RESEARCH PROGRAM ON Livestock

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An introduction to rangeland management planning for integrated One Health operations

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1. Introduction

Rangeland health has been identified as one of the key aspects of environmental health in a One Health framework. Halting degradation of rangelands and restoring their productivity would significantly boost livestock production and health, benefitting the nutrition, health, livelihoods, and income of pastoralist producers (Sircely and Tefera 2020). This impact can be built upon to deliver integrative 'win-win' solutions that improve rangeland productivity, and also reduce threats to livestock health. Improved rangeland health and improved livestock health can be achieved through informing coordination of grazing patterns and livestock movements, and restoration of degraded rangelands.

The integration of environmental health is a key component and objective of the One Health for Humans, Environment, Animals and Livelihoods (HEAL) project, which has the goal of fielding operational One Health Units (OHUs) on the ground that provide integrative rural services on all three aspects of One Health: people, animals, and the environment in pastoralist rangelands of Ethiopia, Somalia, and Kenya. The main roles of OHU staff focused on rangeland health are to know the local management system and how to support producers to improve it, and how to actively restore degraded rangelands and support producers to conduct it. Management planning and restoration actions taken by pastoralists can achieve stronger One Health outcomes in terms of the health of people, their livestock, and the land and ecosystems, through development of synthetic land-livestock strategies.

In pastoral areas, a 'community' can cover a large area or 'rangeland unit' (100s to 1,000s of km^2), and herds of livestock are highly mobile within this 'local area'. During some seasons and especially droughts, livestock herds in East Africa move longer distances (100s of km), and the 'community' may have visitors from other areas, or become visitors themselves. In pastoral East Africa, local institutions of some kind (traditional, government-formed, mixed, etc.) make the key management decisions for any such 'rangeland unit' (Nganga et al. 2019). These decisions include controlling how grazing management is conducted, in terms of livestock access, density, and movements in certain areas and specific seasons, along with other fundamental management decisions such as the locations of settlements and regulation of access to water points. Whether formal or informal, these local institutions vary widely in their degree of organization and effectiveness, depending mostly on the 'rangeland unit' and the leadership and membership of the institution. Any local institution can be facilitated effectively to improve the planning, implementation, and enforcement of grazing plans and other aspects of rangeland management.

Participatory rangeland management (PRM) is the essential approach for supporting these local institutions to sustainably manage rangelands for common benefit to users and residents, with a sense of local security over land and land management decisions (Flintan and Cullis 2010). Rangeland management planning in pastoral areas focuses first on large-scale grazing patterns, which can be improved through institutional rules and by-laws and their enforcement, leading to substantial improvements in feed availability (Robinson et al. 2020). The locations of non-rangeland land uses are also planned, especially settlements, cropping areas, and exclosures, as they can both benefit and disrupt the larger livelihoods system. Planning of grazing and land use provides the structure of the rangeland management plan, under which institutions guide the locations and practices used for restoration of degraded rangelands (Robinson et al. 2020). These sometimes costly investments (Napier and Desta 2011; Eba et al. 2014; Negasa et al. 2014; Kimiti et al. 2017) can be located and conducted in ways that will deliver tangible, long-term benefits to rangeland condition and livestock production, if targeted to achieve the overall management plan.

In this introduction to integrating rangeland management into One Health approaches and operations, the rangeland management planning process is described in detail, referencing the step-by-step tools developed for management planning, and with examples for each key step given for a rangeland unit in southern Ethiopia where the approach was tested. In doing so, it provides an overview of how rangeland management planning can be linked with information on livestock densities and movements, diseases, and other threats to livestock health, toward building integrative solutions for One Health in pastoral rangelands.

2. Tools development

To prepare relevant and appropriate tools for practitioners to use on the ground with local institutions to improve rangeland management, necessary due diligence was exercised in reviewing existing manuals, guidelines, and tools used to support participatory rangeland management (PRM) piloting, first in Ethiopia (Aygachew et al. 2015; Flintan et al. 2019) and more recently in Tanzania (Ministry of Livestock and Fisheries 2019) and Kenya (Flintan 2020). From this review, the first observation was that existing tools could be improved and streamlined. Second, social inclusivity in planning along the lines of gender and youth were generally weak and vague for complex pastoral societies. Finally to ensure effective, inclusive, and consistent mapping and management planning there was a need for clear, robust yet flexible, step-by-step tools for practitioners to use.

Management planning is an essential step in the process of supporting a community to improve management of its rangelands, and a detailed step-by-step tool was created (Appendix A). Since large-scale grazing management is the most important factor in rangeland management, poor grazing management makes it difficult for any pastoral community to move forward toward self-reliant resilient livelihoods, even with major investments from outside the system. In addition to the need for effective large-scale grazing planning, the other essential component of management planning is the creation of a restoration plan guiding the use of intensive restoration techniques to where they will be most effective. These are the critical tools, briefly summarized, by which communities can improve management of their rangelands. Naturally, if rangelands continue being degraded and remain unhealthy, the production of livestock suffers first, people second, and ecosystem services to greater society third.

In our case, we pushed management planning further, using management planning to also take first steps toward introduction of new or modified restoration and silvopastoral management practices, monitoring of rangeland condition, and perhaps most significantly One Health integration, in pastoral communal rangelands. Management planning includes explicit planning of intensive restoration—ranging from bush-thinning to reseeding to gully rehabilitation, etc.—to enable targeting of specific restoration options to where they are most likely to succeed as part of the management plan for the rangeland unit. One Health integration refers to improved livestock nutrition from better land management, the use of grazing patterns and restoration to reduce disease and pest effects, and any other fully synthetic, integrative actions that improve both land health and livestock health (and in doing so, human health in more than one way). These additional components were represented in mini-tools designed to capture essential information for planning and preparation of protocols for field implementation. Additional protocols (e.g. Sircely and Eba, *in press*) are and will continue to be prepared based on this information from the ground.

3. Management planning: Process to outcomes

For testing of the management planning tool, the main case study is Arda Olla, a rangeland unit composed of four kebeles in Moyale Woreda of Somali Region in Ethiopia. Arda Olla residents and users of the rangeland have an informal, moderately developed rangeland management institution based largely on traditional or customary clan-based rules. The rules of the institution include, for example, where grazing should focus and in which seasons, and the institution has the ability to issue fines and penalties for not adhering to agreed rules. Enforcement is likely not perfect, but its existence demonstrates that the rangeland management institution holds some degree of authority in the eyes of residents and users.

A rangeland unit like Arda Olla provides strong opportunities for modest changes in large-scale grazing patterns, which will reduce degradation, begin restoration and adaptation to climate change, while dramatically enhancing the livelihoods and resilience of residents and users. In doing so, several One Health opportunities are being seized on to test and deliver integrative strategies that benefit both land and ecosystems, and help control or minimize effects of livestock disease.

The existing rangeland governance in Arda Olla did include a documented management plan. The tools described here were used for management planning (Appendix A) to create a documented management plan for Arda Olla. When an existing management plan is in place for a community or a rangeland unit, these tools can serve as a guide to revise the management plan—to ensure it includes all necessary components, has high technical quality, and is a good fit to the needs of residents and users of the rangeland.

In using Arda Olla as our test case for the HEAL tools developed for management planning (and associated components—on monitoring, silvopastoral enhancement, and One Health integration), we describe the process and key results and outcomes of management planning in Arda Olla, while referring to the appropriate sections and steps in the HEAL tools to serve as a guideline for those who would like to understand or to use the techniques and tools presented in the appendices. The relevant sections of the HEAL tools (Appendix A) are given in the header of each section, with steps described in the order they arise, and examples for each step given from the experience of testing in Arda Olla.

4. Preparation (Planning Stage 1 — Preparation)

Form the planning team. Management planning begins with preparation, including identifying who will serve on the planning team (Stage 1, Step 1). The planning team should combine a mix of several key groups of stakeholders, especially traditional or customary leaders or elders, members of the rangeland institution including women, youth, and other vulnerable groups, and government representatives as observers (except in cases where local government is a part of the leadership of the local rangeland institution, they form part of the planning team).

> *In Arda Olla, the planning team included members of the community from several stakeholder sub-groups. The team included leaders of the Arda Olla rangeland institution, specifically traditional or customary elders from the Garre system (8) and leaders of the four kebeles (4). The planning team included members of the Arda Olla rangeland institution including youth (3), women (4), and men (7). These planning team members were selected to represent all four kebeles (sub-districts) that comprise the rangeland unit. They were also selected as being particularly knowledgeable on the rangeland unit, grazing patterns, and other aspects of rangeland management, among the membership of the institution.*

Briefing and visit the rangeland. Before the planning meeting is held, briefings are held for the planning team members, to introduce them to the purpose and content of the management planning meeting (Stage 1, Step 2). Once they have been briefed, a visit to the rangeland unit is conducted and the planning meeting is organized (Stage 1, Step 3).

> *From the visit to the rangeland unit in Arda Olla, it was found that the rangeland is becoming degraded over time from heavy use, poor rainfall, poor land management and governance practice. These factors resulted in declining rangeland quality, for example with serious erosion leading to gully formation.*

Rangeland management planning in Arda Olla, Moyale-Somali Woreda, Somali Region, Ethiopia, March 2021 (photo credit: ILRI/Bedasa Eba).

5. Management planning: Initial steps (Planning Stage 2A — Facilitation A)

Open the meeting. Opening of the management planning meeting is a simple step, but an important one to start the work off with introductions and a prayer as appropriate (Stage 2A, Step 1). The purpose of the meeting is then explained to the group: a management plan will be created by the community; the plan should benefit all residents and users of the rangeland; it should improve rangelands and livestock production sustainably; it can be updated at any time; and government representatives are present to ensure local awareness.

Set the vision. To set the stage for management planning from the perspective of the community, the long-term vision for the rangeland is discussed, and goals for the meeting agreed among participants toward achieving this long-term vision (Stage 2A, Step 2).

> *In Arda Olla, the vision was to improve rangeland productivity in terms of grass and browse, toward enhancing livestock production (milk and meat). All participants agreed to this vision, and agreed with the goals of management planning to accomplish their vision.*

Check maps. Management planning requires that mapping of rangeland resources has been conducted previously. However, it is important for the facilitators to re-validate this map with the planning team, to correct any major errors, and to make any changes needed (Stage 2A, Step 3). This step is especially important where the boundaries of the rangeland unit are unclear or contested; where the boundaries of subunits of the rangeland (in Arda Olla, the 4 kebeles) are unclear or contested; or where there are any other kinds of disputes or even conflicts among the membership of the rangeland unit, or with neighbouring communities.

> *In Arda Olla, a possible boundary dispute was noted during mapping; however, during management planning the planning team clarified that this was not correct. Due to remoteness and heavy rain, one kebele was not represented during mapping previously, and therefore grazing areas, water points, schools, churches, and other items were added to the map for their kebele.*

Degradation causes. In rangelands degradation and restoration do not happen quickly, and are rather the long-term results of management. Because rangeland condition changes slowly, restoration requires time and investment, which is why preventing degradation is important. To ensure that the management plan contributes to preventing and reversing degradation, the causes of rangeland degradation are identified (Stage 2A, Step 4). To help plan restoration, the locations and use of areas with severe degradation are recorded. In the next step (Stage 2A, Step 5) management objectives able to prevent or reverse these causes of degradation will be decided to direct the creation of the management plan. Rangeland degradation can take many forms, from reduced production (light degradation) to loss of preferred grasses (moderate), to major invasions of weeds, shrubs, toxic plants, invasive species and extensive bare ground with gully formation (heavy degradation). Each type of degradation will have different causes in each rangeland over time (see under Stage 2A, Step 4), including heavy grazing, droughts, cutting of large trees, infestations of shrubs, weeds, and invasive species. For a single rangeland, often more than one cause of degradation will be active.

> *In Arda Olla, which once had highland forests in its higher elevations and more large savanna trees, tree cutting over recent decades, droughts, and heavy grazing were all considered important causes of degradation. Some kebeles faced higher tree-cutting, and in areas with red soils continuous heavy grazing had led to severe erosion and gullies, while droughts affected the entire rangeland unit. Degradation from tree-cutting, heavy and disorganized grazing, and drought is a threat not only to rangeland ecosystems, but also to livestock production and health, and the livelihood and well-being of pastoralists.*

Set management objectives. Some degradation causes are more feasible to reverse. For example, droughts cannot be controlled (although their impacts can be mitigated indirectly), while forage availability can be improved through better organized grazing management. To prevent degradation and initiate restoration, the goal in setting management objectives is to identify achievable targets that will improve the livelihoods of users and residents of the rangeland unit (Stage 2A, Step 5). In other words, management objectives must be effective, must serve the needs of local producers, and must be feasible to accomplish.

> *In Arda Olla the first priority was reverse major degradation in highly degraded localities with severe encroachment of shrubs and toxic plants, and major soil erosion including gullies. Their second priority to improve the quantity and quality of forage and browse across the entire rangeland unit. Reversing severe degradation can be accomplished through restoration, while improving the quality and quantity of feed can be achieved through grazing management—these two strategies are the main approaches by which rangeland health can be improved to deliver One Health outcomes.*

Rangelands in the dry season in Arda Olla, Moyale-Somali Woreda, Somali Region, Ethiopia, March 2021. The foreground shows moderate degradation from encroachment of woody shrubs and toxic forbs, and moderate levels of soil erosion. In the background are previously forested hills (photo credit: ILRI/Bedasa Eba).

6. Management planning: Main steps (Planning Stage 2B — Facilitation B)

Grazing management planning. At the core of rangeland management is a good grazing plan, which is the most important step a community can take to begin managing their rangelands in a more productive way (Stage 2B, Step 1). A grazing plan specifies which areas can be grazed, during which seasons, for what period of time, and by how many animals. This simple statement contains a great deal of complexity, which is simplified and made practical by the grazing planning process. One way of simplifying the process is to plan when different pastures are *rested from grazing*, in contrast to planning when and where grazing is allowed.

Grazing planning starts with the seasonal calendar used locally, since most pastoralists use seasonal grazing—according to seasons and grazing areas for those seasons. Most pastoral areas in East Africa have four seasons per year—the long rainy season (on average, ~March-May), long dry season (~June-September), short rainy season (~October-December), and the short dry season (~January-February). For a specific rangeland, the precise months of rainy and dry seasons depend on its latitude, as the movement of the Intertropical Convergence Zone brings most rainfall to East Africa. These seasons are used by pastoralists to focus grazing in the pasture types most appropriate for the season, and the two main pasture types are dry season grazing areas, and wet season grazing areas (drought reserves, exclosures, and other pasture types are other possibilities). Generally speaking, dry season grazing areas have higher grass production and quality, are in lower areas of the landscape (near rivers, streams, swamps), and often have water available—for these reasons, dry season grazing areas are grazed mostly during the dry season. Wet season grazing areas typically have lower grass production and quality, are in higher areas of the landscape (often rocky hills), and often have water available only in ponds formed by rainfall—wet season grazing areas are grazed mostly during the rainy season. By simply shifting seasonal grazing pressure between wet and dry season grazing areas, the other areas are rested from grazing, which helps rangelands to recover from grazing to maintain productivity and healthy rangeland condition.

Seasonal grazing can be either 'complete' or 'partial' (Robinson et al. 2020). In 'complete' seasonal grazing, a grazing area is rested fully, with no livestock grazing, when the season is not right. For example, in a dry season grazing area, all grazing is prohibited during the wet season (and *vice versa*; in a wet season grazing area all grazing is prohibited during the dry season). More common than 'complete' seasonal grazing is 'partial' seasonal grazing. In 'partial' seasonal grazing, some animals are allowed to remain year-round in each grazing area. For example (Figure 1), during the wet season, 20% of the total community livestock herd may be allowed to graze in the dry season grazing area, meaning that 80% of the total herd grazes in wet season grazing areas. Similarly, during the dry season, 20% of the total herd may graze in the wet season grazing area, so that 80% of the total herd grazes in dry season grazing areas. These proportions are not ideal, but they are sufficient to allow partial resting of dry season grazing areas during the wet season, and partial resting of wet season grazing areas during the dry season. A community may choose 'partial' over 'complete' seasonal grazing for several reasons including the need of households to keep the 'milk' or 'house' herd close to settlements and water to provide milk to sustain the household, and the difficulty of strict enforcement in many cases, especially in large, remote pasture areas. The 'grazing box' approach (Figure 1) is a useful way of planning partial seasonal grazing in a practical manner. Always remember, some rest is better than no rest.

Figure 1. 'Grazing box' for an example of 'partial' seasonal grazing. Percentages are the percentage of the total community livestock herd that graze in a certain grazing area during a certain season.

		Grazing areas				
		Wet season grazing area		**Dry season grazing area**		
Seasons	Wet season	80%	+	20%	=	100%
	Dry season	20%	+	80%	=	100%

Once the planning team has defined the seasons and specified their preference for 'complete' or 'partial' seasonal grazing, the local rangeland institution now has a new management system. Several institutional decisions must be made to implement the seasonal grazing plan. These decisions include the timing of opening and closing of grazing areas, whether or not the spread of invasive plant species can be slowed through grazing management, and, most importantly, the rules or by-laws that will be used to enforce grazing management. The timing of opening and closing of grazing areas can use fixed dates, which is simpler. Using flexible dates based on rainfall received and pasture condition is usually a more effective and efficient approach that can respond to the rainfall pattern of each season, which is growing less predictable due to climate change and increasing variability. Using flexible dates requires that a process for making the decision be set, including who in the local rangeland institution will have the authority to make opening and closing decisions. Grazing management needs to be enforced through rules or by-laws agreed on by the planning team, and accepted by the larger community of users and residents of the rangeland. Rules and by-laws can be set based on where and when grazing is allowed or not allowed (grazing-focused rules), where and when permanent and temporary settlements are allowed to be located, and sometimes how many animals each household can keep in those settlements (settlement-focused rules), and where and when access of livestock to water points is allowed (water-focused rules). While most rules and by-laws in pastoral systems use punishments for breaking the rules (usually fines of cash or livestock), always encourage the planning team to consider incentives that reward those who adhere to the rules, as opposed to punishment of those who break the rules.

In Arda Olla, the planning team noted four seasons per year—the Gana long rainy season (April-June), the Adolesse long dry season (July-September), the Hagaya short rainy season (October-December), and the Bira short dry season (January-March). 'Partial' seasonal grazing was selected by the planning team, allowing some animals to remain year-round in each grazing area. 'Partial' seasonal grazing was selected on account of the locations of settlements, which make full grazing bans impractical, and the cost and challenge of enforcement of 'complete' seasonal grazing. The 'partial' seasonal grazing for Arda Olla allows only a small proportion of animals to be outside of the 'right' grazing area at the 'right' time of year (Figure 2).

Figure 2. 'Grazing box' for 'partial' seasonal grazing in Arda Olla. Percentages are the percentage of the total community livestock herd that graze in a certain grazing area during a certain season.

		Grazing areas				
		Wet season grazing area		**Dry season grazing area**		
Seasons	Wet season	90%	+	10%	=	100%
	Dry season	20%	+	80%	=	100%

The Arda Olla partial seasonal grazing plan allows for restorative resting of rangelands, a plan more effective and ambitious than some (e.g. Figure 1). Under the grazing plan, 10% of the total herd can remain in dry season grazing areas during the wet season, but these animals are restricted to areas close to settlements only, and only certain livestock types will be allowed (milking cows and camels, young and weak animals, and equines used to transport water and other loads). The 20% of animals in wet season grazing areas is not to be strictly enforced during the dry season, because grazing is low in wet season grazing areas during the dry season, due to lack of water for livestock and availability of pasture elsewhere. The plan is effective, yet is not perfect and can be improved upon. Arda Olla aspires to rest dry season grazing areas completely during the wet season, by ensuring that the remaining animals do not enter and graze dry season grazing areas, but are rather fed from other sources of livestock feed (e.g. grass from exclosures and crop residues).

The existing rules and by-laws for Arda Olla were not changed by the planning team. In Arda Olla, the rangeland management process is handled under a combined system of the traditional Garre leadership, and the administrations of the 4 kebeles. The core leadership is based in Arda Olla kebele, and there are committees for grazing and water in each of the other 3 kebeles under the rangeland unit. Grazing-focused rules include seasonal opening and closing of dry season grazing areas, as decided flexibly by a 5-member committee (4 men, 1 woman in each committee) at the level of the 4 kebeles (sub-units) of Arda Olla rangeland unit, in consultation

the administration of each kebele. Water-focused rules are determined flexibly by a separate 5-member kebele level committee (4 men and 1 woman each, led by a 'father of water' traditional leader) to decide watering times for each water point, the routes by which community members drive their livestock to water points, and separation of watering times for livestock with disease symptoms versus healthy livestock. Breaking the rules for access to dry season grazing areas results in escalating consequences for repeat violators. If someone violates the grazing rules unknowingly, they are given a warning. If they knowingly violate the rule, the individual can be punished with a fine of ETB500, or in special cases up to ETB1,000. These fines are primarily placed on anyone who brings their livestock to dry season grazing areas too early, or fails to remove their livestock from dry season grazing areas on time.

Land use planning. The final step in forming the overall rangeland management plan is land use planning for the rangeland unit. Planning includes the accepted locations for non-rangeland areas, water points, and settlements, including to maintain livestock mobility (Phase 2B, Step 2). The locations, sizes, and spatial pattern of settlements, cropping areas, exclosures for fodder production, and dry season reserve exclosures can significantly constrain livestock movements. Severe loss of mobility reduces livestock health and production and negatively affects the core livelihoods of pastoralists, and prevents pastures from being rested and causes rangeland degradation. If large areas of a rangeland unit are converted from grazed rangelands to settlements, cropping areas, and private exclosures, the size of the entire rangeland unit is effectively decreased, while livestock numbers often remain the same and end up degrading the limited rangelands available.

Usually, the locations of existing settlement are not changed. However, in some cases the decision is taken to move settlements that are causing rangelands to become degraded. Areas where new settlements and water points are to be avoided, as they would likely increase grazing pressure and degrade pastures, are documented as part of the management plan. Acceptable and prohibited locations of cropping areas and exclosures for private fodder production or communal dry season reserves, are similarly indicated. To stimulate discussion and long-term planning of these and other non-rangeland land uses, their positive and negative linkages to rangelands and grazing areas are discussed and documented. Croplands and private exclosures remove land from the communal rangelands accessible to the entire community, including its most vulnerable members, and place this land under private control. Both croplands and exclosures provide fodder for livestock, which reduces the grazing burden on rangelands at the times those livestock would otherwise be grazing. However, the removal of land from communal rangelands concentrates livestock into a smaller area, and can block movement of animals, leading to further concentrations of animals that increase risk of livestock diseases and pests, and increase risk of degradation.

The existing and acceptable locations of crops, hay-making areas near crops, private exclosures, and artisanal mining in Arda Olla were agreed. According to the planning team, cropping of more fertile rangelands areas has a negative, 'competitive' effect on rangelands. Expansion of cropping areas can contribute to rangeland degradation by displacing grazing from more fertile pastures (now converted to crops) to the remaining less fertile, uncropped pastures. Maize, the main crop grown, produces significant amounts of quality feed biomass, but generally fails to produce grain for food in the area (due to low and erratic rainfall), meaning that maize is often effectively a fodder crop. The planning team found that hay-making areas near crops had an overall positive effect on rangelands, by reducing grazing during stressed periods. Similarly, private exclosures were considered by the planning team to ease pressure on rangelands. Anyone can conduct artisanal mining, but only within a specific area. All of these land uses contribute to fragmentation of rangelands that concentrate livestock and can exacerbate rangeland degradation and disease transmission.

In the future, as nearby Moyale town and smaller settlements continue to grow, the loss of pastures and their fragmentation will make livestock production more challenging, and more of an individual than a communal enterprise. These trends may or may not be inevitable, but at minimum, the local rangeland institution will have clarified to its membership how they stand on land individualization currently. This clarity and agreement on the long-term vision for the area could improve the local sense of security over land use, hopefully enhancing the sustainability of resource management. In addition to securing rangelands for communal livestock production, the planning and protection of livestock routes is perhaps equally important in the short- and long-term to preserve mobility and reduce the threats of degradation and disease.

Reality check. The management plan has taken shape. Before completing the plan, checks are conducted to ensure that each element of the management plan is effective, feasible, and realistic (Phase 2B, Step 3). First, by returning to the management objectives identified earlier by the planning team, the management plan is checked to assess if it will successfully achieve these objectives, and in doing so, will effectively contribute to reversing rangeland degradation and accelerating restoration at large scales. Second, the plan must be feasible for it to work. It may be necessary to challenge the community on certain points that may seem difficult to implement, including both the likelihood of technical effectiveness as well as the capability of the local rangeland institution to implement and enforce the plan. Third, it is important to remind the planning team that the steps they have taken can likely be improved at a later date as new and more sophisticated options become more feasible.

> *The planning team for Arda Olla found that all aspects of the management plan are effective in addressing their management objectives, and is feasible to implement and enforce. Since the existing grazing management and enforcement approaches already in place in Arda Olla are a significant advantage, they are not likely to face unexpected challenges in introducing the management plan.*

Action planning. The rangeland management plan is complete at this point, with the exception of restoration planning. This is the time to begin action planning for the rangeland (Phase 2B, Step 4), so that when the planning team comes back on the second day, they will have had some time for reflection on what changes may need to be made, and the final action plan will be more effective and feasible. Action planning follows the simple framework presented in 'Tool 1-2: Annual work planning for the rangeland management institution' (Robinson et al. 2020).

> *In Arda Olla several actions were planned for the next one year. Some of these actions seek to clarify and grow local ownership over range management, and to coordinate with neighbouring pastoralists. First, they planned to hold meetings in major settlements and with potentially vulnerable groups to explain the management plan and get feedback. They also planned walking tours to clarify the boundary of the rangeland unit with neighboring communities, and to clarify the boundaries of grazing areas and sub-divisions inside the rangeland unit. Planned discussions to sensitize neighboring communities on the management plan are geared toward preventing conflicts and disruption of the plan. Finally, all members of the community planned more organized efforts to strengthen the existing grazing system through enhanced sensitization and enforcement, a collective responsibility placed upon the entire membership.*

7. Planning Stage 2C — Facilitation C

Restoration planning. The management plan provides the large-scale plan for grazing and land use, including structure and operations, and the rules and by-laws needed to enforce the plan. This large-scale plan can now be used for targeting intensive restoration techniques to portions of the rangeland where they are most needed to reverse severe degradation (Phase 2C, Step 1). Intensive restoration techniques in lightly or moderately degraded rangelands include resting for one or more growing seasons, reseeding of preferred grasses, and prescribed fire (Hunt et al. 2014). In highly degraded rangelands, intensive restoration techniques can include removal of encroaching shrubs and invasive species (Kimiti et al. 2017), gully rehabilitation and soil and water conservation structures such as trenches (Desta et al. 2005), and creation and enhancement of communal exclosures (Napier and Desta 2011; Aynekulu et al. 2017) but empirical evidences are scarce. Particularly, the role of livestock exclusion related to soil carbon sequestration is not well understood in arid and semiarid savannas of Africa. We investigated the effectiveness of long-term (14–36 years old. These techniques are generally costly in terms of inputs of labour and/or seed, and grazing lost during the recovery phase. To be most effective they must be located where they will produce tangible benefits relative to these costs, and where grazing can be controlled to prevent their failure. Alternatively, some low-cost techniques are available, such as 'short-resting' of degraded areas early in the rainy season (Ash et al. 2011; Robinson et al. 2020). High-priority restoration options can be tested through action research trials. Not only do these trials serve as an effective demonstration of restoration benefits observable to the entire community, the 'control' plots can serve as monitoring plots for the condition of the larger rangeland, especially when used as ground data to train remote sensing models able to track grassland condition at the scale of entire rangeland units.

The first step in restoration planning is to document previous and ongoing restoration efforts, as this experience should be built upon. Next, the planning team is asked to create an ideal list of restoration ideas. This ideal list is then refined into an effective and feasible list of restoration options for the restoration plan. The restoration plan specifies which restoration practices are to be applied, where in the landscape, when, and by whom. The resources in terms of tools, labour, and other inputs are also listed as part of the restoration plan. Finally, the plan includes prioritization of which areas are to be restored first, by which restoration techniques, and when it is to be initiated.

> *Previous and ongoing restoration in Arda Olla has been limited to soil and water conservation measures, specifically trenches dug to enhance infiltration of rainfall. Other 'ideal' options listed by the planning team consisted of range reseeding, planting of fodder trees, removal of encroaching toxic plants and shrubs, and gully rehabilitation. The area has extensive degradation on red soils (nitisols), where an unidentified toxic annual forb is invading rangelands alongside several Acacia spp. and other woody shrubs. The restoration plan calls for soil and water conservation measures as first priority, removal of encroaching toxic plants and shrubs as second priority, reseeding and planting of fodder trees third, and gully rehabilitation fourth. These techniques in order of priority were planned to be conducted over a three-year period. An action research trial focused on removal of encroaching toxic plants and shrubs will serve as a demonstration site, and the unmodified trial 'control' plots will provide rangeland monitoring data capable of detecting changes in rangeland condition in degraded portions of the rangeland unit.*

One Health and rangelands. To help leverage rangeland health improvement to also mitigate livestock diseases and pests, thereby strengthening livelihoods and advancing One Health, the One Health linkages of rangeland ecosystems are assessed (Phase 2C, Step 2). The first line of questioning is general, and focuses on whether the planning team is aware of any possible approaches for controlling livestock disease, or improving livestock health, through changes to grazing management. In other words, can livestock movements and grazing patterns be changed in any way, that also reduces the likelihood of disease transmission, reduces parasite loads, or otherwise benefits livestock health? This inquiry includes diseases affecting only livestock, but also zoonoses that can be transmitted to people as well. Possible One Health linkages of rangeland management are addressed directly by asking about several specific

livestock diseases, their vectors, and parasites, that have been identified as possible areas for integrative One Health action. Specifically, the planning team is questioned on whether the following are present: tsetse flies and animal and human trypansomiasis; ticks, mastitis, and tick-borne diseases; and soil-transmitted helminths including hookworm, roundworm, and tapeworm. The possible linkages of these diseases and parasites to grazing patterns and rangeland degradation are assessed, as each may be influenced by rangeland degradation and grazing patterns, or the converse. Any other major livestock diseases and parasites, and any other linkages of livestock health to rangeland management and degradation are recorded, along with any cases of these diseases in people. Finally, the potential for integrative One Health solutions is assessed by asking whether the planning team has ideas for changing grazing management, or restoring rangelands, helping to control livestock diseases, parasites, and any other aspects of livestock health.

> *In Arda Olla, pastoralists use several approaches to protect the health of their livestock through grazing patterns and livestock movements. They typically avoid grazing their animals in areas dominated by invasive plants toxic to livestock; they frequent shift the locations where animals are kept at night due to the prevalence of worms in manure that accumulates in corrals; and they split their herds into smaller groups sent to different areas, to prevent them from joining large concentrations of livestock in certain pastures where disease transmission among animals may occur rapidly. All of these strategies come from the local or traditional knowledge and experience of pastoralists, demonstrating the value of building upon this knowledge when designing approaches for improving livestock health.*
>
> *Livestock health in the area is affected by tsetse flies and trypansomiasis, ticks and mastitis, soil-transmitted helminths (worms), parasitic flies that lay eggs in animal wounds or lead to emaciation, other external parasites, and toxic plants. An as-yet unidentified toxic forb has recently invaded the area and has become a major problem. Moreover, each of these livestock health problems are related to rangeland degradation, which reduces the effective pasture area, leading to heavy grazing on the remaining rangeland (causing further degradation), and increasing loads of ticks and other external parasites due to concentration of livestock into smaller portions of the rangeland. Several other diseases and livestock health problems are affected by grazing patterns and concentration of livestock into smaller areas, including internal parasites, lumpy skin disease, peste des petit ruminants (PPR), foot-and-mouth disease (FMD), and contagious caprine pleuropneumonia (CCPP).*
>
> *One the main forms of rangeland degradation in the area is encroachment of shrubs and toxic plants. Shrub encroachment may be cause of the expansion of tsetse into new areas (Egeru et al. 2020), which was historically absent from Arda Olla. Pastoralists commonly avoid areas known to host tsetse, which reduces the available pasture area, and furthermore results in under-grazing of tsetse-infested areas that helps shrubs encroach more aggressively. Encroachment of shrubs has been linked to increased tick populations in southern Ethiopia (Bikila et al. 2016)grazing enclosures (rangelands enclosed for 20 years for dry season grazing. If shrub canopies also offer a more suitable micro-habitat for persistence of soil-transmitted helminth eggs (Brooker et al. 2006), shrub encroachment may have multiple links to livestock health and One Health. Positive feedback loops such as these degradation-disease-degradation cycles have been implicated in degradation in rangelands (Anderies et al. 2002; Enfors and Gordon 2007)rainfall variability and poor soils make these systems inherently vulnerable, and land degradation reduces their capacity to cope with disturbances. In this paper we propose a theoretical framework for interpreting dynamics and resilience in such systems, where two aggregate variables, the agricultural soil water index and the ecosystem insurance capacity, are particularly important. We apply the framework to the case of the Makanya catchment in Tanzania and conclude that the studied area has moved towards an increasingly degraded state, where ecosystem services other than food have been lost, over the past 50 years. Three main drivers behind this are identified; a, but not as yet including livestock health as a essential mechanism. Well-organized grazing in accordance with local livelihoods objectives, and intensive restoration of heavily degraded areas, should effectively reduce the risk and burden of multiple livestock diseases and parasites in Arda Olla.*

Silvopastoral options. The potential of silvopastoral enhancement of rangeland production systems (Phase 2C, Step 3) is assessed to identify how trees can play a stronger roles in benefitting livelihoods. Silvopastoralism refers to management systems that include woody trees and shrubs in lands used for grazing and browsing (Plieninger and Huntsinger 2018). In pastoralist rangelands in East Africa, the two main strategies for silvopastoral enhancement are large-scale management of existing woody cover, and small-scale planting fodder trees and shrubs in ungrazed locations, both of which can benefit livelihoods. In a sense, pastoralists are already 'silvopastoralists' by tradition and practice, as they typically have herd browsers like goats and camels, in landscapes such as savannas that are defined

by mixed grass and woody vegetation. Their local knowledge on the benefits of healthy tree cover, to the land (grass production, erosion control) and to livestock (feed, shade), among other benefits, often leads to rules or by-laws governing tree-cutting. Governance may be most important and most successful in protecting the most valuable trees, such as large *Acacia* and other trees that take eons to replace, and species producing marketable gum resins. The other main opportunity for enhancing silvopastoral aspects of pastoral rangelands are in the settlements, cropping areas, and exclosures—fodder trees and shrubs are unlikely to survive outside of these 'niches' in the landscape where grazing can be effectively controlled. Since these locations are usually around settlements, an increased fodder supply would benefit household milk herd production. An assessment of silvopastoral enhancement opportunities is conducted to clarify the potential of these strategies in a particular rangeland.

> *Management is in place in Arda Olla for high-value naturally occurring rangeland trees, especially gum-producing species, where a fine of ETB300 is placed on anyone whose cutting causes the death of any species producing gum arabic (Acacia senegal), myrrh (Commiphora myrrha), or frankincense (Boswellia neglecta). Similarly, cutting of trees used for beekeeping hives results in a ETB1,500 fine from kebele administrations, underscoring the potential of beekeeping to help conserve larger, valuable trees, while also producing a valuable commodity. These rules and by-laws are important, and could be built upon to enhance protection of large trees and shrubs in the landscape. Alternatively, some shrubs and trees unpalatable for livestock can be used to make beekeeping hives and charcoal. Some of these unpalatable species are likely among those shrubs and trees encroaching on rangelands and causing land degradation, which is generally managed by bush-thinning. Clearly, by-laws have a role to play in enhancing healthy woody cover, and this potential will be addressed in future engagements.*
>
> *Earlier in management planning, planting of fodder trees was ranked third among restoration options suggested to the planning team. Settlements, cropping areas, and private exclosures are all excellent candidates for the introduction of new species, and enhanced management of locally valued species, for shade and fodder and other benefits to livestock health, welfare, and production.*

8. Planning Stage 3 — Follow-up plans

Identify other next steps. An action plan for one year has been created for the rangeland unit management plan, and a last check is conducted to see if any other key next steps need to be added to the one-year action plan (Stage 3, Step 1). The progress made in management planning may be supported through steps to help grow local ownership over range management, and to coordinate with neighbouring pastoralists. Common first steps toward building ownership include holding meetings to explain the management plan and receive feedback. Meetings should be held in all major settlements and areas of the rangeland unit. Meetings should also be scheduled to engage specific groups of potentially vulnerable residents and users, with separate meetings for women and women's groups, the youth, ethnic minorities, and internally displaced people (IDPs). Ownership can benefit from clarifying boundaries of grazing areas and subunits of the rangeland, and an organized walking tour is an effective approach. Similarly, an organized walking tour can be used to clarify the boundaries of the rangeland unit with neighbouring communities. Discussions with neighbouring communities are important for sensitization and any possible feedback on the management plan. These and other first immediate steps are listed, ranked in order of priority, and key next steps for the next one-year period are agreed. These next steps will be added, as needed, to the one-year action plan for the rangeland unit.

In Arda Olla, no new next steps needed to be added. All of the examples above were addressed in the action plan.

Plan other next steps. Any new next steps identified are added to the one-year action plan for the rangeland unit (Stage 3, Step 1). For each new next step agreed upon, action planning is conducted in terms of responsibilities, timelines, and resources needed. The action plan is now in its final form.

In Arda Olla, no new next steps were added to the action plan.

9. Conclusion

In this introduction to rangeland management for integrated One Health approaches and operations, the process of rangeland management planning has been described, while referencing the step-by-step tools developed for management planning. Examples are provided for each key step in planning from Arda Olla, a rangeland unit in southern Ethiopia where the approach was tested, to depict the relevant information obtained and how this information can be translated into feasible actions. Rangeland management planning can be linked with information on livestock densities and movements, diseases, and other threats to livestock health, toward building integrative solutions for One Health in pastoral rangelands.

An effective management plan was created and documented for Arda Olla. The plan is not perfect and can be improved upon, for example by resting dry season grazing areas completely during the wet season, and by ensuring that the remaining animals do not enter and graze dry season grazing areas, but are rather fed from other sources of livestock feed (e.g. grass from exclosures and crop residues). Here the roles of cropping, exclosure, and feed preservation demonstrate their potential ability to reduce grazing pressure on the rangeland, especially during dry seasons or droughts when mortality of perennial grasses is most severe. Rangeland governance in Arda Olla can be enhanced to achieve greater success. A rangeland unit like Arda Olla provides strong opportunities for modest improvements in large-scale grazing patterns, that will deliver substantial benefits to rangeland health and livelihoods at the scale of the entire rangeland unit. Improved management, community ownership, and adherence of the community to the management plan will reduce degradation, begin restoration and adaptation to climate change, while enhancing the livelihoods and resilience of residents and users. As this process moves forward, several One Health opportunities are being seized on to test and deliver integrative strategies that benefit both land and ecosystems, and help control or minimize effects of livestock diseases and parasites, and other threats to livestock health.

Management planning in Arda Olla revealed several key areas showing strong, direct, and immediate means for improving One Health through rangeland management in combination with livestock management. Concentration of livestock into smaller areas, including effects of rangeland fragmentation blocking livestock movements, was seen by Arda Olla leaders as a threat to livestock health. Pastoralists currently take action to mitigate the threat of livestock disease and parasites by splitting herds into smaller groups and avoiding such large congregations of livestock. Rangeland degradation and expansion of cropping areas are the main causes leading to livestock being concentrated into progressively smaller areas of pasture. Not only does this concentration of livestock threaten livestock health directly, but it can also cause heavy grazing use in higher-quality pastures, leading to further degradation that threatens the entire livelihoods system. These problems can be solved through large-scale grazing management, which will provide the largest gains in feed availability, ecosystem functioning, livestock health, and producer livelihoods. Planning of land use, especially crops, in Arda Olla but also settlements and private exclosures, will slow degradation and reduce the concentration of livestock that exacerbates the threat of livestock diseases and parasites. Restoration of degraded rangelands can only be accomplished through active means, and restoration plays a significant supporting role in improving rangeland condition and feed availability.

Beyond the role of rangeland health alone in improving One Health outcomes, there are clear options for more integrative actions to improve both rangeland health and livestock health at the same time. First, the grazing management system can be tuned to provide for rangeland restoration and grazing patterns that reduce the risk of livestock disease transmission, and reduce parasite loads. Approaches for grazing to improve livestock health have high potential and will need further development through participatory engagement. These approaches will benefit from, and may require, information systems on pasture, water, livestock densities and movements, and hazards (climate, disease) that monitor these conditions on the ground, and collate and disseminate this information at larger scales to inform grazing patterns and livestock movements. Second, measures complementary to grazing management and rangeland restoration in non-rangeland portions of the landscape can reduce grazing pressure on rangelands, reducing

degradation, and providing alternative feed at times of scarcity. More productive and more sustainable cropping, alternative feeds including trees at margins of cropping areas and, in settlements, exclosures enriched with fodder shrubs and trees, and hay-making and feed preservation are the chief options here. Fodder shrubs and trees adoption may take time to observe the benefits and for acceptance to occur, but may effectively reduce grazing pressure on the larger rangeland while improving household herd milk production. However, crops and private exclosures contribute to fragmentation of rangelands that concentrate livestock into smaller pasture areas, accelerating rangeland degradation and increasing risk of diseases and parasites. If the expansion of cropping and private exclosures remains unchecked, their downsides will outweigh the benefits, and large-scale planning of these land uses can help prevent negative consequences for the most vulnerable residents most particularly.

The integration of environmental health into One Health operations on the ground in pastoral areas is challenging and is only just beginning. Practical integration requires building new approaches able to improve the health of rangelands and livestock through decisive and specific actions. As the strong apparent potential is turned into practical approaches for 'win-win' outcomes for rangeland health and livestock health, new or modified techniques and practices will emerge. These techniques and practices will be based partly on local or traditional systems, and partly on ideas introduced from the science of rangeland management and restoration, enabling the fusion of these vastly different, yet complementary sources of knowledge and experience. Management planning and restoration actions taken by pastoralists can achieve stronger One Health outcomes in terms of the health of people, their livestock, and rangeland ecosystems, through development of synthetic land-livestock strategies.

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11. Appendices

Appendix A. Rangeland management planning tool, with additional components for One Health integration, restoration, monitoring, and silvopastoral enhancement.

HEAL Participatory Rangeland Management (PRM) Protocol for Management Planning

Planning Stage 1 — Preparation

Step 1. Establish the planning team

- Visit the community, and introduce or re-introduce the external team to local leaders.

- With the leaders' assistance, identify the following members of the planning team (minimum for COVID period):
- Traditional/customary leaders _____ _____ _____ _____
- Traditional/customary leaders _____ _____ _____ _____
- 1+ Female community member(s) _____ _____ _____ _____
- 1+ Male community member(s) _____ _____ _____ _____
- Government observers _____ _____
- Other stakeholders (as needed) _____ _____ _____

- How to select the planning team:
- People with leadership roles in the community—including traditional or customary, religious, clan, or a specific locality.
- People knowledgeable on rangelands and grazing, movements, and pastures throughout the rangeland
- As a whole, the team has maximum representativeness of the larger community. This means women, youth, IDPs, neighbouring communities, , marginalized or vulnerable groups

Step 2. Hold or arrange for preparatory briefings for the planning team members

- Before the planning meeting, contact or send an intermediary to give an introduction to the goals and process of the planning meeting.

- Make sure all planning team members know and acknowledge the following:
- Time required for the meeting and overall schedule.
- The purpose of the management plan.
- What the contents of the management plan will include.

- What is expected of them in terms of their role in supporting an earnest and open planning exercise.
- What is expected of them in terms of following COVID-19 protocols.

- If a physical meeting is not possible or can be avoided, conduct these briefings by mobile phone or virtual connection.

Step 3. Visit the rangeland and organize the planning meeting

- With customary and/or other leaders, walk or drive through a portion of the rangeland area, to get a sense of possible issues:
  - What is the condition of the rangelands? Where are they degraded, and where are areas in better condition?
  - Are there significant settlements, croplands, exclosures, or other barriers to livestock movement?
  - How are exclosures managed? Are they closed permanently, or temporarily, and for which animals?
  - Where are the best areas for grazing?
  - What were the traditional patterns of livestock grazing in this area?

- Decide where the workshop should be held. The location should be central, but best at a short distance from settlements (to avoid distractions). Make sure the location has shade from trees, and is outside with good airflow.

- Agree on a date and time, and clarify the transport costs necessary for community members.

- Send out invitations by appropriate channels.

- Prepare for the planning workshop.
  - Write down a checklist of questions for the community based on the site visit.
  - Arrange for community transport, refreshments, and other logistics.
  - Prepare materials for the workshop:
    - Rangeland map: Multiple A3-size copies (minimum 3, 1 for each group). One large A1-size copy.
    - Notebook
    - Pens/pencils
    - Camera (for photos of map changes and the group)
    - Markers in several colors (for editing the map, if needed)

HEAL Participatory Rangeland Management (PRM) Protocol for Management Planning

Planning Stage 2A — Facilitation A

Step 1. Open

- Visit the community, and open the planning meeting with an appropriate prayer.
- Introductions of all planning meeting participants.
- Explain the purpose of the meeting:
    - The community participants will create a management plan for the rangeland unit.
    - The management plan will be designed to benefit the entire community, including all users of the rangeland.
    - The management plan will be designed to improve rangeland condition and livestock production sustainably over the long term.
    - The management plan will be a "living document" that the community can update when necessary or desirable.
    - Government observers are present to ensure that local government are aware of the management planning.
    - Some participants may be trainees that will run similar trainings with other communities in the future.

Step 2. Long-term vision, and agreement of goals for the meeting

- Ask the participants, what is their long-term vision for the rangeland unit? For example, improved grass cover and cow milk production? Other visions? Be as specific as possible.
- Ask the participants if they agree to create a management plan that will help them achieve their vision, and that satisfies the criteria above (under Step 1).

Step 3. Introduce the rangeland map and re-validate your understanding

- Show them maps of the rangeland: Distribute A3-size copies to the groups. Place the large A1-size copy in a convenient location.
- Mention any important issues from the previous PRM mapping reports, based on your understanding community's rangeland management. Check how correct your understanding is, and discuss any disagreements.
    - For example, if a boundary dispute was reported, invasions were reported, etc.
- Note any important changes to your understanding of the community's rangeland management. Note any disputes among community members that will require further attention.

Step 4. Identify Direct Causes of Rangeland Degradation

- Assess and document the major causes of rangeland degradation.
- Examples of degradation causes include:

    - Heavy grazing and droughts cause the loss of preferred, high-quality grasses in important pastures.
    - Heavy grazing and droughts create bare ground, cause soil erosion and reduce grass growth.
    - Shrub invasion reduces grass growth and pasture access.

- Other degradation causes are possible. Focus on the most important causes of degradation from the perspective of participants.

- Multiple degradation causes are common. Record only important causes. Rank causes in order of importance (Rank 1 = most important).

- Degradation causes normally affect only portions of the rangeland. Record for each degradation cause which areas of the rangeland are affected.

Step 5. Set Rangeland Management Objectives

- Discuss and prioritize key management objectives that can successfully reverse the root causes of degradation over large areas of the rangeland.

- Key management objectives will successfully improve both livelihoods and rangeland condition.

- Management objectives may take 5+ years to achieve.

- Examples of management objectives (to address the root causes above) include:
    - Improving the quality of grasses in important pastures.
    - Healing bare ground to reduce soil erosion and improve grass growth.
    - Removing invasive species (such as shrubs) to slow spread and improve grass growth.

- Focus on the management objectives most likely to successfully improve both livelihoods and rangeland condition from the perspective of participants.

- Multiple key management objectives are recommended. Rank key management objectives in order of importance (Rank 1 = most important).

- Management objectives normally affect only portions of the rangeland. Record for each management objective which areas of the rangeland will be affected.

HEAL Participatory Rangeland Management (PRM) Protocol for Management Planning

Planning Stage 2B — Facilitation B

Step 1. Grazing planning

- Record the seasons of the year as seen by the participants. Clarify whether grazing of wet/dry season areas follows these seasons closely, or loosely.

- Note the major seasonal movements of livestock within the rangeland unit.

- Decide whether seasonal grazing will be complete, or partial.
  - 'Complete' seasonal grazing is when the community decides that dry season areas are grazed only during the dry season, and all animals are restricted from grazing during the wet season (and wet season areas are grazed only during the wet season).
    - Strict rules like complete grazing restrictions may be necessary in some cases (e.g., for enforcement), and may be problematic in other cases (e.g., close to settlements and water).

  - 'Partial' seasonal grazing is when most animals are restricted from grazing, but not all. Some animals are allowed at any time. For example, a community could decide:
    - During the dry season, 80% of animals graze the dry season area and 20% remain in the wet season area.
    - Then, during the wet season, 80% of animals graze the wet season area and 20% remain in the dry season area.

  - For a summary of the benefits and problems with 'complete' and 'partial' rest, see pages 5-6 of PRM Toolkit Tool 2-1.

  - If 'partial' resting is selected, the participants estimate feasible limits on livestock grazing for each seasonal grazing area. Livestock grazing can be quantified in terms of:
    - Percentages of the entire herd (including all animals owned by residents and users of the rangeland). If percentages are useful, use the 'Grazing Box' tool on pages 6-7 of PRM Toolkit Tool 2-1.
    - Animal-Days (AD) of grazing = livestock units x number of days (1 livestock unit = 0.8 cattle, 10 shoats)

  - If grazing is to be unrestricted in any area of the rangeland, record these areas also.

- Decide the seasonal timing and process for animal movements. There are two main options:
  - (1) Specific, inflexible dates are pre-announced for opening and closing of wet and dry season grazing areas. These dates may be the same every year.
  - (2) Flexible dates: Dates are decided in real-time for opening and closing of wet and dry season grazing areas. There needs to be a clear process and responsibility for deciding and annoucing the decision.

- For a summary of the benefits and problems with 'inflexible' and 'flexible' dates, see page 7 of PRM Toolkit Tool 2-1.

- Assess invasive species control options
  - What invasive species do you have in your area (e.g., *Prosopis, Parthenium*)? (Note—does NOT include encroachment of native shrub species)
  - What options are feasible for controlling these invasive species?
  - What options are feasible for preventing the spread of these invasive species?

- Discuss and decide on any changes in regulation (community rules and by-laws).

  - There are many ways to create community by-laws or rules to implement seasonal grazing. The choice selected should be agreeable to community residents, and should be enforceable. A rule that cannot be enforced is a rule that does not exist.

  - Common examples of by-laws in communal rangelands include:
    - Grazing-focused rules: Grazing access is decided for each area and each season.
    - Settlement-focused rules: Areas for permanent and temporary settlements during each season are agreed. For temporary, the number of animals that can be kept by each household is decided for each season.
    - Water-focused rules: Access to water points is decided for each season, and penalties are given for using the wrong water point at the wrong time.

  - New rules: If these types of rules will not serve your community, what would? Think broadly and creatively, and consider different enforcement mechanisms.
    - Most communities select 'negative' disincentives—e.g., punishments such as fines for grazing or settling in the wrong location at the wrong time.
    - However, 'positive' incentives are also possible—e.g., those who follow the rules receive a benefit or privilege (such as access to a community credit cooperative).

Step 2. Non-rangeland areas, livestock mobility, water points, and settlements

- Assess the connection between grazing and other land uses and livelihood priorities. Non-rangeland land uses include:
  - Cropping areas for food and livestock feed
  - Hay-making areas
  - Areas for producing rangeland seeds (as well as fodder)
  - Grazing exclosures
  - Conservation areas or key habitat for wildlife valuable for tourism

  - How can the locations of these other land uses benefit rangeland management?

  - How can the locations of these other land uses cause problems for rangeland management, such as degradation?

- Assess rangeland fragmentation problems and solutions.
  - Where in the rangeland is fragmentation a problem?—e.g., where movement of livestock is blocked by farms, exclosures, settlements, gullies, shrub encroachment, etc.
  - How can fragmentation be slowed or stopped?—e.g., using community rules or by-laws on where farms, exclosures, and settlements can be located or not located

- Assess threats to livestock routes in the rangeland.
  - Are there important livestock routes that are threatened by fragmentation?
  - How can these routes be maintained?

- Assess threats to livestock routes in the rangeland.
  - Are there important livestock routes that are threatened by fragmentation?
  - How can these routes be maintained?

Step 3. Check whether management actions and decisions are likely to be successful, and any changes that may be needed.

- Return to the key management objectives that will successfully reverse rangeland degradation.

  - Will the selected management actions and decisions be successful in achieving the key management objectives?

  - What changes to management actions and decisions are needed to make success more likely?

- Take time to congratulate the participants on completing most of the work in management planning!!! Encourage them to push further:
  - Once new rules or by-laws are accepted by the community, and implemented, the community now has a different grazing system. This will be a big accomplishment!
  - Improving their management will show all outsiders that the community is managing their land seriously.
  - From this point forward, progress may come more easily because the grazing system is becoming more organised. A larger set of management options may become feasible in the near future.

Step 4. Action planning for rangeland management

- At this stage, all necessary components of the rangeland management plan have been addressed.

- Remind the participants that the management plan will need to change over time, as conditions and objectives change.

- The participants can now create a 1-year annual work plan for the rangeland unit.

- Use PRM Toolkit Tool 1-2, "Annual work planning for the rangeland management institution," to complete this task.

HEAL Participatory Rangeland Management (PRM) Protocol for Management Planning

Planning Stage 2C — Facilitation C

Step 1. Restoration, monitoring, and evaluation

- Restoration planning
    - Document past and ongoing restoration, including practices and locations
    - Create an ideal list of restoration needs, including practices and locations (with no limits on resources)
    - Make a realistic list of restoration needs, including practices and locations (using realistic resources)
    - Create a restoration plan for the next 1 to 3 years:
        - Who will do it?
        - When/timeline
        - What resources will they need?
        - Who will provide the resources?
- Decide restoration starting point to identify HEAL monitoring locations (the general area—not exact monitoring plots)
    - Where should restoration be conducted first?
        - What restoration practices should be used?
        - When should this restoration be conducted?
        - If time allows, visit the area at the end of the day and GPS the general area.

Step 2. One Health and rangelands in your area

- Do the participants know any options for controlling livestock disease, or improving livestock health, *through changes to rangeland management?*
- Do the participants know any options for controlling disease in people, or improving human health, *through changes to rangeland management?*
- Assess possible rangeland management links to One Health.
    - Ask if each following problem is present in the area (Yes or No):
    - Tsetse flies or Trypansomiasis
    - Ticks/mastitis/tick-borne diseases
    - Worms (soil-transmitted helminths, STH, including hookworm, roundworm, tapeworm)
    - Risk of wildfires

- IF the problem is present, is it related to shrub encroachment or other rangeland degradation, and how?
  - Tsetse flies or Trypansomiasis
  - Ticks/mastitis/tick-borne diseases
  - Worms (soil-transmitted helminths, STH, including hookworm, roundworm, tapeworm)
  - Risk of wildfires

- IF the problem is present, is it related to grazing patterns, and how?
  - Tsetse flies or Trypansomiasis
  - Ticks/mastitis/tick-borne diseases
  - Worms (soil-transmitted helminths, STH, including hookworm, roundworm, tapeworm)
  - Risk of wildfires

- What other links of animal health to rangeland management (grazing patterns, degradation) are present?

- What other major animal diseases are present?

- Have there been any human cases of these diseases? For example, trypanosomiasis, worms, tick-borne diseases

- How can rangeland management (grazing patterns, rangeland restoration) provide solutions for these problems?

- Are other ideas on options for controlling disease in people or livestock, or improving human or livestock health, through changes to rangeland management (grazing patterns, rangeland restoration)?

Step 3. Silvopastoral options

- Assess regulation needed for other important livelihood sources and rangeland resources, such as:
  - Gums and resins, and other high-value products from rangelands
  - Protection of large trees from charcoaling and to prevent rangeland degradation—e.g., by placing bee hives in large trees
  - Any other valuable resources produced by rangelands
- Are there any rules or by-laws are currently in place for these high-value rangeland resources? If so, record them.
- Would NEW rules or by-laws improve the sustainability of these high-value rangeland resources? Record any ideas mentioned, and any constraints to their implementation.

- Assess opportunities and willingness to plant and use fodder trees and shrubs in croplands and settlements.

HEAL Participatory Rangeland Management (PRM) Protocol for Management Planning

Planning Stage 3 — Follow-up Plans

Step 1. Identify possible next steps needed

- Next steps include:
    - Hold meetings in major settlements in the rangeland unit to explain the management plan, and to record feedback
    - Hold meetings with potentially vulnerable groups (women, youth, ethnic minorities, IDPs, etc.) in the rangeland unit to explain the management plan, and to record feedback
    - Walking tour to clarify boundaries inside the rangeland unit
    - Walking tour to clarify boundaries with neighboring communities
    - Discussions with neighboring communities

- Rank next steps in order of priority.

- Agree on key next steps for a one-year period.

Step 2. Plan next steps

- List the next steps they agreed on for a one-year period. For each agreed next step:
    - Who will do it?
    - When/timeline
    - What resources will they need?
    - Who will provide the resources?