***Table 1****. Summary of management strategies used to adapt to climate and resource conditions*

|  |  |  |  |
| --- | --- | --- | --- |
| Management strategy | | | Definition |
| Resource | Spatial resource use | Free grazing | Livestock graze freely throughout the entire pasture. |
| Rotational | The pasture is divided into four paddocks. Livestock move from one paddock to another according to one of the following strategies:  **1)** **end of the season**  **2)** **quantity/quality of resources in the paddock**  **3) body condition of livestock.** |
| Livestock | Stocking rate | Ordinary sales | In the fall, the regular livestock sale takes place (i.e., sale of weaned male calves and non-replacement cows). |
| Extraordinary sales |  |
| Breeding | Uncontrolled | Breeding takes place at any time of the year. |
| Controlled | Breeding takes place in summer. |
| Weaning | Natural | Natural weaning takes place at the age of 8 months. |
| Early | Weaning occurs between 1 and 7 months of age, depending on the mother's condition. |
| Food supplementation | No | Livestock completely dependent on naturally growing pasture. |
| Yes | The livestock system supplements feed for animals below their minimum weight. |

**THREE DIFFERENT LIVESTOCK SYSTEMS**

**Traditional-oriented** livestock farming prioritizes the preservation of traditional practices and cultural values. It involves raising livestock on open pastures, using the natural resources of the territory to support livestock production, with little or no use of external inputs. There is little attention to the improvement of cattle breeding, feed quality or herd management practices. This type of farming is often associated with low-input systems that emphasize self-sufficiency and low costs, and is practiced by small-scale farmers and communities who rely on livestock as a source of income and food.

**How ordinary sales works**: Since this farming approach does not actively manage the herd, the maximum number of animals is determined by the natural limits of the system (i.e., the availability of natural resources), not by the farmer's workload capacity. This means that apart from the normal sale of animals during the selling season, which removes animals from the system, the main factor regulating the livestock population is natural mortality due to old age and resource scarcity. On the first day of fall, they sell only all the male weaned calves and steers with the lowest OR highest live weight (with the exception of the breeding males).

**How breeding works:** breeding males and cows are constantly mixed, resulting in births throughout the year.

**How weaning works:** calves wean naturally after eight months of age or if the mother dies prematurely.

**Market-oriented** farming is a more commercial form of livestock production that is focused on profit maximization through efficient production methods, such as controlled breeding and sell of old livestock to improve the quality of the herd and the use of feed supplements to increase the number and weight of animals. In some cases, there are also practices such as rotational grazing based on animal body condition. In times of drought, a certain number of animals not intended for sale are sold off in order to maximize the profit and to purchase feed to maintain the rest of the herd.

**How ordinary sales works**: In this system, livestock is actively managed to increase production, so the maximum number of animals is limited by the farmer's workload capacity. On the first day of fall, all weaned male calves and steers with the lowest OR highest live weight (except breeding males) and old cows are sold.

If after this sale the number of animals is still above workload capacity, the farmer will sell heifers and cows with the lowest OR highest live weight until the system reaches a herd size just below the farmer's workload capacity or until the system reaches a minimum number of animals set by the farmer (i.e., a minimum number of animals to prevent the system from collapsing)

**How breeding works:** breeding males and cows are put together during the summer to concentrate the birth of animals in spring, which is the season with greatest availability of resources.

**How weaning works:** calves naturally wean after reaching eight months of age. However, they may also wean earlier if the mother dies prematurely or if the mother's body condition falls below a certain threshold.

**How extraordinary sales works:** if at any moment of the year the average live weight of the herd is lower than the minimum live weight desired by the farmer, the farmer considers that the production of the system is at risk, triggering the sale of a certain number of animals until the system reaches the minimum herd size set by the farmer. Animals with the lowest OR highest live weight are sold following the next order: 1) male calves and steers, 2) old cows, 3) heifers and cows. In other words, if all males have been sold and the number of animals is still above the minimum herd size, the farmer will start selling old cows until the system reaches the desired number of animals. If the number if still above this threshold, the farmer will sell heifers and cows until the minimum number of animals is reached.

The purpose of this extraordinary sale is to decrease the number of animals within the system that compete for resources and to generate funds to purchase feed supplements for sustaining the remaining animals during the drought period.

**How feed supplementation works:** this system prioritizes meat production over the preservation of grasslands and animal welfare. As a result, market-oriented farmers aim to sell a minimum number of animals or a minimal amount of meat during ordinary sales to maximize profits. Typically, achieving this minimum number of animals or meat production to maximize profits cannot be accomplished solely with the natural resources of the system. Therefore, feed supplementation is necessary to artificially increase the carrying capacity of the livestock system in order to support a larger number of animals.

**How rotational grazing works:** during rotational grazing, livestock are moved from one paddock to another when the average live weight of the animals falls below a certain threshold. Once the animals have been moved to the new paddock, it is necessary to wait several days to see the effect of the new paddock on the live weight of the animals before the farmer considers moving the animals again if they are still below the threshold. This is because the animals need several days to acclimate to the new paddock conditions.

**Environmental-oriented** farming prioritizes conservation of natural resources and livestock welfare over profit maximization. This type of ranching often includes practices such as rotational grazing based on the state of the resource, which allows for better management of grazing pressure and promotes healthy soils and vegetation. Control breeding is used to synchronize the birth of animals with the season of the year with the greatest availability of resources. Exceptional sales during a drought, such as the sale of old livestock and animals not intended for sale, only take place when the state of the resource is at risk, with the intention of maintaining the welfare of the animals and the conservation of the grasslands. Environmentally oriented livestock production often results in lower yields, with a lower stocking density and a slower rate of growth of the cattle. This can result in higher production costs, but has the potential to create more resilient and sustainable systems in the long term.

**How ordinary sales works**: This farming approach actively manages livestock to ensure animal welfare and grassland conservation, so the maximum number of animals is determined firstly by the farmer's workload capacity and secondly by the amount of resources in the system. During the ordinary sales, **they follow the same strategy as the market-oriented farmer**: they sell all male weaned calves and steers with the lowest OR highest live weight (except breeding males), old cows and a certain number of cows with the lowest OR highest live weight until the system reaches a herd size just below the farmer’s workload capacity or until the system reaches a minimum number of animals set by the farmer (i.e., a minimum number of animals to prevent the system from collapsing)

**How breeding works:** breeding males and cows are put together during the summer to concentrate the birth of animals in spring, which is the season with greatest availability of resources.

**How weaning works:** calves wean naturally after eight months of age or if the mother dies prematurely.

**How extraordinary sales works:** if at any moment of the year the stocking rate of the system is greater than the stocking rate desired by the farmer, the farmer considers that animal welfare and resource levels are at risk, triggering the sale of a certain number of animals until the system reaches a herd size just below the desired stocking rate set by the farmer or until the system reaches a minimum number of animals set by the farmer. Animals with the lowest OR highest live weight are sold following the next order: 1) male calves and steers, 2) old cows, 3) heifers and cows. In other words, if all males have been sold and the number of animals is still above workload capacity, the farmer will start selling old cows until the system reaches a herd size just below the desired stocking rate or until the system reaches a minimum number of animals. If the number is still above this threshold, the farmer will sell heifers and cows until the desired stocking rate or minimum number of animals is reached.

The purpose of this extraordinary sale is to decrease the number of animals within the system that compete for resources and to generate funds to purchase feed supplements for sustaining the remaining animals during the drought period.

**How feed supplementation works:** when the system meets or falls below the minimum herd size desired by the farmer, the farmer purchases feed to supplement and maintain the animals.

**How rotational grazing works:** when rotational grazing is in effect, livestock move from one paddock to another based on the SR of the paddock. Once the animals have been moved to the new paddock, it is necessary to wait several days to see the effect of the new paddock on the stocking rate before the farmer considers moving the animals again if they are still below the threshold. This is because the animals need several days to acclimate to the new paddock conditions.

***Table 2****. Summary of management strategies in use by each livestock production system*

|  |  |  |  |
| --- | --- | --- | --- |
| Management strategy | **Traditional-oriented** | **Market-oriented** | **Environmental-oriented** |
| Spatial resource use | Free grazing | Free grazing  or  Rotational grazing (based on body condition of livestock) | Free grazing  or  Rotational grazing (based on resource quantity/quality) |
| Ordinary sales:  Sell all male weaned calves and steers (except breeding males) | Yes | Yes | Yes |
| Ordinary sales:  Sell old cows | No | Yes | Yes |
| Ordinary sales:  Sell heifers and cows | No | Depending on the farmer’s workload capacity | Depending on the farmer’s workload capacity and on the state of the resource and animal welfare |
| Extraordinary sales in times of crisis:  sell livestock not intended for sale | No | Only when the body condition of livestock deteriorates does the sale of cattle with the **WORST/BEST** BCS take place, to maximize profits | Only when the state of the resource is compromised, for animal wellbeing and grassland conservation |
| Breeding | Uncontrolled | Controlled | Controlled |
| Weaning | Natural | Early | Natural |
| Food supplementation | No | Yes | Only when the system is at or below the minimum herd size desired by the farmer. |

**OUTCOMES TO COMPARE BETWEEN LIVESTOCK SYSTEMS**

* Farmer wellbeing: farm income vs workforce
  + Income:
    - Sell of animals
  + Costs:
    - Food supplementation
    - Operating costs (e.g., farm infrastructure, equipment, etc.)
    - Workforce
* Animal welfare: body condition and pregnancy rate
* Resource level: resource quantity (total amount) and quality (bush encroachment)