

3.1.2 Selected Technology

With the above background, together with extensive stakeholder discussions, in the Part I of the TNA report, 7 technologies for climate change adaptation in Bhutan were shortlisted for the natural resources and infrastructure sector. Out of these, 3 technologies were selected through an extensive multi-criteria decision analysis (MCDA), that was used to prioritize technologies through a process that was country-driven, participatory and involved a number of stakeholders. A three day workshop for criteria weighting and technology prioritization was held at Paro, Bhutan.

Real-time weather stations and weather forecasting (multi-range), climate resilient roads and community-based early warning systems are the prioritized technologies for natural disasters and infrastructure sector. Further information on these technologies is contained in the TNA report.

Out of these three technologies, climate resilient farm road development was selected as the preferred technology for preparation of barrier analysis, enabling framework and technology action plan under the natural disasters and infrastructure sector. This is because it is aligned with the government's road policy and legislation that advocates environment-friendly road construction. However, implementation of the same in Bhutan so far has been weak because of a number of barriers such as inadequate knowledge, skills, demonstrational measures, and equipment. Creation of a detailed enabling framework and TAP for the technology will definitely help in overcoming many of these barriers and allow it to be scaled up in the nation. Furthermore, the other two top-priority technologies – i.e. real-time weather stations and early warning systems – under this sector were already being planned for implementation through projects supported by the Japan International Cooperation Agency (JICA) and UNDP/GEF/LDCF as a part of the NAPA2 follow-up.

3.2 Action Plan for Climate Resilient Farm Roads

3.2.1 About Climate Resilient Roads

Climate-resilient road development technology refers to a set of technological measures that take into account local climate conditions and vulnerabilities in planning, design and construction. The most effective method of making roads climate-resilient is to anticipate and fully consider climate change impacts during the planning stage and integrate resilience measures in the design using local climate information in combination with geophysical information.

The measures to make roads climate proof are generally classified in the following categories⁴:

Engineering and structural measures: Under these measures the technologies typically include the following:

- Slope stabilization structures such as dry stone wall, gabion wall and jute bag wall. The choice of the structure is dependent on the gradient of the road and road construction materials and *in situ* soil condition
- Paving of roads with durable materials;
- Proper alignment of new roads to avoid vegetative loss, steep gradient and fragile terrain;
- Improved drainage systems to avoid erosion of road materials and the road section/stretch itself. The drainage system includes roadside drainage and cross drainage structures such as cascades, small check dams, culverts and causeway;
- Improved planning of roads with proper cross section and standard dimensions;

⁴<http://www2.adb.org/Documents/RRPs/CAM/42334/42334-01-cam-oth-03.pdf>

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- Improved survey and design techniques with adequate considerations for Environment Friendly Construction Technologies;
- Adequate geological and geotechnical considerations.

Bio-engineering measures: This involves the use of vegetation, either alone or in conjunction with civil engineering structures (Howell, et al)⁵ such as small check dams, wall and drains to manage water and debris thereby reducing instability and erosion on slopes (Paudyal 2007)⁶. Bio-engineering measures are also taken during earthwork and excavation activities of road construction. These include among others spreading of top soil, broadcasting seeds, grass slips and seedling of local plants. Typical bio-engineering methods include the following:

Grass Planting- Grass seed is spread or alternatively grass is hand-planted in lines across the slope. This results in slope stabilization by armouring and reinforcing of slopes.

Shrub and Tree Planting- Shrubs or trees are planted at regular intervals on the slope which later create a dense network of roots in the soil supporting the slope.

Brush Layering, Palisades and Fascines- In this system, woody cuttings are laid in lines across the slope usually following the contour which form a strong barrier, preventing the development of rill, and trap material moving down the slope. The system catches debris, armours and reinforces the slope.

Composite Systems- A range of composite systems are also used including live check dams, vegetated stone pitching and planted geo-textiles later supplemented by the vegetation. The composite systems reinforce the soil thereby stabilising the slopes.

Integration of local climate and geologic information in planning and design: This is a critical aspect of climate-resilient road development and will influence the choice and design of civil work structures and bioengineering measures to be put in place.

As a terminology, climate-resilient road development is being introduced recently but conceptually it is not completely new to the country. It has to certain extent existed in the form of “environment-friendly road construction”, or EFRC in short, a concept and term that has been in circulation in the country’s road construction parlance since 1999. EFRC concept was adopted as an integral component of the Rural Access Project (RAP), started in 1999/2000 with funds from World Bank and technical support of the Netherlands Development Organization (SNV). The RAP has covered more than 250 km of rural roads using EFRC approach and practices, and led to the commencement of a second RAP in 2008. Many other road construction projects have also applied EFRC but largely in partial or piecemeal fashion.

During the course of stakeholder consultations for the Technology Needs Assessment and Technology Action Plan, it was inferred that EFRC was somewhat of a misnomer as road construction can never be environment-friendly but can only go to the extent of employing practices and measures to minimize adverse environmental impacts. ‘Climate-resilient road development’ was identified as a more suitable terminology for the TNA and TAP.

3.2.2 Target for technology transfer and diffusion

The Road Master Plan (2007-2027), produced by the Ministry of Works and Human Settlement, reflects a national target of 2,654.4 km of dzongkhag roads (formerly feeder roads), 537 km of inter-dzongkhag highways, and 794 km of national highway. The master plan does not project any target for farm roads.

The goal will be to make the whole of country’s farm road network climate-resilient. Discussions with representatives from the Department of Agriculture, Ministry of Agriculture and Forests, suggest that the farm road target for 11th Five-Year Plan target (June 2013-July 2018) could be used for the TAP. This target is, however, under discussion at this point in time and expected to be finalized in the next 2-3 months. For pilot projects to implement and demonstrate the full-range of climate-resilient farm road development technology,

⁵<http://himachal.nic.in/hpridc/RandD.pdf>

⁶<http://www.scidev.net/en/features/landslide-victory-bioengineering-in-nepal.html>

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15-20 km of farm roads, covering construction of new farm roads as well as improvement of existing farm roads, in each Dzongkhag is proposed for the next five-years, coinciding with the 11th Five-Year Plan period. This translates to a national target of 300-400 km of farm roads over a period of five years.

3.2.3 Barriers to the technology's diffusion

Given the current situation in Bhutan with regard to development climate resilient farm roads, in the course of TNA process several barriers have been identified. These barriers are either economic barriers or non financial barriers. The non financial barriers are mostly those associated with the limitations of the current institutional structure, the current policy and regulatory framework or those associated with social, cultural and behavioral barriers with regard to development of climate resilient roads. Based on these identified barriers, suitable enabling measures which will assist the country in overcoming these barriers have also been identified. A brief summary of these barriers and enabling measures is presented here below. These enabling measures have further been defined and elaborated on with concrete action for each in the next section of this report.

3.2.3.1 Economic and financial barriers

The main barrier for climate-resilient farm roads is the huge upfront costs for detailed planning and design, entailing not only well-trained personnel but also advanced survey and engineering equipment, and use of robust construction materials. The Project Appraisal Document of the Second Rural Access Project has cited an additional capital cost of 20-30 percent for roads using EFRC approach and practices. Integrating climate-resilience measures will further raise the cost of building roads. Whilst environmental codes of practice exist for road construction, they are generally not applied unless environmental management costs are built in as in the case of specially funded projects, such as those by the World Bank and Asian Development Bank, where environmental and social safeguards are conditional for securing funds. According to the Guidelines for Farm Road Development, Nu 3 million (around USD 57,000) is estimated for construction of each km of farm road integrating basic environmental measures (World Bank 2006). In practice, that kind of budget is very rarely available for farm road construction. Furthermore, in sites where climate and geophysical conditions are more difficult, even Nu 3 million(around USD 57,000) per km is reportedly far from adequate⁷.

3.2.3.2 Non financial barriers

- a) **Institutional barrier:** A key institutional issue is the poor coordination and line of communication between the Department of Agriculture/ Ministry of Agriculture and Forests and the Dzongkhag Administrations, where the Dzongkhag Engineers are based work-wise. The Dzongkhag Administrations have no clear institutionalized working linkages with the Department of Agriculture. As a result, coordination between the two agencies has been poor and this has among other things impacted proper implementation of farm road development guidelines and technical standards.

Most Dzongkhag engineering sections are short-staffed and ill-equipped to carry out proper planning and design of farm roads, and monitor construction work. This constraint is further exacerbated by the lack of knowledge and skills among the private contractors to carry out environment-friendly/ climate-resilient road construction.

Another major institutional issue is the role of Dzongkhag Administrations in environmental assessment and environmental clearance. Currently, farm roads are planned by Dzongkhag Engineers and Dzongkhag Agriculture Officers and Geog Administrations, environmental assessment and collation of information for environmental clearance of farm roads up to 5 km are done by Dzongkhag Environmental Officers, followed by review of application for environmental clearance by the Dzongkhag Environment Committees. So, the entire procedure of planning, environmental assessment, review, and environmental clearance is housed within a single agency, i.e. the Dzongkhag Administration. This presents a great risk of 'conflict of interests' and undermining the purpose and value of environmental assessment and environmental clearance, which is a crucial procedural

⁷Stakeholder consultation session for TAP for climate-resilient farm road development, 10th October 2012, NECS conference hall.

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framework for ensuring that recommended technical and environmental standards are implemented in the development of farm roads.

- b) **Policy, legal and regulatory barrier:** Currently, there is no national road development policy. The road master plan (2007-2027) which exists focuses on operational plans and targets for dzongkhag (feeder) roads, inter-dzongkhag highways, and national highway and does not feature other road types. The Road Act 2004 advocates that roads need to be constructed in environmentally sound manner but it lacks comprehensive provisions on how this will need to be implemented. There is no clear-cut policy or legal provision for compensation/ land substitution for acquisition of private land to build farm roads.
- c) **Technical barrier:** Environmental codes of practice for roads and highways were developed in 2002, and are inadequate in terms of outlining specific practices for planning and designing climate-resilience in roads. The Guidelines for Farm Road Development 2009 is also deficient when it comes to technical standards for climate proofing of farm roads.

Field interventions that demonstrate the full range of climate-resilient farm road development technology are also limited. Thus, there is insufficient basis on the ground for developing cases for replication and scaling-up. A major technical barrier is also the unavailability of local meteorological data for use in planning and designing farm roads. This is largely due to the limited network of meteorological stations.

- d) **Social, cultural and behavioral barrier:** Developing climate-resilient farm roads will require meticulous planning and implementation of construction standards and additional funds than what is normally available. However, public demand for farm roads is enormous. Consequently, ambitious targets for farm roads have been set in the ongoing 10th Five-Year Plan (July 2008-June 2013). These are, in most dzongkhags, not commensurate with the implementation capacity. Nonetheless, due to relentless public demand and consequent political pressure, the attempt is to build more and more farm roads with limited human and financial resources.

Furthermore, there is the misconception that climate-resilient or environment-friendly roads are very expensive and beyond the financial means of a country like Bhutan with scarce budget. This is mostly because lack of life cycle cost analysis or understanding of the analysis while planning for climate resilient farm roads. There is, also, no country-specific evidence providing quantified data of comparative costs and benefits of climate-resilient roads, which can be used to sensitize the stakeholders, and inform investment decisions.

3.2.4 Enabling measures

Based on intensive discussions with experts, extensive secondary research as well as international experience, measures for building an enabling environment for development and diffusion of the technology in a way to overcome the above barriers have been identified. These measures include:

Economic and financial measures to overcome barriers to development and diffusion of drought and pest resistant varieties of crops

It is recommended the budget for farm road development be rationalized in accordance with the technical standards required for climate-resilience. In this respect, the following activities are proposed:

- § Review existing costs and budget for farm road development in relation to the recommended technical standards for farm roads, include those required for climate-resilience, and come up with specific recommendations;
- § Convene inter-agency meetings/ workshops to discuss the review findings and implementation of recommendations;
- § Produce and disseminate farm road budgeting guidelines for implementation together with the technical standards.

Non financial measures

The following measures are recommended to address the non-financial barriers associated with environment-friendly/ climate-resilient roads:

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Institutional Measures: Inter-agency coordination and working linkages need to be developed and strengthened, in particular between the Engineering Division, Department of Agriculture/ Ministry of Agriculture and Forests. To achieve this, the following activities are proposed:

- § Review existing institutional arrangements for farm road development, analyze the gaps and come up with recommendations for strengthening coordination and institutional linkages;
- § Convene inter-agency meetings/ workshops to discuss the review findings and implementation of recommendations;
- § Incorporate the recommendations in the Farm Road Development Guidelines.

Institutional capacity of the Engineering Division of DoA/MoAF and Dzongkhag Engineering Sectors will also need to be strengthened. This would involve: staff training for DoA/MoAF and Dzongkhag Engineers; equipment support to the Dzongkhag Engineering Sectors; review of existing staffing structure for engineering works at dzongkhag and development of dzongkhag staffing plan for engineering works based on the scale and nature of work; and deployment of engineering staff according to the dzongkhag staffing plan for engineering works

Policy Measures: Climate-resilience mainstreaming in road development policies and guidelines requires to be enhanced. This will require a review to examine to what existing policies and guidelines relevant to road development address climate-resilience aspect and come up with specific recommendations to comprehensively integrate this aspect in the policies and guidelines.

There is also the need for clear policy/ legal provisions with regards to compensation/ land substitution for private land acquisition for farm roads. It is proposed that a review be carried out to examine the policy/ legal framework for land acquisition and come up with recommendations to address the issue of compensation/ land substitution for private land acquisition for farm roads

Information and Awareness: Information and country evidences to support the case for climate-resilient farm road development need to be developed. To do so, it is proposed that case studies be carried out to examine and highlight comprehensive (economic, social and environmental) costs and benefits of climate-resilient farm roads vis a vis roads that do not integrate climate-resilient measures and environmental standards.

Using the case studies as country evidences, conduct sensitization, advocacy and awareness-building activities for the following (but not limited to) target audiences: (a) policy-makers; (b) parliamentarians; (c) dzongkhag administrations; (d) gewog administrations. In addition, the case studies can be used to produce a video to highlight the various adverse impacts of poorly-built farm roads and the importance and benefits of climate-resilient farm roads, and broadcast it through TV.

Technical Measures: To demonstrate the full range of climate-resilient farm road development technology, pilot projects are proposed. This will entail selection of pilot sites using multiple criteria, including poverty reduction, population size, and climate impacts. It is proposed that the full-range of climate-resilient farm road development technology be implemented in pilot sites at the rate of 15-20 km per Dzongkhag. Targets may include both new farm roads as well as existing farm roads that require to be improved for climate-resilience.

Concurrently, activities will need to be undertaken to strengthen the technical know-how and skills among various people who will have a role in the planning, design and construction of climate-resilient farm roads. This will involve dissemination of technical know-how and skills through training and provision of knowledge resources (toolkit, handbook, reference materials, etc). Target audience for dissemination of technical know-how and skills include private contractors, private engineers, site supervisors and machine operators (Government staff not included here as they can be covered through staff training mentioned as part of institutional strengthening measures).

3.2.5 Proposed Action Plan for Farm Roads Development

In order to develop a most relevant action plan for diffusion of climate resilient farm roads focused sector specific roundtable discussions were held in Thimphu, Bhutan at NEC. The roundtable participants consisted of sectoral experts and representatives from Department of Agriculture under MOAF, Royal Government of

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Bhutan and Department of Roads, Ministry of Works and Human Settlement. Through a technology specific presentation, the roundtable had intensive discussions, which focused on following aspects:

- *Overview of infrastructure sector-* discussions were held on relevant institutions, stakeholder networks, policies, acts and regulations governing the sector and likely to facilitate diffusions of farm roads
- *General sector barriers and measures-* this brought forward discussions on general profile of barriers faced in the infrastructure sector and the kind of measures that are needed to overcome them.
- *Defining the technology domain:* special focus was given to discussion in terms of defining the technology in a most relevant way given the national circumstances of Bhutan
- *Targets for technology transfer and diffusion-* specific targets were identified for farm road diffusion. These were based government plans and documents, particularly the 11th FYP and any ongoing or planned government programme for diffusion of these varieties.
- *Barriers to diffusion of farm roads-* barriers as identified in Part II of the TNA report, were again revisited along with specific enabling measures to overcome them.
- *Proposed Action Plan Framework for Technology diffusion-* a draft action plan framework was presented and discussed in detail to aggregate and rationalize the measures identified to develop national capacities for acceleration of technology diffusion. The discussion also prioritized and characterized measures for technology diffusion for a national action plan along with estimates of possible technology investment costs.

Based on discussions held at the roundtable, a revised national strategy/action plan was prepared and sent to roundtable participants, especially to the Ministries, for review and comments. Based on which a final prioritized action plan along with national strategy was prepared.

The section brings together the Action Plan which is reflective of the national priorities as those highlighted in the Government of Bhutan Plans, such as the 11th FYP as well as those felt most urgent by TNA Taskforce members and Bhutanese experts.

The Action Plan and thereby the national strategy formulation for the diffusion of farm roads is reflective of national priorities. The budgets of each of these action points are those provided by the Ministries.

a) Aggregation and rationalization of measures identified for technology acceleration

The list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table 13 below.

Table 13: Measures for strategy formulation- Farm roads

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Economic and Financial Measure			
Rationalize the budget for farm road development in accordance with the technical standards for climate-resilience	X	X	X
Non Financial Measures			
Institutional			
Strengthen inter-agency coordination and working linkages for farm road development	XX	XX	XX

Institutional strengthening of the Engineering Division of DoA/MoAF and Dzongkhag Engineering Sectors		X	XX
Streamline environmental assessment and environmental clearance procedures at the dzongkhag level so that the risk of 'conflict of interests' is eliminated.		X	X
Policy, Legal and regulatory			
Climate-resilience mainstreaming in road development policies and guidelines	X	X	X
Develop clear policy/ legal provisions with regards to compensation/ land substitution for private land acquisition for farm roads		x	X
Information and Awareness			
Develop information and country evidences to support the case for climate-resilient farm road development	X	X	X
Conduct sensitization, advocacy and awareness-building activities to support climate-resilient farm road development		X	X
Technical			
Pilot projects to demonstrate the full range of climate-resilient farm road development technology, covering construction of new farm roads as well as improvement of existing farm roads that lack climate-resilience.		X	X
Strengthen technical know-how and skills among various people who will have a role in the planning, design and construction of climate-resilient farm roads		X	X

* Note: This table illustrates for a strategy of acceleration measures according to letters of each square, using the timescale for completion of an action, where:

- Letter "X" refers to measures which need to be started in the short term and carried out within the next five years;

- Letter "XX" refers to measures which can be completed in up to 10 years;

- Letter "XXX" refers to measures longer-term measures which can be planned for completion within 15 years from the current date and also will be used for other technologies below.

b) Prioritization and characterization of technology acceleration measures for a national plan

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Based on the barriers and the enabling measures required for development and diffusion of farm roads in Bhutan, the key action points that are essential and immediate are described in Table 14. These action points are organized in priority, in order to convey the importance of action required.

The proposed measures are aligned with the 11th Five Year Plan of Royal Government of Bhutan to ensure that these measures receive required policy and funding support of the Government.

The Action Plan Table constitutes of 10 key measures:

- Rationalization of the budget for farm road development in accordance with the technical standards for climate-resilience;
- Strengthening inter-agency coordination and working linkages for farm road development;
- Institutional strengthening of the Engineering Division of DoA/MoAF and Dzongkhag Engineering Sectors;
- Streamlining environmental assessment and environmental clearance procedures at the dzongkhag level so that the risk of 'conflict of interests' is eliminated;
- Climate-resilience mainstreaming in road development policies and guidelines;
- Development of clear policy/ legal provisions with regards to compensation/ land substitution for private land acquisition for farm roads;
- Development of information and country evidences (cost-benefit analyses) to support the case for climate-resilient farm road development;
- Sensitization, advocacy and awareness-building activities to support climate-resilient farm road development;
- Pilot projects to demonstrate the full range of climate-resilient farm road development technology, covering construction of new farm roads as well as improvement of existing farm roads that lack climate-resilience;
- Development of technical know-how and skills among various people who will have a role in the planning, design and construction of climate-resilient farm roads.

The rationale, implementing agency(ies), approach, timeframe, indicators of success, and indicative budget for the aforesaid measures are outlined in the following table:

Table 14: Technology Action Plan for farm roads development based on measures identified for technology acceleration (in priority)

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S.No	Measure	Why is it important?	Who should do it?	How should they do it?	Time-scale	Monitoring, reporting and verification for measure	Indicators of Success	Budget (000' USD)
1.	Rationalize the budget for farm road development in accordance with the technical standards for climate-resilience	Inadequate budget compromises the implementation of recommended technical standards, which in turn leads to poor quality of roads and consequently higher costs of maintenance and restoration	DoA/MoAF, MoF, GNHC	<ul style="list-style-type: none"> § Review existing costs and budget for farm road development in relation to the recommended technical standards for farm roads, including those required for climate-resilience, and come up with specific recommendations; § Convene inter-agency meetings/ workshops to discuss the review findings and implementation of recommendations; § Produce and disseminate farm road budgeting guidelines for implementation together with the technical standards. 	2013-2014	MoAF, MoF, GNHC	Number of farm roads constructed with adequate budget for climate-resilience	35
2.	Strengthen inter-agency coordination and working linkages for farm road development	Weak institutional linkages and coordination between DoA/MoAF and Dzongkhag Administrations have led to non-conformity with guidelines and standards for farm road development	DoA/MoAF, MoWHS, Dzongkhag Administrations/ MoHCA	<ul style="list-style-type: none"> § Review existing institutional arrangements for farm road development, analyze the gaps and come up with recommendations for strengthening coordination and institutional linkages; § Convene inter-agency meetings/ workshops to discuss the review findings and implementation of recommendations; § Incorporate the recommendations in the Farm Road Development Guidelines 	2013-2015	MoAF and MoWHS	Level of coordination between DoA/MoAF and Dzongkhag Administrations	13
3.	Institutional strengthening of the Engineering Division of DoA/MoAF and Dzongkhag Engineering Sectors	The institutional capacity of DoA/MoAF and Dzongkhag Engineering Sectors is limited for climate-resilient farm road development	MoAF, MoWHS and RCSC,	<ul style="list-style-type: none"> § Staff training for DoA/MoWHS and Dzongkhag Engineers § Equipment support to the Dzongkhag Engineering Sectors § Review of existing staffing structure for engineering works at dzongkhag and development of dzongkhag staffing plan for engineering works based on the scale and nature of work § Deployment of engineering staff according to the dzongkhag staffing plan for engineering works 	2013-2018	MoAF and MoWHS	§ Proportion of staff in DoA/MoAF and Dzongkhag Engineering Sectors with improved knowledge and skills	420

							for climate-resilient farm road development	
							§ Staff strength of Dzongkhag Engineering Sectors proportionate to the scale and nature of works	
4.	Streamline environmental assessment and environmental clearance procedures at the dzongkhag level so that the risk of 'conflict of interests' is eliminated.	Existing in-house procedures of planning, environmental assessment, review, and environmental clearance (for farm roads up to 5 km) within the Dzongkhag Administration present the risk of 'conflict of interests' and undermining the value and purpose of environmental assessment and clearance	NECS and DoA/MoAF	<p>§ Review existing procedures for environmental assessment and environmental clearance, and come up with recommendations to streamline the procedure to remove the risk of 'conflict of interests';</p> <p>§ Revise the procedures as per the recommendations, and incorporate these revisions in all relevant guidelines and planning frameworks.</p>	2013-14	NECS	Effectiveness of environmental assessment and clearance procedures in improving the quality of farm roads	15
5.	Climate-resilience mainstreaming in road	Current policies and guidelines for roads cover environmental management in generic sense but do not sufficiently address	MoAF, GNHC, NEC	Examine to what existing policies and guidelines relevant to road development address climate-resilience aspect and come up with specific recommendations to comprehensively integrate this	2013-2015	GNHC and NEC	Coverage of climate-resilience aspect in	15,000

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	development policies and guidelines	climate resilience aspect in specific terms.		aspect in the policies and guidelines			policies and guidelines relevant to roads	
6.	Develop clear policy/ legal provisions with regards to compensation / land substitution for private land acquisition for farm roads	Ambiguity in policy/ legal provisions with regards to compensation/ land substitution for private land acquisition for farm roads is an impediment to proper alignment and planning of farm roads	NLC, MoAF, GNHC	Examine the policy/ legal framework for land acquisition and come up with recommendations to address the issue of compensation/ land substitution for private land acquisition for farm roads	2013-2015	NLC and GNHC	Existence of clear policy/ legal provisions on compensation/ land substitution for private land acquisition for farm roads	15
7.	Develop information and country evidences to support the case for climate-resilient farm road development	The need to strengthen information, which is currently weak, to support the case for climate-resilient farm road development	DoA/MoAF	Conduct case studies to examine and highlight comprehensive (economic, social and environmental) costs and benefits of climate-resilient farm roads vis a vis roads that do not integrate climate-resilient measures and environmental standards.	2013-2015	MoAF	Availability of information and country evidences to comprehensively support the case for climate-resilient farm road development	60
8.	Conduct	The need to create larger and	DoA/MoAF	§ Using the case studies as country evidences, conduct sensitization, advocacy and awareness-	2015-	MoAF	Level of	100

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	sensitization, advocacy and awareness-building activities to support climate-resilient farm road development	deeper understanding of the comparative advantages of climate-resilient farm roads, and influence the public and political opinion for moderation of road construction targets commensurate with available human resource and financial capacities		building activities for the following (but not limited to) target audiences: (a) policy-makers; (b) parliamentarians; (c) dzongkhag administrations; (d) gewog administrations; § Using the case studies, produce a video to highlight the various adverse impacts of poorly-built farm roads and the importance and benefits of climate-resilient farm roads, and broadcast it through TV.	2018			awareness and support for climate-resilient farm roads at the level of policy-makers, parliamentarians, and local governments.	
9	Pilot projects to demonstrate the full range of climate-resilient farm road development technology, covering construction of new farm roads as well as improvement of existing farm roads that lack climate-resilience.	The need to demonstrate the technology and provide the ground basis for replication and scaling-up, and to influence future policy work	DoA/MoAF and Dzongkhag Administrations	§ Select pilot sites using multiple criteria, including poverty reduction, population size, and climate impacts. § Implement the full-range of climate-resilient farm road development technology in the pilot sites at the rate of 15-20 km per dzongkhag. Targets may include both new farm roads as well as existing farm roads that require to be improved for climate-resilience.	2013-2018	MoAF and GNHC		Number of climate-resilient farm roads established in the field	18,000

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10.	Strengthen technical know-how and skills among various people who will have a role in the planning, design and construction of climate-resilient farm roads	The need to strengthen technical knowledge and skills for climate-resilient farm road development	DoA/MoAF and Dzongkhag Administrations	Disseminate technical know-how and skills through training and provision of knowledge resources (toolkit, handbook, reference materials, etc). Target audience for dissemination of technical know-how and skills include private contractors, private engineers, site supervisors and machine operators (Gov't staff not included here as they can be covered through staff training mentioned as part of institutional strengthening measures)	2013-2018	MoAF	Proportion of private contractors, private engineers, site supervisors, and machine operators with technical knowhow and skills for climate-resilient farm roads	300
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18,973

Acronyms used in the table: DoA- Department of Agriculture; GNHC- Gross National Happiness Commission; MoAF- Ministry of Agriculture and Forests; MoF- Ministry of Finance; MoHCA- Ministry of Home and Cultural Affairs; MoWHS- Ministry of Works and Human Settlement; NEC- National Environment Commission; NLC- National Land Commission; RCSC- Royal Civil Service Commission.

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c) Finalizing national strategy

Based on priority technology action plans in the sub-sectors, a national strategy and action plan for the climate resilient farm road targets are presented in Table 15.

Table 15: National Strategy for Farm roads (technology transfer and development for adaptation)

Timeline	0-5 years	5-10 years	10-15 years
<i>Large-scale, short-term technology</i>			
Rationalize the budget for farm road development in accordance with the technical standards for climate-resilience	X		
Strengthen inter-agency coordination and working linkages for farm road development	X		
Institutional strengthening of the Engineering Division of DoA/MoAF and Dzongkhag Engineering Sectors	X	X	X
Streamline environmental assessment and environmental clearance procedures at the dzongkhag level so that the risk of 'conflict of interests' is eliminated.	X	X	
Climate-resilience mainstreaming in road development policies and guidelines	X		
Develop clear policy/ legal provisions with regards to compensation/ land substitution for private land acquisition for farm roads	X		
Develop information and country evidences to support the case for climate-resilient farm road development	X		
Conduct sensitization, advocacy and awareness-building activities to support climate-resilient farm road development	X	X	
Pilot projects to demonstrate the full range of climate-resilient farm road development technology, covering construction of new farm roads as well as improvement of existing farm roads that lack climate-resilience.	X		
Strengthen technical know-how and skills among various people who will have a role in the planning, design and construction of climate-resilient farm roads	X		