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IMPROVED GRAZING MANAGEMENT TECHNIQUES FOR RAMPUR LANDSCAPE

SEPTEMBER 2016

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PARTNERSHIP FOR LAND USE SCIENCE (Forest-PLUS) PROGRAM

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CONTENTS

1.0 Background 1

1.1 National Context 1

1.2 Impetus for the study in Himachal Pradesh 1

2.0 Grazing Management Techniques Piloted 3

2.1 Technique 1: Silvopastoral system 3

2.1.1 Institutional mechanism 3

2.1.2 Demonstration Area 5

2.1.3 Species Selection 6

2.1.4 Protection measures 7

2.1.5 Fodder tree Plantation 8

2.1.6 Fodder Production 9

2.1.7 Challenges 9

2.2 Technique 2: Stall feeding – Maize Silage 9

2.2.1 Maize Silage 10

2.2.2 Maize Silage making process 10

2.2.3 Selection of maize stem for silage making 11

2.2.4 Chopping and compaction in the silo 11

2.2.5 Silage for Stall Feeding 12

2.2.6 Demonstration Effect 12

3.0 Conclusions 14

4.0 References 15

TABLES

TABLE 1: JFMC/VFDS IN RAMPUR FOREST PLUS LANDSCAPE 4
TABLE 2: PREFERENCE RANKING OF SPECIES 7
TABLE 3: FODDER TREES PLANTATION IN THE JFMC AREA. 8
TABLE 4: NUTRITION CONTENT OF MAIZE SILAGE VIS-À-VIS DRY MAIZE STEMS 11
TABLE 5: MATERIAL REQUIREMENT FOR MAIZE SILAGE 12
TABLE 6: ADOPTION OF MAIZE SILAGE TECHNIQUE 13

FIGURE 1: JFMC MEMBERS DURING FOCUS GROUP DISCUSSION IN DOI VILLAGE. 5
FIGURE 2: FODDER MANAGEMENT AREA AFTER REMOVAL OF GRASS AND WEEDS. 6
FIGURE 3: AGAVE PLANTATION AS BIO FENCING ALONG WITH BARBED FENCE. 7
FIGURE 4: OAK SEEDLINGS IN THE FODDER PRODUCTION AREA RAISED THROUGH DIRECT ACORN SEEDING. 8
FIGURE 5: QUADRANT USED TO ASSESS FODDER GRASS YIELD. 9
FIGURE 6: JFMC CHAIRPERSON SHOWING HIS MAIZE CROP FOR SILAGE PLAN 10
FIGURE 7: JFMC MEMBERS PROCESSING CHOPPED MAIZE STEM FOR SILAGE. 11
FIGURE 9: FILLING OF SILO AND COMPACTION PROCESS. 12
FIGURE 8: SILO STORAGE IN RURAL CONDITIONS. 12
FIGURE 10: PROMOTIONAL MATERIAL DEVELOPED BY FOREST-PLUS ON SILAGE TECHNIQUE IN HINDI. 13

ACRONYMS AND ABBREVIATIONS

FGD	Focus Group Discussion
FRI	Forest Research Institute
GHG	Greenhouse Gas
GIM	Green India Mission
GOI	Government of India
HPFD	Himachal Pradesh Forest Department
HRG	Himalayan Research Group
JFMC	Joint Forest Management Committee
MoEF&CC	Ministry of Environment, Forests, and Climate Change
NAPCC	National Action Plan on Climate Change
NGO	Nongovernment Organization
PVC	Polyvinyl Chloride
REDD	Reduced Emissions from Deforestation and Forest Degradation
SFD	State Forest Department
t/ha	tons per hectare
TTM	Tools, Techniques, and Methods
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

Forest-PLUS is a five-year U.S. Agency for International Development (USAID)-funded activity that contributes to global climate change mitigation by reducing greenhouse gas (GHG) emissions from India's forested landscapes. Forest-PLUS achieves this goal by developing, and demonstrating through field deployment and testing, key Reduced Emissions from Deforestation and Forest Degradation (REDD+) tools, techniques, and methods (TTM) adapted to the Indian context. Forest-PLUS contributions to establishing REDD+ in India support the Government of India's (GOI) National Action Plan on Climate Change (NAPCC), Green India Mission (GIM), and REDD+ Cell. In all its activities, Forest-PLUS works closely with the Ministry of Environment, Forests & Climate Change (MoEF&CC), State Forest Departments (SFDs), local governments, and appropriate non-governmental organizations (NGOs) to establish REDD+ in forest policies and forest management at the national, state, and local levels.

The TTMs being developed by Forest-PLUS include improved grazing management techniques that consider equity, productivity, and sustainability. Forest-PLUS undertook a grazing assessment study in the Rampur landscape, which identified prevalent unsustainable and destructive grazing practices and proposed an improved grazing management technique detailing technical interventions that include policy recommendations. The study analysed the extent of the problem in the three forest divisions of Rampur, Anni, and Kotgarh in the landscape. The technique recommended is for specific areas of the landscape comprising the lower reaches of Ani, Rampur, and Kotgarh divisions.

Forest-PLUS followed up on the study recommendations and piloted silvipastoral models and forage conservation techniques as measures to reduce grazing pressure on the forest lands. The demonstration area was selected from within a village grassland in Doi. The area was earlier used to cut and carry fodder grasses by the villagers of Doi and is close to the habitation, where local community enjoy rights of fodder collection and grazing. Traditional grasslands in the site were managed as per suggestions of the study report through the Joint Forest Management Committee (JFMC). The area was protected using biological fencing made up of Agave planted along the barbed wire fence, and JFMC members were also encouraged to adopt social fencing. Multipurpose tree species chosen by the local community have been planted in the demonstration area. The protection measures are also helping the natural regeneration of native species such as Dalbergia. The results have been encouraging: the average fodder grass production (air dry weight) was 1.4 tons per hectare (t/ha) in demonstration area as compared to 0.2 t/ha in unmanaged area. The grass yield is likely to increase significantly in coming years because of the improved management practices. JFMC members have shown interest in protecting this area from grazing, forest fires, and grass cutting by outsiders. JFMC is sharing the grass from the area among its members.

Forest-PLUS is also promoting stall-feeding in selected villages through usage of maize silage. Maize is traditionally grown throughout Rampur landscape for corn, and its stalk is used as dry fodder. Dried whole maize stalk is not palatable and results in more than 40 percent wastage of precious fodder. Maize stalk as silage, however, contains about 2.5 times more protein than dry maize stalk. Forest-PLUS is promoting maize silage to improve the quality of feed and reduce fodder wastage. The activity has had a successful demonstration, and many community members are coming forward to adopt silage. Forest-PLUS has developed simplified technical brochures, which have been shared widely to aid replication. Forest-PLUS plans to work closely with the Himachal Pradesh Forest Department (HPFD) and local communities for large-scale replication of these techniques through training and outreach.

1.0 BACKGROUND

1.1 NATIONAL CONTEXT

India, having 2.5 percent of the world's geographical area and 1.8 percent of the forest area, supports 18 percent of the domestic cattle population of the world. Livestock rearing is an important source of livelihood for the rural population in India and is an integral part of India's agrarian economy since time immemorial. It not only contributes to the national economy but also provides opportunities for employment generation, asset creation, a coping mechanism during crop failure, and offers social and financial security. India's livestock population, made up of large and small animals, depends on a meager area of the pastureland demarcated for green fodder[1]. Over the decades, the large livestock population has put tremendous pressure on the common grazing lands for feed.

In the absence of sufficient productive pasturelands, forests are an important source of grazing and fodder. It is estimated that around 60 percent of the livestock (about 270 million) graze in forests (Nayak et al., 2013). These animals include traditional confined village livestock and migratory animals herded by ethnic grazers. A study by the Forest Survey of India (FSI) has estimated that 38.49 percent (199.6 million) livestock in India are completely or partially dependent on forests for feed, either through stall-feeding or grazing (FSI, 2011). Grazing is estimated to be affecting 78 percent of the India's forests (World Bank, 2006). To overcome fodder deficit, trees in forests and from private land holdings are felled indiscriminately, which adversely affects the health of the forest.

1.2 IMPETUS FOR THE STUDY IN HIMACHAL PRADESH

Forest-PLUS program is developing tools, techniques, and methods (TTMs) for improving ecosystem management in four pilot landscapes in India. The TTMs include improved grazing management techniques taking into account equity, productivity, and sustainability. The study undertaken in Himachal Pradesh in the Rampur landscape identified prevalent unsustainable and destructive grazing practices and proposed an improved grazing management technique detailing technical interventions that included policy recommendations. The study analyzed the extent of the problem in the three forest divisions of Rampur, Ani, and Kotgarh in the landscape. The technique recommended was for specific areas of the landscape comprising the lower reaches of Ani, Rampur, and Kotgarh divisions. The technique needed to be tested in a smaller area for its applicability and then adopted across a larger area based on the results. The proposed technique includes interventions at the managerial, technical, and policy levels.

The study involved primary and secondary research including data collected from secondary sources and analysis for a better understanding of realities on the ground. The primary research involved interactions with the concerned government departments at the divisional and district levels followed by field-level discussions with Forest Range Officers, community leaders, Joint Forest Management Committee (JFMC) members, and women groups. This stratified consultative approach helped to gain insights into the issues related to grazing management and fodder requirements in the landscape.

[1] (http://www.indiaenvironmentportal.org.in/content/6087/the-great-divide/ , June 2000

Based on the discussions with the communities in the three divisions in the landscape, the concerned forest officers, as well as officers from the animal husbandry department, the following inferences were drawn:

- Over time, traditional agricultural practices are giving way to orchard development (commercial plantation of apple, plum, almonds, and related crops), becoming the primary income generating activity, while livestock rearing has become a secondary option.
- The livestock species composition, their numbers, and the methods of rearing have changed considerably with time. Locals are now rearing livestock for subsistence rather than income. Hence, the per capita livestock population has gone down with time; at the same time, the quality (in terms of milk production) has improved. Improved cattle breeds are replacing low yielding indigenous species.
- The households allow cattle to roam free once they become unproductive. The issue of stray cattle is an important factor leading to unsustainable and degrading grazing practices in the landscape affecting the naturally available fodder as well as forest.
- Invasive species such as Parthenium and Lantana are encroaching on the grasslands and forest areas, adversely affecting grass production and forest regeneration in the landscape
- Recurrent forest fires in the landscape are emerging as the major obstacle in the regeneration of the forest species.

Over time, the livestock composition, its population, and the grazing practices changed, but not entirely and not before inflicting resource degradation. The composition and total number of livestock for the migratory grazers have also reduced over time. With the change in cattle holding from unimproved breeds to hybrid breeds, stall feeding has become the preferred option to traditional grazing. Generally it is women who collect grasses from the forest. During times of fodder scarcity, women are forced to move to riskier locations, which prove fatal many a times through attack by wild animals and other factors. To minimize such risks, the forests areas are cleared of grass (often unpalatable and un-harvestable) by setting forests on fire. Burning grasses reduces the availability and thereby the risks to women who cut grass from precarious locations and steep slopes (in other words, reduces drudgery). It reduces the cover for wildlife as well, but that is not a concern to the local communities at this stage. Such practices have, over the years, reduced the natural regeneration capacity of forest areas and inhibited diversity. On the contrary, grass left unharvested from closures poses a threat to the forest, which also needs to be adequately addressed along with improved grazing management techniques.

Excessive and indiscriminate clearing of broad-leaved trees—especially of “the three oaks”—across the landscape was found to be an important driver of degradation. The practice of overcutting is damaging oak trees; at times the oaks are unable to cope with the repeated stress of overcutting, leading to immature death. In the absence of adequate regeneration, the need for taking up gap planting and ensuring sustainable harvesting can act as an appropriate corrective measure. Oaks need to be protected wherever they occur naturally in the landscape, and other broad-leaved species, suitable to the landscape, must be planted to overcome the leaf fodder requirement.

The communities expect a more proactive role from the local government departments such as the Animal Husbandry Department and the Forest Department. The Forest Department, on the other hand, has made sincere efforts by initiating Gaushalas[2], providing permits for

[2] Protective shelters for cows in India.

the migratory graziers that made grazing in the alpine pasture more systematic. All these initiatives have contributed positively in significantly reducing grazing pressure, though more can be done to address other related issues, which will further improve the grazing management in the landscape.

2.0 GRAZING MANAGEMENT TECHNIQUES PILOTED

Forest-PLUS carried out two pilot studies to investigate their utility in mitigating these issues of resource degradation. In discussion with the Himachal Pradesh Forest Department and community members and with their active participation, it has piloted a combination of techniques for grazing management in the landscape. The techniques include fodder augmentation and promotion, fodder conservation, and stall feeding.

The study highlighted two techniques to improve forest ecosystems by addressing the problem of overgrazing:

1. A silvopastoral grazing system, and
2. A silage system

The improved grazing management technique has been carried out at a pilot scale in low altitude areas of the three divisions of the landscape with the participation of stakeholders. The successful results will be replicated in other areas of the district as well as neighbouring districts and states to fulfil the objectives of the Forest-PLUS program.

2.1 TECHNIQUE 1: SILVOPASTORAL SYSTEM

The Rampur Forest Circle of Himachal Pradesh is occupied by large stretches of Ghasni (grasslands) across various altitudes. These Ghasnis are managed for grass production through destructive cultural practices such as burning and removing tree seedlings and shrubs, leaving grass cover for to meet the fodder requirement. Silvopasture practice, a combination of trees and grasses in grazing lands, is an ideal combination for producing green leafy fodder from trees and fodder grasses. In addition, this combination provides fuel wood, small timber, leaf litter, and fruit. The tree/grass combination is also useful for optimizing land productivity and limiting biotic pressure on an area. Small and marginal farmers who are engaged in raising livestock can benefit by adopting this system.

Forest-PLUS, with the active participation of the JFMCs and Himachal Pradesh Forest Department, initiated testing of the technique through a small pilot in 2015.

The steps to implement the model in the landscape identified are as listed below:

- Institutional requirements,
- Selection of a forest patch for a demonstration area,
- Species selection,
- Construction of fencing for protection,
- Fodder tree planting, and
- Watch and ward.

2.1.1 INSTITUTIONAL MECHANISM

Forest-PLUS adopted a participatory approach for testing the technique and, in consultation with the local forest officials, shortlisted 12 JFMCs from the six forest ranges in the Rampur landscape. The Forest-PLUS regional team visited these JFMCs to collect detailed information through focused group discussions. Some of the JFMCs participated actively in

the focus group discussions, and the village leadership showed keen interest in forest management related activities. The table given below lists the 12 JFMCs and includes remarks by the Forest-PLUS regional team on the level of participation and the suitability of the JFMC for testing of the silvopastoral system:

Table 1: JFMC/VFDS in Rampur Forest PLUS Landscape

Forest Division	Name of JFMC	Members		JFMC Leadership	FGD (Focused Group Discussion) Participation	JFM Area (ha)	Remarks
		Male	Female				
Rampur	Lellan	136	89	Male	Inactive	191	Inactive
	Doi		80	Female	Active	157	-Current Ghasni with clear boundary -Active role in protection and fire fighting
Kotgarh	Sainj	497	633	Male	Inactive	13	Inactive
	Naula	129	106	Male	Inactive	32	Limited area
	Kanda	180	120	Male	Active	30	Limited area
	Teshan	28	37	Male	Inactive	9	Limited area
Anni	Tharla	366	349	Male	Inactive	44	Limited area
	Sarahan	35	45	Female	Active	57	Biotic interference
	Ganchwa	64	44	Female	Active	342	Distance from settlement
	VFDS Behna	22	20	Female	Active	80	Limited area
	VFDS Khanag	93	36	Male	Inactive	80	Inactive
	VFDS Khun	88	48	Male	Inactive	80	Inactive

Source: FGD in JFMCs.

Figure 1: JFMC members during focus group discussion in Doi village.

Doi JFMC, Nankhadi Range, was selected for the demonstration program, as it was found to be suitable and its members showed keen interest in protection and management of the area where silvopastoral model would be piloted. The JFMC members, mostly women, promised their active involvement in forest fire control and protection of the JFMC area. The Forest Guard represented the HPFD in the discussions and played a key role in motivating the JFMC. Subsequently, frequent meetings were conducted with Doi JFMC members, and the JFMC members, the Forest-PLUS regional team, and the local Forest Guards jointly finalized the demonstration area.

2.1.2 DEMONSTRATION AREA

The demonstration area was selected from within a village grassland in Doi. The area had been used to cut and carry fodder grasses by the villagers of Doi and is situated between 31°22’71” N and 77°34’17”E at an elevation of 1,100 meters to 1,500 meters (mean sea level). The area is close to the dwellings, where the local community enjoys rights of fodder collection and grazing. It has natural protection from two sides: a steep slope on one side, and a deep water channel (nalla) on the other. The site was an open grazing space for the livestock of the local community before the JFMC formed in 2004. When the JFMC formed, the area was planted in small patches with Leucena, *Robinia pseudoacacia*, *Melia azedarach*, *Prunus armeniaca*, and *Pyrus pashia*. This area is occupied with indigenous grass species that regenerate naturally through seed dispersal and tuft multiplication. Commonly occurring grasses of this area are *Andropogon tristis, Chrysopogon montanus*, *Cynodon dactylon, Dichanthium annulatum,* and *Heteropogon contortus*. Grazing reduces its productivity though the grasses possess enough resistance to survive against grazing and fire.

Figure 2: Fodder management area after removal of grass and weeds.

A patch of six hectares has been set aside for production of grasses combining with fodder-yielding trees. The area had earlier been affected with fire during November 2014, and most of the grasses and JFMC plantation was damaged by the fire. It is proposed to close the area for an initial period of five years, after which it may be opened or remain closed as per the decision of the local community.

Doi village profile: Doi village has 80 households, and all of them are members of the JFMC. In total, 50 percent members belong to Scheduled castes. The average household of the village is five and the average land holding is 0.4 hectare. Average livestock per household is 1 cow and 1 goat/sheep. Dairy is an important source of cash income of 74 percent of the households in the village, followed by 70 percent households that practice subsistence agriculture. Members from 34 percent of the households are also engaged in private and government jobs in addition to dairy and agriculture. The village has high dependence on adjoining forests for fodder.

2.1.3 SPECIES SELECTION

Forest-PLUS facilitated a community led participatory process for species selection and considered the grazing study recommendations as well. Site-specific community preferences of fodder species for plantation were worked out during the Focus Group Discussion (FGD). The village is located along a steep hill slope and is suitable for a wide range of fodder tree species. The views of the community were clear during the FGD and the community unanimously supported indigenous multipurpose tree species for planting, ignoring fruit and timber yielding trees. Oak emerged as the most preferred species, though its regeneration is a challenge in the area (Table 2).

Table 2: Preference ranking of species

S.N	Species (Local Name)	Preference	Remark
1	*Quercus incana* (Ban)	1	Exists near the village on farm and forestland
2	*Grewia optiva* (Behul)	2	Exists in the village and nearby forest
3	*Bauhinia variegata* (Kachnar)	3	Exists on private and forest land near the village
4	*Morus serrata* (Toot)	4	Exists near village and farm lands
5	*Celtis australis* (Khark)	5	Available nearby in forest and farm lands

Source: FGD in JFMC.

Among multipurpose tree species Chulli (*Prunus armeniaca)*, Kainth (*Pyrus pashia*), and Majhnu (*Salix babylonica*) were also suggested, as these can meet fuel and fodder demand. Chulli and Kainth produce edible fruits, which are eaten by monkeys and can reduce the human-wildlife conflict in the area.

2.1.4 PROTECTION MEASURES

Figure 3: Agave plantation as bio fencing along with barbed fence.

The Forest-PLUS regional team developed an institutional mechanism with the JFMC, which instilled a sense of community ownership for the resource. JFMC members have been encouraged to protect the fodder production area through social fencing. The community members keep their cows, goats and sheep away from the selected fodder production area, but abandoned cattle are a threat to the newly planted area. To ward off this threat, the selected area was protected by barbed wire and live fencing of Ramban bulbs (*Agave americana*). Small agave bulbs were planted at ½-meter spacing along with the barbed wire, which would later be shifted to form a second row after the bulbs become established. A two-layered, fully grown Agave hedge will help in keeping cattle away and check forest fires from spreading from the adjacent area. The area has natural protection as well, with hills and a steep slope on one side and a stream and road on the other.

Fire is another major threat, as the mature and dry grass is susceptible to forest fire. The risk of forest fire can be tackled by timely removal of fodder grasses and weeds, which are major fire hazards if left for very long. The delay in removing or cutting grasses occurs mainly in the crop harvesting season when the local communities remain busy in their fields. With the intervention of Forest-PLUS, the community members understood the need for timely removal of grasses and addressed the issue, thereby controlling fire.

Unknown persons tried to set fire in the protected area in November 2015 from the roadside, but fire did not spread in the area because of the lack of hazardous material and only a small, inaccessible patch adjacent to the road burned.

Weeds have been a problem in the area, as noxious weeds and unpalatable coarse grasses infest grazing lands. This infestation hinders the growth of palatable grasses and thereby reduces fodder grass productivity. The prominent thorny shrubs and weeds present in the area are *Artemisia vulgaris, Rubus ellipticus, Woodfordia fruticosa, Zizyphus oxyphylla, Desmodium tiliaefolia*, and *Parthenium hysterophorus*. *P. hysterophorus* is mainly spreading through roadsides where stray cattle move freely, and its invasion in the fodder production area has been limited so far. Under the Forest-PLUS initiated pilot, the weeds growing in the grass production area were removed by cutting and uprooting just before the onset of monsoon and before the planting season, which allowed more space and light for growth of the palatable fodder grasses.

2.1.5 FODDER TREE PLANTATION

The Forest-PLUS regional team procured 1,100 saplings of fodder trees from the University of Horticulture and Forestry, Solan, and planted them in the demonstration area after closure. The demonstration plantation was planted during the early monsoon season at a spacing of 3 meters by 2 meters. Certain patches were planted out in line with the old plantation, and only gap filling was done. Existing plantation of *Prunus armeniac*, and *Melia azedarach* was left undisturbed to enrich the biodiversity of the grass production area. The protection and cultural operations undertaken in the area also benefitted the previous plantation by providing favourable growth conditions (Table 3).

Table 3: Fodder trees plantation in the JFMC area

Sn	Fodder species	Number of plants	Survival (As on April 2016)
1	*Salix babylonica.*	500	80%
2	*Grewia optiva*	100	60%
3	*Bauhinia variegata*	100	90%
4	*Morus serrata*	200	90%
5	*Celtis australis*	100	60%

Forest-PLUS has also started direct seeding of oak in the fodder production area during 2016. The JFMC was involved in the collection and direct seeding; around 2,000 acorns have been directly sown in the fodder production area, and germination is awaited.

The plantation received a short one month's rainy season for establishment and growth. There was no rainfall during the period August 2015 to February 2016, which put stress on the new plantation. Survival was recorded in the spring season (April), and plants showing new growth during the season were recorded as survived. Bauhinia and Morus have shown highest survival among the planted species.

Figure 4: Oak seedlings in the fodder production area raised through direct acorn seeding.

Figure 5: Quadrant used to assess fodder grass yield.

2.1.6 FODDER PRODUCTION

During the first year of management, fodder grass production was measured by laying 10 quadrants of 1 meter by 1 meter, randomly placed in the selected area. The fodder production results from the demonstration area were compared with the adjoining area (without protection and no silviculture operation) in October, when grass is traditionally harvested. Average fodder grass production (air-dry weight) was 1.4 t/ha in the demonstration area as compared with 0.2 t/ha in unmanaged area.

In addition, the weeded area also has clean grass, which is easy to cut and carry. Therefore, time needed to collect grass from the demonstration area has also been reduced and members can cut more grass from a managed area within given time.

As is mentioned above, the removal of unpalatable grasses, weeds, and shrubs from the grass production area would yield more fodder grass and is a standard practice by the community in their private grasslands. The community will have to be paid to weed the forests, as the community and the JFMC lack the financial resources to do it on their own, and there is no such provision with the Forest Department. There is a possibility that Forest-PLUS can demonstrate weed removal on a significant scale as a silvicultural operation.

2.1.7 CHALLENGES

Quality planting material was not easily available in the desired quantity; therefore, the plantation started with fewer numbers of the preferred species. Low rainfall during the plantation year and a long dry period resulted in poor growth and a low survival rate.

2.2 TECHNIQUE 2: STALL FEEDING – MAIZE SILAGE

In Himachal Pradesh, a major obstacle in raising dairy cattle is the lack of sufficient feed, especially during the winter season. Forest-PLUS carried out a participatory diagnosis of livestock feeding problems with the livestock owners in the Sarahan village of Rampur to better understand the problem. It was found that many cattle owners buy hay, concentrates, or feed at very high prices just to keep their animals alive during the winter. The poorly fed, unhealthy livestock expectedly produce very little milk. Traditionally, the local community has been using crop residues, especially wheat straw and maize stalks as fodder.

Maize, usually considered a food crop, produces a large quantity of crop residue. Traditionally in the Rampur region, dry maize stems are stacked for winter feeding and is an important feed crop in mountains, where the area for production is limited. The maize crop

provides livestock producers a high-yielding, relatively consistent source of forage and the animals with a highly digestible and palatable feed. During the winter, wheat straw or maize stalks are the main fodder available, together with hay and concentrated feeds. As a minimum, it is essential to provide a green fodder supplement to enhance the rumen function for bovine animals. The livestock owners are familiar with the use of crop by-products as animal feed but less familiar with forage conservation. Forest-PLUS worked on this aspect and generated awareness of forage conservation among the livestock owners, which sparked interest for testing forage conservation methods, and especially silage from the maize crop.

2.2.1 MAIZE SILAGE

Forages can be conserved as hay or as silage. Silage helps to preserve nutrients, especially protein, before they decline in the plant on maturity. Maize is a thick-stemmed crop, and its dried stem is hard for animals to chew, resulting in wastage of a large portion of the fodder. Chopped maize stem passes through a series of processes that ferment forage to produce a stable feed. The objective is to retain the nutrients present in the original forage and deliver silage accepted by livestock, usually attained through an anaerobic fermentation dominated by lactic acid bacteria.

2.2.2 MAIZE SILAGE MAKING PROCESS

Dried whole maize stem is not palatable and results in more than 40 percent wastage of valuable fodder. Silage is the material produced through controlled fermentation of semi-green agriculture crop residues or grasses under anaerobic conditions. This process is known as ensilage. The anaerobic fermentation of green herbage produces sufficient concentration of lactic acid to prevent other types of bacterial activity, such as clostridia activity that may render the material unfit for feeding. Carbohydrates in forages such as maize occur naturally or may be added as a separate ingredient, such as molasses obtained as sugar industry byproducts, which aids fermentation and prevents clostridia activities. Urea increases the crude protein content and the lactic acid content of silage made from cereal fodders.

Figure 6: JFMC Chairperson Showing his Maize Crop for Silage Plan

Anaerobic conditions in silo promote species of *Escherichia, Bacillus, Clostridium, Leuconostoc, Lactobacillus*, and *Pediococcus*. Lactic acid bacteria (*Streptococcus, Leuconostoc, Lactobacillus*, and *Pediococcus*) are the important organisms for preservation of silage of good quality. Nutritional facts about maize silage have been compared with dry maize stalk and reveal information of importance of the silage over the dry stem (Table 4).

When forage is put into a sealed container such as a drum or a plastic bag, the container is called a "**silo"**. Polyvinyl chloride (PVC) black bags of 90 centimeters by 150 centimeters were used as a silo for maize silage promotion. Two such bags are sufficient for 100 kilogram (kg) silage. Silo bags should be strong enough to withstand wear and tear during filling and compaction of the material. Experience has shown that recycled plastic bags or reject fertilizer bags serves as good silos. One bag can hold 15 kg of silage, which is enough feed for a cow in the dry season for one day. The fertilizer bag is the best type to use, as it will last for at least three seasons.

Table 4: Nutrition content of maize silage vis-à-vis dry maize stems

Nutrition Constituent (%)	Green Maize Silage	Dry Maize Stem
Moisture	70.83±0.95	17.86±2.01
pH	4.23±0.00	6.14±0.01
Protein	20.58±4.34	8.46±1.08
Carbohydrate	20.00±0.0	14.00±5.47
Fat	1.26±	1.36±
Fiber	34.00±1.00	44.33±4.61
Ash	7.61±0.03	8.18±0.91
Nitrogen (N)	1.90±0.36	0.81±0.15
Phosphorus (P)	1.0±0.00	1.0±0.00
Potassium (K)	3.24±0.15	2.94±0.41
Energy Value (Kcal/100g)	81.63±5.47	66.41±3.98

Source: HRG Primary Study

2.2.3 SELECTION OF MAIZE STEM FOR SILAGE MAKING

Semi-green maize stalks are cut before ensiling at a proper stage of maturity, as it is the most important factor for controlling the silage quality. Just after the mature corn is removed from the stalk, the stalk should be cut and stored in shade until it is chopped. Semi-green stalk produces better quality silage than overripe or dry stems.

2.2.4 CHOPPING AND COMPACTION IN THE SILO

Figure 7: JFMC members processing chopped maize stem for silage.

Fodder choppers are used to shred maize stem. Chopped silage is more palatable to livestock and has little chance of secondary fermentation. Chopped material is treated with a mixture of molasses, Urea, and salt as per the recommended ratio in Table 5. This material

is mixed thoroughly in a clean floor or mat. The chopped maize stem can be left under shade for few hours if it shows excess moisture. This mixture is than filled in silo bags. During filling in silo bags, the material is pressed with some object or the feet. A silo has to be completely sealed against air and the forage material must be compressed in the silo to ensure the fast development of anaerobic conditions and a rapid fall in pH. The purpose of chopping and compacting forage for silage is to release as much plant sugar as possible for fermentation and to ensure that all the air is pushed out of the plant material so that, when the silo is sealed, the plant material is free of air. Enough plastic from the bag must be free to tie up so that it does not come loose from the twine. Jute twine or hay baling twine is best for tying up the bag, and it should be twined around the top of the bag several times to ensure the bag is completely sealed.

Table 5: Material requirement for maize silage

Sn	Material	Quantity
1	Chopped maize stem	100 kg
2	Molasses	2-5 kg
3	Urea	200-500gm
4	Salt	100gm

2.2.5 SILAGE FOR STALL FEEDING

After 45 days of ensilage, the silage can be used for feeding animals. The sugars, proteins, and lactic acid present in the silage are subject to attack by mold growth and oxidation. Exposure of prepared silage to air should be prevented by limited opening and proper closing of the silo after silage is removed. The pH of good quality silage is 4.5 to 5.0, total nitrogen less than 10 percent, and lactic acid -3 to 12 percent. Feeding of silage to milk cows during the winter season maintains milk production and health of the cattle without cash investment and reduces fodder wastage, leading to forest conservation.

Figure 9: Silo storage in rural conditions.

Figure 8: Filling of silo and compaction process.

2.2.6 DEMONSTRATION EFFECT

The silage technique has proved beneficial to the community members in Sarahan village and has yielded good results; there is a potential for increasing the capacity of the JFMC by providing maize for fodder, a chaff cutter, mangers, and a silo for each household of the village. Forest-PLUS organized exposure visits for other villages in the landscape to Sarahan village for wider replication of the technique. As an outcome of the visit, members from two villages replicated the maize technique in their villages with Forest-PLUS demonstration support. Forest-PLUS continues to provide support through follow-up visits to check for problems and discuss with farmers their experiences with silage making. Learning

by doing, the farmers found that silage making is not difficult or as complicated as they thought it would be. The Forest-PLUS regional team and sub-contractor HRG (Himalayan Research Group) is in constant contact with the farmers to monitor adoption and discuss their needs to have a better understanding of techniques that have the best potential for success in Himalayan conditions.

Table 6: Adoption of Maize Silage Technique

Village	Members
Sarahan (Kullu)	65
Doi	3
Kanda	2
Total	70

A sustainability plan developed by HRG is also one step forward to promote the technique in the Sarahan and adjoining villages. The other groups visited are also requesting that the regional team demonstrate the technique. A simplified pamphlet on silage technique has been published for wider dissemination by Forest-PLUS. Handholding support would be required for adoption of the technique by a majority of the forest-dependent communities.

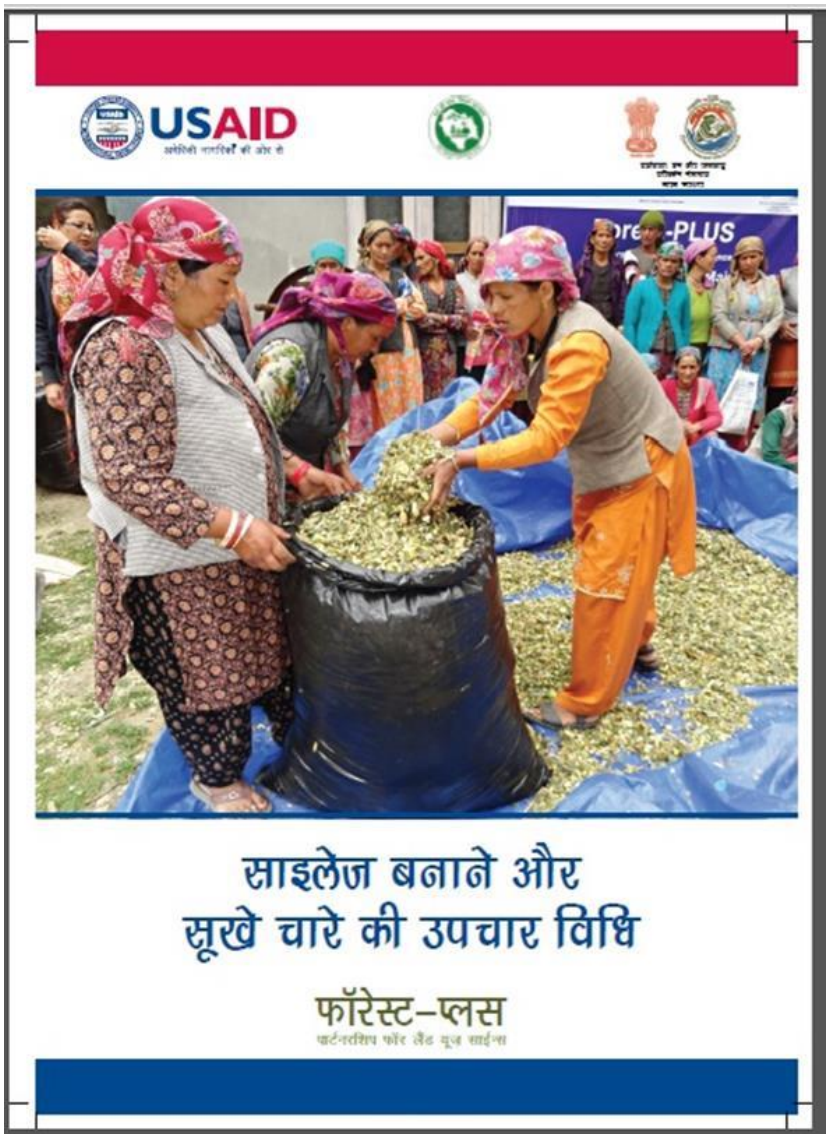

Figure 10: Promotional material developed by Forest-PLUS on Silage technique in Hindi.

3.0 CONCLUSIONS

The improved grazing management techniques are useful in reducing community dependence on adjoining forests for fodder. The silvipastoral technique enhances the productivity of grasslands (traditional Ghasani) and maintains tree cover, thereby improving the carbon pool, boosting biodiversity and improving the nutrient cycling in the forest area as compared with pure grasslands. Biological fencing and grass cuttings will help control the spread of forest fires, and improved social fencing will help JFMCs develop ownership over their forests and promote benefit sharing.

Silage has raised community interest in growing maize in their farmlands. This practice encourages stall-feeding and improves nutritional status of the agriculture waste. More silage in practice would result in less demand for fodder (hay) from forest areas. Increased availability of fodder from silage and silvipasture management would reduce forest fire, especially the winter fires that are set intentionally to yield better fodder in the next season. Improved fodder management practices such as the silvipasture system, biological fencing, and silage are helpful in protection of new plantation areas from the biotic pressures of fodder.

The improved grazing management techniques have gained popularity among stakeholders within the demonstration period, and their willingness to adopt these techniques is an encouraging sign. However, the community members and HPFD need support for large-scale replication. Forest-PLUS partner Himalayan Research Group is trying to promote the silage in the adjoining villages of Rampur Forest Circle. HRG has submitted proposals to donors for similar interventions in the landscape.

Forest Officials are trying to enrich Ghasani and plantation areas by sowing seeds of indigenous fodder species, which will result in development of grass and woody perennial combinations in the landscape. Forest-PLUS is also working on multiplying the direct seeding of indigenous fodder species in the landscape with JFMCs, Village Panchayats, and the Forest Department. There is a provision for the Forest Department to adopt the technique in its afforestation/ plantation programs and replicate it in other ongoing forestry projects in the state.

4.0 REFERENCES

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