Agriculture Land Development Guidelines (ALDG) - 2017

Department of Agriculture
Ministry of Agriculture and Forests
Royal Government of Bhutan

Citation of this document:
DoA, 2017. Agriculture Land Development Guidelines (ALDG). Department of Agriculture, Ministry of Agriculture and Forests, Royal Government of Bhutan, Thimphu.

Technical Working Group Members

1) Dr. Karma Dema Dorji, Program Director/Soil Specialist, NSSC
2) Wangda Drukpa, Chief, ARED, DoA
3) Tashi Wangdi, Chief, APD, DoA
4) Gonpo Tenzin, Chief, PPD, NLCS
5) Gyembo Tenzin, Executive Engineer, AED, DoA
6) Tsheten Dorji, Senior SS & LE Officer, NSSC
7) Phuntsho Gyeltshen, Dy. Chief SS & LE Officer, NSSC, and
8) Dr. Tshering Dorji, Principal Land Management Officer, NSSC

TABLE OF CONTENTS

Figures

Tables

FOREWORD

Bhutan is largely an agrarian country. About 58% of the total population depends on agriculture for their livelihoods. Of the country's total land area, just about 8% is cultivable. However, farming communities across Bhutan cultivate on just about 2.9% of land. Among other factors, the difficult terrain contributes to limited land being used for agriculture. Steep slope farming is challenging, characterized by soil erosion, poor soil fertility status, soil moisture stress, and labour intensive. Low crop productivity, subsistence farming, low cash income, rural poverty, rural-urban migration, fallow land, and youth unemployment are all in one way or the other related to land and its management. As a result, all these ultimately impact food self sufficiency/security objectives, land degradation, biodiversity loss, and provision of ecosystem services. In the light of above, the Ministry of Agriculture and Forests (MoAF) is pleased to bring out the much-needed Agriculture Land Development Guidelines (ALDG) 2017.

For sustainable management of our limited land resources, proper processes, procedures, and technologies are indispensible at this juncture particularly in the light of the rate at which the arable land is being lost in terms of productivity and to other land uses. In this regard, the development of ALDG is timely so that the Ministry's focus on land development is accorded the right priority in the 12th FYP preparation. This priority will contribute to the Government's 12th FYP three priority Sustainable Development Goals (SDGs) i.e. SDG 15: Life on Land; SDG 13: Climate Action, and SDG 1: No Poverty. The main objective of focusing on land development is to avoid, reduce, and reverse land degradation for increasing crop productivity, reducing climate change, and enhancing ecosystem services.

I would like to mention here that, His Majesty, the King has always accorded high priority to empowering our people by granting land *kidu* or land ownerships. His Majesty's aspiration in granting land *kidu* to landless is that after placing the much-treasured land in the hands of our people, they are expected to take good care of the land and use it for the betterment of their lives. However, our rural land has not been properly managed and used to its full potential to increase crop production and enhance agro-ecosystem services.

I am certain that this comprehensive agriculture land development guidelines developed in consultation with relevant stakeholders, would be very useful in addressing some of our socio-economic problems such as youth unemployment and rural-urban migration, both of which are of great concerns for the Country. The guidelines will help in developing land suitable for farm mechanization and enable large scale commercial agriculture without degrading the land. This along with improved soil fertility, land productivity, crop production and carbon sequestration on arable land will be enhanced significantly.

With this guidelines in place, it is anticipated that all the concerned stakeholders will diligently use it in whatever land development activities they undertake. It is also hoped that through the use of this guidelines, our SLM interventions will be more focused and effective in combating land degradation to increase crop production, mitigate climate change, and enhance agro-ecosystems in the country while making the most out of our limited land resource in improving the livelihoods of our rural people, sustainably.

Tashi Delek!

(Yeshey Dorji)

Minister
Ministry of Agriculture & Forests

ACRONYMS

AED	Agriculture Engineering Division
AES	Agriculture Extension Supervisor
AKRA	Agency Key Result Areas
ALD	Agriculture Land Development
ALDG	Agriculture Land Development Guidelines
ARDC	Agriculture Research and Development Centre
AWP&B	Annual Work Plan and Budget
BVG	Beneficiary Voluntary Group
CMU	Central Machinery Unit
DEM	Digital Elevation Model
DLRO	*Dzongkhag* Land Record Officer
DoA	Department of Agriculture
DoFPS	Department of Forests and Park Services
EA	Extension Agent
FYP	Five Year Plan
GDP	Gross Domestic Product
GNH	Gross National Happiness
GNHCS	Gross National Happiness Commission Secretariat
IPCC	Intergovernmental Panel on Climate Change
INDC	Intended Nationally Determined Contribution
LDN	Land Degradation Neutrality
M&E	Monitoring & Evaluation
MoAF	Ministry of Agriculture and Forests
MoLHR	Ministry of Labour and Human Resources
NECS	National Environment Commission Secretariat
NKRA	National Key Result Areas
NLCS	National Land Commission Secretariat
NSB	National Statistical Bureau
NSSC	National Soil Services Centre
SALT	Sloping Agriculture Land Technology
SLM	Sustainable Land Management
SRF	State Reserve Forest
TA/DA	Travel Allowance / Daily Allowance
THPP	Targeted Household Poverty Program
TWG	Technical Working Group
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification

1. Executive Summary

The agriculture sector accords high priority for food self-sufficiency and it is incorporated as the overarching objective for agriculture development since the 5th Five Year Plan (1981-1987). The agriculture sector's development policy shifted from food self-sufficiency to food security since 8th FYP (1997-2002). In addition to food security, the government also focused on nutrition security and as such, food and nutrition security was the main agriculture development policy of the Ministry of Agriculture and Forests (MoAF) during the 11th FYP (2013-18). However, all along these plan periods, limited land resources, steep and rugged terrain, land degradation, and low land productivity continued to remain as major challenges in achieving the sector's objectives and goals.

Even as the country intends to gradually shift from subsistence agricultural farming to commercial farming; small land holdings, inability to mechanize farms, drudgery, shortage of farm labours, land degradation, and low land productivity continue to remain as a major challenge. These factors attribute in making agriculture farming unattractive especially for youths who aspire to take up agricultural farming as a vibrant enterprise. Further, rural to urban migration reduces rural farming populace and increases pressure on the ever reducing rural habitants in producing food for the rapidly growing urbanites. To address the issue, concerned agencies have made various attempts in the recent past to make agriculture farming an attractive source of livelihoods.

Considering the urgency of the matter, the MoAF has identified and prioritized Agricultural Land Development (ALD) as the key intervention in addressing food shortage, poverty, land degradation, and climate change and incorporated it into the mainstream planning process in the 12th FYP. Different forms of land development activities such as terracing and consolidation of existing small terraces have been implemented by different agencies, both within and outside the MoAF, to combat land degradation, improve soil fertility, ease workability, and enhance crop productivity. However, in absence of a standard guideline for agriculture land development, it has been difficult for the government to follow and enforce a uniform standard for different ALD programs and activities across the country.

In view of the above facts, this ALDG was developed based on a set of guiding principles and is anticipated that all the ALD efforts will now be more focussed, standardized, and effective in addressing issues that confront sustainable agriculture production, such as, land degradation, fallowing of agriculture land, difficulty in farm mechanization, poor farm feminization, and low inherent soil fertility. Sustainable ALD is also expected to directly contribute to achieving land degradation neutrality (LDN), national food and nutritional security, and poverty alleviation in the country. At a regional or global scale, it is anticipated to help in reducing global warming, conserving natural environment, and enhancing ecosystem services.

This guidelines is broadly divided into seven different sections followed by two appendixes. The introduction section gives an overview of the ALDG followed by the guiding principles, purpose of ALDG, objectives of ALD, ALD implementation arrangements, and ALD framework. Under the ALD implementation arrangements, the institutional structure and roles and responsibilities of different agencies involved are clearly spelled out. Similarly, under the ALD framework, the six stages of ALD framework cycle are explained. Finally, the ALDG concludes with two appendixes on description and implementation procedure for different ALD technologies (Appendix A) and ALD Forms (Appendix B).

2. Introduction

2.1 Agriculture and Land Resources

Agriculture is the mainstay of the Bhutanese economy as it contributes about 14% of the country's gross domestic product (NSB, 2016) and provides direct employment to about 58% of the population (MoLHR, 2015). The land cover assessment of 2010 indicates that only about 2.9% of the total land area (of 38,394 km^2) is under cultivation (LCMP, 2010). In other words, the cultivated land accounts about 123,189.3 ac including 77,495.3 ac under irrigated paddy land (*chhuzhing*), 17,217.8 ac under rain-fed agriculture (*kamzhing*), 28,443.1 ac under orchards, and 33.2 ac falling under other land use types.

The per capita available land in the country is around 0.6 ac (GNH, 2009). More than 31% of the total agricultural land is situated on slopes as steep as 50% or more (LCMP, 2010) - considered unsuitable for cultivation by international standards. However, due to limited arable land, our farmers are forced to cultivate even on such steep slopes. As such, farm mechanization is almost impossible on such steep slopes resulting in drudgery of farming. As a result, agriculture remains largely subsistence in nature as the scope to opt for commercial farming through farm mechanization in country is limited.

Agriculture productivity is also significantly impacted by high proportion of fallow land in the country. According to the Department of Agriculture (DoA), about 23% of the rural households reported leaving agriculture land fallow resulting in about 26.3% of total arable land being left unused (DoA, 2015). One of the main reasons for this is due to acute shortage of farm labour caused mainly by rural-urban migration and 100% enrolment of children in the schools. According to the study done by the Ministry of Agriculture and Forests (MoAF) on 'Migration in Bhutan', it was reported that about 21.4% (152,414) of the estimated total population were found to be migrants, of which rural to urban migrants represented 18.2% (128,634) while rural to rural migrants constituted 3.2% (23,780) (MoAF, 2014).

In addition to the problem of fallow land and farm labour shortage, small land holdings, landlessness, and low land productivity deprive farmers from producing optimum crop yields and generate enough income, thus, leading to a high poverty rate and lower happiness index in the rural communities (GNH Survey Report, 2015). The poverty analysis report (NSB, 2012) points out that the national level poverty stands at 12%, which is considered high when compared in the region. However, poverty is largely a rural phenomenon with 16.7% in the rural areas and only 1.8% in the urban areas.

2.2 Land degradation and agriculture production

The other most important factor that impacts crop production is soil erosion. It is prevalent in the country as most of the agriculture lands are located on steep and fragile slopes devoid of any land management practices. Annually, about 3 to 21 t ha^{-1} of fertile topsoil is being lost due to soil erosion (NSSC 2010) and this significantly reduces the inherent soil fertility resulting in poor crop productivity. Further, due to soil erosion and tillage practices, about 0.84 tC ha^{-1} y^{-1} from topsoil is being released from the arable land which directly contributes to climate change. Soil erosion and other forms of land degradations also negatively impact the environment and disrupt the delivery of ecosystem services. Although it may not be feasible to completely mitigate land degradation, it is certainly possible to slowdown the land degradation processes and increase agriculture production and other agro-ecosystem services through sustainable land management (SLM).

2.3 Land, Climate Change and Food Security

SLM contributes to the National Key Result Areas (NKRA) 5: Healthy Ecosystem Services Maintained and NKRA 6: Carbon Neutral, Climate and Disaster Resilient Development Enhanced, and 8; Water, food and nutrition security enhanced. It contributes specifically to the Agency Key Result Areas (AKRA) of food and nutrition security for the 12th FYP through enhancement of crop productivity. While SLM contributes to the achievement of several sustainable development goals (SDGs), the SDG 15; Life on Land and its Target 15.3 in particular, is the most relevant to the efforts made in combating land degradation. Also as a member country of the United Nations Convention to Combat Desertification (UNCCD) and a pilot country for Land Degradation Neutrality (LDN), Bhutan is responsible for contributing to climate change mitigation and adaptation through SLM.

As a mountainous country, agriculture in Bhutan remains highly sensitive and vulnerable to climate change impacts. According to the Inter-governmental Panel on Climate Change (IPCC), mountainous countries will experience a decline in crop yield due to increase in water stress (either too much or too little) and land degradation (IPCC, 2007). Recognizing soil as the largest terrestrial soil organic carbon (SOC) storage, Bhutan's Intended Nationally Determined Contribution (INDC, 2015) specifically declares soil and land development as a means to both mitigate and adapt to climate change and enhance continuous ecosystem services.

2.4 Agriculture Land Development and SLM

Agriculture Land Development (ALD) is defined as "sustainable development and management of arable land, through change in land form, for enhanced agriculture production and continuous agro-ecosystem services". As such, only those SLM technologies that fulfil this condition can be considered as ALD technologies e.g. land terracing, alley cropping, and contour stone bunds. Recognizing the vulnerabilities of steep slope agriculture, as early as the 5th FYP, ALD efforts by the farmers were supported by the government with cash incentives. For example, government paid Nu. 300 and Nu. 200 per acre for land terracing and construction of contour stone bunds, respectively. However, due to shift in the developmental priorities of the government over the years, SLM incentives were stopped and along with this, farmers' land development efforts slowly dwindled by 7th FYP.

With the devastating impacts of the 2004 flash flood incidence in the entire eastern region of the country, the focus on SLM was heightened with various programs and projects aiming to promote SLM, especially in vulnerable agriculture land, to mitigate soil erosion and other forms of land degradation. Although the 11th FYP emphasised the importance of ALD to address land degradation problems, the scope was limited due to resource constraints. However, during the 12th FYP, ALD program is set to receive high priority for the Ministry to increase crop production and help alleviate rural poverty while also addressing land degradation problems and related issues in the country.

With increasing population and rapid socio-economic development taking place in the country, the competition for good agriculture land from various other sectors is slowly forcing more marginal lands to be brought under cultivation to meet the food demand. On the contrary, huge areas of agriculture land are left fallow due to land degradation, low land productivity, farm labour shortage, wildlife depredation, and scarcity of water for irrigation. With all these challenges impacting food security goal and ecosystem services delivery, properly planned ALD is critical to bring more agriculture land under sustainable production. Further, it would also facilitate to ease farm labour shortage through mechanization, mitigate land degradation, and enhance agro-ecosystem services.

However, to date, there is no proper policy or guidelines put in place to implement ALD and this has created problems in monitoring and evaluation of ALD activities in the field. With the introduction of this guidelines, it is anticipated to streamline all ALD activities in the country and help to combat land degradation, increase agriculture production, and enhance agro-ecosystem services more efficiently and effectively.

3. Guiding Principles

The ALDG has been developed based on the following five main principles: -

a) Ensure effective and sustainable use of agriculture land;
b) Make agriculture farming an attractive source of livelihood;
c) Safeguard food and nutrition security;
d) Protect agriculture land from conversion to other land uses;
e) Enhance socio-economic development while ensuring environment wellbeing; and
f) Reduce land degradation, conserve biodiversity, and increase resilience to climate change.

4. Purpose of ALDG

a) To establish a common approach and practice for ALD across the country;
b) To assist agriculture staff and other stakeholders in planning, implementing, monitoring and evaluation of ALD programs and activities; and
c) To guide planners and policy makers for informed decision making with regard to ALD.

5. Objectives of ALD

a) To bring cultivated and fallow agriculture land under sustainable management and effective utilization;
b) To make agriculture land feasible for farm mechanization and thereby promote commercial farming;
c) To contribute towards enhancing national food and nutrition security;
d) To make agriculture land more resilient to climate change;
e) To help reduce rural-urban migration and youth unemployment; and
f) To contribute towards achieving targets set by Global Agreements and SDG goals.

6. ALD Implementation Arrangements

The implementation of ALD programs and activities shall be a part of the mandate of MoAF. However, this ALDG underscores specific institutional structure and roles and responsibilities for implementing the ALD activities intending to streamline accountability and efficient delivery of ALD services.

6.1. Institutional Structure

The institutional set up for the implementation of ALD is in accordance with the principles of democracy, harmonized with the Local Government Act of Bhutan 2007, wherein decision process in any ALD programs and activities shall be assumed as per the prevailing planning and decision making processes. However, in an attempt to reduce the "distance to frontier" or decreasing the turnaround time in delivering ALD services more efficiently and effectively, the best possible institutional setup shall be considered through timely amendment of this guidelines, if required.

The institutional structure, presented in Figure 6.1, intends to enhance the stakeholders' participation, ownership, and accountability across the relevant agencies in implementing the ALD programs and activities. The National Soil Services Centre (NSSC) under DoA shall be the overall coordinating agency to implement ALD in the country.

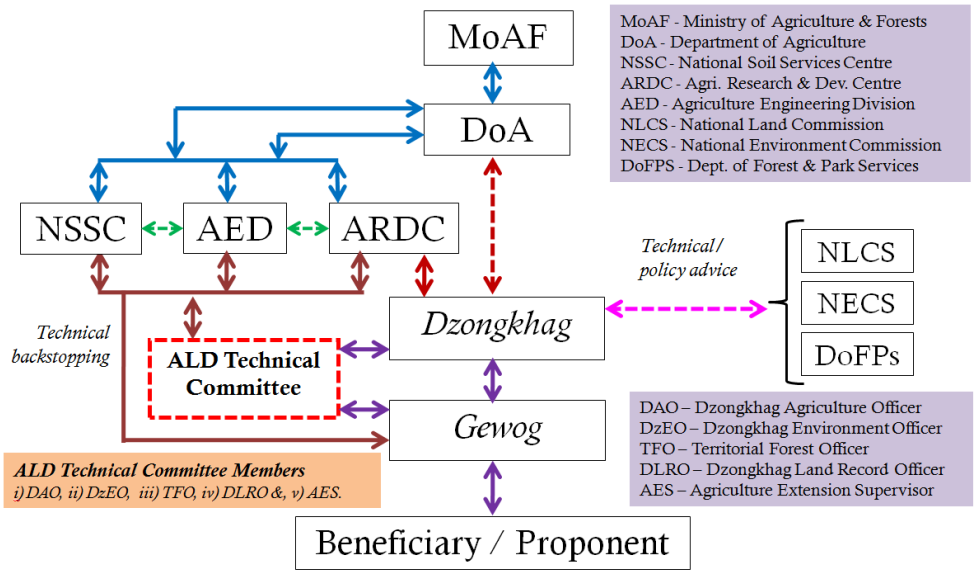

Figure 6.1 Institutional structure for implementing ALD

6.2. Roles and responsibilities

In order to implement the ALD programs and activities, multiple agencies are involved as it cuts across all sectors. The roles and responsibilities of the different agencies involved are as detailed below:

6.2.1 Ministry of Agriculture and Forests

a) Provide policy guidance on the overall agriculture and farmland development;
b) Provide approval for deployment of machineries for ALD programs and activities; and
c) Explore and mobilize resources for ALD programs and activities.

6.2.2 National Environment Commission Secretariat

a) Provide relevant policy guidance; and
b) Issue environmental clearances if beyond the scope of the *Dzongkhag* Environment Committee (DEC).

6.2.3 National Land Commission Secretariat

a) Provide necessary policy guidance; and
b) Issue land clearances if beyond the scope of *Dzongkhag* Land Record Office (DLRO).

6.2.4 Department of Forests and Park Services

a) Provide relevant policy guidance; and
b) Issue forest clearances if beyond the scope of the *Dzongkhag* Territorial Forest Division.

6.2.5 Department of Agriculture

a) Review requests for machinery support from *Dzongkhags* and accordingly seek Ministry's approval;
b) Instruct relevant agencies to align ALD activities with the fiscal plans and programs;
c) Explore and mobilize funds for ALD programs and activities; and
d) Strengthen institutional capacity for ALD.

6.2.6 National Soil Services Centre

a) Coordinate formulation, review, and amendment of ALDG;
b) Coordinate the implementation of ALD programs and activities at the national level;
c) Create awareness on ALD both at national and regional levels;
d) Provide technical backstopping for ALD activities;
e) Build capacities of both the Centre and relevant agencies in implementing ALD programs and activities;
f) Coordinate timely monitoring and evaluation (M&E) and knowledge sharing at the national level;
g) Explore funds for ALD programs and activities;
h) Align ALD programs and activities into fiscal plan and propose for government budget approval; and
i) Collate ALD information from ARDCs, build national database on ALD programs and activities, and publish/submit annual progress report.

6.2.7 Agriculture Engineering Division

a) Deploy machineries to the ALD sites as per the approval accorded by the Ministry;
b) Do timely maintenance of machineries in coordination with CMU; and
c) Carry out timely monitoring of deployed machineries by CMU at the ALD sites.

6.2.8 Agriculture Research & Development Centres

a) Provide necessary technical backstopping in implementing ALD activities;
b) Explore and propose budgetary support for ALD activities;
c) Conduct half yearly M&E for ALD activities at regional level;
d) Conduct and coordinate capacity building for agriculture extension supervisors (AES) and beneficiary voluntary groups (BVG);
e) Compile approved ALD activities from the *Dzongkhag's* annual work plan and budget (AWP&B) and submit to DoA with a copy endorsed to NSSC; and
f) Compile and submit annual progress report on ALD activities in the region to DoA with a copy endorsed to NSSC.

6.2.9 *Dzongkhag* Administration

a) Provide ALD services (e.g. clearances, demarcation, etc.) within its jurisdiction;
b) Approve *Dzongkhag* machines (e.g. bull dozer, and backhoe) for ALD activities on priority basis. However, if machines are not available, *Dzongkhags* should formally write to DoA for necessary machinery support.
c) Conduct quarterly monitoring of ALD activities at the field level;
d) Submit physical and financial progress reports to ARDC on quarterly and annual basis;
e) Compile approved ALD activities from *Gewog's* AWP&Bs and submit to ARDC; and
f) Resolve issues and disputes amongst the beneficiaries and target communities in close consultation with the relevant sectors and agencies.

6.2.10 *Gewog* Administration

a) Review and validate the ALD application and other relevant documents;
b) Coordinate and conduct feasibility study by the ALD committee with technical backstopping from ARDC/NSSC depending upon the nature of ALD activities;
c) Carry out design and layout and make budget estimates for the proposed ALD activities;
d) Incorporate proposed ALD activities in the AWP&B and implement it;
e) Form BVG to oversee the implementation of ALD activities;
f) Carry out monitoring of ALD activities on regular basis;
g) Submit progress report on quarterly and annual basis to the *Dzongkhag*; and
h) Execute agreement with the proponent.

6.2.11 Proponents

a) Ensure approval is sought for all ALD activities;
b) Submit a duly filled ALD application form along with other relevant documents to the *Gewog* Administration (Form B1).
c) Shall agree to the terms and conditions specified under the support scheme of this guidelines; and
d) Ensure utilization of developed ALD sites for agriculture purposes as per the terms and conditions.

7. ALD Framework

The ALD framework comprises of six key stages viz. i) development, review, and amendment of ALDG, ii) determination of ALD beneficiaries / proponents, iii) ALD application process, iv) feasibility studies, v) implementation of ALD activities, and vi) monitoring and evaluation (M&E) (Fig. 7.1). Each of these stages involves a set of activities described in the following sections.

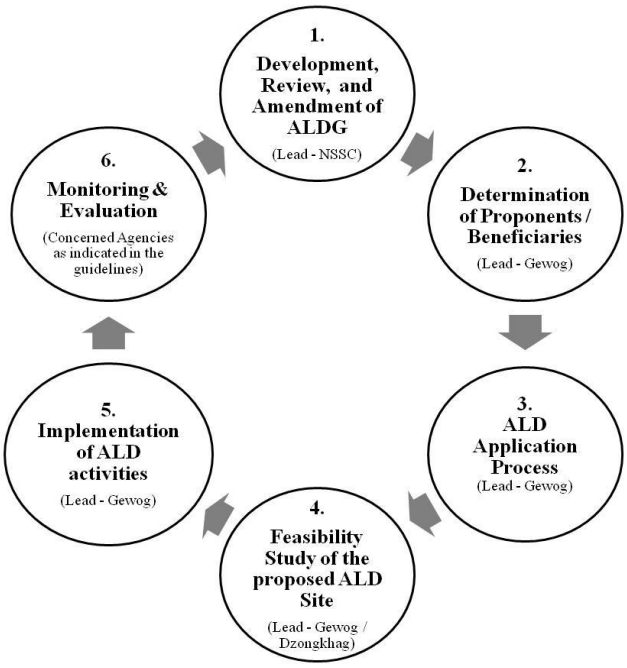

Figure 7.1 ALD Framework cycle

7.1 Development, review, and amendment of ALDG

The National Soil Services Centre (NSSC) under DoA shall take the lead to develop, review, and amend the ALDG in collaboration with concerned agencies.

7.2 Determination of ALD proponents / beneficiaries

Broadly, three types of proponents or beneficiaries have been identified for ALD i.e. i) individual person, ii) community/group, and iii) institution/private sector. In order to qualify as one of the categories of proponents for ALD with some support from the government, the following criteria should be followed.

1. **Individual:** The minimum area of the proposed site for ALD using machine should be at least 3ac and must be in the same location or in a cluster. However, if ALD is intended to be done manually, the proposed site should be 1ac or more.
2. **Community/group:** The proponent must include at least 5 households (HHs) and the proposed area for ALD using machine should be at least 5ac, and a minimum of 3 ac if ALD is proposed to be carried out manually. Furthermore, the proposed sites must either be situated in the same location or in a cluster.
3. **Institution/private sector**: The proposed site for ALD (using machine only) must cover at least 5ac and should be in the same location or in a cluster.

7.3 Application process

The proponent shall submit a duly filled ALD application form along with all necessary documents to the *Gewog* Administration. Upon receiving the application, the AES will review and validate the application form and all other documents. If all the requirements are fulfilled, the AES will coordinate and make necessary arrangements for the feasibility study of the proposed ALD site.

7.4 Feasibility study

a) The AES will coordinate with the ALD committee members and conduct the feasibility study of the proposed ALD site. Depending upon the type of ALD proposed, only the relevant ALD committee member(s) shall be involved in the feasibility study. The ALD committee shall be comprised of the following members:
   - ✓ *Dzongkhag* Agriculture Officer;
   - ✓ Representative of Territorial Forest Division;
   - ✓ *Dzongkhag* Environment Officer;
   - ✓ *Dzongkhag* Land Record Officer; and
   - ✓ AES from the concerned *Gewog*.

b) During the feasibility study, the team shall look at the following aspects:
   - ✓ Type of clearance required to be issued;
   - ✓ Details of documents required for the clearances;
   - ✓ Technical feasibility for the proposed ALD based on this guidelines;
   - ✓ Prospects, if any on enhancing farm productivity and marketing;
   - ✓ Adverse effect, if any on the environment;
   - ✓ Encroachment, if any into the state reserve forest (SRF), or on to any adjoining land that are not intended to bring under the proposed ALD.

c) In order to reduce the turnaround time, the assessment for issuing necessary clearances shall be done during the feasibility study.
d) After the feasibility study, the committee shall submit a detailed feasibility assessment report to the *Gewog* with a copy to the *Dzongkhag*. If the proposed ALD activity was found to be feasible, a detailed design and layout along with cost estimates should be included in the feasibility assessment report.
e) ALD application process and feasibility study should be completed by the end of every January to enable incorporation of the required budget proposal in the next fiscal year.

7.5 Implementation of ALD Activities

7.5.1 ALD implementation procedure

Based on the recommendation of the ALD committee and AWP&B, the AES shall coordinate to implement the proposed ALD activities. The latter which does not require any machinery support shall be directly implemented as per the AWP&B. However, for those ALD activities which require machinery support, the AES, through the *Gewog* Administration, should formally write to the *Dzongkhag* for necessary support. The *Dzongkhag* then shall make necessary arrangements to deploy the *Dzongkhag* machine for ALD activities on a priority basis. But if *Dzongkhag* machines are unavailable, the concerned *Dzongkhag* should formally write to DoA for necessary machinery support. The latter, in turn, will review the request from the *Dzongkhag* and accordingly seek Ministry's approval to provide necessary machinery support. However, the *Gewog* and *Dzongkhag* Administrations should explore and arrange fuel for the machines. Before carrying out the ALD activities, an agreement should be signed between the proponent and *Gewog* Administration as indicated in this guidelines. The actual implementation of ALD activities shall be done by AES with technical backstopping from ARDC and NSSC.

7.5.2 ALD Technologies

As defined earlier, ALD is the sustainable development of arable land, through change in landform, for enhanced agriculture production and continuous agro-ecosystem services. Based on this definition, eight different ALD technologies have been identified viz: i) bench terracing, ii) consolidation of existing small terraces, iii) orchard terracing, iv) removal of surface stones from agriculture fields, v) contour stone bunds, vi) orchard basin, vii) alley cropping, and vii) check dam. All these ALD technologies have been tried and proven to be effective in mitigating soil erosion, increasing soil fertility, easing workability, promoting farm mechanization, and/or enhancing agriculture production thereby helping to increase rural livelihoods, enhance resilience against climate change, conserve biodiversity, and ensure sustainable agro-ecosystem services. A detailed description and implementation procedures of these ALD technologies are given in Appendix A.

7.5.3 ALD Support Schemes

Support scheme is an important aspect of any program as it greatly contributes to its success. It also helps to bring on board all sections of the society and makes the program more inclusive and beneficial to the communities. However, there is a risk that such schemes might create some dependency on the government if not properly planned and executed. Support schemes are particularly necessary for those programs and activities that require significant level of inputs from the beneficiaries. Otherwise, the disadvantaged and vulnerable groups may not be able to participate actively and reap its benefits. One classical example of such programs is ALD where a support scheme is critical for the following reasons:

a) ALD activities are both cost and labour intensive if the area is vast requiring deployment of machinery;
b) ALD benefits are long-term in nature and therefore need incentives to encourage farmers to adopt ALD;
c) ALD not only benefits at the actual sites of implementation but also downstream by combating land degradation and enhancing ecosystem services;
d) Farmers need to sacrifice a certain portion of their productive land while taking up ALD;
e) Although ALD significantly contributes to climate change mitigation and ecosystem services delivery, adoption of ALD is still low due to lack of any support schemes.

In view of the above justifications and to achieve the intended objectives of ALD, the following support modalities are proposed:

7.5.2.1 Cost sharing

In cost sharing scheme, beneficiaries are required to share certain portion of the total cost, in cash or kind, for developing their agriculture land e.g. if the government provides machinery support, the beneficiary should provide labour support. However, the fuel cost may be covered from area development projects or *Dzongkhag*/*Gewog* development grants. A detailed cost-sharing modalities for different ALD technologies are given in Table 7.1. In order to avail this support scheme, the following criteria must be fulfilled:

a) The proposed site should have road access if machinery deployment is required;
b) The proposed site should fulfil the required site conditions as prescribed in this guidelines;
c) The proposed site should not have any social and community conflicts;

d) It should not encroach into the SRF, or to any adjoining land;
e) The land intended for ALD must have potential for maximizing crop production;
f) The proponent must accept and ensure cost sharing approach as specified under this guidelines;
g) The proponent shall agree to full utilization and management of the developed farmland for a minimum of 10 years; and
h) Sign an agreement to this effect with the implementing agency.

The priority for ALD shall be given to the proponents, where proposed ALD sites are in the same location or in a cluster.

7.5.2.2 Full support

Under the full support scheme, all costs involved in the proposed ALD activities shall be borne by the government. However, to avail this benefit, the following criteria shall apply:

a) Only households enlisted under the Targeted Household Poverty Program (THPP) survey conducted by GNHCS and other disadvantaged community/households/individuals identified in consultation with the concerned community/*Gewog* are eligible for this support scheme;
b) The proposed ALD site should have road access if farm machinery is required;
c) The proposed site should fulfil the required site conditions as prescribed in this guidelines;
d) The proposed site should not have any social and community conflicts;
e) The area proposed should not encroach into the SRF, or to any adjoining land;
f) The land intended for ALD must have potential for maximizing crop production;
g) The proponent shall agree full utilization and management of the developed farmland for 10 years and;
h) Sign an agreement to this effect with the implementing agency.

7.5.2.3 Technical support only

In case of proponents seeking only technical support, government shall provide services such as feasibility study of the proposed ALD site, technical supervision, and monitoring of the ALD activities. To avail this ALD support scheme, the following criteria should be fulfilled:

a) The proponent shall ensure that the proposed ALD sites are developed as per the technical specifications included in this guidelines;
b) The sites proposed for ALD should not have any social and community conflicts;
c) The proposed area should not encroach into the SRF, or to any adjoining land;
d) The land intended for ALD must have potential for maximizing crop production;
e) The proponent shall agree to fully utilize and manage the developed farmland; and
f) Sign an agreement to this effect with the implementing agency.

Table 7.1 Details of cost sharing modalities for ALD

Sl. No.	Particular	Cost to be borne by:	
		Beneficiary	Government
1	*Terracing using machine (bench, orchard & terrace consolidation) - For individuals & community/Group*		
	a. Machinery (plus transportation & maintenance)		✓
	b. Machine Operator (TA/DA)		✓
	c. Fuel, oil and lubricant		✓
	d. Labour & farm tools	✓	
2	*Terracing using machine (bench, orchard & terrace consolidation) - for institutions/private sectors*		
	a. Machinery (plus transportation & maintenance)		✓
	b. Machine Operator (TA/DA)	✓	
	c. Fuel, oil and lubricant	✓	
	d. Labour & farm tools	✓	
3	*Collection of excess surface stones - for individuals & community/group*		
	a. Machinery (plus transportation & maintenance)		✓
	b. Machine Operator (TA/DA)		✓
	c. Fuel, oil and lubricant		✓
	d. Labour & farm tools	✓	
4	*Collection of excess surface stones - for institutions/private sectors*		
	a. Machinery (plus transportation & maintenance)		✓
	b. Machine Operator (TA/DA)	✓	
	c. Fuel, oil and lubricant	✓	
	d. Labour & farm tools	✓	
5	*Manual terracing (fully levelled bench and orchard terraces) - for individuals & community/group*		
	a. Cash incentives (Nu. 15,000/ac)		✓
	b. Labour & farm tools	✓	
6	*Manual terracing (partially levelled bench terrace) - for individuals & community/group*		
	a. Cash incentives (Nu. 7,500/ac)		✓
	b. Labour & farm tools	✓	
7	*Alley cropping (Hedgerows) - for all proponents*		
	a. Cash incentives (Nu. 2,500/ac)		✓
	b. Plantation materials (fodder grass slips)		✓
	c. Transportation of planting materials		
	i. Up to road head		✓
	ii. Road head to site	✓	
	d. Labour & farm tools	✓	
8	*Contour stone bunds (with or without fodder grass strip) - for all proponents*		
	a. Cash incentives (Nu. 5,000/ac)		✓
	b. Plantation materials (if required)		✓
	c. Transportation of planting materials		
	i. Up to road head		✓
	ii. Road head to site	✓	
	d. Labour & farm tools	✓	
9	*Orchard basin (soil or stone) - for all proponents*		
	a. Cash incentives (Nu. 6,000/ac)		✓
	b. Materials (stones)	✓	
	c. Labour & farm tools	✓	
10	*Check dam (Log or stone check dam) - for all proponents*		
	a. Cash incentives (Nu. 1,500/check dam)		✓
	b. Materials (logs and stones)	✓	
	c. Labour & farm tools	✓	

7.6 Monitoring & Evaluation

Regular monitoring and supervision of the ALD activities shall be carried out by the BVG in collaboration with the concerned AESs. In addition, *Dzongkhag*, ARDC, and NSSC shall monitor ALD activities on a quarterly, half yearly, and annual basis, respectively to make sure that ALD activities are properly carried out in the field.

The reporting on the physical and financial progresses of the ALD activities shall be routed as per the existing reporting system in place. The concerned AES shall report to the *Dzongkhag*, and *Dzongkhag* shall compile ALD activities of different *Gewogs* and submit to ARDC. The ARDC, in turn, shall collate ALD progress reports from different *Dzongkhags* within the region and then submit to DoA with a copy endorsed to NSSC (Table 7.2).

Table 7.2 Sequencing of ALD activities

Sl#	Stages	Activity	Lead Agency	Collaborating Agency
i	Application Process	Review and validate ALD application documents	*Gewog*	-
ii	Feasibility Study	Coordinate and conduct feasibility study	*Gewog*	*Dzongkhag*, ARDC, NSSC
		Issuance of clearances	*Gewog*	Concerned agencies
		Design, lay out, cost estimate and ascertain the input requirements	*Gewog*	*Dzongkhag*, ARDC, NSSC
	Planning Process	Integrate into fiscal plan and secure budget allocation	*Gewog*	*Dzongkhag*, ARDC, NSSC
iii	Implementation	Deployment of machineries	*Dzongkhag*/AED	MoAF, *Dzongkhag*, CMU
		Arrange necessary ALD inputs (planting materials)	*Gewog*	*Dzongkhag*, ARDC, Input supply agencies
		Ensure labour contribution as per the cost sharing modalities	*Gewog*	*Dzongkhag*, ARDC
		Constitute BVG to manage the ALD activities	*Gewog*	*Dzongkhag*
iv	Monitoring & Evaluation	Conduct monitoring	BVG/*Gewog*/ARDC	*Dzongkhag*, NSSC
		Build database on ALD	NSSC	ARDC, *Dzongkhag*, *Gewog*
		Conduct evaluation of the ALD program	NSSC	ARDC, *Dzongkhag*
		Publish/submit annual report on ALD programs	NSSC	ARDC, *Dzongkhag*. *Gewog*

The M&E for ALD programs and activities shall be carried out by the relevant agencies, corresponding to different levels of expected results chain as shown in Table 7.3. The lead agencies corresponding to the results chain shall coordinate with the collaborating agencies and develop M&E plan. There are two levels of M&E adopted in this guidelines depending on the nature of ALD proposals as follows:

7.6.1 Technical support only

Proponents requiring only technical support from the government shall be monitored and facilitated through timely/regular technical supervision and guidance. The monitoring shall ensure that the ALD activities are implemented in conformity to the technical standards and norms adopted under the guidelines.

7.6.2 Support scheme

The individual, community/group, or institution/private sector taking up ALD activities under support schemes shall be monitored through comprehensive M&E structure as follows:

a) ARDC in collaboration with *Dzongkhag* and NSSC shall develop M&E plan and set baselines.
b) ARDC shall coordinate and lead the monitoring of ALD activities under its region.
c) *Dzongkhag* shall monitor and review the progress on quarterly basis and conduct field visits at appropriate stages to confirm and assess physical and financial progress.
d) ARDC shall submit monitoring report to DoA with a copy endorsed to NSSC.
e) NSSC shall coordinate the evaluation of ALD programs in consultation with relevant agencies.
f) The Evaluation Protocol and Guidelines developed by the GNHCS shall be the basis for evaluating the ALD impact assessment of the nation as a whole.
g) The national database on ALD programs and activities shall be developed by NSSC with ALD information submitted by *Gewogs* to *Dzongkhags*, *Dzongkhags* to ARDC, and ARDCs to NSSC.

Table 7.3 Result chain corresponding to lead and collaborating agencies for M&E (Example)

Result Chain	Description	Indicator/ Unit	Frequency	Lead Agency	Collaborating Agency
Activity	Bench terracing	Area (ac)	On daily basis	*Gewog*	*Dzongkhag*
Output	Farmland stabilized	Area (ac)	Biannually	ARDC	*Dzongkhag*
Outcome /Impact	Farm production enhanced	Kg/ac	After two years	NSSC	ARDC, *Dzongkhag*

Note: M&E shall be continued until the ALD sites are fully established.

Appendix A – Description & Implementation Procedures of ALD Technologies

Prior to taking up any of the ALD technologies, it is necessary to carry out a proper design and layout in the field, for which, a landform mapping of the proposed site is necessary to differentiate landforms with different slope gradients. Landform mapping can be done using digital elevation model (DEM) and/or through field surveys. Since terracing, contour stone bunds, and alley cropping are done following the contours, it is necessary to locate the contour lines. One easy way to locate the contour line is by using an 'A' frame (Fig. A1.1(a)). This is a simple field equipment used for locating contour lines by joining points of equal elevation from the mean sea level (Fig. A1.1(b)).

How to lay out the contour lines?

a) Indentify different landform shapes and measure their slope gradient in degree (°).
b) Determine the terrace, stone bund or hedgerow interval (A-B) for each landform shape using Table A1.1, A3.1, or A5.1.
c) From the bottom of each landform, measure the required interval and mark it using pegs.
d) Continue marking the interval for other landform shapes.
e) From the marked interval, run the 'A' frame across the slope to lay out the contour lines, and
f) After marking the contour lines, adjust it to form a smooth contour lines.

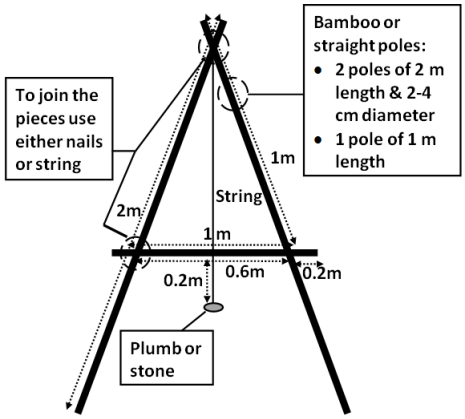

Figure A1.1(a) 'A' Frame

Figure A1.1(b) Laying out contours

A.1 Bench terracing

Bench terracing is a soil conservation measure consisting of a series of level or nearly level strips (benches) running across a slope following the contour lines at certain vertical intervals. The level strips supported by steep banks or risers made of earth or rocks are used for cultivation. Bench terraces can be constructed either manually or by using machinery. The major benefits of terracing are conservation of soil and water through reduced surface runoff and soil erosion, enable farm mechanization, and intensification of crop production.

Based on the slope of the bench, bench terracing can be divided into two types. The first one is the fully levelled bench terrace, while the second one is the partially levelled bench terrace. In the latter, the natural slope of the land is decreased by 50% and the height of the terrace riser is relatively short than the riser of the fully levelled bench terrace for a given slope. Further, the partially levelled bench terrace is less labour intensive and thus more economical compared to the fully levelled bench terrace. However, it may not be as effective as the fully levelled bench terrace in reducing soil erosion, retaining water and soil nutrients, and easing the workability before it develops into a fully levelled bench terrace. Bench terracing is considered as one of the most sustainable ALD practices in mountainous areas.

Bench terracing is feasible in agriculture land with deep soils (>1 m), good soil drainage, less stone content (<20%), and moderately gentle slope. For manual terracing, agriculture land with slope up to 30° is recommended. However, if machines are used e.g. spider machine or JCB dozer, only slopes up to 20° are recommended for bench terracing. This is to reduce risk to the machine and also to minimise soil disturbance on steep slopes.

How to construct a bench terrace?

a) Determine the terrace interval of each landform (Table A1.1) and lay out the contour lines.
b) Start at the bottom of the slope where the bottom terrace is to be constructed.
c) Remove the topsoil (first 20 cm) from the cut area (upper half of the terrace) and save it on one side. Use the subsoil from the cut area to level the bench terrace as shown in Fig. A1.2 and Fig. A1.3. Extracted stones and boulders should be used as a foundation for the terrace riser.
d) The riser should slant backwards by about 70° towards the hillside to increase its stability.
e) After terracing (both for partially and fully levelled bench terrace), put back the topsoil on the surface uniformly and level it completely.
f) The newly constructed bench terrace should not be used for irrigated paddy cultivation at least for the first two to three years – thus, allowing the terrace riser to fully settle down and fully stabilize.
g) Drains around the terraced land should be made to safely drain out the surface runoff.

Table A1.1 Terrace interval for partially or fully levelled bench terracing (Sheng, 1981)

Slope=θ (°)	Slope = S (%) Tan θ × 100	Vertical Interval (m)	Width of bench Wb (m) Vary	Width of riser Wr(m) Wr = Hr× U	Width of terrace Wt (m) Wt = Wb+Wr	Distance of A-B (m) $AB = \sqrt{VI^2 + Wt^2}$
2	3.49	0.53	15.00	0.18	15.18	15.19
4	6.99	0.72	10.00	0.24	10.24	10.27
6	10.51	0.87	8.00	0.30	8.30	8.34
8	14.05	1.03	7.00	0.35	7.35	7.42
10	17.63	1.13	6.00	0.38	6.38	6.48
12	21.26	1.26	5.50	0.43	5.93	6.06
14	24.93	1.43	5.25	0.49	5.74	5.91
16	28.67	1.35	4.25	0.46	4.71	4.90
18	32.49	1.46	4.00	0.50	4.50	4.73
20	36.40	1.45	3.50	0.49	3.99	4.25
22	40.40	1.41	3.00	0.48	3.48	3.75
24	44.52	1.57	3.00	0.54	3.54	3.87
26	48.77	1.61	2.75	0.55	3.30	3.67
28	53.17	1.62	2.50	0.55	3.05	3.46
30	57.74	1.80	2.50	0.61	3.11	3.59

U = Constant, AB=Actual distance between two contour lines (m), VI = Vertical interval, Wb = Width of bench, Wr = Width of riser, Wt = Width of terrace, Hr = Height of riser, slopes greater than 20° is not recommended for machine terracing.

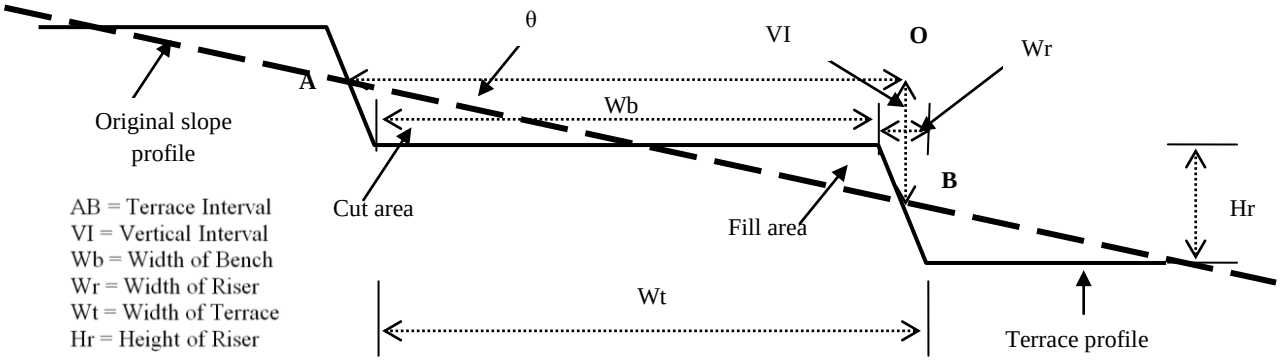

Figure A1.2 A vertical cross section of a fully levelled bench terrace

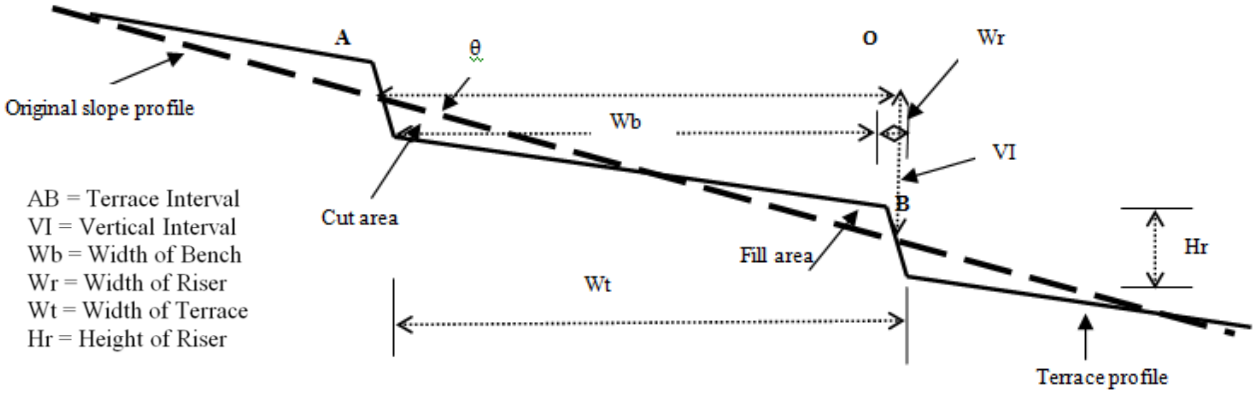

Figure A1.3 A vertical cross section of a partially levelled bench terrace

A.2 Consolidation of existing small terraces

Consolidation of terraces is the merging of existing small bench terraces into large terraces to enable farm mechanization, agriculture feminization, and crop intensification. Currently, most of the existing bench terraces are very narrow and are not feasible for farm mechanization. Since farm mechanization and crop intensification are slowly picking up in the country, these narrow bench terraces need to be consolidated into bigger terraces wherever feasible. However, one needs be cautious while merging and realigning the existing small bench terraces as the natural slope has already been disturbed. If not done cautiously and properly, there is a great risk of destabilizing the already stable bench terraces and cause severe land degradation.

Thus, consolidation of old bench terraces is recommended only if the general slope of the proposed site is less than 20° with good soil drainage and minimal risk of land degradation. While consolidating small terraces into large terraces, the new terrace riser height should not be more than 1.5 m and width of the bench not less than 3.5 m.

How to consolidate small terraces?

a) Measure the general slope of the proposed site for terrace consolidation.
b) Use Table B1.1 to find out what the riser height and width of the bench should be for that given slope.
c) Remove the topsoil from the terraces and keep it aside. Then start consolidating the old terraces by maintaining the recommended riser height and bench width (refer Table A1.1).
d) The consolidation of small terraces should be done by following the landform shape of the proposed site. This is because, due to the existing terraces, an ‘A’ frame cannot be used to lay out the contour lines. In addition, the slope of the bench should be maintained at zero degree as far as possible.

A.3 Orchard terracing

Orchard terracing is also another form of bench terracing but for a given slope its bench width is much narrower than the fully levelled bench terrace. A strip of undisturbed land is also kept, for steeper slopes, between the terraces to increase the stability of the terrace risers. As such, orchard terraces are more stable than other bench terraces. The main advantage of orchard terracing is that it enables better orchard management by increasing the ease of irrigation, fertilization, tree pruning, and fruit harvesting compared to the conventional orchard.

The method for orchard terracing is similar to that of fully levelled bench terrace. For manual construction, orchard terracing can be done on slopes up to 35°. However, if machines are used, only slopes up to 20° are recommended for orchard terracing. The other site requirements for orchard terracing remain same to that of the fully levelled bench terracing.

How to construct orchard terraces?

a) Find out different landform shapes and measure their slope gradient in degree (°).
b) Determine the orchard terrace interval from Table A3.1 by using the slope gradient.
c) If the slope gradient is greater than 16°, a strip (Ws) between the terraces should be left undisturbed to increase the stability of the riser (Table A3.1).
d) Follow the steps used in constructing a fully levelled bench terrace (refer Section A.1).

Table A3.1 Terrace interval for orchard terracing (Sheng 1981)

Slope	Slope = S	Vertical Interval (VI)	Width of bench (Wb)	Width of riser (Wr)	Width of terrace (Wt)	Width of the strip (Ws)	Orchard terrace interval
	Tan ɵ × 100	$VI = \frac{SxWb}{100 - (SxU)}$	Vary	Wr = Hr × U	Wt = Wb+Wr		$AB = \sqrt{(Wt^2 + VI^2)} + Ws$
(°)	(%)	(m)	(m)	(m)	(m)	(m)	(m)
2	3.49	0.25	7.00	0.08	7.08	0.00	7.09
4	6.99	0.50	7.00	0.17	7.17	0.00	7.19
6	10.51	0.65	6.00	0.22	6.22	0.00	6.26
8	14.05	0.74	5.00	0.25	5.25	0.00	5.30
10	17.63	0.94	5.00	0.32	5.32	0.00	5.40
12	21.26	0.92	4.00	0.31	4.31	0.00	4.41
14	24.93	0.95	3.50	0.32	3.82	0.00	3.94
16	28.67	0.95	3.00	0.32	3.32	0.00	3.46
18	32.49	1.02	2.80	0.35	3.15	0.05	3.36
20	36.40	1.12	2.70	0.38	3.08	0.05	3.33
22	40.40	1.17	2.50	0.40	2.90	0.05	3.18
24	44.52	1.21	2.30	0.41	2.71	0.08	3.05
26	48.77	1.32	2.25	0.45	2.70	0.08	3.08
28	53.17	1.30	2.00	0.44	2.44	0.10	2.86
30	57.73	1.44	2.00	0.49	2.49	0.10	2.97
31	60.08	1.43	1.90	0.49	2.39	0.10	2.89
32	62.48	1.43	1.80	0.49	2.29	0.15	2.84
33	64.94	1.42	1.70	0.48	2.18	0.20	2.80
34	67.45	1.40	1.60	0.48	2.08	0.25	2.75
35	70.02	1.38	1.50	0.47	1.97	0.30	2.70

U = Constant, AB=Actual distance between two contour lines (m), VI = Vertical interval, Wb = Width of bench, Wr = Width of riser, Wt = Width of terrace, Hr = Height of riser, slopes greater than 20° is not recommended for machine terracing.

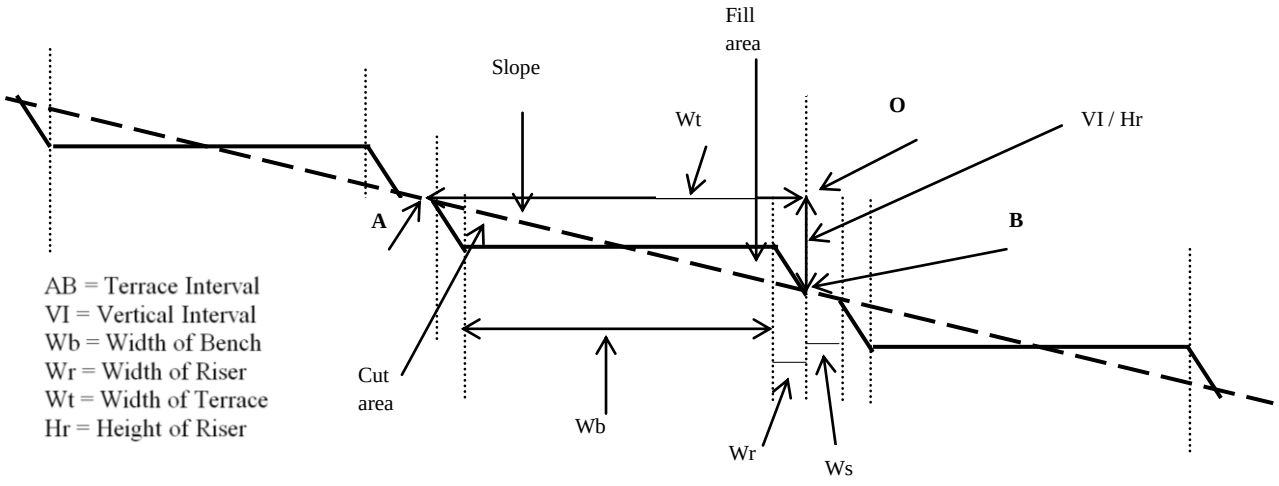

Figure A3.1 A vertical cross section of an orchard terrace

A.4 Removal of surface stones

Although surface stones (< 25.6 cm diameter) on cultivated lands have multiple benefits such as reducing rainfall impacts, control surface erosion, and conserve soil moisture, they are usually regarded as nuisance for agriculture farming. This is largely from the workability point of view as high percentage of surface stones would hinder tillage operation, farm mechanization, and demand lots of farm labour input. Hence, removal of

surface stones using small machines is justifiable in agriculture lands that are feasible for farm mechanization and has potential for large scale farming.

Thus, it is recommended that agriculture land with surface stone (<25.6cm diameter) coverage of more than 50% and slope gradient not more than 5° is recommended for surface stone removal using a small machine only e.g. a tractor attached with a surface stone remover. However, removal of huge boulders (>25.6cm diameter) would be beyond the scope of ALD and therefore it is not recommended. While removing the surface stones, care should be taken not to disturb the topsoil too much as this might trigger surface erosion. All the removed surface stones should be stacked, if possible, along the field boundaries to serve as a fence.

A.5 Orchard basin

Orchard basin literally means a basin constructed around a tree or plant for better orchard management. It is mainly constructed to increase the ease of irrigation and fertilization. Orchard basins also help to control surface runoff, conserve soil moisture, and improve soil fertility. Depending on the slope of the orchard, different orchard basins can be prepared. For example, a crescent-shaped basin (Fig. A5.1(a)) is recommended for orchards that are on steep slopes (>10°). However, on gentle slopes (≤10°) a ring-shaped basin (Fig. A5.1(b)) is more appropriate. Orchard basin should be constructed based on the size of the tree canopy but the slope gradient and availability of stones in the field would more or less determine the size and height of the tree basin.

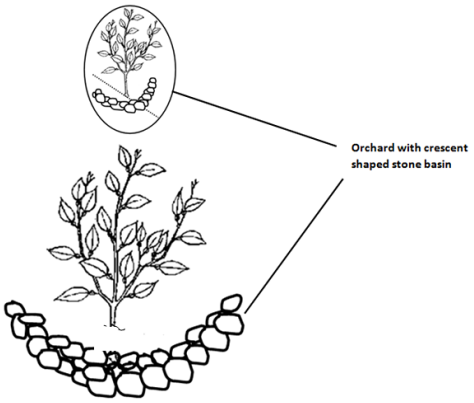

Figure A5.1(a) Crescent-shaped basin

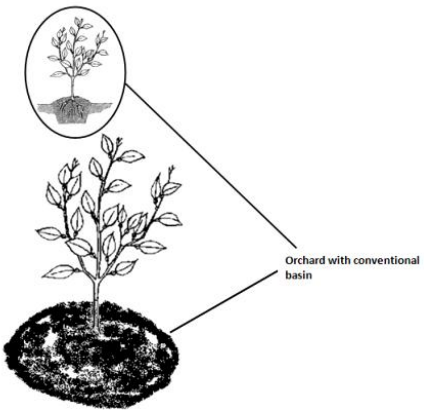

Figure A5.1(b) Ring-shaped basin Figure

A.6 Contour stone bund

Contour stone bund is a single line of stones that is laid along the contour line {Fig. A6.1(a)}. It is recommended only in agriculture fields that have plenty of surface stones (>20%). Construction of contour stone bunds not only helps to get rid of the excess surface stones and gravels but also reduces the slope gradient through formation of partial terraces in few years time. As such, it helps to reduce soil erosion, conserve soil moisture, and increase soil fertility. In some cases, a strip of fodder grasses is planted at the base of the stone bund to further stabilize it and provide fodder for the cattle {Fig. A6.1(b)}.

How to construct contour stone bunds?

a) Determine the spacing between two stone bunds for each landform shape (Table A6.1).
b) Demarcate the interval from the middle of the field and then lay out the contour lines.
c) Along the contour line, dig a trench of 0.1-0.2 m deep and 0.5 m wide to lay out the foundation of the stone bund.
d) Start constructing the stone bund from the base of the field and work up-slope.
e) Larger stones should be placed at the base to set a proper foundation.
f) Depending upon the slope and availability of stones in the field, a typical stone bund should be 0.3 - 1.5 m high and 0.30 - 0.5 m wide (broader base and narrower top).
g) Plant fodder grass slips at the base of the stone bund if fodder is required {Fig. A6.1(b)}.

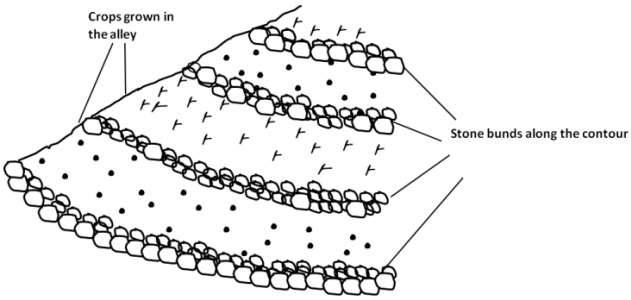

Figure A6.1(a) Stone bunds

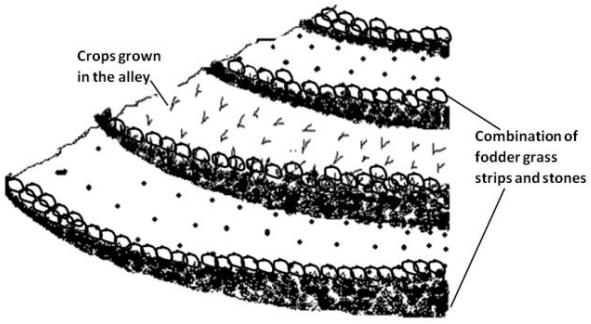

Figure A6.1(b) Stone bund with fodder grass

Table A6.1 Interval between stone bunds (Sheng 1981)

Slope θ (°)	Width of the Alley (m)	Width of Hedgerow (m)	Distance of A – B (m)	Slope θ (°)	Width of the Alley (m)	Width of Hedgerow (m)	Distance of A – B (m)
2	Vary	0.18	15.19	10	6.00	0.38	6.48
4	10.00	0.24	10.27	12	5.50	0.43	6.06
6	8.00	0.30	8.34	14	5.25	0.49	6.03
8	7.00	0.35	7.42	16 - 30	4.25	0.46	6.00

AB=Actual distance between two contour lines (m)

A.7 Alley cropping / Hedgerows

Alley cropping is an agro-forestry practice designed to enable permanent farming of sloping agriculture land on a sustainable basis. Essentially, it consists of planting hedgerows of nitrogen-fixing shrub species along the contour lines of sloping land at intervals determined by the slope. The hedgerows create a live barrier that traps sediments and reduce surface runoff. With time, as the sediments build up behind the hedges, the area between the hedgerows develops into a flat alley suitable for growing crops. In Bhutan, nitrogen-fixing fodder shrubs are not readily available and, thus, only fodder grasses are used as hedges (Fig. A7.1(a)). In some cases, improved fruit trees (e.g. apple and citrus) could be planted at a spacing of 5 m along the fodder grass strip to further stabilize the hedges and provide additional cash income (Fig. A7.1(b)).

How to establish fodder grass strips / hedgerows?

a) Determine the hedgerow interval for each landform shape (Table A6.1) and then lay out the contour lines. Along the contours, prepare a strip of land with a width of about 40-50cm wide to plant the grass slips or broadcast fodder grass seeds. Napier (*Pennisetum spp.*) grass is usually recommended as hedgerow plants for areas that are below 1600 m. However, for areas above 1600 m, temperate grass mixture is usually recommended.
b) A row of fodder grass slips should be planted with a spacing of 15-20 cm. If grass slips are used, at least one node should be inserted into the soil for proper germination. On the other hand, if grass seeds are used, the seed rate should be 25g per square metre.
c) Mulching should be done right after grass slip planting or grass seeding to reduce surface erosion, conserve soil moisture, and aid proper germination.
d) Gap filling and trimming of hedgerows should be done as and when required. The trimmed materials can be either used as fodder or mulching materials.
e) If desired, improved fruit trees that are suitable at the proposed site can be planted along the hedges at 5 x 5 m spacing. Fruit trees in two adjacent hedgerows should be planted in staggered position to avoid competition for sunlight, water, and soil nutrients (Fig. A7.1(b)).

Figure A7.1(a) Alley cropping

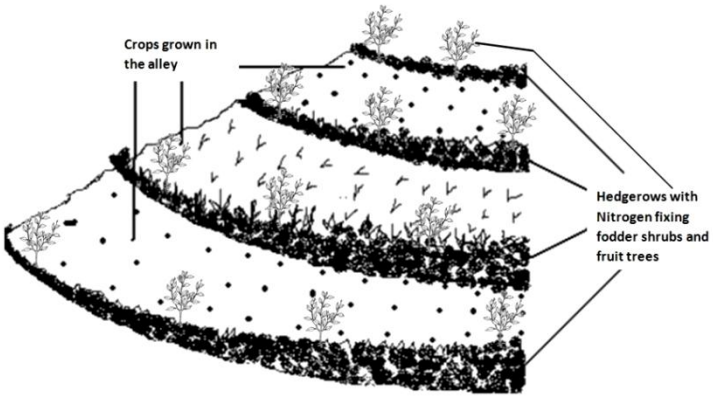

Figure A7.1(b) Alley cropping with fruit trees

A.8 Check dam

Check dams are simple physical structures designed to reduce gully erosion by runoff in agriculture fields. By providing periodic steps, check dams reduce the velocity of the overland flow, arrest the sediments, and safely discharge the water (and perhaps debris) via a spillway. Check dams can be differentiated into many types depending upon the kind of materials used. However, the most common and popular ones are the stone and log check dams. This is because stone and log check dams are not only very easy to construct but also quite effective in controlling gully erosion compared to their counterparts. While stone check dam is constructed using stones {Fig. A8.1(a)}, log check dams are constructed with multiple layers of a single row of logs placed across the gully bed {Fig.A8.1(b)}. It is only natural that stone check dams are more durable and effective in controlling gully erosion as opposed to log check dams.

Stone and log check dams are usually recommended if the gullies are less than 2 m deep and 4 m wide. If both stones and logs are available, stone and log check dams should be constructed alternately as it is more effective and economical in controlling gully erosions. A proper distance should be maintained between the check dams to make it more effective in controlling the gully erosion. If the gully is sufficiently uniform, the spacing between the check dams should be determined using Table A8.1 for different effective heights (H_E). The H_E of the check dam should be rightly considered based on the gully depth with higher H_E for deeper gullies.

Table A8.1 Check dam design for H_E = 0.5m, 1.0m and 1.5m

Slope	Effective height of check dam			Slope	Effective height of check dam		
(°)	H_E = 0.5m	H_E = 1.0m	H_E = 1.5m	(°)	H_E = 0.5m	H_E = 1.0m	H_E = 1.5m
2	47.8	95.5	143.3	22	2.7	5.3	8.0
4	23.9	47.8	71.7	24	2.5	4.9	7.4
6	15.9	31.9	47.8	26	2.3	4.6	6.8
8	12.0	24.0	35.9	28	2.1	4.3	6.4
10	9.6	19.2	28.8	30	2.0	4.0	6.0
12	4.8	9.6	14.4	32	1.9	3.8	5.7
14	4.1	8.3	12.4	34	1.8	3.6	5.4
16	3.6	7.3	10.9	36	1.7	3.4	5.1
18	3.2	6.5	9.7	38	1.6	3.2	4.9
20	2.9	5.8	8.8	40	1.6	3.1	4.7

How to construct a stone check dam?

a) With check dam spacing in mind, first construct a trench (foundation) across the gully with at least 50 cm into each side slope of the gully for better keying (Fig. A8.1(a)). As a rule of thumb, the bottom width of the dam should be 0.6 times the H_E of the check dam while the mid and top widths should be 0.5 and 0.4 times the H_E, respectively.
b) Fill the key trench up to the ground level with stones. Then stack the stones from the ground level till the required effective height is achieved i.e. up to the base of the spill way.
c) The dam should be properly keyed across its base and up to the abutments, to the crest elevation. Use angular stones that can interlock easily and form a dense structure. Voids between the stones should be filled with smaller stones.
d) An adequate spillway should be provided for safe discharge of water.

e) The perimeter of the spillway should be greater or equal to the wetted parameter of the gully.
f) The dam should be given a batter of 20% to further stabilise it. An apron of stones should be provided at the base, to dissipate the energy of water falling through the spillway and avoid scouring of the soil (Fig. A8.1(b)).

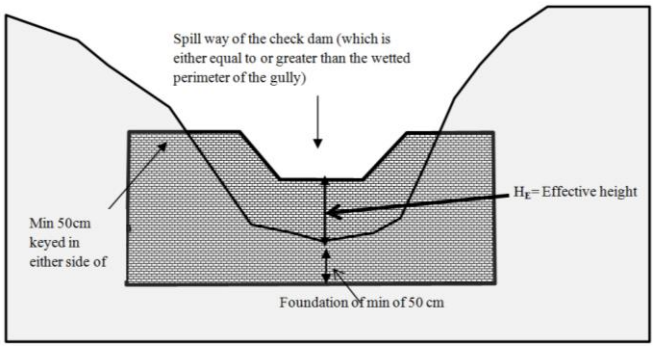

Figure A8.1(a) Front-view of stone check dam

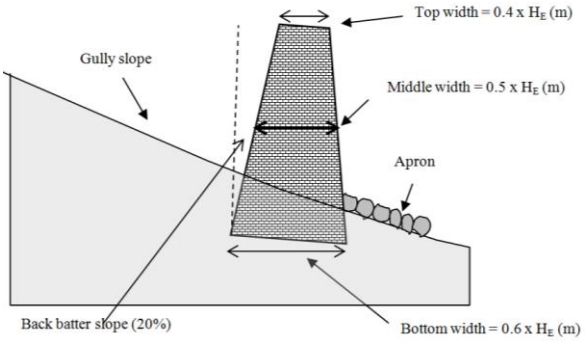

Figure A8.1(b) Side-view of stone check dam

How to construct a log check dam?

a) Excavate the foundation as per the diameter of the logs (10-15 cm) with at least 50 cm into each side slope of the gully for better keying.
b) Erect two vertical posts below the base of the trench on either side of the spillway.
c) Allow 2-3 logs to sink into the trench (excavation) for better vertical keying and then place the horizontal members, directly one above another, starting from the bottom. As one horizontal member is placed, backfill the log with stones and aggregates.
d) As the placement of log progresses to the level of the spillway, prepare for the spillway. Use shorter logs to make the sides of the spillway. Put the edges of the logs from the vertical post to the side slopes of the gully for proper keying {Fig. A8.2(a)}.
e) The spillway should be big enough to safely discharge the water translating to the fact that the perimeter of spill way should be either equal to or greater than the wetted perimeter of the gully.
f) After constructing the log check dam, plant live truncheon cuttings just next to the two vertical posts to provide additional support to the check dam later on.
g) An apron of non-erodible materials (stones) should be provided at the base, to dissipate the energy of water falling through spillway and avoid scouring of the soil {Fig. A8.2(b)}.

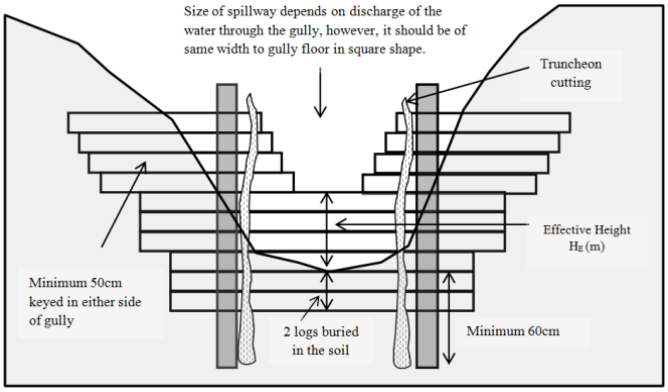

Figure A8.2(a) Front-view of a log check dam

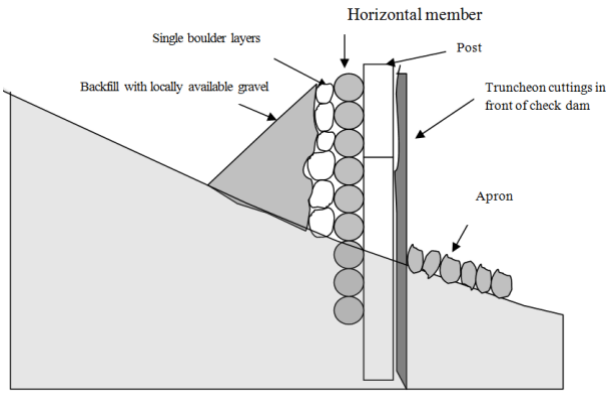

Figure A8.2(b) Side-view of a log check dam

Appendix B – ALD Forms

B1: ALD Application Form

Date:

1. Name of the Proponent:_____ CID No.: _____
2. Type of proponent: a) Individual ☐ b) Community/Group ☐ c) Institution/Private Sector ☐
3. Village:_____ *Gewog*:_____ *Dzongkhag*:_____
4. Name of the proposed ALD site:_____ Thram No.:_____
5. Area (ac):_____ Land category in Thram: _____ Current land use:_____
6. If fallow, provide reason why it was left fallow and for how many years: _____

   _____
7. Proposed ALD type:

   a) Fully levelled bench terracing ☐ b) Partially levelled terracing ☐ c) Terrace consolidation ☐

   c) Orchard terracing ☐ d) Removal of excess surface stones ☐ e) Contour stone bund ☐

   d) Orchard basin ☐ e) Alley cropping / hedgerows ☐ f) Check dam (stone/log) ☐

   g) Others _____
8. Support scheme requested:

   a. Cost sharing ☐ b) Full support ☐ c) Technical support only ☐
9. Road access: Yes ☐ No ☐
10. Location of proposed site(s): a) In same location ☐ b) In a cluster ☐ c) Scattered ☐
11. Slope of ALD site: a) Very steep (>20°) ☐ b) Moderately gentle (10-20°) ☐ c) Gentle (<10°) ☐
12. Risk of land degradation/ flash floods: Yes ☐ No ☐ If yes, specify_____
13. Any conflicts with the community: Yes ☐ No ☐ If yes, specify_____
14. Any encroachment to state reserve land/adjoining land: Yes ☐ No ☐
15. Copy of CID &Thram attached: Yes ☐ No ☐

Name & Signature
Date

Verified by:

B2: ALD Agreement Form

ALD AGREEMENT

I, _____ bearing CID# _____of _____Village, _____ *Gewog* under _____ *Dzongkhag* hereby agree to develop _____ (ac) of agriculture land (Thram#:_____) at _____ as per the land development specifications provided in the ALDG 2017.

I also hereby agree to use the developed land only for agriculture purposes for a minimum of 10 years. Should I fail to abide by this agreement, I will be liable to reimburse all the cost incurred in developing the land.

Date: _____ Place: _____

ALD Proponent

(Legal Stamp)

Signature
Name:
CID#:
Mobile #:

Implementing Agency

Signature
Name:
Agency:
Mobile #:

Proponent's witness

Signature
Name:
CID#:
Contact #:

Agency's witness

Signature
Name:
CID#:
Contact#:

B3: ALD Feasibility Assessment Form

Date:

1. Name of the Proponent:_____ CID No.: _____
2. Type of proponent: a) Individual ☐ b) Community/Group ☐ c) Institution/Private Sector ☐
3. Village:_____ *Gewog*:_____ *Dzongkhag*:_____
4. Name of the proposed ALD site:_____ Thram No.:_____
5. Land category (Thram): _____ Current land use:_____
6. Area of the proposed site(s): _____ Proposed ALD type _____
7. Location of proposed site (s): a) In same location ☐ b) In a cluster ☐ c) Scattered ☐
8. Site Information:
   a) Altitude (m) _____ b) Slope (°) _____ c) Aspect (°) _____
   d) Surface stone (%) _____ f) Surface drainage: Well drained ☐ Poorly drained ☐
   g) Risk of land degradation: Yes ☐ No ☐ If yes, specify_____
   h) Vertical height from the nearest stream/river (m) _____
9. Soil information:
   a) Soil depth (cm) _____ b) Stone content (%) _____ c) Texture _____
   d) Soil drainage: a) Excessively well drained ☐ b) Well drained ☐ c) Poorly drained ☐
10. Road access: Yes ☐ No ☐
11. Any other observations:_____
12. Is the proposed site feasible for the proposed ALD? Yes ☐ No ☐ Justify _____

_____

_____

_____

NB: Refer this guidelines whether the site and soil information fulfils the criteria of the proposed ALD technology.

Name & Signature of all committee members **Date:**

B4: ALD Data Collection Form

Date:

1. Name of the proponent: _____ CID No.: _____
2. Type of Proponent: a) Individual ☐ b) Community/Group ☐ c) Institution/Private Sector ☐
3. Village:_____ *Gewog*:_____ *Dzongkhag*:_____
4. ALD Type:_____ Area (ac):_____ No. of years under ALD: _____
5. Main crop yield: a) Before ALD (ton/ha): _____ b) After ALD (ton/ha):_____
6. Soil fertility: a) Before ALD (NPK): _____ b) After ALD (NPK): _____
7. Surface stone (%): a) Before ALD: _____ b) After ALD: _____
8. Landform shape (explain):

   a) Before ALD: _____

   b) After ALD: _____
9. Farm mechanization: Before ALD: Yes ☐ No ☐ b) After ALD: Yes ☐ No ☐

   Explain: _____
10. How has the cropping pattern changed after ALD? _____

    _____
11. Annual household income (Nu.): a) Before ALD: _____ b) After ALD: _____
12. Demarcate the ALD site boundary using GPS and save the track: Done ☐ Not done ☐
13. Any additional information:

    _____

    _____

    _____

    _____

Data collected by:
Name and date

REFERENCES

NSB, 2016. Statistical year book of Bhutan 2016. Thimphu, Bhutan.

MoLHR, 2015. Labour force survey report 2015. Ministry of Labour and Human Resources, Thimphu, Bhutan.

LCMP, 2010. Land cover mapping project. National Soil Services Centre, Ministry of Agriculture and Forests, Semtokha, Thimphu, Bhutan.

GNHC, 2009. Population and development situational analysis report 2009. Gross National Happiness Commission Secretariat, Thimphu, Bhutan.

DoA, 2015. Agriculture statistics for 2015. Ministry of Agriculture and Forests, Thimphu, Bhutan.

GNH Survey Report, 2015. Gross National Happiness Commission, Thimphu, Bhutan.

MoAF, 2014. Migration in Bhutan - it's extent, causes and effects. Policy and Planning Division, Ministry of Agriculture and Forests, Thimphu, Bhutan.

IPCC, 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the 4th Assessment Report. Cambridge Univ. Press, Cambridge, UK.

INDC, 2015. Intended nationally determined contribution of the Kingdom of Bhutan 2015. National Environment Commission Secretariat, Thimphu, Bhutan.

Sheng, T. C., 1981. Terracing system for small farmers. In: Conservation handbook Kraayenhagen J. (*comp.*), 14 p. (Field document, Report No: FAO-FO-THA/76/001).