

# Unveiling the Synergy: A Comparative Factor Analysis of Research Extension and Education Integration in Nepal

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## Article

**Keywords:** Research-education-extension linkage, Exploratory factor analysis

**Posted Date:** September 17th, 2026

**DOI:** <https://doi.org/10.21203/rs.3.rs-10506051/v1>

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**Additional Declarations:** No competing interests reported.

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# Abstract

The performance of Agriculture Research, Extension, and Education (AREE) Institutions and their contribution to the healthy agricultural producers-traders' nexus are the strong pillars of the agriculture innovation system. Their functional effectiveness, measured in terms of performance, depends on their strong linkage and interdependence. The factors contributing to weak linkages among the core systems of agricultural development are institutional, functional, personnel, technical, communication, and policy environments, which resulted in programmes and interventions irrelevant to farmers' needs and conditions, delivered in an ad-hoc manner without reaching the needy farmers. This research provides the factors useful to consider while formulating the linkage strategies. A nation-wide cross-sectional survey research was conducted to identify the factors responsible for linkage and integration among the AREE institutions in Nepal. A total of 250 respondents from four categories of strata: Research, extension, education, and private sectors across the country were selected as respondents. The specifically constructed self-report questionnaire using Likert scale items was used to collect the data. After collecting the data, the exploratory factor analysis (EFA) was employed to identify the dimensions contributing to linkages among research, education, and extension. The survey was conducted from January to June 2023. The measurement model showed the research instrument had adequate internal consistency and composite reliability (0.739). The EFA analysis identified personal-psychological, internal to the organization, and enabling policy environment factors as key determinants of effective linkage and integration, while external factors to the organization were also considered. This study has developed a framework for linkage and integration among the AREE institutions and for the implementation of their improvement strategies. Using this linkage and integration framework, extension managers can develop their strategies for linkage and integration among the institutions.

## 1 Introduction

The agriculture system can perform well once its three important entities, i.e, research, extension, and education, are either linked and/or integrated. The technologies generated by research are supposed to be transferred among the stakeholders to produce relevant knowledge, skills, favorable attitudes, technologies, products, and materials (Borge and Bröring 2020). The dissemination is possible through effective extension service performed by the extension units/organizations. The education sector serves as a center for producing quality manpower as per the market need for research and education services (Gryshova et al. 2019). Therefore, understanding the linkage and integration among research, extension, and education is important. The success or failure of agricultural research of any nation depends largely on the performance of researchers and extension personnel to communicate and collaborate (Ragasa et al. 2016; Alston 2010). In this respect, adjacent interaction among researchers, extension agents, and farmers is obligatory, so as to lead to the design and delivery of appropriate technology (Kumar et al. 2001).

The concept of linkage and integration goes back to the Land Grant Institution model, particularly the Morrill Act (1862), Hatch Act (1887), and Smith-Lever Act (1914) of the USA. The rationale for linkage and

integration was that the new research conducted in the lab and other facilities would be transferred into practice to the rural and urban population (Ashraf et al. 2007; Radhakrishna et al. 2014). Conceptually, the higher agriculture academic institutions were established with the tripartite mission: education, research, and outreach (Biang et al. 2024). Most of the AREE professionals and experts suggest that AREE agencies in Nepal are working independently and separately; as a result, there is minimal or no linkage or integration among these institutions (Jaishi et al. 2020). Timsina et al. (2018) reviewed the conventional linkage system among the three types of agricultural research, extension, and education institutions. The review suggested the requirement of thematic linkage and coordination in terms of three different levels: Policy coordination, technology generation, and technology dissemination. Ghimire et al. (2021) also defined the concept of functional linkage, meaning where all the parties meet, not necessarily in person, and share their knowledge, information, and experiences. They give something and take something, fostering reciprocity among those involved. The discussions of Seegers and Kaimowitz (1989) and Rivera Huerta et al. (2011) showed that it is necessary to stimulate a more intense nature that allows long-term linking.

In this regard, an attempt has been made to present the AREE linkage framework of the interface. This study provides the ideas to explore and explain the factors of linkage and integration among the AREE institutions. Specifically, research was designed to identify the linkage and integration factors that facilitate and hinder formal research extension and teaching activities in their respective institution. This quantitative study also examines the linkage and integration framework for agriculture research, extension, and education institutions.

## **2 Concept of linkage and integration among agriculture research, extension, and education institutions**

### **2.1 Types of linkage among agriculture research, education, and extension**

Three general types of linkages are globally observed between research, extension, and farmers observed in AREE: Linear, fragmented, and integrated (Jaishi et al. 2022). Thiele et al. (1998), in their findings, mentioned three types of linkages between the organization: direct suppression, formation of permanent committees within the institutions being linked, and coordinating the position and units of the linked organization. An effective model for linking research and extension using a liaison unit has been developed in Bolivia. Felton (2014) suggested two fundamental linkage mechanisms: the structural and the operational linkage mechanisms. Structural linkage mechanisms as reported by Thiele et al. (1998) include 'bridging', 'adjusting', 'training', and 'facilitating'. Merrills-Sands et al. (1990) have grouped operational linkage mechanisms into four broader categories, i.e., planning and review process, collaborative professional activities, resource allocation procedures, and communication devices (Fig. 1).

Deneke and Gulti (2016) stated three generic types of linkage models: the linear-top-down model, commonly known as the transfer of technology (ToT) model, the farming systems research (FSR) model, and the Innovation Systems Model. These models have their own historical backgrounds, characteristic features, and resulting implications with mechanisms for linkage between the agricultural research and extension systems, along with the linkage among the various actors in the agricultural commodity value chains in general. Research and extension are dependent on each other for their successful operation (Eneyew 2013). Issues of research and extension may be multifaceted and complex (Karim et al. 2009; Eneyew 2013; Singh et al. 2019; Rahman et al. 2021); however, they are summarized under five headings, as mentioned in Table 1.

Table 1

Key characteristics of agriculture research-extension linkage in Nepal

| Characteristics of linkage              | Description of characteristics                                                                                         |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Trickled and non-participatory approach | Government mechanisms to link AREE institutions do not exist after federalization.                                     |
| Subsidies-oriented mindset up           | Research and extension activities are limited to the subsidies and materials incentives                                |
| Competition rather than cooperation     | Similar types of service delivery packages by all categories of service-providing agencies.                            |
| Low priority of linkage and integration | RE institutions have not prioritized the level of linkage, specifically production linkage and post-production linkage |
| Activities rather than performance.     | AREE institutions are focused on annual targets and activities, rather than output and outcome.                        |

## 2.2 Linkage and integration between extension-education agencies

In Nepal, agricultural universities, faculties, academic institutions, campuses, and colleges are under the Ministry of Education, which has no forward and backward linkages with the Ministry of Agriculture and Livestock Development (MoALD) as illustrated in Fig. 2. Since MoALD is the line ministry of agriculture development in Nepal, agriculture education being isolated from MoALD is a curse in the path of linkage and integration. This has resulted in poor linkage and departmental integration, leading to weak coordination with the agricultural knowledge and information system (AKIS) as a system. Interestingly, these two fundamental institutions of AKIS lack strategic action and a common platform for discussion. As a vicious process, understanding of potential research extension and education linkages is also rudimentary (Landini et al. 2023). Innovation platforms, particularly at the community level, are very crucial to communicate, cooperate, and share information, tasks, and activities needed for innovation between education and extension institutions to take place (Munthali et al. 2018).

Eneyew (2013) highlighted that the meaning of extension is ‘extending university education in a non-formal way to the surrounding community or to the rural sector to improve the routine of producers’.

Until recently, extension has been the weak link at the university because of a lack of appreciation for the extension role of educational institutions. Shrestha and Timilsina (2022) highlighted many weaknesses of agricultural academic institutions in Nepal, but also stated the strengths of the agriculture academic institution (AAI). Highly competent faculties with advanced knowledge and skills from universities abroad, highly experienced and contributing faculty with due expertise, satisfactory teacher-student ratios, a good number of AAls, geographical distribution of AAls, agriculture disciplines in AAls, and a good number of graduates produced every year (Shrestha 2022). In addition to the faculties and graduating students’ involvement in agricultural research activities, the AAls have also been contributing to the research, extension, and mobilization capacity of the development sector (Yu et al. 2022).

AAI can contribute to capacity development by producing competent manpower for the AKIS and enhancing the professional ability of the agricultural innovation system (AIS) through short-term and in-service training programs. The integration of experiential service learning through community engagement programs holds potential for competency development (Culhane et al. 2018). Policy constraints, policy gaps, evidence gaps, and research priorities are major gaps in the AREE linkage in Nepal (Table 2). To bridge the gaps of AREE institutions at the community level, mobilizing faculties, undergraduate, and doctoral scholars may be one of the possible cost-effective strategies (Shrestha et al. 2022; Borecki and Province 2008).

Table 2

Policy constraints, policy gaps, evidence gaps, and research priorities for the AREE linkage in Nepal

| Policy constraints                                                                                                                            | Policy Gaps                                                                                     | Evidence Gaps                                                                                                                | Research Priorities                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Functional and operational coordination between AREE organizations and stakeholders at different hierarchical levels needs to be strengthened | Holistic research and extension policies in the changed federal context are yet to be developed | Empirical information and database, inventory on the extent of vertical and horizontal coordination among AREE organizations | Identify the factors for appropriate institutional mechanisms and policy framework for strengthening coordination among AREE at the three tiers of government and private sector actors |

In AAls, education is an integral part of technology generation and extension for the improvement of production systems to achieve sustainable agriculture and rural development (Rudebjer et al. 2022). Table 3 shows that educational institutions must be a fundamental part of agricultural innovation systems. However, AAI is not yet properly linked to the National Agricultural Research and Extension System (NAERS). The reason may be that different affiliations of educational, research, and extension institutions are with two separate ministries (Kyvik and Lepori 2010). The education system falls under the Ministry of Education (MoE), and research and extension fall under the Ministry of Agriculture and Livestock Development (MoALD). Thus, they are mutually exclusive in terms of integration or being formally linked together. In this way, AAls have a weak linkage with MoALD, and cannot get ample opportunities for budget and program to use in research and outreach funds provided by the ministry.

The agricultural education domain includes actors from educational institutions at various levels. The instructors, researchers, lecturers, and learners’ extension personnel must be well-connected to each other (Promboon et al. 2018). A typical example of connection is those programs designed to update educational materials and to innovate curricula through joint curricula workshops. AAI neither has a systematic linkage with the extension system that absorbs its product nor has an effective linkage with research institutions (Table 3). These poor linkages suggest that university graduates will not receive the necessary feedback to adjust and deliver the most up-to-date and relevant services to the extension system (Eneyew 2013).

Table 3  
Key characteristics of education and extension agency linkage

| Linkage characteristics                         | Description of linkage                                                                                                                                                                                                         |
|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Limited practical orientation                   | The agriculture education system exists under criticism for its lack of sufficient practical orientation and hands-on skills.                                                                                                  |
| Deferred research thesis                        | Academic researchers were making inappropriate contributions to real-world problems, lacking a linkage to extend research outputs.                                                                                             |
| Insufficient networking                         | The extension of university knowledge practice is only through workshops and seminars to the scientific communities.                                                                                                           |
| Deferred academic curricula                     | Most of the agriculture education curricula are outdated and not linked to real-world problems.<br><br>AAI teaching and learning approaches without or with insufficient community engagement rely on lectures and instruction |
| Lacking AAI-community engaged teaching learning | Job-seeking rather than job-creation nature of teaching and learning approach and instruction<br><br>Profit-oriented agriculture education has a limited orientation to the farming system                                     |

But AREE institutions are now realizing that the significant contribution of AAI can link and integrate at the formal, informal, institutional, and administrative levels through structured or unstructured platforms (Zahoor et al. 2024). This realization can be observed at the federal, provincial, and municipal levels. Representative from the AAI is now included in the federal and provincial AREE coordination committee, which is the national and provincial apex and coordinating forums (Lyall and Larsen 2017). The AREE coordination committee is supposed to advise AREE institutions in setting their priorities at the federal, provincial, and municipal levels. This committee mechanism is envisioned to be established in four levels: National, provincial, cluster, and municipal. Thus, the AAI can play its potential roles to connect AAIs with the communities, research, and extension agencies through this mechanism, although extension and outreach services are offered by all the institutions (Chowdhury et al. 2014). Currently, this mechanism is secretariat by the Department of Agriculture.

An agricultural innovation system is a network of actors (individuals, organizations, and enterprises), together with supporting institutions and policies, in the agricultural and related sectors (Anandajayasekera 2022). These actors are supposed to bring existing or new products, processes, and forms of organization into social and economic use. Formal and informal policies and institutions shape how these actors interact, integrate, cooperate, link, and learn together, and how they generate, share, and use agriculture and allied knowledge (Sulaiman 2015). Under the AIS framework, innovation is related to technical innovation, for example, acceptance of an improved variety (Zwane 2020). AIS also includes organizational innovation (organization of farmers as groups) and institutional innovation (addressing uncertainties in land leasing through policy changes). The National Agriculture Extension System (NAES) currently recognizes the importance of enhancing the capacity of all actors in the AIS instead of just research or extension. NAES now realizes that neither research knowledge nor extension activities alone drives AIS.

## **3 Methods**

### **3.1 Research area**

Four types of stakeholders: Research, extension, education and the farmers as respondents are considered as field works of this research. Research extension, education and farmer stakeholders are taken into consideration from across the country.

### **3.2 Theoretical framework of the study**

The study formulated the theoretical framework of agricultural research, extension, and education linkage and integration from a global perspective, focusing on the South Asian context. The study focuses on four factors: a) personnel-psychological factors, b) internal organization, c) external organization, and d) policy enabling factors (Fig. 3). The Theoretical framework is concerned only with the public AREE sector. The framework assumes that these four factors collectively contribute to improving linkage and integration. The theoretical lens focused on Inter-organizational theory for integration for this study.

According to Hooyman (1975), the inter-organizational theories describe how two or more formal organizations or institutions relate to each other functionally. Goal and mission, functionalities of the organization, responsiveness towards the integration, working modalities, and strategic action for integration are the elements of organizational factors. This functional relationship can be useful to assess the structural variables that affect the problems and the potential for cooperation between and among the agencies. Integration of agricultural services for the improvement of service delivery has been the current focus of the reform agenda. According to Oliver (1990), organizations are assumed to make conscious and intentional decisions to make functional relations. Five critical contingency factors: Number of extension staff, funds and budget, integrative culture, human personnel skills, and intra-personnel skills are important internal to organizational factors. Four contextual variables need to be considered by the integration practitioner in their attempts to implement linkage and integration: the

purpose they serve, how they fit into the existing infrastructures and resources, how they are managed, and the main actor's level of commitment (Bourgeois 1990). To achieve success in linkage and integration, enabling policy factors such as policy instruments, participatory approach, collaborative efforts, community level platforms and network, facilitation for the interaction among extension staff and clients are very instrumental.

There is no single issue responsible for the problems of integration within the AREE institutions, several factors are responsible for this (Bourgeois, 1990). There is not even a general management model that applies to solve the problem of integration. Strengthening AREE in general and extension in particular has not received due priority in Nepal (Shrestha, 2022). Among the factors of integration, external to the organization is one of the important factors to be considered. Organizational goal and mission, functions and functionalities of the organization, organizational priority towards integration, appropriate working modalities and strategic action for integration are the external to the organization factor responsible for integration. Likewise, the number of staff, their skills and competencies, adequate funding and budget, culture of organization, personal skills and inter-personnel skills are subject to internal organizational factors considered for the linkage and integration.

### **3.3 Research design, approach**

A cross-sectional deductive research approach based on the positivist philosophy was applied. An self-administered structured survey as a research design to measure the strength of the relationship among the AREE institution was conducted. The study assessed the four different types of variables into three main groups: Personnel-psychological factors, internal to organizational factors, external to organizational factors and enabling policy factors. The AREE linkage and integration interface was considered as dependent variable of the study. This study was conducted through a socioeconomic survey of voluntary participants. All research procedures were carried out in accordance with the relevant guidelines and regulations of the Institute of Agriculture and Animal Science (IAAS), Tribhuvan University (TU), Nepal. The study did not involve any invasive procedures or interventions, and ethical approval was waived by the Ethical Review Board, Directorate of Research and Publication, IAAS, Tribhuvan University, Nepal. Prior to participation, all respondents were informed of the study's objectives, and informed consent was obtained from each participant.

### **3.4 Sampling and data collection**

An appropriate sample size of 250 was first established. The number of sample size was determined by the minimum sample size criteria of EFA. A wide-ranging thumb rule for the sample size in EFA is inclusion of at least 100–200 samples respondents which is considered benchmark (MacCallum *et al.*, 1999). However, the sample size rests on the features like number of factors, expected factor structure, and level of commonality. Cattell (1978) and Beavers *et al.* (2013) asserted that the minimum desired sample size is 250, while Guilford (1954) maintained that the sample size should be at least 200. So, considering all the criterias, the sample size for the surveys was determined based on the minimum of 5 cases for each construct (Table 4). Respondents were taken as a sample, meeting the criteria for the

maximum number of samples required for EFA (Table 4). The study focused exclusively on the factors of formal and public sector linkage mechanisms. The study did not examine the private and informal profit-oriented linkage and integration system; however, the consent of the private sector was also taken in the study.

Table 4  
Stakeholders and the number of respondents taken in the opinion survey

| AREE Stakeholders       | Position of the respondent by level of operation |           |             | Total |
|-------------------------|--------------------------------------------------|-----------|-------------|-------|
|                         | Executive                                        | Mid-level | Field level |       |
| Research agencies       | 33                                               | 30        | 13          | 76    |
| Extension agencies      | 19                                               | 33        | 18          | 70    |
| Education agencies      | 23                                               | 20        | 11          | 54    |
| Private sector agencies | 27                                               | 19        | 4           | 50    |
| Total                   | 102                                              | 102       | 45          | 250   |

Conceptually, this research investigates four major factors affecting linkage and integration among the AREE institutions. There is no single issue responsible for the problems of integration within these institutions; rather, multiple factors contribute (Bourgeois 1990). Although there is no universal management model to address the problem of integration, strengthening AREE as a whole, especially in extension, has not received adequate priority in Nepal (Shrestha 2022). Among external factors influencing integration, one of the most important is the organizational environment. External factors include organizational goals and mission, functions and personnel, priorities towards integration, suitable working modalities, and strategic actions. Internal organizational factors such as the number of staff, their skills and competencies, adequate funding and budget, organizational culture, personal skills, and interpersonal skills also play crucial roles in linkage and integration (Pedraza-Rodríguez et al. 2023). Additionally, psychological factors influence integration, including personnel’s interest in teamwork, opportunities for collaboration, convenience, psychological support, and staff preferences. Lastly, supportive policies are critical in AIS, shaping the overall environment through policy instruments, participatory working modalities, incentives for collaboration and networking, community platforms for multi-stakeholder engagement, and interactions between service providers and clients (McIntosh et al. 2023).

### 3.5 Methods of data collection

The self-administered questionnaire method of data collection was used. This technique is more useful and convenient because all the respondents in this survey have at least a bachelor's level of education. It is more economical and has a higher rate of return (Saunders and Kulchitsky 2021). A self-administered survey is a questionnaire designed explicitly to be completed by respondents without the assistance of interviewers or bias (Jenkins and Dillman 1995). A self-administered survey is a questionnaire designed

explicitly to be completed by respondents without the assistance of interviewers or bias (Cleo and Dillman, 1995). To ensure the appropriateness of the self-administered questionnaire set, it is piloted for the 30 responses among 250, and best utilized the best lessons learnt from the pilot study. A Pilot study prior to full-scale implementation ensured the credibility and reliability of the study. Questionnaire pre-testing supported to rephrase the statements to make them more meaningful and reader-friendly. Data collection was conducted during August-September, 2023. In the phase-I, of data collection, self-response structured opinion survey instruments were constructed. Many of the variables are psychological in the form of latent constructs difficult to observe directly (Likert, 1932; Blanchard *et al.*, 2014). The Likert-type scale is constructed by adding up the defining the items of observation. To explore the factors of linkage and integration, a five-point Likert-type scale was utilized (Strongly agree to strongly disagree, 1–5). Five points Likert types scale denotes to the score system with likely five possible answer choices (Johns., 2010; Joshi *et al.* 2015).

### **3.6 Methods of data analysis**

EFA was conducted to identify the latent factor structure in the data. To ascertain the strength of the relation among AREE institutions, research methodologists advise employing the method known as Structural Equation Modeling, popularly known as SEM (Westland 2015). In regression analysis, only one dependent variable is assumed; however, the variables could be either a predictor or an outcome (Hellevik 2009). To conduct multiple regression for multiple outcomes, the model is tedious and difficult to combine the results. Multiple regression has many shortcomings. To overcome these limitations, path analysis is one of the best solutions. Path analysis is a method to assess the effects of one construct on another construct in a model (Ingram *et al.* 2000). Normally, the model is structural, where several paths are analyzed simultaneously - the inter-relationships among constructs in one model.

In this research, EFA was conducted by using AMOS to validate the number of constructs based on the conceptual framework. As AMOS is considered a powerful tool to evaluate the construct validity of measurement models, it was implemented to determine the construct validity concerning the concept of linkage and integration. AMOS is a powerful structural equation modeling software that supports research and theories by extending standard multivariate analysis methods, including regression, factor analysis, correlation analysis, and analysis of variance (Collier 2020). AMOS is an added SPSS module, especially used for SEM path analysis and confirmatory factor analysis (CFA). In this research, exploratory factor analysis was conducted to explore the factor structure of a measure and its internal reliability. EFA is recommended when there is no hypothesis about the nature of the relation underlying the factor structures of their measures. According to Henson and Roberts (2006), latent factors are thought to cause and summarize observed variables. Framework development and score validity are closely related to exploratory factor analysis.

## **4 Results**

This chapters covers the socio-demographic characteristics of the respondents, deimensions of the factors of linkage and integration and the factors score of the dimension and the scale reliability are

explained in this section.

### 3.3 Data preparation

For quantitative data analysis, data preparation and screening were conducted and checked as described by Hair et al. (2011) and Shivakumar et al. (2017). The KMO test and Bartlett's test of sample adequacy were conducted, with  $KMO \geq 0.6$  (Vogt 2005) indicating sample adequacy. The p-value of Bartlett's Test of Sphericity should be less than 0.05, and only after this assessment can the dataset be considered suitable for analysis. Initially, the factorability of the 25 items was examined. The KMO measure of sampling adequacy was 0.631, exceeding the commonly recommended value of 0.6. Bartlett's test of sphericity was also significant,  $\chi^2 = (468.85, df = 45), p \leq 0.05$  (Field 2013).

### 4.1 Socio-demographic characteristics of the respondents

The descriptive statistics of categorical variables are presented in the Table 5. The respondents were 58.40% from the public sector, 21.60% from the corporate sector, and 20% from the private sector. As stated in the sampling strategies, respondents from research, extension, education, and farming sectors represented 30.4, 28.0, 21.6 and 20% respectively. Further, the respondents were categorized into three levels: Executive (34.8%), mid-level (41.6%), and front-line (23.6%), according to their organizational hierarchy. The highest number of respondents had an academic qualification equivalent to a Master's degree (66%), followed by Bachelor's (18.4%) and Doctoral (15.6%). The experience of the respondents was categorized as career beginners (32.2%), slightly experienced (21.2%), moderately experienced (15.2%), and highly experienced (30.4%).

Table 5  
Socio-demographic characteristics of respondents

| Variable                          | Categorical level      | Frequency | Total | Percentage | p      |
|-----------------------------------|------------------------|-----------|-------|------------|--------|
| Type of organizations             | Research               | 76        | 250   | 30.4       | < .001 |
|                                   | Extension              | 70        | 250   | 28.0       | < .001 |
|                                   | Education              | 54        | 250   | 21.6       | < .001 |
|                                   | Farming                | 50        | 250   | 20.0       | < .001 |
| Level of respondents              | Executive level        | 87        | 250   | 34.8       | < .001 |
|                                   | Mid level              | 104       | 250   | 41.6       | 0.009  |
|                                   | Front line level       | 59        | 250   | 23.6       | < .001 |
| Education level of the respondent | Bachelor               | 46        | 250   | 18.4       | < .001 |
|                                   | Master                 | 165       | 250   | 66         | < .001 |
|                                   | Doctoral               | 39        | 250   | 15.6       | < .001 |
| Level of experience               | Career beginners       | 83        | 250   | 33.2       | < .001 |
|                                   | Slightly experienced   | 53        | 250   | 21.2       | < .001 |
|                                   | Moderately experienced | 38        | 250   | 15.2       | < .001 |
|                                   | Highly experienced     | 76        | 250   | 30.4       | < .001 |

## 4.2 Data reduction on dimensions of AREE linkage and integration

The dimensions underlying the AREE linkage and integration factors were identified through exploratory factor analysis (EFA). Exploratory factor analysis is generally used to discover the structure of measures and to examine their internal reliability (Beavers et al. 2013). EFA is often recommended when researchers have no hypothesis about the nature of the underlying factor structure of their measures. The models are considered to have adequate construct validity if they have a good fit with the data and their standardized factor loadings are significant and above 0.3. The findings demonstrated the fact that agriculture research, extension, and education are conducted by separate institutions with little formal interaction and relationship exacerbates the issues of poor linkage and integration.

The result of performing the factor analysis on the model of measuring linkage and integration are presented in the Table 6. The generated values showed that the standardized factor loadings of all items were above 0.5 and significant at  $p \leq .05$ . During the EFA analysis, four factors were extracted through Maximum Likelihood method which have eigen value of one and were retained for rotation. These

factors together explained 67.54% of the total variance in the data, which is reasonably close to the acceptable level of 60% (Hair et al. 2014).

Table 6  
Total variance explained by the factors responsible for AREE linkage and integration

| Factor                                 | Initial Eigenvalues |               |              | Rotation sums of squared loadings |
|----------------------------------------|---------------------|---------------|--------------|-----------------------------------|
|                                        | Total               | % of Variance | Cumulative % | Total                             |
| 1                                      | 2.42                | 24.21         | 24.21        | 1.45                              |
| 2                                      | 1.80                | 17.99         | 42.20        | 1.6                               |
| 3                                      | 1.31                | 13.06         | 55.26        | 1.30                              |
| 4                                      | 1.23                | 12.29         | 67.55        | 1.32                              |
| 5                                      | .76                 | 7.57          | 75.12        |                                   |
| 6                                      | .64                 | 6.40          | 81.52        |                                   |
| 7                                      | .56                 | 5.63          | 87.15        |                                   |
| 8                                      | .49                 | 4.85          | 91.99        |                                   |
| 9                                      | .43                 | 4.26          | 96.26        |                                   |
| 10                                     | .37                 | 3.74          | 100.00       |                                   |
| Extraction Method: Maximum Likelihood. |                     |               |              |                                   |

The pattern matrix is displayed in Table 7 and shows that all the questionnaire items loaded exactly (values exceeding 0.40 on a single factor based on the sample size exceeding 250 (Stevens 2002)) on their hypothesized factors. The perfect item loading on respective factors indicates adequate convergent validity. The pattern matrix shows the unique contribution of items to a factor and is generally simple to interpret. The pattern matrix contains the variable loading on each factor represented by a coefficient indicating the linear combination of the items.

The scree plot (Fig. 4) shows that the first four factors account for most of the total variability of the data, given by eigenvalues. The eigenvalues for the first four factors are greater than one, and the remaining factors account for a very small proportion of variability and are likely unimportant. In EFA, the first step was to determine the fitness and investigate the fitness indicators of the models. The presence of a relationship between the observed and latent variables highlights the factorial validity of the model (Miles and Gilbert 2005). To assess the fitness of the model, we assumed a specific theoretical model, collected the data, and then fit the data with a test model. The concept of linkage and integration among the AREE institutions consists of four subscales, including external, internal, personal-psychological, and enabling environment.

On the first factor, three statements representing the latent factor 'Personnel-Psychological factor' loaded and explained 24.21% variance. The second factor was termed 'Internal factor to organization,' where only two items were loaded with 17.99% variance. While the third factor, 'Enabling policy factor' had two items, explained 13.06% and the fourth factor 'External to organization factor' loaded with two items, with 12.29% variance loaded in the data. The results indicate that the total amount of variances explained by factors are personal-psychological factors (2.42), which was the strongest determining factor, followed by internal organizational factors (1.80), enabling policy factors (1.30), and external organizational factors (1.22), which had the weakest factor.

Table 7

Exploratory factor analysis of linkage and integration characteristics among the AREE institutions of Nepal.

| Factor                         | Item | Description of items                                                            | Factors |       |       |       |
|--------------------------------|------|---------------------------------------------------------------------------------|---------|-------|-------|-------|
|                                |      |                                                                                 | 1       | 2     | 3     | 4     |
| Personal-psychological factor  | C4   | I feel psychological support when working for linkage and integration 0.        | 0.89    |       |       |       |
|                                | C5   | I prefer working with REE activities in the same organization                   | 0.62    |       |       |       |
|                                | C3   | I feel more convenient doing AREE institutional linkage integration 0.          | 0.46    |       |       |       |
| Internal organizational        | B1   | Number of staff is adequate to integrate AREE linkage and integration 0.        |         | 0.83  |       |       |
|                                | B2   | Funds and budgets are more inclined for AREE linkage and integration 0.         |         | 0.69  |       |       |
| Enabling policy factor         | D4   | Common platforms exist in the community for AREE linkage integration 0.         |         |       | 0.92  |       |
|                                | D5   | Interaction between client and service providers is instrumented by policies 0. |         |       | 0.49  |       |
| External organizational factor | A5   | My organization has a strategic action for linkage and integration              |         |       |       | 0.77  |
|                                | A4   | Working modalities exist in my organization for linkage and integration         |         |       |       | 0.56  |
| Eigen value                    |      |                                                                                 | 2.42    | 1.80  | 1.30  | 1.22  |
| Variance explained (%)         |      |                                                                                 | 24.20   | 17.99 | 13.00 | 12.28 |
| Cronbach alpha                 |      |                                                                                 | 0.59    | 0.87  | 0.67  | 0.60  |

Extraction Method: Maximum Likelihood. Rotation Method: Promax with Kaiser Normalization. The converged in 4 iterations.

## 4.4 Scale reliability

Cronbach's alpha is the most common measure of internal consistency (reliability of scale). When using Likert scales, it is important to calculate and report Cronbach's Alpha coefficient for internal consistency

and reliability of any scales. The analysis of the data must use these summated scales, not individual items. Cronbach's alpha does not provide reliability estimates for single items (Flora 2020). Results displayed in Table 8 indicate that all four factors extracted from EFA had close adequate internal consistency reliability (Cronbach alpha > 0.60, Omega coefficient > 0.60).

Table 8  
Reliability coefficient of factors associated with the AREE  
institution linkage and integration

| <b>Factors</b> | <b>Omega Coefficient (<math>\omega</math>) and</b> | <b>Alpha Coefficient (<math>\alpha</math>)</b> |
|----------------|----------------------------------------------------|------------------------------------------------|
| Factor 1       | 0.669                                              | 0.598                                          |
| Factor 2       | 0.710                                              | 0.675                                          |
| Factor 3       | 0.712                                              | 0.674                                          |
| Factor 4       | 0.666                                              | 0.609                                          |
| Total          | 0.740                                              | 0.632                                          |

McDonald's omega coefficient ( $\omega$ ) is based on a factor analytic approach, in contrast to alpha ( $\alpha$ ), which is primarily based on the correlation between the questions. Omega has the power to be more robust than alpha, considered a more suitable measure for internal consistency (Candia and Caiozi 2005).

Goodness of fit indices for the model generated through Jeffreys's Amazing Statistical Program (JASP) to test the relationship. A good fitting model is accepted if the value of the goodness of fit (GFI) indices, the Tucker and Lewis (1973) index TLI, and the confirmatory fit index (CFI) (Bentler 1987) is  $\geq 0.90$ . In addition, an acceptable fitting model was accepted if the JASP computed value of standardized root mean square residue (RMSR)  $\leq 0.05$  and the root mean square error approximation (RMSEA) is between 0.05 and 0.08 (Hair et al. 2011). The fit indices for the model shown in Table 9 fell within the acceptable range.  $\chi^2/df$ , the goodness of fit (GFI), CFI, TLI, NFI, MFI, Root mean square error of approximation (RMSEA), and SRMR also fell within the acceptable range (Hair et al. 2011).

Table 9  
Goodness of fit indices of the measurement model of the AREE linkage integration factors

| Index                                                                                                                                                                                                                                                          | Value |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Comparative Fit Index (CFI)                                                                                                                                                                                                                                    | 0.957 |
| Tucker-Lewis Index (TLI)                                                                                                                                                                                                                                       | 0.926 |
| Bentler-Bonett Normed Fit Index (NFI)                                                                                                                                                                                                                          | 0.910 |
| Root mean square error of approximation (RMSEA)                                                                                                                                                                                                                | 0.063 |
| Standardized root mean square residual (SRMR)                                                                                                                                                                                                                  | 0.054 |
| Goodness of fit index (GFI)                                                                                                                                                                                                                                    | 0.996 |
| McDonald's fit index (MFI)                                                                                                                                                                                                                                     | 0.968 |
| <p>• <i>Note 1.</i> T-size CFI is computed for <math>\alpha = 0.05</math>. The T-size equivalents of the conventional CFI cut-off values (poor &lt; 0.90 &lt; fair &lt; 0.95 &lt; close) are poor &lt; 0.829 &lt; fair &lt; 0.899 &lt; close for Model 1.</p>  |       |
| <p>• <i>Note 2.</i> T-size RMSEA is computed for <math>\alpha = 0.05</math>. The T-size equivalents of the conventional CFI cut-off values (close &lt; 0.05 &lt; fair &lt; 0.08 &lt; poor) are close &lt; 0.08 &lt; fair &lt; 0.107 &lt; poor for Model 1.</p> |       |

## 5 Discussion

Researcher, extension agents and the education expert characteristics are important factors in shaping their perception towards the linkage and integration mechanisms. To capture the nature of linkage and integration, the scale was developed and administered to three different types of respondents, representing executive, mid-level, and frontline, were taken into consideration. The percentage of respondents with MSc and PhD degrees was significantly higher than at the bachelor's level. Four different categories of the respondents by organization, i.e., research, extension, education, and private sectors, were taken, 36.19%, 33.33%, 25.71% and 23.80% respectively, to fulfill the sampling criteria.

Based on the results presented above, the context of linkage and integration and their factors are further delineated into the four-fold factors as briefly elucidated in the discussion chapter. The linkage and integration strength is influenced by personnel and psychological factors. Similar findings also found in the study of Kumar et al. (2001), Chen and Lim (2012) and Song et al. (2023). In the context of the changed political scenario of Nepal after 2015, it is assumed that the establishment of local government would be more effective in linking and coordinating the different entities of the agricultural sector. Ghimire et al. (2021) argue that the new restructured system of municipal service delivery mechanism appears to be less effective, local representatives seem to be confused, and budget and resources are either limited or not properly channeled and integrated. In many cases of developing countries, deficit incentives and structural aid were reported as barriers to integration (Agbamu 2000; Kumar et al. 2001; Khan 2006; Eneyew 2013; Gauchan et al. 2022; Shrestha 2022).

People's personal and psychological feelings about the importance, support, and preference to link and integrate among the AREE institutions are primary factors of influence. This also implies how the organization and the persons engaged manage and implement their program. The main actors' level of commitment, their psychological state of mind, and their characteristics were found to be the primary factors of linkage.

Second, the level of funds and human resources was also found to influence the level of linkage and integration among the AREE institutions. Internal organizational structures first denoted the number of qualified staff. The second aspect is the funds and budget, especially for the linkage and integration; most of them blame the budget limitation for linking and integrating kinds of activities involving multi-stakeholders in a pluralistic way. It certainly demands more time, investment, and devotion in comparison to working in isolation (de Laat 2025). Third, the organizational cultures to link and integrate, forth the personnel skills of integration and motivation to link with other institutions, and the fifth is the inter- and intra-personal skill of linkage and integration (Sparrow et al. 2015). Overall, the strategic action and working modalities for linkage and integration of the AREE institution determine the level and effectiveness.

Many researchers conducted in developing countries like Nepal (Babu and Sah 2019; Timsina et al. 2018) reported problems of proper inter-agency coordination, linkage between and among the organizations. The point raised by several authors, for example, Bhattarai (2019), Kassa and Alemu (2016); Upreti and Shivakoti (2019), and Jaishi et al. (2022), is that bridging the gap between research and extension is a challenging institutional problem to develop an effective research and extension design. Referring to the implication of linkage practice, Ghimire et al. (2021) mentioned that functional integration and linkages are mentioned in the guidelines, documents, and progress reports, but are seldom practiced. Actually, such practices are dependent on the interest, motivations, and initiation of individual extension personnel of the agencies, recognition of the work (Kumar et al. 2001; Adesiji et al. 2015). Similarly, Bhattarai (2019) and Kassa and Alemu (2016) felt there is a lack of a system that pushes and pursues such linkages in Nepal, explained as external and internal organizational factors.

Mulder and Pachau (2011) discussed that the general trend in agriculture education and extension needs to adapt itself within the framework of the global agricultural development trend. To do so, an enabling policy framework is necessary. Enabling policy to make the maximum possibility of contact, collaboration, synergy, partnership, and networking happen in three levels of tiers: Federal, provincial, and local. In Nepal, agriculture research, extension, and education duties are mainly publicly dominated; they are highly dependent on adequate policy support. The enabling policy factors that require attention were found to be sufficient policy and governance structures to strengthen the agriculture innovation framework. Since agriculture service delivery has been devolving to the local government, existing community multi-stakeholder platforms and effective interaction between service providers and beneficiaries must be instrumented by enabling a policy governance framework that identifies important factors of linkage and integration.

AREE institution, coupled with external-internal structures, the mindset of the people engaged, and an enabling policy environment, is a crucial building block (Figueira and Fullman 2025). To maximize functional linkage and integration, coordinated action is to be instrumented. It is important to consider multi-stakeholder collaborations for investments in agriculture development among institutions, and to share innovations and good practices for sustainable income generation and food production. It can be concluded that with a well-planned development agenda and sustained support for agricultural extension and advisory services, methodologically, financially, and politically, future agricultural transformation can be achieved.

The strategic significance of having unified interorganizational connections for attaining sustained agricultural development is unquestionable. The importance of the linkage between AREE institutions has increased in the face of growing challenges agriculture sector facing today. The interorganizational theory of integration make an interesting contribution to help AREE stakeholders who are keen to adapt and apply those factors of integration to enrich the ASD at local level. Despite the significance of linking and integration, stakeholders believe that they are guided and directed by their organization's goals when fulfilling yearly targets and activities, not by integrating AREE operations. Growing concerns about fragmentation and alienation in agriculture service delivery has refocused attention on service integration. Despite the significance of linkage and integration, stakeholders believe that they are guided and directed by their organization goals, yearly targets and activities, not by AREE integration philosophy and practice.

The focus of interorganizational theory of integration (Hooyman, 1976) is on how organizations work together and coordinate their efforts to accomplish shared objectives, handle challenging problems, and provide services more efficiently. Reitan (1998) acknowledged for many years, researchers and politicians have shared concerns about improving interagency interactions and functional integration. Sarri and Hasenfeld (1978) listed the causes of interagency barriers: distant places, subject to different laws, different government levels, have distinct policies and standards, have limited budget, have different professional worldviews, and so on. The effective linkage of multi-level governance, which is necessary for the creation, organization, management, and promotion of community initiatives, is a relatively new topic in the literature, and its governance is still not well thought out (Belletti et al. (2024).

## **6 Study limitations**

There are multiple ways to analyze the linkage and integration of AREE institution to enhance service delivery at LG level. However, this study does not aim to cover all the approaches and aspects of AREE integration. Rather, it focuses on one of the most challenging aspects in examining the structural and organizational consideration from AIS and ASD framework. This study employed the cross sectional design based on perceptions. Since perception may intends to change, it is essential to investigate the dynamics of change over the time.

## **7 Conclusion**

Despite the high potential of coordinated efforts in the agricultural innovation system, the AREE agencies were found to be working in isolation. Developing or employing current structural mechanisms to link and integrate agricultural research, technology transfer activities, and teaching tasks may be an appropriate way to achieve the expected output. Exploratory factor analysis shows that the four main factors of linkages and integration are equally important and influence AREE linkages and integration in different situations and contexts. These four factors condition their effective linkage and integration, resulting in a fundamental but complex relationship. From the beneficiaries' perspective, participatory, action-learning processes can produce the most successful results in empowering the agricultural development process in the municipality, which is very important to consider. Most municipalities lack capable human resources, proper targeting of commodities and products, and priority setting to strengthen consolidated efforts. The objective of this article is to explore and suggest the best framework for linkage and integration to improve agricultural service delivery. The insights provided lay the groundwork for developing and designing a agriculture service delivery framework to address the current shortcomings of linkage and integration provided in the Fig. 2.

## 8 Recommendations for future work

As a long-term, two-fold proposal, the potential course of action is suggested.

1. It is advised to structure the apex agency like a center or central directorate of agriculture research, extension, and education at the federal level. Possible roles may be to identify, developing, and evaluate AREE integration efforts. In addition, the agency should also support as a springboard for capacity strengthening for researchers, extension educators, faculty, and stakeholders to carry out extension efforts. The curriculum of any capacity development should be approved and assessed by this agency.
2. Multi-stakeholder platforms are suggested to be instrumental in the community level to operate participatory interaction among the AREE stakeholders. Multi-stakeholder platforms are not predefined constructs but emerge from interaction among the actors mutually complementing one another's contributions. Methodological pluralism in AREE is the means of enhancing the relevance of linkage and integration.

As a short-term, following four-fold strategic endorsement are suggested.

1. Deep thoughtful, hands-on orientation on linkage and integration is to be implemented to develop a culture of cooperation, collaboration, and networking among institutions.
2. To complement and supplement the scarce financial and human resources to improve agriculture service delivery is to be prioritized in the agriculture sector at the subnational government level.

3. Strategic action to strengthen AIS should be instrumented in federal, provincial, and municipal levels. AREE platforms that support institutions and policies, are already in execution, must be operationalized.
4. Linkage and integration-based performance indicators in AIS should be implemented. This may also motivate AREE institution managers to meet the indicators.

## Declarations

### Funding

This research received partial funding from Research Directorate, Tribhuvan University [Grant Number: 2080-037].

### Ethical approval

All methods were carried out in accordance with the relevant guidelines and regulations of the Institute of Agriculture and Animal Science (IAAS), Tribhuvan University (TU), Nepal, governing survey-based research involving human participants. Ethical approval for this study was waived by the Ethical Review Board, Directorate of Research and Publication, IAAS, Tribhuvan University, Nepal, as the study involved a voluntary socioeconomic survey and did not include any invasive procedures or interventions.

### Consent to participate

Participation was voluntary, informed consent was obtained from all respondents prior to data collection, and all information was collected and analyzed anonymously.

### Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

### Declaration of interest statement

The work reported in this manuscript have no known conflict of interest.

### Author contributions

M.J., P.B.N., G.P.S., and R.D contributed to the study conception and design. M.J performed material preparation, data collection, and analysis. The first draft of the manuscript was written by M.J., and writing, reviewing, and editing were performed by M.J., P.B.N., G.P.S., D.G., H.N., J.C., and R.D; critical revision of the manuscript was performed by M.J., J.C., and R.D. All authors read and approved the final manuscript.

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## Figures

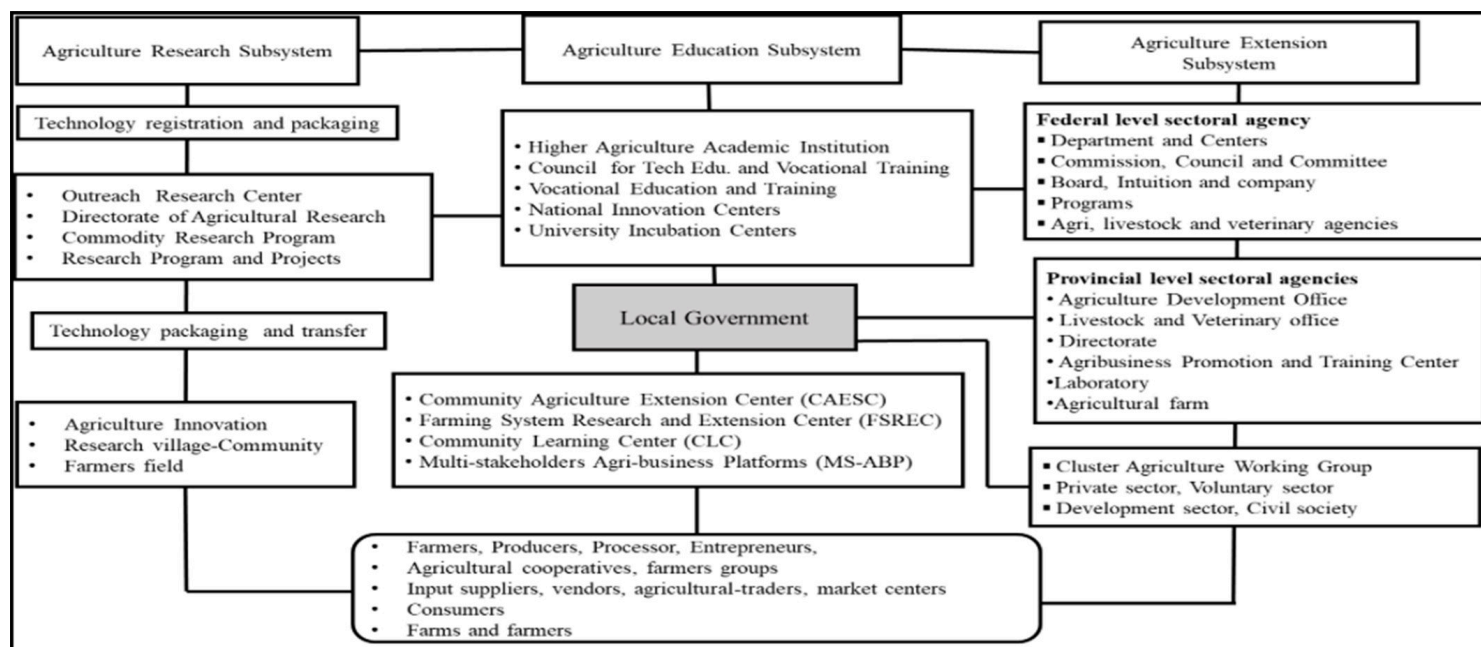


Figure 1

Three subsystems of AREE of Nepal and its integration with the AREE framework

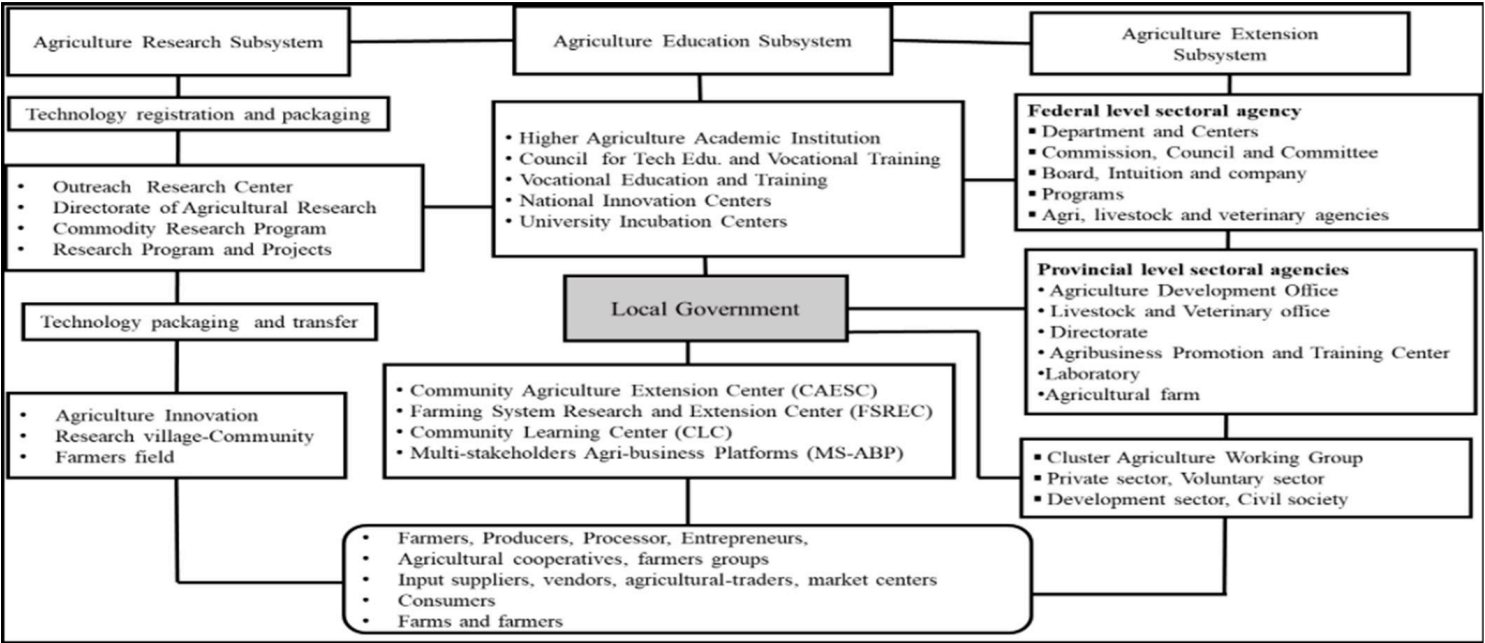


Figure 1

Three subsystems of AREE of Nepal and its integration with the AREE framework

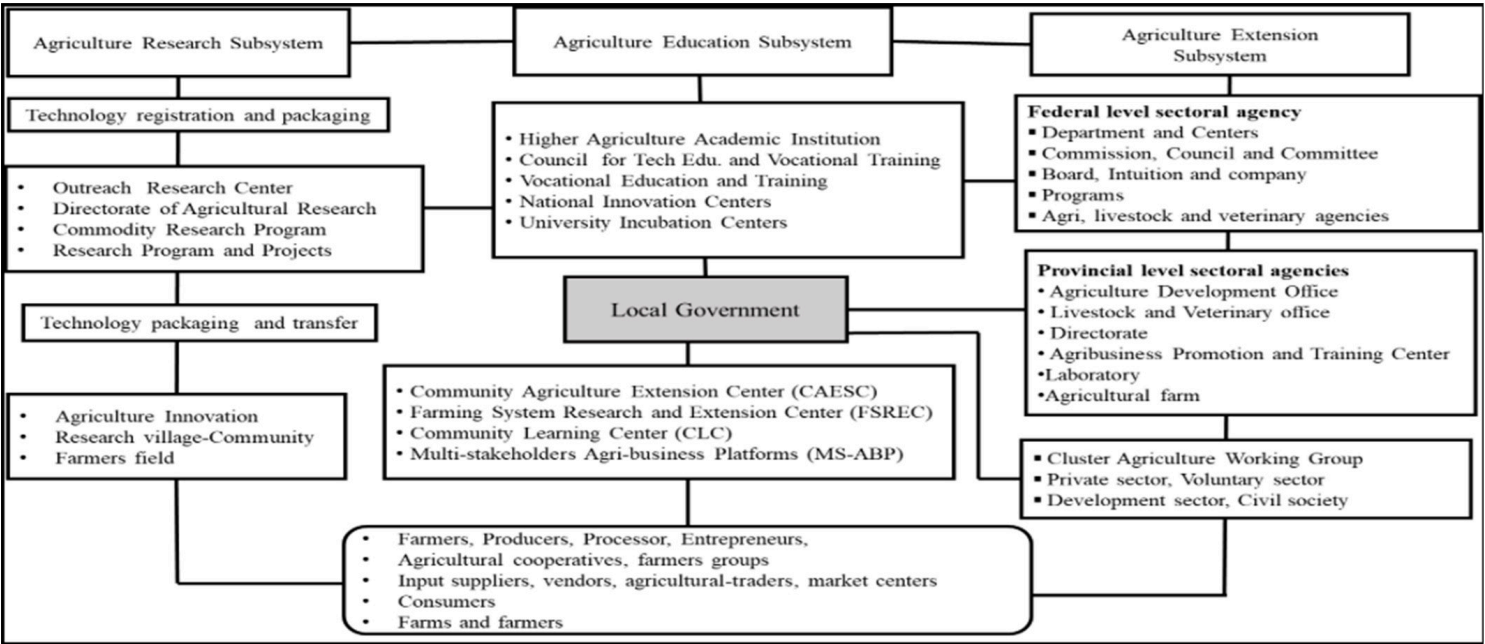


Figure 1

Three subsystems of AREE of Nepal and its integration with the AREE framework

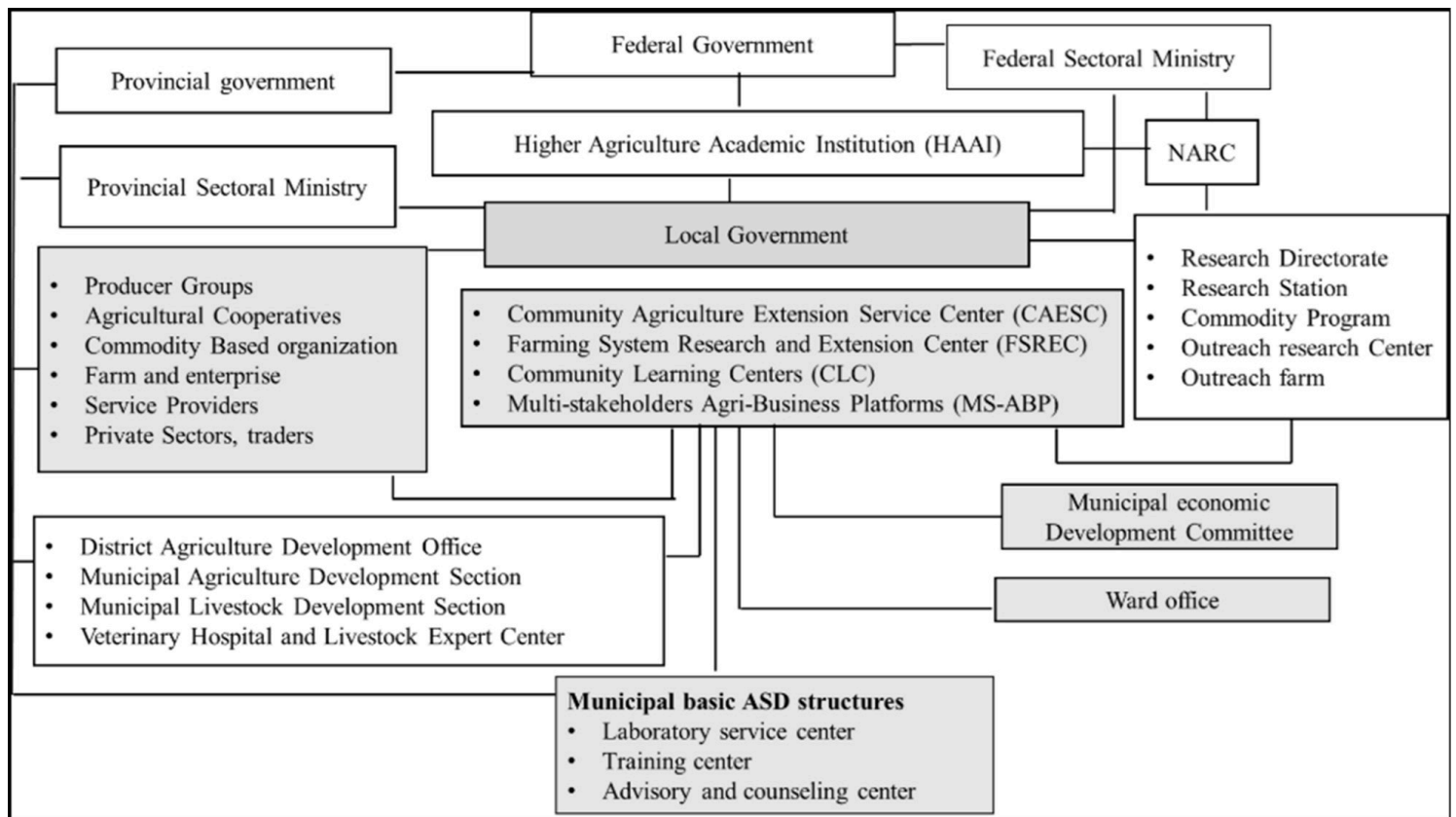


**Figure 2**

Potential agriculture service delivery units and mechanisms in Nepal

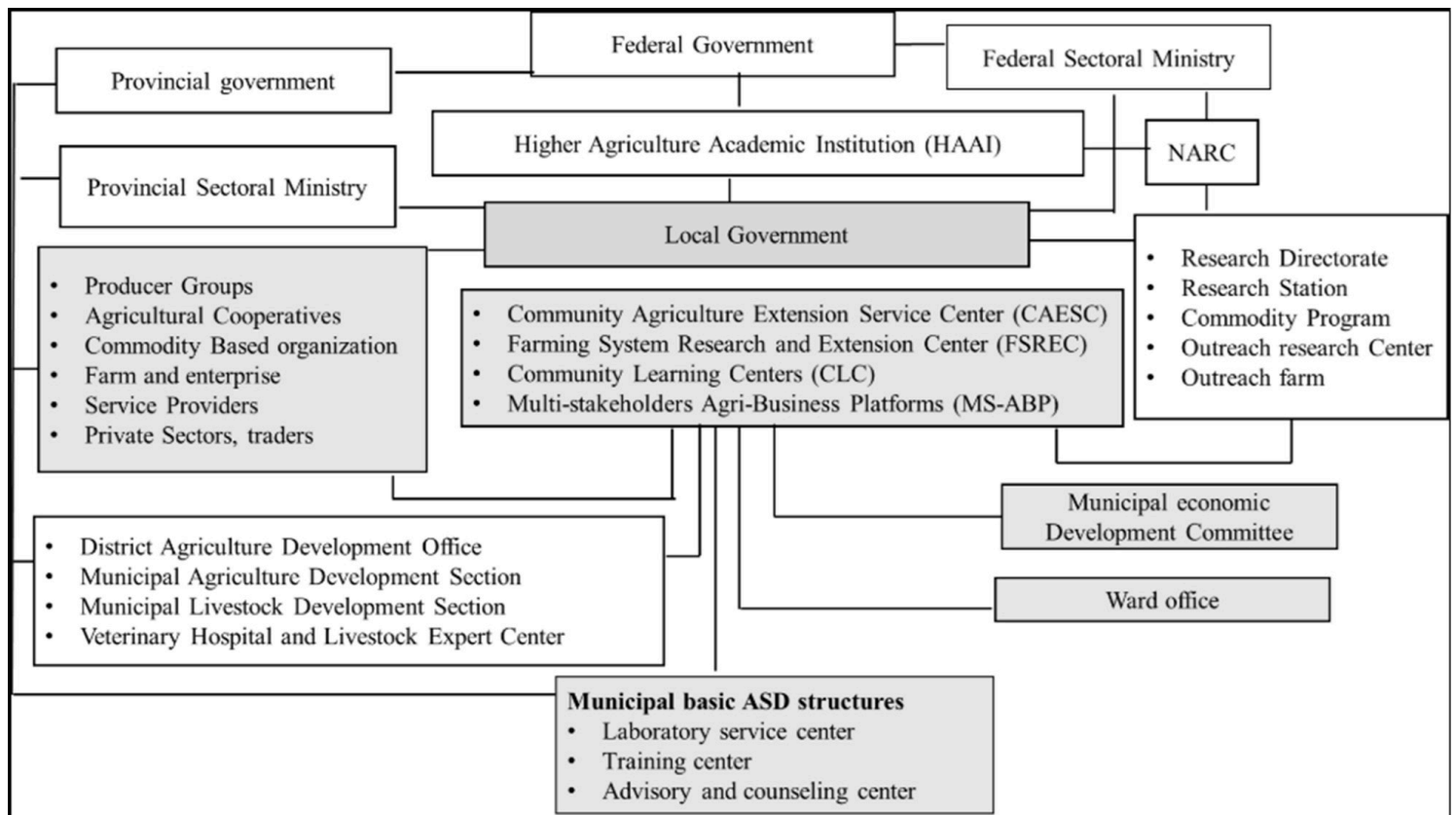


Figure 2

Potential agriculture service delivery units and mechanisms in Nepal

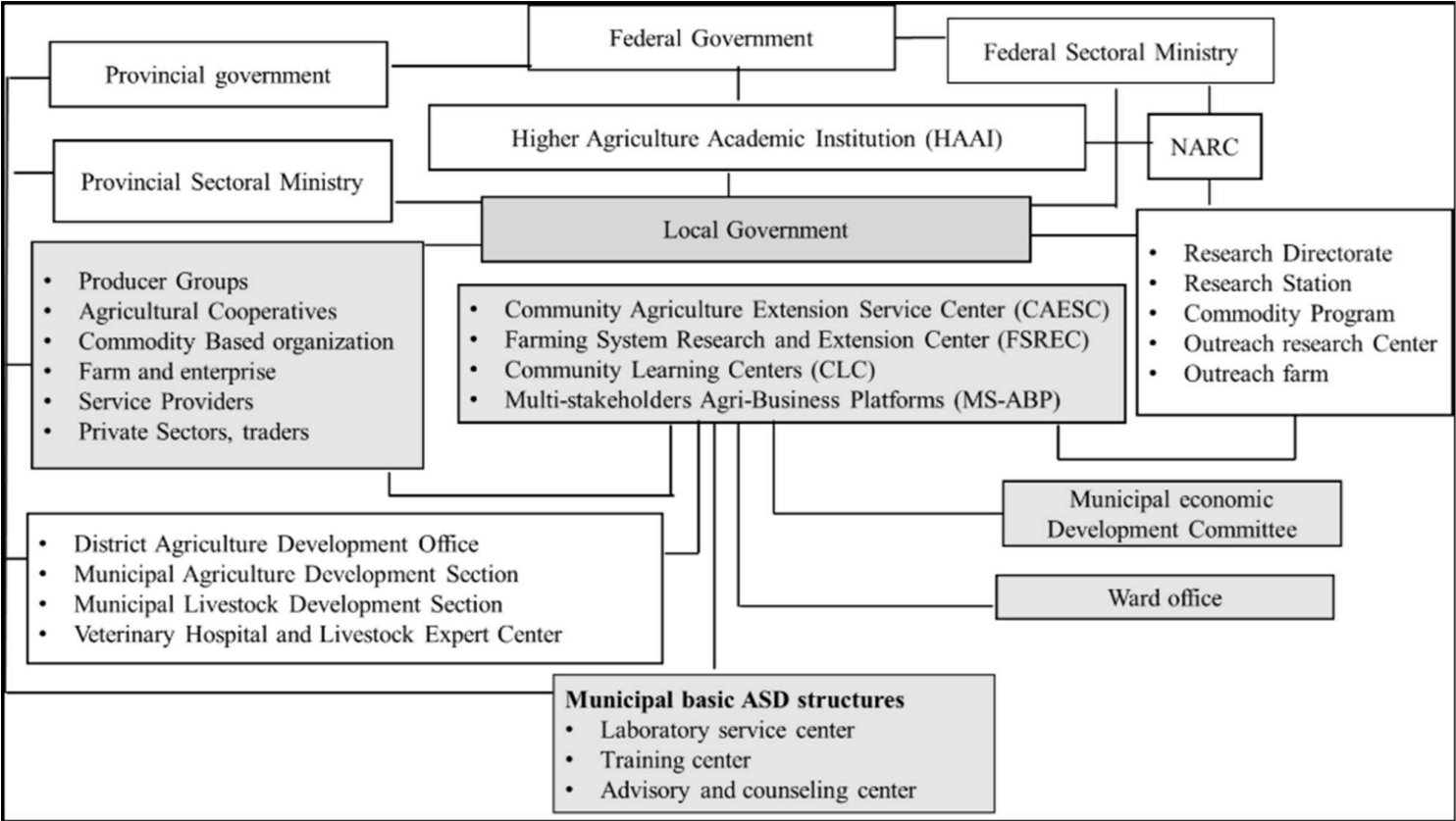


Figure 2

Potential agriculture service delivery units and mechanisms in Nepal

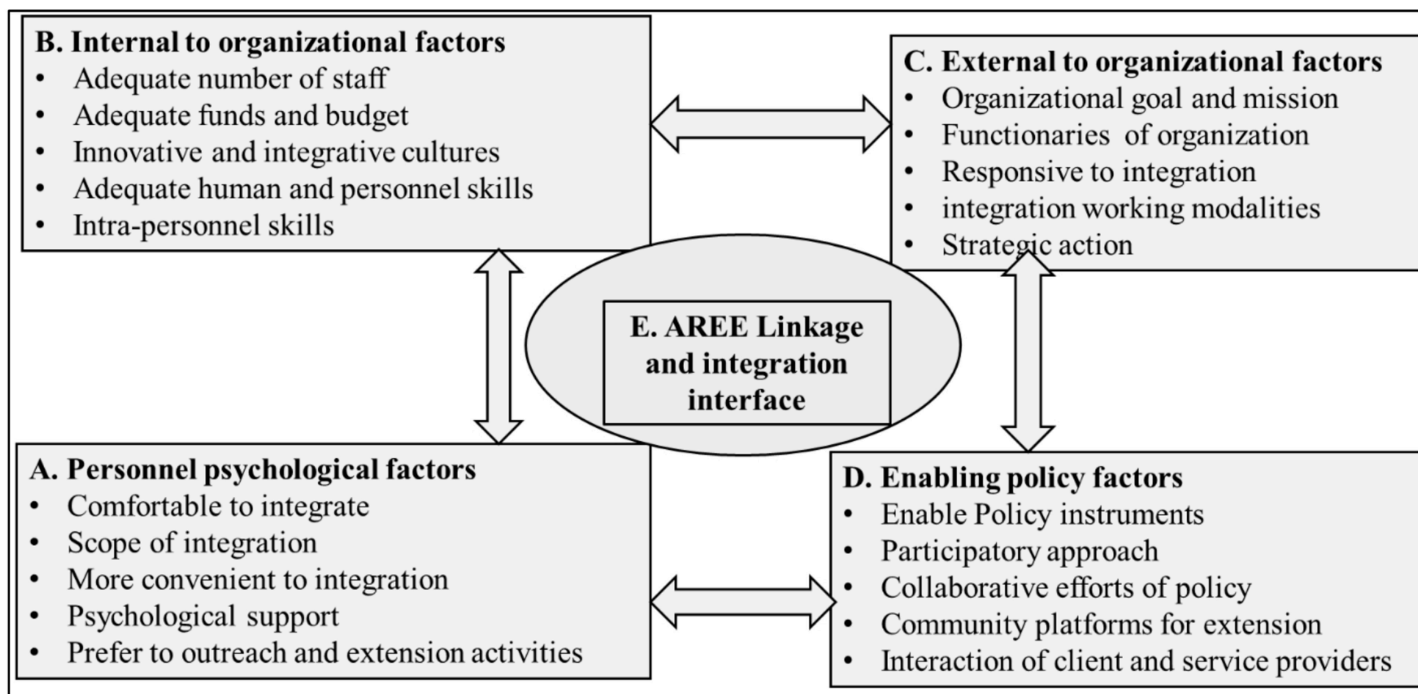


**Figure 3**

Conceptual framework of linkage and integration factors between agriculture research, extension, and education institutions

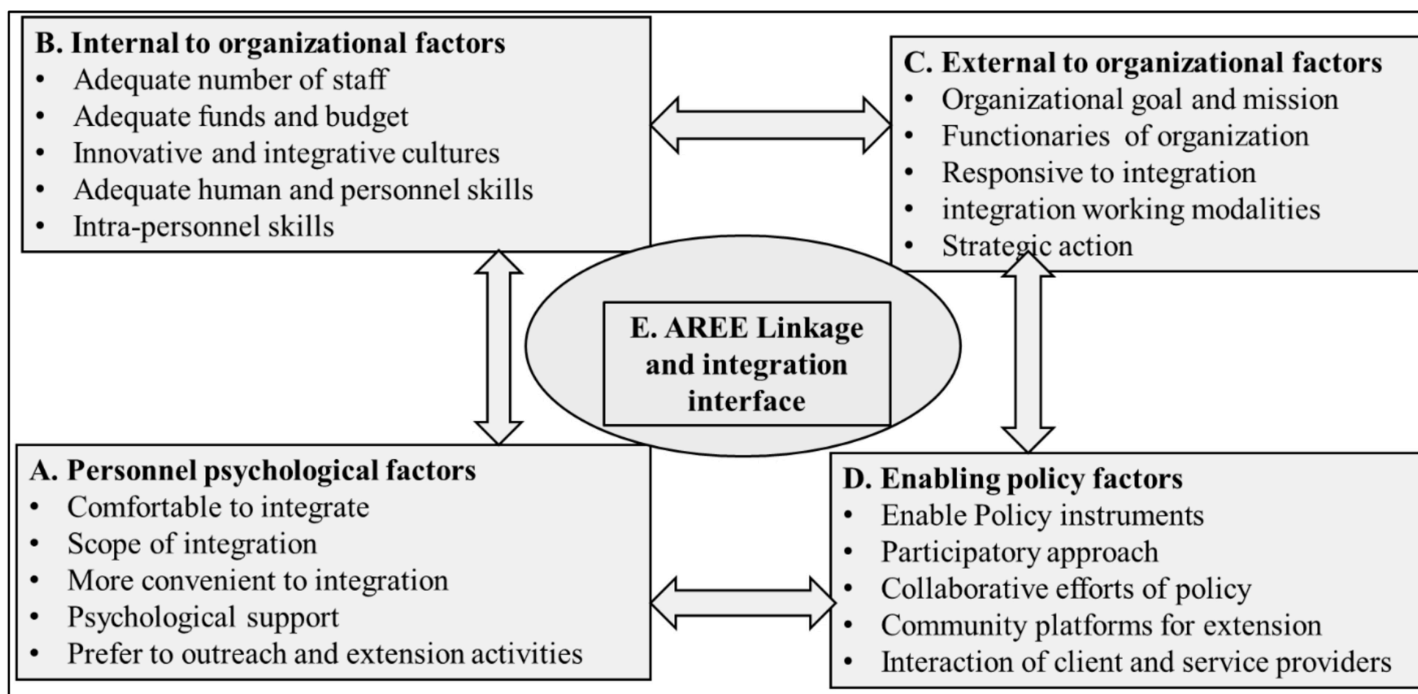


**Figure 3**

Conceptual framework of linkage and integration factors between agriculture research, extension, and education institutions

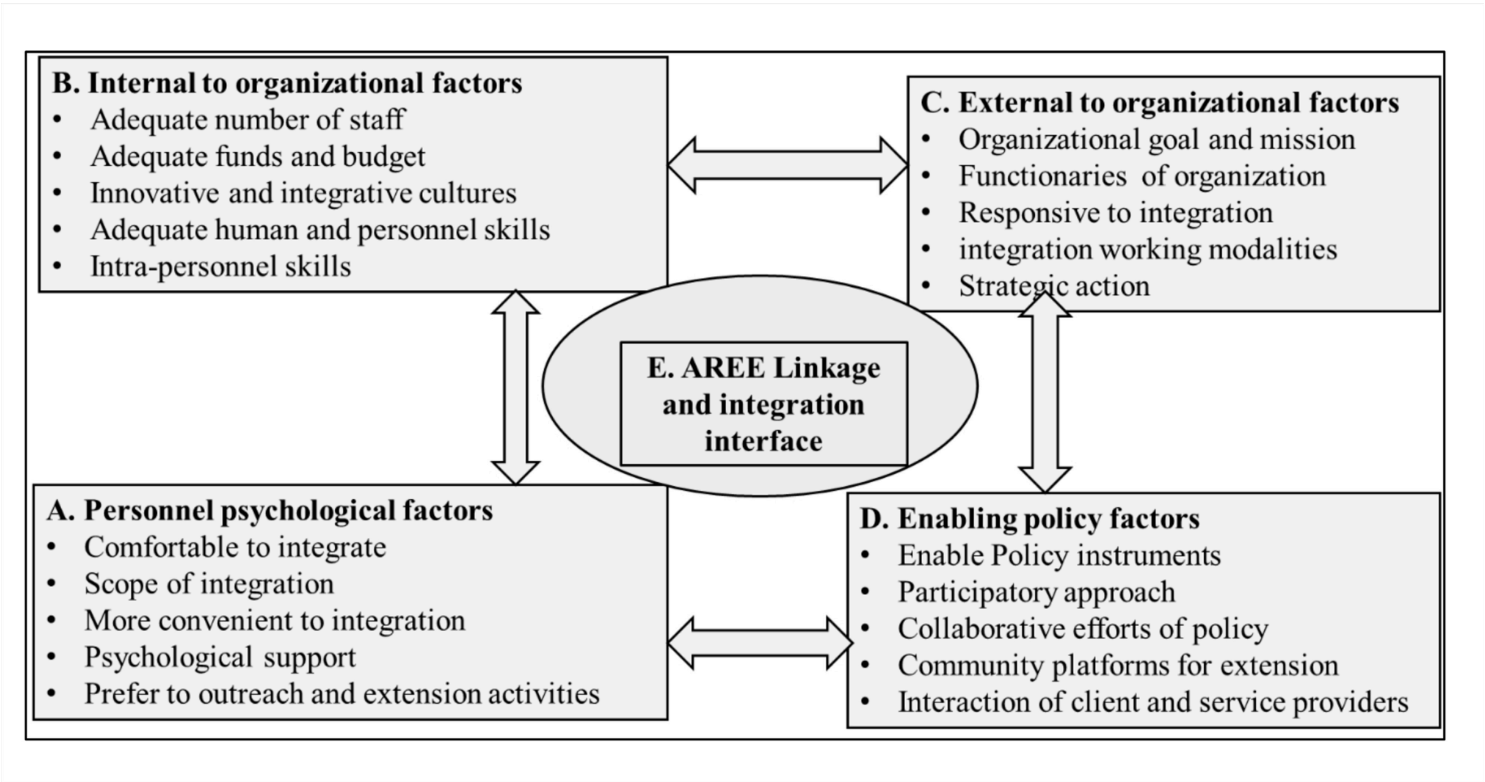


Figure 3

Conceptual framework of linkage and integration factors between agriculture research, extension, and education institutions

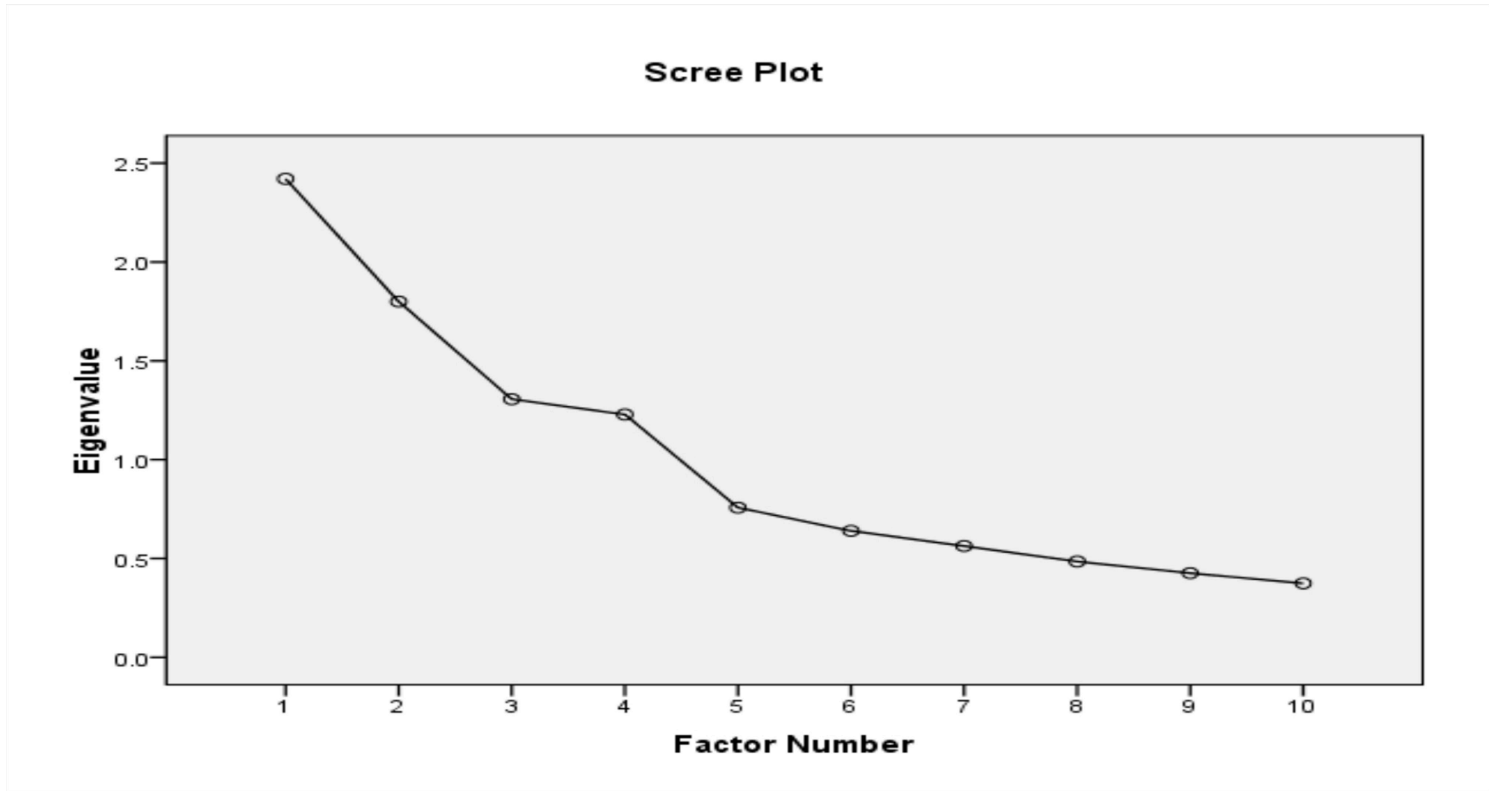


Figure 4

Scree plots of four factors and eigenvalues

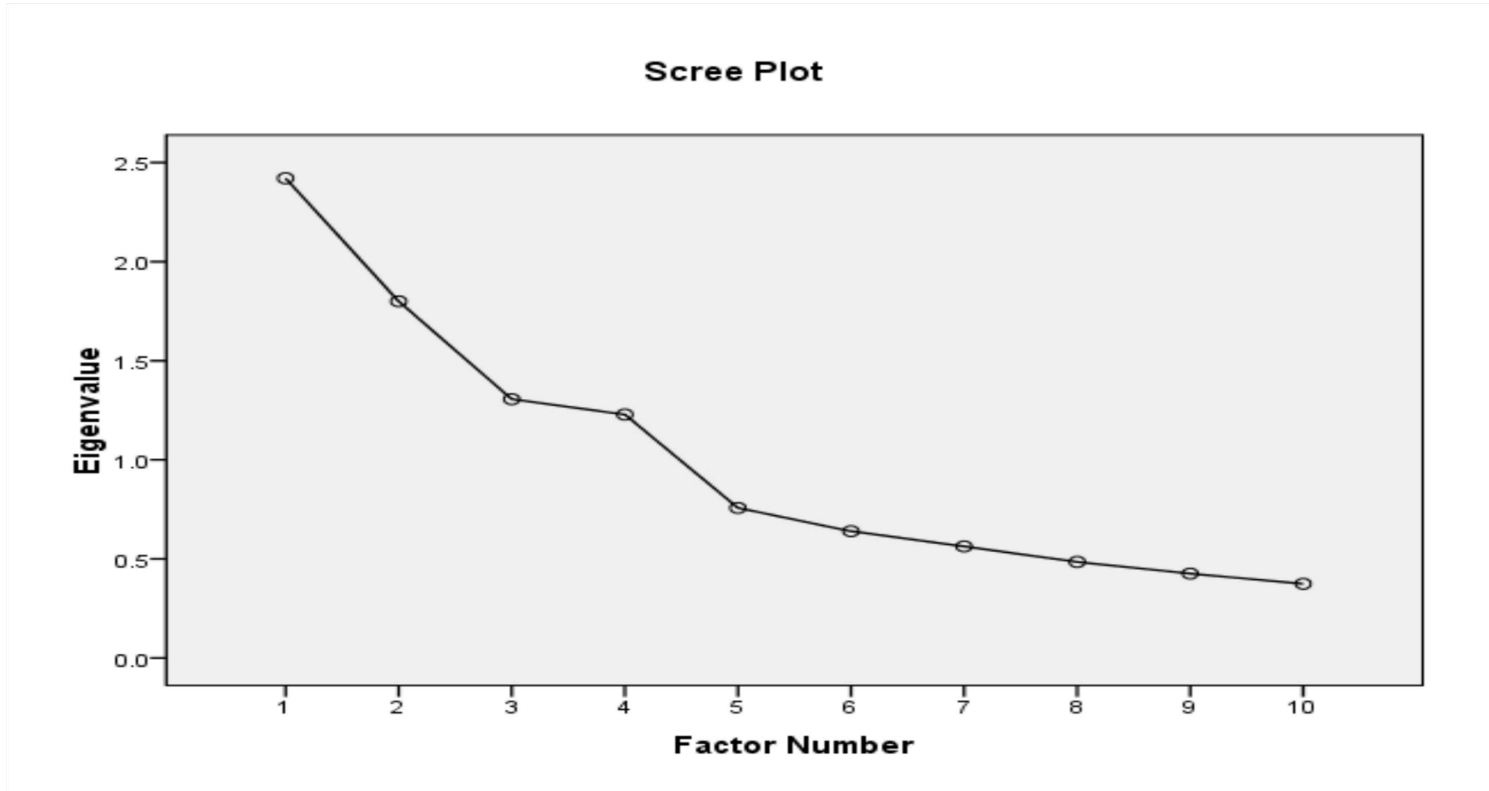


Figure 4

Scree plots of four factors and eigenvalues

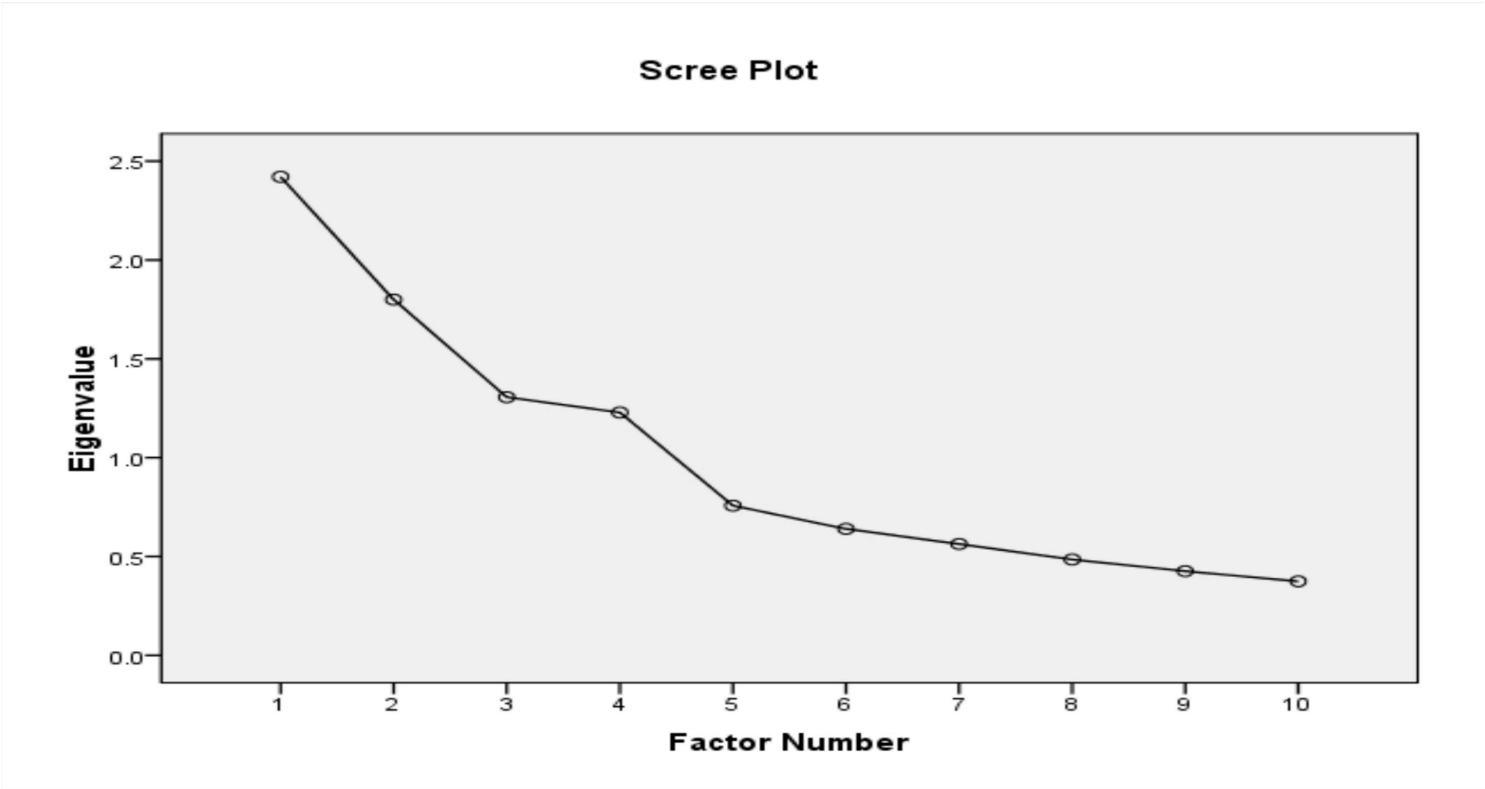


Figure 4

Scree plots of four factors and eigenvalues