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Evaluating Agroforestry Extension Workers' Technical and Human Relation Competencies: A Ranked Discrepancy Model Needs Assessment

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Abstract: Increasingly, agroforestry is being promoted to smallholders as a method to adapt to and mitigate climate change while addressing socio-economic limitations. Promoting agroforestry practices requires organizations to have competent staff with requisite knowledge, skills, and abilities (KSAs) for their roles. This study examined perceived competency training needs among international workers promoting agroforestry. A Ranked Discrepancy Model (RDM) was used to determine and prioritize the KSA training needs of agroforestry professionals in selected countries in the Global South. This study was conducted with a nonrandom snowball sample of 107 professionals who promote agroforestry to smallholder farmers. As a nonrandom sample, the results represent those who participated, and caution is warranted in generalizing. Agroforestry Extension professionals deemed all items as either average or important, and training gaps existed in all agroforestry KSAs; however, the most notable training gaps were in (a) agribusiness, and (b) pests and disease. The research provides insights into the training needs of agroforestry personnel promoting agroforestry to smallholders in selected areas across the Global South. This study contributes to the theory for both professional development researchers and practitioners with the inclusion of a Ranked Discrepancy Model.

Keywords: smallholders; agroforestry training; change agents; Global South; organizational needs assessments; agricultural innovation systems

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1. Introduction

Climate change significantly impacts vulnerable groups such as smallholder farmers in the Global South [1,2]. The "Global South" generally includes Latin America, Asia, Africa, and Oceania, although it does not include all countries in these regions. The term refers to low-income, politically, and/or culturally marginalized countries. Many international institutions call for more sustainable agriculture practices, such as promoting agroforestry for farms to address climate change [3]. Agroforestry intentionally integrates crops, trees, and livestock into landscapes providing many biophysical and socioeconomic benefits, including (a) food security, (b) household income, (c) increased biodiversity, and (d) carbon sequestration [1,3,4]. Despite the well-documented benefits of agroforestry, there have been barriers to scaling up its adoption. Many barriers to adoption among smallholders in the Global South include economic, policy, biophysical, and cultural barriers.

Organizations promoting agroforestry require staff with competencies in complex biophysical and socioeconomic factors to address the barriers [5,6]. Extension staff must also possess the ability to (a) transfer technology and innovation, (b) provide advisory services, (c) support human resource development, and (d) empower others as they engage with farming communities [7]; however, past research has found that organizations often need better-trained extensionists with the required competencies [8–10]. An agroforestry workforce that is qualified in biophysical and socioeconomic competencies and able to engage with the community is needed to expand agroforestry practices to smallholders in the Global South. An agroforestry extension competency needs assessment was conducted to understand better the extension workforce's training needs.

Stone and Bieber defined competencies as the "application of knowledge, technical skills, and personal characteristics leading to outstanding performance" [11] (p. 1). McClelland advised that competencies should address work's occupational and social aspects. Furthermore, McClelland contended that academic institutions and employers should use competencies to assess students and employees [12]. Ghimire et al. proposed a conceptual framework for the competency assessment that informed this study: (a) identify competency areas, (b) examine the importance of competencies, (c) examine levels of competency, (d) identify gaps in competencies, (e) identify ways to acquire competencies, (f) revise/update curricula, and (g) provide education and training. This research addressed three steps of Ghimire et al.'s framework: (a) examine the importance of competencies, (b) examine competency levels, and (c) identify gaps in the competencies of agroforestry professionals using a training needs assessment [13]. Training need is identified as the gap or discrepancy between "what is" and "what should be". The discrepancy can identify competencies requiring professional development [14]. In agricultural education and extension research, needs assessment models are an accepted method for assessing training needs [15–19]. Competency needs assessments identify discrepancies between respondents' perceived levels of importance of the competencies and their proficiency in individual competency items.

Little is known respective to nonformal educators' agroforestry competencies from the literature. Our exploratory investigation examined perceived competency training needs among international workers promoting agroforestry. This research provides insight that can guide governmental, nongovernmental, and tertiary educational institutions in assessing the knowledge, skills, and abilities (KSAs) required of agroforestry extension workers in selected areas in the Global South. The three objectives of this study were as follows:

1. Describe differences between perceived proficiency and importance of agroforestry extension KSAs;
2. Prioritize agroforestry professionals' training needs based on gaps identified using a Ranked Discrepancy Model (RDM);
3. Demonstrate how the agroforestry RDM can be used by institutions promoting agroforestry extension.

Narine and Harder proposed the RDM as an intuitive approach to assessing the training needs of a sample [18]. The RDM is an appropriate method when the following conditions exist: (a) cross-sectional data are gathered at one point in time from a sample or census of a target population, (b) data for each item are paired on two ordinal scales with an equal number of response anchors, and (c) discrepancies are being assessed between two clearly identified conditions for each item [18]. The RDM provides a standardized discrepancy score of the competencies based on the identified conditions of equilibrium. Items that score below zero represent a more significant training gap, and items above zero represent no training gap [18]. The RDM is an intuitive approach to understanding the severity of a training need. It allows for direct comparison and priority ranking between competencies, indicating the needs of the sample, making it a tool that organizations can use to understand the training needs of their staff and prioritize professional development that addresses these needs.

An RDM is a contemporary technique to assess educational needs using a systematic evaluation of ranked discrepancies in professional capabilities' importance and levels of performance. RDMs are advantageous assessments that illustrate data interpretations and provide robust improvements of discrepancy analyses that are easier to understand and utilize versus the Borich model. As a result, for professional development researchers and practitioners, an RDM may be the ideal statistical procedure to illuminate professional priorities and aptitude for staff development [20].

2. Materials and Methods

A cross-sectional research design was used for this study. This design allowed survey data to be collected from different individuals at a single point [21]. Using a self-assessment of training needs, we evaluated agroforestry extension workers' perceived competencies from a nonrandom sample of agroforestry extension professionals working with smallholders in the Global South.

The study population comprised global agroforestry extension professionals: (a) directors, (b) managers, and (b) extension field staff. A non-probability snowball sampling technique [22] was used for this study. A snowball method of sampling was used to identify a hard-to-reach population that is geographically dispersed [23]. The researcher invited (via email) 65 program directors and managers from organizations that work in extension or agroforestry in selected areas across the Global South; this group was identified during the selection process of an agroforestry extension Delphi study [24]. These participants invited others from their organization or network to participate. The survey was also shared on extension and agroforestry listservs and social media sites based on participants' suggestions. Those who completed the assessment became a part of the nonrandom sample. This study's results represent those who participated; caution is warranted in generalizing beyond the nonrandom sample.

The researcher developed a 65-item split matrix instrument using the agroforestry extension knowledge, skills, and abilities (KSAs) derived from the researchers' previous Delphi study [24]. A four-member panel of extension and agroforestry experts reviewed the instrument to ensure content validity. The split matrix instrument had two response columns: the first was for respondents to rate the perceived importance, and the second was to rate the perceived proficiency for each item. Using a 4-point ordinal scale with the following options: 1 = None, 2 = Low, 3 = Average, and 4 = High [18], respondents identified their perceived importance and personal proficiency in technical and human relation KSA items. The survey concluded with five additional demographic questions to better understand participants. The survey was translated into Thai, French, and Spanish by native-speaking translators with agriculture translation experience. Another native-speaking translator checked each translation. Cronbach's alpha coefficients were not calculated because agroforestry KSA items were not considered as a set of scaled items that could be summed to measure the dimensionality of an overall concept. As such, Cronbach's alpha was unnecessary because dimensionality and/or unidimensionality were not of concern in this study [25]. The researcher administered the questionnaire through Qualtrics via a survey link. Participants could select their preferred language (English, French, Spanish, or Thai) within the survey. The survey was open from 1 March 2022 to 30 April 2022.

The study utilized three data analysis methods: (a) descriptive statistics, (b) ANOVA tests, and (c) an RDM. Data were analyzed using SPSS 29 and Excel software. Descriptive statistics were used to describe the sample and explain respondents' levels of importance and proficiency on the agroforestry extension KSA items. Objective one was to determine whether there was a significant mean difference between the item's perceived importance and perceived proficiency [20]. An ANOVA was conducted to determine the statistical significance. Mean differences between importance and performance on KSA items were tested at $p < 0.05$. Cohen's d was then calculated to determine the effect size on statistically significant items [26]. Cohen's d effect size measures the magnitude of the difference between two means and identifies the practical significance. The larger the effect size, the larger the difference between the items (i.e., larger practical significance). According to Cohen [27], a value of d = 0.2 represents a small effect size, d = 0.5 represents a medium effect size, and d = 0.8 is a large effect size.

A Ranked Discrepancy Score (RDS) was calculated for each competency statement to address objective two: prioritize agroforestry professionals' training needs [21]. This analysis allows for the gaps between perceived levels of competency and perceived importance to be prioritized. The RDM was used previously in competency research to identify training gaps [18–20]. Narine and Harder [18] outline three steps in the RDM. First, calculate the number of occurrences in the sample when participants' ability ratings are either: (a) less than participants' importance ratings (Negative Ranks = NR), (b) more than participants' importance ratings (Positive Ranks = PR), or (c) equal to participants' importance ratings (Tied Ranks = TR). This analysis was conducted in SPSS 27 by running a Wilcoxon rank test between paired responses [28]. Data were then exported to Microsoft Excel. After finding the number of NR, PR, and TR occurrences for each item, the Wilcoxon ranked scores were converted into percentages. The last step was to assign relative weights (W) to NR% (WNR = −1), PR (WPR = 1), and TR (WTR = 0) and calculate the RDS for each item. The formula for calculating the RDS was RDS = NR% (−1) + PR% (1) + TR% (0). The RDS is a standardized score ranging between −100 and 100. The RDS has an equilibrium of zero, with negative scores indicating a priority need and positive scores indicating the absence of a need. The RDS represents the overall capacity of the sample to perform a competency [18], providing insight into the training needs of this broad sample of professionals promoting agroforestry in the Global South.

3. Results

The respondents' demographic data are presented in Table 1. The assessment was completed by 107 agroforestry professionals, of which 76% were male. More than one-half (55%) held a graduate degree, followed by a bachelor's degree (41%). Most (65%) worked for nongovernmental organizations (NGOs). Their work experience ranged from 0 to 5 years (41%), 6 to 10 years (23%), and 11 or more years (36%). The majority (68%) worked in selected countries in Africa, while 17% self-reported working in selected countries in Asia, or Latin America and the Caribbean (11%).

Table 1. Demographics of agroforestry extension study participants.

Variables	Characteristics	*f*	%
Sex	Male	81	76
	Female	26	24
Education	Technical degree	4	4
	Bachelor's degree	44	41
	Graduate degree	59	55
Organization	Nongovernmental organization	69	65
	Government	14	13
	University	10	9
	Other	14	13
Experience in agroforestry	0–5 years	44	41
	6–10 years	25	23
	11 or more years	38	36
Regions	Africa	68	64
	Asia	18	17
	Latin America and the Caribbean	12	11
	Another country outside the Global South	9	8

Objective one was to describe the differences between perceived proficiency and the importance of agroforestry extension competencies. ANOVA was conducted to determine if significant differences existed between the mean scores of perceived importance and proficiency across all knowledge items. If significant differences were found, Cohen's d was calculated to assess the magnitude of the mean difference between importance and proficiency scores. Table 2 shows knowledge items rated from highest- to least-rated based on the total mean. The highest-rated items were sustainable agricultural production systems and practices (M = 3.62, SD = 0.58) and communication (M = 3.51, SD = 0.67), showing a substantial gap between the respondent's perceived proficiency and importance in those items.

Table 2. ANOVA of Perceived Importance and Proficiency of Agroforestry Extension Knowledge Items (n = 107).

		M [a] (SD)					
Knowledge	**Type** [b]	**Proficiency**	**Importance**	**Total**	***F***	***p*** *	***d*** [c]
Sustainable agricultural production systems and practices	TK	3.44 (0.66)	3.80 (0.42)	3.62 (0.58)	23.10	<0.001	0.66
Communication	HRK	3.34 (0.69)	3.68 (0.61)	3.51 (0.67)	15.22	<0.001	0.53
Tree nursery management (seed collection, propagation, seedling care, transportation)	TK	3.34 (0.74)	3.63 (0.71)	3.48 (0.74)	8.58	0.004	0.40
Trees in agroforestry systems (species, planting, pruning, harvesting, uses, crop interactions)	TK	3.18 (0.79)	3.72 (0.60)	3.45 (0.75)	32.29	<0.001	0.78
Community development practices	HRK	3.25 (0.78)	3.63 (0.65)	3.44 (0.74)	14.51	<0.001	0.52
Socioeconomic conditions and livelihoods of the local community	HRK	3.24 (0.72)	3.62 (0.56)	3.43 (0.67)	17.82	<0.001	0.58
Agroforestry systems, practices, and principles	TK	3.19 (0.78)	3.61 (0.58)	3.40 (0.72)	20.11	<0.001	0.61
Drivers of agroforestry adoption by smallholders	TK	3.07 (0.82)	3.65 (0.62)	3.36 (0.78)	35.50	<0.001	0.81
Costs and benefits of implementing agroforestry (socioeconomic, environmental, nutrition, food security)	TK	3.07 (0.74)	3.64 (0.66)	3.36 (0.75)	34.23	<0.001	0.80
Climate change adaptation	TK	3.14 (0.76)	3.56 (0.73)	3.35 (0.77)	17.11	<0.001	0.57
Gender roles in the community	HRK	3.19 (0.74)	3.51 (0.73)	3.35 (0.75)	10.55	0.001	0.44
Adult learning theory and extension methods	HRK	3.10 (0.85)	3.56 (0.75)	3.33 (0.83)	17.46	<0.001	0.57
Agriculture and natural resource ecology	TK	3.12 (0.76)	3.47 (0.70)	3.29 (0.75)	11.89	<0.001	0.47
Local culture, history, language, and development efforts	HRK	3.06 (0.72)	3.51 (0.68)	3.29 (0.74)	22.78	<0.001	0.65
Indigenous agroforestry practices	HRK	3.03 (0.81)	3.46 (0.74)	3.24 (0.80)	16.44	<0.001	0.55
Nutrient cycle process in agroforestry systems	TK	2.90 (0.75)	3.50 (0.59)	3.20 (0.74)	42.00	<0.001	0.89
Natural regeneration (farmer-managed natural regeneration, assisted natural regeneration)	TK	2.93 (0.82)	3.44 (0.63)	3.19 (0.77)	25.59	<0.001	0.69
Land and tree tenure practices	TK	2.83 (0.82)	3.50 (0.69)	3.16 (0.83)	41.03	<0.001	0.88
Local institutions and policies that impact agroforestry	HRK	2.82 (0.80)	3.48 (0.69)	3.15 (0.81)	41.03	<0.001	0.88
Plant pests and diseases	TK	2.80 (0.75)	3.48 (0.59)	3.14 (0.75)	53.74	<0.001	1.00
Climate and weather (regional climate, microclimates, weather patterns)	TK	2.79 (0.78)	3.47 (0.66)	3.13 (0.80)	47.69	<0.001	0.94
Business management (agroforestry markets and value chains)	TK	2.71 (0.71)	3.43 (0.69)	3.07 (0.79)	56.35	<0.001	1.03

[a] 1.0 = None, 2.0 = low, 3.0 = average, 4.0 = high. [b] TK = Technical Knowledge, HRK = Human Relation Knowledge. [c] Effect sizes were based on Cohen's *d* (small = 0.2, medium = 0.5, and large = 0.8). * $p < 0.05$.

Agroforestry staff perceived 13 knowledge items as important; the remaining items were considered of average importance. The importance level of sustainable agricultural production systems and practices (M = 3.8, SD = 0.42) ranked most important, followed by trees in agroforestry systems (M = 3.72, SD = 0.59). The panel's two least important knowledge items were business management (M = 3.43, SD = 0.69) and natural regeneration (M = 3.44, SD = 0.66), though both are still considered of average importance.

Participants perceived themselves as having average proficiency in all knowledge items. The respondents as a group had a higher rated perceived mean in the knowledge items: (a) sustainable agricultural production systems and practices (M = 3.44, SD = 0.66), (b) tree nursery management (M = 3.34, SD = 0.74), and (c) communication (M = 3.34, SD = 0.68). Participants perceived themselves as least proficient in business management (M = 2.71, SD = 0.71), though still considered average based on mean scores, followed by climate and weather (M = 2.79, SD = 0.77). Respondents' perceived importance of knowledge items was greater than their perceived proficiency of those same items, indicating that possible training gaps existed in all items.

An ANOVA test was conducted on each item to describe the differences between perceived proficiency and the importance of agroforestry extension knowledge items. Table 2 shows a statistically significant mean difference ($p < 0.05$) between the perceived importance and perceived proficiency across all knowledge items. Participants perceived their proficiency in the knowledge items as significantly lower than the items' perceived importance. The finding signifies that respondents as a group have a training need in all the knowledge items. However, because the items were statistically significant, Cohen's d was calculated in SPSS for each item to determine the effect size of statistically significant *p* values. The larger the effect size of an item, the larger the discrepancy between importance and proficiency, pointing to a greater training gap. Respondents' perceived importance of the items was greater than their perceived proficiency in the top three knowledge items: (a) business management (agroforestry markets and value chains) (d = 1.03); (b) plant pests and disease (d = 1.00); and (c) climate and weather (d = 0.94). All three items have a large effect size pointing to the need for prioritizing training on these items for this sample, as there is practical significance between the perceived importance and proficiency.

Table 3 shows the skill items rated from highest- to least-rated based on the total mean. A sizable gap exists between the respondent's perceived proficiency and importance in active listening (M = 3.65, SD = 0.54), teaching and/or facilitation (M = 3.64, SD = 0.57).

Descriptive statistics for the skill items (Table 3) show that the skill perceived as most important was active listening (M = 3.80, SD = 0.42), followed by oral communication (M = 3.78, SD = 0.46), and teaching and/or facilitation (M = 3.78, SD = 0.46). The skill item perceived as least important was agroforestry entrepreneurship (M = 3.41, SD = 0.71), followed by disease and insect prevention (M = 3.45, SD = 0.70). These items were still considered as having average importance by the respondents.

Participants perceived themselves to have an average proficiency or more in all the skill items. The skills perceived by participants as being most proficient in were teaching and/or facilitation (M = 3.51, SD = 0.63), followed by an average perceived proficiency in active listening (M = 3.50, SD = 0.60). The skills perceived by participants as being least proficient in were agroforestry entrepreneurship (M = 2.67, SD = 0.82), and disease and insect prevention (M = 2.77, SD = 0.76). Again, agroforestry professionals' perceived importance of these items was greater than their perceived proficiencies, revealing gaps in proficiency.

Table 3. ANOVA of Perceived Importance and Proficiency of Agroforestry Extension Skill Items (n = 107).

Skill	Type [b]	M [a] (SD)			F	p *	D [c]
		Proficiency	Importance	Total			
Active listening	HRS	3.50 (0.60)	3.80 (0.42)	3.65 (0.54)	17.60	<0.001	0.57
Teaching and/or facilitation	HRS	3.51 (0.63)	3.78 (0.46)	3.64 (0.57)	11.89	<0.001	0.47
Oral communication	HRS	3.41 (0.58)	3.78 (0.46)	3.59 (0.56)	25.75	<0.001	0.69
Problem identification, analysis, and solving	HRS	3.36 (0.66)	3.77 (0.51)	3.56 (0.62)	26.04	<0.001	0.70
Soil and water conservation	TS	3.34 (0.82)	3.70 (0.65)	3.52 (0.76)	12.95	<0.001	0.49
Community-based development	HRS	3.27 (0.78)	3.68 (0.58)	3.48 (0.72)	19.11	<0.001	0.60
Cultural competency	HRS	3.23 (0.69)	3.62 (0.61)	3.43 (0.68)	18.41	<0.001	0.59
Integration of livestock, crops, and trees	TS	3.11 (0.82)	3.64 (0.69)	3.38 (0.80)	26.57	<0.001	0.70
Tree nursery management	TS	3.17 (0.83)	3.54 (0.74)	3.36 (0.81)	12.05	<0.001	0.47
Making organic fertilizer	TS	3.15 (0.80)	3.50 (0.77)	3.33 (0.80)	10.97	0.001	0.45
Agricultural management	TS	3.10 (0.71)	3.51 (0.71)	3.31 (0.74)	17.99	<0.001	0.58
Agroforestry design, implementation, and management	TS	3.02 (0.87)	3.58 (0.75)	3.30 (0.86)	25.47	<0.001	0.69
Seed collection and processing	TS	2.93 (0.82)	3.49 (0.73)	3.21 (0.82)	27.83	<0.001	0.72
Assisted natural regeneration and Farmer-Managed Natural Regeneration management	TS	2.83 (0.87)	3.42 (0.78)	3.13 (0.88)	27.11	<0.001	0.71
Agroforestry value-added products	TS	2.78 (0.82)	3.46 (0.70)	3.12 (0.83)	42.86	<0.001	0.90
Disease and insect prevention	TS	2.77 (0.76)	3.45 (0.70)	3.11 (0.81)	46.46	<0.001	0.93
Plant identification	TS	2.81 (0.80)	3.33 (0.74)	3.07 (0.81)	23.82	<0.001	0.67
Agroforestry entrepreneurship	TS	2.67 (0.82)	3.41 (0.71)	3.04 (0.85)	49.28	<0.001	0.96

[a] 1.0 = None, 2.0 = low, 3.0 = average, 4.0 = high. [b] TS = Technical Skills, HRS = Human Relation Skills. [c] Effect sizes were based on Cohen's d (small = 0.2, medium = 0.5, and large = 0.8).
* $p < 0.05$.

Table 3 also shows the results of the ANOVA test between the perceived proficiency and importance of agroforestry extension skill items. A statistically significant difference between the mean perceived importance and perceived proficiency in skill items was found at the $p < 0.05$ level. Respondents' perceived importance was greater than their perceived proficiency for agroforestry entrepreneurship (d = 0.96), followed by disease and insect prevention (d = 0.93). The large effect sizes for these items' differences indicate observable differences that require training. The medium effect size for teaching and/or facilitation demonstrates a less-observable or immediate training need for this nonrandom sample of agroforestry professionals.

Table 4 shows ability items by descending means. The highest-rated items were "be a lifelong learner" (M = 3.70, SD = 0.54), and "be tolerant and open-minded" (M = 3.67, SD = 0.51). The mean total for perceived importance was rated high for 14 ability items.

Descriptive statistics of the ability items found that respondents' perceived importance ranked 20 items as important, as shown in Table 4. The most-important ability item was to be a lifelong learner (M = 3.83, SD = 0.40), followed by plan and accomplish multiple tasks (M = 3.80, SD = 0.42). The least-important ability item was using digital tools for accessing information and communication (M = 3.38, SD = 0.74); however, this item was still considered of average importance by respondents.

Participants perceived themselves as having moderate-to-high proficiency levels in all the ability items. The ability item perceived by participants as being most proficient in was to be a lifelong learner (M = 3.57, SD = 0.63), followed by being tolerant and open-minded (M = 3.55, SD = 0.57). The ability item perceived by participants as being least proficient in was using digital tools for accessing information and communication (M = 2.86, SD = 0.80), which was an average proficiency level for respondents.

Table 4 shows the ANOVA test ($p < 0.05$) performed on each ability item to describe the difference between the perceived proficiency and importance of the agroforestry extension ability items. A statistically significant mean difference was observed between perceived importance and participants' perceived proficiency in all ability items except their ability to work independently ($p = 0.454$).

The perceived ability to identify markets for agroforestry products produced a large Cohen's d (1.22), representing a noticeable training gap that would be evident to the naked eye. The perceived ability to adapt agroforestry practices based on local context and research (d = 0.85) also had a noticeable training gap.

For the second objective, RDM was used to prioritize agroforestry professionals' training needs based on the level of discrepancy between the perceived importance and perceived proficiency. This method provides the severity of a need and allows for direct comparison and ranking between items [19]. Table 5 lists the unweighted rank responses to individual agroforestry extension knowledge items. Weights were then applied as NR (−1), PR (1), and TR (0), and summed to determine the RDS. The RDS is a standardized score ranging between −100 and 100, with zero as the equilibrium point. The lower the negative number, the greater the training need. Based on the RDS, there is a performance gap in all the knowledge items, meaning the sample population needs training in all the knowledge items. The three top discrepancies in the technical knowledge items were (a) business management (RDS = −54), (b) plant pests and disease (RDS = −54), and (c) climate and weather (RDS = −53), indicating the items most requiring training for this group of respondents. The items of least priority are tree nursery management (RDS = −26), and gender roles in the community (RDS = −23).

Table 4. ANOVA of Perceived Importance and Proficiency of Agroforestry Extension Ability Items (n = 107).

Knowledge	Type [b]	M [a] (SD)			F	p *	d [c]
		Proficiency	Importance	Total			
Be a lifelong learner	HRA	3.57 (0.63)	3.83 (0.40)	3.70 (0.54)	0.54	<0.001	0.50
Be tolerant and open-minded	HRA	3.55 (0.57)	3.79 (0.41)	3.67 (0.51)	0.51	<0.001	0.49
Plan and accomplish multiple tasks	HRA	3.50 (0.65)	3.80 (0.42)	3.65 (0.57)	0.57	<0.001	0.56
Facilitate farmer learning	HRA	3.46 (0.65)	3.79 (0.48)	3.62 (0.59)	0.59	<0.001	0.57
Identify and diagnose problems objectively	HRA	3.44 (0.60)	3.79 (0.46)	3.61 (0.56)	0.56	<0.001	0.65
Use resources efficiently	HRA	3.46 (0.63)	3.73 (0.54)	3.59 (0.60)	0.60	<0.001	0.46
Exercise emotional intelligence (self-awareness, motivation, empathy, and social skills)	HRA	3.47 (0.65)	3.72 (0.51)	3.59 (0.60)	0.60	0.002	0.43
Display servant leadership with stakeholders	HRA	3.43 (0.62)	3.70 (0.57)	3.57 (0.61)	0.61	<0.001	0.46
Disciplined, detailed, and timely	HRA	3.47 (0.69)	3.65 (0.57)	3.56 (0.64)	0.64	0.032	0.30
Develop training	HRA	3.36 (0.72)	3.74 (0.52)	3.55 (0.65)	0.65	<0.001	0.61
Build strong, trusting relationships with diverse groups of stakeholders	HRA	3.36 (0.70)	3.74 (0.56)	3.55 (0.66)	0.66	<0.001	0.60
Cultural sensitivities	HRA	3.40 (0.71)	3.67 (0.61)	3.54 (0.68)	0.68	0.003	0.41
Reliable; follow directions and assume responsibilities	HRA	3.44 (0.69)	3.64 (0.57)	3.54 (0.64)	0.64	0.025	0.31
Work independently	HRA	3.50 (0.73)	3.58 (0.73)	3.54 (0.73)	0.73	0.454	0.10
Adapt quickly to unexpected events	HRA	3.28 (0.77)	3.65 (0.57)	3.47 (0.70)	0.70	<0.001	0.55
Document and report successes, challenges, and lessons learned	TA	3.09 (0.83)	3.68 (0.62)	3.39 (0.79)	0.79	<0.001	0.80
Facilitate development of participatory action plans	HRA	3.21 (0.77)	3.55 (0.73)	3.38 (0.77)	0.77	<0.001	0.46
Adapt agroforestry practices based on local context and research	TA	3.04 (0.82)	3.65 (0.62)	3.35 (0.79)	0.79	<0.001	0.85
Use tools safely	TA	3.21 (0.70)	3.49 (0.74)	3.35 (0.73)	0.73	0.005	0.39
Monitor and evaluate smallholders' adoption of agroforestry	TA	3.07 (0.81)	3.57 (0.67)	3.32 (0.78)	0.78	<0.001	0.66
Identify community champions and local expertise	HRA	3.09 (0.82)	3.50 (0.74)	3.30 (0.81)	0.81	<0.001	0.53
Promote transdisciplinary collaboration	HRA	3.09 (0.78)	3.50 (0.68)	3.29 (0.76)	0.76	<0.001	0.55
Advocate for the adoption of agroforestry among critics	HRA	3.02 (0.87)	3.49 (0.81)	3.25 (0.87)	0.87	<0.001	0.56
Use digital tools for accessing information and communication	TA	2.86 (0.81)	3.38 (0.75)	3.12 (0.82)	0.82	<0.001	0.67
Identify markets for agroforestry products	TA	2.58 (0.84)	3.56 (0.77)	3.07 (0.94)	0.94	<0.001	1.22

[a] 1.0 = None, 2.0 = low, 3.0 = average, 4.0 = high. [b] TA = Technical Ability, HRA = Human Relation Ability. [c] Effect sizes were based on Cohen's d (small = 0.2, medium = 0.5, and large = 0.8).
* $p < 0.05$.

Table 5. Unweighted ranks/ranked discrepancy scores for agroforestry extension knowledge items (*n* = 107).

Items	Type	Ranks (%)			RDS
		NR	PR	TR	
Business management	TK	64	9	27	−54
Plant pests and diseases	TK	61	7	33	−54
Climate and weather	TK	55	2	43	−53
Nutrient cycle process in agroforestry systems	TK	54	4	42	−50
Land and tree tenure practices	TK	54	6	40	−49
Local institutions and policies that impact agroforestry	HRK	50	3	47	−48
Drivers of agroforestry adoption by smallholders	TK	49	4	48	−45
Costs and benefits of implementing agroforestry	TK	54	10	36	−44
Trees in agroforestry systems	TK	50	7	44	−43
Local culture, history, language, and development efforts	HRK	41	3	56	−38
Adult learning theory and extension methods	HRK	42	5	53	−37
Indigenous agroforestry practices	TK	42	7	51	−36
Natural regeneration	TK	47	11	42	−36
Agroforestry systems, practices, and principles	TK	40	6	54	−35
Climate change adaptation	TK	39	7	53	−32
Socioeconomic conditions and livelihoods of the local community	HRK	36	6	58	−31
Community development practices	HRK	37	7	56	−31
Sustainable agricultural production systems and practices	TK	36	6	59	−30
Communication	HRK	36	6	59	−30
Agroforestry and natural resource ecology	TK	39	11	50	−28
Tree nursery management	TK	36	9	55	−26
Gender roles in the community	HRK	36	12	51	−24

TK = Technical Knowledge, HRK = Human Relation Knowledge, NR = Negative Ranks, PR = Positive Ranks, TR = Tied Ranks, RDS = Ranked Discrepancy Score.

Table 6 shows the unweighted rank responses and RDS for each technical and human relation skill item. The scores signify a training gap in all the skill items. The top two priority technical skill items requiring training are agroforestry entrepreneurship (RDS = −55) and disease and insect prevention (RDS = −54). The two least-rated items are active listening (RDS = −25) and teaching and/or facilitation (RDS = −23).

Table 6. Unweighted ranks/ranked discrepancy scores for agroforestry extension skill items (*n* = 107).

Items	Type	Ranks (%)			RDS
		NR	PR	TR	
Agroforestry entrepreneurship	TS	58	3	39	−55
Disease and insect prevention	TS	57	3	40	−54
Agroforestry value-added products	TS	56	8	36	−48
Seed collection and processing	TS	50	5	45	−46
Agroforestry design, implementation, and management	TS	47	5	49	−42
Plant identification	TS	50	8	41	−42
Integration of livestock, crops, and trees	TS	50	8	41	−42
Assisted natural regeneration and FMNR	TS	50	8	41	−42
Agricultural management	TS	40	4	56	−36
Problem identification, analysis, and solving	HRS	40	4	56	−36
Community-based development	HRS	40	5	55	−36
Oral communication	HRS	42	7	51	−36
Cultural competency	HRS	39	6	55	−34
Soil and water conservation	TS	36	6	59	−30
Tree nursery management	TS	36	8	55	−28
Making organic fertilizer	TS	36	9	54	−27
Active listening	HRS	29	4	67	−25
Teaching and/or facilitation	HRS	31	7	62	−23

TS = Technical Skill, HRS = Human Relation Skills, NR = Negative Ranks, PR = Positive Ranks, TR = Tied Ranks, RDS = Ranked Discrepancy Score.

Table 7 lists the unweighted rank responses and RDS for each ability item. The top priority was identifying agroforestry product markets (RDS = −62). The least-rated item was for work independently (RDS = −7). These findings demonstrate the need for training in identifying markets for agroforestry products; however, there is little need for training in the ability to work independently for those who participated in the needs assessment.

Table 7. Unweighted ranks/ranked discrepancy scores for agroforestry extension ability items (*n* = 107).

Items	Type	Ranks (%)			RDS
		NR	PR	TR	
Identify markets for agroforestry products	TA	66	4	30	−63
Adapt agroforestry practices based on local context and research	TA	50	2	49	−48
Document and report successes, challenges, and lessons learned	TA	51	4	45	−48
Monitor and evaluate smallholders' adoption of agroforestry	TA	44	4	52	−40
Use digital tools for accessing information and communication	TA	47	11	42	−36
Build strong, trusting relationships with diverse groups of stakeholders	HRA	36	1	63	−36
Identify community champions and local expertise	HRA	37	3	60	−35
Promote transdisciplinary collaboration	HRA	41	7	52	−35
Advocate for the adoption of agroforestry among critics	HRA	42	9	49	−33
Develop training	HRA	38	6	56	−33
Identify and diagnose problems objectively	HRA	33	2	65	−31
Facilitate farmer learning	HRA	33	3	64	−30
Adapt quickly to unexpected events	HRA	35	7	58	−27
Facilitate the development of participatory action plans	HRA	36	8	56	−27
Use resources efficiently	HRA	33	7	60	−25
Use tools safely	TA	37	12	50	−25
Display servant leadership with stakeholders	HRA	30	5	65	−25
Plan and accomplish multiple tasks	HRA	27	3	70	−24
Cultural sensitivities	HRA	28	5	67	−23
Be a lifelong learner	HRA	26	3	71	−23
Be tolerant and open-minded	HRA	24	3	73	−21
Exercise emotional intelligence	HRA	30	8	62	−21
Reliable; follow directions and assume responsibilities	HRA	24	7	69	−18
Disciplined, detailed, and timely	HRA	26	9	64	−17
Work independently	HRA	19	12	69	−7

TA = Technical Ability, HRA = Human Relation Ability, NR = Negative Ranks, PR = Positive Ranks, TR = Tied Ranks, RDS = Ranked Discrepancy Score.

Two subjects emerged as areas of priority for training this group of respondents. All agribusiness KSA items and the pest and disease knowledge and skill items had top-ranking RDSs. Respondents had an elevated RDS in all the agribusiness KSA items (−63 to −48) relative to the other items. Participants only rated one item as important (identify markets for agroforestry products), while the other items were rated as average. However, the effect size between proficiency and importance ranged from d = 0.58 to d = 1.22 for all the agribusiness items, showing an above medium to large effect size. The pest and disease knowledge item had an RDS of −54, and the disease and insect prevention had an RDS of −48. Again, items had average importance to participants but had a large effect size, highlighting a large training discrepancy.

4. Discussion

This study aimed to examine the perceived importance and proficiency of selected agroforestry extension workers' competencies and to prioritize their training needs. The findings revealed training discrepancies in all technical and human relation agroforestry knowledge, skills, and abilities. The RDM provides an intuitive method to prioritize the training needs of groups. Though the RDM scores of this study are limited to this specific sample and not representative of all countries in the Global South, it shows how organizations with staff promoting agroforestry globally could use this needs assessment to identify staff training needs. Organizations that use the RDM to assess agroforestry extension competencies should assess technical and human relations KSAs. Based on the findings, organizations can prioritize a mix of technical and human relations KSA training needs to create professional development opportunities, ensuring that staff acquire the technical and social competencies needed [12].

These findings prioritized the training needs of the respondent group in areas related to agribusiness and pests and diseases. For agroforestry to be viable, market and business development must be supported [29]. Agroforestry extension can play an active role in this. Amare and Darr discussed how extension services have been shown to increase agroforestry adoption through training farmers in business development skills [30]. Also, organizations developing value-added agroforestry goods and services can increase farmers' income while having ecosystem benefits [31] when extension services link farmers to markets [32,33]. However, as this needs assessment found and as research has discussed, there is often a need for more expertise in agroforestry organizations related to agribusiness topics [31]. Dehmukh et al. also make the case that extension organizations must also understand the socioeconomic status of farmers practicing agroforestry [34]. Agroforestry professionals often work with a wide range of trees and agricultural crops [35], with farmers with access to various markets and entrepreneurial possibilities, making it dynamic and innovative [36]. Extensionists with KSAs that can be adapted to specific farmers' needs should be considered. Though there are opportunities for organizations to provide agroforestry business-related training and services through competent staff, care should be taken not to focus on initiatives that bypass the smallholder [32,33] and lead away from the broader socioeconomic and biophysical benefits agroforestry can provide if conducted using agroecological principles [37].

We found training needs for knowledge and skill items related to pests and disease. One benefit touted by agroforestry advocates has been its role in decreasing pest and disease issues often associated with monoculture crops [38,39], where farmers are often concerned that agroforestry systems increase pest and disease incidence [40]. With these two conflicting views, it is not surprising that pests and diseases have been prioritized as an extensionist training need. Agroforestry's species diversity is the leading reason for its ability to control pests and diseases [39]. However, complex agroforestry systems requiring knowledge of multiple trees and agricultural crops make agroforestry knowledge-intensive for researchers, extension workers, and farmers when pests and diseases are an issue [41]. Because of the complexity of agroforestry, extensionists should have general knowledge and skills related to pest and disease management that draws from local and outside sources [42]. Schroth et al. suggested implementing a central database of pests and diseases associated with agroforestry systems [41]. A database would allow organizations to develop appropriate training materials for field staff and farmers on specific pest and disease issues they face. Even without access to a central database, organizations should inventory the pest and disease issues related to agroforestry systems.

Respondents did not have large training gap needs in gender roles in the community, as revealed in other knowledge items. This is surprising because previous research shows that female farmers face more significant challenges to agroforestry knowledge acquisition than male farmers, even in the presence of extension services [43,44], demonstrating that agroforestry extension can be ineffective in reaching female farmers. Martini et al. [45] found this was true in their research, wherein female farmers were less receptive to information presented by male extension workers. Female farmers often have increased social and economic barriers that limit their knowledge acquisition compared to male farmers [43]. It is important for organizations promoting agroforestry to understand intrahousehold decision-making [46,47] and to develop extension services accordingly [7]. This knowledge item should be investigated more because our findings differed from the literature.

5. Conclusions

Our findings, though not generalizable to international agroforestry change agents, provide insight into the multidimensional nature of competency deficiencies from the Ranked Discrepancy Model results. These descriptive findings can serve as a flashlight on the pathway for future researchers seeking to develop a larger, quantitative, potentially generalizable study that examines cause and effect relationships and magnitudes of a respective competency level (independent variable) on change agent teachings (dependent variable) or promotion (dependent variable) on best agroforestry practices (independent variables). As Narine and Harder found program-planning deficiencies of extension agents, Seitz et al. [19] found sustainable cotton-production-practice deficiencies in regional cotton extension personnel, and as Lamm et al. uncovered extension staff's deficiencies in sustainable food production practices, our exploratory study adds to the literature—not only to the RDM as a methodological tool for competency assessment but primarily for extension and other nonformal change agents tasked with producing positive behavior change and impacts in targeted stakeholders [18,19,48].

Our roadmap can serve to assist research and program planners in focusing on scholarly and programmatic efforts in improving agroforestry change agents' technical and human dimensional knowledge, skills, and abilities. Our findings can only be generalized to the participants in our study but offer science and practice as both a roadmap and vehicle to develop and execute an advanced quantitative methodology in a food and agricultural contextual domain, which is a sustainability priority of the FAO (Food and Agriculture Organization of the United Nations), World Agroforestry Center, the EU (European Union), IMF (International Monetary Fund), USAID (United States Agency for International Development), Embrapa (Brazilian Agricultural Research Corporation), USDA (United States Department of Agriculture), etc. Our science not only informs practice but our findings also contribute to the multi-dimensional lens of the innovation–decision process from institutions to change agents to stakeholders. When a broken link in the diffusion chain exists, innovations and information will not reach critical mass.

The results found that the group of respondents all had training needs in all the KSA items. This indicates a need to explore agroforestry extension competencies more by using the RDM to investigate specific agroforestry extension programs throughout the Global South to test the instrument further. The RDM helps to identify extension staff's training needs at distinct experience levels, allowing organizations to craft targeted training interventions to meet expressed needs. To accurately test and substantiate the validity of the RDM, researchers should include samples from more diverse populations beyond that of agroforestry extension professionals. Results could demonstrate the RDM as both an innovative and rigorous quantitative assessment technique for understanding professionals' and volunteers' development needs. Further, it is plausible that the RDM could serve as a substitute quantitative technique for needs assessments in which ordinal, cross-sectional, or non-normally distributed data exist [49].

The success of agricultural extension staff in disseminating knowledge to enhance farmers' adoption of current agricultural innovations is essential in the adoption cycle [50]. The compatible phenomena of the degree to which a technology, program, idea, or policy's positive attributes align with a farmer's needs are crucial to both adoption and diffusion [50]. The recommended needs assessment will identify extension staff's agroforestry competency gaps that are potentially compatible with the agroforestry program's positive attributes. Once needs are identified, if they are followed by professional development interventions targeting the expressed need, an improved rate of sustainable agroforestry practice adoption should result.

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