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Training Needs of the National Agricultural Research System Scientist of Bangladesh

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Abstract
Knowledge, skills and attitude are components for increasing the job efficiency and performances of the employees for increasing productivity in an organization that can achieve through training. Scientist requires knowledge, abilities and skills for better performance that can identified through training need assessment, which is lacking in National Agricultural Research System (NARS) in Bangladesh. Assessing training needs through proper methods is of paramount importance in this regard. Agricultural researches mainly conducted by the researchers of the 13 national research institutes work under the coordination of the Bangladesh Agricultural Council (BARC). The objective of the present study was to identify the types of training needs for the NARS scientists of mono-crop and multi-crop organizations. The empirical data were collected from 25 September to 01 November 2022 from the individuals through online survey and face to face sessions on the training need assessments (TNAs) in each of the NARS institutes. During the TNA sessions, job and task analyses exercised, and skill-gap analyses conducted to identify the types of training required for the scientists. The present article highlighted the training needs which are significant to design training programs in achieving scientist's efficiency, and lead to achieve objectives of the organizations.

Keywords: Training Requirement, Scientists, Agricultural Research, Job And Task Analysis, Skill-Gap Analysis

1. Introduction

Human resources serve the needs of organizations with their up-to-date expertise. In the present radical technological changes efficient workforce is urgently needed. It is realized that employee expertise is meaningless unless an organization can develop it such a ways that respond to the organizational needs (Lacsamana et al., 2018). Any organization wants to train and develop its workforce should first learn how to properly identify and assess training needs which is the single most important thing that helps organizers to address the gaps between the existing training and training which will be required in the future. Effective training or development depends on knowing what is required - for the individual, the department and the organization as a whole.

Simply throwing training at individuals may miss priority needs, or even cover areas that are not essential. Training Need Assessment enables organizations to channel resources into the areas where they will contribute the most to employee development, enhancing morale and organizational performance (Bansal and Tripathi, 2017).

In Bangladesh, Agricultural research is conducted mainly in 13 research institutes under the National Agricultural Research System (NARS) coordinated by the Bangladesh Agricultural Research Council (BARC). The NARS institutes working under the umbrella of BARC are Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI), Bangladesh Jute Research Institute (BJRI), Bangladesh Institute of Nuclear Agriculture (BINA), Bangladesh Sugarcrop Research Institute (BSRI), Bangladesh Wheat and Maize Research Institute (BWMRI), Soil Resources Development Institute (SRDI), Bangladesh Tea Research Institute (BTRI), Bangladesh Forest Research Institute (BFRI), Cotton Development Board (CDB), Bangladesh Sericulture Research and Training Institute (BSRTI), Bangladesh Fisheries Research Institute (BFRI) and Bangladesh Livestock Research Institute (BLRI). Research on crop varieties are conducted by 10 commodity based research institutes except BARI and BINA, while there are separate institutes for conducting research for livestock, fisheries and forestry. Each of these research institutes has developed a considerable number of technologies. The institutes under NARS have so far developed 655 high yielding varieties and 591 advanced technologies since 2009 (Rashid, et al., 2023). A considerable progress has also been made in case of digitalization in agriculture. The notable agricultural digitalization are: mobile apps of agricultural technology, community rural radio, agricultural call center, agri-website, e-book, ICT lab and agricultural information (e.g. *kiosk*). Print media, radio and television are working as co-actors of these activities. However, while narrating the 100 years of agricultural development in Bangladesh Bohktiar *et al*. (2021) have identified the major emerging challenges in agriculture are: i) reduction of cultivable lands and natural resources, ii) soil degradation, iii) limitations of agro-processing industries, iv) narrowing diversity of agricultural production, v) shortage of agricultural labourer, vi) climate change impacts, vii) skill gap in scientists and academicians in agricultural research and education. Rahman (2017) has also identified the following upcoming challenges in agricultural sector: i) increasing agricultural production through sustainable use of resources, ii) promoting agricultural research for enhancing productivity, iii) commercialization of agriculture, iv) sustaining self-sufficiency in rice production, v) diversification towards high value crops, vi) farm mechanization, vii) overcoming the socioeconomic constraints, viii) managing open water fisheries, ix) sustainable development of shrimp farming, x) conserving marine fishery resources and expanding marine fishing zone, xi) developing and preserving improved breeds of livestock, xii) conservation of forest resources. In order to cope with the emerging challenges in agricultural sector, the researchers working under the NARS need rigorous training on various aspects of agriculture for conducting need-based research to generate appropriate technologies for increasing productivity for sustainable agricultural development.

The NARS institutes have been running with 1,722 scientists since 2022 but with shortage of 842 scientists compared to the approved position of 2,564 scientists indicating significant vacancies (32.8%). Almost half of the NARS institutes viz., BWMRI, SRDI, BFRI- Forest, CDB, BSRTI and BFRI-Fisheries have been suffering seriously due to higher vacancies of scientists (44.3%, 50.4%, 58.9%, 69.2%, 75% and 44.4%, respectively) compared to the other institutes. Across the position, vacancies were significant in the level of Scientific Officer (40.7%) who are the frontline researchers (Rashid et al., 2023). The vacancies often increased workload to the onboard scientists. The overall shortage of scientists in NARS institutes due to vacancies could be a big challenge for technology development to make the country self-sufficient in the deficit areas of agricultural production and continue maintaining the self-sufficiency and surplus in the production areas being achieved. Therefore, existing scientists are to be trained appropriately to make scientists more efficient.

Skilled and efficient human resources are a prerequisite to meet the requirements of NARS institutes. Training is one of the methods of employee's development which is the ideal approach for preparing employees with certain skills or giving them the ability to fill the gaps in their efficiency (Shree, 2017). The more training provided to the researcher, the further enhanced skills and capabilities, and the more advantages reflected back to the organization. Thus training can be considered as a way to improve their efficiency through the systematic acquisition of knowledge and skills, and improving on existing expertise to change researcher's behaviour (Ibrahim et al., 2017; Nazli et al., 2014). Training Needs Analysis (TNA) provides information about the current researchers' efficiency level, the skill gap areas to be minimized and the ways in which this might best be achieved (Denby, 2010). Training need assessment is urgent to develop a futuristic human resource development program. Hence, the present study was undertaken to identify the training needs of the scientists working in the NARS of Bangladesh.

2. Theoretical background

Training need can be considered a condition in which there is a difference between "***what is***" and "***what should be***". The difference can be in terms of knowledge, skills or attitudes that trainees need to more effectively perform their jobs (Swanson *et al.*, 1997). A need assessment is a method of identifying this gap. Hence, training need assessment is the process of identifying training intervention(s) that would address a performance problem. It indicates what the training should focus. In other words, it guides the formulation of training objectives and the selection of training activity content. Prior to identify the discrepancy or gap it is necessary to determine the cause of the discrepancy. This discrepancy has been stated in a form as follows:

Through training needs assessment, the existing activity, training contents and methods are also evaluated for improved planning. This can be shown as below:

The training needs assessment (TNA) process can be divided into three distinct analytical phases:

1. Job analysis
2. Task analysis
3. Knowledge and skill-gap analysis

Job analysis is a method of determining major areas of tasks where training may be needed. It involves the dissecting of a job into its component events. This analysis allows a trainer to better understand what an employee does in an organization. In doing job analysis (a) identifying activity areas and (b) task breakdown or division of activity areas into specific tasks are determined. A job analysis involves dissecting a job or major work event into its component parts. Jobs usually include a number of different general activity areas. Each activity area consists of a number of specific tasks which must be performed. Analysis of each specific task identifies a number of actions required to complete it. Analysis of each action identifies a number of

individual steps. After the component parts have been identified it is necessary to determine the frequency, relative importance and learning difficulty for each component which has been identified. One can systematically work through this process by using a set of worksheets designed to assist documenting and analyzing each component. The worksheets can be included:

1. Activity Breakdown Worksheet
2. Task Breakdown Worksheet
3. Action/Step Listing Worksheet
4. Action Analysis Worksheet
5. Step Analysis Worksheet
6. Gap Analysis Worksheet

Knowledge, skills and attitudes are the three vital components of job performance of the employees in an organization vis-à-vis the productivity of the organization (Kashem, 2004). The interlinked components are depicted in **Figure 1.**

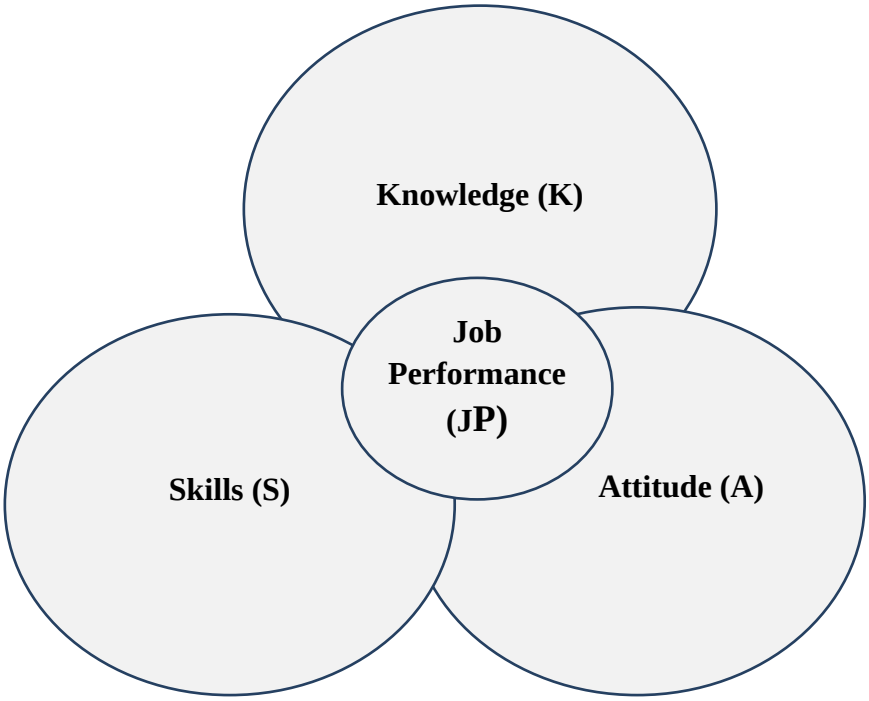

Figure 1. Integration of knowledge, skills and attitude towards increasing job efficiency and productivity

For overall agricultural development of the country, the scientists working in the agricultural research institutes (ARIs) need to have not only the latest scientific knowledge on the subject but also should have adequate skills for conducting research activities and favourbale attitude to work whole-heartedly for the institutes. Personal thinking, attitude and mindset is very important for a person to work for the organization. A person having sufficient knowledge, expertise and adequate skills may not be willing to show him as an effective and efficient researcher unless he mentally prepares him to contribute as much as he can do. Thus, without the integration of these three components: (a) knowledge, (b) skills, and (c) attitude (KSA), the researchers may not be able to contribute significantly and prove his worth in research and development (R & D) activities. It is quite likely that lower is the integration of KSA, lower would be the job performance. The individual NARS institute should take initiatives for Human Resource Development (HRD) in their own way. Anyway, apart from strong knowledge base, arrangements should

be made for providing training in increasing skills to the researchers in their respective disciplines/areas and motivate them in forming favourable attitudes to work for the institutes. However, prior to offer training to the researchers it is indeed essential to identify their training needs through proper training need assessment (TNA).

3. Methodology

Training needs of the scientists of NARS institutes were identified through Training Need Assessment (TNA) that were conducted in each and every NARS institute during 25 September to 01 November 2022 as shown in **Table 1**. The TNAs were conducted by using standard tools. The tools are composed of three sets of Worksheets: (a) Job Analysis Worksheets, (b) Task Analysis Worksheets, and (c) Skill-Gap Analysis worksheets. The TNA worksheets have been presented in **Table 2**. In the TNAs, nominated scientists from different disciplines of each institute participated.

Table 1. Date and time of conducting Training Needs Assessments in the NARS institutes

Sl No.	Name of the institute	Date	Nr. of scientists participated
1.	Soil Resources Development Institute (SRDI), Farmgate, Dhaka	25/09/2022	30
2.	Cotton Development Board (CDB), Farmgate, Dhaka	26/09/2022	08
3.	Bangladesh Jute Research Institute (BJRI), Manik Mia Avenue, Dhaka	27/09/2022	35
4.	Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh	29/09/2022	39
5.	Bangladesh Fisheries Research Institute (BFRI), Mymensingh	29/09/2022	30
6.	Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka	04/10/2022	28
7.	Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur	06/10/2022	36
8.	Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur	06/10/2022	33
9.	Bangladesh Wheat and Maize Research Institute (BWMRI), Noshipur, Dinajpur	16/10/2022	26
10.	Bangladesh Sericulture Research and Training Institute (BSMRTI), Rajshahi	17/10/2022	06
11.	Bangladesh Sugarcrop Research Institute (BSRI), Ishurdi, Pabna	18/10/2022	34
12.	Bangladesh Tea Research Institute (BTRI), Sreemangal, Mouluvibazar	20/10/2022	09
13.	Bangladesh Forest Research Institute (BFRI), Soloshahar, Chattagram	24/10/2022	32
14.	Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka	01/11/2022	26

Sl No.	Name of the institute	Date	Nr. of scientists participated

Table 2. Tools used for conducting Training Need Assessment at the NARS Institutes

Job Analysis Worksheet					
Job: SO/SSO/PSO/CSO/CSO and Head					
Activity Area (tasks)	Frequency Performed [a]	Importance [b]	Learning Difficulty [c]	Total score	Focus (9-12)
1.					
2.					
3.					
4.					
5.					
…					
A: 1= Seldom 2= Occasionally 3= Weekly to monthly 4= Daily to weekly 5= Daily	b: 1= Marginally important 2= Moderately important 3= Extremely important		c: 1= Easy 2= Moderately difficult 3= Very difficult 4= Extremely difficult		

SO = Scientific Officer, SSO = Senior Scientific Officer, PSO = Principal Scientific Officer, CSO = Chief Scientific Officer, Head = Chief of Division (discipline)/ Regional Station

Task Analysis Worksheet					
Job: SO/SSO/PSO/CSO/CSO and Head					
Tasks:					
Components/Steps	Frequency Performed [a]	Importance [b]	Learning Difficulty [c]	Total score	Focus (9-12)
1.					
2.					
3.					
4.					
5.					
…					
a: 1= Seldom 2= Occasionally 3= Weekly to monthly 4= Daily to weekly 5= Daily	b: 1= Marginally important 2= Moderately important 3= Extremely important		c: 1= Easy 2= Moderately difficult 3= Very difficult 4= Extremely difficult		

Skill-Gap Analysis Worksheet				
Job: SO/SSO/PSO/CSO/CSO and Head				
Sl. No.	(Scores) Tasks	Level of Proficiency (1 2 3 4 5)*	Is proficiency a problem? [Y /N]	Can the problem be solved by training? [Y /N]
1.			[ ]	[ ]
2.			[ ]	[ ]
3.			[ ]	[ ]
4.			[ ]	[ ]
5.			[ ]	[ ]
…				
* 1 = Cannot do at all 2 = Can do less than half of the task 3 = Can do more than half but less than total 4 = Can do total but cannot maintain time schedule 5 = Can do within time schedule				

Skill-Gaps of NARS scientists identified through conducting TNA

Training need assessment (TNA) sessions for identifying the skill-gaps were conducted in each of the NARS institutes including BARC. Skill-gaps analysis was determined through using Job Analysis (JA) and Task Analysis (TA) of the scientists. Job Analysis and Task Analysis scores ranged from 3 – 12; however, the job and tasks having scores ranging from 9 - 12 were considered for Skill-Gap Analysis. The scientists of all the NARS institutes identified their skill-gaps. The skill-gaps were identified based on the tasks they perform in their daily routine activities. Finally the training needs of scientists of NARS institutes were identified considering their skill-gaps (Rashid et. al., 2023).

4. Findings and Discussions

4.1 Agricultural Scientists in Bangladesh by Degrees

Agricultural research is mainly conducted by the NARS institutes under the leadership of BARC. However, apart from this, agricultural research studies are also being conducted by the higher educational institutions (especially the agricultural universities and science and technology universities). The percent distribution of agricultural researchers among the research institutes and higher agricultural educational institutions are shown in **Table 3.** The table depicts that the PhD degree holders are far higher at the educational institutions than the research institutes.

Table 4. Percent distribution of agricultural researchers in Bangladesh by degrees

Year	NARS institute						Researchers in Higher Agricultural Educational institutions		
	BARI			Other than BARI					
	B.Sc.	M.Sc.	Ph.D.	B.Sc.	M.Sc.	Ph.D.	B.Sc.	M.Sc.	Ph.D.
2000	19	59	22	19	60	22	7	40	53
2009	15	59	27	8	64	29	4	52	44
2012	2	62	36	9	61	30	0.4	53	47

2016	24	44	32	4	63	33	0.8	49	52

Source: 1) Stads *et al.*, 2019, 2) Stads *et al.* 2014, 3) Rahija *et al.*, 2011

At present there are 53 public universities in Bangladesh out of which 46 are in operation and the remaining is yet to start their academic programs. The degree-wise teachers in the public universities in Bangladesh are presented in **Table 4.** The table exhibits that PhD degree holders in all the public universities is higher than the same degree holders at the research institutes. On the contrary, the MS or MSc degree holders are higher in NARS institutes compared to researchers in higher agricultural educational institutions and public universities. There is some portion of freshly recruited scientific officers with BS or B.Sc. need to go for master degree just after confirmation of their service for understanding of research and basics of research methodology.

Table 4. Degree-wise teachers in public universities in Bangladesh from 2015 to 2019

Year	PhD		Other Higher Degrees (MS/MSc)		Excluding Higher Degrees (BS/BSc)		Total (Number)
	Number	%	Number	%*	Number	%*	
2015	4299	33	1013	8	6856	57	12047
2016	4380	35	870	7	7281	58	12531
2017	4766	35	985	7	7829	58	13580
2018	5015	35	766	6	8538	59	14322
2019	5347	34	338	22	6796	44	15524

Source: UGC, 2020; * % (approx.)

Total number of teachers in the 46 public universities in Bangladesh is 15,524 in 2019 out of which 6,685 have either M.Phil. or Ph.D. degrees (UGC, 2020), i.e., about 56 per cent of the public university teachers have higher degrees.

There was a significant skill gap in NARS institutes as of June 2022 due to poor proportion of scientists with PhD degree (41.2%; 709 out of 1,722 existing scientists). Among the NARS institutes, BARI had the highest PhD holders (61.37%) and SRDI held the lowest proportion (8.33%) although BARC (95.65% PhD holders) being the apex of NARS institutes remained top of all institutes (Table 5). As per the report of Agricultural Science and Technology Indicators (ASTI), in 2016 the share of scientists with PhD degree in Nepal and Sri Lanka were 12.2 and 28.5, respectively, while in India it was 77.5 in 2018 (ASTI, 2022). Therefore, NARS institutes having 41.2% PhD holders remained far below that of ICAR in India (77.5%). For achieving this goal there will be needed PhD scholarships for the improvement of the quality of scientists by fetching advanced knowledge so that they can conduct research effectively and mentor fresh recruited scientists for maintaining self-sufficiency and even surplus in agricultural production under continued risks and vulnerabilities in future.

Table 5: Total number of scientists and % of PhD degree holders in NARS institutes in 2022

NARS Institute	Total scientists (no.)	Scientists with PhD degree	% of PhD degree holders
BARI	554	340	61.37
BRRI	248	107	43.15

BJRI	138	46	33.33
BINA	132	47	35.61
BSRI	51	16	31.37
BWMRI	49	25	51.02
SRDI	204	17	8.33
BTRI	22	8	36.36
BFRI (Forest)	65	15	23.08
CDB	8	3	37.50
BSRTI	5	3	60.00
BFRI (Fisheries)	125	20	16.00
BLRI	98	40	40.82
BARC	23	22	95.65
Total	**1722**	**709**	**41.2**

4.2 Skill-Gaps of NARS scientists identified through conducting TNAs

The training needs of scientists of NARS institutes were identified considering their skill-gaps. The training needs of the different level of scientists of NARS institutes have been presented in **Table 6.** Training Need Assessment should be done hierarchical level of an organization opined by Sharma (2018). Table 6 shows that the scientists required to improve their administrative skills, some general and professional aspects which varied at different level of scientists and different institutes due to differences in mandates of institutes, skills and ability.

Table 6. Identified Training needs for the NARS scientists

6a. Training needs of the different level scientists of Bangladesh Agricultural Research Institute

Chief Scientific Officers (CSOs)			
Score	**Areas**	**Score**	**Areas**
10	Human resource management	11	Confined field trial biosafety
10	Contain trial biosafety	11	Integrated farming systems
9	Impact analysis	12	Hybrid research
12	Agro-processing, value chain and marketing	12	Climate smart and nutrition sensitive agriculture
Principal Scientific Officers (PSOs)			
10	Projection of Demand Supply Analysis	11	Food and nutrition based biological research using mammals
12	Agro-processing, value chain and marketing	11	Integrated farming systems
12	Hybrid research	11	Morphological, bio-chemical and serological study of pathogens
12	Climate smart and nutrition sensitive agriculture	10	Molecular marker design and marker assisted selection
11	Integrated water, nutrient, pest and disease management	12	Sanger sequencing and analysis

10	Biosafety and stewardship of transgenic crop	-	-
Senior Scientific Officers (SSOs)			
10	Software based analysis (AI, IoT)	12	Molecular characterization of pathogens
12	Polymerase chain reaction (PCR)	12	Gene cloning
11	Integrated water, nutrient, pest and disease management	11	Next generation sequencing and computation (Genetics and Bioinformatics data analysis)
11	Gene identification and Characterization	11	DNA/RNA/Protein extraction and quantification
12	Artificial intelligence (AI) and internet of things (IoT) application	11	Cloud computing
9	Research report writing (journal and popular)	11	Gene mapping/genomic prediction
11	Stress management in major crops	9	Machine maintenance
12	Crop bioinformatics and genomics	11	Molecular data analysis
11	Captive animal management	11	Genetic transformation and gene editing
Scientific Officers (SOs)			
10	Sample preparation	9	Machine maintenance
10	Chemical analysis of sample	11	GIS, remote sensing and crop modeling
9	Data collection, analysis and report writing	10	Rodent capture and management
11	Gene identification and characterization	12	Polymerase chain reaction (PCR)
9	Scientific report writing	11	Molecular breeding

6b. Training needs of the different level scientists of Bangladesh Rice Research Institute

Chief Scientific Officers			
10	Genomic analysis of abiotic and biotic stress tolerance	9	Monitoring and execution
11	Seed production and dissemination	9	Financial / budget management
9	Accountability for the actions	11	Application of cutting-edge techniques in breeding like bioinformatics
Principal Scientific Officers			
10	Genomic analysis of abiotic and biotic stress tolerance	11	Breeding value estimation for rice, SNP marker design, high throughput DNA, RNA or protein sequence analysis

11	Application of cutting-edge techniques in breeding like bioinformatics	10	Genomic analysis of abiotic stresses (QTL mapping, GWAS and genomic prediction)
9	Postharvest processing and grain storage technology	9	Maintenance of the machine (LC-MS)
10	Research budget preparation and mangement	11	Rice based machinery design and development
9	Administrative and Financial management	11	Efficient nutrient, water and energy management
11	Managing laborers in experimental farms	11	Cutting edge technology in farming systems
Senior Scientific Officers			
10	Team Building	11	Farming in meta verse
10	Fixing of the dose of insecticide	10	Equipment operation
11	Modification of developed machinery	9	Collection of rice germplasm
11	Molecular breeding	11	Integrated farming systems
10	Research on renewable energy	11	Quality of chemicals
10	Physico-chemical analysis of rice	10	Machine maintenance
10	Breeding value estimation for Rice, SNP marker design, high throughput DNA, RNA or protein sequence analysis	10	Application of Bioinformatics tools (e.g., R, Python, Big data management, Linux based operating system)
12	Biofortification in rice	10	Review of research works and results for research planning
9	Storage/conservation of rice germplasm	9	Evaluation of rice germplasm
9	Regeneration/multiplication of rice germplasm	9	Morphological and molecular characterization of rice germplasm
Scientific Officers			
11	Research methodology	9	Manner and etiquette
9	Data analysis using software	10	Data interpretation and report writing
11	Sample preparation	10	Soil and plant sample analysis
10	Chemical analysis	10	Microscopic work
10	Sample isolation, preservation and inoculation	11	Surveying insect pest incidence
10	Data collection by sample analysis using machines	10	Scoring of the damage
9	Sample preparation	10	Data analysis for interpretation
11	Scientific report writing	10	Breeding value estimation for rice, SNP marker design, high throughput DNA, RNA or protein sequence analysis

11	Advanced line adaptive research trial (ALART)	9	Experimental design and layout
10	Treatments selection and testing, analyzing and reporting	10	Breeding value estimation for rice, SNP marker design, high throughput DNA, RNA or protein sequence analysis

6c. Training needs of the different level scientists of Bangladesh Jute Research Institute

Chief Scientific Officers			
10	Project development and management	10	Office administration and finance management
10	Action plan for implementing delta plan	9	Evaluate project progress and identify the problem during Project implementation
9	Adjustment and adaptation with 4IR	11	National social safety strategy work plan formulation
Principal Scientific Officers			
11	Blending technology for natural and synthetic fiber like acrylic, rayon, wool, viscose, coir, banana, pineapple etc. by using Hopper Feeder machine.	11	Improvement of jute cuttings and low-grade jutes through microbial process
12	Environmental impact assessment	11	Project development and management
10	Automatic data monitoring	11	Production of nucleolus & breeder seed of jute and allied fibre (JAF) crops
10	Collection, characterization, evaluation, documentation and conservation of jute and allied fiber germplasm	9	Improvement of jute fiber, yarn and fabric through biochemical modification
9	Speed breeding	9	Robotic management
10	Development Project Proposal (DPP) preparation	9	Market research on JAF crops
12	Production of bio-plastic, paper and pulp from jute fiber	11	Regeneration and viability assessment of jute and allied fiber germplasm
11	Determination and improvement of jute and allied fiber quality (physical and chemical) properties	10	Breeder seed production and distribution to different seed producing agencies
10	Isolation and identification of effective jute retting bacteria	11	Nucleus seed production and maintenance
10	Molecular characterization of jute retting bacteria	11	Molecular analysis of jute and allied fiber germplasm

11	Action plan on grievance and redress service (GRS) work plan to mitigate the problems of BJRI	10	Bio-informatics analysis of jute
9	Optimization of plant regeneration system for *C. olitorius* for establishing tissue culture plants into the field	9	Adjustment and adaptation with 4IR
9	Drought management	-	-
Senior Scientific Officers			
11	Nucleus seed production and maintenance	12	Computer, router, switch, access switch and network equipment maintenance
10	Molecular analysis of jute and allied fiber germplasm	12	Data Management
9	Bio-informatics analysis of jute	12	E-filing
10	Development and modifications of machinery and equipment for jute and jute products.	11	Sample characterization technique
10	Adopting and implementing programs for manufacturing jute fabrics of various weave design.	9	Molecular characterization of jute germplasm through DNA finger printing
10	Isolation and identification of effective jute retting bacteria	10	DPP preparation
Scientific Officers			
10	Experimental design	11	Data management
9	Physical analysis of raw materials	9	Scientific report writing
10	Chemical analysis of raw materials	9	Sample preparation technique
9	Identification of microorganism	10	Composite fabrication technique
10	Assay/activity test of the enzymes	11	Research Methodology

6d. Training needs of the different level scientists of Bangladesh Jute Research Institute

Chief Scientific Officers			
12	Research project development, execution and management	11	Research strategies development for sustainable crop production and food security
9	Leadership development	12	4IR based Agricultural research
11	National policy and plans such as SDGs, NIS, Perspective Plan-2041, Delta Plan-2100 etc.	9	Quality project management
9	Quality advance scientific reviewer	9	Ways to develop early career scientist
10	Qualitative evaluation and monitoring of research work	10	Advance financial management practices

11	Quality Research Management	11	Administrative management procedures
9	Effective Training for Trainers ToT)	-	-
Principal Scientific Officers			
10	Preparation of Development Project Proposal (DPP)	11	National policy such as SDGs, NIS, Perspective Plan-2041, Delta Plan-2100 etc.
10	Techniques for baseline study for project initiation	9	Qualified advance scientific reviewer
10	How to prepare PCR (Project Completion Report)	9	Quality evaluation and monitoring of research work
12	4IR based Agricultural research	9	Scientific paper presentation skills
Senior Scientific Officers			
10	Advance Data Analysis for quality interpretation and presentation	12	Estimate nutrient use efficiency using ^{15}N isotope
9	Scientific paper /report writing	11	C- sequestration studies using ^{13}C and ^{15}N isotope
11	Quality laboratory analysis (molecular, analytical, biochemical)	10	Water hydrology studies using ^{18}O and ^{2}H isotope
9	Research laboratory equipment maintenance	11	Measurement of critical limit using ^{65}Zn and ^{35}S
10	Use of nuclear techniques	9	Use of different modeling for scientific research results
11	Use of gene editing tool: CRISPR cas-9	9	Scientific paper presentation skills
12	Gene sequencing	12	Use of Nanotechnology
Scientific Officers			
12	Mutation breeding (basic experimental procedures and methods specially in radiation and chemical mutation, mutation mapping, tilling)	10	Molecular technology (MAS, MABC, Mapping, QTL and gene identification)
12	Basic foundation training for newly recruited scientists	11	Biochemical (protein, micronutrients, ROS, hormone) analysis of crop/plant
12	Foundation training on Nuclear Techniques for Agriculture	10	Abiotic stress breeding (screening protocol/methods)
11	Statistical Data analysis	11	Hybrid breeding (basic methodology) techniques for cereal and horticultural crops.
12	Scientific report writing	11	Bioinformatics (SNP to GWS)
10	Research result / data interpretation and management	12	Crop improvement through genome sequencing
12	Research methodology	12	Speed breeding

6e. Training needs of the different level scientists of Bangladesh Sugarcrop Research Institute

Chief Scientific Officers			
10	Policy Analysis	11	Procurement management
12	Research program related to 4IR	12	Supply chain development
11	DPP/TAPP formulation		
Principal Scientific Officers			
12	Precision Agriculture	12	Genomics, QTL mapping and CRISPR-Cas9 based genome editing
12	DPP/TAPP formulation	12	4IR in agriculture
10	Supply chain development	11	Research proposal reparation
Senior Scientific Officers			
11	Genomics, QTL mapping and CRISPR-Cas9 based genome editing	12	Data Management
10	Research proposal preparation	11	GIS in agriculture
Scientific Officers (SOs)			
10	Scientific report writing	9	Android App development
11	Genomics, QTL mapping and CRISPR-Cas9 based genome editing	12	Data Management

6f. Training needs of the different level scientists of Wheat and Maize Research Institute

Chief Scientific Officers			
10	Office management	11	Administration and supervision
11	Financial management	12	e-file management
9	Procurement process	9	Seed production, processing, storage and promotion
Principal Scientific Officers			
11	Maintenance of varietal purity	12	Genome editing for targeted gene
11	Wheat genomics, phenomics and transcriptomics	10	Maintenance of varietal purity
9	Production of hybrids	10	Greenhouse management operation
10	Conservation agricultural practices	11	Pricing of produce
Senior Scientific Officers (SSOs)			
10	Maintenance of parental lines	12	Germplasm screening
9	Conservation agricultural practices	12	Molecular identification
12	Wheat genomics, phenomics and transcriptomics		
12	Collection of DNA samples for DNA isolation	10	Fingerprinting of BWMRI released varieties
Scientific Officers (SOs)			
10	Nutrient management	10	e-file management
9	Inoculation	11	Germplasm screening

6g. Training needs of the different level scientists of Soil Resources Development Institute

Chief Scientific Officers			
10	Project formulation	11	Office management
Principal Scientific Officers			
11	Project formulation	11	Problem soil management
12	Instrument maintenance and trouble shooting	12	Quality control of chemical analysis
11	Lab management	9	Data interpretation
Senior Scientific Officers			
12	Chemical, physical and biological parameter of soil/fertilizer/ water/ plant analysis	10	Field survey
10	Soil map preparation	10	Preparation of Upazila Nirdeshika
10	Heavy metal analysis		Data interpretation
Scientific Officers			
9	Technical report writing	11	Field survey
11	Data management and interpretation	10	Soil map preparation

6h. Training needs of the different level scientists of Bangladesh Tea Research Institute

Chief Scientific Officers			
12	Procurement work following PPR	11	Pesticide residue in tea
9	Project management	11	Factory labor management
11	Farm/campus security management	9	Office management
Principal Scientific Officers			
11	Safe tea production and processing	10	Identification of pesticide components
11	Crop loss assessment of the new insect pest species	10	Determination of ETL of insect pests
12	Development of high yielding clone	10	Development of mass rearing technique
Senior Scientific Officers			
10	Preliminary selection process for promising vegetative clones	9	Insect and diseases management
11	Breeding for selecting suitable parent line	10	Factory machineries maintenance and troubleshooting
9	Data collection, compilation and analysis	11	Field machineries maintenance and troubleshooting
12	Quantification of different components through HPLC/ UV-VIS spectrophotometer	9	Irrigation and drainage management
Scientific Officers			
11	Research methodology	10	Profitability analysis of different methods

10	Preparation of extracts	10	Crop (leaf) harvesting
11	Labor payment management		

6i. Training needs of the different level scientists of Bangladesh Forest Research Institute

Divisional Officers			
11	Mapping climate change and biodiversity conservation	12	Meta data analysis, bioacoustics, biotechnology and genetic analysis
10	DNA sequencing	11	DNA/RNA extraction and quantification
11	Gene detection, expression and exploitation	10	Research planning
9	Research coordination	11	Budget execution and monitoring
Senior Research Officers			
11	Forest pathology	12	Identification of DNA/RNA
11	Meta data analysis, bioacoustics, biotechnology and genetic analysis	12	Gene detection, expression and exploitation
Research Officers			
11	Data analysis and report writing	10	Microbiology
10	Report writing	9	Media preparation and inoculation
10	Field data collection	12	e-file management

6j. Training needs for the different level scientists of Cotton Development Board

Chief Scientific Officers			
9	Policy analysis and formulation	10	Field inspection
Principal Scientific Officers			
11	Transgenic cotton development	11	Stress tolerant hybrid cotton development
11	Pathological identification and monitoring	9	Gene editing
Senior Scientific Officers			
10	Stress physiology	9	Pathogenic analysis in lab
11	Cotton based farming	10	Herbicide effect
Scientific Officers			
10	Farmers motivation	9	Chemical analysis
9	Fiber analysis	10	Pest identification and management

6k.Training needs for the different level scientists of Bangladesh Sericulture Research and Training Institute

Senior Research Officers			
11	Improvement of mulberry and silkworm	11	Management of mulberry plant
9	Research management	11	Silkworm disease management

Research Officers			
11	Scientific report writing	11	Research methodology
10	Office management	9	ToT training

6k. Training needs of the different level scientists of Bangladesh Fisheries Research Institute

Chief Scientific Officers			
11	Climate smart aquaculture and mericulture	10	Domestication of wild fish
12	Bivalves ecology, breeding, culture	10	AMR, heavy metal toxicity
Principal Scientific Officers			
11	Fish stock assessment/population dynamics/ remote sensing	10	Mapping pollution, heavy metal toxicity and food safety
11	Bio-flock technology in fish and shrimp culture	11	Non-conventional fisheries
12	Fish geonomics, phenomics and improvement	11	Bioinformatics, data management and machine learning
11	Marine aquaculture and breeding	10	AMR and climate change
Senior Scientific Officers			
11	Bio-flock technology in fish and shrimp culture	11	Pearl culture
10	Tagging in aquaculture	11	Fish health management
09	Training co-ordination and management		
Scientific Officers			
11	Tagging in aquaculture	09	Research methodology including data analysis & interpretetation

6m. Training needs of the different level scientists of Bangladesh Livestock Research Institute

Chief Scientific Officers			
10	Pollution and waste management	9	Finance management
9	Office management	9	Leadership development
Principal Scientific Officers			
11	Precision animal farming	11	AMR and Vaccine development
10	Climate smart fodder and cost effective feed production	11	Livestock product processing, value chain analysis and marketing
11	Molecular biology	-	-
Senior Scientific Officers			
11	Blood/tissue/samer sample analysis	11	Genomics, phenomics and bioinformatics
9	Software handling	11	Climate smart livestock development
Scientific Officers			

11	Research methodology	11	Scientific report writing
10	Data analysis		

6n. Training needs for the different level scientists of Bangladesh Agricultural Research Council

Chief Scientific Officers			
10	Office management	11	Improvement of research activities of NARS institutes
9	Research recommendation preparation	11	Genomics, phenomics & bioinformatics
12	Feedback in action	10	Preparation of MoU
11	Monitoring research activities	11	Project Management
10	Evaluation of technologies	11	Training need assessment for local and overseas training
11	Evaluation of projects	12	Good governance in agriculture
10	Policy brief preparation	11	Scientific report writing
11	Research need identification	10	Policy updating
11	Research management	9	Capacity development for acting as resource person
11	DPP preparation	10	Action plan preparation
9	Budget preparation and allocation	11	PCR preparation
Principal /Senior Scientific Officers			
11	Research need assessment	9	Skill in recommendation to action for ATECC meeting
9	Research prioritization	10	Preparation of training module
10	Research methodology	10	Impact analysis of transferred technology
10	Concept note preparation	10	Knowledge management
9	Log frame and theory of change	11	Climate smart agriculture
9	Budget preparation	9	Sample analysis, field trial
10	DPP preparation	10	Project implementation
9	Research coordination	11	Policy document preparation
10	Preparation of policy brief	10	Input for foreign policy
10	MoU preparation	10	Conduction of meeting/seminar/ workshop for policy formulation
10	Bilateral meeting conduction and input support	9	Coordination of sample analysis and field trial.
10	Consulting support to service provider	9	Event management in research
11	Modern biotechnological techniques in crops, livestock and fisheries	10	Opinion and feedback collection

Score range: 9-12, indicating low to high priority of training needs

5. Conclusions

The training needs of the each of the NARS institutes have been identified with the present study. The institutes individually or BARC as a whole can make a road map for conducting training on the identified skill gap areas. However, based on the findings some recommendations are presented below:

1. HRD Plan at institute level and implementation strategy: Each of the NARS institutes should have its own strategic plan for HRD. Human resource development plans for the scientists as well as for other managerial staff (supporting staff) should be developed and maintained at the NARS institutes. After thorough TNA (Training Need Assessment) analysis, regular skill-based training should be offered to the scientists. The training should be followed by the feedback and impact studies in order to make the future training programs more fruitful and effective.
2. Research Studies on institutional HRD plan: In order to make the NARS institutes more dynamic, active and productive, research studies on the internal resource management, increasing managerial abilities, capacity building, and leadership development, team building among the scientists, internal conflicts, and conflict resolution are required. Some of the NARS institutes are now suffering due to weak leadership, inadequate managerial ability and lack of teamwork spirit. Training programs need to be strengthened in order to address and mitigate the burning issues.
3. Local and overseas training: Strategic and common training for all the institutes such as Post Doc., PhD, can be organized by the BARC. The responsibilities of training on advance sciences can also be shouldered by the BARC. The sector specific training should be conducted by the NARIs.
4. Collaboration, networking with international community and private sector: For human resource development at the research institutes, team work with international partnership, private sector participation, and collaborative research with international centers are required. Through these practices the scientists would get more scope to improve their knowledge base and skills and would get a unique opportunity to build their professional career towards desired destination.
5. Implication of present study: Needs of training (short, medium and long) of all the NARS institutes identified from the individual scientists and skill-gap analyses by the scientists themselves. Hence, for any future training program, these aspects of training should duly be considered for implementation by the concerned authority.

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Conflicts of Interest

The authors declare no conflict of interest

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