Results of the first demoplot in Ngarenanyuki

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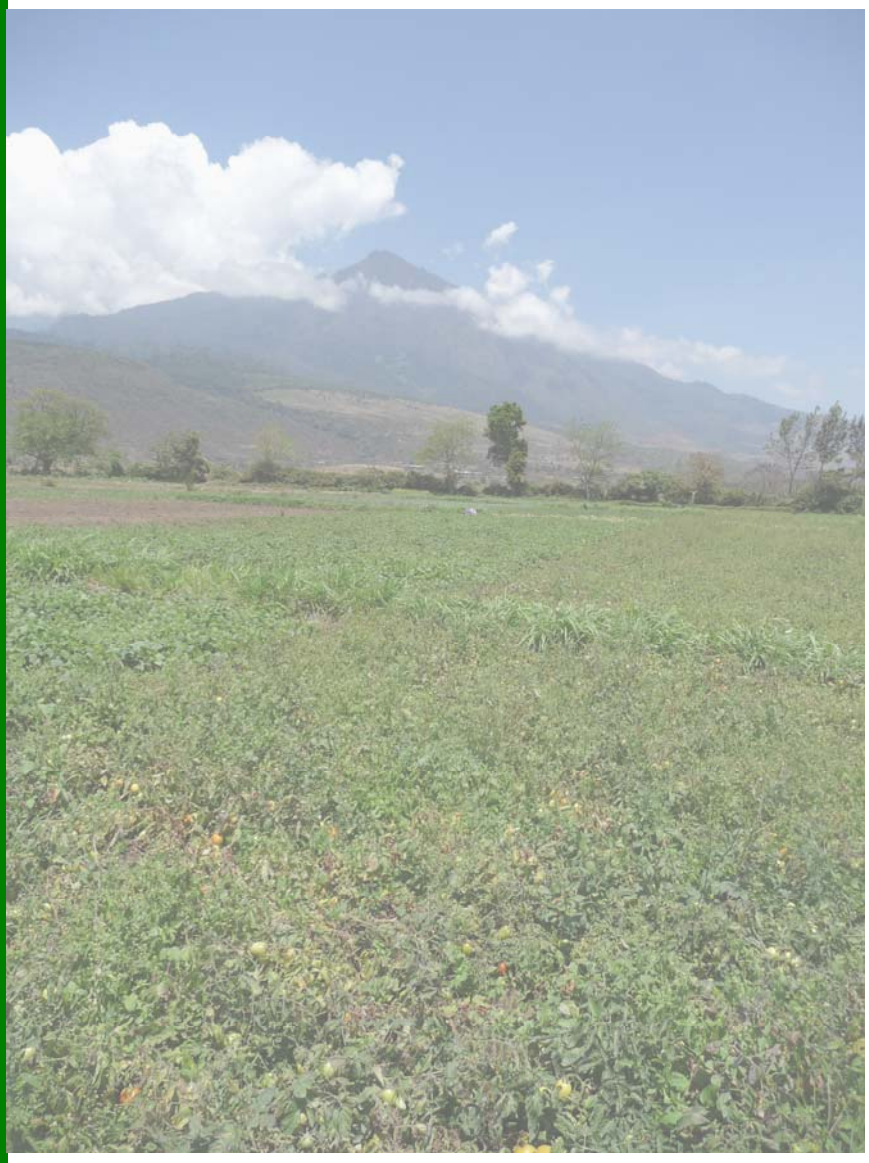
AfriVeg



November 2008 report 6

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1 Introduction

The described activities in this report are part of the BOCI project "Development of commercial field vegetable production, distribution and marketing for the east African 10-006-050-02 and has been started in 2007. The main purpose of this project is to contribute to a vital rural economy of Tanzania and Kenya through the development of effective and integrated field vegetable chains for the domestic and regional market in East Africa.
Tomato is the largest crop in Tanzania acreage and tonnage wise. In 2003 total acreage was 31,913 hectare or 44% of the total fruit and vegetable acreage. Total production was 129,578 ton with average yields of 4 ton per hectare. In terms of production main production areas are Morogoro (17%), Iringa (15%), Kilimanjaro (9%), Tanga (8%), Mwanza (8%), Arusha (6%) and Ruvuma (6%). Estimated is that in the area around Arusha most tomato production takes place at Ngarenanyuki with a total volume of 6400 ton annually.
Ngarenanyuki is a village located north of Arusha national park and is about one hours drive away from Arusha. The area around Ngarenanyuki is dominated by Mount Meru, the second largest mountain of Africa and the production area is situated in a valley between this mountain and Mount Kilimanjaro. Altitude of the area is about 1200 m ASL. The immediately surroundings of Mount Meru consists mainly of sandy soils while more to the north and the west soils are more fertile black and red soils. Along the swamps, bordering the Ngarenanyuki river the soils are saline and contain mainly soda minerals (Na).
The main economic activity of Ngarenanyuki is agriculture, mainly on a small scale base. Mostly tomatoes and onions are grown in the area, but also cabbage, sweet pepper, carrots, Chinese cabbage and banana are grown. On average the farming system is not very reliable and no permanent income is present.
Tomato acreage is estimated at 300 acres with 2 crop cycles annually resulting in a production of approximately 6,000 tons per year. About 80 to 100 farmers are producing tomatoes with an average acreage of 2 to 4 acre per farm for tomato production.
From season to season income varies greatly and depends heavily on farm size and investments in inputs which is hampered due to lack of ready cash. In the area there are farms up to 8 hectares and can sell yearly 2000 crates of tomatoes at a price ranging from 3,000 to 15,000 Tsh. On the other hand small farmers with a maximum of 1 hectare can sell 300 bags at prices base don demand. Content of a crate varies from 36 to 47 kg tomatoes with an average of 42 kg.
Due to mono-cropping, soils are exhausted and poor in nutrients. Because of this farmers have to use a high amount of manure, fertilizers and pesticides to obtain a good yield. In tomato late blight, root knot nematode, aphids, white fly, spider mites and yellow mottle virus are diseases and pests that affect yield levels.
In 2008, with the assistance of Multiflower Ltd., based in Arusha, demo fields on tomato cultivation have been established in Ngarenanyuki, Tanzania. Purpose of these fields was in the first place to show small holders farmers how to improve their tomato production with low cost techniques. In the second place fields were used to collect data on current production techniques and on improved techniques. Results of these fields were communicated to the farmers and they were invited on a regular base to visit the fields to discuss the results and to learn from the results.
In 2007 three farmers groups were identified (see annex I). Per group one practice field was maintained for data collection. At one group also a demo plot on demonstrating the effect of improved starting material and fertilizer use was present. Based on the agronomic results,

registration of inputs and profit calculation conclusions can be drawn on the effects of improved techniques on yield levels and farmers income.

The project will contribute to an improved tomato production in a sustainable way with increased profits. The lay-out of this report is as follows:

1) Reporting on the results of the demoplot on demonstrating the effect of starting material and fertilizer us.
2) Reporting on analyzing profitability of tomato cultivation based on registration of three farmers practice fields.

2 Part I: Demo plot

The demo plot was situated near Ngarenanyuki, a small village situated in the valley between Mount Kilimanjaro and Mount Meru in Northern Tanzania, 80 km north of Arusha (Fig. 1).

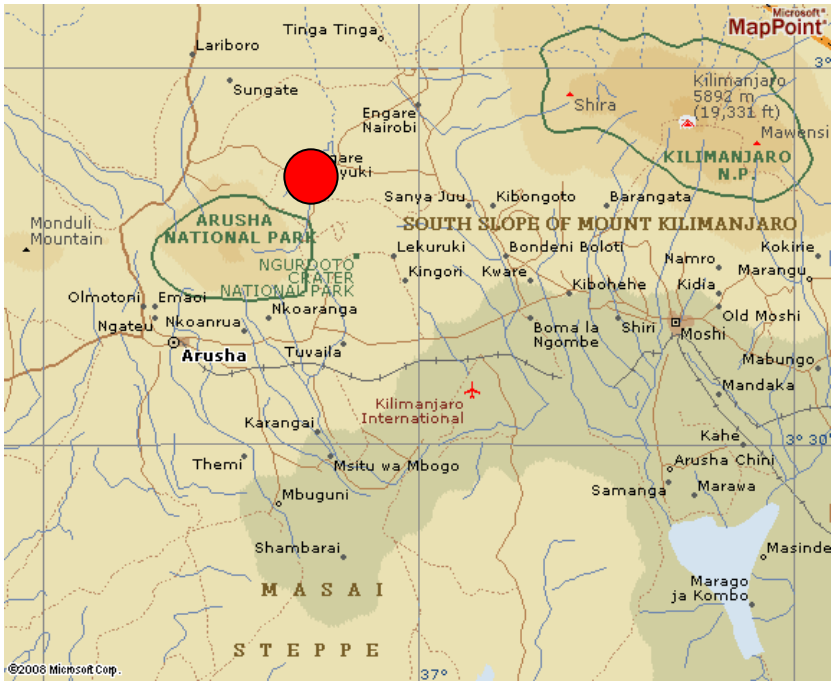


Figure 1. Location of the Ngarenanyuki tomato production area.

The demo field was located at the farm of Semu Kaanya, a farmer experienced in tomato, sweet pepper, hot pepper, beans and maize cultivation. Annually approximately 6 acres in two cycles are cultivated at this farm.

Figure 2. Fields at the slope of Mount Meru.

2.1 Materials and methods

2.1.1 Raising of seedlings

Tomato cv. Onyx was sowed on April 15, 2008 (Table 1). Seeds were sown in a nursery bed next to the production fields.

Three treatments were carried out namely (I) farmers practice, (II) improved practice and (III) improved practice plus insecticide and fungicide drenching (Table 1).

With farmers practice technique, most commonly used in Ngarenanyuki, a nursery bed is prepared and seeds are sown broadcasted in the bed and afterwards mixed through the soil by hand (Fig. 3).

Figure 3. Broadcasting of seeds.

With improved practice a nursery bed is prepared and 30 g/m^2 NPK 17-17-17 fertilizer is added. After incorporating the fertilizer in the soil, lines or rows were drawn with a stick in the bed at a distance of 15 cm between rows. Seeds were placed in rows at a distance varying from 2 to 4 cm (Fig. 4). With improved plus technique at sowing a drench with 1 g/l Ridomil (40g/kg metalaxyl and 640 g/kg mancozeb) and 2 ml/l Thionex) (endosulfan 350g/l) was applied at a rate of 0.5 liter spray mix per m^2 nursery. A drench with Ridomil was applied again 3 days after emergence in the nursery and in the field immediately after transplanting.

Figure 4. Sowing in rows.

At the same time at three farmers, Jackson, Semu and Saanya also seeds of the same tomato variety were sown and raised (Table 1). Jackson and Semu sowed seeds in nursery beds according to the improved practice while Saanya raised his seedlings according farmers practice.

Table 1. Starting material raising treatments.

Treatment	Sowing date	Amount of seeds	Method	Location
I	April 15	17 g	broadcasted	Semu (raised by APR-WUR)
II	April 15	4 g	in rows	Semu (raised by APR-WUR)
III	April 15	4 g	in rows plus drenching	Semu (raised by APR-WUR)
IV	April 15	100 g	in rows	Jackson
V	April 15	100 g	in rows	Semu
VI	April 15	100 g	broadcasted	Saanya

2.1.2 Cultivation

Transplanting took place on May 23, 2008. treatments were tested in four replications on plots of 3 x 4.2 m, each plot consisting of 35 plants.
At transplanting seedlings were lifted out of the nursery bed by using a knife and transported to the field. One day before transplanting, on May 22 the field was flooded and ploughed (Fig. 5).
After transplanting, irrigation was frequently applied as flood irrigation. Crop protection was carried out as common practice.

Figure 5. Field before irrigation and ploughing.

2.1.3 Fertilization

Common practice is to apply two times fertilizer with 20 gram per plant with either NPK 17-17-7, Calcium ammonium nitrate or urea. With a plant arrangement of 60 x 60 cm this means that per hectare two times 555.6 kg fertilizer is applied.

In this experiment two fertilizer strategies were compared:

A: Common practice

- 20 g Calcium ammonium nitrate per plant 2 weeks after transplanting. Applied around the plant and not incorporated in the soil. (150 kg/ha N)
- Polyfeed or Easy grow 19-19-19 applied together with crop protection

B: Improved strategy

- At transplanting:
  - 0.4 kg/plant farm yard manure incorporated in plant hole (10 ton/ha)
  - 20 g/plant Triple super phosphate incorporated in bed just before planting. (250 kg/ha P_2O_5)
- 10 days after transplanting:
  - 20 g/plant NPK 17-17-17 placed at 10 cm from stem and incorporated in soil. (94 kg/ha N, 94 kg/ha P_2O5 and 94 kg/ha K_2O)
- At visible stage of flower buds:
  - 20 g/plant Calcium ammonium nitrate placed at 20-30 cm from stem and incorporated in soil. (150 kg/ha N)
- At fruit set:
  - 20 g/plant NPK 17-17-17 placed at 10 cm from stem and incorporated in soil. (94 kg/ha N, 94 kg/ha P_2O5 and 94 kg/ha K_2O)
- Polyfeed or Easy grow 19-19-19 applied together with crop protection

2.1.4 Harvesting

Harvest took place on August 27, October 3 and October 10. Only red and marketable fruits were picked per harvest date.

Figure 6. Situation a the demo field at harvest.

2.1.5 Observations

Climate

Near to the field a rain gauge and thermometer with minimum and maximum reading was placed (fig. 7). Each day the rainfall was observed at 8.00 a.m. and minimum and maximum temperature was recorded at 12.00 a.m.

Figure 7. Simple rain gauge used to record daily rainfall.

Soil characteristics

On April 14 a soil sample was taken at the field and analyzed in the Netherlands at BLGG a laboratory specialized in analyzing soil samples. On May 21 a second sample was taken after land preparation but before transplanting and analyzed at the Selian Agricultural Research Institute (SARI) based in Arusha, Tanzania. K, Mg, Ca and pH of both samples were analyzed. Total N was only analyzed in Tanzania while phosphate (P) was only analyzed at BLGG.

Percentage seedlings and density

In the nursery, number of transplants was observed and percentage of seedlings was calculated as number of seedlings present at transplanting divided by the number of sowed seeds times hundred.. With improved technique where seeds were sown in rows, per each meter bed one row was randomly selected and all seedlings present in this row were counted. Total number of rows in a nursery bed was observed and dimensions of the nursery bed were also measured. An average number of seedlings per square meter was calculated by multiplying the average number of seedlings per row times the total number of rows present in the nursery bed divided by the surface in square meters of the total nursery bed. At broadcast sowing, per meter bed a surface of 20 x 20 cm was randomly selected and the number of tomato seedlings in this surface present was counted. Total surface of the nursery bed was established and the average number of seedlings per square meter was also calculated.

Cultivation

During cultivation all inputs, material and labor, and costs were recorded.

Harvest

Total marketable yield in kg per plot was recorded. Based on the surface of the plot and the yield in kg, yield per 1000 m^2 was calculated.

2.2 Results

2.2.1 Climate

In figure 8 rainfall, daily minimum and maximum temperature are shown. From June onwards the temperature dropped to 10 – 15°C which is below optimum growing conditions for tomato. Optimum temperatures are night temperatures ranging from 16 to 20 degrees where at temperatures below 12 degrees irreversible damage to flowers and fruits can occur. Optimum daily temperatures are 25 to 35 degrees. During the cultivation only at the start some rainfall was present. From June onwards no rainfall was observed anymore.

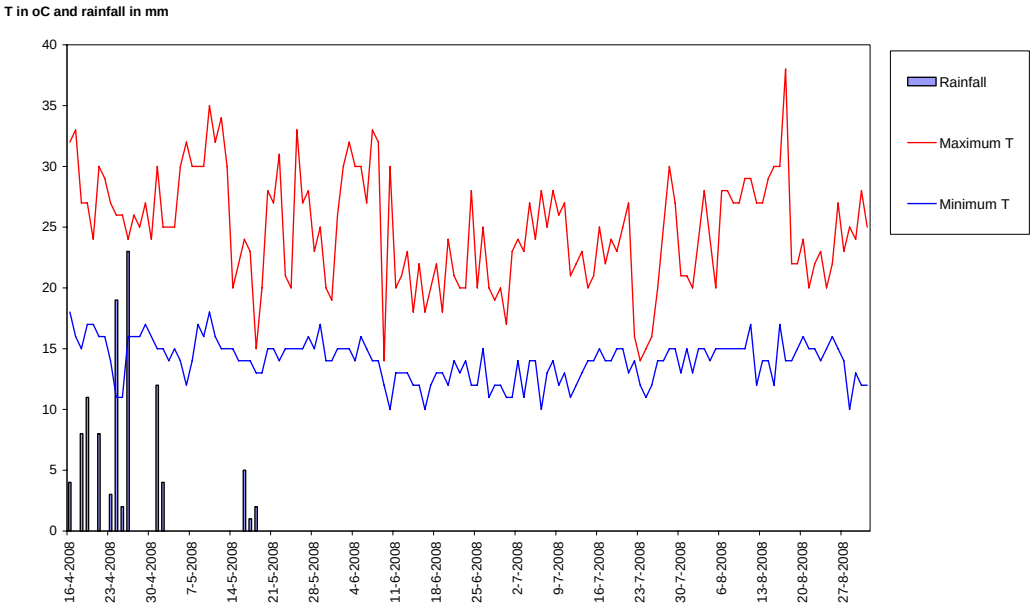


Figure 8. Rainfall, maximum and minimum temperature recorded near the field at Semu's farm.

2.2.2 Soil characteristics

Results from the BLGG analyze were presented in mg per kg soil while the results from the analysis by SARI were presented in meq per 100 kg soil (Table 2). To compare both results with each other, the SARI results were converted to mg per kg soil as well. Potassium (K) was at the BLGG analyze significant lower compared to the SARI result. However, the BLGG result for potassium is already considered as very high and for vegetable cultivation no additional potassium fertilizer application is recommended.

For phosphate the result seems to be sufficient and only a low amount of phosphate fertilizer is recommended to compensate for the uptake by the crop. Due to the high pH uptake of phosphate can be limited.

Nitrogen was only analyzed on total N, but even this total content on nitrogen was very low and nitrogen fertilizer needs to be applied at rates necessary to compensate for the total need of the crop plus additional rates to compensate for losses.

Table 2. Nutrient content of the soil.

	BLGG		SARI			
	result	unit	result	unit	result	converted unit
N total	-		0.39	%	16.6	kg/ha
P	3.0	mg/kg	-		-	
K	515	mg/kg	5.34	Meg/100 g soil	1099	mg/kg
Mg	171	mg/kg	2.52	Meg/100 g soil	159	mg/kg
Na	641	mg/kg	4.00	Meg/100 g soil	484	mg/kg
pH	7.6	pH-KCl	9.0			
Org. content	2.6	%	1.87	%		
Ca	0.2	% CaCO3	5.51	Meg/100 g soil	0.06	%

Result of pH is quite high at the SARI analyze and also the BLGG result indicates a high pH. In combination with a low to medium level organic content, the pH is considered high and advised is to apply fertilizers able to lower the pH. Advisable is not to use urea or calcium ammonium nitrate but ammonium sulphate instead. With this high pH level expected is that the efficiency of urea is limited.

2.2.3 Nursery

Percentage of present seedlings at the farmers' nurseries was quite lower compared to the experimental nursery where three different methods were compared (Table 3). At the farmers practice nurseries, percentage varied from 25 to 55%. While at the nursery maintained by APR-WUR a percentage of more then 70% was present. Percentage was higher at the seedlings sowed in rows (IFP) compared to the broadcasting (FP). When sowing in rows, 15% more seedlings were present compared to broadcasting. Drenching with Ridomil Gold (metalaxyl and mancozeb) and Thionex (endosulfan) at treatment IFP + did not result in a higher emergence compared to the treatment without drenching.

Table 3. Plant density and emergence at different nurseries.

	surface	seeds		plants per square meter nursery				% seedlings
Nursery	(m^2)	gram	amount	minimum	maximum	difference	average	
FP	2.7	17	5414	850	1875	1025	1475	71.8
IFP -	2.7	4	1178	311	415	104	366	83.0
IFP +	2.7	4	1274	289	448	159	360	78.6
Jackson	15.4	100	31847	800	1190	390	1018	49.1
Saanya	24.3	100	31847	356	1072	716	714	54.5
Semu	24.3	100	31847	189	433	244	314	25.8

In the farmers' nurseries and the farmers practice treatment at the APR-WUR nursery plant density was 700 of 1400 seedlings per square meter. Due to the low emergence plant density at Semu's nursery was lower. When taken into account the number of sowed seeds and a possible emergence of 50% at this nursery the density would be approximately 600. With a plant density of 1000 seedlings per square meter one seedling has on average a surface of 10 cm^2 for growing. This space seems to be limited for the needed growing period of the seedlings in the nursery. With sowing in rows at Jackson's nursery a lower density as compared to FP nursery was present but due to the arrangement in lines seedlings were growing to close to each other. Better would be to narrow the distance between the liens and use a greater distance within a row between seedlings.

Figure 9. **Nursery at Saanya's farm, with broadcasting irregular emergence, and no uniform seedlings.**

Figure 10. **Nursery at Jackson's farm, sowing in rows but at a high density within a row.**

Figure 11. Sowing in lines but at a high density results in tall weak seedlings vulnerable to diseases.

Sowing at lower densities around 300 – 400 seedlings per square meter resulted in better quality seedlings (Figure 12). However, agronomically and economically a higher density, but with a different plant arrangement then currently is used, might be possible where good quality seedlings can be raised still and where less land is needed for raising seedlings.

Figure 12. Sowing in lines at low density results in good uniform sturdy seedlings.

2.2.4 Harvest

Harvest took place on August 28, September 3 and September 10, 2008. Marketable tomatoes were harvested and weighed in kilogram.

With improved fertilizer strategy an increase in yield of more then 60% was obtained (Table 4). Origin of seedlings and method of seedling raising did not result in different yield levels.

However, yield levels were in general low in this experiment, since, according to farmers and agronomic experts, in the area a yield of 250 crates per acre or 2.2 kg per m^2 is possible under normal conditions.

Table 4. Tomato yield in kg/m^2.

Nursery	Fertilizer strategy		
	Improved	Common practice	Average p nursery = 0.7 LSD = 0.06
Broadcasted (APR-WUR)	0.73	0.53	0.63
In rows (APR-WUR)	0.81	0.48	0.64
In rows plus drenching (APR-WUR)	0.80	0.42	0.61
In rows (Jackson)	0.79	0.42	0.61
Broadcasted (Saanya)	0.81	0.42	0.62
In rows (Semu)	0.75	0.44	0.60
Average	0.78	0.45	0.62
p fertilizer = <0.001 LSD = 0.04			

Figure 13. Packing of tomatoes in crates.

Figure 14. Harvest of tomatoes.

2.2.5 Profitability of fertilizer treatment

During the cultivation all inputs were recorded for the nursery strategies and fertilizer strategies and production costs were calculated for a surface of 1000 m^2 (Table 5). Taking into account that 2,778 seedlings per 1000 m^2 are needed, the amount of required seeds was calculated based on the percentage of present seedling observed in the nursery for farmers practice. At the time of the observations for this report, tomato price was 3,000 Tsh per crate at the Kilombera market at Arusha. At Mombasa the price was currently 9,000 Tsh per crate, but farmers were not exporting to Mombasa at that moment, since this price was too low to cover for the costs of production and transport.

Overall result shows that the profit of tomato cultivation in the observed period was negative (Table 5 an 6). This was mainly caused by the low yield levels combined with the low tomato market prices. In this case it is difficult to compare the positive effect of fertilizer on yield expressed in terms of profit. Therefore only results for the farmers practice treatment for raising seedlings is presented. Also because differences between starting material in terms of field production was absent. The main effect of different raising methods was on percentage seedlings. After selection of the best seedlings no effect on yield could be found.

To compare techniques on profitability still, decided was to perform a calculation based on an assumed yield of 250 crates per a farm gate price of 10,000 Tsh per crate. Based on agronomic experts and farmers these figures are realistic.

Table 5. Profitability calculation in Tsh for Farmers practice with common practice fertilizer strategy per 1000 m² (approximately ¼ acre).

		volume	unit	unit price	amount	
Gross profit (a)						
Yield	week 35	4.1	crates	3,000	12,300	
	week 36	4.0	crates	3,000	12,000	
	week 37	4.4	crates	3,000	13,200	
	Total	12.5				**37,500**
Production costs						
	seeds	11.6	g	160	1,856	**1,856**
Fertilization						
	CAN	32	kg	1,200	38,400	
	Easy grow	0.4	l	6,500	2,600	
						41,000
Crop protection						
	Farmerzeb(Mancozeb)	0.6	kg	10,000	6,000	
	Bayleton	0.18	kg	24,000	4,320	
	Dynamec	0.2	l	120,000	28,800	
	Thionex	0.3	l	12,000	3,480	
	Deltra	0.2	l	15,000	3,600	
	Ridomil	0.1	l	10,000	1,200	
						47,400
labor						
	Sowing	0.1	day	2,000	200	
	Nursery watering	2.3	day	2,000	4,600	
	Chemical application	2.4	x200ltr	2,000	4,800	
	Irrigation	8	1000 m²	1,235	9,877	
	Transplanting	1	1000 m²	4,938	4,938	
	Fertilizer application	1	1000 m²	4,938	4,938	
	Weeding	2	1000 m²	6,173	12,346	
	Picking	12.5	crates	400	5,000	
						46,699
crates		12.5	crates	1,200	15,000	**15,000**
Total production costs (b)						**151,955**
Net profit (a-b)						**-114,455**

Table 6. Profitability calculation in Tsh for Farmers practice with improved practice fertilizer strategy per 1000 m² (approximately ¼ acre).

		volume	unit	unit price	amount	
Gross profit (a)						
Yield	week 35	5.6	crates	3,000	16,800	
	week 36	5.6	crates	3,000	16,800	
	week 37	6.2	crates	3,000	18,600	
	Total	17.4				**52,200**
Production costs						
	seeds	11.6	g	160	1,856	**1,856**
Fertilization						
	Manure	2	ton	20,000	40,000	
	TSP	56	kg	1,015	56,333	
	NPK17-17-17	111	kg	1,100	122,100	
	CAN	56	kg	1,200	66,600	
	Easy grow	0.4	l	6,500	2,600	
						287,633
Crop protection						
	Farmerzeb(Mancozeb)	0.6	kg	10,000	6,000	
	Bayleton	0.18	kg	24,000	4,320	
	Dynamec	0.2	l	120,000	28,800	
	Thionex	0.3	l	12,000	3,480	
	Deltra	0.2	l	15,000	3,600	
	Ridomil	0.1	l	10,000	1,200	
						47,400
labour						
	Sowing	0.1	day	2,000	200	
	Nursery watering	2.3	day	2,000	4,600	
	Chemical application	2.4	x200ltr	2,000	4,800	
	Irrigation	8	1000 m²	1,235	9,877	
	Transplanting	1	1000 m²	4,938	4,938	
	Fertilizer application	4	1000 m²	4,938	19,753	
	Weeding	2	1000 m²	6,173	12,346	
	Picking	17.4	crates	400	6,960	
						63,474
crates		17.4	crates	1,200	20,880	**20,880**
Total production costs (b)						**421,242**
Net profit (a-b)						**-369,042**

A calculation was then made where a yield level of 250 crates was present but inputs were kept the same as been applied in the experiment since with the same amount of inputs this would be possible. Based on these assumptions production costs will be 2,128 Tsh per crate at the commonly used fertilizer strategy. When comparing this with the improved strategy with also a yield of 250 crates per acre, production costs per crate is for the improved strategy quite higher

(Table 7). However, one can expect a higher yield with this strategy and this will compensate for the higher input costs.
When performing a calculation where per crate a price of 10,000 Tsh is paid, with the improved strategy the yield need to be 330 crates or approximately 15 ton in order to obtain a same profit as is calculated for the common strategy with a yield of 250 crates. This means that with the improved strategy the yield increase should be 32% higher as compared to the common strategy. With the improved strategy a total of 335 kg/ha N was applied while with the common strategy only 83 kg/ha was applied. Advised is to apply about 200 kg per hectare. With the common strategy only 40% of the recommended rate is applied while with the improved strategy 170% of the recommended rate is applied. Fertilizer strategy needs to b optimized still in order to apply a right amount and at the same time obtain a higher profit with also higher input costs. Based on that and on the fact that with improved strategy a significant increase in yield is possible it seems still worthwhile to further investigate the effect of fertilizer amount on yield and profit.

Table 7. Total costs per kg or crate produced tomato in Tsh per fertilizer strategy with a set production of 26 ton/ha or 250 crates/acre.

	Improved strategy		Common strategy	
	per kg	per crate	per kg	per crate
Production costs at 26 ton/ha or 250 crates/acre minus harvesting and packing costs	134.6	5,654	50.3	2,111
Other costs				
Harvesting costs	8.9	400	8.9	400
Packing costs (crates)	26.7	1,200	26.7	1,200
Transport costs per crate	81.0	3,636	81.0	3,636
Custom duties	10.1	455	10.1	455
Broker fee	20.0	900	20.0	900
Total other costs	146.5	6,591	146.5	6,591
TOTAL costs per kg or crate	281.1	12,245	196.8	8,702

3 Part II: Farmers practice fields

3.1 General information

Farmers practice fields were located at the farms of Jackson Lema, Saanya Kaanankira and Semu Kaaya (Table 8). Acreage of tomato production at each farm is respectively 2, 5 and 6 acres annually. All farmers grow tomatoes in 2 cycles per year and beside tomatoes, they grow beans, maize and hot pepper.

Table 8. General information on farmers' fields.

Location :	Ngarenanyuki			
Crop :	Tomato			
Variety:	Onyx			
Amount of seeds sown :	100	gram or	33,333	seeds
Sowing date :	15-Apr-08			
Transplanting date :	26-May-08			
	Jackson Lema	Saanya Kaanankira	Semu Kaaya	
Harvest date start:	28-Aug-08	20-Sep-08	26-Aug-08	
Harvest date end:	5-Oct-08	16-Oct-08	9-Sep-08	
Growing days:	132	141	106	days
Area Transplanted :	1400	1710	3201	m^2
Total plants	15540	4755	8900	plants
Planting distance:	30 x360	60 x 60	60 x 60	cm
Plants per m^2:	11.1	2.78	2.78	plants

At the three farms data was collected regarding all inputs, used materials and labor, of one tomato production field. Surface of observed tomato fields ranged from 0.31 till 0.79 acres. Based on these records for comparison, profit was calculated per acre and use of inputs was analyzed. For comparison all three farmers used the same variety Onyx and started sowing on the same day as well.

Figure 15. Production field of Jackson Lema.

Figure 16. Production field of Saanya Kaanankira.

3.2 Results

3.2.1 Climate

In the cultivation period low temperatures were observed in July (Fig. 8, 17 and 18). At Semu's and Saanya's farm about similar recordings were present for temperature and rainfall. At Jackson's farm more rainfall was observed in April and minimum temperature was from May onwards constantly lower hen 15°C. Maximum temperature is higher compared to that recorded at the two other farms. Not known is whether the reading was taken in a proper way, and if the device is still functioning properly.

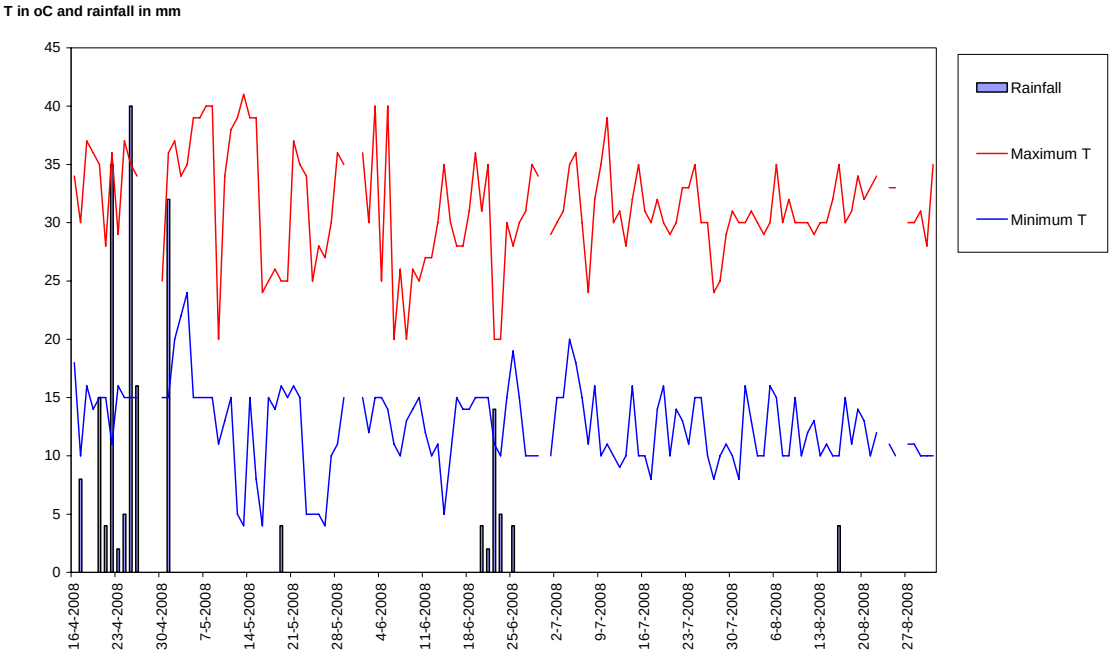


Figure 17. Climate at Jackson's farm.

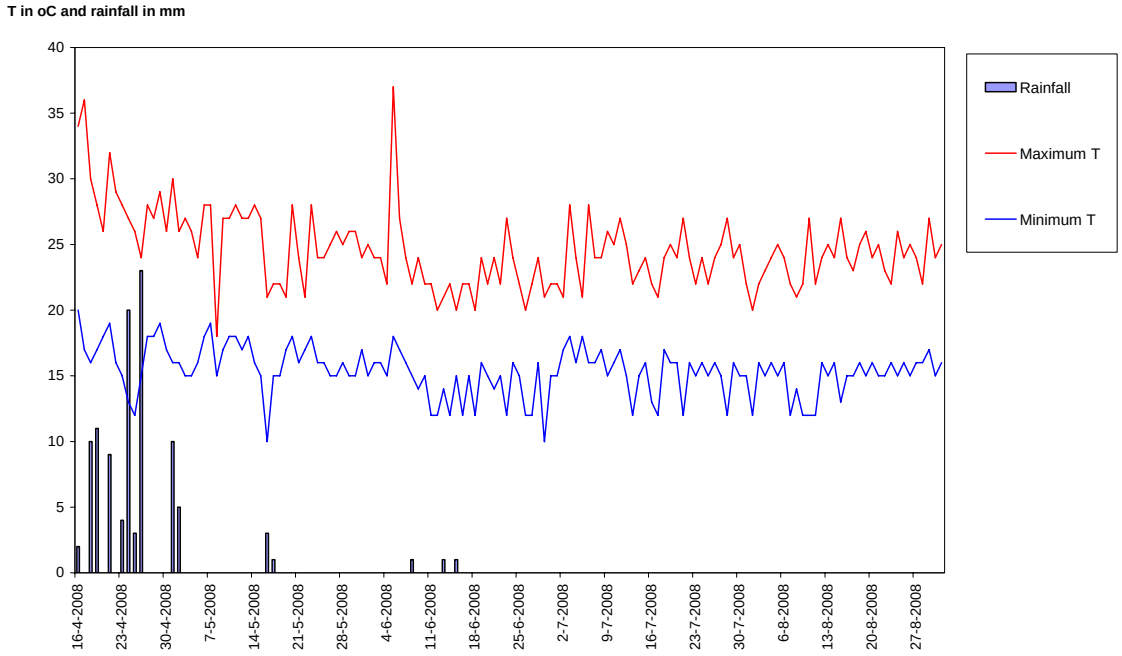


Figure 18. Climate at Saanya's farm.

3.2.2 Profitability

Laborers are mostly paid per activity and only for sowing and harvesting they receive daily wages. For crop protection laborers are paid 2,000 Tsh per each 200 liter spray mixture applied on the crop. This is the volume that fits in one drum where the pesticide is prepared for applying to the crop. Applied volume therefore does not depend on the plot size but merely on the available prepared spray mixture. This means that volume in liters per hectare applied can vary from grower to grower and related to this also the rate of applied pesticide per hectare.

Irrigation, weeding, fertilizing and transplanting is paid in shilling per acre. For harvesting tomatoes, wages are paid per harvested crate. In Annex III prices of all inputs are presented.

Due to the low temperatures yield levels were lower compared to a normal production of 250 crates per acre (Table 9, 10 and 11). Yield levels at Jacksons' farm were somewhat lower. At Semu's farm yield levels were quite lower then the average possible yield of 250 crates.

Tomato prices were also low in the recorded period. Due to heavy competition tomatoes were at that time not exported to the Mombasa market but sold at the local Kilombera market in Arusha for prices around Tsh 3,000 per crate.

Table 9. Profit calculation of tomato production at Jackson's farm per acre based on a production of 0.35 acre.

		volume	unit	unit price	amount	
Gross profit (a)						
Yield	week 37	31	crates	3,000	93,000	
	week 38	89	crates	3,000	265,800	
	week 39	51	crates	3,000	154,200	
	week 40	29	crates	3,000	85,800	
	Total	200			598,800	**598,800**
Production costs						
	Seeds (Onyx OP)	290	g	160	46,400	**46,400**
Fertilization						
	N-P-K 17-17-17	60	kg	1,100	66,000	
	UREA	145	kg	1,300	188,500	
	Easy grow	8.7	l	6,500	56,550	
						311,050
Crop protection						
	Farmerzeb(Mancozeb)	14.5	kg	12,000	174,000	
	Abamectine	0.58	l	120,000	69,600	
	Selecron	11.6	l	15,000	174,000	
						417,600
Labor						
	Sowing	0.5	day	2,000	1,000	
	Nursery watering	10	day	2,000	20,000	
	Chemical application	37	x200ltr	2,000	74,000	
	Irrigation	8	acre	5,000	40,000	
	Transplanting	1	acre	20,000	20,000	
	Fertilizer application	2	acre	20,000	40,000	
	Weeding	2	acre	25,000	50,000	
	Picking	200	crates	400	79,840	
						303,840
Crates		200	crates	1,200	239,520	**239,520**
Total production costs (b)						**1,318,410**
Net profit (a-b)						**-795,610**

Table 10. Profit calculation of tomato production at Saanya's farm per acre based on a production of 0.42 acres.

		volume	unit	unit price	amount	
Gross profit (a)						
Yield	week 39	66	crates	3,000	198,000	
	week 40	33	crates	3,000	99,000	
	week 41	30	crates	3,000	90,000	
	week 42	4	crates	3,001	12,004	
	Total	133				**399,004**
Production costs						
	Seeds	240	g	160	38,400	**38,400**
Fertilization						
	NPK (17-17-17)	120	kg	1,100	132,000	
	CAN	120	kg	1,200	144,000	
	Easy grow	2.4	l	6,000	14,400	
						290,400
Crop protection						
	Farmerzeb(Mancozeb)	5	kg	10,000	50,000	
	Bayleton	0.36	kg	24,000	8,640	
	Abamectine	0.2	l	120,000	24,000	
	Selecron	1.5	l	15,000	22,500	
						105,140
Labor						
	Sowing	0.5	day	2,000	1,000	
	Nursery watering	10	day	2,000	20,000	
	Chemical application	10	x200ltr	2,000	19,000	
	Irrigation (7 times)	7	acre	2,000	14,000	
	Transplanting	1	acre	20,000	20,000	
	Fertilizer application (2x)	2	acre	20,000	40,000	
	Weeding(2x)	2	acre	25,000	50,000	
	Picking	133	crates	400	53,200	
						217,200
Crates		133	crates	1,200	154,800	**159,600**
Total production costs (b)						**810,740**
Net profit (a-b)						**-411,736**

Table 11. Profit calculation of tomato production at Semu's farm per acre based on a production of 0.79 acre.

		volume	unit	unit price	amount	
Gros proffit (a)						
Yield	week 35	11	crates	3,000	33,000	
	week 36	18	crates	3,000	54,000	
	week 37	23	crates	3,000	69,000	
	Total	52				**156,000**
Production costs						
	seeds	170	g	160	27,200	**27,200**
Fertilisation						
	CAN	102.0	kg	1,200	122,400	
	Easy grow	1.4	l	6,500	9,100	
						131,500
Crop protection						
	Farmerzeb(Mancozeb)	1.7	kg	10,000	17,000	
	Bayleton	0.9	kg	24,000	21,600	
	Dynamec	0.6	l	120,000	72,000	
	Thionex	0.8	l	12,000	9,600	
	Deltra	0.6	l	15,000	9,000	
	Ridomil	0.6	l	10,000	6,000	
						135,200
labour						
	Sowing	0.5	day	2,000	1,000	
	Nursery watering	10	day	2,000	20,000	
	Chemical application	10	x200ltr	2,000	20,000	
	Irrigation	8	acre	5,000	40,000	
	Transplanting	1	acre	20,000	20,000	
	Fertilizer application	1	acre	20,000	20,000	
	Weeding	2	acre	25,000	50,000	
	Picking	52	crates	400	20,800	
						191,800
crates		52	crates	1,200	62,400	**62,400**
Total production costs (b)						**548,100**
Net profit (a-b)						**-392,100**

Based on an assumed average yield of 250 crates per acre, production costs ranged from 785,930 Tsh till 1,318,410 Tsh per acre (approximately 2,200 euro per hectare) (Table 12). The highest share in production costs were the purchase costs of crates for packing. Labor had on average the second highest share in the production costs followed by fertilizer use and crop protection. Seed costs were about 3 % of total production costs.

Table 12. Total production costs in Tsh per farm and share of different items based on an assumed production of 250 crates per acre.

	Jackson	Saanya	Semu
Total production costs	1,318,410	997,940	785,930
Seeds	3.3	3.8	2.6
Fertilizer	22.2	29.1	11.5
Crop protection	29.8	10.5	13.2
Labor	23.2	26.5	34.5
Crates	21.4	30.1	38.2

Usually farmers are selling their tomatoes at the Mombasa market, but only in the period from November to April when prices are fair.
For export to Mombasa a truck for transport need to be hired and the rent is Tsh 800,000 per truck of 220 crates. For custom duty per truck an amount of 100,000 Tsh has to be paid. Finally at the market a broker fee of 900 Tsh per crate needs to be paid. It means that total costs per crate are Tsh 4,990 for transport and marketing. Price of an empty crate is 1,200 Tsh and in the case of cultivation where under normal conditions a yield of 250 per acre is a normal average and with inputs comparable to Semu's farm, total costs (cultivation, harvesting and transport) per crate are 8,135 Tsh (Table 13). This means that the minimum price at the Mombasa market needs to be as high as 8,135 Tsh per crate to break even. For the local market the farm gate price needs to be minimal 3,144 Tsh per crate (cultivation costs + harvesting costs + crate costs) at a production of 250 crates per acre.

Table 13. Costs in Tsh per crate for export to Mombasa at a production of 250 crates per acre.

Item	Jackson	Saanya	Semu
Cultivation cost per crate exclusive harvest costs	3,996	2,392	1,860
Harvest costs per crate	400	400	400
Cost of the crate	1,200	1,200	1,200
Transport (800,000 per truck of 220 crates)	3,636	3,636	3,636
Custom duty (100,000 per 220 crates)	455	455	455
Broker fee per crate	900	900	900
Total costs	10,587	8,983	8,451

With lower yields per acre a higher price is required (Table 14). With an average yield of 250 crates per acre prices at farm gate should be at least 3,460 Tsh in Semu's case and with a yield level of only 150 crates (or 15.6 ton/ha) a minimum farm gate price of at least 4,700 Tsh per crate has to be obtained in order to break even. In Semu's case witth a yield of 150 crates Mombasa market price needs to be at least 9,691 Tsh per crate. For the other farmers minimum prices should be even higher then this (Table 14).

Table 14. Break even price (in Tsh per crate) at different yield levels for Mombasa market and Arusha market (farm gate collection).

Market	yield (crates/acre)	Jackson	Saanya	Semu
Arusha	300	4,931	3,594	3,150
	250	5,597	3,992	3,460
	200	6,596	4,570	3,925
	150	8,261	5,587	4,700
Mombasa	300	9,922	8,585	8,141
	250	10,588	8,983	8,451
	200	11,587	9,581	8,916
	150	13,252	10,578	9,691

However, when prices are good and yield levels are average profits can be as high as 5,387,343 Tsh per acre (or 9,000 euro per hectare) (Table 15).

Table 15. Profit of tomato production in Tsh per acre at an assumed yield of 250 crates per acre.

Market	Market price (Tsh per crate)	Jackson	Saanya	Semu
Mombasa	30,000	4,853,223	5,254,333	5,387,373
Arusha	20,000	3,600,950	4,002,060	4,135,100

3.2.3 Fertilizer and pesticide use

For fertilization differences between inputs per farmer exist. Per acre Semu applied the lowest amount of fertilizer with a total amount of only 18.2 kg/acre or 45 kg/ha N. Seeing that nitrogen recommendations for tomato are ranging from 180 to 200 kg nitrogen per hectare this amount is extremely low. A total amount of 51.6 kg/acre or 127 kg/ha N was applied by Saanya. While Jackson applied in total 76.9 kg/acre or 190 kg/ha N.

Table 16. Pesticide use at Jackson's farm.

Date	Volume water/ ha	Pesticide	Rate per liter	Rate per hectare
31 May	1429	Selecron	2.5 ml	3.6 l
		Farmerzeb	5 g	7.1 kg
21 June	1429	Selecron	2.5 ml	3.6 l
		Farmerzeb	5 g	7.1 kg
12 July	2857	Abamectin	0.5 ml	1.4 l
26 July	4286	Selecron	1.7 ml	7.1 l
		Farmerzeb	3.3 g	14.3 kg
9 August	4286	Selecron	1.7 ml	7.1 l
		Farmerzeb	1.7 g	7.1 kg
19 August	4286	Selecron	1.7 ml	7.1 l
Total use		Selecron		28.5 l
		Farmerzeb		35.7 kg
		Abamectin		1.4 l
Total costs per ha in Tsh				952,500

Also with crop protection big differences in pesticide use were present. Although to a certain extend the same pesticides were used the amount of used pesticides differed quite a lot. Also the amount applied per hectare per application differed (Table 16, 17 and 18). Jackson used high volumes of water applied to the plants. This is perhaps due to the high density of plants per hectare. Compared to the other two farms the density at his farm was 4 times higher. However,

suspected is that with these high volumes, a lot of water will run off the plants and active ingredient will be lost. Semu used the lowest volume of water per hectare and his costs for crop protection per hectare were the lowest as well.

Table 17. Pesticide us at Saanya's farm.

Date	Volume water/ ha	Pesticide	Rate per liter	Rate per hectare
4 June	1176	Selecron	1 ml	1.2 l
		Bayleton	0.75 g	0.9 kg
28 June	2353	Selecron	1 ml	2.4 l
		Farmerzeb	5 g	11.8 kg
		Abamectin	0.5 ml	1.2 l
Total use		Selecron		3.6 l
		Farmerzeb		11.8 kg
		Abamectin		1.2 l
		Bayleton		0.9 kg
Total costs per ha in Tsh				337,600

Table 18. Pesticide us at Semu's farm.

Date	Volume water/ ha	Pesticide	Rate per liter	Rate per hectare
4 June	830	Dynamec	1 ml	0.83 l
		Farmerzeb	5 g	4.2 kg
18 June	830	Ridomil	1 g	0.83 kg
		Bayleton	0.75 g	0.62 kg
		Thionex	2.5 ml	2.08 l
2 July	830	Ridomil	1 g	0.83 kg
		Bayleton	0.75 g	0.62 kg
		Deltra	1 ml	0.83 kg
23 July	830	Bayleton	0.75 g	0.62 kg
		Deltra	1 ml	0.83 kg
		Dynamec	1 ml	0.83 l
Total use		Dynamec		1.66 l
		Farmerzeb		4.2 kg
		Thionex		2.08 l
		Ridomil		1.66 kg
		Bayleton		1.86 kg
Total costs per ha in Tsh				264,494

4 Conclusions

1) Winter season with planting in May is not a suitable season for tomato production in Ngarenanyuki because of:
    a. Low yield due to climate
    b. Low prices due to heavy competition from other regions
2) With normal yields of approximately 250 crates per acre the price at the Mombasa market needs to be 9,000 to 10,500 Tsh to break even or farm gate prices need to be 4,000 to 5,500 Tsh.
3) Effect of fertilizer was clearly established where increased nitrogen rate increased yield levels, but overall yield levels were very low and therefore a clear profit of this could not be established.
4) Effect of starting material on yield level was not present. An effect on percent available seedlings was found.

Due to low yield levels in combination of low prices profitability of tomato cultivation in the observed period is negative.
Temperature recordings indicated that during the time of cultivation low temperatures were present. For tomato cultivation optimum night temperatures are between 16 to 20 degrees while optimum day temperatures are between 25 and 30 degrees. During cultivation temperatures below 16 degrees were frequently recorded, especially in the month July. Low temperatures immediately influences yield levels and fruit quality.
Based on interviews with the farmers it became clear also that in the observed period prices are on average always low. This is also observed with the Kilombera and Mombasa market prices recorded in 2005 and 2007 respectively (Annex IV). Based on the recorded input costs and on a normal average yield of 250 crates, an average production price per crate was calculated. Prices at Mombasa market need to be higher then 9,000 Tsh to break even for production costs and transport costs, and farm gate prices need to be higher then 4,000 Tsh. These prices are realistic prices and more often higher prices then these would be paid per crate. In the right season, tomato cultivation can be very profitable then.
Soils are high in potassium and phosphate but low in nitrogen. Under tropical and sub tropical conditions recommended is to apply 180 to 190 kg N per hectare. Only one farmer applied the recommended amount, while one farmer applied only 25% of this amount and the second one 67% of this rate. The farmer that used the recommended rate also obtained a yield levels similar to that possible under favorable conditions, while the other two had lower yield levels. Used fertilizers were NPK 17-17-17, calcium ammonium nitrate and urea. All these fertilizers are increasing the pH level. While when pH level is already high it is not recommended to use these fertilizers. Efficiency of urea is also limited by the high pH and suspected is that a high amount of urea will evaporate as ammonia. Advised is to apply ammonium sulphate (21% N) to lower the pH of the soil.
With application of high levels of nitrogen higher yields were observed. However, due to the climatic conditions yield levels were overall low and profitability could not be properly established. Also tested nitrogen levels were quite high with more 330 kg nitrogen per hectare while only 190 kg is recommended. Based on production costs estimated for a production of 250 crates per acre for the common fertilizer strategy with the improved strategy with a price of 10,000 Tsh per crate, a yield increase of 32% need to be present in order to compensate just for the higher input costs. In terms of nitrogen application, with the improved strategy almost twice the advised rate

was applied. In terms of profitability and sustainable use of fertilizer, the amount of applied fertilizer in improved strategy needs to be reduced still.
Pesticide use is high at one farmer, where pesticide use almost 30% of total production costs is. Since pesticides were sprayed with high volumes of water suspected is that a lot of pesticides were wasted due to run off. Also pest and disease resistance are possible present at this farm since the same pesticides were used for the whole cultivation period.
At farmers' nurseries percentage of seedling emergence was low. About 50% of the seeds produced a seedling. Not observed was the number of usable seedlings for transplanting and this percentage might be even lower. At the experimental nursery percentage of seedlings was higher as compared to the farmers' practice nurseries. With the improved technique where seeds are sown at fixed distances in rows, percentage of emergence was 10 to 15% higher as compared to broadcasting sowing. In case of using hybrid varieties where seeds are more expensive and it is important to limit loss of seeds to a minimum.
In terms of yield, once good seedlings are selected from the diverse treatments no effect on yield levels were found.

5 Recommendations

Starting material
At raising of seedlings a high percentage of seeds is lost with the current practice where seeds are broadcasted in nursery beds. Already an improvement is to sow seeds at fixed distances in rows. However, the raising of seedlings can be further improved by:

- using nursery beds away from the production fields
- making shelters for the nursery
- improving the beds instead of using sunken beds with inundation irrigation
- using trays filled with potting soil

Especially when hybrid varieties will be used in the future it is necessary to reduce the loss of seeds to a minimum.

Fertilizer use
Use of nitrogen fertilizers is necessary seeing that the soils contain only low amounts of nitrogen. Split applications are also advisable since with furrow irrigation a lot of nitrogen will be flushed out. At this moment the use of nitrogen is in general low. With higher nitrogen levels higher yields can be obtained but the amount of fertilizers need to be optimized in order to achieve maximal profit.

Crop protection
A lot of pesticides are used to control white fly, red spider mite, aphids and American bollworm. Because of the repetitive use of the same pesticides expected is that resistance of insects is present or will occur in the near future. Also applied volume of water per hectare needs to be investigated. Advisable volumes are 500 to 1000 liter per hectare.
Another issue is effective control of aphids and whitefly and to prevent virus transmission. For this coating of seeds with insecticide might be effective. In this way a good control is achieved while at the same time use of pesticides will be reduced and risk for farmers' health and pollution to the environment will be reduced as well.

Profitability
When yield levels are around 250 crates per hectare and prices are 20,000 to 30,000 Tsh per crate then profit of the farmer is excellent. In order do obtain more data regarding profit it is necessary to collect more production data and price information in different seasons.

Annex I. Farmers groups

Saanya Kaanankira group

1. Fredy John
2. Terevaeli Soori
3. Fred John
4. Fuatael Peter
5. Wifred Ismael
6. Ismael Kishongo
7. Godfrey Saanya
8. Gabriel William
9. Anaeli Palangyo
10. Ernest Mbise

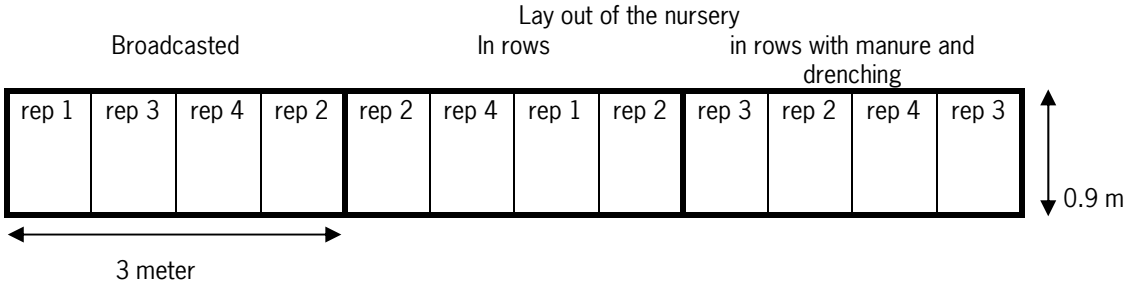
Semu Kaaya group

1. Fuataeli Zakayo
2. Sarijaeli Sawe
3. Bakari Juma
4. Ernest Erasto
5. Lamek Kaaya
6. Hamphrey Thomas
7. John Kaaya
8. Peter Marko
9. Zebedayo John
10. Zakaria Emanuel

Jackson Lemu group

1. Mary Wilson
2. Mbunja Kaaya
3. Ismael Japhet
4. Godfrey Sumaeli
5. Mosse Kanaeli
6. John Nnko
7. Kundaeli Mbise
8. Julius Elias
9. Peter John
10. Aminieli Nnko

Annex II. Lay out demo plot at Semu Kaaya Farm



Rep = plants raised in this area are designated to be transplanted in the respective replication in the production field.

Ay out of the production field. Dimensions are: 36.0 x 16.8 = 604.8 m^2

Rep 1	Rep 2	Rep 3	Rep 4
1:N5F1 Semu	13:N3F2 Mathew FP	25:N3F1 Mathew FP	37:N6F1 Saanya
2:N4F1 Jackson	14:N5F2 Semu	26:N6F1 Saanya	38:N3F2 Mathew FP
3:N3F2 Mathew FP	15:N2F1 Mathew Impr plus	27:N4F1 Jackson	39:N5F2 Semu
4:N4F2 Jackson	16:N4F2 Jackson	28:N5F2 Semu	40:N4F2 Jackson
5:N3F1 Mathew FP	17:N6F2 Saanya	29:N2F1 Mathew Impr plus	41:N3F1 Mathew FP
6:N1F1 Mathew Impr min	18:N3F1 Mathew FP	30:N5F1 Semu	42:N4F1 Jackson
7:N6F2 Saanya	19:N5F1 Semu	31:N3F2 Mathew FP	43:N6F2 Saanya
8:N2F1 Mathew Impr plus	20:N1F1 Mathew Impr min	32:N6F2 Saanya	44:N1F2 Mathew Impr min
9:N1F2 Mathew Impr min	21:N2F2 Mathew Impr plus	33:N4F2 Jackson	45:N2F1 Mathew Impr plus
10:N2F2 Mathew Impr plus	22:N1F2 Mathew Impr min	34:N2F2 Mathew Impr plus	46:N5F1 Semu
11:N6F1 Saanya	23:N6F1 Saanya	35:N1F2 Mathew Impr min	47:N1F1 Mathew Impr min
12:N5F2 Semu	24:N4F1 Jackson	36:N1F1 Mathew Impr min	48:N2F2 Mathew Impr plus

3 m

4.20 m

Red marked fields = fertilisation scheme F2.
Blank fields = farmers practice fertilisation

Annex III. Yield data of demo plot

kg per plot			Replication				
Harvest	Fertilizer	Nursery	1	2	3	4	Average
1	high	FP	2.9	2.9	3.4	2.7	11.9
		IMP-	3.4	2.9	3.1	2.9	12.3
		IMP+	2.9	2.8	3	3.3	12
		Jackson	2.8	3.1	3	3.2	12.1
		Saanya	3.2	2.8	3	2.8	11.8
		Semu	3.1	2.9	3.3	2.6	11.9
	low	FP	2.3	2.2	2.1	2.1	8.7
		IMP-	2.4	1.5	2.5	2.3	8.7
		IMP+	2.1	1.8	2	1.5	7.4
		Jackson	1.9	1.8	2	1.6	7.3
		Saanya	2	1.9	2.3	1.6	7.8
		Semu	1.9	1.9	2.1	2.2	8.1
2	high	FP	3.2	2.9	3.1	2.7	11.9
		IMP-	3.2	2.9	2.8	3.2	12.1
		IMP+	2.8	2.8	2.9	3.4	11.9
		Jackson	3	3	3.2	3.2	12.4
		Saanya	3.2	2.9	3.2	3.1	12.4
		Semu	2.9	2.9	2	2.6	10.4
	low	FP	2.2	2.1	2.2	2	8.5
		IMP-	2.1	2.3	2	2	8.4
		IMP+	1.9	2	2	2.2	8.1
		Jackson	1.9	2	3	1.7	8.6
		Saanya	2	1.8	2	2	7.8
		Semu	1.8	1.9	3.1	2.1	8.9
3	high	FP	4.2	3.7	4.2	1.1	13.2
		Jackson	4	3.9	4.1	3.1	15.1
		IMP-	4.1	4.6	3.7	3.9	16.3
		IMP+	4.3	4.4	3.8	4	16.5
		Saanya	4	4.8	4	4	16.8
		Semu	3.8	3.8	4	4	15.6
	low	FP	2.6	1.6	1.1	4.1	9.4
		IMP-	1.5	1.6	1.7	2.4	7.2
		IMP+	1.5	1.3	1.5	1.5	5.8
		Jackson	1	1.4	1.5	1.6	5.5
		Saanya	1.5	1.4	1.4	1.2	5.5
		Semu	1	1.4	1.4	1.5	5.3

Annex IV. Prices of inputs collected in a period from May – September 2008.

Crop protection

Product	Active ingredient	A.I. content	price	unit	
Bayleton	Triadimefon	25% WP	24,000	kg	Fungicide
Farmerzeb	Mancozeb	??	10,000	kg	Fungicide
Ridomil gold	Metalaxyl+mancozeb	68 WG	10,000	kg	Fungicide
Deltra	Deltamethrin	2.5 EC	15,000	liter	Insecticide
Dynamec	Abamectin	1.8 EC	120,000	liter	Insecticide
Selecron	Profenofos	720 EC	15,000	liter	Insecticide
Thionex	Endosulfan	35 EC	12,000	liter	Insecticide

Fertilizers

	price per kg or l (50 kg packs)	price per kg N	price per kg P_2O_5	price per kg K_2O
Urea (46% N)	1,300	2,826	-	-
CAN (26% N)	1,200	4,615	-	-
Ammonium sulphate (21% N)	1,000	4,762	-	-
Di Ammonium phosphate (21% N +53% P_2O_5)	1,355	6,447	2,557	-
TSP (45% P_2O_5)	1,015	-	2,256	-
N-P-K 17 – 17 – 17	1,100	6,471	6,471	6,471
N-P-K 20 – 10 – 10	1,100	5,500	11,000	11,000
Bayfolan (17 – 17 – 17)	3,723	21,900	21,900	21,900
Polyfeed (19 – 19 – 19)	2,200	11,579	11,579	11,579
Easygrow (19 – 19 – 19)	3,385	17,814	17,814	17,814

Labor

Activity	unit	wage
Sowing (broadcasting)	day	2,000
Sowing (in lines + drench)	day	4,000
Transplanting	acre	20,000
Irrigation (gravity)	acre	2,000
Irrigation (pump)	acre	5,000
Spraying	200 litres applied	2,000
Fertilization	acre	20,000
Weeding	acre	25,000
Harvesting	5 crates	2,000
Harvesting	day	2,000

Other inputs

	unit	price
Crates	crate	1,200 – 1,600
Truck hire to Mombasa (one way)	220 crates	800,000
Custom duty	per truck	100,000
Broker fee	per crate	900

Selling unit is one crate (Sanduku) which contains about 42 kg net weight of tomatoes

Market prices per crate (Sanduku):

	J	F	M	A	M	J	J	A	S	O	N	D
A	12500	12500	17500	22500	17500	2500	7500	10000	15000	7500	7500	20000
M	19500	27050	19325	11665	15095	14000	14375	10650	10800	11975	13150	9500

A= Arusha Kilombera market 2005

M=Mombasa Kongowea market 2007 (Afriveg report June 2008)

Annex V. Records of Jackson Lema's field

Total surface is 1400 m^2 or 0.35 acre.

date	Activity	Inputs	Volume	Unit	Unit price	Amount per 0.35 acre
15 April	Sowing					
		seeds	100	g	160	16,000
		labor	0.25	day	2,000	500
15 April – 20 May	Daily watering nursery (35x)	labor	4	day	2,000	8,000
20 May	Irrigation	labor	0.35	acre	7,000	2,450
21 May	Transplanting	labor	0.35	acre	20,000	7,000
31 May	Crop protection					
	1429 l/ha	labor	1	200 l	2,000	2,000
		Selecron	0.5	l	15,000	7,500
		Farmerzeb	1	kg	10,000	10,000
21 May	Fertilization					
		labor	0.35	acre	20,000	7,000
		NPK	20	kg	1,100	22,000
4 June	Weeding	labor	0.35	acre	25,000	8,750
21 June	Crop protection					
	1429 l/ha	labor	1	200 l	2,000	2,000
		Selecron	0.5	l	15,000	7,500
		Farmerzeb	1	kg	10,000	10,000
11 June	Fertilization					
		labor	0.35	acre	20,000	7,000
		Urea	50	kg	1,300	65,000
10 June	Irrigation	labor	0.35	acre	7,000	2,450
24 June	Irrigation	labor	0.35	acre	2,000	700
4 July	Weeding	labor	0.35	acre	25,000	8,750
8 July	Irrigation	labor	0.35	acre	7,000	2,450
12 July	Crop protection					
	2857 l/ha	labor	2	200 l	2,000	4,000
		Abamectin	0.2	l	120,000	24,000
		Polyfeed	3	kg	6,500	19,500
22 July	Irrigation	labor	0.35	acre	7,000	2,450
26 July	Crop protection					
	4286 l/ha	labor	3	200 l	2,000	6,000
		Selecron	1	l	15,000	15,000
		Farmerzeb	2	kg	10,000	20,000
		Polyfeed	3	kg	6,500	19,500
5 August	Irrigation	labor	0.35	acre	7,000	2,450
9 August	Crop protection					
	4286 l /ha	labor	3	200 l	2,000	6,000
		Selecron	1	l	15,000	15,000
		Farmerzeb	1	kg	10,000	10,000
		Polyfeed	3	kg	6,500	19,500
19 August	Irrigation	labor	0.35	acre	7,000	2,450
19 August	Crop protection					
	4286 l/ha	labor	3	200 l	2,000	6,000
		Selecron	1	l	15,000	15,000

2 Sept	Irrigation	labor	0.35	acre	7,000	2,450
16 Sept	Irrigation	labor	0.35	acre	7,000	2,450
12 Sept	Harvest					
		labor	11	crates	400	4,345
		crates	11	crates	1,200	13,034
27 Sept	Harvest					
		labor	31	crates	400	12,552
		crates	31	crates	1,200	37,655
1 Oct	Harvest					
		labor	18	crates	400	7,241
		crates	18	crates	1,200	21,724
5 Oct	Harvest					
		labor	10	crates	400	3,862
		crates	10	crates	1,200	11,586
Total						500,800

Annex VI. Records of Saanya Kaanankira's field

Total surface is 1700 m^2 or 0.42 acre.

date	Activity	Inputs	Volume	Unit	Unit price	Amount per 0.42acre
15-Apr	Sowing					
		seeds	100	g	160	16,000
		labor	0.25	day	2,000	500
15 April – 20 May	Daily watering nursery (35x)	labor	4	day	2,000	8,000
20 May	Ploughing	labor	0.5	day	2,000	1,000
21 May	Irrigation	labor	0.42	acre	2,000	840
21 May	Transplanting	labor	0.42	acre	20,000	8,400
4 June	Crop protection					
	200 l water	labor	1	200 l	2,000	2,000
		Selecron	0.2	l	15,000	3,000
		Bayleton	0.15	kg	24,000	3,600
		Polyfeed	1	l	6,000	6,000
4-Jun	Fertilization					
		labor	0.42	acre	20,000	8,400
		NPK	50	kg	1,100	55,000
4-Jun	Weeding	labor	0.42	acre	25,000	10,500
9-Jun	Irrigation	labor	0.42	acre	2,000	840
27-Jun	Irrigation	labor	0.42	acre	2,000	840
28-Jun	Crop protection					
	400 l water	labor	2	200 l	2,000	4,000
		Abamectin	0.2	l	120,000	24,000
		Farmerzeb	1	kg	10,000	10,000
		Selecron	0.4	l	15,000	6,000
4-Jul	Fertilization					
		labor	0.42	acre	20,000	8,400
		CAN	50	kg	1,200	60,000
4-Jul	Weeding	labor	0.42	acre	25,000	10,500
17-Jul	Irrigation	labor	0.42	acre	2,000	840
4-Aug	Irrigation	labor	0.42	acre	2,000	840
22-Aug	Irrigation	labor	0.42	acre	2,000	840
9-Sep	Irrigation	labor	0.42	acre	2,000	840
18-Sep	Harvest					
		labor	29	crates	400	11,600
		crates	29	crates	1,200	34,800
23-Sep	Harvest					
		labor	37	crates	400	14,800
		crates	37	crates	1,200	44,400
26-Sep	Harvest					
		labor	20	crates	400	8,000
		crates	20	crates	1,200	24,000
29-Sep	Harvest					
		labor	13	crates	400	5,200
		crates	13	crates	1,200	15,600
3-Oct	Harvest					
		labor	10	crates	400	4,000
		crates	10	crates	1,200	12,000
6-Oct	Harvest					

		labor	7	crates	400	2,800
		crates	7	crates	1,200	8,400
8-Oct	Harvest					
		labor	5	crates	400	2,000
		crates	5	crates	1,200	6,000
11-Oct	Harvest					
		labor	6	crates	400	2,400
		crates	6	crates	1,200	7,200
16-Oct	Harvest					
		labor	4	crates	400	1,600
		crates	4	crates	1,200	4,800
TOTAL						460,780

Annex VII. Records of Semu Kaaya's field

Total surface is 2401m^2 or 0.59 acre.

date	Activity	Inputs	volume	unit	unit price	Amount per 0.59 acre
15-Apr	Sowing					
		seeds	100	g	160	16,000
		labor	0.25	day	2,000	500
15 April – 20 May	Daily watering nursery (35x)	labor	4	day	2,000	8,000
21-May	Irrigation	labor	0.59	acre	5,000	2,950
21-May	Transplanting	labor	0.59	acre	20,000	11,800
4-Jun	Crop protection					
		labor	1	200 l	2,000	2,000
		Dynamec	0.2	l	12,000	2,400
		Farmerzeb	1	kg	10,000	10,000
4-Jun	Fertilization					
		labor	0.59	acre	20,000	11,800
		CAN	60	kg	1,200	72,000
4-Jun	Weeding	labor	0.59	acre	25,000	14,750
11-Jun	Irrigation	labor	0.59	acre	5,000	2,950
18-Jun	Crop protection					
		labor	1	200 l	2,000	2,000
		Ridomil	0.2	kg	10,000	2,000
		Bayleton	0.15	kg	24,000	3,600
		Thionex	0.5	l	12,000	6,000
25-Jun	Irrigation	labor	0.59	acre	5,000	2,950
2-Jul	Crop protection					
		labor	1	200 l	2,000	2,000
		Ridomil	0.2	kg	10,000	2,000
		Bayleton	0.15	kg	24,000	3,600
		Deltra	0.2	l	15,000	3,000
		Polyfeed	0.4	l	6,500	2,600
4-Jul	Weeding	labor	0.59	acre	25,000	14,750
9-Jul	Irrigation	labor	0.59	acre	5,000	2,950
23-Jul	Irrigation	labor	0.59	acre	5,000	2,950
23-Jul	Crop protection					
		labor	1	200 l	2,000	2,000
		Bayleton	0.15	kg	24,000	3,600
		Deltra	0.2	l	15,000	3,000
		Dynamec	0.2	l	120,000	24,000
		Polyfeed	0.4	l	6,500	2,600
6-Aug	Irrigation	labor	0.59	acre	5,000	2,950
20-Aug	Irrigation	labor	0.59	acre	5,000	2,950
26-Aug	Harvest					
		labor	7	crates	400	2,682
		crates	7	crates	1,200	8,045
2-Sep	Harvest					
		labor	11	crates	400	4,291
		crates	11	crates	1,200	12,873
9-Sep	Harvest					
		labor	13	crates	400	5,364
		crates	13	crates	1,200	16,091
TOTAL						295,995

Annex VIII. Rainfall, minimum and maximum temperature recorded at the three farms.

	Jackson			Semu			Saanya		
date	Rainfall	Maximum T	Minimum T	Rainfall	Maximum T	Minimum T	Rainfall	Maximum T	Minimum T
16-4-2008	0	34	18	4	32	18	2	34	20
17-4-2008	8	30	10	0	33	16	0	36	17
18-4-2008	0	37	16	8	27	15	10	30	16
19-4-2008	0	36	14	11	27	17	11	28	17
20-4-2008	15	35	15	0	24	17	0	26	18
21-4-2008	4	28	15	8	30	16	9	32	19
22-4-2008	35	36	11	0	29	16	0	29	16
23-4-2008	2	29	16	3	27	14	4	28	15
24-4-2008	5	37	15	19	26	11	20	27	13
25-4-2008	40	35	15	2	26	11	3	26	12
26-4-2008	16	34	15	23	24	16	23	24	15
27-4-2008	0			0	26	16	0	28	18
28-4-2008	0			0	25	16	0	27	18
29-4-2008	0			0	27	17	0	29	19
30-4-2008	0	25	15	0	24	16	0	26	17
1-5-2008	32	36	15	12	30	15	10	30	16
2-5-2008	0	37	20	4	25	15	5	26	16
3-5-2008	0	34	22	0	25	14	0	27	15
4-5-2008	0	35	24	0	25	15	0	26	15
5-5-2008	0	39	15	0	30	14	0	24	16
6-5-2008	0	39	15	0	32	12	0	28	18
7-5-2008	0	40	15	0	30	14	0	28	19
8-5-2008	0	40	15	0	30	17	0	18	15
9-5-2008	0	20	11	0	30	16	0	27	17
10-5-2008	0	34	13	0	35	18	0	27	18
11-5-2008	0	38	15	0	32	16	0	28	18
12-5-2008	0	39	5	0	34	15	0	27	17
13-5-2008	0	41	4	0	30	15	0	27	18
14-5-2008	0	39	15	0	20	15	0	28	16
15-5-2008	0	39	8	0	22	14	0	27	15
16-5-2008	0	24	4	5	24	14	3	21	10
17-5-2008	0	25	15	1	23	14	1	22	15
18-5-2008	0	26	14	2	15	13	0	22	15
19-5-2008	4	25	16	0	20	13	0	21	17
20-5-2008	0	25	15	0	28	15	0	28	18
21-5-2008	0	37	16	0	27	15	0	24	16
22-5-2008	0	35	15	0	31	14	0	21	17
23-5-2008	0	34	5	0	21	15	0	28	18
24-5-2008	0	25	5	0	20	15	0	24	16
25-5-2008	0	28	5	0	33	15	0	24	16
26-5-2008	0	27	4	0	27	15	0	25	15
27-5-2008	0	30	10	0	28	16	0	26	15
28-5-2008	0	36	11	0	23	15	0	25	16
29-5-2008	0	35	15	0	25	17	0	26	15

		Jackson			Semu			Saanya	
		Maximum	Minimum			Minimum		Maximum	Minimum
date	Rainfall	T	T	Rainfall	Maximum T	T	Rainfall	T	T
30-5-2008	0			0	20	14	0	26	15
31-5-2008	0			0	19	14	0	24	17
1-6-2008	0	36	15	0	26	15	0	25	15
2-6-2008	0	30	12	0	30	15	0	24	16
3-6-2008	0	40	15	0	32	15	0	24	16
4-6-2008	0	25	15	0	30	14	0	22	15
5-6-2008	0	40	14	0	30	16	0	37	18
6-6-2008	0	20	11	0	27	15	0	27	17
7-6-2008	0	26	10	0	33	14	0	24	16
8-6-2008	0	20	13	0	32	14	1	22	15
9-6-2008	0	26	14	0	14	12	0	24	14
10-6-2008	0	25	15	0	30	10	0	22	15
11-6-2008	0	27	12	0	20	13	0	22	12
12-6-2008	0	27	10	0	21	13	0	20	12
13-6-2008	0	30	11	0	23	13	1	21	14
14-6-2008	0	35	5	0	18	12	0	22	12
15-6-2008	0	30	10	0	22	12	1	20	15
16-6-2008	0	28	15	0	18	10	0	22	12
17-6-2008	0	28	14	0	20	12	0	22	15
18-6-2008	0	31	14	0	22	13	0	20	12
19-6-2008	0	36	15	0	18	13	0	24	16
20-6-2008	4	31	15	0	24	12	0	22	15
21-6-2008	2	35	15	0	21	14	0	24	14
22-6-2008	14	20	11	0	20	13	0	22	15
23-6-2008	5	20	10	0	20	14	0	27	12
24-6-2008	0	30	15	0	28	12	0	24	16
25-6-2008	4	28	19	0	20	12	0	22	15
26-6-2008	0	30	15	0	25	15	0	20	12
27-6-2008	0	31	10	0	20	11	0	22	12
28-6-2008	0	35	10	0	19	12	0	24	16
29-6-2008	0	34	10	0	20	12	0	21	10
30-6-2008	0			0	17	11	0	22	15
1-7-2008	0	29	10	0	23	11	0	22	15
2-7-2008	0	30	15	0	24	14	0	21	17
3-7-2008	0	31	15	0	23	11	0	28	18
4-7-2008	0	35	20	0	27	14	0	24	16
5-7-2008	0	36	18	0	24	14	0	21	18
6-7-2008	0	30	15	0	28	10	0	28	16
7-7-2008	0	24	11	0	25	13	0	24	16
8-7-2008	0	32	16	0	28	14	0	24	17
9-7-2008	0	35	10	0	26	12	0	26	15
10-7-2008	0	39	11	0	27	13	0	25	16
11-7-2008	0	30	10	0	21	11	0	27	17
12-7-2008	0	31	9	0	22	12	0	25	15
13-7-2008	0	28	10	0	23	13	0	22	12
14-7-2008	0	32	16	0	20	14	0	23	15
15-7-2008	0	35	10	0	21	14	0	24	16
16-7-2008	0	31	10	0	25	15	0	22	13

		Jackson			Semu			Saanya	
		Maximum	Minimum			Maximum	Minimum		
date	Rainfall	T	T	date	Rainfall	T	T	date	Rainfall
17-7-2008	0	30	8	0	22	14	0	21	12
18-7-2008	0	32	14	0	24	14	0	24	17
19-7-2008	0	30	16	0	23	15	0	25	16
20-7-2008	0	29	10	0	25	15	0	24	16
21-7-2008	0	30	14	0	27	13	0	27	12
22-7-2008	0	33	13	0	16	14	0	24	16
23-7-2008	0	33	11	0	14	12	0	22	15
24-7-2008	0	35	15	0	15	11	0	24	16
25-7-2008	0	30	15	0	16	12	0	22	15
26-7-2008	0	30	10	0	20	14	0	24	16
27-7-2008	0	24	8	0	25	14	0	25	15
28-7-2008	0	25	10	0	30	15	0	27	12
29-7-2008	0	29	11	0	27	15	0	24	16
30-7-2008	0	31	10	0	21	13	0	25	15
31-7-2008	0	30	8	0	21	15	0	22	15
1-8-2008	0	30	16	0	20	13	0	20	12
2-8-2008	0	31	13	0	24	15	0	22	16
3-8-2008	0	30	10	0	28	15	0	23	15
4-8-2008	0	29	10	0	24	14	0	24	16
5-8-2008	0	30	16	0	20	15	0	25	15
6-8-2008	0	35	15	0	28	15	0	24	16
7-8-2008	0	30	10	0	28	15	0	22	12
8-8-2008	0	32	10	0	27	15	0	21	14
9-8-2008	0	30	15	0	27	15	0	22	12
10-8-2008	0	30	10	0	29	15	0	27	12
11-8-2008	0	30	12	0	29	17	0	22	12
12-8-2008	0	29	13	0	27	12	0	24	16
13-8-2008	0	30	10	0	27	14	0	25	15
14-8-2008	0	30	11	0	29	14	0	24	16
15-8-2008	0	32	10	0	30	12	0	27	13
16-8-2008	4	35	10	0	30	17	0	24	15
17-8-2008	0	30	15	0	38	14	0	23	15
18-8-2008	0	31	11	0	22	14	0	25	16
19-8-2008	0	34	14	0	22	15	0	26	15
20-8-2008	0	32	13	0	24	16	0	24	16
21-8-2008	0	33	10	0	20	15	0	25	15
22-8-2008	0	34	12	0	22	15	0	23	15
23-8-2008	0			0	23	14	0	22	16
24-8-2008	0	33	11	0	20	15	0	26	15
25-8-2008	0	33	10	0	22	16	0	24	16
26-8-2008	0			0	27	15	0	25	15
27-8-2008	0	30	11	0	23	14	0	24	16
28-8-2008	0	30	11	0	25	10	0	22	16
29-8-2008	0	31	10	0	24	13	0	27	17
30-8-2008	0	28	10	0	28	12	0	24	15
31-8-2008	0	35	10	0	25	12	0	25	16

		Jackson			Semu			Saanya	
		Maximum	Minimum			Minimum		Maximum	Minimum
date	Rainfall	T	T	Rainfall	Maximum T	T	Rainfall	T	T
1-9-2008				0	29	15	0	25	13
2-9-2008				0	25	15	0	26	15
3-9-2008				0	32	15	0	24	15
4-9-2008				0	30	13	0	25	13
5-9-2008				0	30	12	0	24	15
6-9-2008				0	31	12	0	25	13