SUPPORTING THE TRADITIONAL RAIN-FED SMALL-SCALE PRODUCERS IN SINNAR STATE

Design Completion Mission

WORKING PAPER 3

LIVESTOCK NUTRITION

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SUPPORTING THE TRADITIONAL RAIN-FED SMALL-SCALE PRODUCERS IN SENNAR STATE

WORKING PAPER 3: Livestock Nutrition

I. INTRODUCTION

1. This paper revises and updates the previous findings of the livestock component, coined by the formulation mission fielded to the project area during the period 15 March to 3 April 2010. The paper also presents new findings and attitudes of the potential participating farmers, describes livestock production systems, livestock husbandry practices, assesses livestock productivity and constraints as well as describes the proposed interventions. The findings in this paper are based on the design completion mission that took place from 21 June to 5 July 2010 in Sennar State.

II. OVERVIEW OF LIVESTOCK PRODUCTION IN THE PROJECT AREA

A. Classes and numbers of animals raised

2. The classes and numbers of animals raised in the project area are summarized in table 1.

Table 1: Distribution of livestock by locality

<table>
<thead>
<tr>
<th></th>
<th>Cattle</th>
<th>Sheep</th>
<th>Goats</th>
<th>Camels</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dali&amp;Mazmoum</td>
<td>520308</td>
<td>429443</td>
<td>293637</td>
<td>53292</td>
<td>1296680</td>
</tr>
<tr>
<td>Abu Hujar</td>
<td>541562</td>
<td>552012</td>
<td>341255</td>
<td>66637</td>
<td>1501466</td>
</tr>
<tr>
<td>Dindir</td>
<td>383273</td>
<td>407258</td>
<td>197516</td>
<td>169745</td>
<td>1157792</td>
</tr>
<tr>
<td>Total</td>
<td>1445143</td>
<td>1388713</td>
<td>832408</td>
<td>289674</td>
<td>3955938</td>
</tr>
</tbody>
</table>

3. There are approximately 4 million heads of animals in the project area. Percentage-wise cattle numbers amount to about 36.5; sheep about 35.1; goats about 21; and camels about 7.4. When expressing the numbers of animals in terms of animal units (tropical animal units TAU), cattle still constitutes the greatest number at 59.1% followed by camels 16.9% then sheep 16.2% and last goats about 7.8%. Calculations of the number of animals in terms of animal units clearly reflect the high pressure exerted by large ruminants (cattle and camels) on the scarce animal feed resources. Cattle and camels together constitute about 76% of the total number of animals present in the state and consequently about 76% of the quantity of animal feeds go to meet the nutrient requirements of these two species. Income-wise, small ruminants like sheep and goats, together with cattle constitute the highest source of income to pastoralists in the project area. During drought spells and feed scarcity, small ruminants constitute the major coping mechanism for pastoralists in the project area due to their lower nutrients requirements and better heat tolerance in comparison to cattle.

B. Livestock Production systems

4. Three livestock production systems can be distinguished in the project area:

- The small-scale livestock production system, where households hold a few number of small ruminants (5-20 heads) and 1-3 heads of cattle. These herds are called village herds and usually graze within the village or in surrounding areas.

- The pastoral production system, where the herds migrate between summer grazing grounds to the South in Upper Nile and Blue Nile states, and rainy season grazing grounds, in Sennar,
White Nile and Gedaref States. According to estimates obtained from the local authorities, pastoral herds represent 70% of the total livestock wealth in the State.

- The herds of the mechanized schemes. With the deterioration in crop production, schemes owners have recently shifted to fattening sheep, 100-400 heads. The sheep graze on the stubble and crop residues. They access water from a hafir constructed in the scheme. Once fattened, the animals are sold in the main livestock market of Um Durman.

5. The first two production systems are facing severe shortages of rangelands and fodder. Agriculture in the project area has expanded to 3 million feddans of mechanized farming, and the conventional rainfed agriculture has shrank to 0.2 million feddans of traditional rainfed cultivation, 0.05 million feddans of irrigated areas, 0.12 million feddans of forested areas and only 0.05 million feddans of rangelands. The total land use is equivalent to the production of 3.2 million tons of dry matter of fodder. This production only covers 57% of the annual fodder requirements of the approx 4 million heads in the project area (annex 1). Up to recent times, this deficit used to be compensated by migration in the summer season. However with the increasing trend of settlement of the pastoralists, return of pastoralists threatened by insecurity in the summer grazing grounds, the key challenge is how to bridge this feed/fodder gap.

C. Flocks structure, composition and husbandry practices

6. Composition of the sheep flocks in the project area seem to be in agreement with the findings of Cook and Fadalla (1987), who reported that traditional sheep flocks in South Kordofan Sudan, contained approximately 75% breeding females. Growing young animals constitute about 20% and mature male breeding rams about 5%

7. Many of the respondent farmers stated that they control breeding (mating) time in their flocks. They reported that the main breeding seasons are January-April, followed by October-December. However, some of the interviewed farmers stated that they practice no breeding control measures and allow their animals to mate and reproduce all the year-round. The breeding control measure used was reported to be the “Kinan” (tying of purbuce with the base of the testicles). Ewes at breeding age were reported to account for >50% of the flock, the respondent farmers reported low conception and lambing rates and high lamb mortality rates.

8. Open rangelands constituted the major feed resource for raising livestock for the majority of the interviewed farmers. Moreover, farmers stated that they give no special care or attention to pregnant and / or lambing ewes/cows. Nonetheless, some of the respondent farmers reported that they provide supplements to lactating ewes and cows that rear lambs/calves when grains and sesame cakes are cheap and available. Salt-lick blocks and trace-mineral vitamins are not used. A considerable number of the respondent farmers stated that they vaccinate their sheep flocks against epidemic diseases. Vaccination was reported to be done when there is a disease outbreak.

9. The major types of cattle are Zebu humped -horned type cattle, sub-type Kenana, or North Kenana type also known as Fung cattle raised mainly by Rufaa and Rufaa Al Hoj and Kenana tribes in addition to some others like Kawahla, and Gwasma tribes. Kenana cattle are dual purpose type cattle raised for both milk and meat, but rather famous as being good Sudanese dairy cows. Under good management and feeding conditions at Umbenein Livestock Research Station, it produced about 2500 litres of milk/lactation season (of about 10 months). However under range conditions, productivity was rather poor due to nutrient deficiencies and poor management: interviewed farmers reported that milk production would not exceed 500 litres / season, with shorter lactation seasons of <5 months and very long calving intervals ranging between 15-36 months or even more than that.

III. ASSESSMENT OF LIVESTOCK PRODUCTIVITY AND CONSTRAINTS

10. Productivity of livestock in the project area is rather poor. As mentioned above, cattle produce low quantities of milk not exceeding 500 litres/lactation season with shorter periods of lactation seasons probably not exceeding 3-5 months per season. Calving intervals were rather very long ranging between 1-2 years or even longer than that as mentioned by certain respondents in the field visits. Milk hygienic handing is rather poor; processing of milk or dairy products is rather limited and traditional with some sour milk or Roub –making. Farmers use limited concentrate-feeding.
11. The productivity of small ruminants productivity was also poor, with fewer rates of twinnings and poorer growth rates of lambs under range conditions and shortage of water particularly during periods of droughts. Diseases were also mentioned by farmers as handicaps to livestock productivity. However, marketing was not mentioned as first or second order constraint to production. The most critical period for range cattle and sheep in the semi-arid zone of Sudan is from March to end of June, when ambient temperature becomes hot and range grazing is scanty and depleted of nutrients and vitamins. Sheep suffers from a variety of diseases, such as pneumonia which causes high mortality in young lambs.

12. In summary, poor rangelands and feed shortage resulting from drought and erratic rains, water scarcity and disease are the major constraints to production reported by the interviewed farmers. The majority of the interviewed farmers stated that the factors mentioned above were all first order constraints. In view of this, it can be concluded that possibilities for improving livestock productivity in the project area could be done through improving the quantity and quality of feed supply, availing drinking water, controlling disease and improving management and production traits.

IV. THE SOLUTIONS THAT WERE TESTED AND THEIR OUTCOMES

13. **Improving the quantity and quality of feed.** The State Ministry of Agriculture, Animal Wealth and Irrigation has embarked with the support of the Multi-Donor Trust Fund financed Integrated Livestock Development and Marketing Project on an ambitious project of demarcating the stock routes in the State and opening the stock routes to a width of 2 km. In addition to fodder supply from the range, other tested solutions consist of integrating grass and browse varieties in community forests and incorporating a fodder crop in the crop rotation (see working paper 2). Treatment of crop residues and resolving to supplementary feeding proved successful in other parts of Sudan. El Hag (2001) reported that premating supplementary feeding (flushing) was beneficial in improving fertility and increasing conception rates in the Sudan Desert sheep under rangeland conditions in North Kordofan State similar in ecological terms to the arid parts of Sinnar. In addition, prepartum supplementary feeding (steaming-up) reduces abortions, maintains ewe condition and results in heavier lambs at birth. Flushing and steaming-up had resulted in increased twining rates. The research found that supplementary feeding is needed for ewes lambing during hot summer months in order to restore body condition and support quick resumption of cyclicity.

14. **Availing drinking water.** The livestock water demand in the project area is estimated at 22 million m³ per year. The water gap between demand and supply is estimated at 5 million m³. The gap is currently bridged by the Agriculture Revival Programme which has constructed two dams, Abu Guroud and Doba in the project area that can be used for livestock watering. The Department of Animal Production in the MAAWI estimates that there is a need for approximately 85 additional hafirs or 30 000 m³ capacity. The Integrated Livestock Development Project is rehabilitating and constructing waternyards and hafirs in the locality of Abu Hujar. Moreover, the State is currently extending a water pipeline from the Blue Nile river to the town of Dali thus providing more reliable and cheaper source of water to the residents of the Dali rural administrative unit.

15. **Controlling disease.** Farmers and herders already treat and vaccinate their animals. They purchase the veterinary drugs from local drugstores in the market. Tested solutions in this domain include the training of paravets, providing them with a basic kit and training them to offer their services on a cost recovery basis. This system works in presence of high density of livestock, dense network of markets and a well structured referral system linking the paravets with the animal health department. Other solutions include training the pastoralists and farmers on veterinary care and organizing large veterinary campaigns in the makharef and masayef (rainy season and summer season grazing grounds). Infrastructure to control diseases includes the location of check points and crush pens along the livestock corridors/stock routes, equipped with the services of dipping tanks, mobile veterinary care, etc...

16. **Improving management and production traits.** Tested solutions include improved husbandry practices, and animal breeding. The breeding of the Kenana cattle is an on-going programme at the Um Benein Livestock Research Station.
V. PROPOSED INTERVENTIONS

A. Rationale

17. The project interventions will address the supply of fodder from the cultivated area, the communal rangelands and the community forests. It will also encompass training on disease prevention and treatment targeting the producers, both women and men. The project will not address livestock water as this is largely covered by the State investments. Animal breeding will not be considered as it is assumed that improved nutrition and good husbandry will enable existing stock to increase its productivity.

B. Model 1: Sheep supplementary feeding raised on rehabilitated natural range land

Model description

18. The realization of this intervention consists of using natural range grass for livestock grazing and supplemented by additional animal feeding concentrates. It will be achieved by the rehabilitation and development of existing communal grazing reserve and provision of animal feeding in specific times of sheep breeding and pregnancy.

Open rangeland rehabilitation and improvement

19. In Dali, the Range and Pasture Department operates a reserved range land of about 9000 feddans located across a traditional stock route. The Range and Pasture Dept is responsible for rangeland regeneration and conservation, vegetation surveys, and organization of community for operation and management of the reserve. This communal range reserve was successful in the past, however it has deteriorated recently and failed to support the nomadic community, Helat Hamad, settled around the reserve. The community is still guarding the reserve however it is routinely encroached by mechanized farmers.

20. The project intervention would address the rehabilitation, improvement and management of range resources through a set of activities including water harvesting treatment, seeding and re-seeding and community organization related to operation and management. The concept is not only to concentrate runoff for range improvement, but to rehabilitate degraded environment in an area with an average annual rainfall of only 300 – 400 mm. This area was selected mainly for range improvement because the majority of the inhabitants are agro-pastoralists.

21. On-farm micro-catchment (MC) systems are suggested as an important water harvesting techniques for runoff collection from small catchments area with mainly sheet flow over short distance. They are simple and may be constructed at low cost, making them easily replicable and adaptable. They have higher runoff efficiency than the macro-catchment systems, which require usually large catchment area – that does not exist in the adjacent area where mechanized farming dominates. MC allow soil erosion to be controlled and sediments to be directed to settle in the cultivated area. The most important rangeland-based MC or on-farm water harvesting systems for the dryland are contour ridges and runoff strips, depending on the available equipment for construction.

22. Contour ridges are one of the most important techniques for supporting regeneration and new plantation of grasses, forages and trees on gentle to steep slopes in the semi-arid and steppe areas. The contour ridges or bunds constructed along the contour line, are usually spaced between 5 and 20 m apart. The first 1 – 2 m above the bund is for cultivation, whereas the rest is the catchment. The height of the ridge or the bund varies according to the slope’s gradient and the expected depth of runoff water retained behind it. They are constructed on a wide range of slopes, from less than 1 % to 50 %. For the relatively flat topography in the reserve area, depth of 50 – 70 cm is adequate for height of bund. Bunds can be formed manually, with an animal-driven implement or by tractors with suitable implements such as bund former, land-leveler and scraper. The key success of this system is to locate the bund as precisely as possible along the contour. Otherwise water will flow along the bund, accumulate at the lowest point, eventually break through and destroy the whole downslope system. A-frame or line level can be used for contouring as the simplest survey methods. If precise contouring is not feasible, small cross-bunds (ties) may be added at suitable spacing (5 – 10 m) along the ridge to stop the flow of water along the ridge.
23. The technique of runoff strips is suitable for gentle slopes. The strips are used to support grasses, forages and field crops in the drier environment, where the production is risky. The farm is divided into strips along the contour. The upstream is used as a catchment, while the downstream strip supports crops. The downstream strip should not be too wide (1 – 3 m), while the catchment width is determined in accordance with amount of runoff water required. Under the climatic condition and hydrological set up and soils in the target site, the catchment width could be double to the downstream width or a ratio of 1:2. Runoff-strip cropping can be fully mechanized and needs only a relatively low input of labor. Under good management, continuous cultivation of the cropped strip especially with grasses of leguminous type can build up soil fertility and improve soil structure, making the land more productive. The cultivated land can be used for grazing after collecting the grass seeds or cutting of grasses. One problem this technique may face, however, is that the distribution of water across the strip may not be uniform. This happens when the cropped strip is too wide, or small ridge is formed during cultivation along the upstream edge of the cropped strip. To overcome this problem, it is recommended that the cropped strip should not exceed 2 – 3 m in width, and that water distribution should be helped by good till of the strip surface such as using chiseling.

24. The implementation of range improvement intervention entails the following activities:

- Field investigation for identification of target area and layout of range plots, tree boundary and protection sorghum strips;
- Use of simple survey technique for demarcation of contour lines and land gradient;
- Construction of contour bunds before the rainy season and/or runoff strips with chisel when the soil is thoroughly wet, along the contour with specifications described above;
- Construction of broadbed and furrows (BBF) spaced 3 m, with one meter for BBF and 2 m as catchment area for boundary tree planting (10 lines) using ditcher before the rainy season to capture and conserve early rains into furrows;
- Chisel plowing for periphery boundary planting of sorghum as protection means outside the tree shelterbelt with seeding in one operation when adequate moisture is retained in the soil;
- Broadcasting of range grass seeds on cultivated area at the rate of 5 kg per feddan with participation of community;
- Broadcasting of tree seeds (Acacia type) into the furrows of the BBF system at the rate of 3 kg/fed with participation of community;
- After receiving few showers of rain and if water distribution is not uniform, then small cross-bunds (ties) may be added at suitable spacing (5 – 10 m) along the ridge to stop the flow of water along the ridge;
- Collection of grass seeds;
- Organization of grazing process with community;
- Controlled grazing is also essential to maintain good quality rangeland, and the treated area must be rested periodically for it to regenerate, so that natural reseeding can take place.

B.1.2 Supplementary feeding

25. Preparation of the protein- mineral supplement (by weighing of the different quantities of the raw materials using a well calibrated scale or balance ranging from: 0-120 Kg, in the same quantities listed in annex table 2 for flushing of breeding female ewes during breeding or mating time (usually breeding of ewes is done 5-6 months prior to the onset of the rainy season, expected to start during July). For flushing, each female breeding ewe (in the sheep flocks that are raised on the rehabilitated range or the enhanced community forests) is given 450g of the protein- mineral supplement in addition to the feed – intake from the range or forests, every three days in separate feed troughs (during watering time of the animals) for a period of 45 days (to guarantee on-set of three oestrous cycles). Accordingly, any female breeding ewe will receive: 15x450 = 6.75 Kg of the supplement. For steaming-up, each pregnant female ewe is again given 450g of the same protein- mineral supplement, every three days in separate feed troughs (during watering time of the animals) for a period of 45 days prior to parturition. Accordingly any pregnant female ewe will receive: 15x450 = 6.75 Kg of the supplement. Consequently the total amount of the protein- mineral supplement needed by any breeding –pregnant female ewe will be = 13.5 Kg. The total amount from the supplement will therefore depend on the number of breeding –pregnant female ewes targeted. On the basis of animal units, any 1 AU is equivalent to a flock of 5 sheep and since it is assumed that under traditional systems of raising sheep in the Sudan, 70% of the sheep in any flock are considered to be breeding females, therefore in any 1 AU, there are :5x70% = 3.5 breeding females.
Table 2 – composition of the supplementary feeding for flushing and steaming

<table>
<thead>
<tr>
<th>Item</th>
<th>SSC</th>
<th>Salt lick brick</th>
<th>Supplement mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (DM%)</td>
<td>91.1</td>
<td>90.0</td>
<td>90.0</td>
</tr>
<tr>
<td>Organic matter (OM%)</td>
<td>73.6</td>
<td>69.9</td>
<td>69.9</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>17.5</td>
<td>21.1</td>
<td>21.1</td>
</tr>
<tr>
<td>Crude protein (CP%)</td>
<td>43.7</td>
<td>41.5</td>
<td>41.5</td>
</tr>
<tr>
<td>Crude fibre (CF%)</td>
<td>6.9</td>
<td>6.6</td>
<td>6.6</td>
</tr>
<tr>
<td>Ether extract (EE%)</td>
<td>6.3</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Nitrogen free extract (NFE%)</td>
<td>25.6</td>
<td>24.3</td>
<td>24.3</td>
</tr>
<tr>
<td>Energy density (Mcal DE/kg)</td>
<td>3.06</td>
<td>2.9</td>
<td>2.9</td>
</tr>
<tr>
<td>Ca (%)</td>
<td>3.66</td>
<td>3.6</td>
<td>3.6</td>
</tr>
<tr>
<td>P (%)</td>
<td>1.71</td>
<td>0.23</td>
<td>1.62</td>
</tr>
</tbody>
</table>

Source: El Hag (2001)

26. Since any breeding–pregnant female ewe requires 13.5 Kg of the protein-mineral supplement (as mentioned before), it is expected that any 1 AU of sheep requires: 13.5 x 3.5 = 47.25 Kg /breeding cycle (or per year). It is preferable to prepare the amounts of the supplement, separately for flushing and steaming-up.

27. Materials needed. In addition to the raw materials, producers will need: (i) scales (weighing balances for both feeds and animals, for monitoring and evaluation of litter weight; (ii) records for feed, birth weights, weaning weights, mortality, vaccines and drugs. Recording is very urgent and needs to be done on hard–cover note books prior to inputting in computers.

28. The assumption is that in any 1 AU equivalent to a flock of 5 sheep there are about 70% breeding females (5x70%=3.5) and under traditional range feeding conditions (without the project), fertility is low and about 57% (Fertile females:3.5x57%=2) with zero twinning % (Newly born lambs:2x1=2), mortality of newly born lambs from birth to weaning is rather high and is about 15% (surviving live lambs until weaning : 2x0.85=1.7) and weaning weight (Kg) for surviving off-springs is about 10.

Litter weight at weaning = Surviving live lambs until weaning x weaning weight

Fertile females

Litter weight at weaning (Kg/fertile female) = \( \frac{1.7}{2} \times 10 = 8.5 \)

Litter weight at weaning (Kg/AU) = 2x8.5 = 17

29. With improved feeding due to the use of the supplementary feed of a protein–mineral supplement during breeding (flushing) and pregnancy (steaming-up) periods, the quality of the feed produced by range and forest plants will be enhanced resulting in: improved fertility to 80% (Fertile females:3.5x80%=2.8) with the same number of breeding females of 3.5/5 sheep or 1AU, decreased abortions or mortality of newly born lambs to about 9% and increased twinning to about 20% (newly born lambs:2.8x20% twin births ; 0.56x2=1.12 lambs+2.8x0.8% single births=2.24x1=2.24 lambs with total number of born lambs to be:1.12+2.24=3.36 with 9% mortality , surviving lambs until weaning.

In the absence of Sesame cake, Groundnut cake can be used. Supplement mixture is prepared by mixing 5 parts of the salt lick brick with : 95 parts of the Sesame cake (W:W ) and fed at a rate of 450g/head every 3 days at watering time where the allotted amount is fed separately in separate feed troughs while the female animals are maintained on an open range grasses. For flushing, the ewes receive the supplement in the above mentioned way for 45 days at breeding (mating time). For steaming up, the ewes receive the supplement for 45 days prelambing. For flushing and steaming --up, the ewes receive the supplement both at flushing and prelambing.
are: 3.36x0.91=3.06), and weaning weight (Kg) for surviving off-springs is about 13. Accordingly litter weight after flushing and steaming-up will be:

\[ \text{Litter weight at weaning (Kg/fertile female)} = 3.06 \times 13 = 2.8 \]

Litter weight at weaning (Kg/AU) = 2.8x14 = 39.2

30. It is quite clear that the use of the supplementary feed of a protein–mineral supplement during breeding (flushing) and pregnancy (steaming-up) periods will result in an outstanding improvement of meat (liveweight or litter weight at weaning) produced/1AU of sheep.

**Target area and beneficiaries**

31. The distribution of the target areas, beneficiaries and animal units under this intervention for the demo phase and scaling up phase is shown in table 3.

**Table 3: Phasing of areas and beneficiaries for demonstration and scaling-up on model -1 (The total range reserve is 9000 feddans) – concerns 1 community**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>YR1</th>
<th>YR2</th>
<th>YR3</th>
<th>YR4</th>
<th>YR5</th>
<th>YR6</th>
<th>YR7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>Feddans</td>
<td>-</td>
<td>100</td>
<td>100</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>4200</td>
</tr>
<tr>
<td>DM-Yield: in an area of 100 fed./year</td>
<td>(ton/fed)</td>
<td>50</td>
<td>100</td>
<td>70</td>
<td>150</td>
<td>200</td>
<td>100</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Animals supported in an area of 100 fed./year</td>
<td>Animal units (AU)²</td>
<td>15</td>
<td>30</td>
<td>21</td>
<td>45</td>
<td>60</td>
<td>30</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>Beneficiaries</td>
<td></td>
<td>10</td>
<td>7</td>
<td>15</td>
<td>20</td>
<td>10</td>
<td>25</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

32. Adaptation of this intervention includes launching community based seed collection by training beneficiaries that can then become small-scale seed entrepreneurs in their community. The establishment of the seed activity would enable them to sell it to Range and Pasture Department (R&P), for rehabilitation during expansion phase, and provide them with livelihood activities for income generation. This activity will be implemented in close collaboration with the R&P to ensure selection of seeds and nomads who will participate in the project activities.

**Outputs**

33. The main output of this intervention will be increased awareness and understanding among the agro-pastoralists of the potential of the water harvesting in improving rangeland productivity in an area of 4200 feddans, increased utilization of range resources and animal carrying capacity and community returns, encouraged local community to take responsibility of protecting and developing the rest of the reserve. Indirect benefits are increased animal litter weight (meat production). These outputs are shown in (Annex 3).

**Table 4 : Outputs from model 1.**

² Any animal unit requires 3.3 tons of DM/year.
### Table 1: Livestock Nutrition

<table>
<thead>
<tr>
<th>Unit</th>
<th>YR1</th>
<th>YR2</th>
<th>YR3</th>
<th>YR4</th>
<th>YR5</th>
<th>YR6</th>
<th>YR7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>Feddans</td>
<td>100</td>
<td>100</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>4200</td>
</tr>
<tr>
<td>DM-Yield</td>
<td>(tons)</td>
<td>50</td>
<td>100</td>
<td>70</td>
<td>1500</td>
<td>2000</td>
<td>1000</td>
<td>2500</td>
</tr>
<tr>
<td>Animals supported</td>
<td>Animal units (AU)</td>
<td>15</td>
<td>30</td>
<td>21</td>
<td>455</td>
<td>606</td>
<td>303</td>
<td>758</td>
</tr>
<tr>
<td>Litter weight expected (Without intervention)</td>
<td>Kg</td>
<td>255</td>
<td>510</td>
<td>357</td>
<td>7735</td>
<td>10302</td>
<td>5151</td>
<td>12886</td>
</tr>
<tr>
<td>Litter weight expected (With the intervention)</td>
<td>Kg</td>
<td>588</td>
<td>1176</td>
<td>823</td>
<td>17836</td>
<td>23755</td>
<td>11879</td>
<td>29714</td>
</tr>
<tr>
<td>Quantities of the supplement needed for flushing and steaming-up (with the intervention)</td>
<td>Kg</td>
<td>709</td>
<td>1418</td>
<td>992</td>
<td>21499</td>
<td>28634</td>
<td>21499</td>
<td>35816</td>
</tr>
</tbody>
</table>

### C. Model 2: Sheep supplementary feeding raised on enhanced reserved community forests

**Model description**

34. For the enhanced reserved community forests, the same assumptions used for rehabilitated range are also used in the same way for flushing and steaming-up of animals raised on the enhanced forests.

**Reserved community forests enhancement and improvement**

35. In terms of numbers, Sinnar State is endowed with large number of reserved and community forests. Establishment of community forests with community participation in management and protection was successful in Sinnar to assist communities to generate income from producing timber used in the establishment of social services in addition to its environmental benefit as well as providing some grazing ground for livestock. The primary focus of community forests has been on the production of timber and firewood of economic value from *Acacia Nilotica* (*Sunt*) and *Talih* (*Acacia seyal*) trees. With the reduction of grazing areas around the villages due to expansion of agricultural lands, livestock feeding becomes a problem especially during the summer time. In some other similar semi-arid areas, animal feeding and browsing on forest trees constitutes 60 – 70 % of animal needs.

36. The improvement of these forest plantations located nearby villages will consist of the introduction of fodder trees and nutritive grass species. This is expected to diversify the income of rural communities and provide reliable source of fodder during the critical summer months. In addition to primary purpose of the fodder, the multi-purpose trees are important elements in farming systems to improve soil quality (in case of leguminous trees). This would ensure continued availability of fodder to animals from vigorous growing trees.

---

3 For practical grazing of the rehabilitated range area of 100 fed during the demo phase, it is recommended that a sort of rotational grazing be arranged under the supervision of range and pasture dept. There can be 3 equal areas or strips of the 100 fed, they should be rotated each for 3-4 weeks to allow for better utilization of range. In the demo phase, during year 2, only 30 AU are targeted and accordingly 10 beneficiaries are expected to participate from the settled pastoralists in Algwezat community. Average animal units/beneficiary is = 3 and then increase gradually in the scaling up phase.
37. The enrichment of forest plantation would require provision of multi-purpose tree seeds of high fodder value trees such as Talih (Acacia seyal), Hegleeg (Balanites aegyptiaca) and Cidir (Ziziphus spinac-christi). Within the community, a participatory approach will be used to select the Village Forestry Committees (VFC) and outline a community based plan of action to conduct the proposed activities incurred in the establishment, management and operation of the community forest. Thereafter the community will be trained on group dynamics, conflict resolution, micro-catchment water harvesting issues, planting techniques and O & M and record keeping. The existing reserved/community forests will be enriched by broadcasting of tree seeds for those located in depressions, whereas tree seedlings will be planted into newly introduced MC water harvesting planting pits installed in the upper sloping shoulders. The landscape of the area adjacent to natural ponds is intensively dissected by steep terrains and gullies. The gullies, although unfavorable for agricultural development, are good places for planting trees and grasses. Trees and grasses grow several times faster in the gullies and steep land than on the relatively dry ridge summits and slopes and give better economic yields provided that runoff water is intercepted and collected. The use of MC techniques in view of their capability to reduce flow velocities and soil loss proved to be very effective for improving plant growth. Through site investigations and analysis for the existing tree types, it is recommended to plant fast growing trees linked to the MC techniques.

38. The community will be provided with necessary tools to facilitate activities in the installation of water harvesting schemes, which would include hand-hoe, shovels and axes. Other than the tools, basic technical and advisory leaflets will be developed and distributed to communities to strengthen community understanding and skills of O & M.

Supplementary feeding

39. For the animal nutrition activities the same process of animal feed supplementation described for range improvement is used here. However for the animal nutrition component, an area of one feddan of the enhanced forests is used in each community forest with one animal unit (or a herd of 5 sheep). As mentioned, range: litter wt. in Kg without project and with project is 17 and 39.2 respectively.

Target area and beneficiaries

40. The distribution of the target areas, beneficiaries, animal units and litter weight under the forest enrichment intervention for the demo phase and scaling up phase is shown in table 5.

Table 5: Phasing of areas and beneficiaries for demonstration and scaling-up on model 2 - The enriched forests (total area is 2000 feddans)

<table>
<thead>
<tr>
<th>Area</th>
<th>Unit</th>
<th>YR1</th>
<th>YR2</th>
<th>YR3</th>
<th>YR4</th>
<th>YR5</th>
<th>YR6</th>
<th>YR7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feddans</td>
<td>-</td>
<td>280</td>
<td>280</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>DM-Yield: in an area of one fed</td>
<td>tons</td>
<td>0.5</td>
<td>1.0</td>
<td>0.7</td>
<td>1.5</td>
<td>2.0</td>
<td>1.0</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Animal units supported in an area of one fed.</td>
<td>number</td>
<td>0.19</td>
<td>0.36</td>
<td>0.27</td>
<td>0.52</td>
<td>0.68</td>
<td>0.38</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>Community</td>
<td>Number</td>
<td>14</td>
<td>14</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

41. The typical average forest area per community for the demo phase and the expansion phase is 20 feddans. The distribution of targets in table 5 indicates the total forest area covered under model

---

4 The area of one forest is about 20 feddan and each forest is on average used by one community. Average households / community is about 200.
2 includes 560 feddans during the demo phase and 1,440 feddans in the scaling up phase, benefiting a total of 100 communities.

**Outputs**

42. The expected output will be established and effectively operated community forests that provided livestock browse and feed to bridge the fodder gap during the critical times and offers additional significant potential cash resource from sale of timber and firewood to local communities, in addition to increased animal units supported as well as improved litter weight.

**D. Model 3: Crop residue –based nutrition improvement intervention**

**Rationale**

43. Crop residues particularly those of sorghum constitute the major source of animal feed in the project area. It is considered to be the major feed resource during the critical dry summer period when the range is depleted in nutrients and vegetation is scarce. Sorghum stover or straw is an average or below average quality roughage. It contains about 40-45% TDN (energy), about 4-5% CP, very high in CF about 35%, rather low in Ca and P (about 0.2%, for each) and it is very deficient in trace minerals and vitamins (characteristic feature of all crop residues). Beside these low nutrients, sorghum straw is rather bulky and have low bulk density which makes the material difficult for handling, particularly during transportation and storage. Handling of the straw in its natural intact form creates great difficulty for the animals during prehension and conveyance to the mouth for chewing and swallowing. In most cases, the animals spend much time and energy in breaking down the straw into small pieces prior to grinding and swallowing and usually most of the animals can not access the stem and just take the leaves. In essence this is the rationale for chopping sorghum straw by a machine mainly to reduce the particle size and to break down the lingo-cellulose bonding in the cell walls of the straw, thus rendering it more palatable and digestible. The treatment of the straw with 4% urea solution will increase the Nitrogen content from the ammonia released from the urea and hence CP-content will increase from 4.5% to about 4x280%:11.2+4.5 =15.7 or approximately 15%. This treated straw is very close in its CP-content to Alfalfa or Berseem hay and if fed with an energy –rich supplement such as sorghum grains or molasses in addition to a trace –mineralized salt lick block will constitute a very valuable animal feed for ruminants in the project area.

**Model description**

44. This model aims at using sorghum straw, resulting from crop development models, described in working paper 2. This model is targeting communities with adequate water supply (no water is to be purchased for animals) in Dindir and Mazmoum localities. The objectives are: (i) to chop the straw, using a trailer – driven mobile chopping machine, (ii) then treat the chopped straw with a 4% urea solution in an attempt to decrease the particle size of the straw, (iii) improve nutritive value, digestibility and intake and also (iv) to facilitate handling and storage of the straw.

45. The model will consist of the substrate raw material (sorghum straw), prepared by the participating farmer (about 1.2 tons are needed for chopping and treatment with urea to satisfy fattening 9 growing sheep + fattening of 4 culled old animals for a period of 3 months, drawn or obtained annually from a nucleus flock or herd of sheep containing 14 breeding female ewes + 1 male ram (3 animal units). It is considered that after the start of the project and due to improved feeding as mentioned for model 1, using supplementary feeding for flushing+ steaming –up, fertility will improve to 85% and mortality in the newly born lambs, from birth to weaning is about 9 %, and twining % also will improve from zero to 20%. With this in mind the 14 breeding female ewes are expected to have: 14 X 85% = 11.9 fertile females and since twining % is 20 , we expect 20%x11.9:2.38 twin births , or about 2.38x2 =4.76 newly born twin lambs and from single births we expect to have :11.9x80%=9.52 single births , accordingly total born lambs are :4.76+9.52=14.28 and with 9% mortality , surviving lambs will be : 14.28x91% = 13 , from which 4 female lambs will be used annually to replace the old culled female breeding ewes from the nucleus stock and the remaining 9 lambs will be fattened together with 4 culled old female animals this will be a good annual culling or replacement ratio of 4+14 =29%.
46. The chopping machine is preferred to be mobile (annex 5) and moved to farmers sites. After chopping the straw to small particle size of about 1-2 inches length (annex 5) the material will be ready for urea treatment if the technical staff is ready or it can be stacked or packed after chopping in normal Jute sacks (prepared by the farmer). Following chopping and prior to the treatment with urea, 4%-urea solution is prepared as follows:

- It is preferable to divide the 1.2 tons of the chopped straw into 6 lots, each weighing 200 Kg;
- For each of the lots weighing 200 Kg, weigh 8 Kg of urea (Fertilizer grade-46% N) in a small plastic container and then transfer it to a plastic barrel (capacity more than 200 litres), containing 200 litres of clean water and stir it with a wooden stirrer until it is fully dissolved in water (urea is highly soluble in water and it takes no more than 10-15 minutes to solubilize the urea in water), this is now the 4%-urea solution needed to treat one lot of the 200 Kg chopped straw.
- For the other lots of the 200 skg chopped straw, repeat the same process using the same quantities of urea and water each time. The chopped straw should be carefully distributed or spread on top of a plastic sheet put under shade, the 4%-urea solution is manually sprayed or sprinkled on the surface of the chopped straw in a manner to guarantee contact with all particles of the chopped straw. Following urea- treatment, the straw is wrapped carefully with the plastic sheet and stored anaerobically under shade for 21 days. After this period the material can be opened, but still stored under shade to cater for volatilization and loss of ammonia from the treated straw if kept under direct sun-light for many days. Accordingly we recommend treating the chopped straw in many batches and in different times not all in one day (although it can be treated all in one day if there are adequate storage facilities. The procedure for urea-treatment of straw is summarized in annex 3.

47. Following the preparation of the treated chopped straw with 4% urea, then the energy-protein supplement is also prepared as follows:

- The ground raw materials (sorghum grains, sesame cake and common salt) are purchased by the project and the supplement is prepared by weighing the same proportions mentioned in annex 3.
- For the fattening period of 90 days and for 13 animals (9 fattened sheep and 4 culled old ones), we need: 0.3x13x90 = 351 Kg / farmer of the mixed supplement, make it about 353 Kg by weighing: 300 Kg of ground sorghum grains, 51.5 Kg ground sesame cake + 1.5 Kg salt.
- The ingredients can be very adequately mixed (assuming the raw materials have been ground appropriately) on a concrete pad with a shovel, in a manner similar to the dry mixing of cement and sand. Raw materials should be layered one above each other and then mixed and turned to form an adjacent heap.
- An efficient shovelling and mixing of the heap at least three times should produce an acceptable product with the even distribution of small quantities of salt. The evenness of color of the mixture will often give a fair indication as to the homogeneity of the mixed feed.

48. In addition to the treated straw and the energy-protein supplement, each 5 sheep should be provided with one salt-lick block (5 Kg-weight) for the entire fattening period. The nucleus stock (15 sheep) should also be provided with salt-lick blocks for the entire year (8 Blocks will be enough for the entire year for the nucleus herd) to improve its performance. All these requirements should be procured by the project during the pilot phase to demonstrate to the farmers how to make the energy-protein supplement and the advantages of mineral supplementation through the use of salt-lick blocks. Fattening is done by the farmers in their own pens. Before starting the fattening regime, animals should be checked by vets and treated against internal and external parasites and dehooved if needed.

49. This nutritional package can be used in the context of the voluntary de-stocking involving weak but healthy animals. This pilot is described in working paper 1. The voluntary de-stocking will involve collecting from the village old animals or less fertile or poor producers of milk etc that will be grouped in one place and managed by beneficiaries. The animals will be fattened together and after slaughtering and selling of meat (usually at a reduced rate compared to the young fattened sheep),
money is paid back to animal owners after deduction of cost of feeding. In this case, the farmers will have an incentive to get rid of poor performing animals and this will keep the herd in a continuous dynamic productive cycle by annually culling 4 animals and replacing them by 4 young new female animals, the ratio of 4+14 =29% is an ideal culling or replacement ratio. This is also good in keeping the number of animals in proportion to the carrying capacity of the range instead of keeping too many animals over and above the carrying capacity of the range.

**Target Beneficiaries**

50. The pilot phase is expected to start with 600 farmers in 10 villages in year 2 and the same for year 3; the project will purchase 10 chopping machines in year 1 and 10 in year 2.

51. The daily amount of feed needed from the chopped –urea treated straw per animal is about 1.0 Kg for 90 days and from the energy –protein supplement is about 0.3 Kg /head/day also for 90 days. Salt-lick blocks should be available ad libitum in front of the animals in addition to water.

52. During the Demo-phase the animals should be weighed prior to the fattening process, monthly and at the end of the fattening period. Changes in weights should be recorded by animal production engineers as well as the intake of feeds by the different animals. This is fundamental to evaluate feed intake, growth rates and feed conversion efficiency and economics of the fattening operation and its feasibility. Dressing% for fattened young animals and old culled fattened animals should be determined during the pilot phase of the project for evaluation and monitoring. If cattle is to be culled then additional amounts of feeds should be prepared to feed the culled cows at a rate of 5.5 Kg/head/day from the treated urea straw and 1.5 Kg/head/day from the energy-protein supplement + one salt-lick block (5Kg) /head for the entire period of fattening.

53. In this package **destitute women** and some needy returnees will receive 2000 heads of sheep during the demo-phase and they will constitute part of the beneficiaries from this package (Model 3 Crop residue –based nutrition improvement intervention through chopping (Physical) and urea (Chemical) treatment. The rationale behind distributing the 2000 heads of sheep to this category is because this socio-economic group has lost their assets during the war years and have no lands to cultivate currently and no reliable source of generating income. With their background as pastoralists, they have a very good experience in animal husbandry and production and traditionally in such communities women take care of small ruminants. Accordingly distributing the 2000 heads of sheep to those people in the two communities of Mazmoum (Taro and Trao) will help them to establish their livelihoods and be able to depend on themselves. More over distributing 2000 heads of sheep to destitute women in Mazmoum area will only add about 400 animal units which will increase the total animal units in the state by about 4%. This is not a significant increase and the mission expects that it will be offset by the following measures: (i) increase in the quantity of animal feeds proposed in the project area (like the increase in the production of fodder crops or the rehabilitation of range), (ii) improvement in the feeding value of crop residues, (iii) and/or restructuring the herd composition at Sinnar state by decreasing the number of the non –productive animals by adopting a reasonable culling policy for the old, infertile and non productive animals.

54. One chopping machine will be allocated by the project for the two communities of the destitute women and needy persons. Extension teams and other technical staff will train them on chopping. urea-treatment and ration formulation etc...

55. The distribution of the target areas, beneficiaries and targeted animals under the crop residue –based nutrition improvement intervention through chopping (Physical) and urea (Chemical ) treatment, for the demo-phase and scaling up phase is shown in table 6.
In order to ensure maximum benefit, it is proposed that beneficiaries participating in the crop demonstrations also participate in the demonstrations on livestock nutrition. However, the field extension teams will need to make sure that water does not constitute a limiting factor for livestock husbandry in the selected village.

VI. MODALITIES FOR PROJECT IMPLEMENTATION

1- Selection of participants. In order to ensure maximum benefit, it is proposed that beneficiaries participating in the crop demonstrations also participate in the demonstrations on livestock nutrition. However, the field extension teams will need to make sure that water does not constitute a limiting factor for livestock husbandry in the selected village.

2- Demonstration on the operation and management of the chopping machines. Chopping machines (preferably mobile units). Choppers will be distributed to farmers' groups and the extension teams will train them on their operation and maintenance, as well as on the appropriate storage of the chopped crop residues. The farmers will be supported by the project for two consecutive years. It is assumed that in case of success, traders and farmers will purchase it as individuals or in groups.

3- Farmers’ organization. It was estimated that each chopper will be used by 20 producers. This requires the organization of the farmers into a common interest group, allocation of clear responsibilities for the supervision, operation and maintenance of the chopper. Consideration should be given to providing choppers in priority to women groups as they have the main burden of supplementing the feeding of the livestock.

4- Capacity building of extension teams and farmers. Each extension team will have a livestock production extension agent and a forestry/range extension agent. The extension teams as a whole will be oriented to the livestock nutrition packages. The livestock and range/forestry extension agents will be more thoroughly trained so that they can train the farmers and provide them with technical backstopping. High performing farmers will be receiving advanced training so that they can train their peers, particularly for the scaling up of the animal nutrition techniques. Training will focus on animal nutrition, animal health and range management (annex 4 presents the detailed training curriculum). The results of the demonstration and the experiences gained will be documented in a manual on animal nutrition.

5- Synergies with the other project components. As the minimum tillage package under the technology transfer package will be producing large amounts of fodder crops such as clitoria and range grasses, the project will be rehabilitating the irrigated farm of the Range and Pasture Dept. The rehabilitation of two FNC nurseries to produce up to 250 000 seedlings per year is also planned.

6- Monitoring and Evaluation. Key indicators to be monitored are drawn from the logframe annex of the main report. Key indicators consist in: the characteristics of the improved nutrition package on livestock daily ration, fertility, twinning percentage, litter weight; the net benefits from improved

Table 6: Beneficiaries and animals targeted for demonstration and scaling-up on model -3: the crop residue-based nutrition improvement intervention

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>YR 1</th>
<th>YR2</th>
<th>YR3</th>
<th>YR4</th>
<th>YR5</th>
<th>YR6</th>
<th>YR7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Villages (^5)</td>
<td>Number</td>
<td>-</td>
<td>10</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Beneficiaries</td>
<td>Number</td>
<td>600</td>
<td>600</td>
<td>930</td>
<td>1045</td>
<td>1275</td>
<td>1390</td>
<td></td>
<td>5840</td>
</tr>
<tr>
<td>Animals targeted</td>
<td>Number</td>
<td>7800</td>
<td>7800</td>
<td>12090</td>
<td>13585</td>
<td>16575</td>
<td>18070</td>
<td></td>
<td>75920</td>
</tr>
</tbody>
</table>

\(^5\) During demo-phase, 10 villages will be targeted every year in Mazmoum and Dindir localities. These villages were selected primarily based on availability of permanent water sources (with zero cost for animals watering) as well as participation in the crop production interventions. In each village 60 beneficiaries will be selected. During the two years piloting phase, 1200 farmers will be covered, each with 13 animals for fattening with chopped urea-treated straw. For scaling up, participation ratio for participant is assumed about 60% while for non-participants the ratio will increase progressively from 25%, 30%, 40% to 45% starting years 4, 5, 6 and 7, respectively.
nutrition in the different interventions; number of women and men participating in the demonstrations; number of people trained by topic, by job and by gender; the number of women and men adopting improved nutrition techniques.

7- **Legislative and organizational decrees or measures** by both federal and state governments are urgently and badly needed to organize land use, livestock routes and high taxation rates imposed on the pastoralists as well as provision of water, proper veterinary and extension services. The project management office will organize coordinated action on this front with the concerned departments in the MAAWI, the agricultural committee in the State Parliament, and joint communication and advocacy activities with the Integrated Livestock Production and Marketing Project.
Annex 1. Animal types, numbers and Animal Feed-Balance Sheet or supply and demand for feed in the project area.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Heads</th>
<th>Animal Units</th>
<th>Dry matter * Requirements</th>
<th>Supply of animal feed(Drymatter:DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total Requirements Tons/Year</td>
<td>Area feddans (ton/feddan)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A.U</td>
<td>Tons/Year</td>
</tr>
<tr>
<td>Livestock types and numbers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>1445143</td>
<td>10011600.1</td>
<td>3.3</td>
<td>3338280.3</td>
</tr>
<tr>
<td>Sheep</td>
<td>1388713</td>
<td>277742.6</td>
<td></td>
<td>916550.6</td>
</tr>
<tr>
<td>Goats</td>
<td>832408</td>
<td>133185.3</td>
<td></td>
<td>439511.5</td>
</tr>
<tr>
<td>Camel</td>
<td>289674</td>
<td>289674</td>
<td></td>
<td>955924.2</td>
</tr>
<tr>
<td>Total</td>
<td>3955938</td>
<td>1,712,202</td>
<td>5,650,266.60</td>
<td>3,200000</td>
</tr>
</tbody>
</table>

Feed Production (Dry matter)

- Cultivated area (mechanized and bildat): 3200000 tons
- Forested area: 120000 tons
- Rangelands: 53500 tons

Total: 3,230,350 tons

Feed balance = total feed production - animal feed requirements = (3,230,350-560,266.6) = -2,419916.64 tons

The deficit is about (-43%) of the total feed requirements of the herd (tons DM/year).

Animal units are calculated on the basis of tropical animal units (TAU), according to Abu Raya (1980) who considered the average animal unit for cattle herd to be equal to 0.7 AU per head; Camels = 1.0 AU per head; Sheep = 0.2 AU per head; and Goats = 0.16 AU per head. He also considered the total dry matter requirement for one animal unit per year to be equal to 3.3 tons of dry matter. Accordingly, the total requirement (in dry matter/year) for the herd in the above table is calculated according to Abu Raya figures.
**Annex 2. On-going projects of relevance**

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of project</th>
<th>Locality</th>
<th>Status</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stock routes for pastoralists</td>
<td>All 7 localities in the State</td>
<td>Inactive</td>
<td>Development of stock route to decrease conflicts; and improve conservation of range and natural resources.</td>
</tr>
<tr>
<td>2</td>
<td>Settlement of pastoralists in area of 5000 feddans</td>
<td>Taraw community, Dali &amp; Mazmoum locality</td>
<td>Partially active</td>
<td>Settlement of part of Rufaa Al Hoj tribe</td>
</tr>
<tr>
<td>3</td>
<td>Al Guweizat range project, 5000 fed</td>
<td>Dali &amp; Mazmoum locality</td>
<td>Partially active</td>
<td>Support the settlement of pastoralists by providing them with water and fodder; production of seeds of range species for reseeding in deteriorated areas and to use as inputs in supplementary feeding.</td>
</tr>
<tr>
<td>4</td>
<td>Range and Pasture Dept farm, 150 fed</td>
<td>Sinnar locality</td>
<td>Active</td>
<td>Produce seed requirements for the State and sale of range seeds to other states at cost.</td>
</tr>
<tr>
<td>5</td>
<td>Wad Hashem project for fodder production</td>
<td>Sinnar locality</td>
<td>Bridge the fodder gap. Production of green fodder and catalyst of livestock dairy production.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Collection and broadcasting of seeds in rainy and dry season grazing areas, 480 000 fed.</td>
<td>All localities</td>
<td>Inactive</td>
<td>Broadcast range seeds in karrib land (see working paper 2), deep khors and degraded lands.</td>
</tr>
<tr>
<td>7</td>
<td>Abu Gurud Dam</td>
<td>Dali &amp; Mazmoum locality</td>
<td>Completed</td>
<td>Harvest and storage of water for livestock drinking. Targets pastoralists and smallholders.</td>
</tr>
<tr>
<td>8</td>
<td>Atshan Dam</td>
<td>Dindir locality</td>
<td>Completed</td>
<td>Store and harvest water for smallholders and pastoralists.</td>
</tr>
<tr>
<td>9</td>
<td>Doba Dam</td>
<td>East Sinnar locality</td>
<td>Completed</td>
<td>Store Dindir river water for Doba projects for irrigation and production of fodder crops.</td>
</tr>
<tr>
<td>10</td>
<td>Integrated Livestock Production and Marketing Project, stock route development, 180 km length, 2 km width</td>
<td>Dali &amp; Mazmoum locality</td>
<td>Partially active</td>
<td>Map, demarcate and develop the stock route linking Blue Nile-Sinnar-White Nile</td>
</tr>
<tr>
<td>11</td>
<td>Eastern Nile Watershed project</td>
<td>Dindir locality in Sinnar State</td>
<td>Starting</td>
<td>Development of watershed and range resources in and around Dindir park</td>
</tr>
<tr>
<td>12</td>
<td>Baling of fodder</td>
<td>Sinja locality</td>
<td>Inactive</td>
<td>Baling of fodder to bridge needs and to supply feed for export animals and dairy animals.</td>
</tr>
</tbody>
</table>
Annex 3. Steps to be followed in chemical treatment of sorghum straw with 4 % Urea solution for improving its digestibility and Nitrogen content :

- 1st. Chop the sorghum straw to a particle size of approximately 1-2 inches, using a chopping machine.
- 2nd. Weigh 200 Kg of the chopped straw in a polythene plastic sheet.
- 3rd. Prepare the 4% (w:v) Urea solution by dissolving 8 Kg of Urea (46 % N- Fertilizer grade) IN 200 Litres of water.
- 4th. Spray or sprinkle all the 200 litres of the 4% urea solution on the 200 Kg of the chopped straw.
- 5th. After thoroughly mixing of the urea solution with straw, closely wrap the treated straw in the plastic sheet and tie it well and store it (anaerobically) under shade for 3 weeks .
- After the 3 weeks storage period the straw is ready for use, either as a sole roughage or can enter as a component of a fattening or maintenance rations.
- It is preferable to use the treated straw with a good energy source, containing highly fermentable sugars or starch such as molasses or sorghum grains.

The Nitrogen content or the crude protein equivalent will increase from about 4% in the untreated straw to about 15 % following treatment. This is because 4% urea is \( (4 \times 280\% = 11.2\% \text{ CP-equivalent}) \). Accordingly the treated straw will contain: 15 % CP which is almost equivalent to Alfalfa or Breese.

Proposed ingredients composition for energy-protein supplement (% as fed- basis), for fattening sheep.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum grains</td>
<td>85</td>
</tr>
<tr>
<td>Sesame cake</td>
<td>14.5</td>
</tr>
<tr>
<td>Salt</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
</tr>
</tbody>
</table>

*Price: SDG/Kg =1.39

1-Training theme | a. Animal nutrition and production
To enable the extension staff to carry out implementation, monitoring and operation and management (O and M) of the demonstration and scaling up of the proposed technical packages with competence and perfection.

| 2-Training objective | b. Veterinary medicine and health care of livestock
To enable the Vet.-Med. staff to carry out all needed health and preventive medical care for all targeted classes of livestock and poultry in the project area with high competency , during both demonstration and scaling up phases of the project .

| 3-Trainees | 8-10 animal production engineers will be targeted for this in-service training to cover different farmers in the different
| **8-10 Vet.-Med. staff will be targeted for this in-service**
Annex 4. Training module: Training of Trainers

**1- Training theme**

**c: Range management**

To enable the extension staff to carry out implementation, monitoring and operation and management (O and M) of the demonstration and scaling up of the proposed technical packages with competence and perfection in the area of range management.

8-10 range management specialists will be selected for in-
### 3-Trainees

Service training.

- To set the ground for a wise and rational use of the natural resources of the project area, on bases that assure sustained growth and development.
- To demonstrate example that local communities have the abilities to change their own lot once they find guidance and the essential requisites.
- To check ecological degradation and improve range quality and quantity in the project area.
- To serve as a demonstrative example that the ecology of such areas could be better utilized for higher production under proper planning.
- Many activities can be done by range specialists to achieve the above mentioned objectives, such as reseeding and pasture improvement, water harvesting, forest rehabilitation, control of fires and teaching and educating the local people to positively participate in range management and that without their contribution any project or governmental efforts will be futile. Extension and education are thus very vital tools in range management and control of env., desertification and poverty.

### 4-Subjects to be covered

Duration of the training: 10 weeks for both theory and practical (5 working days with 4 hrs./day : 20 hrs/week, with 60% theory and 40% practical training)
Annex 5 – The Chopper (the model presented here is manufactured for the Butana Integrated Rural Development Project, loan SD-717)
Annex-6: Environmental Impact Assessment for Livestock Nutrition in the project area

<table>
<thead>
<tr>
<th>Activity</th>
<th>Environmental Impact</th>
<th>Justification / Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-supplementary feed of a protein–mineral supplement for flushing + steaming-up</td>
<td>+</td>
<td>Higher litter weight per area of rangeland and per ton of fodder.</td>
</tr>
<tr>
<td>2- Crop residue–based nutrition improvement intervention: through chopping (Physical) and urea (Chemical) treatment.</td>
<td>+</td>
<td>Improved digestibility of the fodder and higher efficiency in terms of litterweight per ton of fodder production</td>
</tr>
<tr>
<td>3- Voluntary-Destocking by fattening of culled old animals</td>
<td>+</td>
<td>Balancing the range –carrying capacity by destocking of weak but healthy animals</td>
</tr>
</tbody>
</table>
Annex 7. References

Abu Raya, A. K. 1980. Preliminary survey of the feed resources of the gulf and Arabian peninsula countries along with possible means of developing them. FAO, Rome, Italy.

