Article

Academia-Industry Linkages for Sustainable Innovation in Agriculture Higher Education in India

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Abstract: The Indian Council of Agricultural Research (ICAR) and the World Bank have collaborated on a project entitled the National Agricultural Higher Education Project (NAHEP) to improve agricultural higher education in India, paving the way for sustainable higher education in agriculture. As part of this project, the present investigation was carried out through national-level workshops involving seven State Agricultural Universities (SAUs) across India, with participants from academia and industry, to strengthen ‘academia–industry collaboration’ through effective linkages. Based on the responses of 199 respondents from academia and industry, the study demonstrates an absolute need for linkages between universities and industries (p < 0.001), which are perceived to help improve higher education sustainably. Academic institutions believe that such linkages benefit students concerning their employability, entrepreneurial skills, and financial support received. At the same time, industries believe that they would benefit from novel technologies and influencing academic curricula. This article also establishes an alliance between some parts of academia and industry in the form of MoUs in the identified areas. However, many other areas need more appropriate linkage models. Both sectors, i.e., academia and industry, concur that such exposure and collaboration between the two entities will help to improve the quality of education. Moreover, such collaborations provide financial support, increase students’ employability, and improve their entrepreneurial skills. Among the areas requiring collaboration, the ‘capacity building of students’ was rated most important by academia and industry. Overall, the present study has significant implications for university administrators and industry leaders involved in enhancing academia–industry cooperation and improving the quality and sustainability of higher education in agriculture. Further, the study greatly contributes to the National Education Policy (NEP) to promote innovation among the student communities through Higher Educational Institutes (HEIs) and to the Sustainable Development Goals (SDGs).

Keywords: academia; industry; collaboration; sustainable agricultural education; linkage; policy

1. Introduction

The Indian agriculture sector has successfully addressed various production challenges through research, technology, and innovation. The green revolution in India is a testimony to the collaborative efforts of all stakeholders in improving the agriculture sector in India. With globalization, numerous opportunities have arisen, including the involvement of the
corporate sector in the agricultural value chain, the diversification of products to include high-value commodities, and the increasing demand for processed and value-added foods. However, to capitalize on these opportunities, there is a need for highly skilled, motivated, and well-trained agricultural professionals [1]. Currently, agricultural higher education (AHE) in India is provided through the public sector, consisting of 63 State Agriculture Universities (SAUs), 3 Central Agricultural Universities (CAUs), 4 Deemed Universities under the Indian Council of Agricultural Research (ICAR), and four Central Universities with an Agricultural Faculty.

The key challenges facing the Indian agricultural education include being less preferred by talented students, discrimination among faculty, inadequate funding, a lack of operational autonomy, and a fragile public–private partnership [1]. However, these inadequacies could be mitigated by strengthening the link between academia and industry. These factors also impact sustainable education, which is essential to disseminate knowledge in a way that promotes social and economic growth, as well as enabling a comprehensive understanding of human needs across the country [2]. However, due to unprecedented modernization and commodification, sustainable education is currently based on market-driven theory. Agricultural education is no exception to this trend and has undergone a transformation from production to productivity to business-oriented over the last few decades. The United Nations Sustainable Developmental Goals either directly or indirectly influence agricultural education. The SDG 4 aims to ensure access to equitable and high-quality education for all, wherein SDG 4.3 targets equal access to affordable technical, vocational, and higher education. The overarching goal of SDG 4 is to achieve universal access to quality higher education. Besides many other drivers of quality education, collaboration between academia and industry is a critical requirement. India’s ambitious National Education Policy (NEP) 2020 emphasizes the importance of research and innovation in Higher Education Institutes (HEIs) and calls for greater collaboration between academia and industry.

Academia–industry linkage refers to the interaction between parts of the higher education system and industry to facilitate knowledge and technology exchange [3–5]. Academia–industry collaborations have been recognized as crucial in promoting innovation with the ecosystem. There are numerous potential benefits of such collaboration [6], and multiple studies have documented them. Collaborations between academia and industry help in converting research-based technology into new products and services [7–9], bridge the gaps in expertise and skill sets, and foster innovation, thereby sustaining economic growth [10,11]. In addition, academia–industry collaboration provides an alternative source of funds to academia and rich academic knowledge to industry, thus benefitting both parties [12–15].

The study of academia–industry collaboration is essential to address real-world challenges and allow practitioners to adopt novel research-based strategies [16]. This collaboration is also facilitated by the personnel transition between academia and industry, aiding knowledge transfer [17]. Simon [18], in his work, suggested that academia must better prepare students for emerging technologies while still teaching foundational concepts and theories, and research reinforces that academia and industry must collaborate. In addition to increasing the chances of success in research and development, collaboration between academia and industry also contributes to innovation processes [19]. While academia focuses on knowledge creation, industry strives to solve practical problems. Industry can tap into a vast pool of expertise and insights by exploring and exploiting the landscape of academia and its knowledge generation activities globally [20].

Academia and industry are interconnected and rely on each other for their goals. This collaboration between academia and industry also benefits both parties in many other ways. Collaboration between academia and industry is essential in advancing research and development, solving practical problems, fostering innovation, and maximizing the potential for knowledge creation and application [21]. Industry–academia collaboration increases industry’s problem-solving capacity by granting access to university equipment
and specialized knowledge [22]. In turn, universities benefit from the collaboration by gaining awareness of the current technologies used in industry and accessing new funding opportunities. Initiating an early collaboration between academia and industry is crucial to leverage the strengths of both sectors and maximize the potential for innovation and knowledge creation [23]. Collaboration between academia and industry drives advanced research and innovation [24].

In recent years, there has been a significant increase in academia–industry collaboration in many developed nations, such as the United States [25], Canada [26], Japan [27], Singapore [6], and the European Union [28–30]. The reasons for this increase can be attributed to various factors that place pressure on both industries and universities [31,32], and such collaborations can lead to a reduction in the time lag between discovery and practical application [33]. Unfortunately, several barriers hinder the productivity of the relationship between academia and industry [34]. Barriers to academic collaboration with industry can be attributed to individual and organizational factors. On an individual level, factors such as conflicting interests and expectations, limitations to career progression, and a lack of knowledge about access to grants hinder collaboration [35]. Berman [36] explored the impediments to sustainable research partnerships between academia and industry and found that the ‘cultural gap’ between them significantly impedes successful collaboration. Goel et al. [37] investigated the various modes of collaboration between academia and the manufacturing industry in Germany. They found that university scientists typically start collaborations with industry, while firm employees take over the management of projects. Studies suggest that academia–industry collaborations offer benefits, such as improved research uptake, but face challenges, like intellectual property management, publication freedom, value conflicts, and limitations in academic and managerial theorizing [38–40].

Only a few studies have explored academia–industry interactions in developing countries. Gul and Ahmad [41] highlighted the importance of academia–industry linkage and its long-term effects on development in Pakistan with crucial reference to the biotechnology and pharmaceutical industries. Liu [42] analyzed the academia–industry linkages of Hong Kong electronics concerning small and medium-sized enterprises and showed that companies tend to hire highly qualified laborers trained by academic institutions to gain access to advanced academic knowledge. Ansari and Sharma [43] studied academia–industry interactions in India and identified the steps to improve such collaboration. A NISTADS [44] report studied the linkages between several science and technology institutions and highlighted the different types of linkages among them. Using data from seven universities, Bhattacharya and Arora [45] investigated the motivating factors and constraints perceived by academic collaborators. A study by Zabidin et al. [46] highlighted the gaps in collaborative approaches between academia and industry. They developed the Industry–Academia Knowledge Equilibrium framework, which could be applied to other fields related to the study. It has also been found that graduates invariably need to acquire more skills. As employers have the most authority in selecting graduates, it is suggested that universities work together with industries to develop the skills and traits that they demand [47]. Since quality education results in professional and skilled students who are industry-ready, educational institutions must focus on providing high-quality education to contribute to the SDGs [48].

The ICAR is currently operating a mega-research project entitled the National Agriculture Higher Education Project (NAHEP), funded by the World Bank and the Government of India on a 50:50 cost basis, operative at 60 SAUs, CAUs, and ICAR institutes. Under Component 2 of NAHEP, the ICAR National Academy of Agricultural Research Management (NAARM), Hyderabad, is associated with a subproject named ‘Investment in ICAR Leadership in Agricultural Higher Education’, along with the ICAR Indian Agricultural Statistical Research Institute, New Delhi. Based on the recommendations of the project’s International Advisory Committee (Supplementary Material: Table S1), a global study was undertaken to analyze the academia–industry collaborations in various global universities, with the specific objectives of (i) studying the perceptions of academia and industry regard-
ing the linkages among them and (ii) identifying areas that require collaboration between academia and industry towards improving agricultural higher education (AHE) in India, in line with the NEP 2020.

This study is based on the triple helix model (THM) approach that can be employed to create an innovation-friendly environment. The three interacting components of this model are industry, government, and universities, which complement each other. The industry desirous of the solution seeks a knowledge source for ideas, duly provided by universities linked to the industry [49]. This study considers two components, academia (agricultural universities) and agri-based industries. The present work was carried out to answer the following research questions: (i) What are the different means of improving higher education through linkages? (ii) What are the areas requiring linkages among academia–industry and academia–academia? (iii) What is the perception of academicians and industrialists regarding the need for linkages between academia and industry? and (iv) What is the perceived effectiveness of these linkages in improving the quality of agricultural higher education, and how can we improve its quality?

2. Materials and Methods

2.1. Conceptual Framework

Over the past two decades, academies have grown significantly. To survive in the age of modernization, industries are compelled to adopt a theory that responds to the market. Adopting a flexible theory in regard to the market will undoubtedly stop academia from adhering to the founding principles of educational philosophy. We propose a conceptual framework for the sustainable growth of academia in collaboration with industry, as shown in Figure 1. This framework also includes the research questions.

![Conceptual Framework](image)

**Figure 1.** Conceptual framework of academia–industry linkages for sustainable education and opportunities in agricultural higher education.

2.2. Sampling Plan and Data Collection

The stratified random sampling plan was employed to collect the data required to conduct the study. The country was divided into seven strata comprising different states and union territories based on agro-ecological regions. The ICAR-NAARM organized seven consultative workshops on ‘Academia–Industry–Government Linkages for Quality Agricultural Education’ in each of these strata during the year 2019 (Supplementary Material: Table S2). Stakeholders from all the states and union territories (except Goa) participated in these workshops. Faculty members from Central Agricultural Universities (CAUs) and State Agricultural Universities (SAUs), professionals from agri-based industries involved in
producing and marketing farm inputs, agri-service providers, and consultancy firms were randomly selected from each of these strata and were invited to participate in the workshop. The current status, challenges, and prospects of academia–industry–government linkages were discussed in this workshop. After deliberation, a structured survey questionnaire was distributed among the participants, and the responses were collected. The authors developed the questionnaire using a Likert-type standardized scale [50,51]. The questionnaire aimed to gather information on the role of academia–industry linkages in improving the quality of AHE in India.

The responses from 199 respondents were collected and analyzed, with 84.4% being faculty members (n = 168) and 15.6% being professionals from agri-based industries (n = 31). Data with basic details of the respondents, including gender, designations, and organizations, were collected. The gender-wise and sector-wise distribution of the respondents is given in Table 1. The Likert scale, ranging from 1 (not at all) to 5 (significantly), was used to gather respondents’ perceptions on the need for linkages between academia and industry and their effectiveness in improving the quality of higher education in agriculture. The questionnaire also included statements on how linkages could improve AHE quality, and respondents were asked to rate the comparative importance of academia–industry, and academia–academia linkages on a Likert scale.

Table 1. Gender-wise and sector-wise distribution of the respondents.

<table>
<thead>
<tr>
<th>Category</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academia</td>
<td>140</td>
<td>28</td>
<td>168</td>
</tr>
<tr>
<td>Industry</td>
<td>31</td>
<td>00</td>
<td>31</td>
</tr>
<tr>
<td>Total</td>
<td>171</td>
<td>28</td>
<td>199</td>
</tr>
</tbody>
</table>

2.3. Statistical Analysis

The data collected through the questionnaires were analyzed using appropriate statistical techniques. The percentages of responses for various points on the Likert scale were calculated. Categorical responses were subjected to descriptive statistical analyses in accordance with Venkatesan and Biwas [52]. To compare the central tendency scores from respondents in academia and industry, Mood’s median test [53] was employed, which is a nonparametric test best suited for categorical and ordinal data. Polychoric correlation, a technique used to estimate the correlation between two theorized, normally distributed, continuous latent variables from two observed ordinal variables, was used to measure the correlations among the areas requiring linkages [54].

Exploratory factor analysis (EFA) was performed to study the underlying structure of the areas requiring academia–industry linkage. EFA helps to discover the number of factors influencing the variables and to identify similar variables [55]. The Kaiser–Meyer–Olkin (KMO) test of factorial adequacy and Bartlett’s test for sphericity were used to check the suitability of data for the factor analysis. The KMO test returns values between 0 and 1, and a value above 0.8 suggests adequate sampling [56]. Bartlett’s test checks the correlation among variables necessary for the factor analysis [57]. The critical areas requiring collaboration were grouped based on their factor loadings. The internal consistency among the areas representing a particular group, obtained from EFA, was measured using Cronbach’s reliability coefficient [58]. All analyses were conducted using the R 3.6.2 statistical programming language, and the infographics were created using PowerBI.

3. Results

3.1. Perception of Needs and Outcomes from Academia–Industry Linkages

The study analysis indicated a critical requirement for linkages between industry and academia in the AHE sector (Figure 2). More than 50% of the respondents from academia and more than 46% of the respondents from industries emphasized the strong need for collaboration. However, the respondents from academia felt that the need for
collaboration among academia was significantly higher \((p < 0.001)\) than that of academia and industry. Similarly, respondents from industry opined that the need for collaboration among industries was significantly higher \((p < 0.01)\) than that between industry and academia. These \(p\) values indicate a significant difference in the perceptions of academicians and industrialists about academia–industry linkages. In the study, more than 90% of the respondents from academia and more than 85% of the respondents from industry felt that linkages would significantly enhance AHE quality (Figure 3).

Figure 2. Respondents’ perceptions on ‘need for collaboration’ (values in %).

Figure 3. Respondents’ perceptions about ‘improvement in the quality of higher education by collaboration’ (values in %).

3.2. Means of Improving Higher Education through Linkages for Sustainable Agricultural Higher Education

Table 2 summarizes respondents’ views on enhancing higher education through linkages, suggesting vast opportunities for academia and industry to collaborate towards shared objectives. Both groups agreed that collaboration would provide academic students with practical exposure and hands-on training in industry settings. Academia members strongly felt that linkages could help in increasing students’ employability
(average score = 4.44), securing internships and scholarships (average score = 4.25), and improving their entrepreneurial skills (average score = 4.20). Industry representatives strongly felt that linkages helped in developing entrepreneurial skills among students (average score = 4.37) and that universities adopting newer technologies (average score = 4.28) and designing curricula based on industry needs (average score = 4.22) can benefit the industry. However, respondents expressed less support for the notion that linkages would lead to greater academic, administrative, and financial autonomy (average score = 3.83). Mood’s median test indicated that the distribution of responses from both academia and industry was similar, except for the statement that ‘students will get practical exposure/hands-on training in industry’ (Table 2).

Table 2. Means of improving higher education through linkages.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Average Score</th>
<th>Median Test&lt;sup&gt;#&lt;/sup&gt; (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.U.</td>
<td>Ind.</td>
<td>Overall</td>
</tr>
<tr>
<td>(n = 151)</td>
<td>(n = 17)</td>
<td>(n = 168)</td>
</tr>
<tr>
<td>Students will get practical exposure/hands-on training in industry</td>
<td>4.44</td>
<td>4.60</td>
</tr>
<tr>
<td>Students’ employability will be increased</td>
<td>4.24</td>
<td>4.05</td>
</tr>
<tr>
<td>Industry can adopt new technologies with the help of the university</td>
<td>4.06</td>
<td>4.28</td>
</tr>
<tr>
<td>Will help in design/modification of the curricula in academia according to the needs of the industry</td>
<td>4.09</td>
<td>4.22</td>
</tr>
<tr>
<td>Will facilitate sponsoring of students’ research and internship/fellowships</td>
<td>4.25</td>
<td>3.79</td>
</tr>
<tr>
<td>Will develop entrepreneurship among students</td>
<td>4.20</td>
<td>4.37</td>
</tr>
<tr>
<td>Will encourage greater academic, administrative, and financial autonomy</td>
<td>3.83</td>
<td>3.84</td>
</tr>
</tbody>
</table>

Scale: 1—Not at all; 2—Slightly; 3—Moderately; 4—Very; 5—Extremely. <sup>#</sup> A p-value less than 0.05 rejects the null hypothesis that both distributions are the same.

3.3. Areas Requiring Linkages between Academia and Industry

The respondents were asked to rate 14 different pre-identified areas in a five-point continuum on a Likert scale. The results indicated that, among these areas, sharing hi-tech lab facilities (average score = 4.63), networking (average score = 4.47), and soft skills and career development for students (average score = 4.46) were rated as the most critical areas requiring collaboration. This was followed by entrepreneurship development (average score = 4.43), training and internships (average score = 4.4), and human resource development (average score = 4.41) (Table 3). The remaining variables were given comparatively less priority.

The responses were analyzed using exploratory factor analysis (EFA) after the adequacy of the sample was established based on the high Kaiser–Meyer–Olkin (KMO) value (0.88). Two factors emerged with eigenvalues greater than one, capturing 60% of the variation in the data, with the first factor accounting for 39% and the second for 21%. Based on the factor loadings, each variable found representation mostly in any of the two factors (Table 3). The factor loadings of variables with direct or indirect financial obligations, such as training and internships, industrial parks, entrepreneurship development, technology commercialization, networking, consultancy services, facility sharing, and skills and development centers, were collectively represented by the financial factor. Variables such
as inclusion in the board of directors, knowledge management, databases, and curriculum design fell under the technical factor, while human resource development had equal loadings in both factors. Subsequently, the two factors could be defined as financial and technical factors. The high values for Cronbach's alpha (0.86 and 0.83 for factor 1 and factor 2, respectively) confirmed the internal consistency of these two factors. The matrix of polychoric correlations between these variables is presented in Figure 4.

Table 3. Results of the factor analysis on areas requiring linkages between academia and industry.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean Score</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1 Training and Internships</td>
<td>4.40</td>
<td>0.59</td>
<td>0.02</td>
</tr>
<tr>
<td>V2 Industrial Parks</td>
<td>3.89</td>
<td>0.54</td>
<td>0.05</td>
</tr>
<tr>
<td>V3 Entrepreneurship Development</td>
<td>4.43</td>
<td>0.57</td>
<td>0.09</td>
</tr>
<tr>
<td>V4 Technology Commercialization</td>
<td>4.38</td>
<td>0.69</td>
<td>−0.04</td>
</tr>
<tr>
<td>V5 Networking</td>
<td>4.47</td>
<td>0.46</td>
<td>0.30</td>
</tr>
<tr>
<td>V6 Consultancy in Services</td>
<td>4.30</td>
<td>0.69</td>
<td>−0.01</td>
</tr>
<tr>
<td>V7 (Product Testing, Certification, etc.)</td>
<td>4.63</td>
<td>0.77</td>
<td>−0.06</td>
</tr>
<tr>
<td>V8 Soft Skills and Career Development for Students</td>
<td>4.46</td>
<td>0.65</td>
<td>0.06</td>
</tr>
<tr>
<td>V9 Inclusion in Board of Directors</td>
<td>3.72</td>
<td>−0.11</td>
<td>0.81</td>
</tr>
<tr>
<td>V10 Knowledge Management</td>
<td>4.30</td>
<td>0.02</td>
<td>0.74</td>
</tr>
<tr>
<td>V11 Databases for Information</td>
<td>3.99</td>
<td>0.25</td>
<td>0.49</td>
</tr>
<tr>
<td>V12 Mutual Trust</td>
<td>4.15</td>
<td>0.19</td>
<td>0.53</td>
</tr>
<tr>
<td>V13 Curriculum Design</td>
<td>4.07</td>
<td>0.09</td>
<td>0.53</td>
</tr>
<tr>
<td>V14 Human Resource Development</td>
<td>4.41</td>
<td>0.35</td>
<td>0.39</td>
</tr>
</tbody>
</table>

Variance proportion explained: 39% for Factor 1 and 21% for Factor 2.

Internal consistency (Cronbach’s α value) for Factor 1 is 0.86 and for Factor 2 is 0.83.

Figure 4. Polychoric correlation matrix depicting the extent of correlation among areas requiring collaboration between academia and industry (Note: dark blue—strong positive correlation; dark red—strong negative correlation).

3.4. Areas Requiring Linkages among Academic Institutions

A Likert scale was used to grade 15 pre-defined areas requiring linkages within academia (Table 4). Among the 15 areas, research resource support (average score = 4.61), technology incubation centers (average score = 4.45), and student exchange programs (average score = 4.40) were rated as the most critical areas requiring collaboration. The suitability of the data for EFA was confirmed by the KMO test (KMO = 0.95) and Bartlett’s
test (chi-square = 2279.753, p < 0.01). Subsequently, the data were analyzed using EFA (Table 4).

Table 4. Results of the factor analysis on areas requiring linkages among academia.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean Score</th>
<th>Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1</td>
<td>Factor 2</td>
</tr>
<tr>
<td>Consultancy and Contract Research</td>
<td>4.17</td>
<td>0.64</td>
</tr>
<tr>
<td>Training and Development of Staff</td>
<td>4.39</td>
<td>0.62</td>
</tr>
<tr>
<td>Student Internships</td>
<td>4.34</td>
<td>0.45</td>
</tr>
<tr>
<td>Technology Incubation Centers</td>
<td>4.45</td>
<td>0.88</td>
</tr>
<tr>
<td>Networking</td>
<td>4.25</td>
<td>0.66</td>
</tr>
<tr>
<td>Joint Courses</td>
<td>3.96</td>
<td>0.61</td>
</tr>
<tr>
<td>Consultancy for Higher Education</td>
<td>4.17</td>
<td>0.74</td>
</tr>
<tr>
<td>Student Exchange Program</td>
<td>4.44</td>
<td>0.80</td>
</tr>
<tr>
<td>Sharing of Infrastructural Services</td>
<td>4.34</td>
<td>0.59</td>
</tr>
<tr>
<td>Quality Improvement Programs</td>
<td>4.36</td>
<td>0.95</td>
</tr>
<tr>
<td>Joint Patents</td>
<td>4.13</td>
<td>0.10</td>
</tr>
<tr>
<td>Joint Publications</td>
<td>4.22</td>
<td>-0.05</td>
</tr>
<tr>
<td>Joint Projects</td>
<td>4.33</td>
<td>0.09</td>
</tr>
<tr>
<td>Research Resource Support</td>
<td>4.61</td>
<td>0.33</td>
</tr>
<tr>
<td>Research Guidance</td>
<td>4.30</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Variance proportion explained 34% 23%

Internal consistency (Cronbach’s α value) (n = 199) 0.94 0.91

Based on the eigenvalues, two factors were sufficient to capture 57% of the variation in the data, out of which the first factor explained 34% of the variation. The variables were assigned to these two factors based on the factor loadings. The first factor consisted of consultancy and contract research, the training and development of staff, student internships, technology incubation centers, networking, joint courses, consultancy for higher education, student exchange programs, the sharing of infrastructural services, and quality improvement programs. The second factor included joint patents, publications, joint projects, and research resource support. Looking at the areas included, factor 1 could be financial, and factor 2 could be technical. However, the area of research guidance had approximately equal loadings on both factors. The polychoric correlations between these variables are shown in Figure 5.

Figure 5. Polychoric correlation matrix depicting the extent of correlation among areas requiring collaboration within academia. (Note: dark blue—strong positive correlation; dark red—strong negative correlation).
3.5. Present Status of Linkages

Some universities and industries already have some linkages with each other, but there is still much scope for improvement. The majority of the respondents from both universities (70.0%) and industries (65.0%) indicated that some linkages currently exist. However, only 50.7% of universities and 58.8% of industries have established models for linkages in the form of a Memorandum of Understanding (MoU), highlighting the need to develop other models to establish more linkages. In addition, only 49.3% of universities and 28.6% of industries reported having institutional mechanisms such as representation and participation on boards, committees, and councils related to academia–industry linkages.

In a similar survey conducted by ICAR-NAARM in 2022, results showed that approximately 44% of universities had linkages with more than 15 industries (from the unpublished data of NAHEP Component 2) concerning the career development and placement of students (Figure 6a). Out of the total number of MoUs (168) signed by universities with industries, 164 were national, and only four were international (Figure 6b). On average, approximately nine MoUs were signed by each university with industries.

Figure 6. (a) Number of industries linked with universities regarding career development and placements of students; (b) number of MoUs signed by universities with national and international industries.

4. Discussion

4.1. Academia–Industry Linkages for Mutual Benefit

The current study’s findings indicate a significant need for linkages between academia and industry in terms of gaining practical exposure and hands-on training, as indicated by most respondents. Collaborations between academia and industry have been ongoing for several decades to transfer knowledge and combine strengths for mutual and societal benefits [59]. These linkages provide benefits to both academia and industry in numerous ways. For industry, relations with universities help to enhance their innovation capacity and improve competitiveness through product and process development. Similarly, universities benefit from increased financial and other resources, access to updated good practices, technical knowledge, knowledge creation and utilization networks, industrial information, applied knowledge, and visibility through the transfer of proper scientific knowledge, increased workforce participation, and the development of students [13,14,60–63].

The benefits that industries can gain from collaborations with universities and public research organizations are access to basic and applied research results, economically relevant scientific and technological knowledge, and the ability to develop and test prototypes. Industries also receive support in solving specific problems, obtaining new product specifications, and recruiting highly qualified and skilled personnel. Industries have often shown interest in collaborating with universities and public research organizations to improve their innovation performance and benefit from the new scientific knowledge produced [64].
Universities in many countries face significant pressure to secure private sector funding [65]. Academia–industry collaborations have resulted in many innovative products [66]. The emergence of science and technology-based industries has motivated academia to play a more direct role in innovation [31,67,68].

### 4.2. Areas Requiring Academia–Industry Linkages

This study reveals that areas such as sharing hi-tech lab facilities, networking, and soft skills and career development for students are the most crucial for academia–industry linkages, followed by training and internships and entrepreneurship development. Linkages between academia and industry are essential in maintaining quality standards in research and development, generating new scientific and technological capabilities, and producing research and development resources [45]. Industry can benefit from academic institutions by acquiring and utilizing research results; hiring students, graduates, and researchers to enhance their innovation capabilities; and providing financial support for academic research to support their product development [42].

The objectives of academia and industry may differ, requiring significant effort from both parties to collaborate effectively [69]. This study reveals that the areas requiring collaboration also vary among them. Despite this, many areas encourage collaboration, which can be grouped into two broad categories: the first is technical collaboration, where there is an exchange of ideas and innovations; the second is financial collaboration, where the facilities are shared between the collaborators, and there is financial support from one to the other. Prior studies suggest that the academia–industry linkage relationship may differ across industries as the organizational characteristics of companies and the business and legal environments in which companies operate vary [4]. Likewise, academic institutions also differ concerning their innovation goals and how they innovate [70].

Academia focuses more on basic sciences, whereas companies focus more on applied research with the goal of profit maximization [71]. Towards this, industries use their own knowledge and technologies, which they either have developed independently or acquired from other sources, such as academic and research institutions. Industries may obtain knowledge and technologies from academia by acquiring patents and licenses developed by academia, partnering with academic institutions to develop technologies, or hiring students and graduates and attracting researchers to join them in their endeavors [42,72–74]. Transnational academic mobility is necessary for knowledge development and academic quality [75].

In the NITI Aayog document [76], Strategy for New India @75 (under Section 26. Skill development), it has been highlighted that industry–institute linkage is crucial in providing cross-learning by teachers and industry experts. It helps to upgrade teachers’ capacity to provide a quality education with skills development. Similarly, transnational academia–industry collaboration will help to achieve academic excellence. In the Working Group Report [77] on ‘Strengthening academia–industry interface for the 11th 5-year plan’, it was also emphasized that industry–institute linkage is crucial in providing cross-learning by teachers and industry experts by upgrading the capacity of teachers to provide quality education and helping students to find placements through established relationships with industry.

### 4.3. Academia–Industry Linkages for Higher Education

Though academia and industry differ in perceiving how collaboration can improve AHE, there is a unanimous belief that collaboration is necessary. Academia believes that the students most benefit from such linkages either through industrial exposure or grants and fellowships. Since higher education produces graduates for industry, an industry-driven approach is desperately needed to increase the effectiveness of higher education through a scientifically well-regulated levy system. In addition to having the option of pre-paid tuition, students may also take advantage of a post-paid fees method, where the university should collect its fees directly from the hiring industry on behalf of its employed graduates [2]. Collaboration with universities allows industry to access new knowledge
and save costs incurred for their R&D [78,79]. At the individual level, collaboration has been proven beneficial to education [80]. Collaboration between universities and industry will likely improve the communication between higher education, universities, and industry [81]. A framework developed by Al-Sultan and Al-Zaharnah [82] to promote research and development in Saudi institutions of higher education suggested continuing to engage with enterprises and formal consultation with industries to structure M.Sc. and Ph.D. programs that address industry requirements, as the availability of only a small number of graduates remains an obstacle to knowledge generation.

4.4. Vision of NEP 2020 to Strengthen Higher Education

As per the Indian National Education Policy (NEP) 2020 published by the Ministry of Human Resource Development, India, under Section 9: Quality Universities and Colleges: A New and Forward-Looking Vision for India’s Higher Education System, and Subsection 11.12: Higher Education Institutes, it is necessary to focus on research and innovation by setting up more significant industry–academia linkages. The NEP also stresses that while providing rigorous research-based specialization in graduate, master’s, and doctoral education, they should also provide opportunities for multidisciplinary work, in academia, the government, and industry. In addition, opportunities for internships with local industries, businesses, artists, etc., for students at higher educational institutes, and research internships with faculty and researchers at their respective or other institutions, would help to engage students actively in practical learning that improves their employability.

4.5. The Way Forward for Academia–Industry Linkages in India for Sustainable Agriculture Higher Education and Innovation

In India, nurturing and expanding the existing linkages between academia and industries is essential for educational progress and in promoting sustainability in agriculture and higher education. A multifaceted approach is necessary to achieve this, involving legislative measures and institutionalized frameworks fostering industry–academia connections, with active government support. Moreover, barriers such as a lack of mutual trust and appreciation, a lack of infrastructure, different standards of evaluation, different ethos, a lack of financial gains, problems with the mutual ownership of Intellectual Property Rights (IPRs), a lack of communication, poor research management, obsolete research topics, a fear of sharing sensitive information, etc., act as constraints in establishing fruitful linkages [45,83]. Soam et al. [84] identified possible linkages to the General Agreement on Trade in Services (GATS) challenges and global standards in ‘Agricultural Higher Education’ in India. It is evident from the present study that although some collaboration exists between academia and industry, only a few have established models for such linkages, indicating the need for institutionalization. The relationships between academia and industry are often founded on unequal expectations and are usually characterized by short-term arrangements. Without regulations governing public goods and the public interest, sustainable education will remain unattainable for developing countries and only theoretical. Educational resources are often heavily misused or squandered in the absence of sustainable education, likely leading to educational inflation [2]. Furthermore, cultural divergences are high and often lead to disappointing outcomes [85]. Approaches that involve attitudinal changes and the cross-sharing of values are required to overcome these issues [13]. Many studies have also explored the role of public and private provisions in delivering sustainable higher education by comparing the strengths and weaknesses of each counterpart. Without sacrificing the tenets of higher education, academia and industry must acknowledge the overwhelming realities of 21st-century higher education. By addressing these issues and fostering a culture of sustainability, academia and industry in India can truly enhance the quality of agricultural higher education sustainably.
4.6. Institutionalization in Sustainable Education: Challenges and Opportunities

The study highlights the critical need for institutionalization to facilitate successful academia–industry linkages and to establish sustainable agricultural higher education in India. While globalization and internationalization have brought opportunities for higher education in developing countries, they must be mindful of creating a sustainable education system, rather than relying solely on the export of students and the loss of foreign exchange. This sustainable approach involves using research and innovation to transform elementary and secondary education into long-term, locally relevant solution providers. Further, the government should enact enabling policies and regulations to promote the sustainability of agriculture and higher education, by encouraging the inclusion of sustainability criteria in funding allocations and educational accreditation processes. Moreover, students should be involved in sustainability initiatives, fostering a sense of responsibility and passion for environmental and social causes. This would equip them with practical skills and ensure a new generation of sustainability advocates.

Suppose that we see higher education in developing countries. In this case, it is now forced to act as an agent that advances the interests of its main counterparts due to the complete one-way traffic and trade resulting from this borrowing paradigm. This is referred to as internationalization in higher education, which might not produce a sustainable education system. Additionally, the General Agreement of Trade and Services (GATS) ruling, which permits higher education as an international commodity, has not been well utilized by higher education in the eastern part of the world [2]. Many students from developing countries travel to the west for higher education, which can result in a direct loss of foreign exchange. It is ideal for higher education to use research and innovation to mold elementary and secondary education into sustainable providers. A popular belief is that merit-driven higher education, and not elite-driven higher education, supports sustainable development in education.

The most important aspect that must be implemented nationwide is the standardization of national education programs. The alignment of a nation’s economic and social development goals with a human needs perspective should be considered when deciding on this standardization. Not socioeconomic status but the students’ merits alone should be the deciding factor in the education that they receive. Adherence to the concept of standardized education is mandatory for all educational institutions. Moreover, a sustainable education system should mechanize the returns on education for both the public and private sectors, ensuring that graduates contribute to the nation’s development. To make higher education more effective and industry-oriented, it is crucial to establish a system driven by industry participation. This includes the meaningful engagement of stakeholders such as academicians and industrialists to collectively work towards sustainable innovation [2,86]. Such an approach will enhance the quality of education and contribute to India achieving the Sustainable Development Goals in agriculture and higher education.

5. Conclusions

The present study holds several implications for the administrators of universities and firms in terms of strengthening academia–industry collaboration towards improving the quality of higher education in agriculture. First, this study highlights the absolute need for academia–industry collaboration and linkages within each group. Second, respondents from both sectors believed that such collaborations helped in improving the quality of higher education in agriculture. However, academia and industry differ in their perceptions of the extent to which such collaborations help students to obtain practical industry exposure. A higher collaboration requirement is suggested to exist within academia, rather than between academia and industry. Similarly, among industry, it is believed that there is a higher collaboration requirement among industries than between industry and academia. Nevertheless, both sectors concur that such exposure will help to improve the quality of education. Moreover, such collaborations provide financial support, increase students’ employability, and improve their entrepreneurial skills. Among the
areas requiring collaboration, the capacity building of students was rated most important by academia and industry. Therefore, under this project, ‘Career Development Centers’ have been started in five Agricultural Universities. The exchange of students was ranked highly among academia. The areas can be grouped into two broad categories, technical and financial, according to their implications. This study showed that most industries and academia already had some collaboration between and among them. However, the study found that only a few had a structured model that could be scaled up and institutionalized to strengthen linkages. There are various ways to improve the quality and relevance of agricultural higher education. These include flexible curriculum design, development, and implementation. The National Education Policy (NEP) 2020 emphasizes the creation of large, multidisciplinary higher education institutions that facilitate research and innovation, which requires effective linkages among stakeholders—more specifically, among academia and industry. The AHE will focus on research and innovation by setting up incubation centers, technology development processes, centers in frontier research areas, more significant industry–academic linkages, and interdisciplinary research, including humanities and social science research. The development of national, state, and university-level policies for academia–industry linkages would improve the quality of agricultural higher education and promote sustainable innovation and the growth of the nation. Without sustainable education, there would be the significant waste or misuse of educational resources, which would, in turn, lead to educational inflation. Thus, the foundation for sustainability in education is critical for sustainable education.

The key limitations of the present investigation are as follows: (i) we considered a small number of multinational industries and few State Agricultural Universities; (ii) the parameters used in the questionnaire were developed through brainstorming sessions and by referring to the existing literature; and (iii) we diversified the sample size from stratum to stratum, which altogether led to unequal representation. Surveying more universities and diverse industries with critical analyses would further enhance our understanding and allow us to make better decisions. Overall, the present research supports the NEP in introducing hand-holding mechanisms and competitions to promote innovation among student communities within HEIs and also in meeting the requirements for the 21st century and promoting vocational education.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su152316450/s1, Table S1: Experts of the International Advisory Committee of NAHEP (Component 2); Table S2: Details of the consultative workshops conducted.


Funding: This study was financially supported by the World Bank-funded project ‘National Agricultural Higher Education Project, NAHEP’ under Component 2A (Grant Number: NAHEP: 2018).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: This study was a survey type of study in which 199 human subjects were involved, and the informed written consent of the academicians as well as industry experts was obtained before the commencement of the study.

Data Availability Statement: Data are contained within the article and supplementary materials.

Acknowledgments: The authors gratefully acknowledge the coordinators at the SAUs and their contributions to the organization of the workshops and collection of data.
Conflicts of Interest: The authors declare no conflict of interest.

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