– Natural Conditions and Farm Management Information –

ANNEX:
– Atlas of Agro - Ecological Zones, Soils and Fertilising by Group of Districts –

Subpart C2
Coast Province

Lamu County
This project was supported by the German Agency for International Cooperation (GIZ)
Farm Management Handbook of Kenya

VOL. I  Labour Requirement, Availability and Costs of Mechanisation

VOL. II  Natural Conditions and Farm Management Information

Part II/A  WEST KENYA
Subpart A1  Western Province
Subpart A2  Nyanza Province

Part II/B  CENTRAL KENYA
Subparts B 1a/b  Rift Valley Province, Northern (except Turkana) and Southern Part
Subpart B2  Central Province

Part II/C  EAST KENYA
Subpart C1  Eastern Province, Middle and Southern Part
Subpart C2  Coast Province

VOL. III  Farm Management Information - Annual Publications were planned. The idea changed to Farm Management Guidelines, produced by the District Agricultural Offices annually and delivered to the Ministry in April every year.

VOL. IV  Production Techniques and Economics of Smallholder Livestock Production Systems

VOL. V  Horticultural Production Guidelines

Publisher: Ministry of Agriculture, Kenya, in Cooperation with the German Agency for International Cooperation (GIZ)

VOL. II is supplemented by CD-ROMs with the information and maps in a Geographical Information System. Additionally there will be wall maps of the Agro-Ecological Zones per district group (= the former large districts) for offices and schools. There is also a CD with the maps and the most important information for each district group (now county).

Layout by Ruben Kempf and Mike Teucher, Trier, Germany.
Annex:
- Atlas of Agro - Ecological Zones, Soils and Fertilising
by Group of Districts in Coast Province -

Subpart C2

Lamu
County

by

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Additional Contributions to the 2nd Edition by: Dr. J. Ahenda & P. M. Maluku, KEPHIS; G. Awinyo (GIZ) – assisting R. J. & digitizing of soil maps into GIS; Th. Büttel – support by analyzing remote sensing data; M. Fiebig – rainfall data analysis, probability calculations, yield probabilities by simulation programs; B. Girkens – final computerized drawing of maps in GIS and other maps; Heike Hoefler – project coordination in GIZ Nairobi; Ph. Karuri – assistance in the Farm Survey; Anna Kaufhold – final computerized drawing of fertiliser maps; Ruben Kempf – typing and layout; Elizabeth Kimenyi & Anne Njoroge – coordination of farm survey; Z. Mairura, Dir. of Farm Business Subdivision; S. N. Maobe (KARI); N. M. Maweau (KARI); Susanne Meissner – water availability & requirement diagrams, typing; M. Mueller – calculation and diagrams of growing periods, ENSO influence; Dr. Anne W. Muriuki & J. N. Qureshi – soil and fertiliser recommendation maps and information; Francis Muthamj (GIZ); Dr. Dorothy Mutia and Dr. J. Ochieng – crops and fodder list; Birgit Schütz – basics for maintaining and regaining soil fertility; Joshua Shivachi & Ch. R. Wambugo – analysing the Farm Survey data using SPSS software; M. Teucher – final computerized drawing of soil and fertilizer maps; Dr. Lusíka Wasilwa – horticult. part of the crop list; J. Wieczorek – computerization of maps in GIS; tables and diagrams.
PREFACE TO THE ATLAS
The internet and CD versions of the handbook have technically a reduction of details:
The most important information, the maps, are due to reduction of the 24 MB to the CD-size of 6 MB, not
well readable (esp. formulas of the AEZ Subzones and of the soils). Therefore we prepared additional Atlas-
CDs for each group of districts, containing the maps of Rainfall, Agro - Ecol. Zones and Subzones, Soils,
and Fertilizer Recommendations together with the legends.
These maps are produced as pdf-files and can be zoomed for easy reading.

ACKNOWLEDGEMENT
for the Support to the First Edition
In compiling this Handbook, we have relied on the support of many officers from a variety of institutions
too numerous to mention, who made available their data and experience. We would like to thank them for
their invaluable assistance.
I would also like to thank my colleagues, the Research Officers, the District Land and Farm management
Officers, for their cooperation, and a special thank you to those who typed the draft edition.
Our particular thanks go to Prof. Dr. Ralph Jaetzold, University of Trier, for his selfless support in compiling
this handbook and for his assessment of the natural conditions including land and population. His deep
understanding of the needs of agricultural extension officers and farmers was a great asset. Our thanks also to
Dr. H. Kutsch, University of Trier, who computerized a large and complex amount of information involved
in establishing the AEZs.
Many thanks also to the staff of the Geographical Department of the University of Trier, Germany, for their
major effort in drawing up maps of outstanding quality, the centrepiece of the work.

Helmut Schmidt
Farm Management Research Officer
Nairobi, May 1982

ACKNOWLEDGEMENT
for the Support to the Second Edition
In revising this Handbook, various personalities and institutions were relied upon to provide the necessary
data required to update the previous data sets. In this regard, we would like to sincerely thank them for their
invaluable input in the exercise.
Special thanks go to the Ministry of Agriculture staff who undertook the Farm Surveys to elucidate on the
fundamental changes that have taken place in farming at the household level.
We are indeed very grateful to the people of Germany, who despite their limited financial resources, have
continued to support Kenya. Of importance here is the German Agency for Technical Cooperation (GTZ)
and the German scientists who have been working for Kenya over the years. Last but not least, thanks to Mr.
Reimund Hoffmann, the PSDA Coordinator, Nairobi, whose office ably managed the Handbook revision
project.

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Professor of Agroclimatology
Dept. of Geography
Kenyatta University, Nairobi
Nairobi, January 2009

Elizabeth Kimenyi
Assistant Director of Agriculture
FMD, MOA
Kenya
Nairobi, January 2009

We want to thank very much also Mr. Zachariah Mairura, Deputy Dir. of Agri-Business Dep., for his en-
gaged support of our inquiries in the districts 2009 and 2010.

Prof. em. Dr. Ralph Jaetzold
Retired Professor of Geography
University of Trier, October 2010

Prof. Dr. Berthold Hornetz
Professor of Agricultural Geography
University of Trier, October 2010
PREFACE to the Second Edition

Institutional memory is of paramount importance for planning and development. For any research or agricultural extension to be successful, information on the natural farming potential is equally important.

In an effort to consolidate research - extension work of many years, the first edition of the Farm Management Handbook (FMHB) of Kenya Vol II (Natural conditions and farm management information), which described the conditions of the Kenyan farming community at that time, was produced in 1982/83. The handbook was in three parts i.e.:

A – for Western Kenya (Western and Nyanza provinces)
B – for Central Kenya (Central and Rift Valley provinces).
C – for Eastern Kenya (Eastern and Coast provinces).

For more than two decades, the handbook has proved very valuable to researchers, planners, extensionists, developers etc. This is a document that has been sought for enormously and hence the need to revise it in order to accommodate the changes that have taken place in our country since the production of the first edition. Some of these include: changes in the administrative boundaries, opening up of new farming areas due to population pressure, many new crop varieties, etc.

This second edition has been produced on the basis of Provincial administrative boundaries for the six Provinces i.e. Western, Nyanza, Rift Valley, Central, Eastern and Coast. The information will be availed in hard copies and in CD – ROMS to facilitate updating any future changes.

It is not possible to acknowledge the contribution of all the individuals who made this edition a reality but I need to mention the following individuals:

Thanks to the Ministry of Agriculture officers, especially the Farm Management Division officers at the headquarters (Mrs. E.W. Kimenyi, Mr. F.N. Nderitu, Mrs. H.W. Njoroge, Mrs. A.W. Njoroge, Mrs. A. W. Wanyama, Mr. P.T. Karuri and most engaged Mr. Z. Mairura), and the District staff, for their selfless contribution; Prof. Dr. Chris Shisanya, leader of the revision team, for his tireless efforts and guidance; Prof. em. Dr. Ralph Jaetzold for his enormous knowledge on the definition of the agroecological zones and his great contribution to their mapping; George Awinyo (German Technical Cooperation (GTZ) – Private Sector Development in Agriculture (PSDA)) for his expertise and contribution in the area of Geographical Information Systems (GIS).

I also wish to thank the GTZ who have facilitated the production of this edition both financially and by the use of their personnel, specifically the late Prof. Werner van der Ohe who supported the idea of the revision, and Mr. Reimund Hoffmann (GTZ – Team Leader Private Sector Development in Agriculture PSDA), for supporting and taking up the task to completion.

Dr. Wilson Songa, OGW
AGRICULTURAL SECRETARY
Nairobi, January 2009
# 3.6 LAMU GROUP OF DISTRICTS

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Note: Numbering of chapters is equivalent to numbering in Farm Management Handbook of Kenya

3.6.1 NATURAL POTENTIAL

Introduction

It is difficult to define the climatic potential accurately because there are very few rainfall recording stations. The amount of rainfall in the first rains decreases from a coastal strip of about 10 km wide to the hinterland at a rate of about 100 mm per 5 km. The second rains increase from the coast for the first 10 km, and then drop again. The intermediate rains between both seasons (very important for relay-planted crops like simsim and cowpeas) are also most frequent a few kilometers inland from the coast. For these reasons the highest average annual rainfall above 1 000 mm occurs about 5-20 km inland, interrupted by Mkunumbi Bay. From the climatic point of view, this high rainfall zone includes the Coconut-Cassava Zone CL 3, but the soils are often not suitable for those leading crops. They are in many places waterlogging or, near Hindi, too heavy. Slow growth of coconuts increases the danger of pests and diseases (esp. rhinoceros beetle and bollrot disease).

The Cashewnut-Cassava Zone CL 4 extends around AEZ CL 3. Towards the hinterland, the rainfall in dry years is often not concentrated enough for cassava to encourage the formation of big tubers. The rainfall distribution also becomes less suitable for cashewnuts: the small rains fall during the flowering period and in wet years cause poor fruit setting and infestations of black spots on the nuts. Northwards this danger lessens but there is also a general decrease in rainfall in this direction. The actual boundary of CL 4 is very difficult to define because apart from Kiunga on the coast there is no rainfall station there. The AEZ map gives an optimistic view, the agro-climatic map a pessimistic one. The real extension is important for settlement prospects 1) in this sparsely populated area.

The Agro-Ecological Zone CL 5 should be left for ranching land (like CL 6) until technologies are available which allow a sufficient return from agriculture. A promising start seems to be already in progress in Farm Survey Area 204: Bodhái. El Nino =ENSO years have higher and longer rainfall. They are announceable by the Kenya Met. Dept. (see Final Statements, p.444). 2) as well as the alternating La Nina (Anti ENSO) years. They have not only less rainfall but strong dry winds in June 3) which have a severe negative effect on the maize yields in the first rainy season even in CL 3 because this crop has in June its most sensible tusseling stage to water deficit (see Muti and KIBE, 2009). Therefore, if a La Nina year in the preceeding Short Rains occured which normally continues into the following Long Rains, then it is wise to plant sorghum which is less sensible to a June drought than maize.

### TABLE 1: RAINFALL FIGURES FROM SELECTED TYPICAL STATIONS IN LAMU GROUP OF DISTRICTS HAVING RECENTLY AT LEAST 16 YEARS OF RECORDS

<table>
<thead>
<tr>
<th>No. and altitude</th>
<th>Name of Station</th>
<th>Agro-Ecol. Zone and Subzone</th>
<th>Kind of records</th>
<th>Annual rainfall in mm</th>
<th>Monthly &amp; seasonal average rainfall in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>9141000 3 m</td>
<td>Kiunga</td>
<td>CL 5 s/vs i</td>
<td>Average</td>
<td>572</td>
<td>J 4 1 4 109 139 48 16 45 31 20 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reliability*</td>
<td>423</td>
<td>F 0 0 0 43 128 100 25 6 9 0 0 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Seas. Av.</td>
<td>446</td>
<td>M 7 3 33 125 320 160 90 41 54 52 49 30</td>
</tr>
<tr>
<td>9240001 14 m</td>
<td>Lamu Met. Station</td>
<td>CL 4 m/s i</td>
<td>Average</td>
<td>964</td>
<td>J 7 3 33 125 320 160 90 41 54 52 49 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reliability*</td>
<td>821</td>
<td>F 0 0 0 85 239 109 57 26 21 11 6 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Seas. Av.</td>
<td>728</td>
<td>M 113 136 111 32 64 146 146 146 146 146</td>
</tr>
<tr>
<td>9240003 3 m</td>
<td>Witu, D.O.</td>
<td>CL 3 m i (vs)</td>
<td>Average</td>
<td>1203</td>
<td>J 47 4 39 129 285 162 91 54 32 113 136</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reliability*</td>
<td>706</td>
<td>F 136 111 111 32 64 146 146 146 146 146</td>
</tr>
<tr>
<td>9240005 4 m</td>
<td>Mkunumbi</td>
<td>CL 3-4 m/s i (v)</td>
<td>Average</td>
<td>1075</td>
<td>J 18 5 36 148 306 184 112 42 46 47 68 65</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reliability*</td>
<td>912</td>
<td>F 0 0 0 96 228 129 84 14 16 5 14 32</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Seas. Av.</td>
<td>786</td>
<td>M 178 178 178 32 64 146 146 146 146 146</td>
</tr>
<tr>
<td>9240007 13 m</td>
<td>G.K. Hindi Prisons</td>
<td>CL 3 m i (v)</td>
<td>Average</td>
<td>1129</td>
<td>J 5 2 53 114 403 170 109 89 43 68 42 31</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reliability*</td>
<td>608</td>
<td>F 0 0 0 68 241 129 78 28 19 25 7 12</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Seas. Av.</td>
<td>849</td>
<td>M 141 141 141 32 64 146 146 146 146 146</td>
</tr>
<tr>
<td>9240014 13 m</td>
<td>Lake Kenyatta Settlm. Sch.</td>
<td>CL 3 m i (v)</td>
<td>Average</td>
<td>1367</td>
<td>J 16 7 63 144 415 289 116 61 54 49 96 58</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>Reliability*</td>
<td>1026</td>
<td>F 203 203 203 58 64 146 146 146 146 146</td>
</tr>
<tr>
<td>9240015 8 m</td>
<td>Mkowe</td>
<td>CL 4-3 m i</td>
<td>Average</td>
<td>918</td>
<td>J 6 3 42 119 335 160 80 53 28 34 28 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reliability*</td>
<td>780</td>
<td>F 0 0 0 43 219 97 35 16 20 0 0 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Seas. Av.</td>
<td>736</td>
<td>M 92 92 92 30 64 146 146 146 146 146</td>
</tr>
<tr>
<td>9241000 5 m</td>
<td>Faza</td>
<td>CL 4 m/s i</td>
<td>Average</td>
<td>793</td>
<td>J 6 3 14 117 276 132 77 31 49 38 36 14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reliability*</td>
<td>709</td>
<td>F 0 0 0 77 251 105 60 15 16 5 10 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Seas. Av.</td>
<td>616</td>
<td>M 88 88 88 14 30 92 92 92 92 92 92</td>
</tr>
<tr>
<td>9241002 9 m</td>
<td>Siyu</td>
<td>CL 4 m/s i</td>
<td>Average</td>
<td>920</td>
<td>J 4 3 25 111 299 202 93 43 36 36 40 28</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reliability*</td>
<td>909</td>
<td>F 0 0 0 67 198 108 69 16 9 10 11 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Seas. Av.</td>
<td>730</td>
<td>M 104 104 104 28 40 92 92 92 92 92 92</td>
</tr>
</tbody>
</table>

* 66% reliability = this amount will be surpassed in 10 out of 15 years
66% RELIABILITY OF RAINFALL IN AGROHUMID PERIOD OF FIRST RAINY SEASON
(March - Sept. or less)
Amounts in mm, surpassed normally in 10 out of 15 years.

Broken isolines are uncertain because of lack of rainfall records.
OF SECOND RAINY SEASON
IN AGROHUMID PERIOD
66% RELIABILITY OF RAINFALL

LAMU GROUP 7

Group of Districts

LAMU
TABLE 2: CLIMATE IN THE AGRO-ECOLOGICAL ZONES

<table>
<thead>
<tr>
<th>Agro-Ecological Zone</th>
<th>Subzone</th>
<th>Altitude in m</th>
<th>Annual mean temp. in °C</th>
<th>Annual average rainfall in mm</th>
<th>66% reliability of rainfall 1)</th>
<th>60% reliability of growing period</th>
<th>Total 2) in days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1st rainy season in mm</td>
<td>2nd rainy season in mm</td>
<td>1st rainy season in days</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CL 3</td>
<td>Coconut-Cassava Zone</td>
<td>m i vs</td>
<td>1-80</td>
<td>27.0-26.5</td>
<td>1000-1200</td>
<td>600-700</td>
<td>150-200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>m i (vs)</td>
<td></td>
<td>botanical</td>
<td>1050-1300</td>
<td>600-700</td>
<td>130-180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>m i (vu)</td>
<td></td>
<td>botanical</td>
<td>1000-1300</td>
<td>600-700</td>
<td>80-130</td>
</tr>
<tr>
<td>CL 4</td>
<td>Cashewnut-Cassava Zone</td>
<td>m/s i</td>
<td>1-100</td>
<td>27.0-26.4</td>
<td>Very small and transitional</td>
<td>750-980</td>
<td>550-630</td>
</tr>
<tr>
<td></td>
<td></td>
<td>m/s i</td>
<td></td>
<td>botanical</td>
<td>900-1000</td>
<td>550-650</td>
<td>70-120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>m/s i + (vu)</td>
<td></td>
<td>botanical</td>
<td>650-950</td>
<td>500-600</td>
<td>40-130</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s/m i</td>
<td></td>
<td>botanical</td>
<td>880-920</td>
<td>580-620</td>
<td>&lt;50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s/m i (vs)</td>
<td></td>
<td>botanical</td>
<td>680-900</td>
<td>450-550</td>
<td>140-180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s/m i (vu)</td>
<td></td>
<td>botanical</td>
<td>700-800</td>
<td>400-530</td>
<td>50-130</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s/m i + (vs)</td>
<td></td>
<td>botanical</td>
<td>800-850</td>
<td>500-550</td>
<td>&lt;50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s/m i + (vu)</td>
<td></td>
<td>botanical</td>
<td>680-850</td>
<td>350-450</td>
<td>140-180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s/m i + (vs)</td>
<td></td>
<td>botanical</td>
<td>580-680</td>
<td>200-350</td>
<td>150-180</td>
</tr>
<tr>
<td>CL 5</td>
<td>Coastal Lowland Livestock-Millet Zone</td>
<td>s/vs i</td>
<td>1-70</td>
<td>27.0-26.6</td>
<td>500-600</td>
<td>280-400</td>
<td>&lt;50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>vs/s i (vs)</td>
<td></td>
<td>botanical</td>
<td>620-750</td>
<td>350-400</td>
<td>150-200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>vs/s i (vs)</td>
<td></td>
<td>botanical</td>
<td>550-650</td>
<td>170-250</td>
<td>140-160</td>
</tr>
<tr>
<td></td>
<td></td>
<td>vs/s i (vs) + (vu)</td>
<td></td>
<td>botanical</td>
<td>480-520</td>
<td>180-280</td>
<td>&lt;50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(vs) + (vu)</td>
<td></td>
<td>botanical</td>
<td>550-580</td>
<td>130-180</td>
<td>100-130</td>
</tr>
<tr>
<td>CL 6</td>
<td>Coastal Lowland Ranching Zone</td>
<td>b r</td>
<td>60-70</td>
<td>27.0-26.9</td>
<td>&lt;550</td>
<td>&lt;130</td>
<td>&lt;100</td>
</tr>
</tbody>
</table>

NOTES:

1) Amounts surpassed normally in 10 out of 15 years, falling during the agro-humid period which allows growing of most cultivated plants.
2) Only added if rainfall continues at least for survival (>$0.2 \text{ E}_0$ resp. $0.25 \text{ PET}$) of most long term crops.
3) Interrupted by a period with water supply between $0.2$ and $0.4 \text{ E}_0$ (resp. $0.25-0.5 \text{ PET}$) for more than 50 days (intermediate rains)
AGRO-ECOLOGICAL ZONES AND SUBZONES

Introduction

The yield potentials are calculated for the important annual crops with the programs WATBAL and MARCROP by B. Hornetz (see chapter 3.1 and Annex). The other crops are classified by estimates according to their temperature and water requirements. Not all suitable crops could be mentioned here because of limited space. More crops and the most suited varieties can be found in the crop list (Table IX) and in IRACC: Small Holder Farming Handbook for Self Employment, Nairobi 1997, when comparing both sources with the climatic data of the AEZ and Subzones (Table 2) as well as considering the soil requirements (Table IV) and the soil map. The potentials require optimal fertilising and manuring as well as good crop husbandry to reach the given percentages.

Recommended for checking in Table IX are the following crops resp. varieties if they have not been mentioned in the potentials: Some more maize and bean varieties; more vegetables like french beans, celery, brinjals and others; more fruits like grapefruit, mandarines, limes, lemons, tangerines and pineapples. It is important to compare the yields, f. i. a fair yield of med. mat. maize is higher than a good one of an early mat. maize but more risky. For fodder and forage many other plants than the mentioned ones are possible, classified by Agro-Ecological Zones in Table X.

The tables beneath the diagrams of growing periods may differ from other calculations because they do not include the drier grass growing periods which can give a minimum supply of moisture to low demanding crops. The gap between the number of sufficient growing periods and that of total crop failures is filled by fair to poor yields.

It must be kept in mind that the potentials are ecological zone based. What is economical depends on the present relation of costs-yields-prices and the marketing possibilities, of course.

AGRO-ECOLOGICAL ZONES AND SUBZONES (Legend to the Map)

<table>
<thead>
<tr>
<th>CL</th>
<th>= COASTAL LOWLAND ZONES</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL 3</td>
<td>= Coconut-Cassava Zone</td>
</tr>
<tr>
<td>CL 3</td>
<td>= Coconut-Cassava Zone with a medium cropping season, intermediate rains, and a very short to short one</td>
</tr>
</tbody>
</table>

(See Diagrams Witu and Table 3)

Very good yield potential (av. more than 80 % of the optimum)¹)
Whole year: Mangoes

Good yield potential (av. more than 60-80 % of the optimum)²)
1st rainy season, start norm. end of March: Coast comp. and Pwani Hybrid maize & 2KX 17, m. mat. white sorghum, m. mat. finger and pearl millet; dolichos beans (- 60%)³), green grams (60-70 %)⁴), cowpeas (60-70 %)⁵), pigeon peas (1st-2nd r.), soya beans, yam beans (tubers), sweet potatoes; groundnuts (Makulu red)³), bambara groundnuts³, cotton (with danger of rain in open bolls), roselle; tomatoes, egg plants/brinjals, kales, Chinese cabbage, chillies, sweet pepper, pumpkins, onions, sweet and water melons, cucumbers, garlic, okra, trop. Lima beans⁶), guar⁷),
Whole year, best planting time b. of April: Sisal; cashew nuts⁸), bixa, pawpaws, West Indian avocados; cassava; guavas, senna, castor

Fair yield potential (av. 40-60 % of the optimum)¹)
1st rainy season: Rice in seasonal flooded grasslands or semi-permanent swamps⁹); simsim (J-/July- S.O.); cabbage, chick peas on heavy black soils after flooding (July - S.)
2nd rainy season, start indistinctly mid Oct.: V. e. mat. foxtail millet, Proso millet; green grams (fair-poor), cowpeas, black grams, Mung beans, Dolichos beans, chick peas
Whole year: Coconuts⁴) (danger of bolllrot disease), bananas, lemons and limes, oranges and grapefruits⁸), pineapples⁸), curcuma
Some marginal crops with poor yield potential (av. 20-40% of the optimum)
2nd rainy season: Sweet potatoes (necessary to continue from 1st r. to keep plant material for
the next long rains); simsim; pearl millet (Kat/PM1, bristled var.), v. e. mat sorghum
(IS 8595)

Pasture and forage
More than 1 ha/LU of 300kg on secondary high-grass savanna between relicts of semi-
deriduous tropical forest. Grazing also in seasonal waterlogged areas; feeding Napier or Bana
grass, siratro (Macroptilium atropurpureum), centro (Centrosema pubescens, also to
improve pasture and soil) and planting horse tamarind (Leucaena tricandria) for
browsing down to 0.2 ha/LU; Mimosa pudica under coconut trees

CL 3 m i vs/s
= Coconut-Cassava Zone with a medium cropping season,
intermediate rains, and a very short one or (weak) very short one
Potential almost as CL 3 m i vs/s but no reliable cultivation in the 2nd rainy season because
it is too short, weak and erratic (risk of crop failure more than 50%). Lemons and limes
fair, other citrus marginal; bananas esp. var. Bocoboco and Zanzibari
Partly heavy soils
(red loam on old coral reefs), good for maize, less suitable there for groundnuts, bambara
groundnuts, cashew nuts and coconuts

CL 3 m i
= Coconut-Cassava Zone with a medium cropping season
followed by intermediate rains
Good yield potential
1st rainy season, start norm. end of March: Coast comp. and Pwani Hybrid maize PH 4 (60-
70%), m. mat. white sorghum (70-80 %), m. mat. finger millet; cowpeas (~60 %)
yam beans (tubers), sweet potatoes; tomatoes, egg plants, kales, Chinese cabbage,
chillies, sweet pepper, pumpkins, onions, water melons, cucumbers, garlic, okra, roselle,
trop. Lima beans, guar
2nd rains insignificant
Whole year: Sisal; mangoes, cashew nuts, pawpaws, West Indian avocados, cassava; bixa
(good to fair), senna, castor
**THE BEST AGRO-ECOLOGICAL ZONE OF THE NORTHERN PART OF COAST PROVINCE**

<table>
<thead>
<tr>
<th>Station name</th>
<th>Cereal and legumes growing period</th>
<th>Dry conditions</th>
<th>Precipitation is cumulated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Witu D.O.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Station no.: 9240003  
Altitude: 9m  
AEZ: CL 3  
Grass growing period only:  

### Rainfall / c. & leg. gr. p.

- 10 gr. p. of at least 60 days = 67% of all seasons

### Seasonal Rainfall

- **March**
  - Rainfall: 682 mm
- **June**
  - Rainfall: 242 mm

### AGH Period

- **2nd AHP**
  - 38% 13% 6% 6% 0% 0% 0% 38% 63% 75% 88% 94% 100% 100% 100% 94% 94% 94% 100% 81% 81% 50% 44% 31% 38% 31% 25% 31% 69% 69% 75% 75% 75% 59% 66%

### Reliability of AHP

- No AHP: 14 15 15 16 16 16 16 10 6 4 2 1 1 0 0 0 1 1 1 0 3 3 8 9 11 10 11 12 11 8 5 5 4 4 4 7

### Station no. Altitude AEZ

- V.e.mat. cowpeas: 88% of all seasons (May - July), 81% of all seasons (June - August)

### Minor millets

- 16 gr. p. of at least 50 days = 100% of all seasons

### V.e.m. cowpeas

- 7 gr. p. of at least 70 days = 47% of all seasons

### Dwarf sorghum

- 15 gr. p. of at least 80 days = 94% of all seasons

### Minor millets

- 11 gr. p. of at least 50 days = 73% of all seasons

### Existential risks:

- No cereal growing period in a year or more: 0 times = 0% of the years
- 2 or more consecutive rainy seasons without the min. AHP of 50 d.: 0 times in 16 years
- No grass growing period in a season: 1 time = 3.1% of the seasons
- No grass growing period in a year or more: 0 times = 0% of the years

**Rerainfall scenario: DISCON**

**WATBAL run specifications by B. Hornetz**

<table>
<thead>
<tr>
<th>C. R</th>
<th>Year</th>
<th>ISUM</th>
<th>ESUM</th>
<th>ELUM</th>
<th>OLUM</th>
<th>STOCK</th>
<th>RE</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>2009</td>
<td>254</td>
<td>235</td>
<td>235</td>
<td>235</td>
<td>235</td>
<td>235</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>235</td>
<td>235</td>
<td>235</td>
<td>235</td>
<td>235</td>
<td>235</td>
<td>150</td>
</tr>
</tbody>
</table>

**First rainy season:** Av. end of March - end of September  
years of usable records: 16  
Chances for the right growing periods:

- **Coast Comp. maize** 14 gr. p. of at least 105 days = 88% of the seasons
- **PH 1 maize** 15 gr. p. of at least 85 days = 94% of all seasons
- **Dwarf sorghum** 15 gr. p. of at least 80 days = 94% of all seasons
- **V.e.mat. cowpeas** 15 gr. p. of at least 70 days = 94% of all seasons
- **Minor millets** 16 gr. p. of at least 50 days = 100% of all seasons

**Second rainy season:** Av. end of Oct. - beginning of January  
years of usable records: 15  
Chances for the right growing periods:

- **Coast C. maize** 1 gr. p. of at least 105 days = 6% of all seasons
- **PH 1 maize** 2 gr. p. of at least 85 days = 13% of all seasons
- **Dwarf sorghum** 4 gr. p. of at least 80 days = 27% of all seasons
- **V.e.m. cowpeas** 7 gr. p. of at least 70 days = 47% of all seasons
- **V.e.m. beans** 10 gr. p. of at least 60 days = 67% of all seasons

## Relay planting:

**V.e.mat. cowpeas:** 88% of all seasons (May - July), 81% of all seasons (June - August)

## M.mat. simensis: 69% of all seasons (May - September)**
TABLE 3: CLIMATIC YIELD POTENTIALS OF SEASONAL CROPS in CL 3 m i vs/s (calc. for station 9240003 Witu D.O. with locally dominating Luvisols)

<table>
<thead>
<tr>
<th>Yield Potential (in % of Optimum)</th>
<th>Crop variety</th>
<th>Estim. average yield (kg/ha) 1)</th>
<th>Total crop failures out of 10 seasons</th>
<th>Crop variety</th>
<th>Estim. average yield (kg/ha) 2)</th>
<th>Total crop failures out of 10 seasons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very good (80-100 %)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize (Coast Composite)</td>
<td></td>
<td>3250</td>
<td>1</td>
<td>Maize (PW 909)</td>
<td>2600</td>
<td>1</td>
</tr>
<tr>
<td>Maize (Pwani Hybrid 1)</td>
<td></td>
<td>3280</td>
<td>1</td>
<td>Proso millet (Serere I)</td>
<td>1400</td>
<td>1</td>
</tr>
<tr>
<td>Sorghum (White)</td>
<td></td>
<td>3050</td>
<td>0</td>
<td>Foxtail millet (Ise 285)</td>
<td>1500</td>
<td>1</td>
</tr>
<tr>
<td>Sorghum (2 KX 17)</td>
<td></td>
<td>2980</td>
<td>1</td>
<td>Tepary beans</td>
<td>510</td>
<td>2</td>
</tr>
<tr>
<td>Finger millet (Ekalakala)</td>
<td></td>
<td>2830</td>
<td>1</td>
<td>Cowpeas (MTW 63, MTW 610)</td>
<td>1050</td>
<td>3</td>
</tr>
<tr>
<td>Green grams (KS 2010)</td>
<td></td>
<td>1180</td>
<td>0</td>
<td>Moth beans (Jodhpur)</td>
<td>810</td>
<td>1</td>
</tr>
<tr>
<td>Dolichos beans (Kat/DL 3)</td>
<td></td>
<td>2200</td>
<td>0</td>
<td>Green grams (KVR 22)</td>
<td>500</td>
<td>1</td>
</tr>
<tr>
<td>Pigeon peas (Kat/Mbaazi 3)</td>
<td></td>
<td>1180</td>
<td>0</td>
<td>Green grams (KVR 26)</td>
<td>520</td>
<td>1</td>
</tr>
<tr>
<td>Soyabeans (Magoye)</td>
<td></td>
<td>2560</td>
<td>0</td>
<td>Black grams</td>
<td>600</td>
<td>1</td>
</tr>
<tr>
<td>Soyabeans (TGX 1869)</td>
<td></td>
<td>2850</td>
<td>0</td>
<td>Mung beans (Kat Dengu 26)</td>
<td>590</td>
<td>1</td>
</tr>
<tr>
<td>Groundnuts (Makulu Red)</td>
<td></td>
<td>2140</td>
<td>0</td>
<td>Dolichos beans (Kat/DL-1)</td>
<td>880</td>
<td>1</td>
</tr>
<tr>
<td>Groundnuts (Makulu Red)</td>
<td></td>
<td>2140</td>
<td>0</td>
<td>Chick peas</td>
<td>600</td>
<td>1</td>
</tr>
<tr>
<td><strong>Good (60-80 %)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize (WS 909)</td>
<td></td>
<td>2600</td>
<td>1</td>
<td>Hog millet (Jodhpur)</td>
<td>780</td>
<td>0</td>
</tr>
<tr>
<td>Proso millet (Serere I)</td>
<td></td>
<td>1400</td>
<td>1</td>
<td>Proso millet (Serere I)</td>
<td>1400</td>
<td>1</td>
</tr>
<tr>
<td>Foxtail millet (Ise 285)</td>
<td></td>
<td>1500</td>
<td>1</td>
<td>Foxtail millet (Ise 285)</td>
<td>1500</td>
<td>1</td>
</tr>
<tr>
<td>Tepary beans</td>
<td></td>
<td>510</td>
<td>2</td>
<td>Tepary beans</td>
<td>510</td>
<td>2</td>
</tr>
<tr>
<td>Cowpeas (MTW 63, MTW 610)</td>
<td></td>
<td>1050</td>
<td>3</td>
<td>Cowpeas (MTW 63, MTW 610)</td>
<td>1050</td>
<td>3</td>
</tr>
<tr>
<td>Moth beans (Jodhpur)</td>
<td></td>
<td>810</td>
<td>1</td>
<td>Moth beans (Jodhpur)</td>
<td>810</td>
<td>1</td>
</tr>
<tr>
<td>Green grams (KVR 22)</td>
<td></td>
<td>500</td>
<td>1</td>
<td>Green grams (KVR 22)</td>
<td>500</td>
<td>1</td>
</tr>
<tr>
<td>Green grams (KVR 26)</td>
<td></td>
<td>520</td>
<td>1</td>
<td>Green grams (KVR 26)</td>
<td>520</td>
<td>1</td>
</tr>
<tr>
<td>Black grams</td>
<td></td>
<td>600</td>
<td>1</td>
<td>Black grams</td>
<td>600</td>
<td>1</td>
</tr>
<tr>
<td>Mung beans (Kat Dengu 26)</td>
<td></td>
<td>590</td>
<td>1</td>
<td>Mung beans (Kat Dengu 26)</td>
<td>590</td>
<td>1</td>
</tr>
<tr>
<td>Dolichos beans (Kat/DL-1)</td>
<td></td>
<td>880</td>
<td>1</td>
<td>Dolichos beans (Kat/DL-1)</td>
<td>880</td>
<td>1</td>
</tr>
<tr>
<td>Chick peas</td>
<td></td>
<td>600</td>
<td>1</td>
<td>Chick peas</td>
<td>600</td>
<td>1</td>
</tr>
<tr>
<td><strong>Fair (40-60 %)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulrush millet (Serere Comp. II)</td>
<td></td>
<td>1520</td>
<td>1</td>
<td>Bulrush millet (Serere Comp. II)</td>
<td>1520</td>
<td>1</td>
</tr>
<tr>
<td>Pearl millet (Kat/PM 1, bristled var.)</td>
<td></td>
<td>1030</td>
<td>1</td>
<td>Pearl millet (Kat/PM 1, bristled var.)</td>
<td>1030</td>
<td>1</td>
</tr>
<tr>
<td>Sorghum (IS 8595)</td>
<td></td>
<td>1440</td>
<td>1</td>
<td>Sorghum (IS 8595)</td>
<td>1440</td>
<td>1</td>
</tr>
<tr>
<td>Bambara groundnuts (N-Cameroon)</td>
<td></td>
<td>390</td>
<td>3</td>
<td>Bambara groundnuts (N-Cameroon)</td>
<td>390</td>
<td>3</td>
</tr>
</tbody>
</table>

1) Only crops listed with total crop failures (TCF) generally less than 33 % (acc. to calculations with MARCROP model of HORNETZ, 2001; see Methodology in Annex).

2) Well manured, fertilized and protected. Water loss as surface runoff is stopped by contour ridges.
Fair yield potential
1st rainy season: M. mat. rice NERICA 10 & 11 in seasonal flooded grasslands or semi-permanent swamps; dolichos beans, green grams, groundnuts, bambara groundnuts (Apr-Aug.); simsim; cotton; cabbage
Whole year: Coconuts (danger of bollrot disease), drought resistant bananas like Bocoboco and Zanzibarini, pineapples, lemons, and limes, oranges and grapefruit (fair to poor)

Pasture and forage
More than 1 ha/LU on secondary high-grass savanna; feeding Napier and Bana grass, siratro, Stylosanthes hamata, and centro (legumes also to improve pasture and soil) and planting horse tamarind for browsing down to about 0.25 ha/LU

CL 4 = Coastal Lowland Cashewnut-Cassava Zone

CL 4 m/s i
= Cashewnut-Cassava Zone with a medium to short cropping season
intermediate rains, and a (weak)
very short one

Very small and transitional. Potential in first rains see CL 4 m/s i but Lima and yam beans only fair, in second rains almost as CL 4 s/m i (vs)

CL 4 m/s i
= Cashewnut-Cassava Zone with a medium to short cropping season
followed by intermediate rains
(see Diagram Lamu)

Good yield potential
1st rainy season, start norm. end of March/b. of April: Med. mat. maize like Coast comp. and Pwani Hybrid PH 4, m. mat. sorghum, m. mat. bulrush (pearl) and finger millet; cowpeas (~60 %); dolichos beans; m. mat. groundnuts (Apr-Aug.); e. mat. trop. Lima beans, yam beans (tubers), sweet potatoes; e. mat. sunflower like Kenya Almasi, m. mat. soya beans on h. and m. soils, e. mat. soya beans on light soils; kales, onions, pumpkins, chillies, sweet pepper, okra, egg plants, Chinese cabbage, garlic, water melons, cucumbers, guar.
Whole year: Cashew nuts, cassava; sisal, mangoes

Fair yield potential
1st rainy season: E. mat. rice in semiperm. swamps; green grams (May/June-A./S.) and simsim; cotton, safflor; cabbages, tomatoes; trop. Lima beans
Whole year: Pawpaws, senna, bixa

Some marginal crops with poor yield potential
Whole year: Bananas, coconuts

Pasture and forage
More than 1.5 ha/LU on secondary high-grass savanna; down to about 0.3 ha/LU feeding Bana grass, centro, siratro, Clitoria ternatea, Stylosanthes hamata, Macrotyloma axillare (legumes also to improve pasture and soil), and planting horse tamarind (Leucaena tricandria) for browsing. Mangrove leaf. Nat. vegetation: dry forest patches on free draining land, doum palm savanna on lower places; tsetse flies near forest

CL 4 m/s i + (vu)
= Cashewnut-Cassava Zone with a medium to short cropping season, intermediate rains, and a (weak) very uncertain one
(see Diagram Mkunumbi)

Potential almost as CL 4 m/si but cowpeas and simsim planted towards the end of 1st rains give normally only poor yields; 2nd rains too weak or uncertain for crops

CL 4 s/m i
= Cashewnut-Cassava Zone with a short to medium cropping season
followed by intermediate rains

Potential almost as CL 4 m/s i but Coast Comp. and Pwani Hybrid maize PH 4, finger millet, cowpeas give normally only fair yields, cashew nuts good to fair
### DIAGRAM OF GROWING PERIODS IN THE COCONUT-CASSAVA ZONE CL 3
with a reliable medium to short first rainy season and a very uncertain second rainy season

<table>
<thead>
<tr>
<th>Station name</th>
<th>Canal and legumes growing period</th>
<th>Dry conditions</th>
<th>Precipitation is cumulated during agro-humid period in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamu Met. Stn.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9240001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subzone:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### First rainy season:
Av. end of March - end of September

- Years of usable records: 38
- All with AHP

#### Second rainy season:
Av. end of Oct. - beginning of January

- Years of usable records: 36, 14 with AHP

#### Chances for the right growing periods:

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Probability (%)</th>
<th>Probability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coast Comp. maize</td>
<td>28</td>
<td>74</td>
</tr>
<tr>
<td>PH 1 maize</td>
<td>35</td>
<td>92</td>
</tr>
<tr>
<td>Dwarf sorghum</td>
<td>36</td>
<td>95</td>
</tr>
<tr>
<td>V.e.mat. cowpeas</td>
<td>37</td>
<td>97</td>
</tr>
</tbody>
</table>

#### Relay planting:
V.e.mat. cowpeas: 86% of all seasons (May - July), 71% of all seasons (June - August)

M.mat. simissir: 60% of all seasons (May - September)

#### Existential risks:

1. No cereal growing period in a year or more: 0 times = 0% of the years
2. 2 or more consecutive rainy seasons without the min. AHP of 50 d.: 0 times in 38 years
3. No grass growing period in a season: 13 times = 17.1% of the seasons
4. No grass growing period in a year or more: 0 times = 0% of the years

---

1) valid = no significant gaps in the records
2) AHP = Agro-humid period – growing period for cereals and legumes; GGP = grass growing period
CL 4
s/m i
(tn)
Very short one

**Good yield potential**
1st rainy season, start norm.
end of March: E. mat. sorghum like Gadam; e.
mat. pearl millet (bristled variety); dolichos beans, green grams, cowpeas, e. mat.
groundnuts like Makulu Red, mung beans; e. mat. cassava

Whole year: Sisal, perennial castor

**Fair yield potential**
1st rainy season: M. mat. maize Coast composite or e. mat. maize PH 4; chick peas, black
grams; e. mat. bambara groundnuts⁶; simsim, sweet potatoes; sunflower Almasi; e. mat.
soya beans on h. and m. soils; luffa gourds, kales, cabbage, onions, tomatoes, chillies

2nd rainy season, start norm. e. of S.: V. e. mat. millets (proso, foxtail & hog millet); green
grams (~40 %), chick peas (on h. bl. soils), cowpeas mainly for spinach

Whole year: L. mat. cassava like Kaleso (on light soils); cashew nuts, mangoes, pineapples

**Poor yield potential**
2nd rainy season: V. e. mat. sorghum IS 8595

**Pasture and forage**
Around 2 ha/LU in woodland, more than 3 ha in thickets: partly danger of tsetse if not
cleared enough, feeding Bana grass and planting horse tamarind for browsing down to
about 0.4 ha/LU. Cassava is an add. forage. More forage plants see Table X

Situation in 2nd rainy season is 10-20% better during an ENSO season (33% of the years)

---

CL 4
s i
(tn)
= Cashewnut-Cassava Zone with a short cropping season,
intermediate rains, and a (weak)
very short one

**Good yield potential**¹
1st rainy season, start norm. end of March: E. mat. sorghum, e. mat. pearl millet (bristled
var. Kat/PM 1 above 250 m); chillies

Whole year: Mangoes, castor, sisl, jatropha

**Fair yield potential**¹
1st rainy season: E. mat. Pwani Hybrid PH 4 or WS 202, e. mat. rice NERICA 10 & 11
in mbugas, finger millet; cowpeas, dolichos beans, mung beans, green grams, e. mat.
pigeon peas Kat/Mbaazi 3 and simsim²; sweet potatoes; e. mat. groundnuts³ and
bambara groundnuts⁶; kales, onions, tomatoes, red and green sweet pepper; e. mat.
cassava like Nzalauka

2nd rainy season, start norm. O.: V. e. mat. foxtail millet (ISE 285) & proso millet
(Serere 1); green grams, cowpeas (for leaves), simsim (~40 %)

Whole year: Cashew nuts, ye-eb nuts

**Some marginal crops with poor yield potential**
2nd rainy season: Coast comp. maize¹ (S.-D./J.), v. e. mat. sorghum like Gadam or KARI
Mt. 1 (maize & sorghum fair yields in ENSO seasons), v. e. mat. sweet potatoes (to
keep plant mat. for next long rains)

Whole year: Pawpaws¹

**Pasture and forage**
Around 2 ha/LU on short grass doum palm savanna on low, seasonally waterlogged land;
feeding Bana grass and fodder legumes like siratro (med. soils on free draining land) and
planting horse tamarinds (also on mbuga edges) down to about 0.35 ha/LU. Cassava is an
add. forage. Sclerophytic dry forest on free draining land, tsetse flies near these forest patches

---

CL 4
s i
(tn)
= Cashewnut-Cassava Zone with a short cropping season
followed by intermediate rains

**Good yield potential**¹
1st rainy season, start norm. end of March: E. mat. sorghum, e. mat. (bristled) pearl millet
Kat/PM 1; e. mat. pigeon peas Kat/Mbaazi 3

Whole year, best planting time b. of April: Buffalo gourds (on light soils)¹⁰
Fair yield potential

1st rainy season: E. mat. maize like Pwani Hybrid PH 4 or WS 202; cowpeas, dolichos beans like Kat DL 1, green grams and simsim (e. of May- e. of Aug.); e. mat. groundnuts³ and bambara groundnuts³⁶; onions, tomatoes, chillies

Whole year: Cashewnuts, mangoes, sisal, castor, jatropha

Pasture and forage

Around 2.5 ha/LU on bushland with acacias, about 2 ha on short grass doum palm savanna in mbugas; horse tamarinds to plant on mbuga edges, saltbush (Atriplex nummularia) on higher land for browsing

CL 4 = Cashewnut-Cassava Zone

with a short cropping season

Potential almost as CL 4 s but cowpeas and simsim planted towards the end of 1st rains get poor yields only

CL 4 = Cashewnut-Cassava Zone

with a short to very short cropping season, intermediate rains, and a (weak) very short one

Potential almost as CL 4 s (vs) but 1st rains start normally b. of April

CL 5 = Coastal Lowland Livestock-Millet Zone

CL 5 = Livestock-Millet Zone with a (weak) short to very short cropping season, intermediate rains, and a (weak) very short one

Good yield potential

1st rainy season, start normally mid April: Buffalo gourds (on light soils)¹⁰, Marama beans¹⁰

Fair yield potential

1st rainy season, start normally b. of April: E. mat. sorghum Gadam (50-60 %), e. mat. pearl or bulrush millet (bristled var.)¹¹; chick peas (on h. black soils), cowpeas, green and black grams (May-Aug., 50-60 %)¹¹; e. mat. bambara groundnuts¹³⁶; e. mat. onions¹¹

2nd rainy season, start normally end of Oct.: Cowpeas for leaves, green grams¹¹

Whole year: Sisal (50-60 %)¹¹, castor¹¹, drought resistant cassava¹¹, jatropha, ye-eb nuts

Poor yield potential

1st rainy season: E. mat. maize

2nd rainy season: E. mat. pearl millet (bristled var. Kat/PM 1), v. e. mat. proso & foxtail millet

Whole year: Mangoes

Pasture and forage

2-4 ha/LU on sclerophytic evergreen bushland (partly tsetse infested), about 2 ha/LU in mbugas; down to about 0.5 ha/LU on art. pasture of buffel grass (Cenchrus ciliaris) and feeding vines of Mauritius or moth beans, and planting fodder shrubs like saltbush (Atriplex nummularia) and Mesquite (Prosopis spec.)

CL 5 = Livestock-Millet Zone with a short to very short cropping season followed by intermediate rains

Good yield potential

1st rainy season, start normally mid April: E. mat. Gadam sorghum, e. mat. pearl millet (bristled var., ~60 %); chick peas (late planted on heavy black soils)

Whole year: Buffalo gourds (on light soils)¹¹⁰, Marama beans¹¹⁰, physic nut (Jatropha)¹¹⁷

Fair yield potential

1st rainy season: V. e. mat. maize PH 4 or WS 202; cowpeas and grams (May-Aug.); e. mat. groundnuts³⁶; e. mat. bambara groundnuts³⁶; onions

Whole year: Drought resistant cassava (fair to poor), castor

Poor yield potential

1st rainy season: M. mat. maize like Coast Composite
Pasture and forage
More than 3 ha/LU on dry acacia bushland; down to about 0.6 ha/LU on art. pasture of buffel grass and feeding hay or silage of Mauritius and moth bean vines during dry season, and planting fodder shrubs like saltbush and Gao trees on good soils (Acacia albida) for pods

CL 5 = Livestock-Millet Zone with a very short to short cropping season, intermediate rains, followed by a (weak) very short one

Good yield potential
1st rainy season, start norm. April: E. mat. foxtail millet, luffa gourds and e. mat. water melons (from West-Africa)
Whole year: Buffalo gourds (on light soils), Marama beans, ye-eb nuts

Fair yield potential
1st rainy season: E. mat. pearl millet (bristled var. Kat/PM 1)
Gadam sorghum; chick peas (late pl. on heavy black soils), cowpeas, green and black grams, v. e. mat. bambara groundnuts; simsim (May-Aug.)
2nd rainy season, start norm. end of Oct.: Cowpeas for leaves, green grams (fair to poor)
Whole year: Sisal, castor, drought resistant cassava (fair to poor), jatropha

Pasture and forage
Almost the same as CL 5 (s/vs) i (vs)

CL 5 = Livestock-Millet Zone with a (weak) very short to short cropping season, intermediate rains, and a (weak) very short one

Potential almost as CL 5 vs/s i (vs) but good potential there is only fair here; stocking rates about 10 % lower

CL 5 = Lowland Livestock-Millet Zone with a (weak) very short cropping season and a very uncertain (weak) second one

Poor yield potential
1st rainy season: E. mat. pearl millet (bristled var.), v. e. mat. Gadam sorghum; green grams

Pasture and forage
3-5 ha/LU on small-leaved bushland; situation improvable by fodder plants as in CL 5 vs/s and by Opuntia spec.

IL 6 = Inner Lowland Ranching Zone

IL 6 = Inner Ranching Zone with bimodal rainfall

No rainfed crops for good or fair results except desert plants like buffalo gourds or ye-eb nuts. More than 5 ha/LU on short grass savanna mixed with small-leaved bushland; improvable by fodder shrubs like saltbush and on good soils by Gao trees (Ac. albida)

---

1) Not in waterlogged areas or during times of waterlogging, except rice and partly sorghum, sweet potatoes
2) Relay-planted in maize during June/July, cowpeas and chick peas also on places where the waterlogging has just gone; cowpeas for leaves planted already in April.
3) Not on heavy soils
4) Not top quality
5) In deep water: floating rice varieties from Bangladesh, higher places NERICA
6) Gives reasonable yields also on poor soils
7) Jatropha curcas; shrub for hedging, gives medical or technical oil from seeds and blue colour or tannin from bark. Origin: NE-Brazil
8) Cordeauxia edulis, native in the medium bush and in thickets of the coastal hinterland.
9) Very sensitive to salinity
10) Still experimental. Plants produce edible seeds and, after some seasons, also tubers. Bitterness may be washed out in salty water
11) Cyamopsis tetragonolobus (Leguminosae) from India; vegetable or fodder, seeds contain gum; N collector
LAMU
Group of Districts

KEY
- Boundary of District Group
- Boundary of mulching zone
- Towns and Villages
- River
- Seasonal water course
- National Reserve
- Road

SOILS

Groups of Special Soil Care

Necessities
- Organic manuring etc. and protection against soil erosion esp. necessary
- Heavy organic manuring
- Heavy organic manuring and prot. against denudation & erosion
- Organic manuring & mulching and protection against denudation
- Mulching with deep rooting bushes especially profitable
- Flood control & drainage, channeling and ridging
- Different technologies are necessary, partly unsuitable soils

Reasons
- Soils young and shallow, sloppy
- Senile deep soils
- Senile and shallow soils
- Young foot-slope soils
- Bedrock has many nutrients
- Seasonal inundations & waterlogging
- Complex soils, see legend

SOIL DISTRIBUTION, FERTILITY AND MAJOR CHARACTERISTICS

The relief differences of this district are small but important for soil water conditions. Along the coast mangrove swamps occur, backed by extensive coastal plains, which include bottomlands. In the middle and northeastern part, coastal beach ridges occur.

Marine (non-)consolidated sediments are the parent material for most of the area. On coastal plains (Pc) soils of unit PcJ 6 are extensive and of low to moderate fertility. Northwards soils of unit PcJ 5 are found which have the same low fertility.

Soils of units Z 1 and Z 2 of low fertility are found on slightly higher topography, as they are formed on former coastal beach ridges, and are often orientated in a SW-NE direction. If not too shallow, some soils on coral rock are relatively fertile. Southwest from Lamu, soils on dunes (unit D 1) of low to very low fertility occur.

Lower topographical positions on the plains are typical bottomlands with soils of units BJ 1 of a high fertility and BJ 2 of low to moderate fertility.

LEGEND TO THE SOIL MAP OF LAMU GROUP OF DISTRICTS

1 Explanation of the first character (physiography)
   
Pc Coastal Plains
   
A Floodplains and River Terraces (almost flat to gently undulating; slopes between 0 and 5%; various altitudes; seasonally flooded or ponded)
   
B Bottomlands (flat to gently undulating; slopes between 0 and 5%; various altitudes; seasonally ponded)
   
D Dunes
   
T Tidal Flats and Swamps
   
Z Coastal Beach Ridges

2 Explanation of second character (lithology)
   
A Recent Alluvial Sediments from various sources
   
J Lagoon Deposits
   
L Limestones and Calcitic Mudstones

3 Soil descriptions
   
PcJ 2 Imperfectly drained, deep to very deep, very dark greyish brown to olive brown, mottled, firm to very firm, sandy clay to clay; moderately calcareous and moderately saline and sodic throughout or in deeper subsoil: luvo-orthic SOLONETZ, saline phase and vertic LUVISOLS, saline-sodic phase
   
PcJ 5 Imperfectly drained, very deep, brown, very firm, sandy loam to sandy clay loam, abruptly underlying a thick topsoil of friable loamy sand and with a slightly to moderately sodic deeper subsoil; with inclusions of many small bottomlands of unit BJ 1: solodic PLANOSOLS
**Pcj 6**  Somewhat excessively drained to moderately well drained, very deep, yellowish brown to greyish brown, mottled, friable to firm, sandy loam to sandy clay loam, in many places with a thick (60-100 cm) topsoil of light brownish grey to yellow, very friable loamy sand; with inclusions of many small bottomlands of unit BJ 2: (ferralo-)chromic LUVISOLS and calcic ARENOSOLS; with gleyic and albic LUVISOLS, sodic phase, and dystric and solodic PLANOSOLS

**PcL 1**  Well drained, shallow to moderately deep, red to dark reddish brown, friable, rocky, loam to sandy clay loam: LITHOSOLS; with ferralic CAMBISOLS, lithic phase

**AA 4**  Well drained to imperfectly drained, very deep, dark brown to yellowish brown, stratified, micaceous, strongly calcareous, predominantly loamy soils: calcic FLUVISOLS

**AA 5**  Imperfectly drained to poorly drained, very deep, dark reddish brown to dark greyish brown, firm to very firm, cracking clay; in many places mottled and with a calcareous, saline and sodic deeper subsoil: chromic VERTISOLS, saline-sodic phase

**BJ 1**  Imperfectly drained to poorly drained, very deep, light brownish grey to brown, mottled, firm to very firm clay; in places sodic and cracking; higher-level depressions: gleyic PHAEOZEMS; with verto-luvic PHAEOZEMS and pellic VERTISOLS, sodic phase

**BJ 2**  Poorly drained, very deep, greyish brown, mottled, very firm clay, abruptly underlying a topsoil of friable, humic sandy clay loam; lower-level depressions: humic PLANOSOLS

**D 1**  Excessively drained to well drained, very deep, brown to pale brown, loose, slightly to strongly calcareous, medium sand to loamy medium sand: cambic ARENOSOLS and calcic REGOSOLS

**T**  Very poorly drained, very deep, olive to greenish grey, soft, unripe, excessively saline, moderately to strongly sodic, loam to clay; in many places with sulfidic material: thionic FLUVISOLS, saline phase and gleyic SOLONCHAKS

**Z 1**  Well drained, very deep, red, very friable, sandy clay loam: rhodic FERRALSOLS

**Z 2**  Moderately well drained, very deep, dark brown to reddish brown, firm to very firm, often moderately sodic, sandy clay loam, underlying a thick topsoil of friable loamy sand; in places shallow over coral rock: ferralo-chromic / orthic ACRISOLS, sodic phase; with solodic PLANOSOLS

**NOTES for definitions (of underlined words):**
- mollic Nitisols and chromo-luvic Phaeozems: soils are equally important
- mollic Nitisols, with chromic-luvic Phaeozems: Nitisols are prevalent
  - in places: in < 30% of the area
  - in many places: in 30-50% of the area
  - predominantly: in > 50% of the area
- deeper subsoil: below 80 cm

**3.6.2 POPULATION AND LAND**  see main Volume Coast Province

**3.6.3 AGRICULTURAL STATISTICS**  see main Volume Coast Province
3.6.4 FARM SURVEY

The Farm Survey of 2004 was carried out in three AEZs and four sites of the Lamu district as shown in Table 11. The three AEZs were CL 3 (Hongwe), CL 4 (Bahari and Manda) and CL 5 (Bodhai). The data collected during the 2004 FS on various agricultural aspects are presented in Tables 12 a-d, while the cropping pattern results are presented in Tables 13 a-d. In Hongwe, Bahari and Bodhai, the average land per household in the samples is about 4 ha and 3.02 ha at Manda (Tables 12 a-d). These results suggest that the majority of the households still have sizeable pieces of land. In CL 4 (Bahari and Manda) and CL 5 (Bodhai), annual crops allocated more land than perennial crops as illustrated by land use results (Tables 12 b-d) and total sample area in Table 13. In Hongwe (CL 3, Table 12a), the average household land size for annual and perennial crops is 1.54 ha and 1.87 ha, respectively. Further, perennial crops have a total sample area of 52.36 ha compared to area under annual crops 1st rainy season- 37.19 ha, 2nd rainy season- 21.58 ha). Although there are two growing seasons in Lamu district group, the 1st rainy season is the most dependent on by farmers as illustrated by the total sample area under cultivation (Tables 13 a-d). In fact, in AEZs CL 4 (Bahari and Manda), farming during the 2nd rainy season is almost non-existent because the rains are not sufficient. Further inland the second rains increase and are in CL 5 (Bodhai) almost as important as the first rains. Major annual crops are maize and cowpeas. Other annual crops include simsim (in CL 3) 1); pigeon peas (CL 4-Bahari); cotton (CL 4); and sorghum, green grams and finger millet (in CL 4, Manda). Coconuts, cashew nuts and mangoes are major perennial and cash crops in Lamu district group. Nonetheless, bixa and bananas are also grown as cash crops in Hongwe and Bahari respectively. Although a few farmers in Manda and Bodhai apply manure and use improved seeds, use of other farm inputs such as fertilizer and insecticides was not reported in Lamu district group.

There is an average of about 1 ha per household allocated to permanent pasture and fodder in AEZs CL 3 and CL 4. In AEZ CL 5, the average land area for this purpose per household is lower (0.29 ha) because there is still large communal land. It appears land pasture and fodder is set aside for goats and sheep farming in Hongwe and Bahari since none of the respondents kept cattle. Households in Manda and Bodhai keep dairy, zebu and sheep/goats in fairly large numbers. For instance, at Manda, the household has an average of 10 dairy animals, 7 zebu and 33 sheep/goats. The high number has implications on land’s carrying capacity. In Bodhai, stocking rate for dairy and zebu is 8.6 TLUs/ha and 11 respectively (in the quartiles even higher because single households were counted). But these are just statistical figures. The animals graze or browse mainly outside. The situation at Manda is of concern where households who keep zebu animals have no land dedicated to pasture and fodder. Many households in Lamu keep a high number of sheep and goats, thus, approximately one hectare of land under pasture is not sufficient to sustain them. In fact, at Bodhai, households keeping sheep and goats do not have pasture land and go to communal land. This is a potential recipe for land degradation. Although dairy farming is practiced in Bodhai and Manda, the percentage of households practicing it is 32.5% and 21.6%, respectively.

TABLE 11: FARM SURVEY SITES
Representative of the Dominating Agro-Ecological Zones, Sub-zones and Units

<table>
<thead>
<tr>
<th>District 2004</th>
<th>No. in Kenya</th>
<th>Agro-Ecological Unit</th>
<th>Farm Survey Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamu</td>
<td></td>
<td>AEZone</td>
<td>Subzone</td>
</tr>
<tr>
<td>201 CL 3</td>
<td>15</td>
<td>m i (vs)</td>
<td>PeJ 6</td>
</tr>
<tr>
<td>202 CL 4</td>
<td>19</td>
<td>m/s i</td>
<td>Z2 &amp; PeJ6</td>
</tr>
<tr>
<td>203 CL 4</td>
<td>19</td>
<td>m/s i</td>
<td>PeJ 6</td>
</tr>
<tr>
<td>204 CL 5</td>
<td>18</td>
<td>vs/s i (vs)</td>
<td>PeJ 6</td>
</tr>
</tbody>
</table>

1) Sismim is mainly planted at the end of the first rainy season to avoid damaging rains in the open flowers. In the Table 12a most of this crop is therefore listed under the second rainy season.

Tables 12 a - d: ASSETS, LAND USE, FARMING INTENSITY AND INPUTS see main Volume Coast Province
Tables 13 a - d: CROPPING PATTERN see main Volume Coast Province
3.6.5 INTRODUCTION TO THE ACTUAL LAND USE SYSTEMS AND POTENTIAL INTENSIFICATION BY BETTER FARM MANAGEMENT IN DOMINATING AGRO-ECOLOGICAL SUBZONES IN LAMU GROUP OF DISTRICTS

In order to realize the main task of the farm management, a question targeting specifically the inputs used by farmers and resultant increase in yields was included in the Small Farm Survey questionnaire that was conducted. In each survey area the purposively sampled 30 farmers were divided into 3 groups: one group applying low inputs, a second one medium inputs, and a third one high inputs. The difference between these groups shows the amount of yields that can be realistically achieved by the farmers practicing better farm management. The column with the yield potential finally shows figures under optimal soil conditions, water supply, crop husbandry and pest control, which is the ultimate goal of any farmer.

More detailed information can be found together with calculations of profitability in the Farm management Guidelines of each district. The tables found there are not yet sufficiently correlated with the relevant and most suited Agro-Ecological Units, which are necessary for the calculation of expected yields and the amount of inputs. The amount of fertiliser per soil unit is described in MURIUKI & QURESHI: Fertiliser Use Manual, KARI 2001. For more details, see Chapter 3.2.6.

In terms of aerial expanse, the dominant zone in which field data were collected from in Lamu District are: CL 3, 4 and 5. An additional important reference material is “Small Holder Farming Handbook for Self-employment”. First published in 1997 by Information Research and Communication Centre (IRACC) & Marketing Support Services Ltd, Nairobi.

Subzone CL 3 m i (s/vs) of the Coconut–Cassava Zone

This is the Coastal Lowland Coconut-Cassava Zone with a medium cropping season, intermediate rains and a (weak) short to very short one as typified by Hongwe Location, Hongwe Sub-location, in Mpeketoni Division. The dominating soil is well drained, very deep, dark red to strong brown, firm, sandy clay loam to sandy clay, underlying medium sand to loamy medium sand: chromic and ferralo-orthic LUVISOLS. The average annual rainfall amount is between 1000 – 1150 mm*. The first rainy season can expect more than 400 – 650 mm* in 10 out of 15 seasons and second rainy season > 170 – 220 mm*. The 60% reliability of the growing periods during the 1st and 2nd seasons is more than 135 – 155 and 75 – 85 days, respectively.

It should be pointed here at the outset that this farm survey in Lamu district was done within a settlement scheme. Two principles of government settlement policy concern the objective to stimulate small-scale farming and the requirement of payments by tenants for the land they receive. The structural change of substituting small- for large scale farming was of paramount importance but the population growth makes it necessary to reconsider the issue of plot size. Usually, the procedure has been for planners to calculate the farm size needed to support an average family. The plot sizes that were initially issued in the high density schemes were large compared with the customary holding in the former reserves. At the Coast in general, the plots that were given out were generally smaller, although 4-5 ha (10-12 acres) is again higher than the customary plot size. Indeed, the figures presented earlier indicate that the productivity per acre on small farms is higher than on large farms. Attitudes toward farming are also an important factor. It is generally recognised that there is a considerable difference in attitudes toward farming between the coastal Mijikenda and some of the up-country settlers, notably the Kamba in Shimba Hills and the Kikuyu in Lake Kenyatta. The latter have a reputation as diligent cultivators and it is also reported that the traditional gender division of labour has changed considerably with men and women working together in the fields. This cannot be expected to happen easily among the Mijikenda.

* According to the position of the place in the subzone
The food crops grown by farmers who were interviewed are: maize, cowpeas and simsim for both first and second rainy seasons (Table 13a). The yields of maize have consistently remained low (Table 14a) because of low application of farm inputs (Table 12a & 14a). If this trend continues, this area will for a long time remain a food deficit one in the district.

The permanent crops grown include mangoes, coconuts, Bixa and bananas. Cassava is a subsidiary staple in this Subzone and has increasingly becoming an important cash crop. It is regarded as an important security crop because of its tolerance to drought, ability to give reasonable yields on poor soils, low external input and labor requirements, and the option of harvesting over a long period after the first season. The next most important annual crop is cowpea. However, even though cowpea is also drought tolerant, it is very vulnerable to pests and diseases, which often leads to very low yields.

Zone CL 3 is so important that some statements must be made which concern also the other coastal districts. Tree cultivation, which is very common, covers a large area in zone CL3 and is an important source of regular income. Major tree crops are coconuts, cashew nuts, citrus, Bixa, and mangoes. Trees grow easily without much labor input and the fruits are sold for cash. Coconuts are the most important tree crops in this Subzone until recently; now farmers in Lamu district group rank mangoes as the number one cash crop.

Two types of mangoes are grown in Lamu district group and in this Subzone in particular: the local and the exotic or improved varieties. The latter are usually grafted on local mangoes and are grown for the export market. Most local varieties tend to have high fibre content, commonly referred to as “stringy”, and this characteristic makes them unpopular for fresh consumption. The local mango varieties are usually left to grow naturally without much crop husbandry. At the farm-level, key constraints faced by farmers are the lack of clean planting material, inadequate technology, the length of the production cycle and inadequate post-harvest handling facilities. Concerning planting material, there is a generalized shortage of grafted seedlings. Hence, farmers tend to use inferior, low yielding seedlings. Farmers do not have knowledge on improved production technology, and there is little or no use of fertilizers and pesticides. Pests – mainly the mango seed weevil and fruit fly – and diseases – mainly anthracnose and powdery mildew – are also major problems. Some fruit trees are so tall and big such that spraying is only not viable but also impossible. Farmers often lack motorized pumps for effective pest and disease control. Coupled with this, is poor crop management practice, which leads to flower and fruit fall.

Farmers in Lamu district group suffer from poor post-harvest handling techniques, leading to significant losses, which affect returns to the farmer and traders. Furthermore, farmers do not have good storage facilities available at the farm level, and this forces them to sell their product immediately after harvest. No collective bargaining takes place on the price, and each farmer interacts individually with the trader and other buyers, often receiving prices well below reigning market prices. At the marketing stage, a major constraint is the poorly developed transport infrastructure, such as the bad road conditions that serve production areas which further contribute to post-harvest losses and a deterioration of quality leading to low selling prices. In many districts, transport and shipping costs are in fact prohibitive, both within and outside the country. Supply is not well organized with collection, grading and packing facilities and, therefore, farmers are not able to separate higher quality fruits to be remunerated accordingly. Moreover, farmers often lack the necessary information on alternative marketing possibilities and on alternative product uses, such as drying, and other options for value addition. Traders themselves often suffer from poor access to credit, which makes it difficult for them to finance their operations. In regard to exports, inadequate post-harvest/husbandry control, wrong varieties for sea freight, inadequate sea freight facilities and high air freight costs are among the major constraints. Moreover, the need to comply with the EUREGAP and traceability standards, which are necessary to enter the EC market, constitute a further problem. Exporters themselves often suffer from price instability in international markets and from stiff competition from other countries like India, Pakistan, Brazil, Mexico and Costa Rica. These competitors offer higher quality varieties at lower prices, due mainly to lower shipping costs.

Finally, concerning processing, major constraints are the insufficient plant capacity and organization of supplies. Currently, less than 1 percent of mangoes produced in Malindi are processed. The better quality fruits are exported, and processors are left with fruits of the lowest quality. Seasonal production is only enough
to supply factories for seven months of the year. On the consumption side, the price of natural mango juice is too expensive for domestic consumers, who mostly consume cheaper products and indigenous varieties. Relatively cheaper imported mango juices are available from Mauritius, South Africa and Egypt. These countries enjoy preferential tariffs under the regional trade agreement, Common Market for Eastern and Southern Africa (COMESA). Further competition comes from locally manufactured, chemically sweetened mango flavoured soft drinks.

Stakeholders in the industry could look at ways to improve exports of fresh fruit through better quality control and management of the value chain. Given that a sizeable quantity of fruits does not normally meet export standards, other utilization must be examined. In the immediate future, the development of processed products seems to offer the best market opportunities to this end, particularly for export, given that shipping and handling costs are lower for processed products. In the longer term, capacity building of farmers on crop husbandry, technological application and overall farm management are key to the development of the chain. Improvement in extension provided to mango farmers is required. The need to improve plant breeding is required particularly for hybrid and improved varieties. In some areas, better quality could be achieved by adapting existing varieties, but developing new locally-adapted varieties in the long run should be explored. Defining the needs and implementing priorities of infrastructural development must be carried out to support the sub-sector. In the area of physical infrastructures, particular emphasis should be given to storage facilities and to transportation. Concerning institutional infrastructures, the development of adequate credit facilities and other services required by the supply chain and setting up collective farmers’ bodies, responsible for marketing and for the interaction with other stakeholders in the chain, must be examined.

Tree crops are estimated to contribute over 65% of farm produce value in zone CL3. Distance from markets and the small number of marketing outlets are a major constraint to agricultural income generation. Poor infrastructure, perishable farm produce, lack of organized marketing, and the small number of middlemen in the area also mean that agricultural prices and consequently farm income, are low. Several commodities are handled through formal markets where prices and conditions are regulated by the government. They include maize, rice, sugar cane, cashew nuts and Bixa. These markets are dominated by large purchasing organizations such as the National Cereals and Production Board, Kenya Cashew Nuts Limited, and Kenya Bixa Limited. Cooperatives, middlemen, and end-users are licensed buying agents for these organizations. Since the deregulation of cereal markets in the 1990s, however, food crops like maize and rice are mostly handled through informal markets (influenced only minimally by regulations) and where prices tend to be lower than in formal markets. Informal markets also handle vegetables and fruit, cassava, sweet potatoes, tomatoes, mangoes, bananas and papayas.
### TABLE 14a: INCREASE OF YIELDS BY BETTER FARM MANAGEMENT IN AGRO-ECOLOGICAL UNIT \(^3\) **CL 3 m i (s/vs), PcJ 6**

**Subzone: m i (s/vs), Soil Unit: PcJ 6**  
**Survey Area 201 (Hongwe)**

<table>
<thead>
<tr>
<th>Crop Yields(^3) and Inputs</th>
<th>AEZ: CL 3 COCONUT – CASSAVA ZONE</th>
<th><strong>Survey Area 201 (Hongwe)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sub-zone: m i (s/vs)</strong> (Periods in days(^2): 1(^{st}) rainy season 135-155, 2(^{nd}) rainy season 75-85 days)</td>
<td><strong>Unit with predom. Soil: PcJ 6 = well drained chromic and ferralo-orthic LUVISOLS</strong></td>
<td><strong>Reliable rainfall: 1(^{st}) rainy season &gt;400 – 650 mm in at least 10 out of 15 years</strong> <strong>2(^{nd}) rainy season: &gt;170 – 220 mm in at least 10 out of 15 years</strong></td>
</tr>
<tr>
<td><strong>Farmers in Prod. Level</strong></td>
<td><strong>Farmers in Prod. Level</strong></td>
<td><strong>Reliable rainfall: 1(^{st}) rainy season &gt;400 – 650 mm in at least 10 out of 15 years</strong> <strong>2(^{nd}) rainy season: &gt;170 – 220 mm in at least 10 out of 15 years</strong></td>
</tr>
<tr>
<td><strong>Maize local monocropped Yields(^3) kg/ha Fertiliser(^7):</strong></td>
<td></td>
<td><strong>AEU Pot.(^6)</strong></td>
</tr>
<tr>
<td></td>
<td>I= low</td>
<td>II= med.(^4)</td>
</tr>
<tr>
<td>N kg/ha</td>
<td>2500</td>
<td>-</td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Manure t/ha</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>Hybrid maize Yields(^3) kg/ha Fertiliser(^7):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure t/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maize local intercropped with beans Yields(^3) kg/ha Fertiliser(^7):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure t/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maize hybrid intercropped with beans Yields(^3) kg/ha Fertiliser(^7):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure t/ha</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

\(^3\) Source: Interview of 30 farmers (if possible 10 in each level) 2004 by Divisional and Field staff

\(^4\) Figures of these cereals growing periods should be reached or surpassed in 6 out of 10 years; growing periods may be considered longer due to immediately following second rainy season by middle rains. Then the second growing period is shorter than the given figures

\(^5\) Achieved average yields with average rainfall

\(^6\) Farmers with high inputs of Fertiliser, insecticides, soil and water conservation

\(^7\) Potential yield according to crop list and local climate of this Agro-Ecological Unit if soils are optimally fertilized, plus optimal crop management

\(^8\) Fertiliser applications are averaged at 20 % of pure nutrient

\(^*\) Potential not yet determined under the agroecological unit
**Subzone CL 4 m/s i of the Cashewnut–Cassava Zone with sandy soil**

This is the Coastal Lowland Cashewnut-Cassava Zone with a medium to short cropping season and intermediate rains as typified by Bahari Location, Bahari Sub-location, in Mpeketoni Division. The dominating soil is moderately well drained, very deep, dark brown to reddish brown, firm to very firm, often moderately sodic, sandy clay loam, underlaying a thick topsoil of friable loamy sand; in places shallow over coral rock: ferralochromic/orthic ACRISOLS, sodic phase; with solodic PLANOSOLS and LUVISOLS. The average annual rainfall amount is between 850 – 1000 mm*. The first rainy season can expect more than 300 – 500 mm* in 10 out of 15 seasons and second rainy season > 50 – 140 mm*. The 60% reliability of the growing periods during the 1st and 2nd seasons is 115 - 135 and < 40 days, respectively.

Due to the low reliability of the rains and the short cropping season, drought-evading and drought-tolerant crop varieties should be cultivated. In general, the short rains are almost inadequate for the cultivation of annual crops. The indigenous cereals were sorghum and millet, both of which are drought-resistant and therefore well suited for the unreliable and low amounts of rainfall. Since the end of the last century, however, sorghum and millet have almost entirely been replaced by maize. Compared to sorghum and millet, maize has a higher production potential, is less vulnerable to diseases and pests (especially bird attacks), and is more easily prepared for consumption. On the other hand, maize is quite vulnerable to both water deficits and surpluses, while it requires a well drained soil with a good supply of nutrients, which are not added to the soil in this Subzone (Tables 12b & 14b). Due to the usually low and unreliable rainfall, together with the low fertility of soil and inadequate fertiliser application, yields vary from low to almost nil over the years. Yields are on average 200 – 600 kg/ha (Table 14b), which is very low compared to other regions of Kenya,

Weeds are serious competitors regarding nutrients, light and space, especially in the early life stages of the maize. If not properly removed, they can cause considerable yield reductions. A special problem is formed by *Striga spp.* (witchweed), a parasite which attaches to the root system of the maize. Most common pests affecting maize yields are the stalk borer and the army worm, while major diseases are white leaf blight and rust.

Indigenous root crops are the several types of yam, which are not popular any more. More common nowadays is cassava, a crop which was hardly grown before the mid-nineteenth century. Cassava is relatively drought resistant, has a good yield potential on poor soils, and is resistant to pests and weeds. Moreover, it requires little labour and does not show a peak in labour demand. The crop can remain in the field throughout the season, so that it can function as a reserve crop. However, compared with maize, the protein content is very low. The cassava in the Subzone has been infected with the mosaic virus (CMV), which causes considerable yield reductions and farmers lose interest. The CMV resistant variety Nzalauka should be tried (Table IX). Average yields of cassava are about 1-5 kg of tubers per plant. Another root crop is the sweet potato, which is grown by only a few farmers.

Pulses are commonly grown, although always in small quantities. Most common pulses are cow peas and pigeon peas. Cow peas are drought resistant resp. evading. Due the ability to fix nitrogen in the soil, pulses can be useful if intercropped with maize. Most pulses are vulnerable to insect damage, which often leads to a failure of making pods.

The annual cash crop is still cotton although the profit is very low. The permanent cash crop grown in this Subzone are cashewnuts. Cashew is one of the most popular tree nuts in Lamu group of districts and in world markets because of its competitive price, long shelf life, relatively low fat content and excellent flavour. The global market for nuts is projected to grow at an annual rate of at least 5% over the next five years. The main reason is that nuts are regarded as a healthy source of protein and are being consumed in increasing quantities in both developed and developing countries. A market survey carried out by Kenya Horticultural Development Programme (KHDP) in 2005 also showed that the local and regional demand for Kenyan cashew is growing at an even faster rate. This provides a great income opportunity for many thousands of farming families on the Coast, who have cashew trees growing on their small farms.

* According to the position of the place in the subzone
### TABLE 14b: INCREASE OF YIELDS BY BETTER FARM MANAGEMENT IN AGRO-ECOLOGICAL UNIT\(^1\) \(\text{CL 4 m/s i, Z 2 /PcJ 6}\)

**Subzone: m/s i, Soil Unit: Z 2 & PcJ 6**  
Survey Area 202 (Bahari)

<table>
<thead>
<tr>
<th>Crop Yields(^3) and Inputs</th>
<th>Farmers in Prod. Level</th>
<th>Farmers in Prod. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AEZ: CL 4 CASHEWNUT – CASSAVA ZONE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sub-zone: m/s i</strong> (Periods in days(^2): 1st rainy season &gt;115-135, 2nd rainy season &lt; 30 days)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AEU Pot.</strong></td>
<td>I= low</td>
<td>II= med.(^4)</td>
</tr>
<tr>
<td>Maize local monocropped Yields(^7) kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertiliser(^7)</td>
<td>600</td>
<td>-</td>
</tr>
<tr>
<td>N kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Manure t/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hybrid maize Yields(^7) kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertiliser(^7)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>N kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Manure t/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maize local intercropped with beans Yields(^7) kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertiliser(^7)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>N kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Manure t/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maize hybrid intercropped with beans Yields(^7) kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertiliser(^7)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>N kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Manure t/ha</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**NOTES:**
\(^1\)Source: Interview of 30 farmers (if possible 10 in each level) 2004 by Divisional and Field staff
\(^2\)Figures of these cereals growing periods should be reached or surpassed in 6 out of 10 years.
\(^3\)Achieved average yields with average rainfall
\(^4\)Farmers with medium inputs
\(^5\)Farmers with high inputs of Fertiliser, insecticides, soil and water conservation
\(^6\)Potential yield according to crop list and local climate of this Agro-Ecological Unit if soils are optimally fertilized, plus optimal crop management
\(^7\)Fertiliser applications are averaged at 20 % of pure nutrient
*Potential not yet determined under the agroecological unit

However, cashew nuts production has been decreasing in the area here due to: 1) diseases mainly powdery mildew, 2) disorganized marketing environment and 3) loss of local processing capacity due to closure of the only processing plant. With few other income options, many areas where cashews are grown like in this Subzone are now the poorest in coastal Kenya and are experiencing recurrent food insecurity. The processing plant must be supported to open again. The quickest way to increase incomes for cashew farmers and ensure food security problems is to increase productivity of cashew trees. Improved production practices could result in a doubling of current production and a doubling of current farmers’ incomes. Mangoes are another cash crop but also with difficulties.
Subzone CL 4 m/s of the Cashewnut–Cassava Zone on LUVISOLS

This is the Coastal Lowland Cashewnut-Cassava Zone with a medium to short cropping season and intermediate rains as typified by Shella Location, Manda Sub-location, in Amu Division. The dominating soil is well drained, very deep, dark red to strong brown, firm, sandy clay loam to sandy clay, underlying medium sand to loamy medium sand: chromic and ferralo-orthic LUVISOLS. The average annual rainfall amount is between 850 – 1000 mm*. The first rainy season can expect more than 300 – 500 mm* in 10 out of 15 seasons and second rainy season > 50 – 140 mm*. The 60% reliability of the growing periods during the 1st and 2nd seasons is 115 - 135 and < 30 days, respectively.

Due to the low reliability of the rains and the short cropping season, drought-evading and drought-tolerant crop varieties should be cultivated. In general, the short rains are inadequate for the cultivation of annual crops. The indigenous cereals were sorghum and millet, both of which are drought-resistant and therefore well suited for the unreliable and low amounts of rainfall. Since the end of the last century, however, sorghum and millet are more and more replaced by maize. Here on the island the change is not yet completed (Table 13c). Compared to sorghum and millet, maize has a higher production potential, is less vulnerable to diseases and pests (especially bird attacks), and is more easily prepared for consumption. On the other hand, maize is quite vulnerable to both water deficits and surpluses, while it requires a well drained soil with a good supply of nutrients, which are not added to the soil in this Subzone (Tables 12c & 14c). Due to the usually low and unreliable rainfall, together with the low fertility of soil and inadequate fertiliser application, yields vary from low to almost nil over the years. Yields are on average 1500 kg/ha (Table 14c), in the 1st rainy season; the 100 kg/ha in the 2nd rainy season show that it is useless to try maize in that part of the year.

Weeds are serious competitors regarding nutrients, light and space, especially in the early life stages of the maize. If not properly removed, they can cause considerable yield reductions. A special problem is formed by *Striga spp.* (witchweed), a parasite which attaches to the root system of the maize. Most common pests affecting maize yields are the stalk borer and the army worm, while major diseases are white leaf blight and rust.

Indigenous root crops are the several types of yam, which are not popular any more. More common nowadays is cassava, a crop which was hardly grown before the mid-nineteenth century. Cassava is relatively drought resistant, has a good yield potential on poor soils, and is resistant to pests and weeds. Moreover, it requires little labour and does not show a peak in labour demand. The crop can remain in the field throughout the season, so that it can function as a reserve crop. However, compared with maize, the protein content is very low. The cassava in the Subzone has been infected with the mosaic virus, which causes considerable yield reductions. Average yields of cassava are about 1-5 kg of tubers per plant. Another root crop is the sweet potato, which is grown by only a few farmers.

Pulses are commonly grown, although always in small quantities. Most common pulses are beans, cow peas, pigeon peas and green grams, but also groundnuts and bambara nuts are grown incidentally. Most of these pulses, especially the latter two, are rather drought resistant. Due the ability to fix nitrogen in the soil, pulses can be useful if intercropped with maize. Most pulses are vulnerable to insect damage, which often lead to a failure of making pods.

In the sample area on the island coconuts are still the dominating trees by cultural reasons because the climate is marginal for them. The typical permanent cash crop grown in this Subzone toward the hinterland are cashewnuts. Cashew is one of the most popular tree nuts in Lamu group of districts and in world markets because of its competitive price, long shelf life, relatively low fat content and excellent flavour. The global market for nuts is projected to grow at an annual rate of at least 5% over the next five years. The main reason is that nuts are regarded as a healthy source of protein and are being consumed in increasing quantities in both developed and developing countries. A market survey carried out by Kenya Horticultural Development Programme (KHDP) in 2005 also showed that the local and regional demand for Kenyan cashew is growing at an even faster rate. This provides a great income opportunity for many thousands of farming families on the Coast, who have cashew trees growing on their small farms.

* According to the position of the place in the subzone
TABLE 14c: INCREASE OF YIELDS BY BETTER FARM MANAGEMENT IN AGRO-ECOLOGICAL UNIT\(^1\) CL 4 m/s \(i\), PcJ 6

**Subzone: m/s \(i\), Soil Unit: PcJ 6**

Survey Area 203 (Manda/Langoni)

<table>
<thead>
<tr>
<th>Crop Yields(^3) and Inputs</th>
<th>AEZ: CL 4 CASHEWNUT – CASSAVA ZONE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Sub-zone: m/s (i)</strong> (Periods in days(^2): 1(^{st}) rainy season 115-135, 2(^{nd}) rainy season &lt; 30 days)</td>
</tr>
<tr>
<td></td>
<td>Unit with predom. Soil: PcJ 6 = well drained chromic and ferralo-orthic LUVISOLS</td>
</tr>
<tr>
<td></td>
<td>Reliable rainfall: 1(^{st}) rainy season &gt;300 – 500 mm in at least 10 out of 15 years</td>
</tr>
<tr>
<td></td>
<td>2(^{nd}) rainy season: &gt;50 – 140 mm in at least 10 out of 15 years</td>
</tr>
<tr>
<td>Farmers in Prod. Level</td>
<td>Farmers in Prod. Level</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Maize local monocropped</td>
<td>Farmers in Prod. Level</td>
</tr>
<tr>
<td>Yields(^3) kg/ha</td>
<td>I= low</td>
</tr>
<tr>
<td>Fertiliser(^7)</td>
<td></td>
</tr>
<tr>
<td>N kg/ha</td>
<td>1500</td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td></td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td></td>
</tr>
<tr>
<td>Manure t/ha</td>
<td>4</td>
</tr>
<tr>
<td>Hybrid maize</td>
<td>Farmers in Prod. Level</td>
</tr>
<tr>
<td>Yields(^3) kg/ha</td>
<td>I= low</td>
</tr>
<tr>
<td>Fertiliser(^7)</td>
<td></td>
</tr>
<tr>
<td>N kg/ha</td>
<td></td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td></td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td></td>
</tr>
<tr>
<td>Manure t/ha</td>
<td></td>
</tr>
<tr>
<td>Maize local intercropped</td>
<td>Farmers in Prod. Level</td>
</tr>
<tr>
<td>with beans</td>
<td>Farmers in Prod. Level</td>
</tr>
<tr>
<td>Yields(^3) kg/ha</td>
<td>I= low</td>
</tr>
<tr>
<td>Fertiliser(^7)</td>
<td></td>
</tr>
<tr>
<td>N kg/ha</td>
<td></td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td></td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td></td>
</tr>
<tr>
<td>Manure t/ha</td>
<td></td>
</tr>
<tr>
<td>Maize hybrid intercropped with</td>
<td>Farmers in Prod. Level</td>
</tr>
<tr>
<td>beans</td>
<td>Farmers in Prod. Level</td>
</tr>
<tr>
<td>Yields(^3) kg/ha</td>
<td>I= low</td>
</tr>
<tr>
<td>Fertiliser(^7)</td>
<td></td>
</tr>
<tr>
<td>N kg/ha</td>
<td></td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td></td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td></td>
</tr>
<tr>
<td>Manure t/ha</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

\(^1\)Source: Interview of 30 farmers (if possible 10 in each level) 2004 by Divisional and Field staff

\(^2\)Figures of these cereals growing periods should be reached or surpassed in 6 out of 10 years.

\(^3\)Achieved average yields with average rainfall

\(^4\)Farmers with medium inputs

\(^5\)Farmers with high inputs of Fertiliser, insecticides, soil and water conservation

\(^6\)Potential yield according to crop list and local climate of this Agro-Ecological Unit if soils are optimally fertilized, plus optimal crop management

\(^7\)Fertiliser applications are averaged at 20 % of pure nutrient

*Potential not yet determined under the agroecological unit

However, cashew nuts production has been decreasing in the area due to: 1) diseases mainly powdery mildew, 2) disorganized marketing environment and 3) loss of local processing capacity due to closure of the only processing plant.

With few other income options, many areas where cashews are grown like in this Subzone are now the poorest in coastal Kenya and are experiencing recurrent food insecurity. The quickest way to increase incomes for cashew farmers and ensure food security problems is to increase productivity of cashew trees. Improved production practices could result in a doubling of current production and a doubling of current farmers’ incomes. But this needs first a support that a processing plant opens again.
Subzone CL 5 (vs/vs) + (vs) of the Lowland Livestock–Millet Zone

This is the Coastal Lowland Livestock-Millet Zone with a (weak) very short to short and a (weak) very short cropping season as typified by Bodhai Location, Bodhai Sub-location, in Kiunga Division. The dominating soil is well drained, very deep, dark red to strong brown, firm, sandy clay loam to sandy clay, underlying medium sand to loamy medium sand: chromic and ferralo-orthic LUVISOLS. The average annual rainfall amount is between 730 – 810 mm*. The first rainy season can expect more than 190 – 230 mm* in 10 out of 15 seasons and second rainy season > 150 – 170 mm*. The 60% reliability of the growing periods during the 1st and 2nd seasons is 55 - 75* and 40 – 55* days, respectively.

The rains are very unreliable and the cropping seasons very short. Therefore, crop production should be restricted to drought-resistant or drought-evading crops only. Attempts to grow maize usually result in very low yields or total crop failure (Table 14d). Other, more drought adapted crops grown include: cow peas, green grams and cassava. No farmer reported growing the drought tolerant millet, the new bristled variety PM1, well suited for such precarious environments. A small amount of groundnuts is grown by a few farmers.

Cattle kept in this Subzone belong to the small East African Zebu type. This type of cattle is relatively well adapted to the local environment. However, these cattle are not in optimal conditions. During the dry seasons, the animals have to face the harsh circumstances, and trek long distances in search of pasture and water. An ever recurring problem has been rinderpest, which regularly reduces herd sizes. Other troublesome diseases are east-coast fever, foot-and-mouth disease and trypanosomiasis which is transmitted by the tsetsefly.

In many parts of Kenya and in this Subzone in particular, smallholder farmers are being compelled by policy and markets to diversify their traditional export crops, whose potential for growth remains uncertain. Alternative agricultural activities are needed which offer higher returns to land and labour, offer the expectation of future growth, and which are suitable for adoption by the resource-poor smallholder farmers who continue to dominate local production.

* According to the position of the place in the subzone
### TABLE 14d: INCREASE OF YIELDS BY BETTER FARM MANAGEMENT IN AGRO-ECOLOGICAL UNIT\(^1\) CL 5 (vs/s) + (vs), PcJ 6

**Subzone: (vs/s) + (vs), Soil Unit: PcJ 6**

Survey Area 204 (Bodhai)

#### Crop Yields\(^3\) and Inputs

<table>
<thead>
<tr>
<th>Sub-zone: (vs/s) + (vs) (Periods in days(^2): 1st rainy season 55-75, 2nd rainy season 40-55 days)</th>
<th>Unit with predom. soil: PcJ 6 = well drained chromic and ferralo-orthic LUVISOLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliable rainfall: 1st rainy season &gt;190 – 230 mm in at least 10 out of 15 years</td>
<td>2nd rainy season: &gt;150 – 170 mm in at least 10 out of 15 years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Farmers in Prod. Level</th>
<th>Farmers in Prod. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AEZ: CL 3 LOWL AND LIVESTOCK – MILLET ZONE</strong></td>
<td>**AEU Pot. * I= low II= med.(^4) III= high(^5) AEU Pot. * I= low II= med.(^4) III= high(^5) AEU Pot. *</td>
</tr>
<tr>
<td><strong>Crop Yields(^3) and Inputs</strong></td>
<td></td>
</tr>
<tr>
<td>Maize local monocropped</td>
<td></td>
</tr>
<tr>
<td>Yields(^3) kg/ha</td>
<td>I= low II= med.(^4) III= high(^5) AEU Pot. *</td>
</tr>
<tr>
<td>Fertiliser(^7):</td>
<td></td>
</tr>
<tr>
<td>N kg/ha</td>
<td>200</td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td>-</td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td>-</td>
</tr>
<tr>
<td>Manure t/ha</td>
<td>-</td>
</tr>
<tr>
<td>Hybrid maize</td>
<td></td>
</tr>
<tr>
<td>Yields(^3) kg/ha</td>
<td></td>
</tr>
<tr>
<td>Fertiliser(^7):</td>
<td>250</td>
</tr>
<tr>
<td>N kg/ha</td>
<td>-</td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td>-</td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td>-</td>
</tr>
<tr>
<td>Manure t/ha</td>
<td>-</td>
</tr>
<tr>
<td>Maize local intercropped with beans</td>
<td></td>
</tr>
<tr>
<td>Yields(^3) kg/ha</td>
<td></td>
</tr>
<tr>
<td>Fertiliser(^7):</td>
<td></td>
</tr>
<tr>
<td>N kg/ha</td>
<td>-</td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td>-</td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td>-</td>
</tr>
<tr>
<td>Manure t/ha</td>
<td>-</td>
</tr>
<tr>
<td>Maize hybrid intercropped with beans</td>
<td></td>
</tr>
<tr>
<td>Yields(^3) kg/ha</td>
<td></td>
</tr>
<tr>
<td>Fertiliser(^7):</td>
<td></td>
</tr>
<tr>
<td>N kg/ha</td>
<td>-</td>
</tr>
<tr>
<td>P(_2)O(_5) kg/ha</td>
<td>-</td>
</tr>
<tr>
<td>K(_2)O kg/ha</td>
<td>-</td>
</tr>
<tr>
<td>Manure t/ha</td>
<td>-</td>
</tr>
</tbody>
</table>

**NOTES:**

\(^1\)Source: Interview of 30 farmers (if possible 10 in each level) 2004 by Divisional and Field staff
\(^2\)Figures of these cereals growing periods should be reached or surpassed in 6 out of 10 years.
\(^3\)Achieved average yields with average rainfall
\(^4\)Farmers with medium inputs
\(^5\)Farmers with high inputs of Fertiliser, insecticides, soil and water conservation
\(^*\)Potential not yet determined in this agroecological unit
3.6.6 FERTILISER AND MANURE RECOMMENDATIONS FOR IMPORTANT AGRO-ECOLOGICAL UNITS

Introduction

The Fertiliser Use Recommendation Project of the GTZ (FURP) from 1986 till 1992 had only one trial site in the former Lamu District. It was at Mpeketoni in Agro-Ecological Zone (AEZ) CL 3 (on chromic Luvisols), representing the wetter parts of the coastal plains from the Tana River basin up to the border to Somali. The Luvisols have developed on older beach ridges and are associated with rhodic Ferralsols and orthic Acrisols, occurring in small strips and patches parallel to the coast. However, the coastal plains are geologically dominated by former lagoonal deposits of the Kilindini Sands, where Luvisols and Arenosols, both with low to moderate fertility, as well as solodic Planosols in the bottomlands have developed (AEZ CL 3-5). These soils are also covering the area of the Dodori Forest Reserve in the northeast of the district group. Very poorly drained thionic Fluvisols and Solonchaks are occurring in the mangrove swamps of the Lamu archipelago and the adjacent river mouths.

Recommended rates of fertiliser in an Agro-Ecological Unit (AEU) increase towards the wetter subzones and decrease into the dry ones if the soil unit extends there (see small map). In the areas settled by smallholders, mainly zones CL 3 and CL 4 (partly CL 5), we have tended to lower the rates due to the low financial base of the smallholder farmers. If the system could be put in place to give the starter fertiliser on credit, repayable with part of the money obtained from harvest, then higher rates would be used by the farmers. The optimum can be calculated from the yield functions in MURIUKI & QURESHI (2001)\(^1\). In the long run the optimal amount and enough manure must be given to maintain the nutrient content. Some quantities for this can be seen in Chapter 3.1 under the ‘General Remarks’ section.

Higher application rate recommendations are given in the Smallholder Farming Handbook of the IRACC and MSS, Nairobi 1997, but the economic investment and risk is too high for the small farmers. The mentioned rural credit system for the inputs could help a lot. Where scientific sources for quantifying the rates are lacking, some conclusions can be drawn from the difference of inputs and yields between the low and high production levels of the Farm Survey 2004. An empty column in the recommendation tables denoted as “Other Nutrients Recommended” does not mean that there is nothing to be done but it is because of lack of trial data. Symptoms of deficiencies and methods of addressing these can be found in MURIUKI & QURESHI (2001), Table 1&2, p.22-23.

FURP trials at Mpeketoni in the former Lake Kenyatta Settlement Scheme east of Witu showed that all crops responded positively to the application of N under good rainfall conditions; application of P fertiliser was not resulting significantly in higher yields (see Table 15). However, it must be emphasized once more that fertilising alone will increase the yields only for some years. The micronutrients that are not included in the fertiliser become exhausted very fast. Manuring almost up to the full return of the extracted nutrients is a must in order to have a stable agrobiological system for continuous sustainable production\(^2\). The application of Farm Yard Manure (FYM) leads to a stabilization, even to a slight increase of crop yields as well as to an improvement of org. C, pH and other nutrients (like P and Mg) in the long run; this is also positive for nitrogen mineralization and the improvement of soil physical quality (e.g. water storage capacity and plant available soil water, infiltration, aeration) and of the biological parameters. Therefore, 5 tons of manure can be recommended per ha in the district group (see Table 15).

Gross margin (GM) calculations however reveal that with current market prices (gross income for crops minus variable costs) the cultivation of maize and sorghum (as a mono- and intercrop) is less worthy than horticultural crops (like tomatoes, onions, kales, sweet potatoes, water melons, brinjals, capsicums), both under rainfed and/or irrigated conditions in AEZ CL 3 and CL 4; cassava in CL 4 (with lower yields also in CL 5) as well as tree crops like coconuts and mangoes (mainly in CL 3 and CL 4) are also much more profitable due to better market prices, even for farmers who are not able to apply fertilizers, biocides and water on a high level (see FARM MANAGEMENT GUIDELINES OF LAMU DISTRICT, 2010-2011).
Therefore, farmers in the district group should be advised not to rely too much on staple crops like maize and sorghum as cash crops.

2 Southern China has parts with similar soils to Coast Province and stabilized productivity there for hundreds of years by returning the kitchen waste as well as human and animal excrements to the fields. The organic material could be used together with the urea for biogas production first to reduce the hygienic and energy problems. Ecosan toilets are a solution for households to produce manure.
3 see Chapter 2.5, Table IX

### TABLE 15: FERTILISER AND MANURE RECOMMENDATIONS FOR THE AGRO-ECOLOGICAL UNITS of the Coconut-Cassava Sub-Zones CL 3 m i vs, CL 3 m i (vs), CL 3 m i and the Cashewnut-Cassava Sub-Zones CL 4 m/s i vu, CL 4 m/s i, CL 4 s/m i (vs), CL 4 s/m i, CL 4 s i (vs), and CL 4 s i; Soils Z 2, Pe J6

<table>
<thead>
<tr>
<th>Crop varieties and Season</th>
<th>Av. Exp. Yield + Response-curve kg/ha</th>
<th>Recommended Fertiliser Rates kg/ha</th>
<th>Average Yield Increase if this Rate is Applied kg/ha</th>
<th>Average Yield Increase if 5t/ha Manure are Applied kg/ha</th>
<th>Other Nutrients Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First rainy season</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize (Coast Composite)</td>
<td>1638 + 28 N</td>
<td>75 N</td>
<td>2100</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Maize (Coast Comp.) &amp; cowpeas (local var.)</td>
<td>2197 + 48.1 N - 0.32 N² (maize)</td>
<td>50 N</td>
<td>1600</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Cotton (local var.)</td>
<td>1007 + 19.9 N</td>
<td>75 N</td>
<td>1490</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Second rainy season</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorghum (Seredo)</td>
<td>1402 + 30.6 N - 0.18 N²</td>
<td>50 N</td>
<td>1080</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Simsim (local var.)</td>
<td>400</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Permanent crop</strong></td>
<td></td>
<td>0.9 kg CAN per tree and year</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


1 Cowpea as a relay crop is planted in May/June/July (FURP, p. 22).
2 No significant increase.
3 Application of farm yard manure (FYM) and compost is necessary to maintain the organic carbon content/humus as well as CEC and moisture storage capacity of the soil (MURIUKI/QURESHI, p. 142); organic carbon content declined within 2 years substantially (FURP, p. 23). Performance of moisture conservation measures is recommended to improve soil moisture capacity of the soil (MURIUKI/QURESHI, p. 142).
4 The use of coconut frond mulch for improved germination had a positive effect on cotton yields (FURP, p. 24).
5 Significant changes of available K, Ca and Mg could not be observed during the experimental period (FURP, p. 23), but should be kept in mind like the content of phosphorus (FURP p. 24). Regular monitoring of P, K, Ca, Mg, N and organic C is recommended (MURIUKI/QURESHI, p. 142).
6 Yields in areas with 750-1000 mm of rainfall: 15-20 nuts per tree (IRACC, p. 102).
7 The actual conversion into the real nutrient content can be seen in Annex table I, p. 37.
Agro- Ecological Units

Main Soil in the
Coconut - Cassava Z. and the
Cashewnut - Cassava Zone of the Lamu
Group of Districts

CL 3 m i vs, m i (vs), m i,
CL 4 m/s i, m/s i (vu),
s/m i (vs), s/m i, s/m,
s i (vs) & s i;
PcJ 6, Z 2

Fertiliser and Manure Recommendations see Table

15

PcJ 6 = (ferralo-)chromic LUVISOLS and calcic ARENOSOLS; with gleyic and albic LUVISOLS, sodic phase, and dystric and solodic PLANOSOLS: somewhat excessively drained to moderately well drained, very deep, mottled, friable to firm, sandy loam to sandy clay loam, in many places with a thick (60-100 cm) topsoil, very friable loamy sand; with inclusions of many small bottomlands of unit BJ 2

Z 2 = ferralo-chromic / orthic ACRISOLS, sodic phase; with solodic PLANOSOLS: moderately well drained, very deep, dark brown to reddish brown, firm to very firm, often moderately sodic, sandy clay loam, underlying a thick topsoil of friable loamy sand; in places shallow over coral rock

AEZ boundary uncertain or transitional stripe
Agro - Ecol. Subzone boundary
National Park

Related A. - E. Units

much less fertilising
less fertiliser necessary
normal fertilising

Detailed explanations of the symbols
see texts to the AE Zones map and Soil map

Min. of Agr. and GTZ, R. Jaetzold 2012, GIS Cartogr. M. Teucher;
Base KSS (Andriesse & van der Pouw) and MURIUKI & QURESHI 2001, rev.
3.6.7 FINAL STATEMENTS

Lamu West and East are the only districts of Kenya, apart from Tana Delta, with large areas which can still be developed for agriculture and horticulture. The long distances and difficult roads to Nairobi and other centers of population may have been the reason, that this corner of the country was not in the focus for big development except the Settlement Schemes of Lake Kenyatta and Hindi Magogoni. Now the situation has changed. The big projects of Tana Delta District extend also to Lamu West District. Lamu Town gets a modern port, and the plan to plant vegetables and fruit for the desert states of the Arabian Peninsula makes sense geographically because it is the nearest area with (not overpopulated) Agro-Ecological Zones CL 3 and CL 4. Clearing to get rid of tsetse flies gives chances for cattle and dairy. Mangrove leaves and cassava are newly researched additional forages 1). More milk and milk products (f. i. yoghurt) as well as meat will find a growing demand by the labourers of the big agricultural projects and finally a ready market in the Near East.

Zone CL 5 has also a certain hope for the future, which would mean that the up to now almost untouched forests and savannas of the hinterland may improve their agricultural potential. Now the agrohumid periods there are weak and very short. It could be, that due to the global warming the second rainy season gets more rain. Station Witu D.O. got 249 mm average October-December until 1985. In the more recent period 1995-2009 it got 360 mm. Probably the upwelling of cold seawater which reduces the rain (especially in the second rainy season) is less important now because the water is warmer. This hypothesis must be still confirmed by long term records of rainfall and the ocean temperatures. Combined with a long term forecast: How the coming rainy season will probably be according to the El Nino-Southern Oscillation System 2) 3), there could be some land for hungry Kenyans 4), and these conditions extend also into South-Eastern Somalia.

1) See Leaflets by KARI, Mtwapa
2) If the SOI = Southern Oscillation Index (=mean airpressure difference between Port Darwin and Hawai) is below 1.05, then a good ENSO-Season will come (WILLEMS 1993) 3)
4) Ask Kenya Met. Dept. if the air pressure difference is below 1.05, especially in the months August and September, for the second rainy season.