

### 1.3.3 Crop Descriptions

#### (1) Cereal Crops

Cereal crops in Zambia are maize, millet, sorghum, wheat and rice. Those cereal crops are planted 954,000 ha in 1993, which shares 70% of the national total planted area. Maize is dominant among them sharing 86 % of the total cereal planted area as seen in Table 1-40. Consumption of cereal crops is estimated at 157 kg/capita/year including imported cereal crops in 1993 as discussed in section 4.1. Maize, millet and sorghum are cultivated rainfed while wheat and rice are irrigated.

#### (a) Maize

The planted area of maize is dominant as much as 820,000ha producing 1,736,000 ton in 1993. Planted area of maize increases 27,900 ha/year as shown in Table 1-41. In order to ease concentration of labour requirements, a number of high yielding varieties (HYV) are cropped. Their growing periods vary from 100 to 145 days and the labour peaks are thus mitigated. Maize is predominant staple food in Zambia, and the production, however, varies much year by year. The causes of the variation are those by the price control policy and by droughts. The unforeseeable variation by droughts gives much influence to the national food security. Supplementary irrigation for maize is however less payable as shown in Table A2-3 (Appendix-2), so that the stable maize production through irrigation for maize is not realistic. The problems in the present maize production are summarised as follows.

- The present granary belt (Eastern, Southern and Central provinces) except Central province is largely affected by droughts and the national food security may be endangered. (See Section 1.3.5)
- The unit yield in Western province is lowest in the nation as 0.97 t/ha as equivalent to a half of the national average 1.84 t/ha. The cause of the poor unit yield may be due to poor water holding capacity of the sandy soils.
- On the other hand, the unit yields in Northern, Luapula and North-western provinces in the northern region are of less annual variation and at the same or exceeding level of the national average. In the region hoe farming is dominant that expansion of cultivation area is in difficulties. There also has a constraint of acid soils. However as indicated in Table 1 - 11, it does not affect much since soils at allowable low acidity are sufficiently available therein.

In order to assure stable maize production under rainfed agriculture, expansion of production in the northern region is inevitable.

#### <Varieties and Applicability by Regions>

According to the Report "Evaluation of the Performance of Zambia's Subsector, August, 1990", a number of different varieties are grown in Zambia because of large ranges in rainfalls, temperatures and soils. There are currently 10 different high yielding varieties available to farmers in Zambia, of which potential yields range from 40 to 88 bags/ha (3.6 to

7.9 t/ha) under normal weather conditions and recommended cultural practises. All available varieties are white maize. Yellow maize and sweet corn varieties are mainly imported at present.

Varieties MMV600 and MMV400 are open-pollinated and have been developed specifically for regions that are subject to drought such as the Gwembe valley or Western Province. Their growing period is shorter than other varieties, but yield potential is, however, comparatively lower. Following table shows the characteristics of varieties and their applicability recommended by the "LIMA (cultivation) Crop Recommendations, MAFF". Shorter growing varieties are generally recommended for the dry regions.

**Table 1-44 Maize Varieties and Applicability by Regions**

Variety	Growing Period (1) (days)	Potential Yield (1) (bags/ha)	Recommendation and applicability (2)	
			Northern Province	Western Province
MM501	130-135	66		Generally recommended, but not able to cope with the often occurring dry spells.
MM502	140-145	82	Suited to mixed cropping.	
MM504	130-140	71		Generally recommended, but not able to cope with the often occurring dry spells.
MM601	140-145	82	High yield potential, moderate resistance to streak virus.	
MM603 MM604	145-150	77	Well suited to small scale farmers who may plant late.	On Mazulu (*2) gardens, MM603 perfumes well in average year.
MM612	150-155	77	High yielding, moderate resistance to streak virus.	
MM752	155-160	88	High yielding, prone to streak virus if planted late.	
MMV600	130-135	55	Composite variety, suited to low input, good streak virus resistance.	Early varieties with seeds of the flint type.
MMV400	100-110	40	Early maturing and providing early food, suited to low rainfall areas.	Able to use when late planting is considered. (up to early January)
Local Variety (*1)				performed well in years with good rainfall.

(Note)

(\*1): Open-pollinated varieties like Pop local variety.

(\*2): Higher floodplain lands composed of clayey soil.

(Data Source)

(1): Zamseed. (2) LIMA Crop Recommendation, MAFF

### (b) Millet and Sorghum

Millet and sorghum are more durable to droughts than maize, and are planted for food security at farmers' level. The planted area amounts to about 100,000 ha (7.5% of the total cropped area) equivalent to 1/8 of the planted area of maize. Planted area of millet and sorghum increases 7,000 ha/year. Production of millet and sorghum reached 69,000 ton in 1993, which is equivalent to 1/25 of maize production. Their unit yields are about 0.60 t/ha equivalent approximately to 1/3 of maize. Rainfed agriculture will be maintained for the

crops in future, and it is projected that their planted area will remain at 1/8 of maize.

### **(c) Paddy Rice**

Total planted area of paddy rice was 13,700 ha in 1993, and increases 660 ha/year. Paddy rice is popular in Western and Northern provinces. Total production of paddy rice was 14,000 ton in 1993. Paddy rice is extensively cultivated mainly by small-holder farmers at a low unit yield as 1.0 t/ha. Western province has a share of 53% of the national total planted area of paddy rice, while Northern province has 27%. These two provinces have a share about 80% of the national total. Farm gate price of rice is as low as K15,000/90kg-bag and paddy cultivation by commercial farmers is hardly practised. Meanwhile a verification study by JICA reports that the unit yield of HYV by intensive cultivation can be 4.0 t/ha in wet season and 4.5 t/ha in dry season. Consequently the future subjects for paddy rice may be summarised as follows.

- Introduction of HYV to farmers.
- Demarcation of farmlands free from floods and accessible to irrigation water in the flood plain.

### **(d) Wheat**

Two types of wheat, rainfed and irrigated wheat, are cropped. The former was planted 3,686 ha and the latter 13,656 ha in 1993, and produced 1,944 ton and 69,286 ton of wheat respectively. Rainfed wheat is dominant in Copperbelt Province, but the yield remains at low level as 0.8 t/ha and the planted area and production are unstable. On the other hand, irrigated wheat gives high and stable yield as about 5.0 t/ha, and the planted area is increasing at about 1,000 ha/year. Irrigated wheat is anticipated to steadily increase the planted area year by year. Its planted area is dominant in Southern, Lusaka, Copperbelt and Central Provinces, which share 33.8%, 24.4%, 21.8% and 18.9% of total irrigated wheat respectively and 99% totally. Irrigated wheat is generally planted together with oil crops as the first crops; soybean and groundnut. These crops are supplementary irrigated by the irrigation facilities for wheat.

## **(2) Starchy Crops**

### **(a) Potatoes**

The gross margin of potatoes is so high as K1,300,000/ha to K2,400,000/ha with supplemental irrigation that it can be one of highly beneficial crops from farm management viewpoint. However, the demand shows no substantial increase. The cropped area in 1993 is only 1,670 ha in total, and increasing 57ha/year. Most of potatoes 97% are produced in three provinces as Lusaka (48%), Central (36%) and Copperbelt (13%), and consumed in the same region. Total production is estimated at 3,600 ton in 1993, and per-capita consumption level is only 0.45 kg/person/year, accordingly the future increase may not be expected.

Percapita Consumption = 3,607 ton / 7,969,000 persons = 0.45 kg/person/year

### (b) Cassava

Cassava is cropped mainly in the Northern three provinces and Western Province as a secondary staple crop. The planted area in 1993 amounts to 108,000 ha sharing 8% of the national total planted area, and this indicates the importance of the crop in the region. Planted area of cassava increases 4,300 ha/year. Luapula and Northern Provinces share 63% of total planted area of cassava, while Western Province shares 25% and North-Western Province shares 10%. Shares of other provinces are negligible small.

Total production of cassava is estimated at 233,000 ton, which is corresponding to consumption of 29 kg/capita/year.

$$\text{Percapita Consumption} = 233,000 \text{ ton} / 7,969,000 \text{ persons} = 29 \text{ kg/person/year}$$

In Luapula and Northern Provinces, cassava is planted mainly as a supplemental crop for home consumption while farmers proceed fisheries in the lakes, because cassava is cultivated with less labour requirement and harvested any time at necessity. On the other hand, cassava is planted as one of drought resistant crops for food security at household level in Western Province. A constant demand for cassava remains based from their food security and food habits though the calory of cassava is 1/3 of maize. The planted area for cassava in future is accordingly projected to grow along with the population growth.

### (3) Sugar Crops (Sugarcane)

Sugarcane is one of most important crops being at the second place among agricultural products for export. The crop is cultivated in 13,000 ha by sugar estates and the vicinal contract farmers in and around Mazabuka in Southern Province. The farmlands are furrow-irrigated and cultivation is fully mechanised. Complete systems from cultivation till export through refinery by sugar factory have been firmly established. The present unit yield of sugarcane is 104 t/ha, and achievement of the target yield of 125 t/ha may certainly be expected. The sugar estates have a plan to expand the planted area to 21,000 ha in future.

### (4) Pulse Crops (Mixed Beans)

Mixed beans were planted in 38,500 ha in the country in 1993, which corresponded to 2.8% of the national total planted area. The planted area is increasing 2,400 ha/year, and concentrating to the northern region, particularly in Northern Province as 70% of total area or 27,000ha. Mixed beans are important crops as cash crop and vegetable protein in the northern region, where animal protein is difficult to obtain due to far distance from the livestock dominant provinces. Total production was 23,500 ton in 1993, which is equivalent to consumption of 2.9 kg/person/year in national level.

$$\text{Percapita Consumption} = 23,500 \text{ ton} / 7,969,000 \text{ persons} = 2.9 \text{ kg/person/year}$$

Above consumption level of 2.9 kg/capita/year is evaluated as low consumption level from a national viewpoint. However, it is considered that most of mixed means are consumed in the region and percapita consumption is much higher than that in the northern region.

## (5) Oil Crops

Oil crops are important crop as a cash crop for farmers and export of vegetable oil for the country. Vegetable oil earned 1.4 K'billion of export in 1992, which was the third largest share of export in agricultural sector.

Soybeans, groundnuts, sunflower and seed cotton are planted as major oil crops in the country. Planted area of oil crops reached 215,000ha in national level in 1993, which corresponds to 15.8% of national total planted area. Total production of oil crops reached 136,000 ton in 1993. Among oil crops, groundnuts had a largest share of about 82,500 ha or 38% of planted area of oil crops, and followed by seed cotton as 76,500 ha or 36%. Planted area of oil crops increases 10,500 ha/year. Most significant increase is marked by groundnuts as 5,600 ha/year and followed by seed cotton and soybeans as 4,400 ha/year and 2,000 ha/year respectively, while sunflower decreases 1,600 ha/year. The reason of decrease of planted area of sunflower seems due to negative gross income of (-)K'4,200/ha as analysed in Table A2-17.

Most of oil crops, about 112,000 ton or 82% of total oil crops, was produced in Central, Eastern and Southern Provinces in 1993. Yield of most oil crops seems to decline recently as shown in Table A1-13 to A1-16. Oil crops generally need to grow in the soils, of which acidity is over pH4.8. For expansion of planted area and stable production of oil crops, it is necessary to continue acid improvement for existing fields and to reclaim new lands of appropriate acidity. Oil crops produce stable high yield and earn high income when supplemental irrigation is given. It is, therefore, recommended to provide supplemental irrigation utilising irrigation system such as for wheat.

## (6) Vegetables

There is no statistic data on vegetables in MAFF except old data of commercial sector for 7 years from 1982 to 1988 as shown in Table A1-19. Consequently, result of water right survey has been applied to the study. Vegetables are assumed as planted and irrigated in 11,700 ha in 1993 and increasing 900 ha/year. Total production of vegetables is estimated at 466,000 ton (assumed by double cropping with 20 t/ha for one crop) in 1993, which is equivalent to percapita consumption of about 60 kg/year. This consumption seems reasonably high.

$$\text{Percapita Consumption} = 466,000 \text{ ton} / 7,969,000 \text{ persons} = 58 \text{ kg/person/year}$$

## (7) Tree Crops

### (a) Coffee

Coffee is planted about 6,200ha in the country in 1993. The planted area is increasing year by year about 530 ha/year. Coffee is expected as an important crop for export. Coffee plantation is predominant in Northern Province (3,640 ha equivalent to 59% of total planted area) and Copperbelt Province (1,060 ha or 17%). Those two provinces have a share of 76% of total coffee plantation. The variety of coffee is *arabica* in Zambia. Coffee plant is generally grown in temperatures between 18°C and 25°C, and acid soils (pH between 4.5 to 6.5) are favourable to grow. Thus, coffee is planted in high lands above about 1,200 m in

the northern region. Annual rainfalls 1,200 mm to 2,000 mm are desirable for coffee plantation, and below 800 mm for *arabica* can cause uncertainties in economic life of coffee plantation without additional irrigation. Coffee plantations are, therefore, mostly irrigated. The yield of coffee is estimated at 2.0 t/ha after processed under irrigated condition.

#### (b) Tea

Made tea production was 716 ton in the country in 1989. Planted area was estimated at about 140 ha in 1993 and increasing 5 ha annually. Tea plant requires annual rainfall generally more than 1,200 mm, and comparatively cool temperatures but not frosted. Soils are to be well-drained and acid generally below pH 5.

Tea plantation is generally equipped with an irrigation facility and a processing facility. Plucking of green leaves begins when trees reaches two year age, and trees are matured and produce maximum production after 7 or 8 years after plantation. Tea is expected as one of exportable crops.

#### (8) Fruits

Major fruits are oranges and bananas in Zambia. Total planted area of fruits and production are estimated at 8,130 ha and 142,300 ton in 1993 (Table 1-40 and 1-43). It is corresponding to 17.9 kg/capita consumption.

$$\text{Per capita Consumption} = 142,300 \text{ ton} / 7,969,000 \text{ persons} = 17.9 \text{ kg/person/year}$$

#### (a) Oranges

Orange was planted about 7,155 ha in 1993 in the country. Planted area of orange is increasing about 576ha annually. Yield of orange is estimated at 17.5 ton/ha, and total production is estimated at 125,200 ton in said year. Main producing provinces are Northern Province ( 37% of national total planted area of orange), Copperbelt Province (24%) and Central Province (18%). These three provinces share 79% of national total planted area of orange.

Oranges requires generally well-drained soils and slightly acid with pH 5 to 6. Supplemental irrigation is essential for commercial production of oranges. Oranges are generally most critical for water during blossoming and fruit-setting periods from August /September to November till start of rain.

#### (b) Bananas

Total planted area of bananas is 975 ha in 1993 and estimated to increase 76 ha/year. Banana plantation is concentrated in the northern region, 47% of national total planted area in Northern Province and 33% in Luapula Province. These two provinces share 80% of national total planted area of banana. MAFF expects the yield to increase to 17 ton/ha, but this study assumed the target yield lower at 5.34 ton/ha taking present yield of 4.27 ton/ha into consideration. (Table 1-47)

## (9) Flowers

Flowers are recently grown by commercial farmers and commercial estates. Flowers are now one of the most important exportable crops in Zambia. There are two types of flower plantation. One is production of ornamental flowers like roses, and the other is production of processing flowers like marigolds which are utilised as a feed for yellowing egg yolk. Both are mostly exported.

Ornamental flowers are produced mainly by commercial farmers under drip irrigation system in a green house. It is estimated to be planted at about 250 ha in Zambia, mostly concentrating to Lusaka Province (84%) and Copperbelt Province (15%). Two provinces share 99% of total production of ornamental flowers. Zambia has a remarkable advantage to produce ornamental flowers for exporting to Europe, because Zambia enjoys the summer when Europe is winter.

On the other hand, processing flowers are recently grown by commercial estates in large extent as more beneficial crops than previously grown crops like wheat. One of commercial estates, Masstock changed the crops from wheat of 1,300 ha to marigolds of 1,000 ha and paprika of 300 ha. Those are irrigated by centre pivot irrigation systems.

### 1.3.4 GVA of Crops

Gross value added (GVA) of crops amounts to K'million 177,607 in 1993, which shares about 60% of total of agricultural sector. (see Table 1-26)

As shown in Table 1-45, irrigated crops share 32% of total crop GVA or K'million 56,391 of which vegetables produce 55% of irrigated crop GVA. On the other hand, irrigated area shares only 4% of total planted area or 53,023ha.

Table 1- 45 GVA of Crops and Crop Products in 1993

Crops	GVA of Crops					Planted Area				
	Total Crops		Irrigated Crop			Total Crops		Irrigated Crop		
	Crop (k'million)	Compo sition	Crop (k'million)	Compo sition	Ratio to Total	Crop (ha)	Composi tion	Crop (ha)	Composi tion	Ratio to Total
Cereal Crops	83,227.5	47%	2,913.5	5%	2%	954,049	70%	13,656	26%	1%
Starchy	11,824.5	7%	0.0	0%	0%	109,482	8%	0	0%	0%
Sugar Crop	2,238.9	1%	2,238.9	4%	1%	13,000	1%	13,000	25%	1%
M.Bean/ Oil Crops	28,099.8	16%	4,588.1	8%	3%	253,208	19%	0	0%	0%
Tobacco	5,566.3	3%	0.0	0%	0%	6,946	1%	0	0%	0%
Vegetables	31,019.4	17%	31,019.4	55%	17%	11,663	1%	11,663	22%	1%
Fruit/Coffee	14,256.3	8%	14,256.3	25%	8%	14,455	1%	14,455	27%	1%
Flower	1,374.4	1%	1,374.4	2%	1%	249	0%	249	0%	0%
Total	177,607.1	100%	56,390.6	100%	32%	1,363,052	100%	53,023	100%	4%

### 1.3.5 Fluctuation of Maize Production and Yield

Production and yield of maize are largely affected by weather conditions especially by droughts. Yield of maize is not affected equally by drought through the country, much severe in southern region and moderate in northern region. Yield fluctuation of maize was analysed both for national and provincial basis utilising yield data for 12 years from 1982 to 1993. Yield data of 1992 were excluded in few provinces due to exceptional yield reduction beyond normal range. Table 1-46 shows the result of analysis.

According to the results of yield analysis in Table 1-46, yield is extremely lower in Western Province as 0.97 tons/ha in normal year (1/2 years) and 0.77 tons/ha in drought year (1/5 years). Eastern Province is also low in yield, following Western Province. On the other hand, Central Province keeps very steady high yield as well as lower yield reduction even in drought year.

Yield reduction in drought year is relatively large in Lusaka, Western and Southern Provinces as reducing more than 20%. Eastern Province, however, keeps smaller reduction rate, but yield itself is low both in normal year and drought year as shown in the table. On the other hand, northern provinces especially Copperbelt, Luapula and Northern are keeping lower yield reduction as well as high yield both in normal year and drought year. In this respect, it is recommended to encourage cultivation of maize in the northern provinces.

**Table 1-46 Probable Yield Reduction of Maize by Drought**

Yield	(Unit: tons/ha)									
	Lusaka (*)	Copperbelt	Central	N/ Western	Western (*)	Southern (*)	Luapula	Northern	Eastern (*)	Zambia (*)
1/2 yrs	1.69	2.09	2.53	1.72	0.97	1.97	2.08	2.19	1.41	1.84
1/5 yrs	1.33	1.68	2.10	1.52	0.77	1.48	1.82	1.99	1.21	1.62
Reduction	21.3%	19.6%	17.0%	11.6%	20.6%	24.9%	12.5%	9.1%	14.2%	12.0%

(Note)

1) \*: Yield data of 1992 has been excluded, because 1992 yield exceeded the range of 1/100 years.

2) Analysis is based on Log-Normal Distribution Method. (Data described in Table A1-4(1), Appendix-1)

Yield of maize reached to about 1.95 tons/ annum in 1990, increasing by 0.02 ton/annum or 1% annually as shown by trend in Appendix-1, Table A1-4(1).

### 1.3.6 Present and Target Yield of Crop

Yields of crops have been studied with a statistical data of crops for 12 years from 1982 to 1993. Target yields are decided referring to the Gross Margin Budget of DOF, MAFF and information of Zamseed, taking present yield into consideration. Target yields of rainfed crops are considered to increase 1% annually with improvement of technology. Such increase of yield is considered for some irrigated crops such as sugarcane and tea. The results are listed described in Table 1-47.



Table 1-47 Comparative Target Yields by Different Agencies and Applied Yields

Crops	Gross Margin Budget and Horticulture Section, MAFF							Applied Yield (tons/ha)				Zamseed (tons/ha) Research or Experiment
	Kg/bag	Target Yield (bags/ha)			Target Yield (tons/ha)			in This Study				
		Emergent	Small Commercial	Large Commercial	Emergent	Small Commercial	Large Commercial	1990	2005	2015	1993 Actual	
<b>Cereals</b>												
Maize	90	25	45	60	2.3	4.1	5.4	1.95 *1	2.24	2.44	2.12	6.2
Rice (Extensive) *	80	20		1)	1.6			1.00 *2	1.15	1.25	1.02	
Rice (Intensive) *	80		30	50 1)		2.4	4.0	3.50 *3	3.50	3.50		2.2 - 4.2
Sorghum	90	20	35	45	1.8	3.2	4.1	0.62 *2	0.71	0.78	0.75	5.6
Millet	90	10	15		0.9	1.4		0.65 *2	0.75	0.81	0.61	1.25
Rainfed Wheat	90	11	19	22	1.0	1.7	2.0	*4			0.53	
Irrigated Wheat *	90			55			5.0	5.00 *3	5.00	5.00	5.07	5.5
<b>Starchy</b>												
Cassava (Chips)	90	175 (Tube) 1)			3.15 (Chips)			2.16 *2	2.48	2.70	2.16	
Potatoes	10	600	1,500	2,000 1)	6.0	15.0	20.0	13.42 *2	15.4	17.7	13.4	
<b>Sugar Crops</b>												
Sugarcane				1)			130.0	100 *2	115	125	108	
<b>Pulse Crops</b>												
Mixed Beans	90	6	12	15	0.5	1.1	1.4	0.61 *2	0.70	0.76	0.61	
<b>Oil Crops</b>												
Soybeans	90	13	18	25	1.17	1.62	2.25	1.12 *2	1.29	1.40	1.41	2.25
Sunflower	50	14	30	40	0.70	1.50	2.00	0.48 *2	0.55	0.60	0.40	2.52
Seed Cotton	1	700	1,000	2,000	0.70	1.00	2.00	0.64 *2	0.74	0.80	0.63	
Groundnuts	80	8	16	23	0.64	1.28	1.84	0.41 *2	0.47	0.51	0.55	1.3
<b>Cash Crops</b>												
Burley Tobacco	1							0.70 *2	0.81	0.88	0.77	
Virginia Tobacco	1							1.11 *2	1.28	1.39	1.16	
<b>Vegetables</b>												
Tomatoes *	15	500	800	1,650	7.5	12.0	24.8	24.8 *3	24.8	24.8		
Onion *	10	800	1,600	2,000	8.0	16.0	20.0	20.0 *3	20.0	20.0		
Cabbage *	1	10,000	15,000	20,000	10.0	15.0	20.0	20.0 *3	20.0	20.0		
Carrot *	1	6,000	12,000	18,000	6.0	12.0	18.0	18.0 *3	18.0	18.0		
Lettuce *	1	7,000	15,000	20,000	7.0	15.0	20.0	20.0 *3	20.0	20.0		
Fresh Asparagus *	1	6,000	12,000	18,000 1)	6.0	12.0	18.0	18.0 *3	18.0	18.0		
Strawberry *	1	2,500	3,500	5,000 1)	2.5	3.5	5.0	5.0 *3	5.0	5.0		
Green bean *	1	2,500	3,500	5,000 1)	2.5	3.5	5.0	5.0 *3	5.0	5.0		
Pepper *	1			13,000 1)			13.0	13.0 *3	13.0	13.0		
<b>Stimulant</b>												
Coffee (processed) *							2.0	2.00 *2	2.00	2.00	0.93	
Tea (made tea) *								4.44 *2	5.11	5.55	4.44	
<b>Fruit</b>												
Oranges *	1			25,000 1)			25.0	17.5 *2	20.1	23.1	17.5	
Mandarin *												
Banana *	1			17,000 1)			17.0	4.14 *2	4.76	5.18	4.14	
<b>Forage (DM weight)</b>												
Star Grass *	1			12,000 1)			12.0	12.0 *3	12.0	12.0		17.5
Rhodes Grass	1			13,500 1)			13.5	13.5 *3	13.5	13.5		15.0
Lucerne *								10.0 *3	10.0	10.0		11.5
Berseem Clover *								12.0 *5	12.0	12.0		

(Data Sources)

1. Gross Margin Budget, September 1994, MAFF.
2. 1): Farm Management and Horticulture Section, MAFF.

(Notes)

1. Yield in bags is official report. (converted to tons/ha for convenient to refer)
2. \*: Irrigated Crops
3. DM: Dry Material Weight
4. \*1: Yield is trended by actual yield and increased by 1% per annum.  
\*2: The latest or average yield has been applied due to unsteady yield. Yield is projected to increase 1% per annum.  
\*3: Commercial basis yield has been applied for full irrigation development from initial stage.  
\*4: not considered as a crop for future development.  
\*5: experienced in Egypt and Iran.
5. Cassava: 175 bags/ha (90-kg bag) by MAFF in Cassava tuber = 15.75 t/ha  
Chip weight = 15.75 t/ha x 0.2 = 3.15 t/ha

### 1.3.7 Farm Power and Mechanisation

#### (1) Cultivation Capacity by Cultivation Systems

Mechanisation of cultivation is highly advanced in commercial farms. However, commercial farmers comprise only 0.4% of total farmers. The majority of farmers belong to medium or small holder farms. In these farms, ox draught system or hoe cultivation are predominant. Ox draught system is commonly practised in southern and western regions of Zambia. However, ox draught system is not yet introduced so commonly in the northern region, and hoe cultivation is predominant in the northern region. Farming capacity differs by cultivation systems as shown in Table 1-48. Labour requirement of hoe cultivation is about 5 times of mechanised cultivation system.

Table 1-48 Labour Requirement for Maize Cultivation

(Unit: /ha)

Work Item	Cultivation System				
	Hoe Cultivation	Ox Draught Cultivation		Mechanised Cultivation	
	(mandays)	(mandays)	(Ox-days)	(mandays)	(tractor-days)
Manure Spreading	0.0	9.0	3.0	1.0	1.0
Sowing	83.3	14.4	12.4	3.5	3.5
Manuring Practice	21.6	21.6	0.0	5.5	5.5
Harvesting/Post harvest	42.7	35.0	2.0	20.0	3.0
Total	147.6	80.0	17.4	30.0	13.0
Total (excluding Manure Spreading)	147.6	71.0	14.4	29.0	12.0

#### (2) Workable Days by Regions

Cultivation capacity is also largely affected by climatic conditions, especially by rainy days and rainfall amount. Table 1-49 shows the workable days for cultivation by the agro-ecological zones. As shown in the table, workable days in the Agro-ecological Zone-I & II and Zone III are 302 and 278 days in a year. Workable days in Zone-III are less than that in Zone-I & II by 24 days in a year.

For maize cultivation, workable days (Nov. - Apr.) are 124 days for Zone-I & II and 102 days for Zone-III. Workable days for sowing are 30 days for Zone-I & II and 25 days for Zone-III.

**Table 1-49 Average Workable Days by Agro-Ecological Zone**

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
<b>Agro-Ecological Zone-I &amp; II</b>													
Workable Days	28.2	24.6	16.2	15.2	17.1	23.0	27.8	29.9	30.0	30.0	30.0	30.0	302.0
Nov-Dec		40.8 days											
Nov-Apr		123.9 days											
<b>Agro-Ecological Zone-III</b>													
Workable Days	27.2	21.6	12.4	12.1	14.6	15.6	25.3	29.4	30.0	30.0	30.0	29.8	278.0
Nov-Dec		34.0 days											
Nov-Apr		101.6 days											

(Note)

- 1) One month is counted as 30 days.
- 2) Workable days for Maize Sowing: (Period = 45 days = 10 Nov. to 25 Dec.)  
Zone-I&II =  $40.8 \times (45/60) = 30$  days, Zone-III =  $34.0 \times (45/60) = 25$  days
- 3) Detail estimation of workable days is described in Supporting Report I, Irrigation

### (3) Cultivation Capacity by Regions

Cultivation capacity is estimated taking cultivation system and workable day into consideration as shown in Table 1-50. Cultivation capacity of maize is restricted by sowing capacity in case of hoe cultivation system, while it is restricted by total cultivation capacity in cases of ox draught and mechanised systems. Cultivation capacity by regions are summarised as below;

#### Cultivation Capacity by Regions

Agro-Ecological Zone	(Unit: ha/farmer)		
	Hoe Cultivation	Ox Draught Cultivation	Mechanised Cultivation
I & II	0.36	1.74	4.27
III	0.30	1.43	3.51

**Table 1-50 Cultivation Capacity for Maize**

Agro-Ecological Zone	Cultivation System	Sowing Capacity			Cultivation Capacity		
		Workable Days (1) (days)	Required mandays (2) (mandays/ha)	Sowing Capacity (3) = (1)/(2) (ha/farmer)	Workable Days (4) (days)	Required mandays (5) (mandays/ha)	Cultivation Capacity (6) = (4)/(5) (ha/farmer)
I & II	Hoe Cultivation	30	83.3	0.36	124	147.6	0.84
	Ox Draught		14.4	2.08		71.0	1.74
	Mechanised		3.5	8.57		29.0	4.27
III	Hoe Cultivation	25	83.3	0.30	102	147.6	0.69
	Ox Draught		14.4	1.73		71.0	1.43
	Mechanised		3.5	7.14		29.0	3.51

### 4) Number of Oxen for Farm Power

Number of oxen reached about 266,000 in 1990, increased by 48% since 1985 in the traditional sector on a national level as shown in Table 1-51. Increased rate of oxen was higher than cattle increase of 7% over the same period. Number of oxen comprised 12% of cattle number in traditional sector in 1990.

MAFF promotes the introduction of animal power utilisation in traditional sector for expansion and stabilisation of cultivation. Southern Province has the largest number and share of trained oxen (almost 50% of national total oxen), and followed by Eastern and Central Provinces as shown in Table 1-51. These three provinces share over 80% of national total oxen. Increase rate is highest in North-western Province, and followed by Western Provinces, over 200 % in both provinces. On the other hand, oxen decreased by 3% in Luapula, and barely increased in Northern Province.

**Table 1-51 Number of Trained Oxen for Farm Power in Traditional Sector**

Province	Number of Oxen		Rate		Agri. Popu. 1990	Cultivate Area (ha) 1990	Area/ Farmer (ha)	Ox/ha	Ox /farmer
	1985 (head)	1990 (head)	Share in 1990	Increase to 1990					
	(1)	(2)		(2-1)/(1)					
Lusaka	4,261	7,355	2.8%	73%	33,402	39,082	1.17	0.19	0.220
Copperbelt	1,300	2,329	0.9%	79%	60,594	39,123	0.65	0.06	0.038
Central	24,739	42,700	16.1%	73%	120,986	165,844	1.37	0.26	0.353
N/Western	300	2,375	0.9%	692%	77,269	31,847	0.41	0.07	0.031
Western	10,000	31,700	11.9%	217%	95,307	65,916	0.69	0.48	0.333
Southern	96,000	126,400	47.5%	32%	133,022	332,459	2.50	0.38	0.950
Luapula	500	487	0.2%	-3%	109,826	43,026	0.39	0.01	0.004
Northern	4,200	4,620	1.7%	10%	181,935	102,554	0.56	0.05	0.025
Eastern	38,000	47,960	18.0%	26%	302,771	334,049	1.10	0.14	0.158
Total	179,300	265,926	100.0%	48%	1,115,112	1,153,900	1.03	0.23	0.238
% to Cattle	9%	12%							
Cattle Number (5)	2,076,586	2,216,125		7%					

(Data Source)

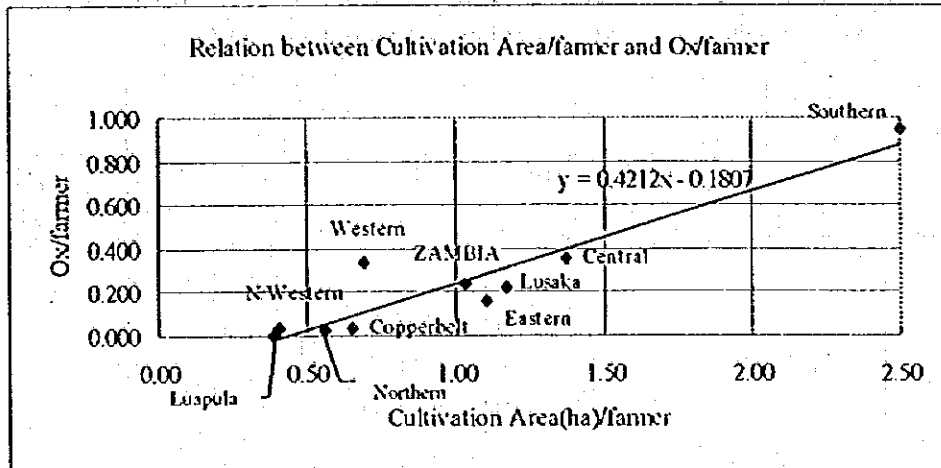
(1),(2): Animal Traction Survey in Zambia, MAFF, 1993

(Note)

Number of oxen of Lusaka and Central in 1985 are divided at same ration in 1990, because of no individual data for Lusaka and Central in 1985.

Figure 1-5 shows the relation between percapita cultivation area (ha/farmer) and percapita ox availability (ox/farmer). As shown in the figure, both ox availability and percapita cultivation area are extremely high in Southern Province. Ox availability is also high in Central and Western Provinces, as 0.353 ox and 0.333 ox per farmer respectively. However, percapita cultivation area of Western Province is extremely smaller than that of Central Province. It seems that mechanised commercial farmers are scarce in Western Province and percapita cultivation area is smaller. On the other hand, although ox availability of Copperbelt Province is very low comparing to Western Province, percapita cultivation area is almost same as that of Western Province. It is considered that share of mechanised commercial farmers is high in Copperbelt Province.

Figure 1-5 Relation between Percapita Cultivation Area and Ox Availability



On the other hand, both percapita cultivation area and ox availability are very low in North-western, Luapula and Northern Provinces. For expanding cultivation area in Zambia, it seems that it is one of key factors to increase oxen number in these three provinces. Taking into account less number of commercial farmers in these three provinces, it seems that it may be necessary to increase ox availability to about 0.4 ox per farmer to achieve 1.00 ha of percapita cultivation area (national average percapita cultivation area) in these three provinces. Availability of ox is also low in Copperbelt Province, it is also necessary to increase oxen number in this province.

### 1.3.8 Post Harvest and By-Product

By-products of cereal crops, oil crops, sugarcane and vegetables are utilised for feeding livestock as concentrated or roughage feed. Bran and oil cake are produced in milling process of cereals and oil seed products, and these are utilised as concentrated feed. Stem and leaf are utilised as roughage feed. By-products of major crops are summarised in Table 1-52. For evaluating the available amount of feed for livestock, by-product amount of crops has been estimated depending on Table 1-52. Available by-product amount is shown for 12 years from 1982 to 1993 in Table 1-53. Total available amount of by-product is estimated at about 263,000 ton annually in average as shown in the table.

**Table I-52 Post Harvest Processing and By-Products of Major Crops**

Crops	Gross Production		Output Material, By-Products and Losses in Processing							
	Whole Grain Weight	Stem/ Leaf Weight	Grain				Oil Crops		Sugarcane	
			Mill	Bran	Husk	Losses	Oil	Oil Cake	Raw Sugar	Molasses
<b>Production Ratio</b>	%	%	%	%	%	%	%	%	%	%
Maize	35	65	80	15		5				
Sorghum	40	60	75	20		5				
Millet	40	60	75	20		5				
Wheat	55	45	60	35		5				
Paddy Rice	52	48	60	10	25	5				
Soybeans	35	65					6	25		
Groundnuts	30	70				5	6	25		
Seed Cotton	30	70					8	20		
Sugarcane	75	25							10	4
<b>Production</b>	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)
Maize	2.40	4.46	1.92	0.36	0.00	0.12				
Sorghum	0.78	1.17	0.59	0.16	0.00	0.04				
Millet	0.90	1.35	0.68	0.18	0.00	0.05				
Wheat	5.00	4.09	3.00	1.75	0.00	0.25				
Paddy Rice	4.00	3.69	2.40	0.40	1.00	0.20				
Soybeans	1.40	2.60					0.08	0.35		
Groundnuts	0.51	1.19				0.03	0.03	0.13		
Seed Cotton	0.80	1.87					0.06	0.16		
Sugarcane (*)	125.00	41.67							12.50	5.00

Note

- 1) Loss rate refers to the loss rate of maize in Food Balance Sheet (1984-86) FAO.
- 2) Losses include all losses in all procedure from farm gate to consumption.
- 3) Yield refers to the target yield.
- 4) (\*) green weight of gross production.

Table I-53 Production of By-product of Crops

Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993 Average	
<b>Crop Production (tons)</b>													
Cereals	750,240	955,280	871,740	1,122,351	1,230,594	1,063,449	1,943,219	1,844,978	1,092,671	1,095,908	483,492	1,736,221	1,180,845
Maize		12,699	13,504	19,442	11,661	30,262	27,000	27,260	31,531	25,573	48,029	33,161	25,466
Millet		13,985	12,518	14,966	20,227	44,996	22,774	33,757	19,591	20,939	13,007	36,031	23,249
Sorghum		16,789	16,498	13,491		27,458	37,126	46,614	53,601	59,108	57,599	71,250	39,951
Wheat		5,272	9,631	9,271	11,233	11,207	8,242	11,734	9,293	14,602	8,289	13,964	10,201
Oil Crops													
Soybeans		7,304	7,952	13,154	14,738	15,906	21,470	20,578	26,791	27,713	7,006	28,026	17,008
Sunflower		26,731	34,930	43,008	42,424	30,577	18,404	15,033	19,966	10,645	1,493	14,330	22,879
Seed Cotton		16,499	31,492	43,907	30,254	33,357	58,530	34,154	36,536	48,721	25,899	48,400	35,659
Sugar Crop													
Sugarcane		893,178	1,010,464	1,086,165	1,207,262	1,173,660	1,241,327	1,321,838	1,126,540	1,221,027	1,315,513	1,410,000	1,178,661
<b>Production of By-Product</b>													
Cereals (Ratio)	0.15	0.20	0.20	0.35	0.10	0.10	0.15	0.20	0.25	0.25	0.20	0.25	0.20
Maize	112,536	140,292	130,761	168,353	184,589	159,517	291,483	276,747	163,901	164,386	72,524	260,433	177,127
Millet	0	2,540	2,701	3,888	2,332	6,052	5,400	5,452	6,306	5,115	9,606	6,632	5,093
Sorghum	2,797	2,504	2,993	4,045	8,999	5,238	4,555	6,751	3,918	4,188	2,601	7,206	4,650
Wheat	5,876	5,774	4,722	0	0	9,610	12,994	16,315	18,760	20,688	20,160	24,931	13,983
Rice	527	963	927	1,123	1,121	824	967	1,173	929	1,460	829	1,396	1,020
Oil Seeds													
Soybeans	1,826	1,988	3,289	3,685	3,977	3,366	5,368	5,145	6,698	6,928	1,752	7,007	4,252
Sunflower	6,683	8,733	10,752	10,606	7,644	4,250	4,601	3,758	4,992	2,661	373	3,583	5,720
Seed Cotton	3,300	6,298	8,781	6,051	6,671	4,031	11,706	6,831	7,307	9,744	5,180	9,680	7,132
Sugar Crops													
Sugarcane	35,727	40,419	43,447	48,290	46,946	49,653	52,874	45,479	45,062	48,841	52,621	56,400	47,146
Sub-Total (tons)	121,736	152,073	142,104	177,409	197,041	181,241	315,399	306,438	193,814	195,837	105,720	300,598	199,118
Cereal	11,809	17,019	22,822	20,342	18,292	11,647	21,675	15,734	18,997	19,333	7,305	20,270	17,104
Oil Seed	35,727	40,419	43,447	48,290	46,946	49,653	52,874	45,479	45,062	48,841	52,621	56,400	47,147
Sugarcane	169,272	209,511	208,373	246,041	262,279	242,541	389,948	367,651	257,873	264,011	165,646	377,268	263,369
Total													

## CHAPTER 2 PRESENT STATUS OF LIVESTOCK

### 2.1 Population and Production of Livestock

It is estimated that 2,669,000 head of cattle, 592,000 sheep and goats, 303,000 pigs, and 7,920,000 poultry were bred in the country in 1990. Southern, Central, Eastern and Western Provinces are predominant in cattle breeding and have a share of some 80% of the total number of cattle. Cattle are the most important livestock in Zambia. They provide essential food products and contribute to draught power and manure for cultivation.

Table 2-1 Number of Livestock and Share by Province in 1990

Province	Cattle		Sheep/ Goats		Pigs		Poultry	
	Number	%	Number	%	Number	%	Number	%
Lusaka	87,647	3.3%	13,407	2.3%	10,321	3.4%	1,582,000	20.0%
Copperbelt	74,374	2.8%	16,504	2.8%	21,186	7.0%	1,219,000	15.4%
Central	503,512	18.9%	47,597	8.0%	19,842	6.5%	987,000	12.5%
N/Western	59,340	2.2%	9,918	1.7%	4,732	1.6%	219,000	2.8%
Western	546,957	20.5%	8,368	1.4%	4,667	1.5%	388,000	4.9%
Southern	1,052,795	39.5%	274,228	46.3%	73,473	24.2%	1,337,000	16.9%
Luapula	12,186	0.5%	29,900	5.0%	3,019	1.0%	326,000	4.1%
Northern	107,821	4.0%	31,875	5.4%	8,318	2.7%	855,000	10.8%
Eastern	223,880	8.4%	160,359	27.1%	157,855	52.0%	1,008,000	12.7%
<b>Zambia</b>	<b>2,668,512</b>	<b>100.0%</b>	<b>592,156</b>	<b>100.0%</b>	<b>303,413</b>	<b>100.0%</b>	<b>7,921,000</b>	<b>100.0%</b>
Sector	Cattle		Sheep/ Goats		Pigs		Poultry	
	Tradition al	Commer cial	Tradition al	Commer cial	Tradition al	Commer cial	Tradition al	Commer cial
Lusaka	37,647	50,000	11,619	1,788	5,137	5,184	339,000	1,243,000
Copperbelt	18,250	56,124	5,964	10,540	9,089	12,097	301,000	918,000
Central	322,732	180,780	34,431	13,166	7,969	11,873	441,000	546,000
N/Western	56,462	2,878	9,918		4,732		219,000	0
Western	546,957		8,368		4,667		388,000	0
Southern	866,378	186,417	261,207	13,021	70,363	3,110	1,246,000	91,000
Luapula	10,031	2,155	29,812	88	2,988	31	326,000	0
Northern	96,437	11,384	30,265	1,610	7,853	465	822,000	33,000
Eastern	222,586	1,294	160,359		157,855		1,008,000	0
<b>Zambia</b>	<b>2,177,480</b>	<b>491,032</b>	<b>551,943</b>	<b>40,213</b>	<b>270,653</b>	<b>32,760</b>	<b>5,090,000</b>	<b>2,831,000</b>
<b>Ratio</b>	<b>82%</b>	<b>18%</b>	<b>93%</b>	<b>7%</b>	<b>89%</b>	<b>11%</b>	<b>64%</b>	<b>36%</b>

(Note) Poultry: estimated by data from 1982 to 1990, due to no sufficient data.

#### 2.1.1 Number of Livestock

##### <Cattle>

- Cattle population increased from 1,730,000 in 1980 to 2,669,000 in 1990 at the high growth rate of 4.53% as shown in Figure 2-1.
- Traditional farmers own about 2,200,000 head or 82% of total cattle, and about 600 commercial farmers share 491,000 head or 18% in 1990.
- However, cattle number decreased from 2,680,000 to 2,540,000 head by 5.5% from 1989 to 1991. The decrease was mainly caused by decrease in Southern Province. In Southern Province, cattle number reached to maximum head of 1,125,000 in 1987, then decreased rapidly by 16% to 940,000 head in 1991. The decrease in Southern Province was mainly caused by decrease in traditional sector. Cattle grazing requires 2 ha area on flood plain areas and 5 ha area on plateau area per head in dry season, which means the



cattle population has exceeded the capacity of the area in Southern Province as discussed Table 2-5.

- Animal draught power is rapidly increasing with some 266,000 trained oxen presently being worked in 1990. (see Table 1-51 in Section 1.3.7)

#### <Sheep and Goats>

- Number of sheep and goats reached 592,000 head in 1990 as shown in Table 2-1, of which 93% is shared by traditional sector. Southern and Eastern provinces, share 70% of total. Breeding of sheep and goats is made together with cattle breeding and it supports stable cattle breeding.
- In commercial sector, 40,000 head of sheep and goats are bred, of which 65% are bred in Southern and Central Provinces. They are bred at the rate of one head of sheep or goat per 12 to 13 head of beef cattle.

#### <Pigs>

- As shown in Table 2-1, total number of pigs were about 303,000 head in the country in 1990, of which 89% were bred in traditional sector. Eastern and Southern provinces are predominant in pig breeding, and share 52% and 24% of national total respectively.
- Commercial sector was breeding 32,760 pigs in 1990, of which 40% were bred in Copperbelt, Central and Lusaka provinces. In North-Western province, 13,600 pigs were bred in 1988, but almost negligible in breeding in 1991. In Southern Province, number of pigs decreased since 1988 to half. In the two provinces, pig breeding is unstable.

#### <Poultry>

- Number of poultry were 7,920,000 birds in 1990 in the country, of which 64% were shared by traditional sector. Poultry breeding is predominant in Southern, Copperbelt and Central Provinces. Poultry breeding is unstable and breeding number fluctuates widely by the year.

Figure 2-1 Growth of Cattle Number in Zambia

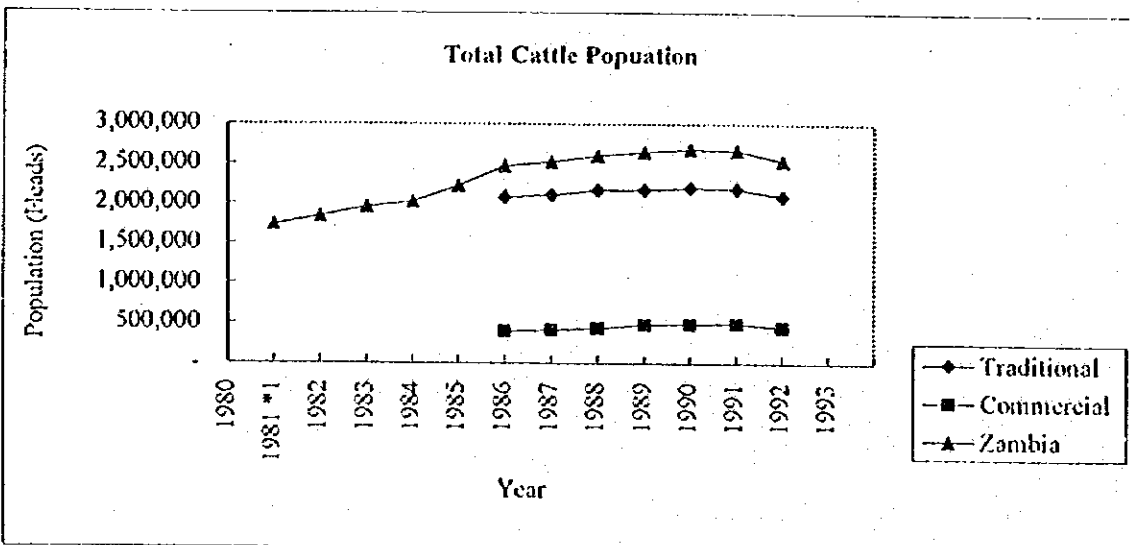
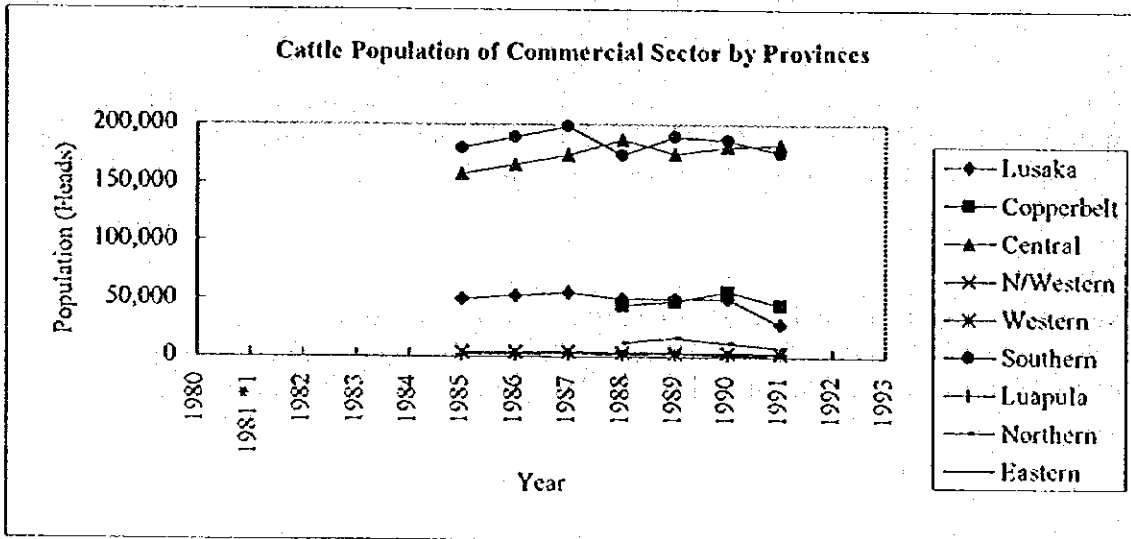
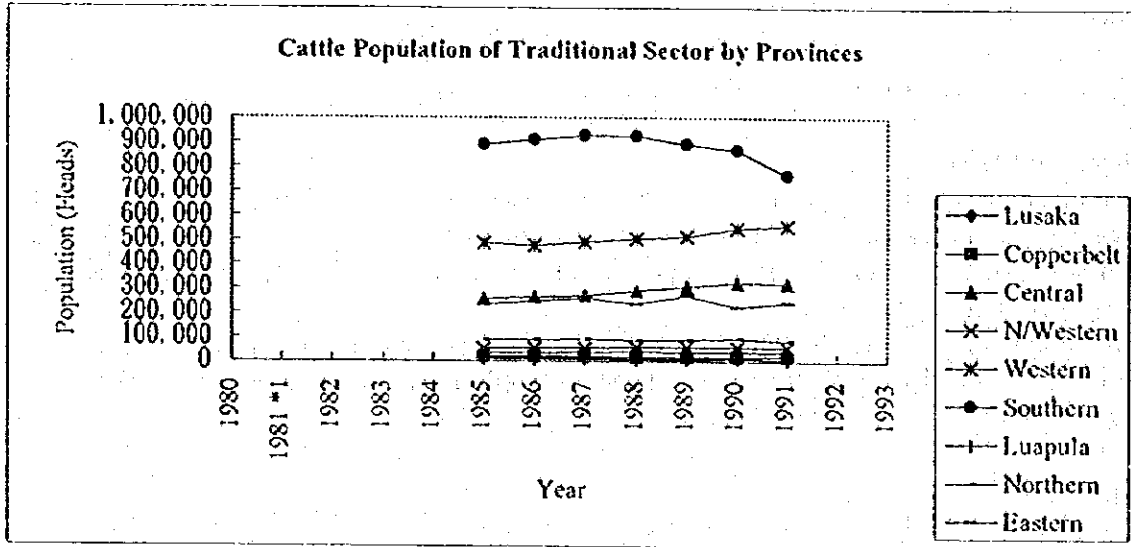


Figure 2-2 Growth of Sheep and Goat Number in Zambia

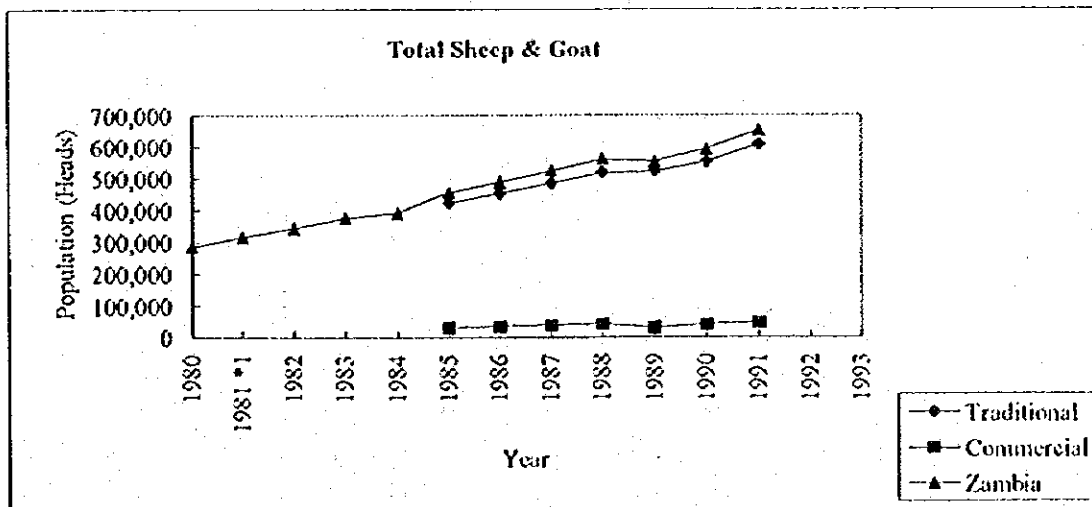
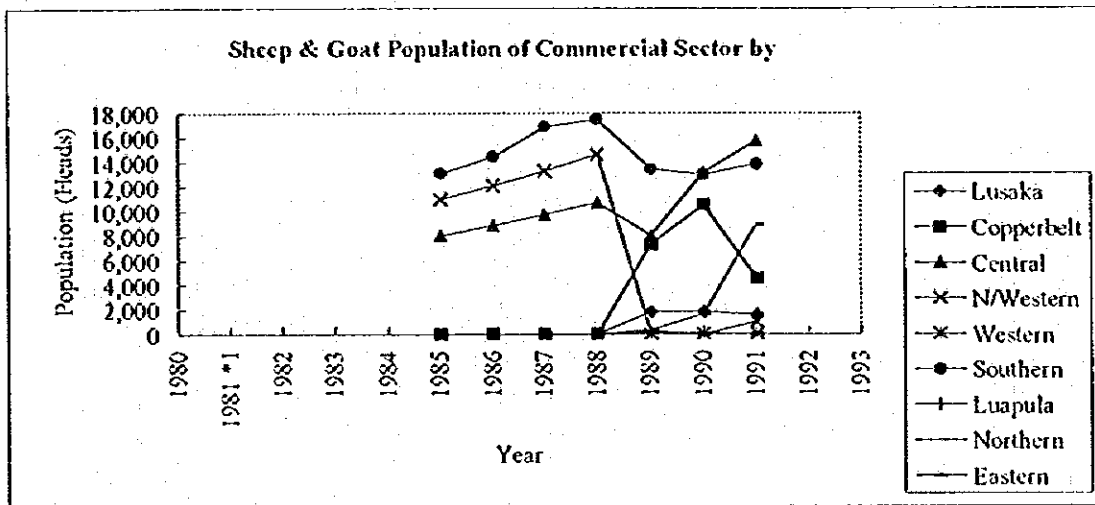
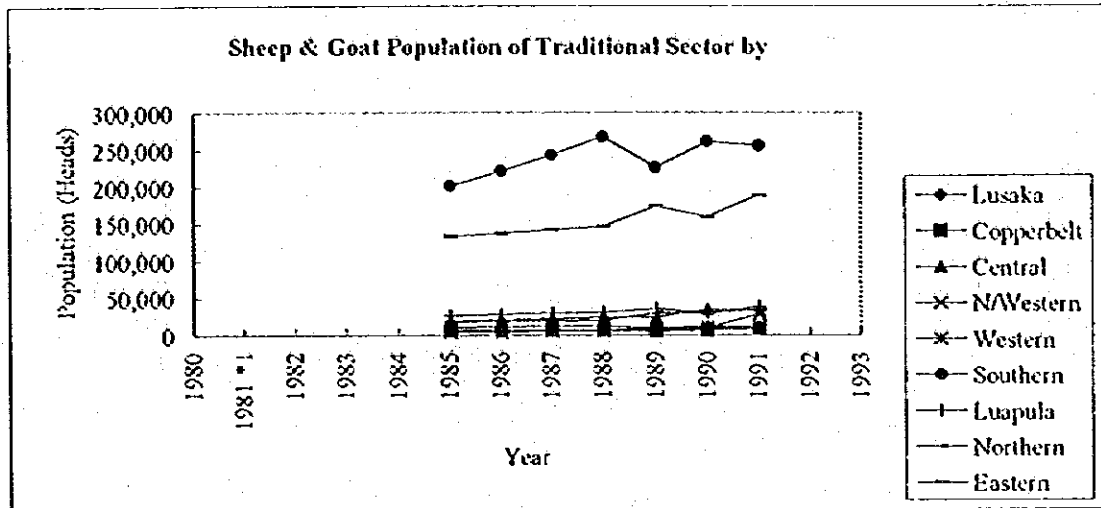
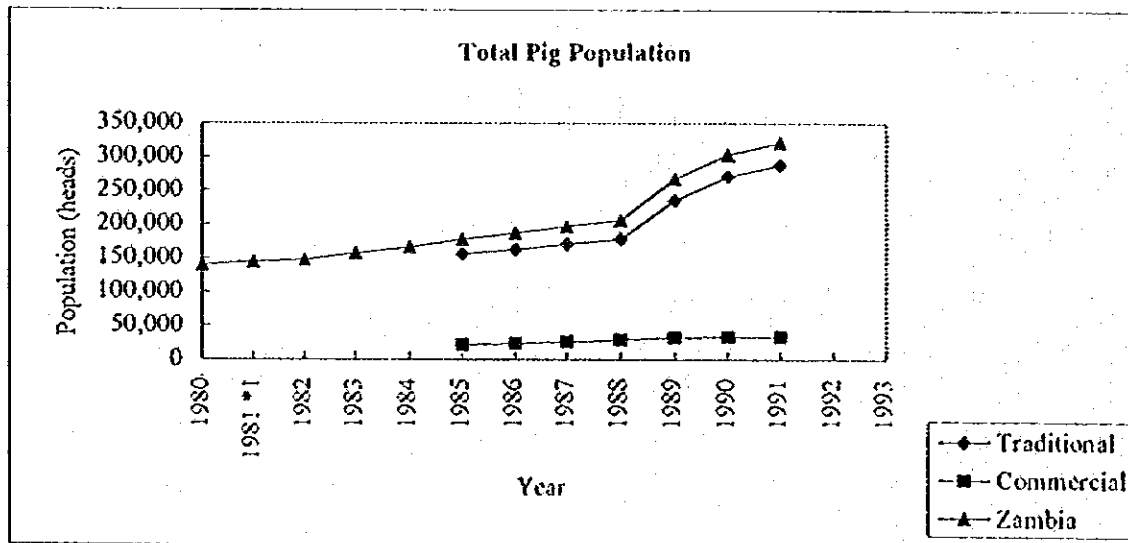
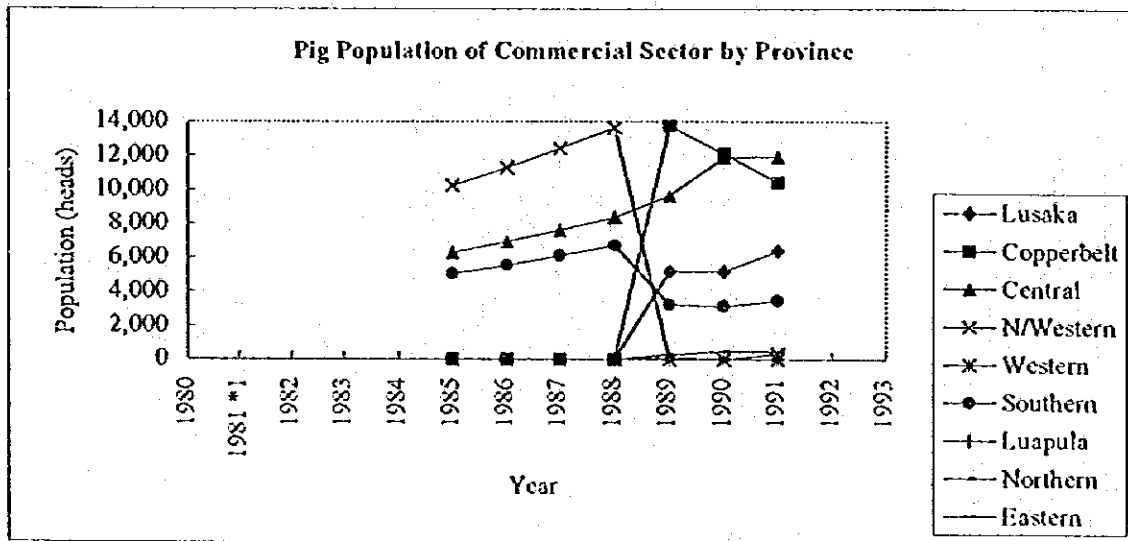
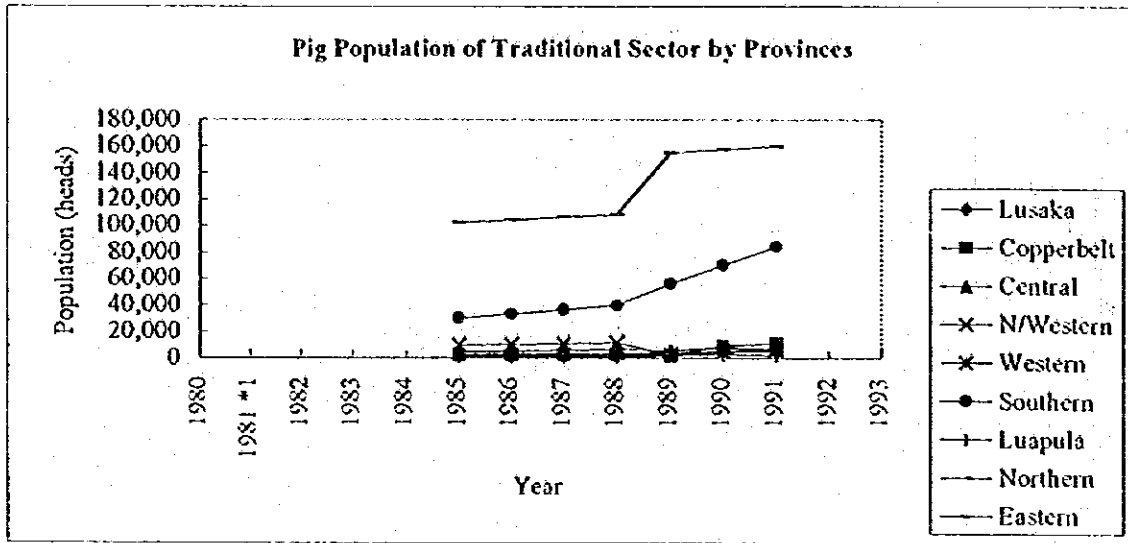


Figure 2-3 Growth of Pig Number in Zambia



## 2.1.2 Production of Livestock

Cattle slaughtering rate estimated by DOA is about 6% in traditional sector, equivalent to 132,000 head per annum, and around 17 - 18% in commercial sector or 84,000 head per year. There is no exact data for traditional sector, because livestock of traditional sector is slaughtered mainly in local sites not in official butchery. Table 2-2 shows the slaughtering in official butchery for 11 years from 1980 to 1990. Average annual slaughtering are 107,924 head of cattle, 28,500 pigs, 2,742 goats, and 1,051 sheep. However, slaughtering was rapidly increased in 1990 for all livestock.

Table 2-2 Livestock Slaughtering in National Basis

Year	Cattle	Pigs	Goats	Sheep	Poultry	Eggs (*2)
1980	92,358	47,894	511	100	(*1)	(1,000eggs)
1981	100,052	37,748	547	29		
1982	82,856	31,157	1,454	29	11,160,796	105,485
1983	99,219	30,068	816	660	45,035	46,934
1984	106,492	30,314	1,279	1,166	5,832,710	44,418
1985	100,047	18,387	1,563	805	5,651,482	53,237
1986	85,875	17,344	1,205	651	6,505,841	74,359
1987	81,679	15,395	810	1,047	7,195,508	85,332
1988	116,041	18,466	1,086	858	9,828,026	128,503
1989	92,218	14,644	741	210		
1990	230,330	52,086	20,149	6,007		
Ave.	107,924	28,500	2,742	1,051	6,602,771	76,895
S.D.	23,731	10,594	3,165	922	2,393,148	25,324
Max.	230,330	52,086	20,149	6,007	11,160,796	128,503
Min.	81,679	14,644	511	29	45,035	44,418
S.D./Ave.	22.0%	37.2%	115.4%	87.7%	36.2%	32.9%

(Data Source)

1) 1980-89: Agricultural Statistics Bulletin 1989/90

2) 1990 : Livestock Population 1990-91, Statistics Section, MAFF

3) Poultry & Eggs: Agricultural and Pastoral Production (Commercial) 1981-82 to 1987-88

(Note)

\*1: Cockerels and Broilers sold only by Commercial Farms.

\*2: Eggs sold only by Commercial Farms.

Annual meat consumption per capita is 11.3 kg. Bovine meat accounted for only 4.9 kg in 1984-86 (FAO). Gross Value Added (GVA) of livestock sector is estimated to reach K45,614 million in 1993 as shown in Table 1-26. Slaughtering data of livestock in 1993 is not obtained by the MAFF, so the GVA of livestock in 1993 was estimated by the latest data as below:

- Cattle Slaughtering : 92,218 head (1989)
- Pig Slaughtering : 14,644 head (1989)
- Sheep/Goats : 951 head (1989)
- Poultry : 9,828,026 head (1988)
- Eggs : 6,425 tons (1988)
- Milk : 34,808,000 lit. (1988)

Average meat consumption of the nation can be calculated as 3.69 kg / capita / year using the figure of meat production given by public slaughterers. As shown in Table 2-4, consumption by urban population is computed as 14.2 kg / person for meat, 1.8 kg / person

for eggs and 13.7 litres / person for milk. This assumes that rural consumption is satisfied by subsistence production. Dressed weight of livestock is estimated as shown in Table 2-3.

**Table 2-3 Dressed Weight of Livestock**

Livestock	unit	Commercial Sec.	Traditional Sec
Beef cattle	(kg/head)	175	155
Pig	(kg/head)	70	70
Sheep/Goat	(kg/head)	14	14
Poultry	(kg/bird)	1.8	1.8

Data Source: Animal Husbandry Section, MAFF



## 2.2 Feed Supply

### 2.2.1 Roughage Feed for Livestock

The flood plain area extending over the country as a whole covers an area of 7,990,000 ha area of which as much as 80% of the total is estimated to be natural vegetation. Assuming the feeding ratio as 2 ha per head, the area holds a capacity able to breed as many as 3,196,000 head of cattle. As to the cattle grazing, 854,000 heads could be raised on the basis of 5 ha area per head under utilisation of 50% of agricultural land (8,543,450 ha excluding the shifting cultivation area). In dry season, residuals such as straws/leaves of maize, paddy, wheat and millet are used for feed supply. Depending on the available residuals, it is able to breed 859,000 heads of cattle on 0.82 ha per head with 80% utilisation in dry season. Total present natural breeding capacity is estimated at 4,909,000 heads of cattle in the country as shown in Table 2-5. However, such potential of natural breeding capacity is not equally distributed in the provinces. As shown in the table, cattle number already reached over grazing stage in Southern Province, where the cattle number exceeds about 140,000 heads than adequate number.

Table 2-5 Present Status of Grazing and Over Grazing in Zambia

Province	Lusaka	Copper-belt	Central	N/Western	Western	Southern	Luapula	Northern	Eastern	Total
Available Feeding by Agricultural Land except Shifting Cultivation Area										
Agricultural Land (ha)	339,666	225,602	1,142,704	503,494	1,457,169	1,963,977	687,620	342,097	1,681,121	8,543,450
Capability of breed (*1)	34,000	23,000	114,000	50,000	146,000	196,000	69,000	54,000	168,000	854,000
Available Feeding by Staple Crops Field (1990)										
Staple Crop Land (ha)	26,948	29,466	114,052	23,830	62,243	252,268	30,757	64,369	276,306	830,241
Maize, Sorghum, Millet	26,893	29,407	113,957	23,642	58,439	252,268	30,264	60,946	274,797	870,613
Rice Extensive	55	59	95	188	3,806	0	493	3,423	1,509	9,628
Capability to breed (*2)	26,000	29,000	111,000	23,000	61,000	246,000	30,000	63,000	270,000	859,000
Available Feeding by Natural Vegetation										
Floodplain Area (ha)	254,114	273,384	970,164	1,066,878	2,392,184	1,179,752	165,047	1,648,743	39,600	7,989,863
Capability to breed (*3)	102,000	109,000	388,000	427,000	957,000	472,000	66,000	659,000	16,000	3,196,000
Capability to breed (heads)	162,000	161,000	613,000	500,000	1,164,000	914,000	165,000	776,000	454,000	4,909,000
Cattle Number in 1990	87,647	74,374	503,512	59,340	546,957	1,053,753	12,186	107,821	223,880	2,668,512

(Note) \*1) Utilization (50%), 5ha head, \*2) Utilization (80%), 0.82 ha head, \*3) Utilization (80%), 2ha head

### 2.2.2 Concentrated Feed by By-Product

As estimated in the Table 2-6, it is necessary to supply maize grain amounting to 329,216 tons/year as concentrated feed for cattle in commercial sector. Unit requirement of concentrated feed refers to Table 2-10.

The available amount of by-products of crops is 290,049 tons. The feed requirement for total livestock in the commercial sector is estimated at 619,265 tons/year depending on unit



feed requirement , enabling the feed supply for 47% by by-product.

$$\text{Availability of By-Product} = 290,049\text{t} / 619,265\text{t} = 47\%$$

**Table 2-6 Present Feed Requirement of Livestock Population**

Year	1985	1986	1987	1988	1989	1990	1991	Average
<b>Number of Livestock of Commercial Sector</b>								
Cattle	393,135	412,792	433,432	475,024	487,516	491,032	446,052	448,426
Pigs	21,559	23,715	26,087	28,694	32,139	32,760	32,910	28,266
Sheep/Goat	32,196	35,417	39,958	42,863	31,240	40,213	45,642	38,218
Poultry	2,567,636	1,228,046	2,150,163	4,006,112	2,400,629	3,291,026	2,607,269 <sup>*1</sup>	2,607,269
<b>Feed Requirement as Concentrated Feed. (tons/year)</b>								
Cattle	3.0*2	430,483	452,007	474,608	520,151	533,830	537,680	488,427
Pigs	2.8*2	22,033	24,237	26,661	29,325	32,846	33,481	33,634
Sheep/Goat	0.3*2	3,525	3,878	4,375	4,693	3,421	4,403	4,185
Poultry	0.1*2	93,719	44,824	78,481	146,223	87,623	120,122	95,165
Total		549,760	524,946	584,125	700,392	657,720	695,686	622,224
<b>Available Amount of By-Product (tons)</b>								
(Table 1-53)		246,041	262,279	242,541	389,948	367,651	257,873	264,011
<b>Deficit of Feed by By-Product (tons)</b>								
		303,719	262,667	341,584	310,444	290,069	437,813	358,213

- (Notes) 1) Feed as concentrated sort only for livestock of Commercial Sector.  
 2) Feed requirement is estimated based on per head requirement and number of livestock of commercial sector.  
 3) \*1: Average has been applied for 1991 due to no data of poultry number.  
 \*2: Concentrated sort requirement for livestock (kg/day/head)

## 2.3 Water Consumption of Livestock

### 2.3.1 Unit Water Consumption of Livestock

Unit water requirement of livestock is as shown in Table 2-7. Cattle consumes 40 lit./day, pigs consume around 20 to 35 lit./day, sheep/goats consume 20 to 29 lit./day, and poultry consumes 0.2 lit./day of water.

**Table 2-7 Unit Water Requirement of Livestock**

Breeding System	(Unit: lit./head/day)							
	Beef Cattle		Pigs Breeding		Sheep/Goats		Poultry Breeding	
	T/Farm	C/Farm	T/Farm	C/Farm	T/Farm	C/Farm	T/Farm	C/Farm
Major Water Source	S/W, G/W	G/W	S/W, G/W	G/W	S/W, G/W	G/W	S/W, G/W	G/W
Water Use								
- Dipping Water	0.7 <sup>*1</sup>	0.7 <sup>*2</sup>				0.7 <sup>*2</sup>		
- Drinking Water	40.0 <sup>*1</sup>	40.0 <sup>*1</sup>	20.0 <sup>*1</sup>	20.0 <sup>*1</sup>	20.0 <sup>*1</sup>	20.0 <sup>*1</sup>	0.20 <sup>*1</sup>	0.20 <sup>*1</sup>
- Cleaning Water				15.0 <sup>*3</sup>		8.0 <sup>*2</sup>		
Total	40.7	40.7	20.0	35.0	20.0	28.7	0.20	0.20

\*1: Animal Husbandry Section, MAFF \*2: Observation of Commercial Livestock Farm.

\*3 Agricultural Techniques Handbook 1985 (Japan)

(Note) 1) S/Farm: State Farm, C/Farm: Commercial Farm, T/Farm: Traditional Farm  
 2) G/W: Groundwater, S/W: Surface water

Depending on above unit water requirement of livestock, provincial unit water requirement can be estimated by the ratio of commercial and traditional livestock number. Table 2-8 shows the unit water requirement taking the ratio of both sectors.

**Table 2-8 Unit Water Requirement of Livestock by Province (Unit: per head)**

Province	Cattle		Sheep/ Goats		Pigs		Poultry	
	(lit./day)	(m <sup>3</sup> /yr)	(lit./day)	(m <sup>3</sup> /yr)	(lit./day)	(m <sup>3</sup> /yr)	(lit./day)	(m <sup>3</sup> /yr)
Lusaka	40.7	14.9	21.2	7.74	27.5	10.04	0.2	0.073
Copperbelt	40.7	14.9	25.6	9.34	28.6	10.44	0.2	0.073
Central	40.7	14.9	22.4	8.18	29.0	10.59	0.2	0.073
N/Western	40.7	14.9	20.0	7.30	20.0	7.30	0.2	0.073
Western	40.7	14.9	20.0	7.30	20.0	7.30	0.2	0.073
Southern	40.7	14.9	20.4	7.45	20.6	7.52	0.2	0.073
Luapula	40.7	14.9	20.0	7.30	20.2	7.37	0.2	0.073
Northern	40.7	14.9	20.4	7.45	20.8	7.59	0.2	0.073
Eastern	40.7	14.9	20.0	7.30	20.0	7.30	0.2	0.073
Zambia	40.7	14.9	20.6	7.52	21.6	7.88	0.2	0.073

### 2.3.2 Present Water Requirement of Livestock

Depending upon the above unit water requirement, total water requirement of livestock is estimated at about 129,000 m<sup>3</sup>/day at present.

**Table 2-9 Number of Livestock and Water Requirement in 1990**

Province	Cattle		Sheep/ Goats		Pigs		Poultry		Total (m <sup>3</sup> /day)
	(head)	(m <sup>3</sup> /day)	(head)	(m <sup>3</sup> /day)	(head)	(m <sup>3</sup> /day)	(head)	(m <sup>3</sup> /day)	
Lusaka	87,647	3,567	13,407	284	10,321	284	1,582,000	316	4,451
Copperbelt	74,374	3,027	16,504	423	21,186	606	1,219,000	244	4,300
Central	503,512	20,493	47,597	1,066	19,842	575	987,000	197	22,331
N/Western	59,340	2,415	9,918	198	4,732	95	219,000	44	2,752
Western	546,957	22,261	8,368	167	4,667	93	388,000	78	22,599
Southern	1,052,795	42,849	274,228	5,594	73,473	1,514	1,337,000	267	50,224
Luapula	12,186	496	29,900	598	3,019	61	326,000	65	1,220
Northern	107,821	4,388	31,875	650	8,318	173	855,000	171	5,382
Eastern	223,880	9,112	160,359	3,207	157,855	3,157	1,008,000	202	15,678
Zambia	2,668,512	108,608	592,156	12,187	303,413	6,558	7,921,000	1,584	128,937

Table 2-10 Present Grazing System and Feed Application for Livestock

Breeding System/ Livestock Sector	Dairy Cattle		Beef Cattle		Pigs		Sheep/Goat		Poultry	
	Commercial	Confinement	Traditional	Grazing	Traditional	Free barn	Commercial	Free barn	Traditional	Commercial
<b>Rearing System</b>										
Required Pasture Acreage (ha/head)			2.0 3)	2.0 3)		4)	4)			
Flood plain (ha/head)		0.21 1)	5.0 3)	5.0 3)		4)	4)			
Plateau		0.10 2)								
<b>Feed</b>										
Concentrated Feed (kg/head/day)		2.0 *1	*6	3.0 *2	2.8 *4					0.1 *3
Maize bran		or 1.5		or 2.0						or 0.1
Maize grain		or 1.5		or 2.0						or 0.1
Maize meal		or 2.5		or 3.0						or 0.1
Millet/Sorghum		or 4.0		or 4.0						or 0.1
Oil-cake Crops		or 2.0		or 2.0						
Molasses				0.1						
DCF										
Roughage (kg/head/day)		40.0		6.5						
Silage		or 10		or 9.0						
Hay		or 8.5		or 2.0		1.0				
Maize culln *5		or 2.0		or 2.0						
Groundnuts leaves/vine		or 2.0		or 2.0						
Sweet potatoes leaves/vine		or 5.0		or 5.0						
Pasture grass										or 1.0

(Data Sources)

Field observation of Commercial Livestock Farms.

(Notes)

- 1) Supplemental irrigation for wet season, but no irrigation in dry season. Silage or hay stocked for dry
- 2) Supplemental irrigation for wet season, and full time irrigation in dry
- 3) generally grazed in floodplain by Traditional Sector as well as by Commercial Sector in dry
- 4) grazed together with beef cattle, and pasture acreage is not specified.

Japanese application standards as reference.

\*1: Wheat bran 3.7 kg/head/day or Rice bran 2.9

\*2: Wheat bran 5.5 kg/head/day or Rice bran 4.3

\*3: Wheat bran 0.1 kg/head/day.

\*4 mainly fed by surrounding leftovers of meal.

\*5 including rice straw, wheat straw, millet/sorghum

\*6 Concentrated Feed is seldom.

## CHAPTER 3 PRESENT STATUS OF FISHERY

### 3.1 Capture Fishery

Zambia has several large bodies of water such as lakes, rivers and swamps covering about 25,000 km<sup>2</sup> of the country. Capture fisheries are conducted in these water bodies as shown in Figure 3-1. Capture fisheries are operated on a commercial basis by professional fishermen or by commercial companies. On the other hand, aqua-culture has started only recently on a commercial or government initiated basis. Production of aqua-culture is still limited compared to the capture fisheries.

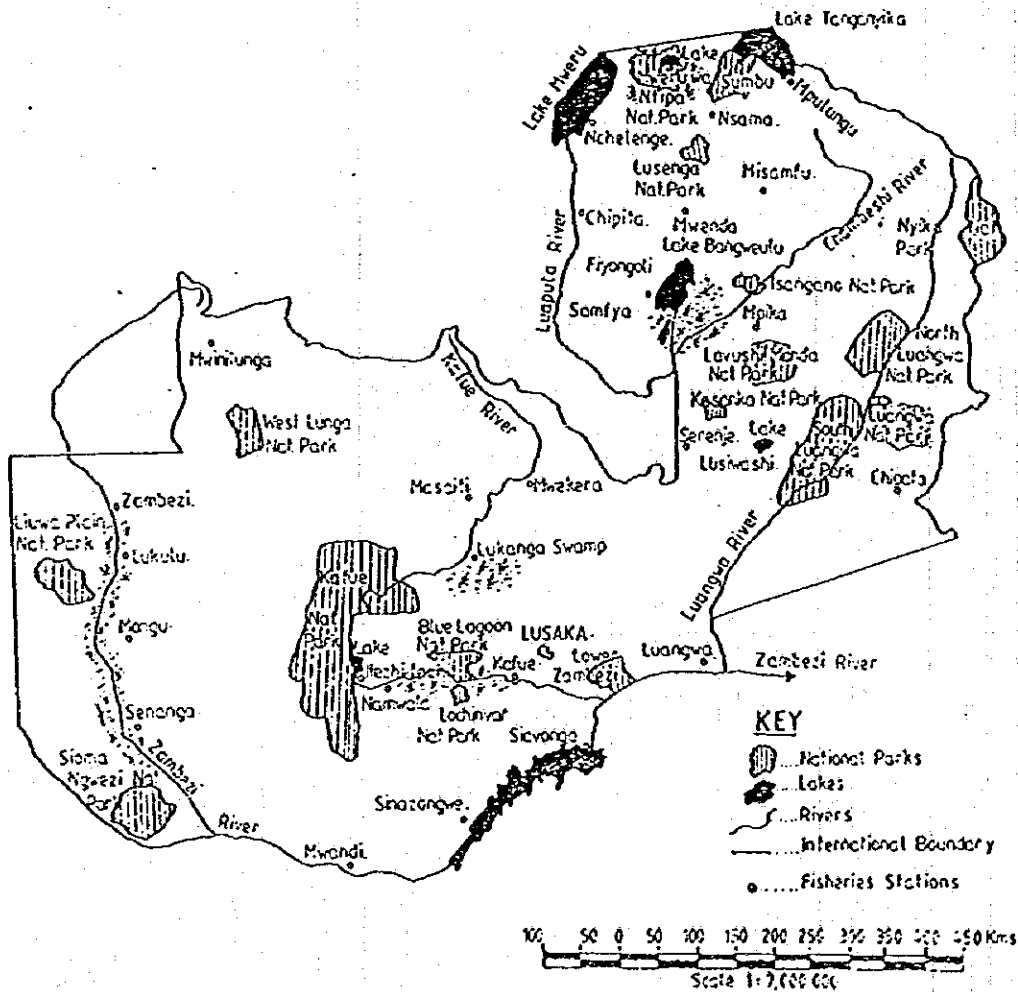


Figure 3-1 Zambia's Major Capture Fisheries

### 3.1.1 Annual Fish Catch of Capture Fishery

As enumerated in Table 3-1, the national annual fish catch in 1994, 1990, 1985 and 1980 was 71,800 tons, 64,800 tons, 67,700 tons and 51,000 tons, respectively. Total fish catch appears to be growing steadily. However, as shown in the figure at the bottom of Table 3-1, fluctuations of fish catches are seriously large at the fishery areas, much higher than those of the total. Fish catches have been threatened not only by natural conditions but social situations such as outbreaks of cholera or wars. When cholera occurred near Lake Tanganyika in 1981, capture fishery was restricted or closed in the surrounding fishery areas. Lake Kariba was closed for almost 5 years during the Zimbabwe War of Independence.

Per capita fish consumption decreased gradually from 12 kgs/year level to 8 kgs/year since 1966 at the right-hand side figure in Table 3-1. The decrease of per capita consumption is definitely caused by population growth rapidly exceeding the growth of fish catch.

Regression analysis of fish catch data over 29 years was carried out for two cases, namely the "actual case" and "modified case". The actual case used actual fish catch data, but natural and social effects have been excluded for the modified case. In the modified case, it is assumed that outbreaks of cholera or wars will be reduced in future because of improvements in domestic water supply and social conditions. The modified fish catch data are shown in Table 3-2 and the results of regression analysis for the two cases are shown in Table 3-3. Annual growth of fish catches are estimated at 924 tons/year for the actual case and 984 tons/year for the modified case. The "Modified Case" will be applied for future projection based on 66,400 tons of fish catch production as of 1990 and with a annual growth rate of 984 tons/year.

#### <Projection of Capture Fishery Growth>

- Base Production :  $984 \times (1990 - 1965) + 41,832 = 66,400 \text{t/year (1990)}$
- Annual Increase : 984 tons/year

### 3.1.2 Fish Supply Plan of DOF

As a target for per capita fish consumption, the DOF set 10 kg/year in the plan prior to ASIP. Table 3-4 shows the current consumption and the future projection of fish production reported by the DOF in February 1994, using the target fish consumption rate of 10 kg/capita/year. This target, combined with rapid population growth, means that the demand for fishery products will grow at a much higher growth rate than the past production trends. Taking account of the keen future demand, as well as the current fluctuation in production mentioned above, fishery and aqua-culture sectors should definitely be expanded to cope with the needs. Much encouragement and promotion by the Government will also be inevitable.

Further more, the Government has since increased the target fish consumption rate to 12 kg/capita/year in ASIP, thus adding to the growth requirements of the fishery sector.

**Table 3-1 Annual Fish Catch from Major Fisheries**

Year	(Unit: tons)											Total	Population (million)	Per Capita Consumption (kg)
	Lake Bangweulu	Lake Mweru-Lusapula River	Lake Mweru Wanipia	Lake Tanganyika	Kafue River	Lake Kariba	Lukanga Swamp	Upper Zambezi	Lake Lusiwashi	Lower Zambezi	Inzhi-techi			
1966	12,408	9,179	1,672	6,600	10,709	1,436	658	1,000				43,962	3.76	11.67
1967	12,394	7,543	2,865	11,968	3,441	980	955	1,000				41,146	3.85	10.89
1968	11,436	7,417	3,704	10,194	6,182	1,410	1,602	1,000				43,050	3.95	10.90
1969	11,894	7,717	4,125	7,066	9,938	1,345	1,366	1,000				44,451	4.06	10.95
1970	12,375	7,326	4,216	10,835	9,582	2,581	1,724	2,500				51,139	4.24	12.06
1971	11,728	9,242	3,825	6,938	8,247	2,311	1,900	3,500				46,841	4.31	10.87
1972	13,034	9,068	3,812	6,281	7,874	1,955	2,370	3,500				49,894	4.48	11.14
1973	14,832	8,031	8,112	3,488	6,289	3,098	1,801	3,500				50,352	4.61	10.92
1974	15,715	8,135	3,992	4,572	5,177	2,181	1,707	3,500				46,929	4.75	9.88
1975	9,881	8,483	16,745	7,449	7,266		1,802	5,927				57,464	4.99	11.75
1976	7,593	10,680	13,330	4,501	9,307		856	3,995				54,267	5.04	10.77
1977	9,496	9,324	12,513	7,956	9,830		1,005	3,490				53,734	5.19	10.33
1978	9,454	7,629	10,352	4,474	3,634		736	4,475		277		49,091	5.36	9.97
1979	11,645	9,039	2,873	3,119	10,851		763	5,559		255		49,511	5.52	9.97
1980	10,367	7,662	8,094	8,256	7,741	407	549	6,572		339		50,983	5.62	9.91
1981	9,543	2,741	5,734	1,983	9,619	875	669	6,694				37,661	5.81	6.48
1982	11,006	7,907	10,979	8,010	8,907	2,601	776	5,290		423		55,509	5.97	9.35
1983	14,457	7,621	8,765	8,522	3,605	4,227	936	3,301		420	308	54,175	6.13	9.81
1984	14,715	11,050	9,476	11,583	4,317	6,789	1,204	4,309		606	199	64,622	6.296	10.26
1985	12,533	10,759	9,220	14,900	5,008	9,092	1,120	3,964		999	238	67,732	6.356	10.48
1986	8,125	6,254	7,000	12,978	4,264	9,637	794	5,255		943	157	35,437	6.619	8.35
1987	11,993	7,707	9,497	12,452	5,935	8,666	1,572	4,491		936	296	63,365	6.818	9.32
1988	10,859	6,966	8,249	10,429	4,440	9,661	1,183	9,200		547	620	60,584	7.002	8.65
1989	9,019	7,130	7,039	14,386	8,560	10,409	1,401	8,358		218	141	66,956	7.190	9.31
1990	8,191	7,822	8,496	13,418	7,333	9,185	2,613	4,213		403	201	64,968	7.383	8.79
1991	11,539	6,997	7,220	14,113	5,262	8,727	1,870	8,493		323	490	65,844	7.582	8.68
1992	10,629	6,398	8,938	13,829	7,601	8,114		9,605		1,183	623	67,349	7.756	8.65
1993	8,725	6,426	3,434	14,233	8,724	9,983	3,318	9,243		1,029	556	65,151	7.993	8.15
1994	15,582	7,925	3,137	18,124	6,293	8,731	2,568	5,703		1,537	234	71,793	8.210	8.74
Ave	11,117	7,938	7,504	9,682	7,278	7,180	1,421	4,838		663	339	56,782	5.76	10.00
Share	20.1%	14.0%	13.2%	17.0%	12.8%	9.1%	2.5%	8.5%		1.2%	0.6%	100.0%		
S.D.	2,191	1,576	3,490	3,978	2,159	3,543	675	2,452		373	174	300		
S.D./Ave	0.19	0.2	0.45	0.41	0.3	0.68	0.48	0.51		0.56	0.51	0.53		

(Data Source)

1966-1993: Table of Production estimates for all the Fisheries of Zambia since 1996, DOF

1994: Preliminary estimation by DOF

(Note)

\*1: Fishing was stopped due to outbreak of cholera in the area

\*2: Fishermen left from the Kariba Lake, due to war in Zimbabwe.

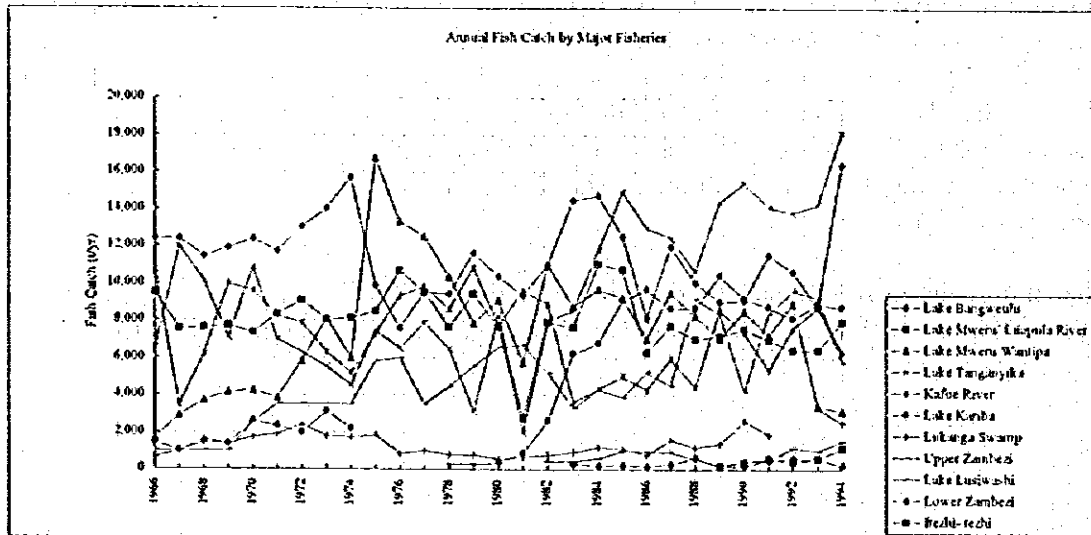
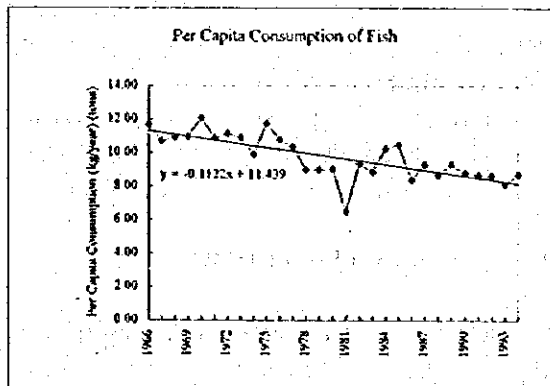
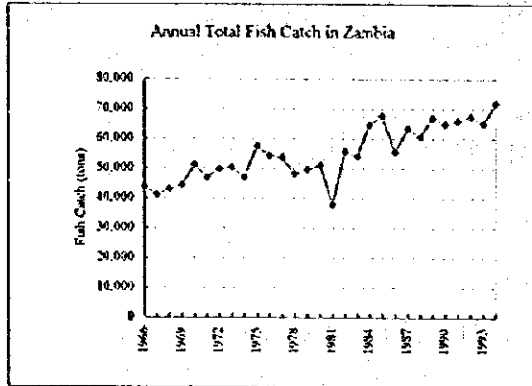


Table 3-2 Modified Annual Fish Catch

(Unit: tons)

Year	Lake Bangweulu	Lake Mweru/Luapula River	Lake Mweru/Wamitipa	Lake Tanganyika	Kafue River	Lake Kariba	Luitanga Swamp	Upper Zambezi	Lake Lusiwashi	Lower Zambezi	Itezhi-tezhi	Total	Population (million)	Per Capita Consumption (kg)
1966	12,408	9,479	1,672	6,500	10,709	1,436	658	1,000				43,862	3.76	11.67
1967	12,394	7,543	2,865	11,968	3,441	980	955	1,000				41,146	3.85	10.69
1968	11,430	7,617	3,704	10,104	6,183	1,410	1,602	1,000				43,050	3.95	10.90
1969	11,894	7,717	4,125	7,066	9,238	1,345	1,366	1,000				44,451	4.06	10.95
1970	12,375	7,326	4,216	10,835	9,582	2,581	1,724	2,500				51,139	4.24	12.06
1971	11,728	8,342	3,825	6,988	8,247	2,311	1,900	3,500				46,841	4.31	10.87
1972	13,034	9,068	5,812	6,281	7,874	1,955	2,370	3,500				49,894	4.48	11.14
1973	14,032	8,031	8,113	5,488	6,289	3,098	1,801	3,500				50,352	4.61	10.92
1974	15,715	8,135	5,992	4,522	5,177	2,181	1,707	3,500				46,929	4.75	9.88
1975	9,881	8,483	16,765	7,440	7,266	2,631 <sup>*2</sup>	1,802	3,500				60,095	4.89	12.29
1976	7,598	10,680	13,330	6,501	9,307	3,080 <sup>*2</sup>	856	5,995				57,347	5.04	11.38
1977	9,496	9,534	12,513	7,866	9,830	3,530 <sup>*2</sup>	1,005	3,490				57,264	5.19	11.03
1978	9,464	7,629	10,352	6,474	8,634	3,979 <sup>*2</sup>	786	4,475	277			52,070	5.36	9.71
1979	11,648	9,438	7,878	3,119	10,851	4,429 <sup>*2</sup>	763	5,559	255			53,940	5.52	9.77
1980	10,367	7,663	9,094	8,256	7,741	4,878 <sup>*2</sup>	549	6,572	339			55,459	5.662	9.79
1981	9,543	2,744	5,734	8,133 <sup>*1</sup>	9,619	5,328 <sup>*2</sup>	669	6,694	381 <sup>*1</sup>			48,645	5,814	8.37
1982	11,006	7,907	10,979	8,010	8,907	5,777 <sup>*2</sup>	776	5,200	423			58,985	5,971	9.88
1983	14,467	7,624	8,765	8,522	3,605	6,227	926	3,301	430	308		54,175	6,131	8.84
1984	14,715	11,050	9,676	11,783	4,317	6,769	1,204	4,309	600	199		64,622	6,296	10.26
1985	12,533	10,758	9,220	14,900	5,008	9,092	1,120	3,864	999	238		67,732	6,466	10.48
1986	8,125	6,284	7,000	12,978	4,264	9,657	794	5,235	943	157		55,437	6,640	8.35
1987	11,993	7,707	9,497	12,452	5,955	8,666	1,572	4,491	936	296		63,565	6,818	9.32
1988	10,059	6,996	8,249	10,629	4,440	8,661	1,183	9,200	547	620		60,584	7,002	8.65
1989	9,019	7,190	7,039	14,386	8,569	10,409	1,401	8,358	218	141	196	66,926	7,190	9.31
1990	9,101	7,522	8,490	15,418	7,335	9,185	2,613	4,213	403	201	387	64,868	7,383	8.79
1991	11,539	6,987	7,220	14,113	5,362	8,727	1,870	8,403	523	490	610	65,844	7,582	8.68
1992	10,629	6,398	8,938	13,829	7,601	8,144	2,994 <sup>*1</sup>	9,605	1,143	623	439	69,943	7,786	8.98
1993	8,725	6,426	7,817 <sup>*3</sup>	14,233	8,724	8,883	3,318	9,243	1,929	556	610	69,564	7,995	8.70
1994	16,383	7,925	7,817 <sup>*3</sup>	18,124	6,293	8,731	2,508	5,763	1,537	234	1,158	76,473	8,210	9.31
Ave. Share	11,417	7,938	7,817	9,894	7,278	5,313	1,462	4,838	646	339	567	57,509	5.76	10.00
S.D.	19.9%	13.8%	13.6%	17.2%	12.7%	9.2%	2.5%	8.4%	1.1%	0.6%	1.0%	100.0%		
S.D./Ave.	2.191	1.576	3.199	3.717	2.159	3.047	697	2.452	368	174	300	9.111		
	0.19	0.2	0.41	0.38	0.3	0.57	0.48	0.51	0.57	0.51	0.53	0.16		

(Note)

\*1) Cholera will be controlled in future by improvement of rural water supply system.  
 \*2) Social problems will be lessened by improvement of social conditions.  
 \*3) Large fluctuation of fish catch will be improved by fishery management. (Average has been applied)

Table 3-3 Regression Analysis of Fish Catch Growth

(Unit: tons)

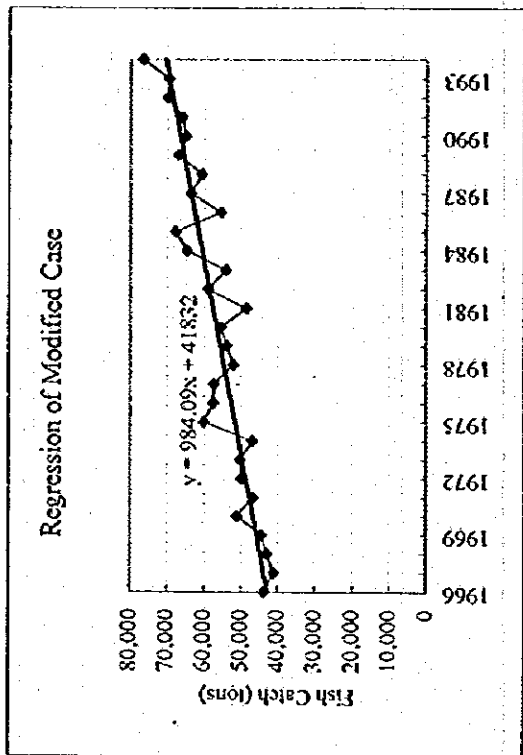
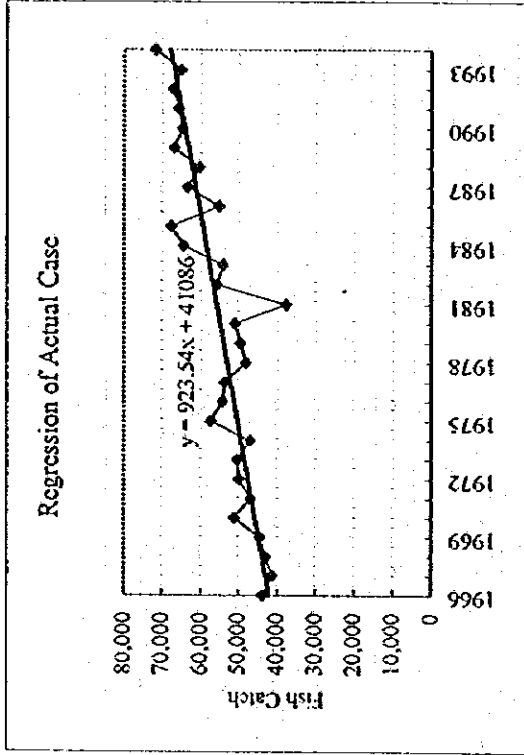
Year	Fish Catch (tons)		Regression Analysis	
	Actual	Modified	Regression of Actual	Regression of Modified
1966	43,862	43,862	42,007	43,259
1967	41,146	41,146	42,927	44,185
1968	43,050	43,050	43,847	45,112
1969	44,451	44,451	44,767	46,038
1970	51,139	51,139	45,687	46,964
1971	46,841	46,841	46,606	47,890
1972	49,894	49,894	47,526	48,816
1973	50,352	50,352	48,446	49,742
1974	46,929	46,929	49,366	50,669
1975	57,464	60,095	50,286	51,595
1976	54,267	57,247	51,206	52,521
1977	53,734	57,264	52,126	53,447
1978	48,091	52,070	53,046	54,373
1979	49,511	53,940	53,966	55,300
1980	50,988	55,459	54,886	56,226
1981	37,661	48,645	55,806	57,152
1982	55,809	58,985	56,725	58,078
1983	54,175	54,175	57,645	59,004
1984	64,622	64,622	58,565	59,930
1985	67,732	67,732	59,485	60,857
1986	55,437	55,437	60,405	61,783
1987	63,565	63,565	61,325	62,709
1988	60,584	60,584	62,245	63,635
1989	66,926	66,926	63,165	64,561
1990	64,868	64,868	64,085	65,488
1991	65,844	65,844	65,005	66,414
1992	67,349	69,943	65,925	67,340
1993	65,151	69,564	66,844	68,266
1994	71,793	76,473	67,764	69,192

(Note)

Regression:

Actual:  $y = 923.54 \times (\text{Year} - 1965) + 41,086$

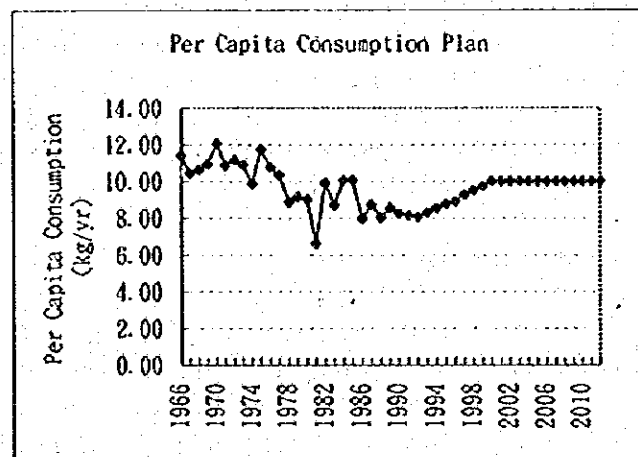
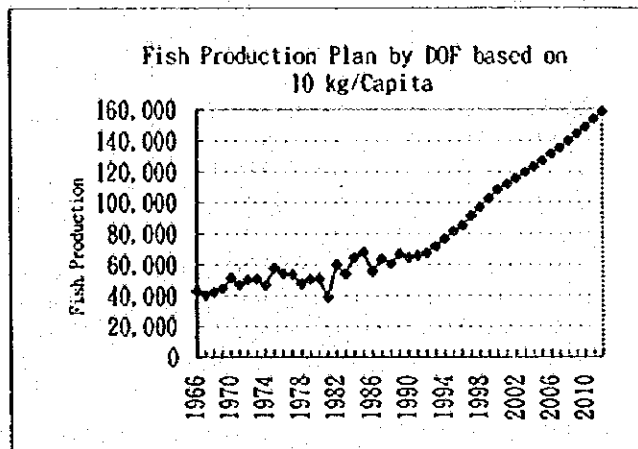
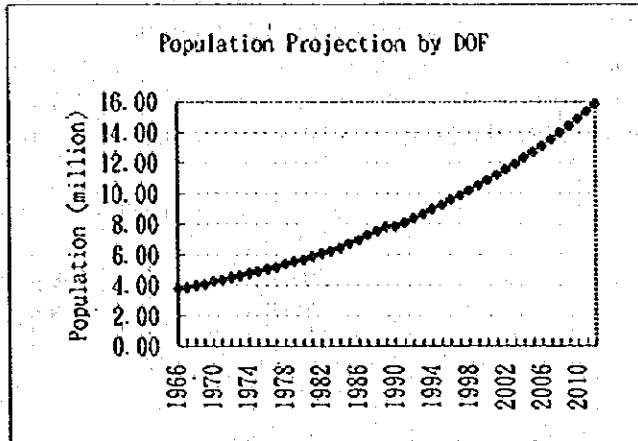
Modified:  $y = 984.09 \times (\text{Year} - 1965) + 41,832$





**Table 3-4 Fish Production Plan by DOF prior to ASIP**

Year	Population (million)	Fish Catch (tons)	Per Capita Consumption (Kg/year)
	(*)1	(*)2	(*)3
1966	3.76	42,860	11.40
1967	3.85	40,146	10.43
1968	3.95	42,050	10.65
1969	4.06	44,451	10.95
1970	4.24	51,139	12.06
1971	4.31	46,841	10.87
1972	4.48	49,894	11.14
1973	4.61	50,352	10.92
1974	4.75	46,929	9.88
1975	4.89	57,464	11.75
1976	5.04	54,267	10.77
1977	5.19	53,734	10.35
1978	5.36	47,569	8.87
1979	5.52	50,411	9.13
1980	5.66	50,988	9.01
1981	5.87	38,841	6.62
1982	6.05	59,945	9.91
1983	6.22	54,175	8.71
1984	6.42	64,622	10.07
1985	6.72	67,732	10.08
1986	6.95	55,437	7.98
1987	7.27	63,565	8.74
1988	7.53	60,584	8.05
1989	7.80	66,730	8.56
1990	7.82	64,481	8.25
1991	8.08	65,945	8.16
1992	8.36	67,465	8.07
1993	8.65	71,882	8.31
1994	8.95	76,523	8.55
1995	9.27	81,483	8.79
1996	9.57	85,173	8.90
1997	9.87	91,594	9.28
1998	10.19	97,009	9.52
1999	10.51	102,578	9.76
2000	10.85	108,500	10.00
2001	11.20	112,000	10.00
2002	11.56	115,600	10.00
2003	11.93	119,300	10.00
2004	12.31	123,100	10.00
2005	12.70	127,000	10.00
2006	13.11	131,100	10.00
2007	13.53	135,300	10.00
2008	13.96	139,600	10.00
2009	14.41	144,100	10.00
2010	14.87	148,700	10.00
2011	15.35	153,500	10.00
2012	15.84	158,400	10.00



(Data Source) Department of Fisheries, MAFF, Feb. 1991

(Note) Plan was based on the Target Per Capita Consumption of 10 kg/year.

### 3.2 Aqua-Culture

As mentioned above, aqua-culture has recently been initiated, and is expected to contribute significantly to increase fish production to meet high demand growth. In these circumstances, aqua-culture is growing rapidly at present. However, the exact status of aqua-culture is not known by the DOF. Table 3-5 shows the present status of aqua-culture as reported to the DOF and registered in the Water Board.

Table 3-5 Current Fish Pond Acreage

Province	Acreage (ha) Reported to DOF	Acreage (ha) registered in Water Board	Acreage applied in the Study
Lusaka	61.3	3	61
Copperbelt	1.4	1,259	1,259
Central	6.7	4	7
N/Western	12.9	3	13
Western	3.6	0	4
Southern	1.3	100	100
Luapula	0.0	42	42
Northern	64.5	194	194
Eastern	11.8	57	57
Total	163.5	1,662	1,737

(Source)

1) Paper of Workshop on Improved Fish Farming Practices and Extension Services for Zambia, 15-19 March 1993, Mansa (DOF)

2) Water Right Registration of Fish Pond, Water Board. (1993)

(Note) larger figure has been used as present fish pond acreage.

There is much difference between two sources. But, there are much lack of registration in the DOF. The fish pond area reported by DOF was only 163.5 ha in 1992. On the other hand, the acreage of fish ponds as estimated by the Water Right Survey was 1,662 ha. The acreage of fish pond was estimated at 1,737 ha, that was agreed by the DOF in principle. This figure can be applied as the acreage of fish ponds as of 1993, and annual production of aqua-culture can be estimated at 3,474 tons based on productivity of 2.0 tons/ha/year which is an average productivity under livestock manure feeding.

### 3.3 Farm Gate Price of Fish

There are two major price systems for fish, one is for sardine by capture fishery and the other is for a large fish as tilapia by aqua-culture. Price of large fish is much higher than sardine. There is no recent exact price data of fish held by MAFF, because fish prices were liberalised in 1992 and no control is imposed on prices by the Government. Most up-to-date farm gate prices of fish are 34.25 K/kg in 1991 and 56.39 K/kg in 1992 for sardine. Using these prices and consumer index of food in general, the fish price in 1993 has been estimated at K200/kg for sardine.

On the other band, price of large fish is not surveyed yet, because market of large fish was expanded recently. According to the DOF, the price of large fish was about K 1,200/kg in 1993.

### 3.4 Fish Production and GVA in 1993

#### 3.4.1 Total Production and Total GVA

Present fish production (in 1993) was at 65,151 tons as shown below. Based on this production, the GVA of fishery amounts to K14,082 million.

- Capture Fishery : 65,151 tons
  - Aqua-culture : 3,474 tons
  - <Total> : 68,625 tons
  - GVA Fishery 1993 : 14,082 million = 65,151 tons x K200,000/ton + 3,474 tons x K302,650/ton
- (Note) Unit VA of aqua-culture (K302,650/ton) refers to Section 3.4.2 (2) as below.

#### 3.4.2 Unit VA of Fishery

##### (1) VA of Capture Fishery

In capture fishery, investment and operation/maintenance costs are negligible small. Therefore, value added (VA) of capture fishery is estimated at K200,000/ton by price of K200/kg.

##### (2) VA of Aqua-culture

For aqua-culture, intensive operation is necessary comparing to capture fishery. VA of aqua-culture is estimated at K605,300/ha/yr or K302,650/ton under following conditions:

Gross earning = 2.0tons/ha/yr x K1,200,000/ton = K2,400,000/ha/yr or K1,200,000/ton

##### Operation Cost:

Fertiliser: (Poultry manure: K300/25kg-bag = K12,000/ton)  
Application = 1.0ton/ha/2weeks = 26.1tons/ha/year  
Cost = K12,000/ton x 26.1tons/ha/yr = K313,200/ha/yr

Seed: (Unit Cost: K10/fry)  
Application = 2.5 fry/m<sup>2</sup> x 10,000m<sup>2</sup>/ha x 2times/yr = 50,000 fry/ha/yr  
Cost = K10/fry x 50,000 fry/ha/yr = K500,000/ha/yr

Water: (Unit Cost: K50/m<sup>3</sup>, Consumption = 19,630 m<sup>3</sup>/ha/yr in Zone-II)  
Application = 19,630 m<sup>3</sup>/ha/yr  
Cost = K50/m<sup>3</sup> x 19,630 m<sup>3</sup>/ha/yr = K981,500/ha/yr

Total      K1,794,700/ha/yr

##### VA (Value Added)

K2,400,000/ha/yr - K1,794,700/ha/yr = K605,300/ha/yr  
or K605,000/ha/yr / 2tons/ha/yr = K302,650/ton

### 3.5 Present Water Requirement of Fishery

Since capture fishery utilises the natural water bodies, it is not counted as a water consumer. Aqua-culture is only counted as a water consumer. As shown in Table 3-6, present water requirement of aqua-culture is estimated at 1.35 m<sup>3</sup>/sec or 116,600 m<sup>3</sup>/day at peak requirement, and 13.6 MCM in a year.

**Table 3-6 Present Water Requirement of Aqua-Culture**

Province	Agro-eco. Zone	Peak (lit/s/ha)	Annual (m <sup>3</sup> /ha)	Area (ha)	Peak (m <sup>3</sup> /s)	Annual (MCM)
Lusaka	II	0.80	10,505	61	0.05	0.6
Copperbelt	III	0.77	7,289	1,259	0.97	9.2
Central	II	0.80	10,505	7	0.01	0.1
N/Western	III	0.77	7,289	13	0.01	0.1
Western	II	0.80	10,505	4	0.00	0.0
Southern	II	0.80	10,505	100	0.08	1.1
Luapula	III	0.77	7,289	42	0.03	0.3
Northern	III	0.77	7,289	194	0.15	1.4
Eastern	I	0.84	14,024	57	0.05	0.8
Zambia		0.79	9,467	1,737	1.35	13.6

(Note) Detail of computation are described in Chapter 7, Section 7.2

## CHAPTER 4 PRESENT FOOD BALANCE

### 4.1 Feed Balance of Livestock

Concentrated feed is generally supplied from the by-product of crops. Table 4-1 shows the balance of supply and demand. The balance analysis has been given for 7 years from 1985 to 1991, because livestock data are only available for 7 years. The requirement has been estimated only for livestock of commercial sector considering present condition, that concentrated feed is seldom applied in the traditional sector. As shown in the table, the supply of by-products is not enough to meet to the required concentrated feed. Annual deficit is about 329,000 tons, and it has to be made up by grain.

**Table 4-1 Feed Balance by Livestock Number and By-Product Production**

Year	1985	1986	1987	1988	1989	1990	1991	Average
<b>Number of Livestock of Commercial Sector</b>								
Cattle	393,135	412,792	433,432	475,024	487,516	491,032	446,052	448,426
Pigs	21,559	23,715	26,087	28,694	32,139	32,760	32,910	28,266
Sheep/Goat	32,196	35,417	39,958	42,863	31,240	40,213	45,642	38,218
Poultry	2,567,636	1,228,046	2,150,163	4,006,112	2,400,629	3,291,026	2,607,269	2,607,269
<b>Feed Requirement as Concentrated Feed (tons/year)</b>								
Cattle	430,483	452,007	474,608	520,151	533,830	537,680	488,427	491,027
Pigs	22,033	24,237	26,661	29,325	32,846	33,481	33,634	28,888
Sheep/Goat	3,525	3,878	4,375	4,693	3,421	4,403	4,998	4,185
Poultry	93,719	44,824	78,481	146,223	87,623	120,122	95,165	95,165
Total	549,760	524,946	584,125	700,392	657,720	695,686	622,224	619,265
<b>Available Amount of By-Product (tons)</b>								
	246,041	262,279	242,541	389,948	367,651	257,873	264,011	290,049
<b>Deficit of Feed by By-Product (tons)</b>								
	303,719	262,667	341,584	310,444	290,069	437,813	358,213	329,216

(Notes)

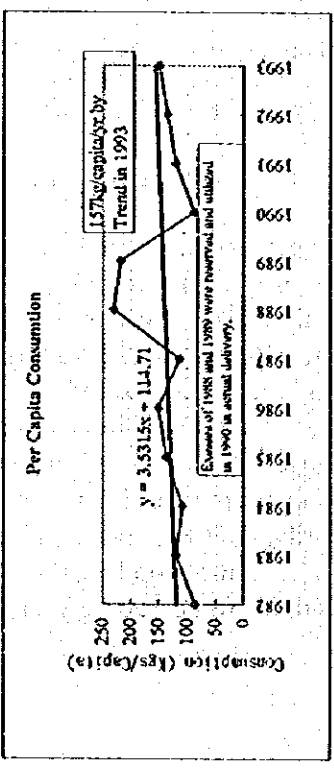
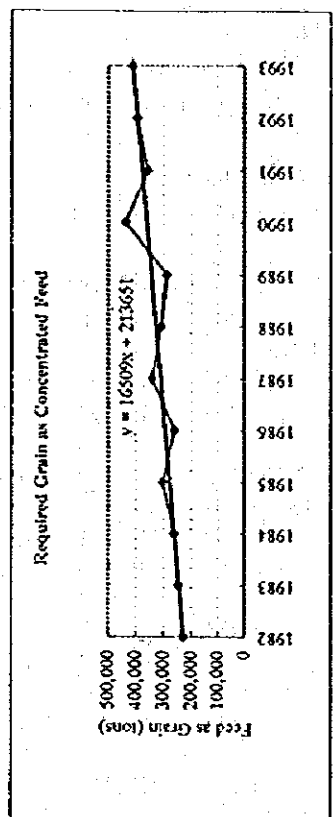
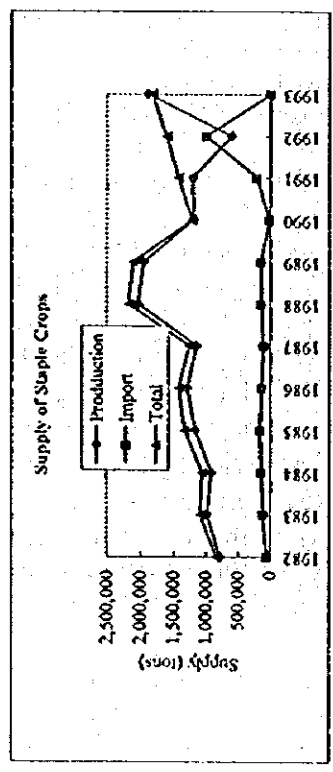
- 1) Feed as concentrated sort only for livestock of Commercial Sector.
- 2) Feed requirement is estimated based on per head requirement and number of livestock
- 3) Poultry: Average has been applied for 1991 due to no data of poultry number.
- 4) Concentrated Feed Requirement (kg/day/head) is referring to Section 2.2.

### 4.2 Present Balance and Per Capita Consumption of Staple Crops

Taking a deficit of feed supply to livestock into account, food balance of staple crops has been analysed from 1982 to 1993 as shown in Table 4-2. As shown in the table, cereals (mostly maize) are imported almost every year except 1990. Average annual import was about 210,000 tons including the heavy import from 1992 to 1993 caused by the severe drought in 1992. Excluding 1992 and 1993, average annual import was only 83,000 tons. Under above conditions, balance is analysed including losses, seed reservation and other purposes. As calculated in trend analysis of per capita consumption in Table 4-2 per capita consumption is estimated at 157 kg/year. According to the information of the Food Security, MAFF, per capita consumption is decreasing in amount recently due to liberalisation of food market. Taking this situation into account, per capita consumption is considered to be 160 kg/year.

Table 4-2 Present Food Balance and Per Capita Consumption of Staple Crops in Zambia

Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993 Average	S.D	S.D/Ave	
Population (million)	5.97	6.13	6.29	6.46	6.64	6.82	7.00	7.19	7.38	7.58	7.77	7.97			
1. Production *1 (tons)	786,286	986,626	922,972	1,173,253	1,298,458	1,153,602	2,039,789	1,964,343	1,206,687	1,216,130	610,416	1,890,607	1,270,931	443,448	34.9%
2. Import *2 (tons)	58,359	111,600	145,912	165,432	132,363	103,286	146,149	148,420	17,934	216,000	1,003,791	0	187,437	243,159	135.1%
3. Export *2 (tons)	0	0	0	0	0	0	0	0	0	0	0	68,000	-5,667	18,794	331.6%
Total (1-2-3) (tons)	844,645	1,098,226	1,068,884	1,338,685	1,430,821	1,256,888	2,185,938	2,112,763	1,224,621	1,432,130	1,614,207	1,822,607	1,452,701	396,066	27.3%
4. Feed Requirement 1 (tons)	230,160	246,669	263,178	303,719	262,667	341,584	310,444	290,069	437,813	358,213	395,250	411,759	320,960	65,252	20.3%
5. Seed (2%)*2 (tons)	15,726	19,733	18,459	23,465	25,969	23,112	40,796	39,287	24,134	24,323	12,208	37,812	25,419	8,869	34.9%
6. Losses (5%)*3 (tons)	42,232	54,911	53,444	66,934	71,541	62,944	109,297	105,638	61,231	71,607	80,710	91,130	72,635	19,803	27.3%
7. Processing (5%)*3 (tons)	42,232	54,911	53,444	66,934	71,541	62,944	109,297	105,638	61,231	71,607	80,710	91,130	72,635	19,803	27.3%
Total (4 to 7) (tons)	330,350	376,224	388,525	461,052	431,718	490,584	569,834	540,632	584,409	525,750	568,878	631,831	491,649	90,553	18.4%
Available for Consumption (tons)	514,295	722,002	680,359	877,633	999,103	766,304	1,616,104	1,572,131	640,212	906,380	1,045,329	1,190,776	961,052	335,335	34.9%
Per Capita Consumption (kg/Capita)	86	118	108	136	150	113	231	219	87	120	135	149	138	44	31.9%



(Note)  
 1) Feed requirement for 1982-84 and 1992-93 is interpolated.  
 2) Annual stock is not considered in supply in this table.  
 Therefore, annual supply fluctuates significantly.

### 4.3 Present Regional Balance of Staple Crops

Regional balance of staple crops is studied as of 1990. Maize, millet, sorghum, rice and wheat are selected as grain, and cassava is also included as one of staple crops. Cassava is an important crop in the northern provinces and Western Province.

Surplus production of staple crops are observed in four provinces, Central Southern, Northern and Eastern Province as shown in Table 4-3. Other five provinces are deficit in balance, and importing staple crops from former four provinces. Southern Province produces the maximum surplus, and Central and Eastern Provinces are following. Copperbelt Province is the most deficit provinces among five deficit provinces, which imports over 150,000 tons per year. Deficit of food is much mitigated to about 9,000 tons by cassava in North-western and Luapula Provinces. Much deficit still remains at about 30,000 tons in Western Province, although cassava is counted.

**Table 4-3 Present Regional Balance of Staple Crops (As of 1990)**

Province	Food Demand		Production		Balance with Food		Balance with Feed	
	Population	Demand (tons)	Grain (tons)	Cassava (tons)	with Grain (tons)	Incl. Cassava (tons)	Requirem ent (tons)	Total Balancé (tons)
Lusaka	987,106	157,937	83,732	0	-74,205	-74,205	not analysed on provincial basis.	
Copperbelt	1,427,528	228,404	75,801	354	-152,603	-152,249		
Central	720,628	115,300	362,562	741	247,262	248,003		
N/Western	387,554	62,009	39,795	12,838	-22,214	-9,376		
Western	606,813	97,090	61,656	6,153	-35,434	-29,281		
Southern	907,150	145,144	421,117	31	275,973	276,004		
Luapula	525,160	84,026	47,269	27,279	-36,757	-9,478		
Northern	855,177	136,828	172,886	27,598	36,058	63,656		
Eastern	965,968	154,555	397,802	45	243,247	243,292		
Zambia	7,383,084	1,181,293	1,662,620	75,039	481,327	556,366		

(Note)

1) Food demand is based on percapita consumption of 160 kg/year.

2) Cassava production is equivalent weight by calorie with maize.

(Calorie of Cassava = 1/3 of Maize: Maize = 2.93 cal/g. Cassava = 1.10 cal/g)

National total deficit is estimated at about 28,000 tons when feed and other requirement are counted.

## CHAPTER 5 AGRICULTURAL DEVELOPMENT

### 5.1 Direction of Agricultural Development

#### 5.1.1 Proposal of Long Term Agricultural Development Plan

Agricultural development plan is proposed, corresponding to the three scenarios set in the socioeconomic framework, based on the present conditions and programmes expressed in ASIP. Water resources development plan for the agricultural sector is formulated according to the proposed agricultural development plan, as shown in Table 5-1.

**Table 5-1 Agricultural Development Scenarios**

	Present Status	Base Scenario - Agricultural Expansion	Base Scenario - Industrialisation	Conservative Scenario
Population (1000 persons)	7,969 (1993) (=100)	12,738 (160)	14,336 (180)	11,589 (145)
Annual Growth in Value Added of Agricultural Sector	Average 2.3% (1985-1993)	1994-2000: 6.0% afterwards: 3.0%	3.0% (constant)	1995-: 2.6% 2000-: 2.3% 2005-: 2.0% 2010-: 1.5%
value Added of Agricultural Sector - 2005  - 2015)	(299.3 billion K.) (=100)	4,949 billion K (165)  6,998 billion K (234)	4,396 billion K (147)  6,164 billion K (206)	3,827 billion K (128)  4,912 billion K (164)

#### 5.1.2 Production of Crops

Rain fed agriculture will remain predominant even in the future, and most of maize and oil crop production will be obtained through rain fed cultivation. Wheat and rice cropping through irrigated farming will be complementary for stable production of cereals. In addition, irrigation will support the production of cash crops, such as vegetable and fruit, and of exported goods, such as coffee, sugar and flowers, in order to contribute to the improved balance of payments of the country and high growth in the Value Added of the sector. Expansion and enhancement of rain fed agriculture in the northern region, where rainfall is comparatively constant, will be necessary to achieve the stable agricultural production of the country. Of the three scenarios, the largest expansion of rain fed agriculture will be required to attain the target in the Base Scenario-Agricultural Expansion. In this scenario, prompt introduction of ox draught system in the northern region should be extensively encouraged.

#### < Staple Crops >

Self supply is assumed in all scenarios. Rain fed maize and irrigated wheat will be main crops. Consumption of staple crops is presumed to be 160 kg/capita/year, and wheat consumption is supposed to remain at 13 kg/capita/year, 8% of the total consumption. Even in the future, main part of the production should rely on rain fed agriculture. In Base Scenario-Agricultural Expansion, increased production will allow to ensure the targeted



cereal reserve for three months (510 thousand tons), which will upgrade the food security against drought events, and for Zambia to become a cereal exporting country. In the other two scenarios, all of the products will be consumed domestically.

#### < Oil Crops >

Oil crops are ranked third of the agricultural products for export and are produced by rain fed agriculture. The market for these crops continues to look promising in the future. ASIP also emphasises the development of processing technology for vegetable oil production, assuming that demands increase. Production increase to two or three times the current volume can be projected by 2015.

#### < Vegetables >

Vegetables are the most suitable for cash earning. Current production has reached to the level to meet the supply of 65 kg/capita/year, and rapid consumption increase will not occur. Further, large scale export will be difficult. Current level of production is assumed to continue.

#### < Fruit >

Current consumption of fruit is 16 kg/capita/year, which corresponds to 30% of the consumption in developed countries (50 kg/capita/year). In the Base Scenario-Agricultural Expansion, where the largest increase of agricultural production is projected, production of fruit is planned to increase to meet a consumption level of 27 kg/capita/year.

#### < Coffee and Tea >

Coffee and tea plantation is expanding by 530 ha/year. Much endeavour is being made by entrepreneurs to marketing and exports of coffee and tea. Current expansion is assumed to continue in the Base Scenario-Agricultural Expansion. In the other scenarios, however, the production will grow at the same rate as that set for growth of total value added of agricultural sector in each scenario, considering possible risks in the future.

#### < Sugarcane >

Sugar is ranked second of the exported agricultural products. The complete process from plantation to exporting has been established by the sugar company. The plantation will be expanded from the current area of 13,000 ha to 21,000 ha by 2005, in accordance with projection of the production expansion planned by the company.

#### < New Products >

Flower growing and exports have been started recently mainly by commercial farmers. ASIP highlights expansion in the future. The markets for flowers are European countries, where stable and expanded supply with lower price in winter can be achieved from Zambia which enjoys summer at the same time. Therefore, production will increase to 10 times the present level in the Base Scenario-Agricultural Expansion. In the other scenarios, the production will grow at the same rate as that of total value added of the sector of each scenario, considering possible risks.

Under above considerations, trial study has been made to get target growth rate of the value added with satisfying the all requirements of livestock production, fishery production and grain production. Since said three productions are fixed by population scenarios because per capita consumption was set at 14.2kg/yr, 12kg/yr and 160kg/yr, adjustment has been made

only by other crops than cereals. Table 5-2 shows the result of crop production, acreage and economic growth of agriculture for three agriculture development scenarios.

Total planted and irrigated areas are maximum in 2015 in case of Base Scenario-Agricultural Expansion of about 2,633,000ha and 114,000ha respectively. Base Scenario-Industrialisation follows the Base Scenario-Agricultural Expansion with the planted area of 2,343,000ha and the irrigated area of 107,000ha. The areas are minimum in Conservative Scenario with the planted area of 1,916,000ha and the irrigated area of 91,000ha. Present planted and irrigated areas are 1,363,000ha and 53,000ha respectively in 1993. Therefore, both areas of Base Scenario-Agricultural Expansion reach almost or over two times the present areas.

**Table 5-2 Crop Production and Water Demand for Irrigation by Three Scenarios**

	Current Status (1993)	Base Scenario - Agricultural Expansion	Base Scenario - Industrialisation	Conservative Scenario
< Crop Production >				
(1) staple Crops (export)	1,894,000 ton	3,664,000 ton	3,383,000 ton	2,728,000 ton
(wheat)	71,000 ton	510,000 ton	-	-
- domestic production	50 %	166,000 ton	186,000 ton	151,000 ton
- Import	50 %	100 %	100 %	100 %
		0 %	0 %	0 %
(2) Oil Crops	154,000 ton (=100)	462,000 ton (300)	385,000 ton (250)	323,000 ton (210)
(3) Vegetable	520,000 ton (65 kg/person/year)	855,000 ton (65 kg/person/year)	958,000 ton (65 kg/person/year)	775,000 ton (65 kg/person/year)
(4) Fruits	129,000 ton (16 kg/person/year)	348,000 ton (27 kg/person/year)	250,000 ton (17 kg/person/year)	202,000 ton (1 kg/person/year)
(5) Coffee & Tea	6,300 ha (=100)	18,240 ha (290)	12,000 ha (190)	9,600 ha (152)
(6) Sugar Cane	13,000 ha (=100)	21,000 ha (162)	21,000 ha (162)	21,000 ha (162)
(7) New Crops (flower)	250 ha (=100)	2,500 ha (1000)	500 ha (200)	380 ha (152)
< Total Planted Area >	1,363,000 ha (=1.00)	2,633,000 ha (193)	2,343,000 ha (172)	1,916,000 ha (141)
< Total Irrigated Area >	53,000 ha (=100)	114,000 ha (215)	107,000 ha (202)	91,000 ha (172)
<Newly Irrigated Area>	-	61,000 ha	54,000 ha	38,000 ha
< Additional Irrigation Water Demand >	-	5,282,000 m <sup>3</sup> /day	4,680,000 m <sup>3</sup> /day	3,242,000 m <sup>3</sup> /day

### 5.1.3 Food Demands and Security

Food demand has been estimated for three scenarios. Per capita demand of staple crop is assumed at 160 kg/year based on actual food balance for 12 years from 1982 to 1993. Consumption of meat is considered at 14.2 kg/capita, that is the present consumption rate. The present meat consumption rate will be also applied for the future consumption in all scenarios.

Necessary production of staple crops are as shown in Table 5-3. Necessary production as minimum requirement of staple crops ranges from 2,728,000 tons/year for the Conservative Scenario to 3,664,000 tons/year for the Base Scenario-Agricultural Expansion in 2015. Production of staple crops has to be increased to 144% and 193% of the 1993 production for the above cases. In case of the Base Scenarios-Industrialisation, it is necessary to produce 3,383,000 tons/year, equivalent to 179% of the 1993 production of 1,894,000 tons.

#### <Reserves>

For security of food, 3 month reserve of grain will be planed in all cases of agricultural development plans. The amount of annual reserves are:

Base Scenario-Agricultural Expansion = 510,000 ton,  
 Base Scenario-Industrialisation = 573,000 ton,  
 Conservative Scenario = 464,000 ton

#### <Export of Grain (Maize)>

In case of Base Scenario-Agricultural Expansion, it is proposed to produce 510,000 tons of maize for export, which is the same amount of three month reserve. By the production of 510,000 tons of maize, total production of staple crops becomes 3,664,000 tons which includes 5% losses (26,000 tons) and 2% of seed (10,000 tons), adding to the target of 3,118,000 tons in total.

**Table 5-3 Required Production of Staple Crops for Three Scenarios**

Agricultural Plan	Base Scenario-Agri- cultural Expansion		Base Scenario- Industrialisation		Conservative Scenario	
	2005	2015	2005	2015	2005	2015
Population (1,000)	10,465	12,738	10,994	14,336	10,025	11,589
<b>Minimum Required Staple Crops (tons)</b>						
Food Demand 1)	1,674,000	2,038,000	1,759,000	2,294,000	1,604,000	1,854,000
Feed Demand 2)	550,000	706,000	510,000	683,000	467,000	547,000
Losses 5%	126,000	156,000	129,000	169,000	118,000	136,000
Manufacturing 5%	126,000	156,000	129,000	169,000	118,000	136,000
Seed 2%	51,000	62,000	52,000	68,000	47,000	55,000
<b>Total</b>	<b>2,527,000</b>	<b>3,118,000</b>	<b>2,579,000</b>	<b>3,383,000</b>	<b>2,354,000</b>	<b>2,728,000</b>
Export	0	516,000	0	0	0	0
<b>Grand Total</b>	<b>2,527,000</b>	<b>3,664,000</b>	<b>2,579,000</b>	<b>3,383,000</b>	<b>2,354,000</b>	<b>2,728,000</b>

(Note)

- 1) Food requirement = 160 kg/capita/yr
- 2) Feed demand = Total Required Feed \* 53% as grain.

## 5.2 Necessary Countermeasures for Stabilising the Production

### 5.2.1 Alternative Plans

For producing the above requirement, the following factors are considered:

- Production of staple crops mostly depend on rainfed maize cultivation.

- The national production of staple crops fluctuates by 25% once in 5 years. If no irrigated cereals are increased, that is equivalent to 780,000 tons/year. In case of Base Scenario-Agricultural Expansion, irrigated wheat is expected to increase to 34,800 ha and expected to produce a stable yield of about 174,000 tons of grain. Therefore, reduction of production will be reduced to 606,000 tons, 225,000 tons will be secured by the national reserve for food security.

#### <Import of Maize>

- Balance of 381,000 tons will be imported from the world market, if no measures are taken.

#### <Expansion of Rainfed Cultivation in the Northern Regions>

- On the other hand, productivity of maize is stable in the northern provinces, such as Northern, Luapula and North-western Provinces. However, hoe cultivation is predominant in these area, and total maize planted area of three provinces shares only 10% of national planted area. In these provinces, there are not enough number of oxen at present stage. The cultivation area per farmer is much less than that in Southern and Eastern Provinces. Therefore, it will be difficult to expand the planted area so rapidly with hoe cultivation in short period. In this study, it is recommended to expand cultivation area in the northern region with an rapid increase of oxen to meet necessary expansion of national planted area. As shown in the table below, agricultural population of northern three provinces are projected to decrease from 33% of national agricultural population in 1993 to 29% in 2015. Therefore, encouragement of oxen introduction is to be strongly proceeded for northern region.

Table 5-4 Projection of Economically Active Agricultural Population

Province	1990 Actual 1990	(Unit:1,000)								
		Base Scenario- Agricultural expansion			Base Scenario- Industrialisation			Conservative Scenario		
		1995	2005	2015	1995	2005	2015	1995	2005	2015
Lusaka	33	39.7	54.3	71.4	37.4	43.7	42.8	39.3	52.0	65.2
Copperbelt	61	70.3	92.4	117.3	70.2	93.8	123.3	69.9	88.6	105.9
Central	121	137.3	171.7	206.8	136.8	172.2	212.6	136.3	165.2	188.3
N/Western	77	85.3	101.8	118.5	83.9	97.4	107.1	84.8	97.7	107.9
Western	95	103.0	117.5	130.8	102.4	117.8	134.4	102.0	112.7	119.0
Southern	133	150.2	186.2	222.1	148.8	183.8	222.0	149.1	178.5	202.5
Luapula	110	119.4	137.2	152.5	118.3	134.8	149.6	118.6	131.2	138.6
Northern	182	197.6	227.3	251.3	195.8	223.3	248.7	196.2	217.4	228.1
Eastern	303	342.8	426.3	509.6	341.7	429.4	528.3	340.1	408.7	463.9
<b>Zambia</b>	<b>1,115</b>	<b>1,245.6</b>	<b>1,514.7</b>	<b>1,780.3</b>	<b>1,235.3</b>	<b>1,496.2</b>	<b>1,768.8</b>	<b>1,236.3</b>	<b>1,452.0</b>	<b>1,619.4</b>
Population of Northern Region (N/Western, Luapula, Northern)										
	369	402	466	522	398	456	505	400	446	475
Ratio to National Population										
	33%	32%	31%	29%	32%	30%	29%	32%	31%	29%

### 5.2.2 Northern Expansion of Rainfed Agriculture

As stated above, for effective utilisation of resources of the country, it is essential to expand the rainfed agriculture in the northern region.

In this expansion plan, following targets are to be achieved for the national and the regional benefits:

- to mitigate fluctuation of staple crop production more or less the three month reserve for drought year once in five years.
- to increase planted area per household more than 1.8ha in the northern region, which supports the expenditure of agricultural household.

Table 5-5 shows the expansion plan for Base Scenario-Agricultural Expansion together with status of 1993. In this scenario, cultivation area increases to 2,633,000ha (193%) in 2015 from 1,363,000ha in 1993, and national average cultivation area per household increases to 3.1ha from 2.5ha. According the results of analysis, the cultivation area of northern three provinces (N/Western, Luapula and Northern) is increased from 268,000ha to 663,000ha by 2.47 times, while that of other 6 provinces is increased 1.69 times. In this plan, reduction of maize production can be reduced from 916,000ton (25% of targeted production of 3,664,000ton) to 580,000ton (16%), which still exceeds the three month reserve of 510,000ton by 70,000 ton, but excess is not large amount which is able to be managed by import. However, export is not able to achieve such drought year, but able to export 510,000ton annually in other years. Per household cultivation area is increased to 1.8ha from 0.9ha in N/Western Province, to 1.9ha from 1.0ha in Luapula Province, and to 3.2ha from 1.7ha for Northern Province.

It is estimated the cultivable capacity per farmer of hoe cultivation, ox draught cultivation and mechanised cultivation at 0.30ha, 1.43ha and 3.51ha respectively. Base on this assumption, oxen number has to be increased from 9,000head in 1993 to 226,000head in 2015 by about 25 times in said three provinces.

For realising this northern expansion programme, increase of ox is an essential factor. Therefore, encouragement of ox expansion is to be strongly proceeded, and veterinary facilities and ox training centres are to be provided as well as extension work for promotion of ox cultivation in the northern region.

**Table 5-5 Northern Expansion of Cultivated Area by Base Scenario-Agricultural Expansion**

Present (1993)							
Province	Cultivated Area (ha)	Cultivated Area Per Household (ha/house)	Wet Season Planted Area (ha)	Planted Area per Farmer (ha)	Cultivation Method		
					Hoe Cultivation (ha)	Ox Cultivation (ha)	Mechanized Cultivation (ha)
Lusaka	39,969	2.7	36,400	1.3	5,906 (16 %)	16,027 (44 %)	14,518 (40 %)
Copperbelt	52,322	2.0	46,200	0.9	12,104 (26 %)	4,213 (9 %)	29,835 (65 %)
Central	249,293	4.6	244,800	2.4	5,618 (2 %)	93,050 (38 %)	146,248 (60 %)
NAWestern	39,767	0.9	29,000	0.5	17,309 (59 %)	5,177 (18 %)	6,669 (23 %)
Western	109,972	2.2	82,900	1.1	5,113 (6 %)	77,813 (94 %)	0 (0 %)
Southern	280,723	4.5	276,200	2.4	0 (0 %)	198,228 (72 %)	78,141 (28 %)
Luapula	73,663	1.0	38,200	0.4	26,651 (78 %)	696 (2 %)	7,020 (20 %)
Northern	154,468	1.7	120,800	0.8	36,416 (30 %)	6,967 (6 %)	77,220 (64 %)
Eastern	362,875	2.6	362,300	1.5	51,726 (14 %)	93,849 (26 %)	216,703 (60 %)
<b>Zambia</b>	<b>1,363,052</b>	<b>2.5</b>	<b>1,236,800</b>	<b>1.3</b>	<b>160,843 (13 %)</b>	<b>496,020 (40 %)</b>	<b>576,354 (47 %)</b>
Base Scenario-Agricultural Expansion (2015)							
Lusaka	79,368	2.8	70,974	1.3	6,764 (10 %)	35,672 (50 %)	28,537 (40 %)
Copperbelt	105,121	2.3	105,121	1.1	6,827 (6 %)	30,325 (29 %)	67,969 (65 %)
Central	375,740	4.4	363,845	2.2	0 (0 %)	145,538 (40 %)	218,308 (60 %)
NAWestern	94,607	1.8	87,495	1.0	11,412 (13 %)	55,969 (64 %)	20,114 (23 %)
Western	131,145	2.1	124,135	1.2	12,740 (10 %)	111,395 (90 %)	0 (0 %)
Southern	402,459	4.2	374,732	2.1	0 (0 %)	260,809 (70 %)	113,924 (30 %)
Luapula	183,002	1.9	168,719	1.4	945 (1 %)	133,879 (79 %)	33,894 (20 %)
Northern	384,914	3.2	368,581	1.9	0 (0 %)	132,689 (36 %)	235,891 (64 %)
Eastern	734,474	3.3	732,473	1.9	0 (0 %)	292,989 (40 %)	439,483 (60 %)
<b>Zambia</b>	<b>2,510,244</b>	<b>3.1</b>	<b>2,396,075</b>	<b>1.7</b>	<b>38,688 (2 %)</b>	<b>1,199,265 (50 %)</b>	<b>1,158,120 (48 %)</b>

### 5.3 Agricultural Development

#### 5.3.1 Value Added of Agricultural Sectors by Three Scenarios

Table 5-6 shows the value added of each sub-sector of agriculture by three scenarios. Total value added is maximum of about K'million 699,801 in 2015 in the Base Scenario-Agricultural expansion, and followed by the Base Scenario-Industrialisation and the Conservative Scenario.

**Table 5-6 Value Added of Agricultural Sectors by Three Scenarios**

Year		1990	1993	1994	1995	2000	2005	2010	2015
<b>Base Scenario-Agricultural Expansion</b>									
Population	(1,000)	7,383	7,969	8,164	8,339	9,412	10,455	11,602	12,738
	Ratio	100	108	111	113	127	142	157	173
<b>GVA Imposed to Agricultural Sector</b>									
	Imposed GVA Growth Rate (%)		52.1	6.0	6.0	6.0	3.0	3.0	3.0
	GVA Growth Ratio to 1993		100.0	106.0	112.4	150.4	174.3	202.1	234.3
<b>Agricultural GVA Plan (Gross Margin)</b>									
Crops	(K million)		177,607	187,692	197,777	248,201	298,625	367,687	436,750
Livestock	(K million)		45,614	47,624	49,635	59,689	69,742	79,686	89,630
Wildlife	(K million)		13,000	13,390	13,806	16,276	17,830	19,637	21,730
Forestry	(K million)		48,979	51,918	55,053	73,665	85,371	98,987	114,758
Fishery	(K million)		14,082	15,410	15,047	19,023	23,352	29,780	36,934
Total	(K million)		299,281	316,034	331,317	416,853	494,919	595,777	699,801
<b>GVA</b>									
	Growth Rate of GVA			5.6%	4.8%	4.7%	3.5%	3.8%	3.3%
	Ratio to 1993		100.0	105.6	110.7	139.3	165.4	199.1	233.8
<b>Increase of Irrigated Area (ha)</b>							31,719	60,619	
<b>Base Scenario-Industrialisation</b>									
Year		1990	1993	1994	1995	2000	2005	2010	2015
Population	(1,000)	7,383	8,012	8,221	8,431	9,713	10,994	12,665	14,336
	Ratio	100	109	111	114	132	149	172	194
<b>GVA Imposed to Agriculture</b>									
	Imposed GVA Growth Rate (%)		52.1	3.0	3.0	3.0	3.0	3.0	3.0
	GVA Growth Ratio to 1993		100.0	103.0	106.0	122.6	141.9	164.2	189.9
<b>Agricultural GVA Plan (Gross Margin)</b>									
Crops	(K million)		177,607	183,813	190,018	221,045	252,072	301,098	350,124
Livestock	(K million)		45,614	48,486	51,359	65,724	80,088	98,810	117,532
Wildlife	(K million)		13,000	13,000	13,000	13,000	13,000	13,000	13,000
Forestry	(K million)		48,979	50,449	51,918	60,049	69,502	80,424	93,012
Fishery	(K million)		14,082	15,410	15,168	19,810	24,926	33,321	42,715
Total	(K million)		299,281	311,158	321,463	379,627	439,587	526,653	616,382
<b>GVA</b>									
	Growth Rate of GVA			4.0%	3.3%	3.4%	3.0%	3.7%	3.2%
	Ratio to 1993		100.0	104.0	107.4	126.8	146.9	176.0	206.0
<b>Increase of Irrigated Area (ha)</b>							18,589.0	54,139.0	
<b>Conservative Scenario</b>									
Year		1990	1993	1994	1995	2000	2005	2010	2015
Population	(1,000)	7,383	7,928	8,109	8,291	9,158	10,025	10,807	11,589
	Rate	100	107	110	112	124	136	146	157
<b>Imposed GDP Growth to Agriculture</b>									
	Growth Rate (%)		52.1	2.6	2.6	2.3	2.0	1.7	1.5
	Growth Ratio to 1993		100.0	102.6	105.2	117.6	129.7	141.2	152.1
<b>Agricultural GVA Plan (Gross Margin)</b>									
Crops	(K million)		177,607	180,922	184,237	200,810	217,384	253,332	289,279
Livestock	(K million)		45,614	47,377	49,140	57,956	66,771	74,233	81,695
Wildlife	(K million)		13,000	13,000	13,000	13,000	13,000	13,000	13,000
Forestry	(K million)		48,979	50,253	51,526	57,600	63,526	69,159	74,497
Fishery	(K million)		14,082	15,410	14,956	18,357	22,021	27,147	32,758
Total	(K million)		299,281	306,961	312,859	347,723	382,702	436,870	491,229
<b>GVA</b>									
	Growth Rate of GVA			2.6%	1.9%	2.1%	1.9%	2.7%	2.4%
	Ratio to 1993		100.0	102.6	104.5	116.2	127.9	146.0	164.1
<b>Increase of Irrigated Area (ha)</b>							16,889.0	37,789.0	

(Note)

- 1) GVA of wildlife is estimated at 3.5% of Agricultural GVA K394 billion of 1993 (CSO), referring to Report No. 11570-ZA, World Bank.
- 2) Wildlife is assumed to increase at an half rate of Agricultural GVA.

### 5.3.2 Scale of Farm Land to be planted

According to the Gross Domestic Product Plan set up for each scenario, farm land to be planted and proposed crops are estimated as following Table 5-7.

Table 5-7 Required Planted Area by Three Scenarios

(Unit:ha)

Crops	Actual	Base Scenario - Agricultural Expansion		Base Scenario - Industrialisation		Conservative Scenario	
		2005	2015	2005	2015	2005	2015
Maize	820,396	1,138,000	1,332,000	1,024,200	1,218,600	944,500	984,800
Sorghum	47,792	79,000	96,800	71,100	88,600	65,600	71,600
Millet	54,808	120,000	157,000	108,000	143,600	99,600	116,100
Rice (Ext.) (*)	13,711	17,500	22,100	19,600	24,800	15,900	20,100
Rice (Int.W.S.) *	0	1,800	2,800	2,100	3,000	1,700	2,500
Rice (Int.D.S.) (*)	0	900	1,400	1,050	1,500	850	1,250
R. Wheat	3,686	0	0	0	0	0	0
I. Wheat *	13,656	24,000	33,200	26,900	37,200	21,800	30,200
<b>Cereals</b>	<b>954,049</b>	<b>1,381,200</b>	<b>1,645,300</b>	<b>1,252,950</b>	<b>1,517,300</b>	<b>1,149,950</b>	<b>1,226,550</b>
Cassava	107,812	135,400	171,600	152,500	193,200	123,000	155,900
Potatoes	1,670	2,500	3,400	2,800	3,900	2,300	3,100
<b>Starchy</b>	<b>109,482</b>	<b>137,900</b>	<b>175,000</b>	<b>155,300</b>	<b>197,100</b>	<b>125,300</b>	<b>159,000</b>
Sugarcane *	13,000	21,000	21,000	21,000	21,000	21,000	21,000
<b>Sugar crop</b>	<b>13,000</b>	<b>21,000</b>	<b>21,000</b>	<b>21,000</b>	<b>21,000</b>	<b>21,000</b>	<b>21,000</b>
M. Beans	38,489	53,800	73,200	60,600	82,400	48,900	66,500
<b>Pulse Crops</b>	<b>38,489</b>	<b>53,800</b>	<b>73,200</b>	<b>60,600</b>	<b>82,400</b>	<b>48,900</b>	<b>66,500</b>
Soybean	19,864	68,900	94,900	26,500	29,200	21,200	29,200
Groundnuts (R)	68,808	299,000	517,400	115,000	123,200	97,400	130,400
Groundnuts (I) (*)	13,656	24,000	33,200	26,900	37,200	21,800	30,200
Sunflower	35,899	0	0	0	0	0	0
Seed Cotton	76,492	68,000	0	68,000	90,000	54,400	72,000
<b>Oilseed Crops</b>	<b>214,719</b>	<b>459,900</b>	<b>645,500</b>	<b>236,400</b>	<b>279,600</b>	<b>194,800</b>	<b>261,800</b>
Tobacco(V)	3,558	5,000	6,200	4,000	5,000	3,200	4,000
Tobacco(B)	3,388	6,900	10,000	5,600	8,100	4,500	6,500
<b>Tobacco</b>	<b>6,946</b>	<b>11,900</b>	<b>16,200</b>	<b>9,600</b>	<b>13,100</b>	<b>7,700</b>	<b>10,500</b>
Tomatoes *	6,000	6,900	9,800	7,700	11,000	6,300	8,900
Onion *	1,000	1,100	1,700	1,300	1,900	1,000	1,500
Cabbage *	3,000	3,400	4,900	3,900	5,500	3,100	4,500
Lettuce *	663	800	1,100	900	1,200	700	1,000
Carrots *	1,000	1,100	1,700	1,300	1,900	1,000	1,500
<b>Vegetables</b>	<b>11,663</b>	<b>13,300</b>	<b>19,200</b>	<b>15,100</b>	<b>21,500</b>	<b>12,100</b>	<b>17,400</b>
Coffee *	6,184	12,000	18,000	7,900	11,800	6,300	9,500
Tea *	140	190	240	130	160	100	130
<b>Stimulant Crops</b>	<b>6,324</b>	<b>12,190</b>	<b>18,240</b>	<b>8,030</b>	<b>11,960</b>	<b>6,400</b>	<b>9,630</b>
Orange *	7,154	9,700	14,600	7,000	10,500	5,700	8,500
Banana *	974	1,500	2,100	1,100	1,500	900	1,200
<b>Fruits</b>	<b>8,128</b>	<b>11,200</b>	<b>16,700</b>	<b>8,100</b>	<b>12,000</b>	<b>6,600</b>	<b>9,700</b>
Flower *	250	1,250	2,500	380	500	310	380
<b>New Crops</b>	<b>250</b>	<b>1,250</b>	<b>2,500</b>	<b>380</b>	<b>500</b>	<b>310</b>	<b>380</b>
<b>Total Planted Area</b>	<b>1,363,050</b>	<b>2,103,640</b>	<b>2,632,840</b>	<b>1,767,460</b>	<b>2,156,460</b>	<b>1,573,060</b>	<b>1,782,460</b>
<b>Irrigated Area (ha)</b>	<b>53,021</b>	<b>84,740</b>	<b>113,640</b>	<b>81,610</b>	<b>107,160</b>	<b>69,910</b>	<b>90,810</b>
<b>Incremental from 1993</b>		<b>31,719</b>	<b>60,619</b>	<b>28,589</b>	<b>54,139</b>	<b>16,889</b>	<b>37,789</b>

1) \*: Irrigated Crops 2) (\*): Irrigated but not counted in irrigated area. 3) Groundnuts(I): considered as supplemental irrigation crop before wheat. 4) Sunflower is considered to decrease its planting area due to decrease of price. 5) Seed cotton is also considered to decrease in ADP-I due to lower income for farmers.



### 5.3.3 Allocation of Irrigation Area by Provinces

As resulting in Table 5-7, irrigated lands are to be developed at about 61,000ha for Base Scenario-Agricultural Expansion, and 54,000ha for Base Scenario-Industrialisation and 38,000ha for Conservative Scenario respectively. On the other hand, potential irrigation areas are estimated at about 132,000ha in the country as shown in Table 5-8. The locations of potential areas are shown in Figure 5-1. For appropriate allocation of said irrigated areas, following priorities have been considered:

#### < Priorities >

- Lower income regions. (Luapula, Western, North-Western, Northern)
- Lower yield region. (Western, Eastern, Lusaka, North-Western)
- Food unbalanced regions among Agriculture dominant provinces. (Western)
- High potential region on water resources. (Luapula, Southern, Central, N/Western, Northern, Western)

Based on above priorities, basic allocation ratio has been tabulated as shown in the Table 5-8.

**Table 5-8 Potential Irrigation Area and Allocated Irrigation Projects**

Province	Lusaka	Copperbelt	Central	N/Western	Western	Southern	Luapula	Northern	Eastern	
<b>Potential Irrigable Area (ha)</b>	<b>132,461</b>	<b>3,010</b>	<b>10,260</b>	<b>15,570</b>	<b>15,260</b>	<b>13,410</b>	<b>23,148</b>	<b>33,555</b>	<b>13,829</b>	<b>4,419</b>
<b>Basic Allocation Ratio</b>		2%	9%	4%	13%	23%	9%	30%	6%	4%
<b>Allocation for 61,000ha based on Basic Allocation Ratio</b>	<b>61,000</b>	<b>1,100</b>	<b>5,000</b>	<b>3,000</b>	<b>8,000</b>	<b>14,000</b>	<b>6,000</b>	<b>18,000</b>	<b>4,000</b>	<b>3,000</b>
<b>Existing Irrigation Projects</b>										
ASIP Rehabilitation Project	267	10	140	0	0	0	89	0	0	28
Existing Expansion Project	16,484	1,900	4,200	0	290	10	8,450	1,144	490	0
<b>New Irrigation Projects</b>										
Multipurpose Dam Project	6,590	810	5,780	0	0	0	0	0	0	0
Irrigation Dam Project	8,480	0	0	0	0	0	0	7,000	0	1,480
Run-of-river Project	29,000	0	0	5,000	6,300	7,000	0	4,000	6,700	0
<b>Total (ha)</b>	<b>60,821</b>	<b>2,720</b>	<b>10,120</b>	<b>5,000</b>	<b>6,590</b>	<b>7,010</b>	<b>8,539</b>	<b>12,144</b>	<b>7,190</b>	<b>1,508</b>

In selection of irrigation project, first priority has been set on the ASIP Rehabilitation Project and the Existing Expansion Project. On the other hand, three multipurpose dams, namely Chongwe, Kafubu and Mutundu dams are selected as peri-urban irrigation projects which are able to produce valuable crops like vegetables. And, among remaining proposed dams, two dams namely Lufubu and Lundazi dams are selected from aspect of less cost and gravity conveyance system. Remaining projects are selected from run-of-river potential areas, to meet the basic allocation areas of provincial basis.

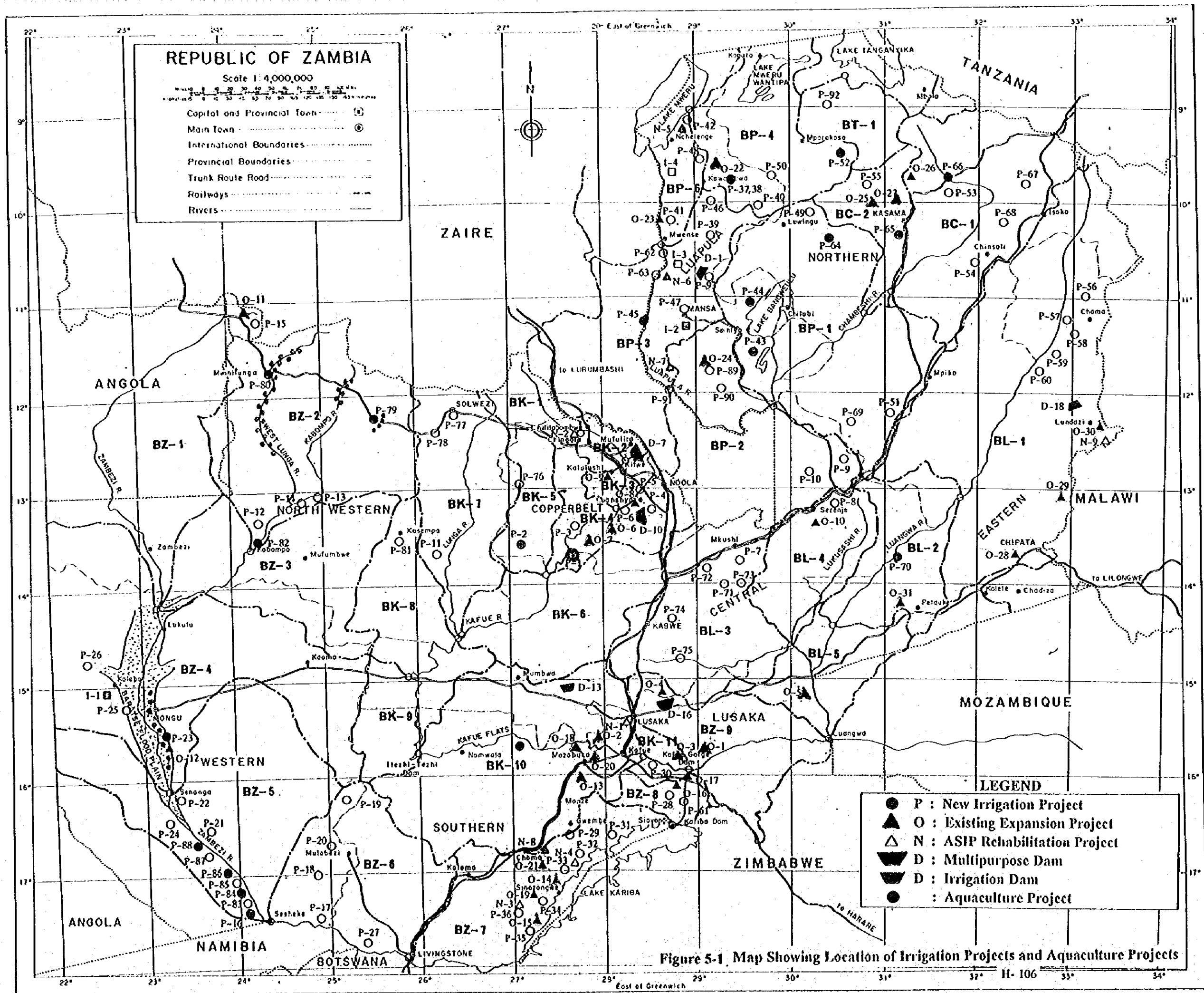


Figure 5-1 Map Showing Location of Irrigation Projects and Aquaculture Projects



## CHAPTER 6 LIVESTOCK DEVELOPMENT

### 6.1 Direction of Livestock Development

It is estimated that 2,669,000 head of cattle, 592,000 sheep and goats, 303,000 pigs, and 7,920,000 poultry were bred by both sectors of traditional and commercial farmers in the country in 1990. Southern, Central, Eastern and Western Provinces are predominant in cattle breeding and have a share of about 80% of the total cattle number. However, three of these provinces (excluding Western Province) have almost reached or exceeded the maximum breeding level in the floodplain grazing system. Particularly in Southern Province, cattle numbers have decreased significantly in recent years.

The cattle population increased from 1,730,000 in 1980 to 2,680,000 in 1989 at the high growth rate of 4.5%, but decreased to 2,540,000 in 1991. Traditional farmers owned about 2,178,000 head (82%) of cattle, and commercial farmers shared 491,000 head of cattle (18%) in 1990. Annual meat consumption per capita is 14.20kg (average for 1980-90 for urban population - figures for rural slaughtering are not known), of which poultry meat is 5.57 kg. This consumption rate is the same as that of Japan in 1970, so that it is proposed to maintain present supply level to the year 2015 with the same rate as national population growth.

Cattle number decreased sharply after 1989, especially in Southern Province. The reason for the decrease is considered to be over-grazing in the Kafue Floodplain. Therefore, growth of cattle number should be much less than 4.5% per annum in the future.

Present percapita meat consumption level is considered to be a good rate, and this rate should be maintained in the future. To realise this percapita meat consumption rate (14.20 kg/year), it is necessary to increase the number of livestock at the same rate as the national population.

### 6.2 Projection of Livestock Population

Livestock numbers are projected to grow at the same rate as national population growth, and will increase to 1.725 times the 1990 number for Base Scenario- Agricultural Expansion, 1.942 times for Base Scenario- Industrialisation, and 1.570 times for Conservative Scenario respectively. Table 6-1 shows the projected livestock numbers in 2005 and 2015 for each case.

**Table 6-1 Projected Number of Livestock for Agricultural Development Plans**

	Base Scenario - Agricultural Expansion			Base Scenario - Industrialisation		Conservative Scenario	
	1990	2005	2015	2005	2015	2005	2015
Ratio of Growth	1.000	1.417	1.725	1.489	1.942	1.358	1.570
<b>Livestock Number (1,000 head)</b>							
Cattle	2,669	3,780	4,603	3,974	5,182	3,625	4,190
Sheep/Goats	592	839	1,021	881	1,150	804	929
Pigs	303	429	523	451	588	411	476
Poultry	7,921	11,224	13,664	11,794	15,383	10,757	12,436

(Notes) Ratio of Growth: following the projected growth ratio of the national population.

As shown in Table 6-1, cattle number would need to increase to 4,603,000 head from 2,669,000 head for the Base Scenario- Agricultural Expansion, to 5,182,000 head for the Base Scenario- Industrialisation, and to 4,190,000 head for the Conservative Scenario.

For the case that cattle numbers increase with national population, cattle numbers by province can be projected as shown in Table 6-2.

**Table 6-2 Projected Number of Cattle without Consideration of Over-Grazing**

Province	Actual	Base Scenario- Agricultural Expansion		Base Scenario- Industrialisation		Conservative Scenario	
Year	1990	2005	2015	2005	2015	2005	2015
Ratio	1.000	1.417	1.725	1.489	1.942	1.358	1.570
Lusaka	87,647	124,000	151,000	131,000	170,000	119,000	138,000
Copperbelt	74,374	105,000	128,000	111,000	144,000	101,000	117,000
Central	503,512	713,000	869,000	750,000	978,000	684,000	791,000
N/Western	59,340	84,000	102,000	88,000	115,000	81,000	93,000
Western	546,957	775,000	944,000	814,000	1,062,000	743,000	859,000
Southern	1,052,795	1,492,000	1,816,000	1,568,000	2,045,000	1,430,000	1,653,000
Luapula	12,186	17,000	21,000	18,000	24,000	17,000	19,000
Northern	107,821	153,000	186,000	161,000	209,000	146,000	169,000
Eastern	223,880	317,000	386,000	333,000	435,000	304,000	351,000
<b>Total</b>	<b>2,668,512</b>	<b>3,780,000</b>	<b>4,603,000</b>	<b>3,974,000</b>	<b>5,182,000</b>	<b>3,625,000</b>	<b>4,190,000</b>

However, as shown in Table 2-5, in Southern province, the cattle number already exceeded the natural breeding capacity at 1990 Year Level. Therefore, to increase the livestock number, it is necessary to solve the over-grazing in the Kafue floodplain.

### 6.3 Livestock Development Plan

There are several alternatives to increase livestock numbers, particularly cattle numbers, by the year 2015. Following alternatives are to be considered for selection:

<Plan-1>: to expand cattle breeding to other vacant floodplains to eliminate the over-grazing in the Kafue floodplain, and to develop other floodplains like Upper Zambezi, Chambeshi, and Luapula floodplains mostly located in the northern region.

<Plan-2>: to produce meadow grass by means of irrigation for excess cattle in the Kafue floodplain in dry season.

<Plan-3>: to combine expansion and meadow grass production in reasonable proportions.

Regional balance between the natural breeding capacity and the cattle number is calculated in Table 6-3 (1) to 6-3 (3) for three scenarios using the following assumptions:

**Agricultural Land: Vacant agricultural land excluding Shifting Cultivation Area**

- Total Area = 8,543,450 ha
- Utilisation Rate = 50 %
- Breeding Capacity = 5ha/head (natural vegetation)

(Note) Natural breeding capacity is estimated at 5 ha for one cattle in the agricultural lands through the country, because the lands are not covered by closed forests, mostly covered by grass or by open forests which are expected to provide reasonably high natural breeding capacity.

**Staple Crop Field: Cereal Crop Area in 2015**

- Total Area = 1,610,900 ha (for Base Scenario- Agricultural Expansion)
- Utilisation Rate = 80 %
- Breeding Capacity = 0.82ha/head (stem utilisation)

**Flood Plain: Floodplain Area of Each Province**

- Total Area = 7,989,863 ha
- Utilisation Rate = 80%
- Breeding Capacity = 2ha/head (natural grass)

According to the results of Table 6-3, lands in Southern province are already over grazed. If no measures are taken, over-grazing will continue to expand and severe soil erosion will be caused in Southern province. Excess number of cattle will be 884,000 head in 2015 in Southern Province in case of Base Scenario- Agricultural Expansion. (Table 6-3 (1) ) As well as Southern Province, over-grazing will be caused also in Central Province after 2005 for all scenarios. If over-grazing continues, water facilities will deteriorate rapidly in these two provinces. Therefore, the most urgent subject on livestock development is to mitigate the over-grazing in Southern and Central provinces.

<Plan-1>: expanding livestock breeding in the northern provinces, it will take a long time to expand breeding technology and to provide veterinary facilities. Therefore, <Plan-2> and <Plan-3> are to be considered as alternative plan.

<Plan-2>: meadow grass production for excess number of cattle, it is estimated that an irrigated area of 116,000 ha would be required by the Year 2015. Necessary irrigation water is estimated at about 116 m<sup>3</sup>/s, that is equivalent to 77% of the regulated flow of the Kafue river (150 m<sup>3</sup>/sec). Water utilisation of this scale in the Kafue floodplain is too excessive for other water usage.

Required meadow grass and Irrigation Water:

- Excess cattle in Southern and Central Provinces = 884,000 + 174,000 = 1,058,000 head
- Required irrigated grass land = Excess cattle x Breeding capacity of grass land = 1,058,000 head x 0.11 ha/head = 116,000 ha (Note: Breeding capacity of irrigated grass land is assumed at 0.11 ha/head)

Required irrigation capacity = 116,000 ha x 1.0 lit/sec/ha = 116 m<sup>3</sup>/sec

Therefore, <Plan-3>: combination of expansion and meadow grass production, has to be considered as an alternative plan of <Plan-1>.

In <Plan-3>, the urgent subject is "How Much Meadow and When". For this subject, following points will be considered:

- To prepare meadow grass in Southern and Central provinces by 2005.
- To produce meadow grass for excess number of cattle by 2005, that is for about 578,000 head of cattle for Base Scenario- Agricultural Expansion.

Required meadow grass and Irrigation Water in case above condition:

- Excess cattle in Southern and Central Provinces = 560,000 + 18,000 = 578,000 head
- Required irrigated grass land = Excess cattle x Breeding capacity of grass land = 578,000 head x 0.11 ha/head = 64,000 ha
- Required irrigation capacity = 64,000 ha x 1.0 lit/sec/ha = 64 m<sup>3</sup>/sec

Consequently, it is necessary to prepare irrigated fields of area 64,000 ha for meadow grass by the year 2005. This irrigation will consume 64 m<sup>3</sup>/s of water, equivalent to 43 % of the Kafue regulated flow. It is still beyond the allowable utilisation level in the Kafue River. Therefore, <Plan-1> is recommended as a development direction for livestock although it takes time for development.

Allocated cattle number in accordance with <Plan-1> is summarised as shown in Table 6-3. Detail computation of allocation is shown in Table 6-3(1) to 6-3(3) for each scenario.

**Table 6-3 Summary of Allocated Cattle Number by Scenarios**  
(Unit : 1000 head)

Province	Present	Base Scenario - Agricultural Expansion		Base Scenario - Industrialisation		Conservative Scenario	
	1990	2005	2015	2005	2015	2005	2015
Lusaka	88	139	170	147	179	133	155
Copperbelt	74	127	164	137	182	121	146
Central	504	695	695	683	683	683	683
N/Western	59	195	330	242	491	186	280
Western	547	878	1,078	944	1,182	845	998
Southern	1,053	932	932	916	916	916	916
Luapula	12	71	135	84	190	62	100
Northern	108	343	574	405	798	313	465
Eastern	224	398	525	416	561	366	446
<b>Zambia</b>	<b>2,669</b>	<b>3,778</b>	<b>4,603</b>	<b>3,974</b>	<b>5,182</b>	<b>3,625</b>	<b>4,189</b>

Table 6-3(1) Preliminary Allocation Plan of Cattle by the Year 2015 (Base Scenario-Agricultural Expansion)

		Usaka	Copper-belt	Central	N. Western	Western	Southern	Lusaka	Northern	Eastern	Total
<b>Breeding Capacity by Available Roughage</b>											
<b>Available Feeding by Agricultural Land except Shifting Cultivation Area</b>											
Agricultural Land (ha)		339,666	225,602	1,182,704	503,894	1,157,169	1,963,917	637,620	342,097	1,681,121	9,543,450
Capacity to breed	*1	34,000	23,000	114,000	50,000	116,000	196,000	69,000	54,000	168,000	854,000
<b>Available Feeding by Staple Crops Field</b>											
Staple Crop Land (ha)		53,632	63,850	197,376	74,740	187,825	270,700	112,156	240,210	486,210	1,610,800
Maize, Sorghum, Millet		53,600	63,800	197,300	73,500	187,400	270,700	111,500	239,200	485,900	1,585,800
Rice Extensive		39	50	76	1,240	11,625	0	650	0,010	2,410	22,000
Rice Intensive Wet S.		0	0	0	0	3,000	0	0	0	0	3,000
Capacity to breed	*2	52,000	67,000	193,000	73,000	184,000	264,000	109,000	234,000	474,000	1,570,000
<b>Available Feeding by Natural Vegetation</b>											
Floodplain Area (ha)		254,111	273,351	970,164	1,066,873	2,392,134	1,179,252	165,047	1,648,743	39,600	7,939,963
Capacity to breed	*3	102,000	109,000	353,000	422,000	957,000	472,000	66,000	639,000	16,000	3,196,000
Capacity to breed (heads)		139,000	199,000	695,000	550,000	1,207,000	932,000	214,000	947,000	658,000	5,620,000
<b>Projected Cattle Number</b>											
Year 1990	1,000	87,447	74,374	503,512	59,340	546,957	1,052,795	12,186	107,821	223,830	2,668,512
Year 1995	1,131	99,000	84,000	570,000	67,000	619,000	1,192,000	14,000	122,000	253,000	3,024,000
Year 2000	1,272	112,000	95,000	642,000	76,000	697,000	1,332,000	16,000	137,000	283,000	3,492,000
Year 2005	1,417	124,000	105,000	713,000	84,000	775,000	1,492,000	17,000	153,000	317,000	3,789,000
Year 2010	1,571	139,000	117,000	791,000	93,000	859,000	1,654,000	19,000	169,000	352,000	4,192,000
Year 2015	1,725	151,000	128,000	869,000	102,000	944,000	1,816,000	21,000	186,000	386,000	4,603,000
<b>Excess Number</b>											
Year 1990 (Actual)		0	0	0	0	0	120,795	0	0	0	120,795
Year 1995		0	0	0	0	0	268,000	0	0	0	268,000
Year 2000		0	0	0	0	0	410,000	0	0	0	410,000
Year 2005		0	0	18,000	0	0	568,000	0	0	0	578,000
Year 2010		0	0	96,000	0	0	722,000	0	0	0	818,000
Year 2015		0	0	174,000	0	0	881,000	0	0	0	1,055,000
<b>Allocation Plan by 2005</b>											
Room for Allocation		64,000	92,000	0	466,000	132,000	0	227,000	791,000	311,000	2,418,000
Ratio of Room for Allocation		0.0255	0.0389	0.0000	0.1927	0.1787	0.0000	0.0939	0.3284	0.1110	1.0001
Allocation Number		15,000	22,000	0	111,000	103,000	0	54,000	190,000	81,000	574,000
Number in 2005		139,000	127,000	695,000	195,000	578,000	932,000	71,000	343,000	398,000	3,778,000
<b>Allocation Plan by 2015</b>											
Room for Allocation		37,000	71,000	0	448,000	243,000	0	223,000	761,000	272,000	2,075,000
Ratio of Room for Allocation		0.0178	0.0342	0.0000	0.2159	0.1267	0.0000	0.1075	0.3667	0.1311	1.0000
Allocation Number		19,000	36,000	0	228,000	134,000	0	111,000	353,000	139,000	1,058,000
Number in 2015		170,000	164,000	695,000	330,000	1,078,000	932,000	135,000	574,000	525,000	4,603,000
<b>Planned Cattle Allocation</b>											
Year 1990 (Actual)		97,447	74,374	503,512	59,340	546,957	1,052,795	12,186	107,821	223,830	2,668,512
Year 1995		105,000	92,000	567,000	67,000	637,000	1,183,000	14,000	122,000	253,000	3,024,000
Year 2000		122,000	109,000	631,000	76,000	697,000	1,332,000	16,000	137,000	283,000	3,492,000
Year 2005		139,000	127,000	695,000	84,000	775,000	1,492,000	17,000	153,000	317,000	3,789,000
Year 2010		155,000	146,000	695,000	93,000	859,000	1,654,000	19,000	169,000	352,000	4,192,000
Year 2015		170,000	164,000	695,000	102,000	944,000	1,816,000	21,000	186,000	386,000	4,603,000
<b>Increase Rate from 1990</b>											
Year 1990 (Actual)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Year 1995		1.20	1.21	1.15	1.17	1.20	0.96	2.63	1.73	1.26	1.11
Year 2000		1.39	1.47	1.25	1.33	1.40	0.92	4.19	2.46	1.52	1.29
Year 2005		1.59	1.71	1.35	1.29	1.61	0.89	5.83	3.19	1.79	1.42
Year 2010		1.77	1.95	1.35	1.43	1.79	0.89	8.43	4.26	2.06	1.57
Year 2015		1.91	2.21	1.35	1.56	1.97	0.89	11.09	5.32	2.33	1.72
<b>Increase Number from 1990</b>											
Year 2015		82,353	89,626	191,488	270,660	331,043	-120,795	122,814	466,179	301,426	1,934,488

(Note)

- \*1. Utilization (50%), 3ha/head
- \*2. Utilization (50%), 0.8ha/head
- \*3. Utilization (50%), 2ha/head



Table 6-3(2) Preliminary Allocation Plan of Cattle by the Year 2015 (Base Scenario-Industrialisation)

		Lusaka	Copper-belt	Central	N Western	Western	Southern	Lusapula	Northern	Eastern	Total
<b>Breeding Capacity by Available Roughage</b>											
<b>Available Feeding by Agricultural Land except Shifting Cultivation Area</b>											
Agricultural Land (ha)		339,666	235,602	1,142,764	503,494	1,357,169	1,963,977	637,620	542,097	1,631,121	8,543,450
Capability of breed *1		34,000	23,000	114,000	50,000	146,000	196,000	69,000	54,000	168,000	854,000
<b>Available Feeding by Staple Crops Field</b>											
Staple Crop Land (ha)		44,749	57,360	185,186	70,250	99,295	253,900	81,240	175,810	406,200	1,373,990
Maize, Sorghum, Millet		44,700	57,300	185,100	69,900	86,700	253,900	80,500	169,600	403,500	1,349,600
Rice Extensive		39	50	74	120	11,625	0	650	6,910	2,418	22,098
Rice Intensive Wet S		10	10	10	110	970	0	90	800	290	2,390
Capability to breed *2		44,000	56,000	181,000	69,000	97,000	248,000	79,000	172,000	396,000	1,342,000
<b>Available Feeding by Natural Vegetation</b>											
Floodplain Area (ha)		254,114	273,381	970,164	1,066,878	2,392,184	1,179,752	165,047	1,648,743	39,600	7,989,863
Capability to breed *3		102,000	109,000	388,000	427,000	957,000	472,000	66,000	639,000	16,000	3,196,000
Capability to breed (heads)		180,000	188,000	683,000	546,000	1,200,000	916,000	214,000	835,000	580,000	5,392,000
<b>Projected Cattle Number</b>											
Year 1990	1,000	87,647	74,374	503,512	59,340	546,957	1,032,795	12,186	107,821	223,889	2,668,512
Year 1995	1,142	100,000	85,000	575,000	68,000	625,000	1,203,000	14,000	123,000	256,000	3,048,000
Year 2000	1,316	115,000	98,000	663,000	78,000	720,000	1,355,000	16,000	142,000	295,000	3,512,000
Year 2005	1,489	131,000	111,000	750,000	88,000	814,000	1,568,000	18,000	161,000	333,000	3,974,000
Year 2010	1,718	150,000	128,000	864,000	102,000	939,000	1,807,000	21,000	185,000	384,000	4,580,000
Year 2015	1,942	170,000	144,000	978,000	115,000	1,062,000	2,045,000	24,000	209,000	435,000	5,182,000
<b>Excess Number</b>											
Year 1990 (Actual)		0	0	0	0	0	136,795	0	0	0	136,795
Year 1995		0	0	0	0	0	286,000	0	0	0	286,000
Year 2000		0	0	0	0	0	469,000	0	0	0	469,000
Year 2005		0	0	67,000	0	0	652,000	0	0	0	719,000
Year 2010		0	0	181,000	0	0	891,000	0	0	0	1,072,000
Year 2015		0	0	295,000	0	0	1,129,000	0	0	0	1,424,000
<b>Allocation Plan by 2005</b>											
Room for Allocation		49,000	77,000	0	458,000	386,000	0	196,000	724,000	247,000	2,137,000
Ratio of Room for Allocation		0.02229	0.0360	0.0000	0.2143	0.1806	0.0000	0.0917	0.3388	0.1156	0.9929
Allocation Number		16,000	26,000	0	154,000	130,000	0	66,000	244,000	83,000	719,000
Number in 2005		147,000	137,000	683,000	242,000	944,000	916,000	84,000	405,000	416,000	3,974,000
<b>Allocation Plan by 2015</b>											
Room for Allocation		10,000	44,000	0	431,000	138,000	0	190,000	676,000	145,000	1,634,000
Ratio of Room for Allocation		0.0061	0.0269	0.0000	0.2638	0.0845	0.0000	0.1163	0.4137	0.0937	1.0000
Allocation Number		9,000	38,000	0	376,000	120,000	0	165,000	589,000	126,000	1,424,000
Number in 2015		179,000	182,000	683,000	491,000	1,182,000	916,000	190,000	798,000	561,000	5,182,000
<b>Planned Cattle Allocation</b>											
Year 1990 (Actual)		87,647	74,374	503,512	59,340	546,957	1,032,795	12,186	107,821	223,889	2,668,512
Year 1995		107,000	95,000	563,000	120,000	679,000	1,007,000	36,000	207,000	288,000	3,102,000
Year 2000		127,000	116,000	623,000	181,000	812,000	962,000	60,000	306,000	352,000	3,539,000
Year 2005		147,000	137,000	683,000	242,000	944,000	916,000	84,000	405,000	416,000	3,974,000
Year 2010		163,000	160,000	683,000	367,000	1,063,000	916,000	137,000	602,000	489,000	4,580,000
Year 2015		179,000	182,000	683,000	491,000	1,182,000	916,000	190,000	798,000	561,000	5,182,000
<b>Increase Rate from 1990</b>											
Year 1990 (Actual)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Year 1995		1.22	1.28	1.12	2.02	1.24	0.96	2.95	1.92	1.29	1.16
Year 2000		1.43	1.56	1.24	3.05	1.48	0.91	4.92	2.84	1.57	1.33
Year 2005		1.68	1.84	1.36	4.08	1.73	0.87	6.89	3.76	1.86	1.49
Year 2010		1.86	2.15	1.36	6.18	1.94	0.87	11.24	5.58	2.18	1.72
Year 2015		2.04	2.45	1.36	8.27	2.16	0.87	15.59	7.40	2.51	1.94
<b>Increase Number from 1990</b>											
Year 2015		91,353	107,626	179,488	431,660	635,043	-136,795	177,814	690,179	337,120	2,513,488

(Note)

- \*1: Utilization (50%) 3ha head
- \*2: Utilization (80%) 0.82ha head
- \*3: Utilization (80%) 2ha head

Table 6-3(3) Preliminary Allocation Plan of Cattle by the Year 2015 (Conservative Scenario)

		Lusaka	Copper-belt	Central	SV Western	Western	Southern	Luapula	Northern	Eastern	Total
<b>Breeding Capacity by Available Roughage</b>											
<b>Available Feeding by Agricultural Land except Shifting Cultivation Area</b>											
Agricultural Land (ha)		339,666	225,602	1,142,704	503,494	1,457,169	1,963,977	637,620	542,097	1,681,121	8,543,450
Capability of breed *1		34,000	23,000	114,000	50,000	146,000	196,000	69,000	54,000	168,000	854,000
<b>Available Feeding by Staple Crops Field</b>											
Staple Crop Land (ha)		44,820	57,420	185,200	69,880	95,310	253,900	81,320	176,120	406,120	1,370,090
Maize, Sorghum, Millet		44,700	57,300	183,100	68,900	86,700	253,900	80,500	169,000	403,500	1,349,600
Rice Extensive		110	110	90	870	7,640	0	730	6,320	2,330	18,200
Rice Intensive Wet S		10	10	10	110	920	0	90	800	290	2,290
Capability to breed *2		44,000	56,000	181,000	68,000	93,000	248,000	79,000	172,000	396,000	1,337,000
<b>Available Feeding by Natural Vegetation</b>											
Floodplain Area (ha)		254,114	273,351	970,164	1,066,878	2,392,184	1,179,752	165,047	1,648,743	59,600	1,989,863
Capability to breed *3		102,000	109,000	388,000	427,000	957,000	472,000	66,000	639,000	16,000	3,195,000
Capability to breed (heads)		180,000	188,000	683,000	545,000	1,196,000	916,000	214,000	885,000	580,000	5,387,000
<b>Projected Cattle Number</b>											
Year 1990	1,000	87,647	74,374	503,512	59,340	546,957	1,052,795	12,185	107,821	223,880	2,668,512
Year 1995	1,123	98,000	84,000	565,000	67,000	614,000	1,182,000	14,000	121,000	251,000	2,996,000
Year 2000	1,241	109,000	92,000	625,000	74,000	679,000	1,307,000	15,000	134,000	278,000	3,313,000
Year 2005	1,358	119,000	101,000	684,000	81,000	743,000	1,430,000	17,000	146,000	304,000	3,625,000
Year 2010	1,464	128,000	109,000	737,000	87,000	801,000	1,541,000	18,000	158,000	328,000	3,907,000
Year 2015	1,570	138,600	117,000	791,000	93,000	859,000	1,653,000	19,000	169,000	351,000	4,190,000
<b>Excess Number</b>											
Year 1990 (Actual)		0	0	0	0	0	136,795	0	0	0	136,795
Year 1995		0	0	0	0	0	266,000	0	0	0	266,000
Year 2000		0	0	0	0	0	391,000	0	0	0	391,000
Year 2005		0	0	1,000	0	0	514,000	0	0	0	515,000
Year 2010		0	0	54,000	0	0	625,000	0	0	0	679,000
Year 2015		0	0	108,000	0	0	737,000	0	0	0	845,000
<b>Allocation Plan by 2005</b>											
Room for Allocation		61,000	87,000	0	464,000	453,000	0	197,000	739,000	216,000	2,277,000
Ratio of Room for Allocation		0.0268	0.0382	0.0000	0.2038	0.1989	0.0000	0.0855	0.3245	0.1212	0.9992
Allocation Number		14,000	20,000	0	105,000	102,000	0	45,000	167,000	62,000	515,000
Number in 2005		133,000	121,000	683,000	186,000	843,000	916,000	62,000	313,000	366,000	3,625,000
<b>Allocation Plan by 2015</b>											
Room for Allocation		42,000	71,000	0	452,000	337,000	0	195,000	716,000	229,000	2,042,000
Ratio of Room for Allocation		0.0206	0.0348	0.0000	0.2214	0.1650	0.0000	0.0955	0.3506	0.1121	1.0000
Allocation Number		17,000	29,000	0	187,000	139,000	0	81,000	296,000	95,000	844,000
Number in 2015		155,000	146,000	683,000	280,000	998,000	916,000	100,000	465,000	446,000	4,189,000
<b>Planned Cattle Allocation</b>											
Year 1990 (Actual)		87,647	74,374	503,512	59,340	546,957	1,052,795	12,185	107,821	223,880	2,668,512
Year 1995		103,000	90,000	563,000	102,000	646,000	1,007,000	29,000	176,000	271,000	2,987,000
Year 2000		118,000	105,000	623,000	144,000	746,000	962,000	45,000	245,000	319,000	3,307,000
Year 2005		133,000	121,000	683,000	186,000	845,000	916,000	62,000	313,000	366,000	3,625,000
Year 2010		144,000	134,000	683,000	233,000	922,000	916,000	81,000	389,000	406,000	3,908,000
Year 2015		155,000	146,000	683,000	280,000	998,000	916,000	100,000	465,000	446,000	4,189,000
<b>Increase Rate from 1990</b>											
Year 1990 (Actual)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Year 1995		1.18	1.21	1.12	1.72	1.18	0.96	2.38	1.63	1.21	1.12
Year 2000		1.35	1.41	1.24	2.43	1.36	0.91	3.69	2.27	1.42	1.34
Year 2005		1.52	1.63	1.36	3.13	1.54	0.87	5.69	2.90	1.63	1.36
Year 2010		1.64	1.80	1.36	3.93	1.69	0.87	6.65	3.61	1.81	1.46
Year 2015		1.77	1.96	1.36	4.72	1.82	0.87	8.21	4.31	1.99	1.57
<b>Increase Number from 1990</b>											
Year 2015		67,353	71,626	179,488	230,660	431,043	-136,795	87,814	357,179	222,120	1,520,488

(Note)

- \*1: Utilization (50%) 1ha head
- \*2: Utilization (80%) 0.82ha head
- \*3: Utilization (80%) 2ha head

#### 6.4 Projection of Meat Production in Urban Area

Meat production is calculated based on slaughtering number. Slaughtering, and milk and egg production are estimated to increase at the same growth rate as urban population, because, if the number of livestock increases at the same rate as national population, marketability will be governed by the urban population ratio.

Table 6-4 shows the estimated slaughtering and production of milk and eggs in each case.

**Table 6-4 Livestock Production Projection**

	Actual				High Growth Case			Low Growth Case		
	1990	1995	2005	2015	1995	2005	2015	1995	2005	2015
<b>Urban Population</b>										
(million)	2.782	3.227	4.253	5.465	3.35	4.886	7.17	3.201	4.074	4.982
(Ratio)	100	116.0	152.9	196.4	120.4	175.6	257.7	115.1	146.4	179.1
<b>Production</b>										
<b>Slaughtering (1,000 head)</b>										
Cattle	92.20	106.95	140.97	181.08	111.01	161.90	237.60	106.12	134.98	165.13
Pigs	14.60	16.94	22.32	28.67	17.58	25.64	37.62	16.80	21.37	26.15
Sheep/Goats	0.95	1.10	1.45	1.87	1.14	1.67	2.45	1.09	1.39	1.70
Poultry	9,828	11,400	15,027	19,302	11,833	17,258	25,327	11,312	14,388	17,602
<b>By-Products</b>										
Milk (1,000 lit.)	34,808	40,377	53,221	68,363	41,909	61,123	89,700	40,064	50,959	62,341
Eggs (1,000 tons)	6,425	7,453	9,824	12,619	7,736	11,282	16,557	7,395	9,406	11,507

(Note)

Production is projected as the same ratio to the urban population growth.

#### 6.5 Projected Livestock Population

Table 6-5(1) and 6-5(2) show the projected number of livestock for 2005 and 2015 that are allocated based on the potential of breeding capacity of each province.

Table 6-5(1) Number of Livestock projected for 2005

Province	Cattle		Sheep/ Goats		Pigs		Poultry	
Number of heads in 1990								
Lusaka	87,647	3.3%	13,407	2.3%	10,321	3.4%	1,582,000	20.0%
Copperbelt	74,374	2.8%	16,504	2.8%	21,186	7.0%	1,219,000	15.4%
Central	503,512	18.9%	47,597	8.0%	19,842	6.5%	987,000	12.5%
N/Western	59,340	2.2%	9,918	1.7%	4,732	1.6%	219,000	2.8%
Western	546,957	20.5%	8,368	1.4%	4,667	1.5%	388,000	4.9%
Southern	1,052,795	39.5%	274,228	46.3%	73,473	24.2%	1,337,000	16.9%
Luapula	12,186	0.5%	29,900	5.0%	3,019	1.0%	326,000	4.1%
Northern	107,821	4.0%	31,875	5.4%	8,318	2.7%	855,000	10.8%
Eastern	223,880	8.4%	160,359	27.1%	157,855	52.0%	1,008,000	12.7%
Zambia	2,668,512	100.0%	592,156	100.0%	303,413	100.0%	7,921,000	100.0%

Base Scenario- Agricultural Expansion : 1.417 times of 1990

Province	Cattle		Sheep/ Goats		Pigs		Poultry	
Lusaka	139,000	3.7%	19,000	2.3%	15,000	3.5%	2,242,000	20.0%
Copperbelt	128,000	3.4%	23,000	2.7%	30,000	7.0%	1,727,000	15.4%
Central	683,000	18.1%	67,000	8.0%	28,000	6.5%	1,399,000	12.5%
N/Western	210,000	5.6%	14,000	1.7%	7,000	1.6%	310,000	2.8%
Western	890,000	23.6%	12,000	1.4%	7,000	1.6%	550,000	4.9%
Southern	916,000	24.2%	389,000	46.4%	104,000	24.1%	1,895,000	16.9%
Luapula	71,000	1.9%	42,000	5.0%	4,000	0.9%	462,000	4.1%
Northern	353,000	9.3%	45,000	5.4%	12,000	2.8%	1,212,000	10.8%
Eastern	389,000	10.3%	227,000	27.1%	224,000	52.0%	1,428,000	12.7%
Zambia	3,779,000	100.0%	838,000	100.0%	431,000	100.0%	11,225,000	100.0%

Base Scenario- Industrialisation : 1.489 times of 1990

Province	Cattle		Sheep/ Goats		Pigs		Poultry	
Lusaka	148,000	3.7%	20,000	2.3%	15,000	3.3%	2,356,000	20.0%
Copperbelt	137,000	3.4%	25,000	2.8%	32,000	7.1%	1,815,000	15.4%
Central	683,000	17.2%	71,000	8.0%	30,000	6.7%	1,470,000	12.5%
N/Western	242,000	6.1%	15,000	1.7%	7,000	1.6%	326,000	2.8%
Western	943,000	23.7%	12,000	1.4%	7,000	1.6%	578,000	4.9%
Southern	916,000	23.0%	408,000	46.3%	109,000	24.2%	1,991,000	16.9%
Luapula	84,000	2.1%	45,000	5.1%	4,000	0.9%	485,000	4.1%
Northern	405,000	10.2%	47,000	5.3%	12,000	2.7%	1,273,000	10.8%
Eastern	416,000	10.5%	239,000	27.1%	235,000	52.1%	1,501,000	12.7%
Zambia	3,974,000	100.0%	882,000	100.0%	451,000	100.0%	11,795,000	100.0%

Conservative Scenario : 1.358 times of 1990

Province	Cattle		Sheep/ Goats		Pigs		Poultry	
Lusaka	133,000	3.7%	18,000	2.2%	14,000	3.4%	2,148,000	20.0%
Copperbelt	121,000	3.3%	22,000	2.7%	29,000	7.1%	1,655,000	15.4%
Central	683,000	18.8%	65,000	8.1%	27,000	6.6%	1,340,000	12.5%
N/Western	186,000	5.1%	13,000	1.6%	6,000	1.5%	297,000	2.8%
Western	845,000	23.3%	11,000	1.4%	6,000	1.5%	527,000	4.9%
Southern	916,000	25.3%	372,000	46.3%	100,000	24.3%	1,816,000	16.9%
Luapula	62,000	1.7%	41,000	5.1%	4,000	1.0%	443,000	4.1%
Northern	313,000	8.6%	43,000	5.4%	11,000	2.7%	1,161,000	10.8%
Eastern	366,000	10.1%	218,000	27.1%	214,000	52.1%	1,369,000	12.7%
Zambia	3,625,000	100.0%	803,000	100.0%	411,000	100.0%	10,756,000	100.0%

(Note) Cattle number of Southern and Central Provinces is allocated to other provinces.

Table 6-5(2) Number of Livestock projected for 2015

Province	Cattle		Sheep/ Goats		Pigs		Poultry	
Number of heads in 1990								
Lusaka	87,647	3.3%	13,407	2.3%	10,321	3.4%	1,582,000	20.0%
Copperbelt	74,374	2.8%	16,504	2.8%	21,186	7.0%	1,219,000	15.4%
Central	503,512	18.9%	47,597	8.0%	19,842	6.5%	987,000	12.5%
N/Western	59,340	2.2%	9,918	1.7%	4,732	1.6%	219,000	2.8%
Western	546,957	20.5%	8,368	1.4%	4,667	1.5%	388,000	4.9%
Southern	1,052,795	39.5%	274,228	46.3%	73,473	24.2%	1,337,000	16.9%
Luapula	12,186	0.5%	29,900	5.0%	3,019	1.0%	326,000	4.1%
Northern	107,821	4.0%	31,875	5.4%	8,318	2.7%	855,000	10.8%
Eastern	223,880	8.4%	160,359	27.1%	157,855	52.0%	1,008,000	12.7%
Zambia	2,668,512	100.0%	592,156	100.0%	303,413	100.0%	7,921,000	100.0%

Base Scenario- Agricultural Expansion-1 : 1.725 times of 1990

Province	Cattle		Sheep/ Goats		Pigs		Poultry	
Lusaka	168,000	3.6%	23,000	2.3%	18,000	3.4%	2,729,000	20.0%
Copperbelt	163,000	3.5%	28,000	2.7%	37,000	7.1%	2,103,000	15.4%
Central	683,000	14.8%	82,000	8.0%	34,000	6.5%	1,703,000	12.5%
N/Western	359,000	7.8%	17,000	1.7%	8,000	1.5%	378,000	2.8%
Western	1,090,000	23.7%	14,000	1.4%	8,000	1.5%	669,000	4.9%
Southern	916,000	19.9%	473,000	46.3%	127,000	24.3%	2,306,000	16.9%
Luapula	133,000	2.9%	52,000	5.1%	5,000	1.0%	562,000	4.1%
Northern	592,000	12.9%	55,000	5.4%	14,000	2.7%	1,475,000	10.8%
Eastern	499,000	10.8%	277,000	27.1%	272,000	52.0%	1,739,000	12.7%
Zambia	4,603,000	100.0%	1,021,000	100.0%	523,000	100.0%	13,664,000	100.0%

Base Scenario- Industrialisation : 1.942 times of 1990

Province	Cattle		Sheep/ Goats		Pigs		Poultry	
Lusaka	179,000	3.5%	26,000	2.3%	20,000	3.4%	3,072,000	20.0%
Copperbelt	182,000	3.5%	32,000	2.8%	41,000	6.9%	2,367,000	15.4%
Central	683,000	13.2%	92,000	8.0%	39,000	6.6%	1,917,000	12.5%
N/Western	491,000	9.5%	19,000	1.7%	9,000	1.5%	425,000	2.8%
Western	1,179,000	22.8%	16,000	1.4%	9,000	1.5%	753,000	4.9%
Southern	916,000	17.7%	533,000	46.4%	143,000	24.2%	2,596,000	16.9%
Luapula	190,000	3.7%	58,000	5.0%	6,000	1.0%	633,000	4.1%
Northern	800,000	15.4%	62,000	5.4%	16,000	2.7%	1,660,000	10.8%
Eastern	562,000	10.8%	311,000	27.1%	307,000	52.0%	1,958,000	12.7%
Zambia	5,182,000	100.0%	1,149,000	100.0%	590,000	100.0%	15,381,000	100.0%

Conservative Scenario : 1.570 times of 1990

Province	Cattle		Sheep/ Goats		Pigs		Poultry	
Lusaka	155,000	3.7%	21,000	2.3%	16,000	3.4%	2,484,000	20.0%
Copperbelt	146,000	3.5%	26,000	2.8%	33,000	6.9%	1,914,000	15.4%
Central	683,000	16.3%	75,000	8.1%	31,000	6.5%	1,550,000	12.5%
N/Western	280,000	6.7%	16,000	1.7%	7,000	1.5%	344,000	2.8%
Western	998,000	23.8%	13,000	1.4%	7,000	1.5%	609,000	4.9%
Southern	916,000	21.9%	431,000	46.3%	115,000	24.2%	2,099,000	16.9%
Luapula	100,000	2.4%	47,000	5.0%	5,000	1.1%	512,000	4.1%
Northern	465,000	11.1%	50,000	5.4%	13,000	2.7%	1,342,000	10.8%
Eastern	446,000	10.6%	252,000	27.1%	248,000	52.2%	1,583,000	12.7%
Zambia	4,189,000	100.0%	931,000	100.0%	475,000	100.0%	12,437,000	100.0%

(Note) Cattle number of Southern and Central Provinces is allocated to other provinces.

## 6.6 Water Consumption of Livestock

Depending on the number of livestock in each province (Table 6-5) and the unit water requirement (Table 2-8), total livestock water demand is estimated, and summarised as shown in Table 6-6. The maximum water requirement reaches 250,000 m<sup>3</sup>/day for Base Scenario-Industrialisation, and minimum will be 202,000 m<sup>3</sup>/day for Conservative Scenario. Detail estimations are shown in Table 6-7(1) for 2005 and in Table 6-7(2) for 2015.

**Table 6-6 Water Requirement of Livestock by Scenarios**

Scenarios	Actual	Base Scenario-Agriculture Expansion		Base Scenario-Industrialisation		Conservative Scenario	
		1993 (m <sup>3</sup> /day)	2005 (m <sup>3</sup> /day)	2015 (m <sup>3</sup> /day)	2005 (m <sup>3</sup> /day)	2015 (m <sup>3</sup> /day)	2005 (m <sup>3</sup> /day)
Lusaka	4,451	6,921	8,367	7,332	9,000	6,610	7,691
Copperbelt	4,300	7,002	8,830	7,494	9,872	6,648	7,935
Central	22,331	30,391	30,962	30,552	31,373	30,305	30,687
N/Western	2,752	9,029	15,187	10,354	20,629	8,009	11,925
Western	22,599	36,713	44,937	38,876	48,636	34,837	41,141
Southern	50,224	47,738	50,007	48,247	51,619	47,293	48,862
Luapula	1,220	3,903	6,666	4,497	9,141	3,513	5,213
Northern	5,382	15,777	25,802	17,948	34,490	14,077	20,484
Eastern	15,678	25,138	31,637	26,711	35,625	23,810	28,469
Zambia	128,937	182,612	222,395	192,011	250,385	175,102	202,407

**Table 6-7(1) Water Requirement of Livestock for 2005**

**Base Scenario- Agricultural Expansion**

Province	Cattle	Sheep/ Goats	Pigs	Poultry	Total		Cost (M'US\$)
	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(MCM/yr)	
Lusaka	5,657	403	413	448	6,921	2,526	1.11
Copperbelt	5,210	589	858	345	7,002	2,556	1.13
Central	27,798	1,501	812	280	30,391	11,093	4.89
N/Western	8,547	280	140	62	9,029	3,296	1.45
Western	36,223	240	140	110	36,713	13,400	5.9
Southern	37,281	7,936	2,142	379	47,738	17,424	7.68
Luapula	2,890	840	81	92	3,903	1,425	0.63
Northern	14,367	918	250	242	15,777	5,759	2.54
Eastern	15,832	4,540	4,480	286	25,138	9,175	4.04
Zambia	153,805	17,247	9,316	2,244	182,612	66,654	29.37

**Base Scenario- Industrialisation**

Province	Cattle	Sheep/ Goats	Pigs	Poultry	Total		Cost (M'US\$)
	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(MCM/yr)	
Lusaka	6,024	424	413	471	7,332	2,676	1.18
Copperbelt	5,576	640	915	363	7,494	2,735	1.21
Central	27,798	1,590	870	294	30,552	11,151	4.91
N/Western	9,849	300	140	65	10,354	3,779	1.66
Western	38,380	240	140	116	38,876	14,190	6.25
Southern	37,281	8,323	2,245	398	48,247	17,610	7.76
Luapula	3,419	900	81	97	4,497	1,641	0.72
Northern	16,484	959	250	255	17,948	6,551	2.89
Eastern	16,931	4,780	4,700	300	26,711	9,750	4.3
Zambia	161,742	18,156	9,754	2,359	192,011	70,083	30.88

**Conservative Scenario**

Province	Cattle	Sheep/ Goats	Pigs	Poultry	Total		Cost (M'US\$)
	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(MCM/yr)	
Lusaka	5,413	382	385	430	6,610	2,413	1.06
Copperbelt	4,925	563	829	331	6,648	2,427	1.07
Central	27,798	1,456	783	268	30,305	11,061	4.87
N/Western	7,570	260	120	59	8,009	2,923	1.29
Western	34,392	220	120	105	34,837	12,716	5.6
Southern	37,281	7,589	2,060	363	47,293	17,262	7.6
Luapula	2,523	820	81	89	3,513	1,282	0.56
Northern	12,739	877	229	232	14,077	5,138	2.26
Eastern	14,896	4,360	4,280	274	23,810	8,691	3.83
Zambia	147,537	16,527	8,887	2,151	175,102	63,913	28.14

(Note) 1) Cattle number of Southern and Central Provinces is allocated to other provinces. (Table 6-3(1)-(3))

2. Water is supplied from boreholes 30cm in diameter and 60m in length and boreholes are equipped with Power Pumps. Safe yield of boreholes are assumed at 158m3/day.

**Table 6-7(2) Water Requirement of Livestock for 2015**

**Base Scenario- Agricultural Expansion**

Province	Cattle	Sheep/ Goats	Pigs	Poultry	Total		Cost
	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(MCM/yr)	
Lusaka	6,838	488	495	546	8,367	3.054	1.35
Copperbelt	6,634	717	1,058	421	8,830	3.223	1.42
Central	27,798	1,837	986	341	30,962	11.301	4.98
N/Western	14,611	340	160	76	15,187	5.543	2.44
Western	44,363	280	160	134	44,937	16.402	7.22
Southern	37,281	9,649	2,616	461	50,007	18.253	8.04
Luapula	5,413	1,040	101	112	6,666	2.433	1.07
Northern	24,094	1,122	291	295	25,802	9.418	4.15
Eastern	20,309	5,540	5,440	348	31,637	11.548	5.09
<b>Zambia</b>	<b>187,341</b>	<b>21,013</b>	<b>11,307</b>	<b>2,734</b>	<b>222,395</b>	<b>81.175</b>	<b>35.75</b>

**Base Scenario- Industrialisation**

Province	Cattle	Sheep/ Goats	Pigs	Poultry	Total		Cost
	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(MCM/yr)	
Lusaka	7,285	551	550	614	9,000	3.285	1.45
Copperbelt	7,407	819	1,173	473	9,872	3.603	1.59
Central	27,798	2,061	1,131	383	31,373	11.451	5.04
N/Western	19,984	380	180	85	20,629	7.530	3.32
Western	47,985	320	180	151	48,636	17.752	7.82
Southern	37,281	10,873	2,946	519	51,619	18.841	8.30
Luapula	7,733	1,160	121	127	9,141	3.336	1.47
Northern	32,560	1,265	333	332	34,490	12.589	5.54
Eastern	22,873	6,220	6,140	392	35,625	13.003	5.73
<b>Zambia</b>	<b>210,906</b>	<b>23,649</b>	<b>12,754</b>	<b>3,076</b>	<b>250,385</b>	<b>91.390</b>	<b>40.25</b>

**Conservative Scenario**

Province	Cattle	Sheep/ Goats	Pigs	Poultry	Total		Cost
	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(MCM/yr)	
Lusaka	6,309	445	440	497	7,691	2.807	1.24
Copperbelt	5,942	666	944	383	7,935	2.896	1.28
Central	27,798	1,680	899	310	30,687	11.201	4.93
N/Western	11,396	320	140	69	11,925	4.353	1.92
Western	40,619	260	140	122	41,141	15.016	6.61
Southern	37,281	8,792	2,369	420	48,862	17.835	7.86
Luapula	4,070	940	101	102	5,213	1.903	0.84
Northern	18,926	1,020	270	268	20,484	7.477	3.29
Eastern	18,152	5,040	4,960	317	28,469	10.391	4.58
<b>Zambia</b>	<b>170,493</b>	<b>19,163</b>	<b>10,263</b>	<b>2,488</b>	<b>202,407</b>	<b>73.879</b>	<b>32.54</b>

(Note) 1. Cattle number of Southern and Central Provinces is allocated to other provinces (Table 6-3(1)-(3)).

2. Water is supplied from boreholes 30cm in diameter and 60m in length and boreholes are equipped with Power Pumps. Safe yield of boreholes are assumed at 158m3/day.



## 6.7 Feed Projection of Livestock

Supply of roughage feed is met by the grazing system allocated as shown in Table 6-7(1) and 6-7(2). Regarding the concentrated feed, a requirement of about 700,000 ton/year of maize grain is estimated for Base Scenario-Agricultural Expansion by 2015 as shown in Table 6-8, and 680,000 ton/year for Base Scenario- Industrialisation and 550,000 ton/year for Conservative Scenario.

**Table 6-8 Required Concentrated Feed for Livestock by Scenarios**

	Cattle	Pigs	Sheep/ Goats	Poultry			
<b>Number in 1990</b>	491,032	32,760	40,213	2,831,000			
<b>Projected Number of Livestock</b>							
<b>Base Scenario- Agricultural Expansion</b>							
2005	1.529	751,000	50,000	61,000	4,329,000		
2015	1.965	965,000	64,000	79,000	5,563,000		
<b>Base Scenario- Industrialisation</b>							
2005	1.756	862,000	58,000	71,000	4,971,000		
2015	2.577	1,265,000	84,000	104,000	7,295,000		
<b>Conservative Scenario</b>							
2005	1.464	719,000	48,000	59,000	4,145,000		
2015	1.791	879,000	59,000	72,000	5,070,000		
<b>Required Concentrated Feed</b>							
	(Unit Feed Requirement (kg/head/day))					fed by	fed by
	3.0	2.8	0.3	0.1	Total	By-Product	Grain
<b>Base Scenario- Agricultural Expansion</b>							
2005 (t/year)	822,000	51,000	7,000	158,000	1,038,000	488,000	550,000
2015 (t/yr)	1,057,000	65,000	9,000	203,000	1,334,000	627,000	707,000
<b>Base Scenario- Industrialisation</b>							
2005 (t/year)	944,000	59,000	8,000	181,000	1,192,000	560,000	632,000
2015 (t/yr)	1,385,000	86,000	11,000	266,000	1,748,000	822,000	926,000
<b>Conservative Scenario</b>							
2005 (t/year)	787,000	49,000	6,000	151,000	993,000	467,000	526,000
2015 (t/yr)	963,000	60,000	8,000	185,000	1,216,000	572,000	644,000

(Note)

- 1) Availability of by-product (47%) is discussed in Chapter-2, Section 2.2.2.
- 2) Concentrated feed is considered to prepare only for commercial sector.

## 6.8 Cost and Benefit Estimation of Livestock Development

### 6.8.1 Water Development Cost of Livestock

Livestock breeding requires stable good quality water supply in the dry season. Dispersed water demand occurs because herds of cattle are widely distributed. For this reason, groundwater is the most suitable source. Water supply for cattle breeding is planned using borehole construction, and the cost of water development will take about US\$ 35.75 million for the Base Scenario - Agricultural Expansion, US\$ 40.25 million for the Base Scenario - Industrialisation and US\$ 32.54 million for Conservative Scenario as shown in Table 6-9.

**Table 6-9 Cost of Water Development for Livestock in 2015**

Province	Base Scenario- Agricultural Expansion			Base Scenario- Industrialisation			Conservative Scenario		
	No of B.H	Cost (M'US\$)	Rep. (M'US\$)	No of B.H	Cost (M'US\$)	Rep. (M'US\$)	No of B.H	Cost (M'US\$)	Rep. (M'US\$)
Lusaka	53	1.35	0.82	57	1.45	0.88	49	1.24	0.76
Copperbelt	56	1.42	0.87	62	1.57	0.96	50	1.27	0.78
Central	196	4.98	3.04	199	5.05	3.08	194	4.93	3.01
N/Western	96	2.44	1.49	131	3.33	2.03	75	1.91	1.16
Western	284	7.21	4.4	308	7.82	4.77	260	6.60	4.03
Southern	317	8.05	4.91	327	8.31	5.07	309	7.85	4.79
Luapula	42	1.07	0.65	58	1.47	0.9	33	0.84	0.51
Northern	163	4.14	2.53	218	5.54	3.38	130	3.30	2.02
Eastern	200	5.08	3.1	225	5.72	3.49	180	4.57	2.79
<b>Zambia</b>	<b>1,407</b>	<b>35.74</b>	<b>21.81</b>	<b>1,585</b>	<b>40.26</b>	<b>24.56</b>	<b>1,280</b>	<b>32.51</b>	<b>19.85</b>

(Note) 1) No. of B.H: Number of boreholes, Rep.: Replacement cost

2) Borehole: Capacity = 158 m<sup>3</sup>/day/borehole, Cost = US\$25,400/borehole

3) Replacement Cost: US\$15,500/borehole (pump) in 10 years

4) Above cost includes Engineering Service (10%).

### 6.8.2 Total Development Cost of Livestock

Above costs are only for water development for livestock, total development cost of livestock will be much higher than above costs. Total development cost of livestock has been estimated in very preliminary level as shown in Table 6-10.

**Table 6-10 Total Development Cost of Livestock**

Descriptions	Base Scenario- Agricultural Expansion	Base Scenario- Industrialisation	Conservative Scenario
Cattle Number	4,603,000	5,182,000	4,189,000
Equivalent Cattle Number	1,105,000	1,244,000	1,005,000
<b>Capital Cost (M'US\$)</b>			
Barns & Machinery	4,199.0	4,727.0	3,819.0
Boreholes	32.5	36.6	29.6
<b>Total</b>	<b>4,231.5</b>	<b>4,763.8</b>	<b>3,848.6</b>
Eng. Service (10%)	423.2	476.4	384.9
<b>Total Cost</b>	<b>4,654.7</b>	<b>5,240.2</b>	<b>4,233.5</b>
<b>Replacement (M'US\$)</b>			
Barns & Machinery	470.29	529.45	427.73
Boreholes	21.81	24.56	19.85
<b>Total</b>	<b>492.10</b>	<b>554.01</b>	<b>447.58</b>
<b>O/M Cost (M'US\$/year)</b>	<b>211.58</b>	<b>238.19</b>	<b>192.43</b>

(Note) 1) Livestock barns and machinery are considered to be invested only by commercial sector.

2) Equivalent cattle number is estimated only for commercial sector (assumed at 20%) including other livestock (plus 20%).

Equivalent cattle number =  $0.20 * (1 + 0.20) * \text{Cattle Number} = 0.24 * \text{Cattle Number}$

3) Capital Cost = M'US\$ 0.190/ 50 cattle

Livestock Barns = M'US\$ 0.174/ 50 cattle, Machinery = M'US\$ 0.016/ 50 cattle

4) Replacement cost of barns and machinery's are 11.2% of capital facility cost for 10 years.

5) O/M cost is estimated at 5% of capital facility cost annually.

Total development cost will take about US\$ 4,655 million for the Base Scenario - Agricultural Expansion, US\$ 5,240 million for the Base Scenario - Industrialisation, and US\$ 4,234 million for the Conservative Scenario including all other necessary facilities as shown in Table 6-10.

### 6.8.3 Production Cost and Benefit of Livestock Development

Production cost and benefit are also estimated in very preliminary level as shown in Table 6-11. Production cost and benefit are estimated as total of both traditional and commercial sectors.

**Table 6-11 Production Cost and Benefit of Livestock**

Descriptions	Base Scenario- Agricultural Expansion	Base Scenario- Industrialisation	Conservative Scenario
Population	12,738	14,336	11,589
Cattle Number	4,603,000	5,182,000	4,189,000
Equivalent Cattle Number	5,524,000	6,218,000	5,027,000
Feed (Table 6-8)			
Grain (ton)	707,000	926,000	644,000
Bran (ton)	627,000	822,000	572,000
<b>Production Cost (M'US\$)</b>			
Feed Cost			
Grain	(107.25)	(140.47)	(97.69)
Bran	(14.27)	(18.71)	(13.02)
Total	121.52	159.18	110.71
Labour Cost	66.08	74.39	60.10
Veterinary Cost	16.52	18.60	15.03
Transportation Cost	32.65	36.75	29.71
Total	236.77	288.92	215.55
<b>Benefit (M'US\$)</b>	653.08	735.01	594.17

(Note) 1) Equivalent cattle number is estimated for both sectors including other livestock (plus 20%)

$$\text{Equivalent Cattle Number} = \text{Cattle Number} * 1.20$$

2) Labour = One person/ 50 cattle \* Equivalent Cattle Number

3) Grain Cost = K8,330/90kg = K92,555/ton = US\$151.7/ton

Bran Cost = 15% of Grain Cost = US\$22.76/ton

4) Labour Cost = 365 days/year \* K1,000/day = K365,000 /person/year = US\$598/person/year

5) Veterinary Cost = 25% of Labour Cost, Transportation Cost = 5% of Benefit

6) Benefit = US\$51.27/person \* Total Population

Meat: 14.2kg/person \* K1,500/kg = K21,300

Milk: 13.7lit/person \* K 400/lit = K 5,480

Eggs: 1.8 kg/person \* K2,500/kg = K 4,500

Total K31,280 =US\$51.27/person

Total production costs will be US\$ 236.77 million for the Base Scenario - Agricultural Expansion, US\$ 288.92 million for the Base Scenario - Industrialisation, and US\$ 215.55 million for the Conservative Scenario. Benefits are estimated at US\$ 653.08 million for the Base Scenario - Agricultural Expansion, US\$ 735.01 million for the Base Scenario - Industrialisation, and US\$ 594.17 million for the Conservative Scenario. Economic internal rate of return (EIRR) of livestock development is estimated at 13.3% in the Base Scenario - Agricultural Expansion including all necessary facilities.

## CHAPTER 7 FISHERY DEVELOPMENT

### 7.1 Future Direction and Scope of Fishery Development

#### 7.1.1 General Direction of Fish Supply and Fishery System

##### (1) Target of Fish Supply

As discussed in Chapter 3, the annual fish catch of capture fishery reached 71,793 tons by the year 1994. However, per capita consumption has decreased to 8 kg/year from 12 kg/year due to rapid population increase. Fish production appears to have steadily increased, but fluctuations are observed in specific rivers, reservoirs and lakes. The Fisheries Sub-Programme aims to supply 12 kg/year per capita as a long term target in Agriculture Sector Investment Programme (ASIP). The population is estimated to reach 12.738 million in 2015 for the case of the Base growth projection. In this case, fish demand will increase to about 153,000 tons per year.

Capture fishing is expected to grow, but it seems unlikely to increase markedly. From the trend of past growth, the fish catch will grow linearly and is expected to reach 91,000 tons per year in 2015 by regression analysis. (see Section 3.1.1)

<Estimated Fish Catch in 2015>

$$\text{Fish Catch in 2015} = 984\text{t/yr} \times (2015 - 1965) + 41,832\text{t/yr} = 91,000 \text{ t/yr}$$

From this viewpoint, aqua-culture has to expand to meet the deficit of about 62,000 tons per annum for the Base population growth case.

##### (2) Recommended Aquaculture System

"Livestock Manure Feeding System" is recommended as a suitable aquacultural system for producers in Zambia. This system is easier to introduce and it ensures 2 tons/ha of fish production per year. Therefore, 31,000 ha of fish ponds are required by the year 2015 in case to meet the demands outlined above.

<Recommended Aquaculture System>

- Average Annual Production : 2 tons/ha
- Harvesting : 2 times/yr (1.0 ton/ha per harvest)
- Fry Supply : 2.5 fry/m<sup>2</sup>/supply or 5 fry/ m<sup>2</sup>/yr
- Feeding System : Poultry or Pig Manure
  - Poultry manure : dosing 1 ton / 1-2 weeks / ha, or
  - Pig manure : dosing 6 tons / 1-2 weeks / ha
- Aerating System : not required (natural oxygen dissolution)
- Water Treatment System : not particularly necessary  
drying at least once in 2 to 3 years

Other than above aquacultural system, direct feeding system is also considered for harvesting more than 2 tons/ha. However, temperature is likely needed over 20°C in average through the year for harvesting more than 4 tons/ha. Furthermore, atmospheric pressure is little low for oxygen dissolution under the extensive direct feeding system not

equipped with aerators due to higher altitude of the country. On the other hand, in case of direct feeding system, BOD treatment will be necessary to consider for avoiding BOD pollution. Therefore, in this study, aquaculture is planned as "Livestock Manure Feeding System" from viewpoint of applicability and past experimental research.

### **7.1.2 General Direction of Development Sites and Manure Collection**

#### **(1) Small Scale Development Sites**

Large quantity of manure is required for feeding aquaculture. It requires much labour works to collect manure from widely spread livestock locations, particularly in the rural areas. For this reason, it is recommended that livestock, especially poultry and pigs, are bred together with aquaculture for small scale development.

#### **(2) Large Scale Development Sites**

In the livestock predominant provinces where poultry and pigs are bred in large extent, such as Lusaka, Southern, Central and Eastern Provinces, floodplains should be considered for aquaculture - in particular Kafue Flats. In floodplain areas, large quantities of water are generally evaporating. As it is difficult to reduce this evaporation loss, aquaculture can be recommended to minimise the effects of these losses. However, because aquaculture requires so much manure, it is necessary to take steps to prevent increases in nutrient levels in water that drains to rivers. It is recommended to keep water level in fish pond little lower than river water level in the Kafue Flats, where river water level is fully controlled.

On the other hand, the Luangwa river is recommended to be developed for aquaculture in large scale, because the lands alongside the river are not suitable for cultivation due to heavy texture. Such heavy texture is suitable for developing fish ponds to minimise water losses.

### **7.1.3 Scope of Fishery Development**

#### **(1) Target of Fish Supply**

The annual fish catch of capture fishery reached 71,793 tons by the year 1994. However, per capita consumption has decreased to 8 kg/year from 12 kg/year due to rapid population increase. Fish production appears to have steadily increased, but fluctuations are observed in specific rivers, reservoirs and lakes. The Fisheries Sub-Programme aims to supply 12 kg/year per capita as a long term target in Agriculture Sector Investment Programme (ASIP). The population is estimated to reach 12.738 million in 2015 for the case of the Base Scenario-Agricultural Expansion. In this scenario, fish demand will increase to about 153,000 tons per year.

Capture fishing is expected to grow, but it seems unlikely to increase markedly. From the trend of past growth, the fish catch will grow linearly with an annual increase rate of 984 tons from 66,400 tons in 1990, and is expected to reach 91,000 tons per year in 2015.

From this viewpoint, aquaculture has to expand to meet the deficit of about 62,000 tons per annum for the Base Scenario-Agricultural Expansion.

## (2) Development Policy for Three Scenarios

Target fish supply is set at 12 kg/capita/year for all scenarios. It is almost impossible to increase the supply from 8.61 kg/capita/year in 1993 to 12 kg/capita/year to meet the raised target of consumption by capture fishery alone. Thus, rapid expansion of aqua-culture as well as encouragement of capture fishery, will be necessary. Because of intensive endeavour for promotion and expansion of aqua-culture by the Department of Fishery (DOF) with support of foreign donors, Zambian aqua-culture will expand, even though the industry is only in the initial stage so far. However, first 10 years will be reduced in its increase rate of supply. The target of 2005 will be set at 10kg/capita/yr, and reach final target of 12kg/capita/yr in 2015.

### <Fish Productivity of Aquaculture>

Aqua-culture utilising manure of poultry or pigs is recommended by the DOF for small scale farmers. Productivity in this case is 2 ton/ha/year. In the future, commercial farmers or enterprises will enter into aqua-cultural business. In that case, direct feeding will be the manner of breeding. Even in the latter case, productivity is estimated as 4 ton/ha/year because of low temperature in winter and insufficient oxygen dissolution at high altitude. It is assumed for higher productivity of aquaculture to keep mean temperature over 20°C through the year. However, mean temperature drops lower than 20°C during winter for four months from May to August. In the present plan, productivity of aqua-culture is assumed as 2 ton/ha/year as a conservative projection.

Under the above mentioned conditions and basic development policy, fish supply and demand for respective target years can be estimated as below;

- 1) Domestic fish demand is supposed to be fulfilled with domestic production. Target supply is achieved with capture fishery and aqua-culture. Growth in capture fishery is projected as the current rate.
- 2) Fish consumption is targeted as 10 kg/capita/year in 2005 and 12 kg/capita/year in 2015.

Table 7-1 Projection of Aqua-culture

	Population (1000 persons)	Unit Consumption (kg/capita/year)	Required Production (ton/year)	Capture Fishery (ton/year)	Aqua-culture (ton/year)	Required Ponds for Aqua Culture (ha)	Water Demand (1000 m <sup>3</sup> /day)
<Actual in 1993>	7,969	8.61	68,625	65,151	3,474	1,737	117
Base Scenario- Agricultural Expansion							
- 2005	10,465	10.00	104,700	81,200	23,500	11,750	813
- 2015	12,738	12.00	152,900	91,000	61,900	30,950	2,131
Base Scenario- Industrialisation							
- 2005	10,994	10.00	109,900	81,200	28,700	14,350	996
- 2015	14,336	12.00	172,000	91,000	81,000	40,500	2,793
Conservative Scenario							
- 2005	10,025	10.00	100,300	81,200	19,100	9,550	656
- 2015	11,589	12.00	139,100	91,000	48,100	24,050	1,648

### (3) Value Added (VA) of Fishery Production

Value added (VA) of fishery product has been estimated as shown in Table 7-2 in accordance with the growth of production in each scenario. Value added amounts to maximum of about M'K42,700 in Base Scenario-Industrialisation, to M'K36,900 in Base Scenario-Agricultural Expansion, and to M'K32,800 in Conservative Scenario. The acreage of fish ponds reaches 40,500 ha, 30,950 ha and 24,050 ha respectively.

**Table 7-2 Fish Production and Value Added by Three Scenarios**

Year	1993	1994	1995	2000	2005	2010	2015
<b>Base Scenario- Agricultural Expansion</b>							
Population (million)	7.969	8.164	8.359	9.412	10.465	11.602	12.738
Plan of GVA to 1993	1.000	1.060	1.124	1.504	1.743	2.021	2.313
Consumption (kg/capita/yr)	8.61	9.22	8.84	9.42	10.00	11.00	12.00
Production (tons/yr)	68,625	75,267	73,900	88,700	104,700	127,600	152,900
Capture Fishery	65,151	71,793	71,300	76,200	81,200	86,100	91,000
Aqua-Culture	3,474	3,474	2,600	12,500	23,500	41,500	61,900
GVA (K million) *	14,081.6	15,410.0	15,046.9	19,023.1	23,352.3	29,780.0	36,934.0
GVA to 1993 (%)	1.000	1.094	1.069	1.351	1.658	2.115	2.623
Fish Pond (ha)	1,737	1,737	=====>	6,250	11,750	20,750	30,950
<b>Base Scenario- Industrialisation</b>							
Population (million)	8.012	8.221	8.431	9.713	10.994	12.665	14.336
Plan of GVA ratio to 1993	1.000	1.030	1.060	1.226	1.419	1.642	1.899
Consumption (kg/capita/yr)	8.57	9.16	8.81	9.40	10.00	11.00	12.00
Production (tons/yr)	68,625	75,267	74,300	91,300	109,900	139,300	172,000
Capture Fishery	65,151	71,793	71,300	76,200	81,200	86,100	91,000
Aqua-Culture	3,474	3,474	3,000	15,100	28,700	53,200	81,000
GVA (K million) *	14,081.6	15,410.0	15,168.0	19,810.0	24,926.1	33,321.0	42,714.7
GVA to 1993 (%)	1.000	1.094	1.077	1.407	1.770	2.366	3.033
Fish Pond (ha)	1,737	1,737	=====>	7,550	14,330	26,600	40,500
<b>Conservative Scenario</b>							
Population (million)	7.928	8.109	8.291	9.158	10.025	10.807	11.589
Plan of GVA ratio to 1993	1.000	1.026	1.052	1.176	1.297	1.412	1.521
Consumption (kg/capita/yr)	8.66	9.28	8.88	9.44	10.00	11.00	12.00
Production (tons/yr)	68,625	75,267	73,600	86,500	100,300	118,900	139,100
Capture Fishery	65,151	71,793	71,300	76,200	81,200	86,100	91,000
Aqua-Culture	3,474	3,474	2,300	10,300	19,100	32,800	48,100
GVA (K million) *	14,081.6	15,410.0	14,956.1	18,357.3	22,020.6	27,146.9	32,757.5
GVA to 1993 (%)	1.000	1.094	1.062	1.304	1.564	1.928	2.326
Fish Pond (ha)	1,737	1,737	=====>	5,150	9,350	16,400	24,050

(Note)

1) \*: VA: Capture Fishery = K200,000/ton, Aqua-Culture = K302,650/ton (1993 Constant Price)

3) : actual production

### 7.2 Unit Water Requirement of Fish Ponds

Water requirement of fish ponds has been calculated in each agro-ecological zone based on evapotranspiration and 1 in 5-year drought rainfall as shown in Table 7-3. As shown in Table 7-3, peak water requirement occurs in September in all zones.

The fish ponds are generally located on the river terrace or bank where heavy soils are deposited. Seepage loss from bottom of the fish ponds, therefore, has been excluded from computation, because such seepage loss returns to the river soon after.

**Table 7-3 Potential Water Use of Fish Ponds**

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
<b>Potential Evapotranspiration (mm/day)</b>													
Zone-3	2.8	3.7	3.7	3.9	3.9	3.7	4.0	4.7	5.5	5.4	4.6	3.7	
Zone-2	3.0	3.9	4.0	4.1	3.8	3.5	3.6	4.4	5.6	5.9	5.0	4.1	
Zone-1	3.9	4.6	4.5	4.4	3.9	3.5	3.6	4.7	5.9	6.2	5.7	4.9	
<b>Potential Evapotranspiration (mm/month)</b>													
Zone-3	87	104	115	117	121	111	124	146	165	167	138	115	1,510
Zone-2	93	109	124	123	118	105	112	136	168	183	150	127	1,548
Zone-1	121	129	140	132	121	105	112	146	177	192	171	152	1,698
<b>Water Consumption (ET<sub>o</sub> + Seepage)</b>													
Zone-3	149	160	177	177	183	171	186	208	225	229	198	177	2,240
Zone-2	155	165	186	183	180	165	174	198	228	245	210	189	2,278
Zone-1	183	185	202	192	183	165	174	208	237	254	231	214	2,428
<b>1 in 5 Year Rainfall (mm/month)</b>													
Zone-3	223.6	201.9	197.3	80.1	11.6	1.2	0.3	0.5	5.0	36.0	129.2	241.3	1,128.0
Zone-2	181.3	146.7	87.8	25.2	3.5	0.3	0.0	0.3	1.7	22.5	81.3	183.3	733.9
Zone-1	139.5	120.4	71.8	19.3	4.1	0.5	0.1	0.4	1.9	21.8	61.7	134.6	576.1
<b>Water Requirement (mm/month)</b>													
Zone-3	0.0	0.0	0.0	96.9	171.4	169.8	183.7	207.5	220.0	193.0	68.8	0.0	1,313.1
Zone-2	0.0	18.3	98.2	157.8	176.5	164.7	174.0	197.7	226.3	222.5	128.7	5.7	1,570.4
Zone-1	43.5	64.6	130.2	172.7	178.9	164.5	173.9	207.6	235.1	232.2	169.3	79.4	1,851.9

(Notes)

1) Evapotranspiration and Rainfall are applied as follows;

Zone-3: Chambeshi, Luapula Basin, Zone-2: Kafue-II Basin, Zone-1, Lower Zambezi-I Basin

2) Kc value for fish pond = 1.0 3) Seepage loss is considered as 2.0 mm/day in above table.

However, seepage loss has to be considered for the facility water requirement. Seepage loss is assumed as 2 mm/day based on seepage from paddy fields. Conveyance loss has to be counted both for facility and water resources consumption. Conveyance loss is generally scattered on the ground and mostly evaporated before infiltrating. Conveyance loss is assumed as 20 % for earth lined canals. Application efficiency might be 100 %, because there are no difficulties in supplying water to the fish ponds. Effective rainfall is counted at 100 % because of large capacity to catch rainfall in the fish pond.

In accordance with above considerations, water requirement of fish ponds is calculated as shown in Table 7-4, and can be summarised as below.

<Zone>	Peak Supply Rate		Annual Water Consumption	
	<Facility>	<Water Resources>	<Facility>	<Water Resources>
Zone-III	1.06 lit/s/ha	0.77 lit/s/ha	16,414 m <sup>3</sup> /ha	7,289 m <sup>3</sup> /ha
Zone-II	1.09 lit/s/ha	0.80 lit/s/ha	19,630 m <sup>3</sup> /ha	10,505 m <sup>3</sup> /ha
Zone-I	1.13 lit/s/ha	0.84 lit/s/ha	23,149 m <sup>3</sup> /ha	14,024 m <sup>3</sup> /ha
<Average>	1.09 lit/s/ha	0.80 lit/s/ha	19,731 m <sup>3</sup> /ha	10,606 m <sup>3</sup> /ha

(Note) Details are shown in Table 7-4.

From above results, if water is available, it is more preferable to introduce fish ponds in the northern regions (Zone-III) than in the southern region (Zone-I) to save water resources as



well as operation cost of water. Fish ponds in the southern region consume almost twice the amount of water than those in the northern region (e.g. 14,024 m<sup>3</sup>/ha compared to 7,289 m<sup>3</sup>/ha in water resources basis)

**Table 7-4 Peak and Annual Water Requirement for Fish Ponds**

		Facility Capacity			Water Resources Consumption			
Peak Water Requirement								
	WRp		Peak Irrigation Rate			Peak Irrigation Rate		
	mm/month	mm/day	WRp	Including Con. Loss	Irrigation Rate	WRp	Including Con. Loss	Irrigation Rate
	(1)	(2) = (1)/30	(3) = (2)	(4) = (3)/0.8	(5) (lit/s/ha)	(6) = (2)-2mm	(7) = (6)/0.8	(8) (lit/s/ha)
Zone-III	220.0	7.33	7.33	9.16	1.06	5.33	6.66	0.77
Zone-II	226.3	7.54	7.54	9.43	1.09	5.54	6.93	0.80
Zone-I	235.1	7.84	7.84	9.80	1.13	5.84	7.30	0.84
Annual Water Requirement								
	WRa		Annual Amount			Water Resources Consumption		
	mm/Year	Excluding Seepage	WRa	Including Con. Loss	Irrigation (m <sup>3</sup> /ha/yr)	WRa	Including Con. Loss	Irrigation (m <sup>3</sup> /ha/yr)
	(1)	(2) = (1)-365x2.0	(3) = (1)	(4) = (3)/0.8	(5) = (4)*10	(6) = (2)	(7) = (6)/0.8	(8) = (7)*10
Zone-III	1,313.1	583.1	1,313.1	1,641.4	16,414	583.1	728.9	7,289
Zone-II	1,570.4	840.4	1,570.4	1,963.0	19,630	840.4	1,050.5	10,505
Zone-I	1,851.9	1,121.9	1,851.9	2,314.9	23,149	1,121.9	1,402.4	14,024

(Note) WRp: Peak Water Requirement, WRa: Annual Water Requirement

### 7.3 Aquaculture Development and Water Requirement

#### 7.3.1 Selection of Development Sites

Development sites of aquaculture are selected based on the criteria as shown below:

- Soils are not suitable for irrigation development like heavy texture and poorly drained like Luangwa River (P-70 site) or like acidity in the northern region (P-2 Luswishi, P-43 Samfya State Farm, P-44 Bangweulu West, P-64 Mutale Mokonge, P-66 Chandamali)
- Floodplains, where large evaporation losses are observed, like Kafue Floodplain.
- Edge (locally named Sishanjo) of Zambezi Floodplain where seepage water from plateau can be utilised and somewhat free from flood. Small scale development will be suitable in Sishanjo because seepage water amount is limited.
- Upstream tributaries of Kabompo River, where perennial flow can be expected. However, development scale will be limited less than 100ha at one site due to limitation of flow capacity.

Among above locations, large scale development can be expected at Kafue Floodplain and Luangwa River. Above locations are shown in Figure 5-1.