Level-wise indices were computed by averaging the MPS values of respective statements:

- Reaction Index
- Learning Index (average of Knowledge and Skill indices)
- Behaviour Index
- Results Index (average of advisories, input supply, and business indicators)

A Composite Impact Index was developed by assigning weights to each level (Reaction: 0.20, Learning: 0.30, Behaviour: 0.25, Results: 0.25) and aggregating the weighted scores to obtain an overall measure of training effectiveness.

Table 2 : reliability analysis of measurement scales (Cronbach's Alpha) (n=40)

Sr. No.	Level	Components	No. of Items	Cronbach's Alpha (α
1	**Reaction**	Feed back on all the components	12	0.84
2	**Learning**	Knowledge	14	0.82
		Skill	16	0.78
3	**Behaviour**	Behaviour statements	08	0.85
4	**Results**	New advisories	13	0.79
		New inputs supplied	09	0.86
		Business indicators	04	0.75

The internal consistency of the measurement scales was assessed using Cronbach's alpha, as proposed by Cronbach, L.J. (1951). The alpha values ranged from 0.75 to 0.86, indicating acceptable to good reliability of the instrument (Nunnally, J.C.1978). These results confirm that the scales used in the study were reliable for further statistical analysis.

Statistical analysis

The collected data were analyzed using both descriptive and inferential statistical techniques. Descriptive statistics such as frequency, percentage, mean, and standard deviation were used to summarize the data. Mean Percent Score (MPS) and ranking techniques were employed to assess the relative importance of different variables.

Further, Principal Component Analysis (PCA) (Pearson, K. 1901) was used to identify the underlying dimensions of training effectiveness and to reduce data complexity in these four levels. Prior to extraction, variables were standardized to eliminate scale effects. Principal components were extracted based on the Kaiser criterion (eigenvalues > 1), and factor loadings greater than 0.50 were considered significant for interpretation. Varimax rotation was applied to improve interpretability of components by maximizing variance of loadings across variables (Kaiser, 1958). The extracted components were interpreted based on the conceptual grouping of variables under the four levels of the evaluation framework. The suitability of data for PCA was assessed using the Kaiser–Meyer–Olkin (KMO) test (Kaiser, 1974) and Bartlett's Test of Sphericity (Bartlett, 1954).

RESULTS AND DISCUSSION

Level-wise impact of DAESI programme

Level 1: Reaction

The reaction level was assessed based on twelve feedback statements covering various aspects of training organization, delivery, and trainer effectiveness. The responses were converted into Mean Percent Scores and aggregated to compute the Reaction Index. The results revealed a high level of satisfaction among participants, with a Reaction Index of 84.04. This indicates that the trainees perceived the programme as well-organized, relevant, and effectively delivered. High satisfaction at this level is crucial, as it forms the foundation for subsequent learning and behavioural changes. Similar observations were reported in agricultural capacity-building programmes where participant satisfaction significantly influenced knowledge acquisition and field-level adoption of extension practices (Rakesh Kumar et al., 2022; Aparna et al., 2023).

Level 2: Learning

The learning component was measured through knowledge and skill acquisition across multiple thematic areas. The Knowledge Index (86.29) and Skill Index (86.47) were combined to derive an overall Learning Index of 86.38, which was the highest among all levels. This finding indicates that the DAESI programme was highly effective in enhancing both technical knowledge and practical competencies of the dealers. The relatively higher score for skill gain suggests that the training successfully emphasized experiential learning approaches such as field visits and practical demonstrations. The strong performance at this level implies that the programme effectively built the technical capacity required for improved advisory services. These results line with the findings of Rakesh Kumar, *et. al.,* 2022, Aparna, *et.al.,* 2023.

Level 3: behavioural change

Behavioural change was assessed through indicators reflecting attitudinal transformation, professional orientation, and advisory confidence. The Behaviour Index was computed as 80.13, indicating a moderate to high level of behavioural transformation among participants. The results suggest that the training contributed to improved confidence in providing agricultural advice and enhanced perception of the dealer's role as an extension service provider. However, the relatively lower score compared to learning indicates that translation of knowledge into behavioural change is gradual and may require sustained reinforcement through follow-up interventions. These results are supported by Jhansi, *et. al*. 2022.

Level 4: Results

The results level captured tangible outcomes in terms of advisory services, input supply, and business performance. The Results Index was found to be 79.85, which, although positive, was the lowest among all levels. This indicates that while the diploma course improved knowledge and behaviour, the translation into measurable field-level outcomes and business gains was comparatively limited. Factors such as market conditions, farmer adoption behaviour, and external institutional support may influence these outcomes. The findings highlight the need for strengthening post-training support mechanisms to enhance long-term impact. Similar findings were reported in agricultural extension studies where training improved knowledge and behaviour but required sustained support to translate into measurable economic and advisory outcomes (Ragasa & Mazunda, 2018).

Composite impact index of DAESI programme

To provide a holistic assessment, a composite impact index was constructed by assigning weights to each level based on their relative importance. The overall Impact Index was computed as 82.70, indicating a high level of effectiveness of the DAESI programme. Among the four levels, the Learning component ranked first, followed by Reaction, Behaviour, and Results. Phillips and Phillips (2016) supported the findings with similar results. Indicating that programme is highly successful in imparting knowledge and developing skills, the

translation of these gains into consistent field level outcomes and economic benefits remains comparatively moderate. Similar findings have been reported in recent agricultural training and extension evaluation studies, which emphasize that structured capacity-building programmes significantly improve technical competencies while requiring sustained institutional support for long-term behavioural and economic outcomes (Raj, 2024; Nyamweru et al., 2024).

Table3 Composite impact index of DAESI programme

Sr. No.	Level of evaluation	Index Score	Weight	Weight score	Rank
1	Reaction	84.04	0.20	16.80	II
2	Learning	86.38	0.30	25.91	I
3	Behaviour	80.13	0.25	20.03	III
4	Results	79.85	0.25	19.96	IV

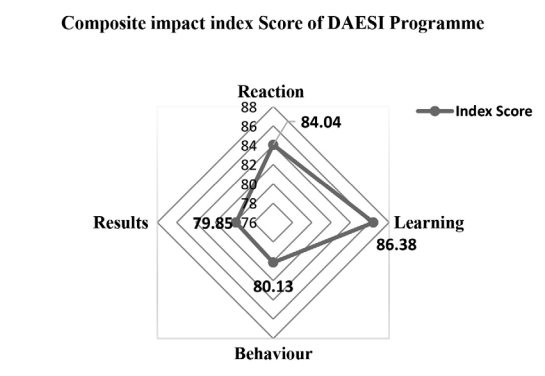

Figure 1. Radar chart illustrating the comparative composite impact index of the DAESI programme across four Kirkpatrick evaluation levels

3.3 Principal component analysis on evaluation variables

Further, Principal Component Analysis (PCA) was employed to identify the underlying dimensions of training effectiveness. The results substantiated the composite index findings, revealing that the four levels of the Kirkpatrick model reaction, learning, behaviour, and results emerged as key dimensions influencing overall impact. This confirms the multidimensional nature of the training programme's effectiveness and validates its comprehensive influence across different competency domains.

3.3.1 Descriptive statistics:

The descriptive statistics of the variables representing different dimensions of training effectiveness are presented in Table 4. The mean scores indicate that the learning components, namely knowledge (86.29) and skill (86.47), recorded the highest values, reflecting the strong learning outcomes of the training programme. This was followed by advisories provided to farmers (84.85) and behavioural change among dealers (80.12), suggesting moderate improvements in advisory services and professional orientation. Comparatively lower mean values were observed for reaction (76.83), new inputs supplied (77.28), and business improvement (77.62). The standard deviation was highest for business improvement (18.33) and behaviour (13.30), indicating greater variability among respondents in these aspects. This suggests that while the training consistently enhanced knowledge and skills, its translation into behavioural and economic outcomes varied across dealers.

Table 4. Descriptive statistics of training outcome variables used in principal component analysis (n=40)

Sr. No.	Variable	Mean	Std. Deviation
1	**Reaction**	76.83	8.768
2	**Knowledge**	86.29	6.792
3	**Skill**	86.47	6.429
4	**Behaviour**	80.12	13.301
5	**Advisories**	84.85	8.544
4	**Newinputs**	77.28	8.353
7	**Business improvement**	77.62	18.327

3.3.2 Suitability of Data for Principal Component Analysis:

Before conducting Principal Component Analysis (PCA), the adequacy of the dataset was tested using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's Test of Sphericity. The KMO value of 0.666 indicates a moderate but acceptable level of sampling adequacy for applying PCA. Bartlett's Test of Sphericity was highly significant ($\chi^2 = 61.792$, df = 21, $p < 0.001$), confirming that the correlation matrix is not an identity matrix and that sufficient relationships exist among the variables. These results indicate that the dataset is appropriate for dimension reduction using PCA.

Table 5 : Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sphericity for suitability of principal component analysis

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.666
Bartlett's Test of Sphericity	Approx. Chi-Square	61.792
	df	21
	Sig.	.000

Extraction of principal components:

The results of PCA revealed the extraction of three principal components with eigenvalues greater than one (Table 6). These three components together explained 70.55 per cent of the total variance in the dataset. The first principal component termed as "Programme Delivery and Advisory Effectiveness"accounted for 38.72 per cent of the variance. This component captures the participants reaction, learning and its translation into advisory services and operational practices (outcomes). This finding is consistent with studies of Birner et al., (2009); Davis, *et al.* (2019), who reported that effective training delivery significantly influences behavioural outcomes and service provision in extension systems.

Followed by the second component (Skill-Driven Business Performance) explaining 16.59 per cent. This dimension reflects the enhancement of practical skills and their influence on business performance and service delivery. It aligns closely with the Behaviour and Results levels. Similar observations were made by Sulaiman and Davis (2014), who emphasized that skill-oriented capacity building directly contributes to improved professional performance and economic outcomes in pluralistic extension systems.

The third component (Knowledge Acquisition Dimension) contributing 15.24 per cent. This component represents the theoretical learning gained through the training programme and corresponds primarily to the Learning level of the Kirkpatrick Model. Similar findings were recorded by Blum 2020, Jadav et. al. (2024), Shalinee, *et. al.* (2025).

The scree plot (Fig-2) also confirmed the retention of three components, as indicated by the clear break in the curve after the third component. This suggests that the multidimensional impact of the DAESI diploma programme can be effectively summarized through these three underlying dimensions like programme effectiveness in advisory services, skill-based business improvement, and knowledge enhancement.

Table 6: Total variance explained by principal components extracted from training evaluation variables

Component	Eigenvalues	% of Variance	Cumulative %
PC1	2.710	38.720	38.720
PC2	1.162	16.594	55.313
PC3	1.067	15.241	70.555

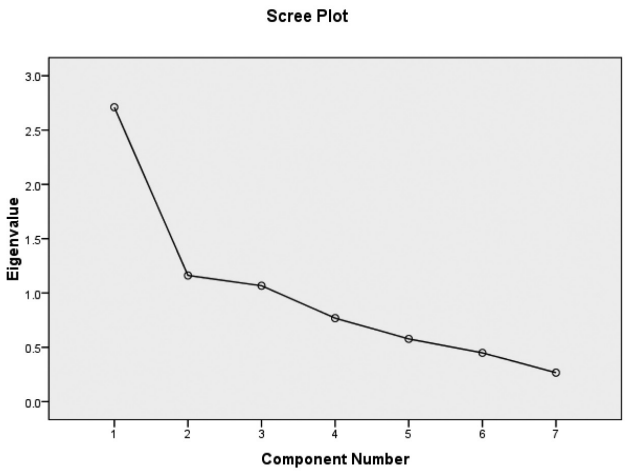

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Fig. 2 : Scree plot showing eigenvalues and number of principal components extracted from training evaluation variables in the DAESI programme

Interpretation of rotated components:

The rotated component matrix was examined to interpret the structure of the extracted components. The first component showed strong positive loadings for reaction (0.871), new inputs supplied (0.822), and advisories delivered to farmers (0.574). This component represents training delivery effectiveness and its immediate translation into advisory practices, indicating that higher satisfaction with the programme (Reaction level) is associated with improved behavioural outcomes such as increased advisory services and input dissemination (Behaviour level). Thus, it

reflects a strong linkage between Reaction and Behaviour in the evaluation framework. These findings supported by the results of Kassem *et. al.* (2021)

The second component was characterized by high loadings for skill (0.835) and business improvement (0.795), along with a moderate loading for advisories (0.493). This component represents practical skill enhancement leading to improved business performance, highlighting that skill acquisition (Learning and Behaviour interface) significantly contributes to tangible outcomes (Results level). It establishes a clear pathway from Learning → Behaviour → Results, emphasizing the economic and professional gains of trained dealers. These results lined with the findings of Ragasa & Mazunda (2018); Mishra et al. (2025); Meena et al. (2024); Saikia et al. (2024); Harikrishna et al. (2021).

The third component exhibited a strong loading for knowledge (0.887), indicating that theoretical knowledge acquisition forms a distinct dimension of the training programme. This suggests that knowledge gain, although closely linked to skills and behaviour, remains an independent contributor to the overall effectiveness of the training intervention. These findings lined with the Birner *et al.* (2009).

Table 7: Rotated component matrix showing factor loadings of training outcome variables in principal component analysis (n=40)

Variable	Component 1	Component 2	Component 3
Reaction	0.871	-0.077	-0.082
Knowledge	-0.057	0.026	0.887
Skill	0.057	0.835	-0.363
Behaviour	0.407	0.255	-0.363
Advisories	0.574	0.493	-0.371
New inputs	0.822	0.232	0.029
Business improvement	0.146	0.795	0.297

The PCA biplot illustrates (Fig-3) the cause-effect relationships among training outcome variables across the Kirkpatrick evaluation levels. The first two principal components capture the major variation in the dataset, with clear separation of variables into distinct directions.

Skill and Business variables are positively associated and aligned in the same quadrant, indicating a strong relationship between skill enhancement and business improvement. Advisories, Behaviour, and new inputs also show positive association, suggesting that improved advisory services are linked with behavioral change and adoption of new inputs.

In contrast, Reaction is positioned in an opposite direction, indicating comparatively weaker alignment with the other outcome variables. Knowledge shows moderate association, positioned between major clusters, reflecting its bridging role between learning and application.

Overall, the study highlights that the DAESI programme plays a crucial role in strengthening the agricultural advisory system by enhancing the professional competence of agri-input dealers and integrating them into the extension network. The findings contribute to the growing body of literature on agricultural training evaluation and demonstrate the usefulness of combining the Kirkpatrick evaluation model with multivariate analytical techniques such as PCA to capture complex training outcomes in agricultural extension systems. PCA results confirm that the effectiveness of the DAESI programme depends on the integrated functioning of reaction, learning, behaviour, and results levels, where knowledge and skills act as key drivers in translating training outcomes into advisory effectiveness and business performance.

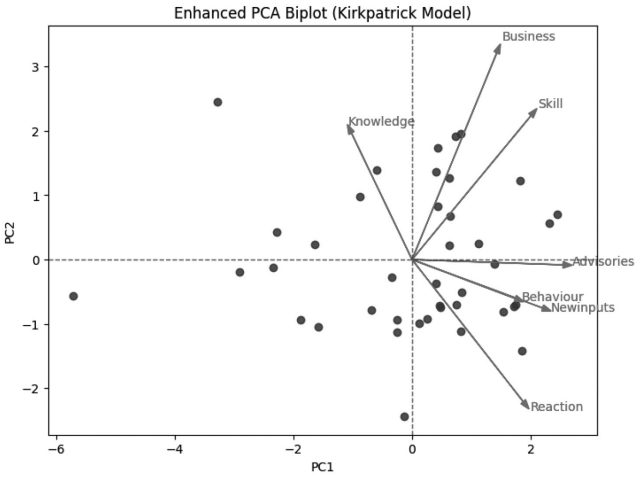

Fig. 3 : PCA biplot representing underlying dimensions of training effectiveness among agri-input dealers in the DAESI programme

CONCLUSION

The study confirmed that the DAESI programme effectively enhanced the competencies of agri-input dealers, as reflected by the high composite impact index (82.70). Among the four Kirkpatrick evaluation levels, Learning recorded the highest impact, followed by Reaction, Behaviour, and Results, indicating strong knowledge and skill enhancement with comparatively moderate translation into field-level and business outcomes. Principal Component Analysis (PCA) further validated the multidimensional effectiveness of the programme by extracting three principal components explaining 70.55 per cent of the total variance, namely Programme Delivery and Advisory Effectiveness, Skill-Driven Business Performance, and Knowledge Acquisition. The findings revealed that the four evaluation levels are functionally interlinked, where learning and behavioural competencies facilitate improved advisory practices and business performance. However, comparatively lower Behaviour and Results scores indicate the need for strengthened post-training support through refresher trainings, mentoring, and institutional linkages to improve long-term programme impact.

RECOMMENDATIONS

- Periodic refresher trainings, field-level mentoring, and follow-up support should be institutionalized to strengthen the translation of knowledge and skills acquired through the DAESI programme into sustained behavioural and field-level outcomes.
- Krishi Vigyan Kendras (KVKs), extension agencies and training institutions should emphasize practical and communication-oriented approaches such as field demonstrations, diagnostic filed visits, and farmer interaction sessions to enhance advisory effectiveness and professional confidence among agri-input dealers.
- Strengthening institutional linkages and digital advisory support systems for DAESI-trained dealers may facilitate continuous technical updating, promote scientific input recommendations, and improve long-term advisory and business outcomes.

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CONFLICT OF INTEREST

The authors declare no conflict of interest

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