Template/Pro forma for Submission

NMHS-Himalayan Institutional Fellowship Grant

FINAL TECHNICAL REPORT (FTR)

NMHS Reference No.:	**GBPI/NMHF/RA/2015-16/8494**

Date of Submission:	1	7	0	2	2	0	2	0
	d	**d**	**m**	**m**	**y**	**y**	**y**	**y**

FELLOWSHIP TITLE

NATIONAL MISSION ON HIMALAYAN STUDIES-FELLOWSHIP PROJECT

Sanctioned Fellowship Duration: *from* (1st April, 2016) *to* (31st March, 2019).

Extended Fellowship Duration (if applicable): *from* (01st April 2019) *to* (31st March, 2020).

***Submitted to*:**

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***Submitted by*:**

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GENERAL INSTRUCTIONS:

1. The Final Technical Report (FTR) has to be commenced from the date of start of the Institutional Fellowship (as per the Sanction Order issued at the start of the Fellowship) till its completion. Each detail has to comply with the NMHS Sanction Order.
2. The FTR should be neatly typed (in Arial with font size 11 with 1.5 spacing between the lines) with all details as per the enclosed format for direct reproduction by photo-offset process. Colored Photographs (4-5 good action photographs), tables and graphs should be accommodated within the report or should be annexed with captions. Sketches and diagrammatic illustrations may also be given giving step-by-step details about the methodology followed in technology development/modulation, transfer and training. Any correction or rewriting should be avoided. Please give information under each head in serial order.
3. Training/ Capacity Building Manuals (with detailed contents of training programme, technical details and techniques involved) or any such display material related to fellowship activities along with slides, charts, photographs should be sent at the NMHS-PMU, GBP NIHE HQs, Kosi-Katarmal, Almora 263643, Uttarakhand. In all Knowledge Products, the Grant/ Fund support of the NMHS should be duly acknowledged.
4. The FTR Format is in sync with many other essential requirements and norms desired by the Govt. of India time-to-time, so each section of the NMHS-FTR needs to duly filled by the Fellowship Coordinator/ PI and verified by the Head of the Implementing Institution/ University.
5. Five (5) bound hard copies of the NMHS-Institutional Fellowship Final Technical Report (FTR) and a soft copy should be submitted to the **Nodal Officer, NMHS-PMU, GBP NIHE HQs, Kosi-Katarmal, Almora, Uttarakhand** *via* e-mail nmhspmu2016@gmail.com.

The FTR is to be submitted into following two parts:

Part A – Cumulative Fellowship Summary Report

Part B – Comprehensive Report

Following Financial and other necessary documents/certificates need to be submitted duly signed and verified along with Final Technical Report (FTR):

Annexure I	Consolidated and Audited Utilization Certificate (UC) & Statement of Expenditure (SE), including interest earned for the last Fiscal year including the duly filled GFR-19A (with year-wise break-up)
Annexure II	Consolidated Interest Earned Certificate
Annexure III	Consolidated Manpower Certificate and Direct Benefit Transfer (DBT) Details showing the education background, i.e. NET/GATE etc. qualified or not, Date of joining and leaving, Salary paid per month and per annum (with break up as per the Sanction Order and year-wise).
Annexure IV	Details and Declaration of Refund of Any Unspent Balance as Real-Time Gross System (RTGS) in favor of NMHS GIA General
Annexure V	Details of Technology Transfer and Intellectual Property Rights developed.

DSL: *Date of Sanction Letter*

3	0	0	3	**2**	**0**	**1**	**6**
d	d	m	m	y	y	y	y

DFC: *Date of Fellowship Completion*

3	1	0	3	**2**	**0**	**2**	**0**
d	d	m	m	y	y	y	y

Part A: CUMULATIVE SUMMARY REPORT

(to be submitted by the Coordinating Institute/Coordinator)

1. Details Associateship/Fellowships

1.1 Contact Details of Institution/University

NMHS Fellowship Grant ID/ Ref. No.:	GBPI/NMHS/HF/RA/20115-16/8494
Name of the Institution/ University:	Doon University, Dehradun
Name of the Coordinating PI:	Prof Kusum Arunachalam
Point of Contacts (Contact Details, Ph. No., E-mail):	9411113894, kusumdoon@gmail.com

1.2 Research Title and Area Details

i.	Institutional Fellowship Title:	**Himalayan Fellowship**					
ii.	IHR State(s) in which Fellowship was implemented:	**Uttarakhand**					
iv.	Scale of Fellowship Operation	Local:	√	Regional:		Pan-Himalayan:	
iii.	Study Sites covered (*site/location maps to be attached*)	Uttarakhand State					
v.	Total Budget Outlay (Crore) :	INR 2,39,22,360.00					

1.3 Details Himalayan Research /Project Associates/Fellows inducted

Type of Fellowship	Nos.	Work Duration	
		From	To
Research Associates	03		
HRA1	01	03-09-2016	06-07-2019
HRA 2	01	01-08-2016	31-03-2020

HRA 3	01	04-09-2017	30-03-2019
Sr. Research Fellow			
Jr. Research Fellows			
JRF-003		01-12-2016	31-01-2019
JRF-008		01-08-2016	31-03-2020
JRF-007		01-12-2016	01-04-2018
JRF-009		01-12-2016	31-03-2020
Project Fellows			
PF-001		01-12-2016	28-02-2019
PF-002		01-12-2016	28-02-2019
PF-004		01-08-2016	31-03-2020
PF-005		01-08-2016	31-01-2020
PF-006		01-08-2016	31-01-2020
PF-10		05-12-2016	31-03-2020

2. Research Outcomes

2.1. Abstract (not more than 1000 words) (it should include background of the study, aim, objectives, methodology, approach, results, conclusion and recommendations based on the institutional fellowship proposal sanctioned under the NMHS).

Background :

The Doon university was granted NMHS fellowship in five broad thematic areas comprising of (i) Water Resource Management, (ii) Livelihood Options and Employment Generation, (iii) Biodiversity Conservation and Management, (iv) Skill Development and Capacity Building, and (v) Handling of Hazardous Substances. Under these five broad themes, following sites were studied, (1) 13 Districts of Uttrakhand State, (2) Tadikhet Block District Almora, (3) District Dehradun, Akhandwani, (4) District Tehri, Satyaun, (5) Corbet and Rajaji NP Uttarakhand, (6).Haridwar, Uttarkashi District Uttarakhand, (7)Askot wildlife sanctuary, (8) Uttarakhand Himalaya, (9) Dehradun: Kalsi Block (Haiya, Kimotha and Kanbua), (10) Pithoragarh, Uttarakhand. There were three RAs and ten JRFs working on different objectives within the above broad thematic areas.

Objectives/ Aim:

The major objectives were, (i) Energy efficiency study and extent of application of new policies and best practices, (ii) Survey, Inventory and Assessment of traditional natural resources management practices in the context of Climate change, (iii) Study of outmigration pattern in the State, (iv) Issues for sustainable tourism including eco-tourism, (v) Waste management, including management of hazardous substances, (vi) Issues concerning development in sensitive areas, (vii) Testing options for human capacity building including promotion of micro-enterprises and green technologies, (viii) Conservation of genetic resources of rare, endemic, threatened and globally significant flora and fauna including agro-biodiversity, (ix) Use of alien plants extracts for bio-preservation of wood, (x) Appraisal to plant diversity and restoration of degraded lands in Pithoragarh district, (xi) Supplementary livelihood options for local communities and other rural population, (xii) Effect of forest fires on nutrient dynamics in the soil, (xiii) Effect of forest fires on soil microbial biomass and diversity.

Methodologies and Approach:

Corresponding to the objectives described above, the methodologies adopted were, (i) Collection of data (secondary) for energy production, distribution, transmission, consumption, then running energy efficiency models (CCR and BCC), collection of renewable energy potential data (secondary), (ii) The villages Survey were conducted for collection of data on the use of natural resources (such as fuel wood consumption, use and status of natural springs, seedling and sapling recruitment in van panchayat forest), (iii) Collection of census data over the years, primary survey conducted in high migration districts of Uttarakhand, (iv) The primary field survey of Corbett and Rajaji National Park sites were conducted for visitor perception, visitor counts at religious site, vehicular movement, noise pollution, solid waste generation and disposal , hotel occupancy, local supply chain and sustainable utilization of resources. (v) The primary data on various aspects of waste generation and composition were collected from Urban Local Bodies (ULBs) in 7 cities and towns of Haridwar district, (vi) The Aster GDEM elevation data were studied for 1996 and 2016 for change detection in eco sensitive zones. The primary survey were conducted in the 15 villages of the area. (vii) Primary Data collected from 110 natural resource based micro enterprises from 11 districts of Uttarakhand.

(viii) In Askot wild life sanctuary, the data was collected from August 2017 to May 2019 in which a total of 63 trails transect and eight Silent Drive Count (SDC) walks varying in length from 1 km to 5 km were established at different elevation from 2500-4500 to cover the maximum area of the valley. Direct and indirect evidence of Himalayan musk deer and other ungulates were recorded. (ix) Data collected on the alien plant diversity of Uttarakhand from available literature. Chemical extraction and characterization of bioactive compounds for efficacy evaluation of active fraction of wood fungi. (x) Representative satellite data (LANDSAT 8 and Sentinel 2) from four different decades of Pithoragarh were studied to look at land cover change. Primary data on flora was collected for appraisal of plant diversity. (xi) Primary survey was conducted in 60 villages for six tehsils for the assessment of present livelihood activities and supplementary livelihood options available. (xii) and (xiii) The soil samples were collected (0-15 cm and 15-30 cm depth) from control and burnt forest sites of the Pauri and Tehri Garhwal district. The samples were analyzed in the lab using UV-Spectrophotometer, Kjeldahl-N, Licor soil gas flux system and others.

***Results*:**

The key results corresponding to the methodologies described above are as follows : (i) Technical efficiency of hills EDDs were found in the range 0.23 to 0.5 while the same were 0.75 to 0.85 for the EDDs of plains. The rooftop solar energy potential with median efficiency (15%) PV panels were estimated to be 7.7 GWh to 12.7 GWh in different seasons. (ii) The fuelwood consumption was 17.2 kg/day at 2301 – 3200 m altitude villages and 11 kg/day 1000-2000 m altitude villages, total carbon emissions in 5 districts was 3821.6 MtCO2 due to fuelwood consumption. (iii) population growth in hills district of Uttarakhand is below national average while Almora(-1.64%) and Pauri(1.41%) recorded decline in population, the major causes identified were unemployment and lack of education facilities. (iv) Jim Corbett tiger reserve (CTR) is major tourist attraction in comparison to Rajaiji National Park (RTR). Both CTR and RTR are facing pressure due to religious tourism activities. The tourism infrastructure is blocking tiger and elephant corridors that connect Corbett with adjoining forests. Solid waste disposal within park and near park is major threat for developing these sites for Eco tourism potential areas. (v) In Haridwar district, ULBs are lacking space for developing land fill sites. Out of 7 ULBs , only 3 ULBs are practicing door to door collection. Haridwar city is generating highest per capita solid waste material. Segregation of waste was not observed at any places. (vi) The presence of narrow valleys, important glaciers, biodiversity and religious spots makes Uttarkashi distriict vulnerable to the impact of human interventions. Most of the area of the basin is at higher elevations, with moderately steep slopes and high drainage density. ~75% landslide occurrence was observed within range of 100meter from road side area. Non scientific muck disposal and solid waste disposal activities are common and rampant. (vii) Handicrafts and handloom based microenterprises earn more profits than others, market knowledge showed maximum effect on performance of microenterprises. (viii) Askot wildlife sanctuary was studied for habitat pattern of Musk deer , Himalayam Ghoral and Serow population. The higher encounter rate of musk deer was observed during autumn season and lowest in winter. Anthropogenic pressure on habitat of Musk Deer breeding time period due to collection of Keedha Jadhi during April, May month was observed. (ix) documented a total of 937 species as aliens belonging to 556 genera and 121 families, In vitro antifungal activities of the selected plant extracts and oil suggest that alien plants can be used for wood preservation. (x) Area under degraded or scrub forest was over 431.6 km^2. 110 species of trees were identified in the forest and village areas to be useful for appraisal of plant diversity. (xi) Medicinal and aromatic plants cultivation was found most suitable livelihood option, a total of 151 plant/fugi species were recorded of which 50 have commercial importance. Income from NTFPs was largely governed by the distances that need to be covered to collect them.

(xii) Soil macronutrients (Total nitrogen, Available P and exchangeable Ca & Mg) were found to be significantly higher ($p \leq 0.05$) at burnt forest sites than control forest sites for both the surface and sub-surface layer of the soil. In contrast, Soil micronutrients (Fe, Zn, Cu and Mn) were found to be reduced at the burnt sites as compared to control sites in both oak .(xiii) The results showed that Microbial biomass carbon (C_{mic}), microbial biomass nitrogen (Nmic), Soil Basal Respiration (SBR) and acid phosphatase activity (ACP) activity decreased while Dehydrogenase (DHA) activity increased at burnt forest sites of Oak and Pine forests.

Conclusion and Recommendations:

Conclusion and recommendation corresponding to the results described above are as follows: (i) Since EDDs efficiency decline in hills, alternative energy sources such as rooftop solar energy potential should be fully exploited especially over the hills. (ii) Huge anthropogenic pressure on forest due to perpetual demand for fuel wood, alternative livelihood options through participatory conservative framework needs to be promoted. (iii) To check outmigration from hills, locally sustainable employment generating decent income needs to be encouraged, quality education (primary and secondary) and health facilities need to created in these regions. (iv) In Corbett and Rajaji national park, waste management system needs to be revamped, there should be emphasis on improving the local people's livelihood with wildlife conservation. (v) The focus should be on segregation of waste at source and efficient management of organic waste. Solid wastes handling system needs to be improved with technological intervention. (vi) The *developmental projects, roads, tourism activities and land use conversion should be controlled for promoting sustainable development of the area.*(vii) Focus on improving human capacity building indicators (such as market knowledge, raw material availability for the sustainable microenterprises) can uplift the economic conditions of enterprises. (viii) Musk deer has suffered heavy decline in population in Askot wildlife sanctuary mainly due to anthropogenic activities, it is suggested that the dependence on NTFPs to be reduced and the collection of medicinal fungus should be regulated. (ix) Employing invasive alien plants for wood preservation could be a viable option for managing wood degradation as well as these alien species. The chemical composition of weeds as well as their abundantly available biomass can be utilized in a cost-effective manner which in turn will boost the overall environment as well as the economy. (x) Support and promotion of agroforestry, agro-horticulture or agrosilviculture will enhance the land quality along with reducing the expansion of degradation by restoring its ecosystem functions. (xi) Market linkages in rural hilly area is still main constraint for farm and non-farm produces. Capacity building for value addition, grading and packaging is much needed in each livelihood activities like Dairy, horticulture, agriculture and NTFPs. (xii) The effect of fire has been found to be significant at the surface layer as compared to sub-surface layer. The nutrient availability within forest can be managed with suitable silvi-culture practices. (xiii) The effect of forest fire was found to vary with altitudinal differences when observed in same forest types. At higher altitude , the impact of forest fire persist because microbial biomass and SBR reduced after fire in the forest dominated by pine species at high altitude as compared to the pine forest present at less altitude.

2.2 Objective-wise Major Achievements

S. No.		Cumulative Objectives	Major achievements (in bullets points)
1.	HRA 1	Energy efficiency study and extent of application of new policies and best practices	• The year wise performance of 30 EDDs were examined in terms of overall efficiency, technical efficiency, and scale efficiency for the period 2009-17. • The CRS and VRS result analysis revealed that the mean efficiency scores of the EDDs decreased continuously over the period of analysis. • The EDDs of hill were much less efficient than EDDs of plains. • The rooftop solar energy potential with median efficiency (15%) PV panels were estimated to be 7.7 GWh to 12.7 GWh in different seasons.
2.	HRA 2	Survey, Inventory and Assessment of traditional natural resources management practices in the context of Climate change	• The participatory conservation framework was strengthened with establishment of the farmer producer companies. • The farmer producer companies are linked with PHD chamber of commerce and industries and with Herbal research Institute, Centre for Aromatic Plants, Agriculture and Horticulture department schemes. All six companies have been registered in the month of March 2019. • Sustainable harvesting protocols for diverse natural resources was developed.

3.	HRA 3	Study of outmigration pattern in the State	• The study addresses out-migration which is a strong socio-economic concern for Uttarakhand. • With this research work we have been able to identify key issues that govern migratory patterns in the state. • Through an intensive social assessment, we also identify potential opportunities for promoting livelihood security in the hill regions of the state that can reducing the current rate of migration and also encourage local residents for reverse migration.
4.	HJRF 1	Issues for sustainable tourism including eco-tourism	Jim Corbett national park is rich in biodiversity and has variety of natural resources. The park management needs to focus on the number of local nature guides to meet the visitor's expectations and eco tourism perspectives. Disposal of solid waste in and out side park is crucial for sustainable tourism management. Visitors mismanagement for religious tourist is also important for reducing pressure on park areas.
5.	HJRF 2	Waste management, including management of hazardous substances	The Haridwar ULBs household waste generation was ranged from 0.3 to 2.3 kg/household/day. ***Over all, there was a shortage of land for landfill site all the Nagar Palikas*** *Household Collection and Segregation is required for proper solid waste management in ULBs.* *Awareness about house hold hazardous disposal is crucial for safe disposal of hazardous material in all ULBs.*

6.	HJRF 3	Issues concerning development in sensitive areas	• Most of the area of the basin is at higher elevations, with moderately steep slopes and high drainage density is critical to undertake major developmental work in Uttarkashi districts. • Landslide affected areas/sites lies in the vicinity of the inhabited stretches of land along the national highway. • In the last two decades, changes in vegetation cover and land use have made the area vulnerable to degradation and natural disasters. So, keeping in mind the ESZ notification and sensitivity of the area, there is a need to restore, conserve and use the natural resources of the ESZ and Bhagirathi basin/sub basin in a sustainable manner with the first benefits flowing to the local population of the area.
7.	HJRF 4	Testing options for human capacity building including promotion of micro-enterprises and green technologies	• Improvement in human capacity building indicator(Market knowledge), market linkage and administrative bottleneck can uplift the economic conditions of enterprises • Raw Material is easily available to develop enterprises therefore there is scope of establishment of new micro enterprises • Reinventing traditional family-based subsistence agricultural practices by encouraging land and labour resource consolidation • Supporting community based initiatives in organic farming and horticulture sector and promoting agri-horti food products • Animal based industries have been observed to be relatively less vulnerable to climatic fluctuations as compared to agro-based industries • Promoting non-farm livelihood sectors such as adventure tourism, homestays, electrical and plumbing services, handicrafts, and handlooms.

8.	HJRF 5	Conservation of genetic resources of rare, endemic, threatened and globally significant flora and fauna including agro-biodiversity	• Habitat use pattern of Himalayan musk deer, Himalayan goral and Serow was studied in Askot wildlife sanctuary. • Major threats were identified. • study reveals that the mid and low altitudes areas of Askot wildlife sanctuary are being used extensively by the livestock herders due to which there is intense pressure on ungulates as they have to share their habitat with livestock inside sanctuary area. It was observed that anthropogenic activities are the main cause of pressure on the existing population of ungulates especially musk deer and Himalayan goral as they have to share habitat with thousands of livestock. It was also observed that due to livestock raring, collection of medicinal herbs, keeda jadi (*Cordyceps sinensis*), overgrazing, and excessive use of fuelwood by shepherds is posing great dangers to the biodiversity of Sanctuary.
9.	HJRF 6	Use of alien plants extracts for bio-preservation of wood,	• Based on all the available literature, inventory documents a total of 937 species as aliens belonging to 556 genera and 121 families. • The Indian Himalayan state of Uttarakhand is vulnerable to alien plants and the intensity of introductions is expected to increase in the near future. • Employing invasive alien plants for wood preservation could be a viable option for managing wood degradation as well as these alien species. The chemical composition of weeds as well as their abundantly available biomass can be utilized in a cost-effective manner which in turn will boost the overall environment as well as the economy.

10.	HJRF 7	Appraisal to plant diversity and restoration of degraded lands in Pithoragarh district,	• The study mapped the land degradation and forest degradation in Pithoragarh district of Uttarakhand. Plant data base of indigenously present species can be used to reclaim the degraded land in the district. • Through our survey it was identified the land ownership is also a problem in restoration on degraded lands present in the vicinity of villages. • As we have categorized the location on ground according to slope degree, soil erosion classes, and different forest types the data base can affectively be used for restoration and conservation related activates at block level in district Pithoragarh.
11.	HJRF 8	Supplementary livelihood options for local communities and other rural population	• Market linkages in rural hilly area is still main constraint for farm and non-farm produces, about 68% of respondents have poor to moderately market linkages because of absence of local Mandi at Tuini and Chakrata, market knowledge, middleman etc; so Small krishi upaj Mandis would be beneficial in these area. • From various marketing channels, channel-A (Farmers- Wholesaler-Retailer-Consumer) is the most common channel amongst different categories of mushroom growers, followed by the channel-II (Farmer-Wholesaler-Consumer) in small and medium size farms, while channel-III (Farmers-Retailer-Consumer) only in case of large growers. • Capacity building for value addition, grading and packaging is much needed in each livelihood activities like Dairy, horticulture, agriculture and NTFPs .

12.	HJRF 9	Effect of forest fires on nutrient dynamics in the soil	• Study results showed that soil physico-chemical and macronutrient availability has been observed higher at the burnt sites in comparison to control sites of oak and pine forests. Exchangeable cations were found to be significantly higher at burnt sites as compared to control site in both the oak and pine forest. • The available nutrients (NPK) also observed higher at burnt sites as compared to control sites. • Soil micronutrients (Fe, Zn, Cu and Mn) were found to be higher at control sites for both types of forest (oak and pine). • The effect of fire has been found to be significant at the surface layer as compared to sub-surface layer. The nutrient availability within forest can be managed with suitable silvi-culture practices.

13.	HJRF 10	Effect of forest fires on soil microbial biomass and diversity	• The study concluded that the forest fire has significant impact on microbial properties, soil enzymatic activity along with soil physical and chemical properties. • The changes in physical and chemical properties of soil found to be correlated with soil microbial activity. Soil microbial biomass C and N and SBR were less at fire-affected sites as compared to burnt site in both the forest types (Oak and Pine). • Impact of fire diminishes if there was intermittent rainfall in the fire season as microbial biomass has found increased even after forest fire with intermittent rainfall. • The results showed that C_{mic}, N_{mic}, SBR and ACP activity decreased whereas DHA activity increased at burnt forest sites. DHA activity showed strong correlation with soil organic matter (r=0.80) and ACP activity showed strong positive correlation with microbial indices

2.3. Outputs in terms of Quantifiable Deliverables*

S. No.		Quantifiable Deliverables*	Monitoring Indicators*	Quantified Output/ Outcome achieved	Deviations made, if any, and Reason thereof:
1.	HRA 1	Support Non-conventional energy sector; □ Promote intervention of state-of-the-art technology; □ Existing institutions and regulatory mechanisms strengthened.	• Energy Consumption • Energy demand • Technical efficiency of EDDS • Scale efficiency of EDDS • Overall efficiency • Rooftop energy potential season wise	• Using DEA, year wise, the relative performance of EDDs in the Indian state of Uttarakhand, over the period 2009–2017. During this period the number of EDDs of this state utility increased from 30 in 2009 to 35 in 2017 in the process of restructuring. • The CRS and VRS result analysis revealed that the mean efficiency scores of the EDDs decreased continuously over the period of analysis. • Through proper policy implementation and reformatory measures there can be significant improvement in the efficiency of energy sector in the state. • The rooftop solar energy potential	

				with median efficiency (15%) PV panels were estimated to be 7.7 GWh to 12.7 GWh in different seasons.	
2	HRA 2	• Participatory conservation framework developed; . • Sustainable harvesting protocols for diverse natural resources developed; • Local natural resource management institutions strengthened; • Good practices documented and up-scaled.	• Number of fodder species, MAPs, NTFPs and Timber species used by local communities. • Number of water springs in Van-Panchayat. • Number of Local natural resource management institutions such as Gram Sabha and Van Panchayats involved in participatory conservation plan.	• Documented 76 species of flora including Herbs, shrubs, trees etc. which are being utilized by communities at large scale level. • Documented 128 springs, their water discharge rates in Van Panchayats of 98 villages. • Six Farmer Producer Companies (FPCs) in 9 blocks of 4 districts. (Almora, Pithoragarh,Champawat and Tehri-Garhwal). Established for sustainable use of natural resources. • Liked the farmers with schemes of Agriculture, Horticulture and Forest Department in 9 blocks of 4 districts as mentioned above. • Developed micro plans for natural resource management in 11 villages for mid and high altitude	NA

				villages in Almora and Chamoli district. • A document have been developed using participatory approach for scaling up and documentation of good practices.	
3.	HRA 3	• Recommendations of policy changes for reducing outmigration • Alternate livelihood options	• Decadal change in population for 13 districts of Uttarakhand. • Percentage of migration altitude wise • Intra-district, Inter-district, inter-state and international migration • Factors responsible for outmigration : 1Lack of employment opportunities, 2Loss of agricultural productivity,3Access to electricity, 4Access to water supply, 5Distance to primary health care, 6 Distance to primary school, 7 Distance to secondary school, 8, Distance to road from the village, 9 Distance travelled to obtain	• The highest mean outmigration percentage was seen in Pauri district, followed by Almora, Tehri, Chamoli, and Uttarkashi, on an average 58.9% of the total population, of the surveyed villages, is currently residing outside their native villages. • The lowest outmigration has been observed in the hill regions of Dehradun district (which includes Chakrata, Kalsi, and Tyuni regions), one of the key factors for low • levels of outmigration in this area can be the strong socio-cultural ties in the community	

			LPG, 10 Distance to nearest hospital, 11 Natural calamities	• A large proportion of the sampled population (41.9%) was migrating within the state primarily to plain districts including Dehradun, Hardwar, and Udham Singh Nagar. The rapid expansion of peri-urban spaces in these plain areas, especially over the last few decades, stands as testimony to the high influx of population in the region. • Outmigration in Uttarakhand is an outcome of social, ecological, and economic push and pull factors • Social push factors range from lack of quality education, aspiration, and marriage. • ecological push factors such as climate change, loss of natural resources, and disaster vulnerability have also been highlighted • pull factors such as improved access to healthcare and education facilities, better job opportunities, less vulnerability to disasters, and improved connectivity, are main factors that	

				attract the local residents to places outside of their native villages • The strongest reasons for outmigration was the lack of employment opportunities in the hills, with 47 per cent of the total respondents enlisting it as the leading cause for migration.	
4.	HJRF 1	• Ecologically compatible and equitable tourism promoted/implemented leading to stoppage of unregulated	• Tourist influx at religious sites of Corbett and Rajaji National Park.	• **T**he tourism infrastructure is blocking tiger and elephant corridors that connect Corbett with adjoining forests. Dhikuli, on the east ern part of Corbett, is a prime example , with a concentration of resorts over 65 and counting • In Mansa Devi and Chandi Devi temple, a sharp increase in the number of tourists was observed in 2018 when compared with 2017. • There is a total of about 250 registered gypsies for jungle safari. The number of trips made in Sitabani zone is unlimited so a significant increase in a number of trips made by gypsies and number of tourists is	

				observed in the month of June. • Ramnagar is *Nagar Palika Parishad* and door to door waste collection facility is provided by it. But NPP does not handle the waste of hotels.50% of waste is dumped at the backyard of the hotels which consequently is polluting the Kosi River. Rest of the waste is transported to the dumping site of Ramnagar..	
5.	HJRF 2	• Existing institutions and regulatory mechanisms strengthened; • Up-scaling of best practices supported.	• Household solid waste generation • Landfill site • Industrial waste generation	• The rate of waste generated was different for the 7 regions of Haridwar district. Haridwar municipality recorded the highest waste generation rate of 0.93 kg/person/day which was slightly above that of Jhabrera recorded as 0.8 kg/person/day. • As per the survey, it is observed that Haridwar stands at the first position in terms of quantity of waste generation owing to high density of spiritual tourists and also allied infrastructure • The two major fractions of MSW in the graph are organic waste and recyclable waste	

				which accounts for an average of 55% and 33% of the total wastes so generated. • The average fraction of inert waste generation in Haridwar ,Roorkee, Manglaur, Jhabrera, Laksar, Landhaura and Shivalik nagar are 56.88, 26,0.9,1.1,0.4, 0.4 and 28.24 t/day, respectively.	
6.	HJRF 3	• Scientific evidences and databases developed/ augmented/ disseminated.	• People perception • Muck disposal site • Landslide zones	• Most of the area (> 50%) of the basin is at higher elevations, with moderately steep slopes and high drainage density. • Landslide affected areas/sites (approx.. 70%) lies in the vicinity of the inhabited stretches of land along the national highway. • The NDVI for the two years showed that the area percentage under values range 0.3 and above has decreased from 19.25% in 1996 to 4 % in 2016 implying degradation in the status of vegetated areas, or forest land conversion	
7.	HJRF 4	• Identify key sectors and capacity building needs of those having immediate bearing on conservation and livelihoods.	• Key sectors: 1. Handlooms & Handicrafts 2. Agro and allied based microenterp	• Natural resource based crop and livestock is decreasing in contribution in GSDP of Uttarakhand.	

		• Natural resource based and community oriented microenterprises developed/ promoted.	rises 3. Animal and allied based microenterprises 4. Miscelleneous • Capacity building indicators 1. Level of market knowledge 2. Level of technology 3. Raw material availability 4. Level of training	• Market knowledge (One of the identified indicator) showed maximum effect on micro enterprises. • If agro based enterprises shifts to handicrafts and handlooms enterprises odds ratio of income changes by a factor of 4.55 • Maximum enterprises are set up in the area where raw material is easily available • Around 35% of entrepreneurs are using traditional equipment's like charkha, wooden sticks to make products • Handicrafts and Handlooms workers received the least training and using traditional knowledge they acquired from previous generation.	
8.	HJRF 5	• Conservation of endemic/threatened/significant species augmented through *ex situ*/ *in situ* mechanisms	• Habitat type • Population of musk deer and other native species	• A total of 58 individuals and 64 pellet groups of Himalayan goral were recorded in 22 observations made in a total of 55 trails (161km). • a total of 11 individuals of Himalayan serow were recorded in 4 observation made	

				in a total of 55 trails (161km). • Himalayan musk deer encounter rate was highest (1.39±0.13 individuals/km) in autumn and lowest (0.66±0.22 individuals/km) in winter • Himalayan serow encounter rate was highest (1.2±0.15 individuals/km) in winter and lowest (0.80±0.17 individuals/km) in autumn • Local pressure during winter through forest fire and collection of keedajari during summer affecting the musk deer abundance	
9.	HJRF 6	• Database of alien plants species • Development of bio-preservatives	• fungicidal activities by different alien plant extract	• Four species namely *Lantana camara*, *Ageratina adenophora*, *Hyptis suaveolens* and *Bidens Pilosa* were selected and authenticated from BSI and voucher specimen deposited • In vitro antifungal activity of the different extracts and oil carried out against wood decaying fungi. • Identification of bioactive essential oil and extract(s)	
10.	HJRF 7	• A database of plant resources will be available. • A database of	• Land cover land change over 10 years.	• Total 2241.47 km2 area is under forest in	

		indigenous technologies of plant use	• Area identification under soil erosion, gully ersion, severe sheet erosion, moderate erosion. • No. of tree species • No. of species meant for fodder and others.	Pithoragarh district. Total 930.415 km2 area is under soil erosion in Pithoragarh district. Gully erosion (4.09%), severe gullies (2.32%), severe sheet erosion (3.91%), moderate erosion (2.15%), sheet erosion (0.6%) •Total 110 tree species were found in forest and agriculture area. •Eighty two are multipurpose and 28 fruit species.	
11.	HJRF 8	• Recommendations on livelihood options • Development of market linkage options	1. No. of households 2. Total population 3. Male population 4. Female population 5. SC/ST population 6. Average family size 7. Average landholding 8. Average livestock/HH 9. Annual income	• Agriculture and allied sector contributed most in livelihood of the respondent followed by business and tourism and travel sector. • On the basis of Cost benefit analysis, assessment of supplementary livelihood options	

			10. Livelihood sources 11. List of plant species used for various purposes (Fodder, Fuel, timber, agriculture implements, NTFPs)	has been done in all the study sites • Medicinal and aromatic plants cultivation was found most suitable livelihood option followed by poultry farming. • A total of 151 plants/fungi species were recorded, out of which 50 species have commercial importance for local livelihoods • The chi-square ($\chi 2$) test implies that the dependency of the households on forest resources was not influenced by the demographic and socio-economic variables • In the present investigation, one hundred forty-nine (n=149) plant species and two (n=2) fungi species belonging to 125 genera and 58 families were found to be utilized. • The study highlights that only 50 species being collected by the respondents have economic and commercial importance. These documented species include 48 plant-based NTFPs, and 2 that of fungi. • We assessed	

				tourism based livelihood strategy in urban and rural tourist sites of Dehradun district located in central Himalayan state of Uttarakhand. • During the field visit a total of 120 various stakeholders hotel (N=30), homestay (N=10) and shops (N=80) were surveyed from 2017 June to 2019 June.	
12.	HJRF 9	• Database on impact of forest fire • Policy recommendations	At control and burnt Pine and Oak forest sites of Tehri and Pauri: • Soil pH • Soil macronutrients 1. Total nitrogen 2. Total phosphorous 3. Available K 4. Available nitrogen, 5. Available P 6. Exchangeable Ca & Mg • Soil Micronutrients 1. Fe 2. Zn 3. Cu 4. Mn	• Total nitrogen in Tehri was found to be increased by 58% (0-15 cm) and 74% (15-30cm) in oak forest, whereas in Pauri, increased by 53% in the pine forest (0-15 cm) and 45% of pine forest (15-30cm) respectively, relative to the control site. • At burnt sites for both Tehri and Pauri, the higher values of available N, P and K were observed in both the oak and the pine forests as compared to the respective control sites • The result of the study showed that in burnt site, the availability of Ca and Mg found to be higher in comparison to control site	

				because soil heating increases the activity of these basic cations through mineralization of organic forms.	
13.	HJRF 10	• Database on impact of forest fire • Policy recommendations	At control and burnt Pine and Oak forest sites of Tehri and Pauri: • Soil microbial properties 1. Microbial biomass carbon (MBC) 2. microbial biomass nitrogen (N_{mic}), 3. Soil Basal Respiration (SBR) 4. acid phosphatase activity (ACP) 5. Dehydrogenase (DHA)	• Microbial biomass carbon (C_{mic}), microbial biomass nitrogen (N_{mic}), Soil Basal Respiration (SBR) and acid phosphatase activity (ACP) activity decreased while Dehydrogenase (DHA) activity increased at burnt forest sites of Oak and Pine forests. • Impact of fire diminishes if there was intermittent rainfall in the fire season as microbial biomass has found increased even after forest fire with intermittent rainfall. • The microbial biomass carbon (MBC)in all the forest type has been found to be increased by 106%,18.2% and 87.47% after forest fire with intermittent rainfall in Pine ,Oak, Sal forest. • No significant change in microbial biomass carbon and nitrogen has found in sal forest but significant changes has found in enzymatic activity of pine forest. • *MBC values decreased by 61% in Subtropical Pine*	

				Forest and 55.7% in Himalayan Moist Temperate Forest after forest fire. • *Acid phosphatase(ACP) activity values decreased(N=187.7 µg/g/hr) between 1100-1500 and (N=190.8 µg/g/hr) between 1500-2000 meter when compared to controlled site between 1100-1500 which was (N=269.5 µg/g/hr) and (N=292.2 µg/g/hr) at 1500-2000 meter.* • *The Dehydrogenase activity (DHA) in Pine forest increased in both the forest types after forest fire which were (N=3.4 µg/g/hr) at 1100-1500 meter and (N=2.6 µg/g/hr) at 1500-2000 meter in fire affected sites. The DHA value in controlled sites was (N=2.5 µg/g/hr) at 1100-1500 meter and (N=1.9 µg/g/hr) at 1500- 2000 meter.*	

(*) As stated in the Sanction Letter issued by the NMHS-PMU.

2.4. Strategic Steps with respect to Outcomes (in bullets)

S. No.	Particulars	Number/ Brief Details		Remarks/ Enclosures
1.	New Methodology developed:	**NIL**		
2.	New Models/ Process/ Strategy developed:	HRA 1	Strategy to enhance energy efficiency and possible intervention of solar energy PV power in the hill districts of Uttarakhand	Part B HRA 1 in report
		HRA 2	strategy developed for conservation of natural resources by linking members of Van Panchayat and Gram Sabha for sustainable use of natural resources.	Part B HRA 2 Appendix 5 attached in report
		HRA 3	Strategies suggested for the inclusive of hill districts of Uttarakhand to check outmigration	Part B HRA 3 report
		HJRF 1	Strategies suggested for tourist influx management and solid waste disposal and involvement of local people as a nature guide for Corbett and Rajaji National Park	Part B HJRF 1 report
		HJRF 2	Strategies suggested for segregation of wastes at source and development of landfill site.	Part B HJRF 2 report

S. No.	Particulars	Number/ Brief Details		Remarks/ Enclosures
		HJRF 3	Strategies suggested for incorporation of local people perception in developmental activities in sensitive zones of Uttarkashi and sustainable methods in developmental activities	Part B HJRF 3 report
		HJRF 4	Strategies suggested for the development of profitable microenterprises based on solid market linkages, suitable level of technology, training, raw material availability	Part B HJRF 4 report
		HJRF 5	Strategies suggested for musk deer conservation, reduction of local pressure for the wildlife management in Askot Wildlife sanctuary	Part B HJRF 5 report
		HJRF 6	Strategies suggested for using alien plants as wood preservative	Part B HJRF 6 report
		HJRF 7	Strategies suggested for plantation of identified species for the restoration of degraded land of Pithoragarh	Part B HJRF 7 report

S. No.	Particulars	Number/ Brief Details		Remarks/ Enclosures
		HJRF 8	Strategies suggested for improving alternative livelihood options for the villages dependent on natural resources for Chakrata and Kalsi	Part B HJRF 8 report
		HJRF 9	Impact of forest fire was assessed for managing the risk of frequent forest fires in Uttarakhand	Part B HJRF 9 report
		HJRF 10	Impact of forest fire was assessed for managing the risk of frequent forest fires in Uttarakhand	Part B HJRF 10 report
3.	New Species identified:	**NIL**		

S. No.	Particulars	Number/ Brief Details		Remarks/ Enclosures
4.	New Database established:	HRA 1	New database for rooftop solar energy potential for the state of Uttarakhand	Part B HRA I (publication : Mishra, T., Rabha, A., Kumar, U., Arunachalam, K., & Sridhar, V. (2020). Assessment of solar power potential in a hill state of India using remote sensing and Geographic Information System. *Remote Sensing Applications: Society and Environment*, *19*, 100370. https://doi.org/ https://doi.org/ 10.1016/j.rsase .2020.100370
		HRA 2	New database of fodder and fuel wood trees have been developed which are being used extensively by communities.	Part B HRA II Appendix 1 attached in report

S. No.	Particulars	Number/ Brief Details		Remarks/ Enclosures
		HRA 3	New database on migration established for six hill districts of Uttarakhand (Uttarkashi, Tehri, Pauri, Almora, Bageshwar, Pithoragarh) with coverage of 60 villages evenly distributed over the six districts.	Part B HRA 3 (***publication*** : Naudiyal, N., Arunachalam, K., & Kumar, U. (2019). The future of mountain agriculture amidst continual farm-exit, livelihood diversification and outmigration in the Central Himalayan villages. *Journal of Mountain Science*, *16*(4), 755–768. https://doi.org/10.1007/s11629-018-5160-6)
		HJRF 1	• New database of waste generation inside the Corbet and Rajaji National Park, • vehicle count and no. of visitors during religious festivals	HJRF 1 PART B report
		HJRF 2	• New database of solid waste generation, collection and disposal from household of 7 Urban local bodies of Haridwar district,	HJRF 2 Part B report
		HJRF 3	• New database on people's perception developmental activities in sensitive area • New database of landuse conversion over the decades in sensitive areas of Uttarkashi	HJRF 3 PART B report

S. No.	Particulars	Number/ Brief Details		Remarks/ Enclosures
		HJRF 4	• New database on different aspects (profits, raw material availability, market knowledge, technology, training) of 110 natural resources microenterprises from 11 districts of Uttarakhand	HJRF 4 PART B report
		HJRF 5	New database on musk deer population trend over the period 2017 to 2019 in Askot Wildlife sanctuary.	HJRF 5 PART B report
		HJRF 6	Prepared a database of 937 species as aliens belonging to 556 genera and 121 families in Uttarakhand	HJRF 6 PART B report
		HJRF 7	Database of 110 species identified to be useful for appraisal of plant diversity	HJRF 7 PART B report
		HJRF 8	New database on 151 plant/fungi species were recorded of which 50 have commercial values as alternative livelihood options	HJRF 8 PART B report
		HJRF 9	New database of soil macronutrients (Total N, available P, available N, available P, exchangeable Ca & Mg) and soil micronutrients (Fe, Zn, Cu, Mn) of control and burnt forests sites of Tehri and Pauri district.	HJRF 9 PART B report

S. No.	Particulars	Number/ Brief Details		Remarks/ Enclosures
		HJRF 10	New database of soil microbial properties (microbial biomass carbon (MBC), microbial biomass nitrogen(N_{mic}), soil basal respiration (SBR), acid phosphate (ACP), dehydrogenase (DHA) and microbial community compostion of control and burnt forests sites of Tehri and Pauri district.	HJRF 10 PART B report
5.	New Patent, if any:			
	I. Filed (Indian/ International)	Nil		
	II. Granted (Indian/ International)	Nil		
	III. Technology Transfer (if any)	City farming composting technique transferred to Sri Ravi Shankar ashram in Rishikesh		
6.	Others, if any:			

3. Technological Intervention

S. No.	Type of Intervention	Brief Narration on the interventions	Unit Details (No. of villagers benefited / Area Developed)
1.	Development and deployment of indigenous technology	NA	
2.	Diffusion of High-end Technology in the region	Nil	
3.	Induction of New Technology in the region	Nil	
4.	Publication of Technological / Process Manuals	Nil	
	Others (if any)	Nil	

4. New Data Generated over the Baseline Data

S. No.		New Data Details	Existing Baseline	Additionality and Utilisation of New data (*attach supplementary documents*)
1.	**H-RA 1**	New database for rooftop solar energy potential for the state of Uttarakhand	MNRE reports on total solar energy potential of Uttarakhand	The data may be utilise for effective energy generation and consumption
2.	**HRA 2**	Documented 76 species of flora including Herbs, shrubs, trees etc. which are being utilized by communities at large scale level.		**B**ased on the data collected micro-plan has been developed for two clusters in two districts. Implementation in progress. Based on analysis of winter rainfall pattern plan for conservation of natural springs has been developed for 25 villages in 4 districts.
3.	**HRA 3**	New data on migration generated for six hill districts of Uttarakhand (Uttarkashi, Tehri, Pauri, Almora, Bageshwar, Pithoragarh) with coverage of 60 villages evenly distributed over the six districts	Census data on population available**.**	The data might be utilised for policy makin for strategic and sustainable development of the hill districts of Uttarakhand
4.	**HJRF1**	New data of waste generation inside the Corbet and Rajaji National Park,	No baseline data	The data might be utilized for sustainable tourism
5.	**HJRF2**	New data of solid waste generation, collection and disposal from household of 7 Urban local bodies of Haridwar district	Baseline data of transported cumulative waste generation of municipal corporation of Haridwar district	The data to be utilized for better waste management practices for sustainable cities and towns.
6.	**HJRF3**	New data on people's perception developmental activities in sensitive area. New data generated on land use conversion over the decades in sensitive areas of Uttarkashi	Partly baseline data available for land use change and landslide zones.	The data to be utilized for better and sustainable development and for disaster management ir sensitive zone

7.	**HJRF4**	New data on different aspects (profits, raw material availability, market knowledge, technology, training) of 110 natural resources microenterprises from 11 districts of Uttarakhand	Baseline on number of microenterprises in Ministry of Small Scale Industries report	The data to be utilized for the development of profitable microenterprises based on solid market linkages, suitable level of technology, training, raw material availablity
8.	**HJRF5**	New data on musk deer population trend over the period 2017 to 2019 in Askot Wildlife sanctuary.	**NIL**	The data to be utilized for musk deer conservation, reduction of local pressure for the wildlife management in Askot Wildlife sanctuary
9.	**HJRF6**	Prepared a database of 937 species as aliens belonging to 556 genera and 121 families in Uttarakhand	Limited baseline data on use of alien plant as wood preservative	The data to be utilized for using alien plants as wood preservative
10.	**HJRF 7**	Database of 110 species identified to be useful for appraisal of plant diversity	Baseline data available for Pithoragarh	The data to be utilized for plantation of identified species for the restoration of degraded land of Pithoragarh
11.	**HJRF 8**	New data on 151 plant/fungi species were recorded of which 50 have commercial values as alternative livelihood options	Limited Baseline data was available on NTFPs and sustainable tourism	The data to be utilized for improving alternative livelihood options for the villages dependent on natural resources for Chakrata and Kalsi
12.	**HJRF 9**	New data of soil macronutrients (Total N, available P, available N, available P, exchangeable Ca & Mg) and soil micronutrients (Fe, Zn, Cu, Mn) of control and burnt forests sites of Tehri and Pauri district.	Baseline data of forest fire events available	The data to be utilized for Impact of forest fire was assessed for managing the risk of frequent forest fires in Uttarakhand.
13.	**HJRF 10**	New data of soil microbial properties (microbial biomass carbon (MBC), microbial biomass nitrogen(N_{mic}), soil basal respiration (SBR), acid phosphate (ACP), dehydrogenase (DHA) of control and burnt forests sites of Tehri and Pauri district.	Baseline data of forest fire events available	The data to be utilized for Impact of forest fire was assessed for managing the risk of frequent forest fires in Uttarakhand.

5. Linkages with Regional & National Priorities (SDGs, INDC, etc.)/ Collaborations

S. No.	Linkages /collaborations	Details	No. of Publications/ Events Held	Beneficiarie
	Linkages with Forest Department, Wild Life Institute of India, Biodiversity Board.	Addressed the SDG Goals 1 & 2 on (Food Security, Reduction of Hunger & Poverty Alleviation & Goal 15 Land on Earth on Biodiversity conservation • Species richness, Conservation of rare species, promoting prospective species in Askot Wildlife Sanctuary.	Meeting done with Forest Department and Wildlife Managers for effective biodiversity utilization and conservation Meetings of farmers was organised with Flex Food Industry to promote cultivation of culinary herbs *Oreganum Vulgare* in 8 villages of gaza block of district Tehri-Garhwal. The habitat suitability of Himalayan musk deer and associated species was identified in Askot wild life sanctuary. Associated Threats were also identified. New data on 151 plant/fugi species were recorded of which 50 have commercial values as alternative livelihood options	600 farmers and villagers out of which 370 were females.

.			4 meeting were held in Doon University, and Tehri and Almora for maximizing the production of crops by sustain able use of natural resources and suggesting alternate crops to mitigate climate change. New database for rooftop solar energy potential for the state of Uttarakhand	
	Linkages with UREDA, district electricity transmission departments,	Sustainable development goal on climate change and Energy was addressed by identifying the renewable energy potential in the state.	The rooftop solar energy potential with median efficiency (15%) PV panels were estimated to be 7.7 GWh to 12.7 GWh in different seasons.	1 awareness was spread in 6 villages of Rudprayag and Pauri on Solar energy benefits
2	State Climate Cell Climate Change/INDC targets	Addressed the State Action Plan on Climate Change in promoting preparedness and adaptation	Participatory conservation frame work developed as micro-plans for mitigation of impact of climate change in Van-Panchayat springs. New datasets on impact of forest fire on soil nutrient and microbial properties in forested sites of Tehri and Pauri districts.	278 farmers and villagers were trained in 4 districts.
3.	International Commitments		Nil	

4.	National Policies	Addressed the mandate of National mission on sustaining the Himalayan Ecosystem	New data of waste generation inside the Corbet and Rajaji National Park New data of solid waste generation, collection and disposal from household of 7 Urban local bodies of Haridwar district Prepared a database of 937 species as aliens belonging to 556 genera and 121 families in Uttarakhand New data on people's perception developmental activities in sensitive area. New data generated on landuse conversion over the decades in sensitive areas of Uttarkashi	
5.	Others collaborations	Nil		

6. Financial Summary (Cumulative)*

*Please attach the **consolidated and audited Utilization Certificate (UC) and Consolidated and ***Year-wise*** Statement of Expenditure (SE)** separately, *ref.* **Annexure I.**

7. Quantification of Overall Research Progress

S. No.	Parameters	Total (Numeric)	Attachments* with remarks
1.	IHR State(s) Covered:	*01*	*Data has been provided in FTR of all researchers.*
2.	Fellowship Site/ LTEM Plots developed:	*13 districts*	
3.	New Methods/ Model Developed:		
4.	New Database generated:	*13*	
5.	Types of Database generated:	*04-*	
6.	No. of Species Collected:	*Nil*	
7.	New Species identified:	*Nil*	
8.	Scientific Manpower Developed (PhDs awarded/ JRFs/ SRFs/ RAs):	*13*	
9.	No. of SC Himalayan Researchers benefited:	*Nil*	
10.	No. of ST Himalayan Researchers benefited:	*Nil*	
11.	No. of Women Himalayan Researchers empowered:	*08*	
12.	No. of Knowledge Products developed:	*Nil*	
13.	No. of Workshops participated:	*15*	
14.	No. of Trainings participated:	*05*	
15.	Technical/ Training Manuals prepared:	*01*	
	Others (if any):		

***** Please attach the soft copies of supporting documents word files and data files in excel.

8. Knowledge Products and Publications*

S. No.	Publication/ Knowledge Products	*Number*		*Total Impact Factor*	*Remarks/* Enclosures**
		National	International		
1.	Journal Research Articles/ Special Issue (Peer-reviewed/ Google Scholar)	01	04	2.5	4 under review
2.	Book Chapter(s)/ Books:	05 NMHS Book Chapter			
3.	Technical Reports/ Popular Articles	02 news paper			
4.	Training Manual (Skill Development/ Capacity Building)		HRA-II Appendix		
5.	Papers presented in Conferences/ Seminars	05	HRA-II (2)		
6.	Policy Drafts (if any)				

S. No.	Publication/ Knowledge Products	*Number*		*Total Impact Factor*	*Remarks/* Enclosures**
		National	International		
7.	Others (specify)				

0*Please append the list of KPs/ publications (with impact factor and URL link details) with due Acknowledgement to NMHS.

**Please provide supporting copies of the published documents.

9. Recommendation on Utility of Research Findings, Replicability and Exit Strategy

9.1 Utility of the Fellowship Findings

S. No.	*Research Questions Addressed*	*Succinct Answers (within 150–200 words)*
1.	What is the existing Energy status and what could be the application of new policies and best practices?	New database for rooftop solar energy potential for the state of Uttarakhand is developed The data could be utilised for effective energy generation and consumption Strategy to enhance energy efficiency and possible intervention of solar energy PV power in the hill districts of Uttarakhand.
2.	What is the status of natural resources and how they could be managed in the context of climate change?	. **B**ased on the data collected micro-plan has been developed for two clusters in two districts. Implementation in progress.. Farmers have been linked with various schemes of the government for natural resource based income generation.Based on analysis of winter rainfall pattern plan for conservation of natural springs has been developed for 25 villages in 4 districts. This model could be replicated in other region for people centric conservation.
3	What is the outmigration pattern in Uttarakhand Himalaya what could be the solutions?	New data on migration generated for six hill districts of Uttarakhand (Uttarkashi, Tehri, Pauri, Almora, Bageshwar, Pithoragarh) with coverage of 60 villages evenly distributed over the six districts .The data could be utilised for policy making for strategic and sustainable development of the hill districts of Uttarakhand.
4	What are the Issues for sustainable tourism including ecotourism and Changing patterns of tourism?	T he data and research findings can be utilized for developing sustainable tourism practices in Protected areas.
5	Waste management, including management of hazardous substances and Innovative approaches developed (No) and implemented/ Quantity of waste treated/ managed	The data to be utilized for better waste management practices for sustainable cities and towns and can also be utilized by smart city projects being implemented in the state.
6	What are the issues concerning development in sensitive areas?	Strategies suggested for incorporation of local people perception in developmental activities in sensitive zones of Uttarkashi and sustainable methods in developmental activities.

7	Testing options for human capacity building including promotion of micro-enterprises and green technologies	New data on different aspects (profits, raw material availability, market knowledge, technology, training) of 110 natural resources microenterprises from 11 districts of Uttarakhand. The data to be utilized for the development of profitable microenterprises based on solid market linkages, suitable level of technology, training, raw material availability.
8	Conservation of genetic resources of rare, endemic, threatened and globally significant flora and fauna including agro-biodiversity.	New data on musk deer population trend over the period 2017 to 2019 in Askot Wildlife sanctuary. The data to be utilized for musk deer conservation, reduction of local pressure for the wildlife management in Askot Wildlife sanctuary.
9	Development of database of alien plant species occurring in Uttarakhand Himalayas. Isolation of alien plants extracts and their screening for bio preservation of wood.	Prepared a database of 937 species as aliens belonging to 556 genera and 121 families in Uttarakhand. Limited baseline data on use of alien plant as wood preservative. The data to be utilized for using alien plants as wood preservative
10	Appraisal to plant diversity and restoration of degraded lands in Pithoragarh district	Database of 110 species identified to be useful for appraisal of plant diversity. The data to be utilized for plantation of identified species for the restoration of degraded land of Pithoragarh
11	Supplementary livelihood options for rural population and other populations Study the market linkages.	New data on 151 plant/fungi species were recorded of which 50 have commercial values as alternative livelihood options The data to be utilized for improving alternative livelihood options for the villages dependent on natural resources for Chakrata and Kalsi
12	Effect of Forest fires on nutrient dynamics and microbial biomass and diversity in soil.	New data of soil macronutrients (Total N, available P, available N, available P, exchangeable Ca & Mg) and soil micronutrients (Fe, Zn, Cu, Mn),l microbial properties (microbial biomass carbon (MBC), microbial biomass nitrogen(N_{mic}), soil basal respiration (SBR), acid phosphate (ACP), dehydrogenase (DHA) of control and burnt forests sites of Tehri and Pauri district. The data to be utilized for Impact of forest fire was assessed for managing the risk of frequent forest fires in Uttarakhand.

9.2 Recommendations on Replicability and Exit Strategy:

Particulars	Recommendations
Replicability of Fellowship, if any	The Study undertaken through Himalayan fellowship has generated important data base on renewable energy, natural resources, supplementary livelihood options and natural resource based micro enterprises. The participatory conservation framework strengthened with establishment of the farmer producer companies, for self-sustaining unit for utilization and conservation, linking the farmer producer companies with iFlex food Company, PHD chamber of commerce and industries Herbal Research Institute, Centre for Aromatic Plants, Agriculture and Horticulture department schemes can be replicated in other districts of the state and other states in Indian Himalayan Regions as well. The Fellowship also studied the migration pattern in the state and identified the causal factors and suggested potential solutions for halting the out migration in the state. The impact of forest fire on soil nutrient particularly soil carbon and microbial diversity and activity can play role in climate change mitigation by sequestering soil carbon wnich has been recognised as potential carbon sequestration strategy in Paris agreement on climate change in 2015.
Exit Strategy:	• The participatory conservation framework was strengthened with establishment of the farmer producer companies, as an exit strategy for self-sustaining unit for utilization and conservation. In addition, the farmer producer companies are linked with Flex food Company, PHD chamber of commerce and industries and with Herbal Research Institute, Centre for Aromatic Plants, Agriculture and Horticulture department schemes. • Sustainable harvesting protocols for diverse natural resources was developed to empower the local communities for enabling conservation-based development model • Through an intensive social assessment, identified potential opportunities for promoting livelihood security in the hill regions of the state that can reducing the current rate of migration and also encourage local residents for reverse migration.

	• Employing invasive alien plants for wood preservation could be a viable option for managing wood degradation as well as these alien species. The chemical composition of weeds as well as their abundantly available biomass can be utilized in a cost-effective manner which in turn will boost the overall environment as well as the economy. This could very well be an exit strategy to avoid loss of wood and therefore timber species. • New data on different aspects (profits, raw material availability, market knowledge, technology, training) of 110 natural resources microenterprises from 11 districts of Uttarakhand. The data to be utilized for the development of profitable microenterprises based on solid market linkages, suitable level of technology, training, raw material availability Industries in the state can perform better despite the odds posed by the topographical and environmental factors. Growth in industrial base of the state will be supported by facilitation of start-ups and MSMEs can increase skill development by developing in the skilling centers in partnership with industrial players and centers of excellence existing in the State.

(**NMHS FELLOWSHIP COORDINATOR**)

(Signed and Stamped) **(Prof. Kusum Arunachalam)**

(**HEAD OF THE INSTITUTION**)

(Signed and Stamped)

Place: Doon University, Dehradun
Date: 1../……/……..