(draft 3.1)

Modeling cattle production in Swaziland with *LDPS*²

Livestock Development Planning System **²**
Training Manual

1998

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Purpose of this training manual

Livestock Development Planning System version 2 (*LDPS²*) is a personal computer based planning and training tool designed for livestock development planners to assist them in decision making.

The livestock planner has to answer many questions, such as; "What if you should need more XX tons of additional milk (or meat) production?" "What if productivity (for example, fertility rate) of the livestock herd should be improved by XX percent", "What if you should have additional XX hectares (or tons) of grazing (or other) feed resources?",... *LDPS²* may give various scenarios to such "What if" questions. It models livestock production, calculating the size, composition, feed requirements and growth of the herd with a given demand for milk or meat production and parameters concerning productivity. The user may explore various scenarios with *LDPS²* by changing the demand and other parameters.

This training manual provides an example of policy designing with *LDPS²*. The user will understand **how *LDPS²* works** and **how *LDPS²* assists policy designing**, using complete data sets of livestock production in Swaziland.

This manual focuses on practical use of *LDPS²*. The user, therefore, may refer to the user's guide when she/he needs theoretical details.

Installation

LDPS² is an Excel workbook named "ldps2e.xls" (English version) or "ldps2f.xls" (French version). It requires a computer with Windows system and Excel 5.0 or later (see the user's guide at page 2).

1) The user needs to copy the workbook into a folder (directory) of its own on her/his hard disk (for example, C:\LDPS2). 2) *LDPS²* can be opened after starting Excel with "FILE_OPEN" menu.

Exercise 1:
In this training manual, livestock production in Swaziland will be modeled for exercise. Copy and open "ldps2_tr.xls" instead of the original *LDPS²*.

Modeling

The first thing to do with *LDPS*^{2} is to model the current livestock herd with the Demand Driven Routine. The routine calculates the size of modeled herd with the following equation;

$$\textit{The number of livestock} = \textit{Production} \div \textit{Productivity}$$

For example, cow number can be calculated simply as follows, though more parameters are used in the actual calculation (see 3.(1) of this section).;

$$\textit{Milk production} \div (\textit{Milk yield per cow} \times \textit{Fertility rate})$$

As information are often inaccurate or lacking, provisional parameters are applied to *LDPS*^{2} first and are adjusted in a number of iterations, comparing the size and composition of the livestock herd calculated by *LDPS*^{2} and those in statistics (Steps 1-3).

1. Set production systems and production demand

LDPS^2 models livestock herds using parameters concerning productivity. Therefore, herds with different productivity are necessary to be separated.

Cattle production in Swaziland can be divided by breeds into a) exotic dairy cattle and b) other cattle (traditional and beef specific cattle). They are assigned to "Dairy cattle" and "Beef cattle" in the labels sheet of *LDPS*^{2}, respectively. Beef cattle production is divided thoroughly into three sub-systems by land tenure; 1) Swazi Nation Land (SNL, communally grazed cattle), 2) Title Deed Land (TDL, commercial production) and 3) Government Ranches (GR).

Regarding milk production, 36,700 tons of milk was produced indigenously in 1996, of which 10,300 tons was produced by dairy breeds. The remaining part (26,400 tons) was produced by traditional breeds which are communally grazed in SNL. Beef cattle in TDL and GR are raised for beef production and do not produce milk.

Total indigenous beef production in 1996 is reported as 15,226 tons (FAOSTAT). Production by each system (SNL, TDL and GR) can be estimated with the numbers of slaughter and sales (see Exercise 2).

Exercise 2: Rename production systems and set production demands
1. Rename production systems **[Labels sheet]** Change names of production systems in blue. from Dairy System 1 [D5] to Dairy breeds (System 2 [D6] beef SNL --------to check milk production) Beef System 1-3 [D9:11] SNL, TDL and GR 2. Set (projective) production demands and distribution loss **[Parameters sheet]**

System		Production	Distribution loss
Dairy	Dairy breeds	10,300	0
	(beef SNL	26,400	0.1*)
Beef	SNL	6,873**	0
	TDL	7,521**	0
	GR	833**	0

*: For SNL beef cattle, milk distribution loss rate is assumed as 0.1 (10 percent).
**: Beef production of each system is provisionally estimated using total production and the number of cattle sales (ref. Table 2)

3. After setting the values, save the current workbook for safety.
Click "File_Save As"menu of Excel and save the file with a new name, "swazi.xls".

2. Collecting information on herd structure

There is a series of agriculture census data which contains cattle numbers by age, sex and region, and some parameters concerning productivity, such as the number of birth, death and slaughters (Tables 1-3).

Table 1: The number of cattle in Swaziland (1996)

	SNL	TDL	GR	Total
Bulls (non-dairy)	21,273	3,028	430	24,731
Cows (non-dairy)	168,822	35,509	6,203	210,534
Dairy cows	1,459	2,369	382	4,210
Oxen	86,626	9,580	1,996	98,202
2-3 year, male	40,523	5,062	1,749	47,334
, female	55,185	10,293	2,049	67,527
1-2 year, male	28,766	6,363	1,093	36,222
, female	29,041	7,292	1,192	37,525
, Dairy	575	668	96	1,339
<1year, male	29,320	7,540	1,215	38,075
, female	28,480	8,008	1,469	37,957
Total	490,070	95,712	17,874	603,656

source: Agriculture census (1996)

Table 2: Birth and offtake of cattle in Swaziland (1996)

	SNL	TDL	GR	Total

Births	72,043	18,393	2,834	93,270
Deaths	41,556	5,358	913	47,827
Total slaughter	27,431	4,359	732	32,522
home slaughter	20,422	1,471	175	22,068
Sales	29,936	32,759	3,628	66,323

source: Agriculture census (1996)

Table 3: Productivity of cattle in Swaziland (1996)

	SNL	TDL	GR	Total
Birth/Cows	42.7%	51.8%	45.7%	44.3%
<1yr/Birth	80.2%	84.5%	94.7%	81.5%
Death/Total	8.5%	5.6%	5.1%	7.9%
Slaughter/Total	5.6%	4.6%	4.1%	5.4%
Sales/Total	6.1%	34.2%	20.3%	11.0%
Bull/Cow	12.6%	8.5%	6.9%	11.7%

derived from Tables 1 and 2

NOTE:

The total cattle number recorded in Swaziland is thought to be accurate as it is actually counted by government officials in every August when cattle are gathered at dip tanks for tick eradication. However, there are very large errors in the distribution to the various age classes. It is suggested that many animals are mis-classified into the next younger class resulting progressively too many in the 0-1, 1-2 and 2-3 year age groups and too few in the 3-year old and older age categories (Review of Swaziland livestock development strategies, 1992). Such errors will be corrected through the modelling with LDPS^2.

3. Set parameters

As mentioned before, provisional parameters are applied to *LDPS*^{2} first and are adjusted in a number of iterations, comparing the size and composition of the cattle herd calculated by *LDPS*^{2} and those in statistics.

(1) Production cycles (years in each class) and mortality rates

Newborns are normally kept for one year as young stocks, and then transferred to replacement stocks or slaughter (or draught) stocks.

Table 4: Production cycles and mortality rates used for calculation (provisional)

	Dairy		Beef (SNL)		Beef (TDL/GR)	
	Y	M	Y	M	Y	M
Young stock	0-1	0.05	0-1	0.10	0-1	0.08/

						0.06
Replacement stock for breeder	1-3	0.03	1-3	0.05	1-3	0.05/ 0.04
first mating	3		3		3	
Breeding (reproduction) stock	3-8	0.04	3-12	0.05	3-9	0.05
slaughter of breeders	8		12		9	
Slaughter (or draught) stock	(1-2)*	0.03	1-9	0.07	1-4/5.5	0.05/ 0.04
slaughter of meat stock	(2)*		9		4/5.5	
Males in the system ?	No		Yes		Yes	
Are young males slaughtered at birth?	Yes		No		No	

Y: Years after birth
M: Mortality rates
*: Almost female youngs are retained for milk production.

(2) Parameters for milk production and reproduction.

The number of cows (*Ncow*) is calculated as follows, with 1) milk production demand (*Pm*), 2) Distribution loss (*Ld*), 3) fertility rate (*Rf*), 4) milk yield per cow (*Y*) and 5) fraction of milking cows (*Fm*);

$$Ncow = Pm \div (1-Ld) \div (Rf \times Y \times Fm)$$

For example, if Ld = 0.1 (10 percent), Rf = 0.8 (80 percent), Y = 0.5 (tons per cow per year) and Fm = 1 (all cows are milking), 90 tons of milk (*Pm*) can be produced by 250 cows (*Ncow*) in one year. $LDPS^2$ does such calculation automatically.

The user needs to adjust these parameters, comparing the number of cows calculated by $LDPS^2$ and that in statistics. When *Rf* and *Y* increase, *Ncow* decreases.

The number of calves (*Ncalves*) is calculated automatically at the same time. In $LDPS^2$, *Ncalves* means the number of birth in one year. It is calculated as follows, with 1) *Ncow*, 2) *Rf* and 3) prolificacy rate (*Rp*);

$$Ncalves = Ncow \times Rf \times Rp$$

In addition to these parameters, production cycles and mortality rates also affect the size and composition of herds. The user needs to adjust all of these parameters, comparing the results of $LDPS^2$ and statistics.

NOTES:
Regarding dairy cattle in Swaziland, 4,210 cows produced 10,300 tons of milk in 1996 (Tables 1 and 2). Then, *Rf* and *Y* were estimated as 0.8 and 3.0, respectively. 10,300 tons ÷ (1-0) ÷ (3.0 tons × 0.8 × 1) = 4,292 cows

The number of calves in the dairy system is calculated as 1,923 heads [Results!S44]. This includes all new born females and a part of males, as males which are not necessary to sustain the herd are slaughtered at birth [Parameters!C31 and 32].

We have decided to model traditional SNL cattle production with the beef calculation routine, however, parameters concerning milk production can be calculated with the same equation. The parameters are estimated as follows:

26,400 tons ÷ (1-0.1) ÷ (0.8 tons × 0.43 × 0.505) = 168,854 cows

Exercise 3: (Calculation of Dairy cattle herds)

Check the numbers of cows and youngs in the **results sheet** [R38] after changing **parameters**, such as fertility rate [C7], milk yield [C10], fraction of females milked [C11], distribution loss [C5], etc.

(3) Parameters for meat production

A) Dairy cattle

Once the herd size and composition have been modeled, the number of slaughters is automatically calculated. Meat production is calculated as follows;

(the number of slaughtered animals) × (average carcass weight).

If calculated meat production is very different from that in statistics, the user is recommended to go back to the former steps and check parameters.

NOTE:

Meat production by the dairy breeds and its offtake (slaughter) rate are calculated as 235 tons and 8.0 percent, respectively. They do not include veal production of newborn males.

B) Beef cattle

Regarding beef cattle, beef productions of each system were roughly estimated with the number of cattle sales (see Exercise 1). They are, therefore, less reliable than the herd size shown in the census data and have to be checked with *LDPS*[2].

NOTE:

We can find that the size and composition of each system calculated by LDPS are larger than those in Table 1.

According to the census data and FAOSTAT, 32,522 cattle were slaughtered in 1996, producing 15,223 tons of beef. Average carcass weight is calculated as 468 kilograms, however, it seems too heavy. On the other hand, offtake rate (slaughters / total cattle) in the statistics is 5.4 percent, while that calculated by LDPS is 8.4 percent. These mean that **total beef production can be over-reported, while slaughter number can be under-reported in the statistics**.

Comparing cattle herds modeled by LDPS and those in the statistics, beef production excluding dairy cattle meat (235 tons) is estimated as **9,750 tons.**

System	Beef (tons)	Slaughter (heads)	Offtake (%)
SNL	6,380	31,700	6.3

TDL	2,900	12,200	12.6
GR	490	2,100	11.3
Sub total	9,750	45,900	7.4

Exercise 4: (Calculation of Beef cattle herds)

Change beef production demand **[Parameters!H:J5**] to 6,380 (SNL), 2,900 (TDL) and 490 (GR) tons, and check the numbers of cattle in the **results sheet**, comparing those in Table 1.

(4) Growth of the herd

The modeling has not been completed at this step, however, growth of the herds can be calculated by the Herd Growth Routine of *LDPS*[2] using estimated parameters. Growth is an important factor to analyze condition of a herd. As *LDPS*[2] is a technical model, it shows the largest growth which is technically possible. When the shown growth is too slow or too fast, the user is recommended to change parameters. Growth rate increases when **years in breeders** and **fertility rate** increase, or **mortality rates** decrease.

As the Herd Growth Routine figures livestock herd using a completely different model from that used in the Demand Driven Routine, results of these routines are different. For example, newborn males are not slaughtered and draught stocks are included in other stocks in the Herd Growth Routine. (see the user's guide at page 45)

Exercise 5:

Go to the **results sheet** and try the Herd Growth Routine, selecting 1) production system, 2) routine and 3) years to display.

NOTE:

The Herd Growth Routine showed that growth rates of beef cattle herds are around zero percent p. a. The beef herds can not expand its size because of low reproduction rates and high mortality rates. In fact, the census data showed that the national cattle herd had decreased at 6.0 percent in 1996 while it had grown at 2.5 percent in 1995. Surprisingly, the herd had grown at more than 5 percent during the early 1990s. The rapid growth in the period seems strange and the cattle numbers in 1990 - 1992 could be over-reported.

(5) Parameters for skins (or hairs)

Skin production is calculated with parameters on the proportion of usable skin and weight of skin per animal.

(6) Parameters for liveweight and milk fat content

These parameters are used for calculation of feed energy and protein requirements. Therefore, they do not change herd size.

(7) Parameters for draught

Draught power is considered an output of adult dairy cattle, beef cattle and buffaloes only. Draught animals are regarded as a "by-product" of cattle and buffalo production systems, where surplus calves (i.e. those calves not kept for herd growth) are partly diverted into draught use, and partly diverted into slaughter stock.

In the *LDPS*[2], four kinds of animals are available for draught use, breeders (males and females), male replacements and draught specific oxen. The user can select animals used for draught with parameters No. 48-51. *LDPS*[2] distribute total power demand to draught specific oxen, which come from other (slaughter) stock, at first. When the demand is not satisfied by the stock, the remaining demand is distributed to male breeders, male replacements and female breeders, in turn.

It is difficult to estimate total requirements for draught (or animal) power with a set of generalized coefficients, because there are many kinds of works, techniques and other factors which affect the requirements. Then, LDPS does not estimate the requirements, but the user determine it empirically. LDPS calculates number of draught animals with the following formula:

No. of draught animals
= (Peek power requirement per month) ÷ 30 days ÷ (Average productivity per animal per day)

A unit for the requirement and productivity is also defined by the user. Hectares/day, Man-day or Animal-day, for example, will be available.

Exercise 6:
Most of oxen in SNL are used for draught power supply for 2 - 3 months mainly in Spring. Input 87,000 heads ×30 days = 2,610,000 to "Peek animal draught power demand/month **[Parameters!H51]**", 1 to "Are there Draught specific oxen?**[Parameters!H52]**", 1 to "Average productivity/animal/day **[Parameters!H59]**", 60 days to number of days worked, respectively. And check the number of draught animals on the **results sheet**.

Now, cattle production in 1996 has been modeled with the Demand-driven Routine of the *LDPS*[2]. Other species (sheep, goats, pigs and poultry) have already been calculated in the workbook.

4. Feed resources

1) Feed inventory

Feed energy supply from grazing lands is calculated by *LDPS*[2] using the area size. In Swaziland, there are 10,810 square kilometers (sqkm = 100 hectares) of SNL grazing lands and 3,329 sqkm of TDL grazing lands. As their productivity is relatively low, 156,667 Livestock Standard Units (LSUs[note], see the user's guide at page 21) and 48,246 LSUs of feed energy are estimated to be supplied from SNL and TDL grazing lands, respectively (see Appendix C).

[note] 1 LSU is defined as a 500 kilogram mature cow, with a calving interval of 13 months, producing 3,500 kilograms of milk per lactation. It is also equivalent to the annual metabolisable energy (ME) requirement of the LSU for maintenance, growth, pregnancy, lactation and activity. This is defined as 35,600 Mega Joules. (see the user's guide at page 23)

In addition to them, non-grazing resources provide 102,000 LSUs of feed energy. (Livestock Sub-sector Review and Range Survey, TCP/SWA/2353, 1994, also see Appendix D)

Exercise 7:
Change hectares (Grazing land), quantity (other resources) and energy contents in the **resources sheet**, and check LSUs calculated. Remind that quantity is in dry matter.

2) Feed Utilization Matrix (FUM)

Those feed energy (in LSUs) is allocated to each production system in the "Feed Utilization Matrix (FUM)" of the resources sheet, using a series of decision rules:

i) Physiological criteria are straightforward in that they can be universally applied. Certain feed types are not suitable for certain animals (e.g. roughage for poultry) and so cannot be allocated to them, or only in small quantities.

ii) Geographical criteria relate to the locational coincidence of feed availability and livestock populations. For example, SNL grazing lands supply 156,667 LSUs and they sustain all SNL cattle, 75 percent of sheep and 95 percent of goats.

iii) Economic criteria relate to cost/price ratios of basic concentrates, or commercial feeds to the price of main livestock products. These ratios roughly indicate the profitability of feeding various feed types at given productivity levels.

Exercise 8:
Check and modify the FUM on the **resources sheet**.

Note: **TO BE CHECKED BY OFFICERS IN VET. SERVICES, SWAZILAND**
According to the FUM, grazing resources are not enough to sustain all the SNL livestock (cattle, sheep and goats). Soil erosion caused by overgrazing is reported especially in SNL grazing lands. Carrying capacity of grazing lands in Swaziland is calculated as only 205,000 LSUs which can supply only 84 percent of total beef cattle requirements. Scarcity of feed resources is one of major constraints for the livestock sector of the country to expand the production. **On the other hand, there are crop residues and by-products which are not utilized as feed.** For example, sugarcane tops are usually burned and not utilized for feed, while they could provide an estimated 170,000 tons of dry matter of winter maintenance ration for cattle. It is equivalent to 40,000 LSUs of energy or 16 percent of current energy requirements for beef cattle. Another possible resource is molasses of which 12,000 tons in fresh weight are used as a feed at present. There are plans to utilize a further 25,000 tons (18,800 tons in dry matter) per year in the local manufacture of a liquid product of molasses to be used by the livestock industry which will be of benefit to the local beef fattening and dairy industries.

*****TO BE CHECKED BY OFFICERS IN VET. SERVICES, SWAZILAND****

I used an information on available feed resources reported in the Livestock Sub-sector Review and Range Survey, TCP/SWA/2353, 1994, by FAO (Dr. Sweet, Dr. Khumalo, Dr. Taylor and Dr. Xaba).

According to the FUM, two thirds and a quarter of total energy are supplied by grazing lands and crop residues, respectively. And, about 70 percent of total energy required by SNL and TDL cattle are supplied by the grazing lands. It means, cattle are reared only by grazing or feed from grazing lands (such as hay and silage) during 70 percent of a year. (Regarding sheep and goats, I assumed that about 40 percent of energy are supplied by the grazing lands.) ****** Do you agree with this figure?

If not, there may be other feed resources, I think.

5. Save and print results

The user can save results as an Excel workbook with a new name (for example, Swazi.xls), using the "File_Save As" menu of Excel.

The simplest way to print results is by pressing the "Print results" button in the results sheet. The user also can print results using "File_Print" menu of Excel.

Livestock development planning with LDPS²

Swaziland's livestock production in 1996 has been modeled in the previous chapter. Now you may explore various scenarios by changing parameters. In this chapter, we will roughly look over how *LDPS²* assists policy designing.

1. Example 1: Dairy Development Plan

Milk consumption in Swaziland grew at the rate of nearly 4 percent p. a. between 1986 and 1995 largely because of human population increases. The demand for milk substantially outstripped production which, in the same period, grew at only 2.5 percent p. a. in average. The shortfall was made up by increased imports from South Africa. At the moment, indigenous cow milk production is about two thirds of the demand.

According to economical projections by the government, the demand will continue to increase over the next decades (Table 5).

Table 5: Milk demand projections, 1997 - 2006 (unit: thousand ton)

Scenario \ Year	1997	2001	2006
Low	54.8	67.3	82.6
Medium	57.6	70.6	90.6
High	58.6	72.9	94.6

source: Ministry of Agriculture and Co-operatives, Swaziland

Will the indigenous milk production satisfy the national demand in 2006? The Demand-driven Routine shows that 90.6 thousand tons of milk (medium projections for 2006) can be produced by 37,750 heads of the current dairy breed cows (880 percent of the current number) or 579,500 heads of SNL cows (340 percent of the current number). However, the Herd Growth Routine shows that the number of the dairy bred cows will expand to 7,200 heads at maximum in 2006 and that of SNL cows will remain at the current level. It means that import of milk will be necessary also in 2006.

Then, let's model the dairy production in 2006 again, assuming indigenous production as 60,400 tons, 67 percent (the current self-sufficiency rate) of the projected demand. The production amount is tentatively divided into the dairy breed and the traditional SNL cattle. Milk production of SNL cows in the future will remain at the current level or decrease slightly, because of poor productivity and feed resources. Milk production of SNL cows in 2006 is therefore assumed as at the current level, 26,400 tons. The remaining part, 34,000 tons, is assumed to be produced by the dairy breeds.

In case productivity (parameters) is at the current level, the Demand-driven Routine shows that 14,200 dairy breed cows will be required to meet the demand, which are 330 percent of cows kept at the moment. However, as we have seen, the Herd Growth Routine shows that the number of dairy breed cows will be able to increase to 7,200, which is about half of those required in 2006. Then, the gap will have to be filled up by imported cows. Investment cost to import the number of cows can be calculated with price of cows, transportation, facilities for raising, etc.

Feed energy requirement of dairy breeds in 2006 will also increase to 21,000 LSUs, up 14,700 LSUs. The Resources-driven Routine shows that the increase is equivalent to 100,000 hectares of grazing lands (7 percent of the current grazing lands), or 12,750 tons of molasses in dry matter. As shown in the section 4 of the previous chapter, scarcity of feed resources, grazing resources in particular, is a major constraint for expanding Swaziland's cattle production. Efficient resources use, such as crop residues and food processing by-products which are not utilized at present, and further development of feed resources, such as molasses, are indispensable for the livestock sector.

Various scenarios for milk production of dairy breeds are shown in Tables 6 and 7. Scenarios shown in Table 6 are calculated with the same parameters used for 1996. Average fertility rate and milk yield per cow are changed in scenarios in Table 7.

Table 6: Projections of milk production by dairy breeds (1)

	1996	2006 (projection)			
		Low*	Medium*	High*	Medium/2**
Milk production (ton)***	10,300	26,000	34,000	38,000	17,000
Number of cattle					
Breeders	4,335	10,942	14,308	15,992	7,154
Replacements	1,976	4,989	6,524	7,292	3,262
Youngs	1,923	4,855	6,349	7,096	3,174
GRAND TOTAL	8,234	20,786	27,181	30,379	13,591
Females in milk	3,433	8,667	11,333	12,667	5,667
Meat production (ton)	235	593	775	866	388
Energy requirement (LSUs)	6,370	16,081	21,029	23,503	10,514

source: Projected by the Demand-driven Routine of $LDPS^2$

*: See Table 5.

**: Half of the medium projection = Indigenous maxmum production projected by the Herd Growth Routine of $LDPS^2$

***: Projected demand - 26,400 tons (SNL milk production in 1996)

Table 7: Projections of milk production by dairy breeds (2)

	1996	2006 (projection)			
		Medium*	A**	B***	A + B
Milk production (ton)	10,300	34,000	34,000	34,000	34,000
Number of cattle					
Breeders	4,335	14,308	12,264	13,627	11,680
Replacements	1,976	6,524	5,592	6,213	5,326
Youngs	1,923	6,349	5,442	6,316	5,414
GRAND TOTAL	8,234	27,181	23,298	26,157	22,420
Females in milk	3,433	11,333	9,714	11,333	9,714
Meat production (ton)	235	775	664	738	633
Energy requirement (LSUs)	6,370	21,029	19,056	20,479	18,590

source: Projected by the Demand-driven Routine of $LDPS^2$

*: See Table 6.

**: Average milk yield is assumed to improve from 3.0 to 3.5 ton/cow/year.

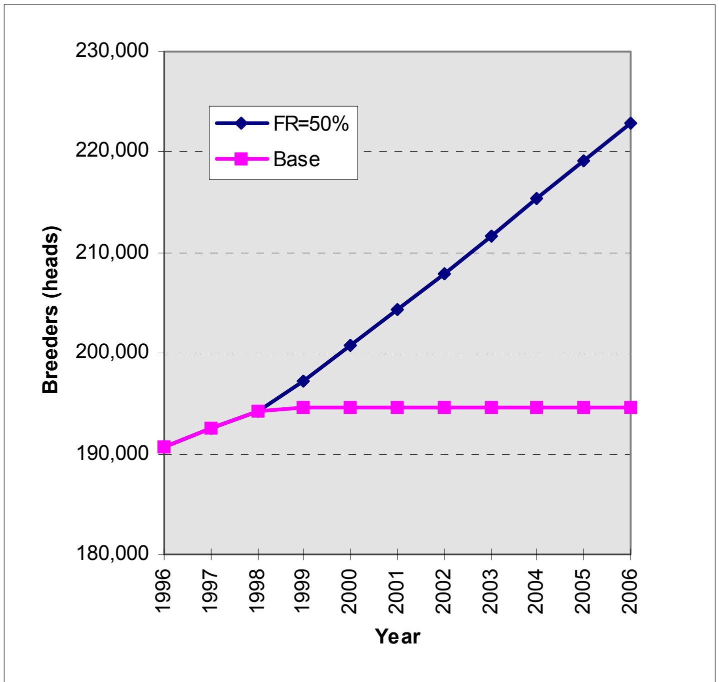
***: Average fertility rate is assumed improve from 80 to 84 percent.

Regarding SNL cows, it will be difficult to increase both the number of animals and the production. On the other hand, the Demand-driven Routine shows that, if average fertility rate of them improves from 43 to 50 percent, the current milk production can be achieved only by 86 percent of cows kept at the moment. Improvement of productivity is one of major policy targets for SNL cattle production. This will also solve another major problem, scarcity of feed resources in the country. This is discussed again in the next section. Another problem is a large amount of distribution loss due to poor hygienic conditions and handling on the farms. In the modeling, the loss is estimated as about 10 percent of the production.

2. Example 2: Beef production

Beef cattle herds in the country can hardly expand their size because of low reproduction rate and relatively high mortality rate. Assuming that enough feeds are provided and the fertility rate improves from 43 percent to 50 percent, the Herd Growth Routine shows that the number of traditional SNL breeders (cows and bulls) in 1996 can expand to 223,000 heads, up 17 percent, at maximum in 2006 (Figure 1). This is only a scenario from the technical view and there are economical and social factors which also make large influences on the growth of cattle herd. However, it shows that improvement of productivity is indispensable for expanding cattle production in Swaziland.

Figure 1: Growth of herd size, SNL beef cattle (breeders)



source: Projection by the Herd Growth Routine of *LDPS*[2]
Base: Base projection, FR=50%: Fertility rate is assumed to improve.

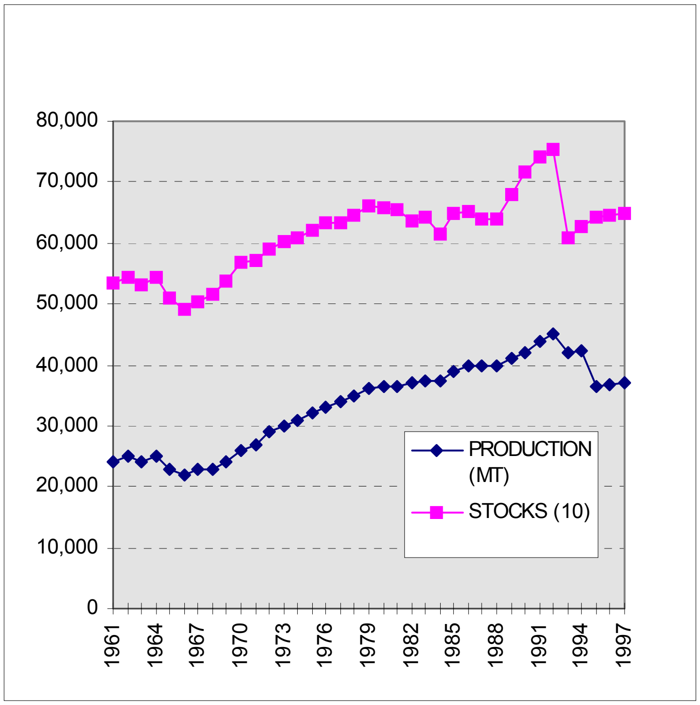
Though fertility rate of TDL beef cattle is higher than 50 percent, growth rate of the herd calculated by the Herd Growth Routine is around zero percent as they are with short production cycles and offtake rate is high. If the fertility rate improves to 60 percent, annual growth rate of the herd will increase to 1.7 percent. The improvements will also causes efficient feed resources use. If the fertility rates improves, total feed energy requirement to produce the same amount of the current TDL beef production will decrease by 3 percent from the current level.

Some technical inconsistencies in the statistics are detected by *LDPS*[2], as shown in section 3.(3) and (4) of the previous chapter.

Firstly, beef production is thought to be over-reported, while slaughter number is under-reported, in the statistics. Both the slaughter number and the sales of cattle in Table 1 do not make sense, as the numbers are larger than the numbers of birth in TDL and GR. *LDPS*[2] shows rational number of slaughters and amount of beef production.

Next, the Herd Growth Routine shows that growth rates of beef cattle herds are around zero percent p.a. Surprisingly, the number of total cattle had grown at more than five percent during the early 1990s (Figure 2). The rapid growth in the period could be over-reported.

Figure 2: Cattle number and cow milk production in Swaziland



The third one is the distribution of total cattle number to the various age classes in Table 1. *LDPS*[2] showed that there might be less 1-3 age cattle and more 3 age old and older cattle than reported. Ages of cattle may be recognized wrongly when the cattle number is counted.

It is recommended to check meat production, including slaughter number, and the growth of cattle herd in the statistics.

Appendix

Appendix A. Parameters for dairy cattle production in 1996

Parameter name	Dairy Cattle Dairy breeds
Milk production demand	10,300
Distribution losses	0.000
Fertility rate	0.800
Prolificacy rate	1.000
Breeder males per breeder female	0.010
Milk yield per lactation	3.000
Fraction of females milked	1.000
Cow mortality rate	0.040
Bull mortality rate	0.040
Female replacement mortality rate	0.030
Male replacement mortality rate	0.030
Female young mortality rate	0.050
Male young mortality rate	0.050
Other stock mortality rate	0.030
Years in breeding herd, cows	5.000
Years in breeding herd, bulls	5.000
Years in replacement herd, females	2.000
Years in replacement herd, males	2.000
Years from young to slaughter, other stock	1.000
Years as young	1.000
Carcass weight of female breeders	0.300
Carcass weight of male breeders	0.350
Carcass weight of other stock	0.250
Males in the system? (Y=1/N=0)	0.000
Are young males slaughtered at birth? (Y=1 / N=0)	1.000
Fraction of fallen animal eaten	0.000
Proportion of female breeders with usable skin	0.950
Proportion of male breeders with usable skin	0.950
Proportion of other stock with usable skin	0.950
	0.950
Weight of skin for female breeders	0.036
Weight of skin for male breeders	0.045
Weight of skin for other stock	0.023
Average live weight, breeder female	0.700
Average live weight, breeder male	0.800
Average live weight, replacement female	0.500
Average live weight, replacement male	0.600
Average live weight, other stock	0.370
Average live weight, young female	0.200
Average live weight, young male	0.220
Milk fat content(g/kg)	34.000
Peek animal draught power demand / month	0
Are there Draught specific oxen?(Y=1 / N=0)	0.00
Are Male Breeders used for draught?(Y=1 / N=0)	0.00

Are Female Breeders used for draught?(Y=1 / N=0)	0.00
Are Male replacements used for draught?(Y=1 / N=0)	0.00
Number of days worked, draught specific animals	0.00
Number of days worked, Breeders	0.00
Number of days worked, Replacements	0.00
Average productivity /animal /day, draught specific oxen	0.00
Average productivity /animal /day, Breeders	0.00
Average productivity /animal /day, Replacements	0.00

Appendix B. Parameters for beef cattle production in 1996

Parameter name	Beef Cattle		
	SNL	TDL	GR
Meat production demand	6,380	2,900	490
Distribution losses	0.000	0.000	0.000
Fertility rate	0.430	0.500	0.500
Prolificacy rate	1.000	1.000	1.000
Breeder males per breeder female	0.130	0.090	0.070
Female breeder mortality rate	0.060	0.050	0.050
Male breeder mortality rate	0.060	0.050	0.050
Female replacement mortality rate	0.050	0.050	0.040
Male replacement mortality rate	0.050	0.050	0.040
Young mortality rate	0.100	0.080	0.060
Other stock mortality rate	0.070	0.050	0.040
Years in breeding herd	9.000	6.000	6.000
Years in replacement herd	2.000	2.000	2.000
Years as young	1.000	1.000	1.000
Years from young to slaughter, other stock	8.000	3.000	4.500
Carcass weight of female breeders	0.200	0.220	0.220
Carcass weight of male breeders	0.220	0.250	0.250
Carcass weight of other stock	0.200	0.250	0.250
Fraction of females milked	0.500	0.000	0.000
Milk yield per lactation	0.800	0.100	0.100
Fraction of calves that are fertile	1.000	1.000	1.000
Retention ratio for young females	1.000	1.000	1.000
Fraction of fallen animals eaten	0.000	0.000	0.000
Are young males slaughtered at birth? (Y=1 / N=0)	0.000	0.000	0.000
Proportion of female breeders with usable skin	0.950	0.950	0.950
Proportion of male breeders with usable skin	0.950	0.950	0.950
Proportion of other stock with usable skin	0.950	0.950	0.950
	0.950	0.950	0.950
Weight of skin for female breeders	0.036	0.036	0.036
Weight of skin for male breeders	0.045	0.045	0.045
Weight of skin for other stock	0.023	0.023	0.023
	0.030	0.030	0.030
Average live weight, breeder female	0.500	0.550	0.550
Average live weight, breeder male	0.550	0.600	0.600
Average live weight, replacement female	0.350	0.400	0.400

Average live weight, replacement male	0.400	0.450	0.450
Average live weight, other stock	0.500	0.550	0.550
Average live weight, young female	0.150	0.200	0.200
Average live weight, young male	0.150	0.200	0.200
Milk fat content(g/kg)	35.000	35.000	35.000
Peek animal draught power demand / month	2610000	0	0
Are there Draught specific oxen?(Y=1 / N=0)	1	0	0
Are Male Breeders used for draught?(Y=1 / N=0)	1	0	0
Are Female Breeders used for draught?(Y=1 / N=0)	0	0	0
Are Male replacements used for draught?(Y=1 / N=0)	0	0	0
Number of days worked, draught specific animals	0	0	0
Number of days worked, Breeders	0	0	0
Number of days worked, Replacements	0	0	0
Average productivity /animal /day, draught specific oxen	1	1	1
Average productivity /animal /day, Breeders	1	1	1
Average productivity /animal /day, Replacements	1	1	1

Appendix C. Grazing feed resources in Swaziland

Grazing land

Growing period (days)	Hectares (x100)	Energy (MJ/kg d m)	Protein (g/kg d m)	Crude fiber (g/kg d m)	Constant	TOT LSU	Total digest. protein (MT)
1 to 75	0	5.0	84.0	296.0	23.5	0	0
76 to 89	0	5.0	84.0	296.0	13.0	0	0
90 to 119	0	5.0	104.0	269.6	10.4	0	0
120 to 149	14,139	5.0	104.0	269.6	6.9	204,913	102,566
150 to 179	0	5.0	143.0	257.1	4.5	0	0
180 to 209	0	5.0	143.0	257.1	3.1	0	0
210 to 239	0	5.0	174.0	236.8	2.0	0	0
240 to 269	0	5.0	174.0	236.8	1.4	0	0
270 to 299	0	5.0	174.0	236.8	0.9	0	0
300 to 329	0	5.0	222.0	200.0	0.6	0	0
330 to 365	0	5.0	222.0	200.0	0.4	0	0
Total	**14,139**	**5.0**				204,913	102,566

Appendix D. Non-grazing feed resources

Crop residues

Name	Quantity (tons)	Imports (tons)	Exports (tons)	Energy (MJ/kg d m)	Protein (g/kg d m)	Crude fiber (g/kg d m)	Total LSUs	Total digest. protein (MT)
straws	0	0.0	0.0	6.0	30.0	400.0	0	0
Potato vine	0	0.0	0.0	10.0	219.0	150.0	0	0
Vegetables	0	0.0	0.0	8.0	23.0	22.0	0	0
Pulses	0	0.0	0.0	16.4	264.0	75.0	0	0
weeds, crop lands	96,000	0.0	0.0	8.0	60.0	350.0	21,573	1,560
weeds, fallow lands	53,000	0.0	0.0	8.0	60.0	350.0	11,910	861
maize stover	223,800	0.0	0.0	7.3	35.0	400.0	45,892	0
other residues	8,000	0.0	0.0	8.0	35.0	400.0	1,798	0
	0	0.0	0.0	0.0	0.0	0.0	0	0
Sugar cane tops	0	0.0	0.0	8.4	59.0	335.0	0	0
Total	**380,800**	**0.0**	**0.0**	**7.6**			**81,172**	**2,421**

Primary products

Name	Quantity (tons)	Imports (tons)	Exports (tons)	Energy (MJ/kg d m)	Protein (g/kg d m)	Crude fiber (g/kg d m)	Total LSUs	Total protein (tons dm)
Maize	16,905	0.0	0.0	14.2	110.0	46.0	6,743	1,762
Wheat	0	0.0	0.0	14.0	135.0	33.0	0	0
Rice	0	0.0	0.0	12.4	70.0	119.0	0	0
Other cereals	0	0.0	0.0	12.0	100.0	30.0	0	0
Soybeans	0	0.0	0.0	14.9	429.0	49.0	0	0
Potatoes	0	0.0	0.0	12.4	103.0	20.0	0	0
Sweet potatoes	0	0.0	0.0	13.6	54.0	23.0	0	0
Cassava	0	0.0	0.0	12.2	39.0	49.0	0	0
Sugar cane	0	0.0	0.0	9.0	63.0	350.0	0	0
Sugar beats	0	0.0	0.0	13.5	74.0	62.0	0	0
Total	**16,905**	**0.0**	**0.0**	**14.2**			**6,743**	**1,762**

Crop by-products

Name	Quantity (tons)	Imports (tons)	Exports (tons)	Energy (MJ/kg d m)	Protein (g/kg d m)	Crude fiber (g/kg d m)	Total LSUs	Total protein (tons dm)
Bran of wheat	2,160	0.0	0.0	10.1	169.0	113.0	613	335
Bran of rice	0	0.0	0.0	12.5	106.0	189.0	0	0
Bran of maize	0	0.0	0.0	12.5	120.0	30.0	0	0
Bran of millet	0	0.0	0.0	12.0	120.0	30.0	0	0
Bran of other cer.	0	0.0	0.0	10.0	100.0	100.0	0	0
Cake of groundnuts	0	0.0	0.0	11.4	335.0	255.0	0	0
cottonseed	135	0.0	0.0	8.7	215.0	240.0	33	25
Cake of rapeseed	0	0.0	0.0	11.7	360.0	104.0	0	0
Cake of soya beans	0	0.0	0.0	13.3	475.0	51.0	0	0
Hominy chop	5,880	0.0	0.0	14.2	109.0	46.0	2,345	607
Total	**8,175**	**0.0**	**0.0**	**13.0**			**2,991**	**967**

Others

Name	Quantity (tons)	Imports (tons)	Exports (tons)	Energy (MJ/kg d m)	Protein (g/kg d m)	Crude fiber (g/kg d m)	Total LSUs	Total protein (tons dm)
Silages etc.	0	0.0	0.0	1.7	80.0	300.0	0	0
Pelagic meals	0	0.0	0.0	20.2	660.0	0.0	0	0
skim milk	0	0.0	0.0	17.3	370.0	0.0	0	0
whey fresh	0	0.0	0.0	15.1	108.0	0.0	0	0
molasses	9,000	0.0	0.0	42.0	35.0	0.0	10,618	315
Fruit wastes	1,350	0.0	0.0	12.6	60.0	131.0	478	59
carcase meal	118	0.0	0.0	16.8	430.0	21.0	56	50
blood meal	9	0.0	0.0	16.8	707.0	0.0	4	7
poultry litter	320	0.0	0.0	16.8	300.0	0.0	151	96
brewers grain	405	0.0	0.0	10.5	279.0	155.0	119	105
Total	**11,202**	**0.0**	**0.0**	**36.3**			**11,426**	**632**

Appendix E. Dairy systems logical flow chart