ウガンダ

UGANDA

DRAFT PROJECT PROPOSAL ON

INCREASING INCOMES OF FARMERS OF DOHO RICE IRRIGATION SCHEME THROUGH IMPROVED AND INTEGRATED RICE PRODUCTION.

TECHNICAL COOPERATION BETWEEN UGANDA, THAILAND AND JICA

ASIA-AFRICA KNOWLEDGE CO-CREATION PROGRAMME (AAKCP)

RURAL COMMUNITY DEVELOPMENT SUB-PROGRAMME (RCDS)

Prepared under the cooperation between
Ministry of Agriculture, Animal Industry and Fisheries, Uganda
and
Department of Agricultural Extension, Ministry of Agriculture and cooperatives, Thailand

Ministry Of Agriculture,
Animal Industry & Fisheries
P.O.Box 102
Entebbe-Uganda
31st May 2006.

Contents of the Project Document

1**. Introduction**:

The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and other concerned institutions, have been collaborating with the Government of Japan through Japan International Cooperation Agency (JICA).

Through this cooperation, Japan has been extending Agricultural and Rural development cooperation to Uganda. Due to this cooperation, Uganda was selected and supported to be among the eight (8) African countries participating in AAKCP since March 2005. Asia-Africa Knowledge Co-creation Programme (AAKCP) – Rural Community Development Sub-program(RCDS) was initiated by JICA in March 2004. Consequently an initial seminar in Japan and Thailand was held from March 22nd – 16th April 2005. This was followed by the Mid Term Seminar held in Thailand from 25th to 28th July 2005. A policy Research Project (PRP) was drafted during this Mid Term Seminar and latter on Revised and a Final Project Document was produced. The Policy Research Project was implemented from February 2006 and it is due to be finalized by the end of May 2006.

During the Project implementation, a number of activities were carried out. They include;

(i) Field Study visits to Thailand in January 2006 by two Officials of Ministry of Agriculture, Animal Industry and Fisheries and two farmer representatives from Uganda.

(ii) Two Thai Facilitators also visited Uganda in March 2006, and conducted a training workshop for Farmers' Leaders, Extension staff and some selected farmers. Training was focused on improved Rice Cultivation and Aquaculture integrated in rice paddy fields. Other Topics were on Group Dynamics, Agricultural Extension systems, Home Economics and Mushroom growing as an Income Generating enterprise.

The above Project activities yielded some achievements as follows;

(i) Both Field Study visits in Thailand and Uganda increased the knowledge of the participants, in areas of Agricultural production systems, irrigation strategies for increasing rice production integrated with fish rearing in paddy fields, Group Dynamics and Formation of Farmers' Groups like women, Youth and Men groups.

(ii) The training workshop at Doho Rice Irrigation Scheme in Uganda also attained some achievements as outlined below.

a) Rice cultivation integrated with fish rearing was initiated at Doho Rice Irrigation Scheme.
b) The number of Farmers adopting the recommended rice cultivation techniques increased from 40% to 60%, except for line transplanting which increased but at a slower rate (from 10% to 20%). Farmers improved in ;

- Seed selection
- Nursery bed preparation
- Timely transplanting
- Number of seedlings transplanted per hill
- Spacing

c) Farmers water users groups committees were formed at Doho Rice Irrigation Scheme comprising of eleven members per block to a total of 110 (one hundred and ten members).
d) The PRP led to an improvement in the Framers' trust of Doho Rice Irrigation Scheme Farmers Association (DORSFA) as indicated by increase in the number of farmers registering as members of the Association prior to and during the Election of new DORSFA Executive Committee on 23rd May 2006. Many Farmers expressed willingness to join and strengthen the Association. Registration increased from 5% to 10%. (100 to 200 farmers)
e) The farmer trainee participants, scheme management and other stakeholders together with Thailand facilitators, JICA Officials in Uganda made joint recommendations for improvement in the management and production at Doho Rice Irrigation Scheme.
f) A joint recommendation of initiating a bigger and longer Technical Cooperation Project between Uganda, Thailand and JICA was made.

However, the PRP has not yet yielded a substantial increase in the farmers' incomes, and this is mainly due to the insufficient training because of the short PRP period of 6 months (six) only. The project budget was limited to **41,604 US $** only and could not enable the project management to effectively carry out many demonstrations to cover more farmers. Hence the need for this new project proposal.

The new project proposal focuses on:-

(i) Further Strengthening of Farmers Association, the Irrigation water users groups, and other specialized farmers groups, targeting the women groups, youth groups, men groups for income generating enterprises like rice farming, fish farming, mushroom growing, vegetable growing, poultry rearing.

(ii) Strengthening fish rearing integrated with improved rice cultivation, which was initiated in the ending **6 Month Policy Research Project.**

(iii) Establishment of an Agricultural Technology Transfer Centre/information Centre at Doho Rice Irrigation Scheme, for continued training of Extension Staff and farmers.

N.B Number (i) and (ii) above will have to be achieved through training of fifteen (15) technical staff and 400 (Four hundred) farmers. Three Extension staff will be trained in Thailand i.e. one for Rice/Fish culture, one for Water Management and

one for Farm Machinery. Three Farmers group representatives will also have a visit to Thailand, one for fish farmers group, one for women groups and one for water users groups.

The three Extension Staff to be trained will be expected to be the local experts in those fields and they will act as trainers of other staff and farmers. The farmers to have a study visit to Thailand will be expected to get the practical knowledge and skills in various fields like improved rice cultivation techniques, techniques of integrated fish rearing in paddy fields, water management, and women groups income generating enterprises. They will then apply those practical skills and knowledge to improve their outputs when they return to Uganda. The Scheme management will use the Farmer to Farmer Extension System to supplement the Extension Staff in training the rest of the farmers.

2. Background.

2.1 Social Economic context of Uganda.

Poverty is still the key problem in Uganda. It is largely a rural phenomenon; with 96% of the country's poor living in the country side and 39% of the rural population living below the absolute poverty line, compared to 10% of the urban dwellers. Women makeup the majority of the rural people and female-headed households are becoming increasingly common.

2.2 The Agricultural Sector.

*2.2.1 Current Situation***.**

The contribution of the Agricultural sector to the National economy as at 2003/2004 is as follows;

- 76.5% of the population are employed in the Agricultural sector.
- 40% share of GDP.
- 85% of total export earnings.
- 68% of Agricultural GDP is contributed by Crops.
- 16% of Agricultural GDP is contributed by Livestock.
- 12% of Agricultural GDP is contributed by Fisheries.
- 4% of Agricultural GDP is contributed by Forestry.
- 3.4% share of total budget is allocated to the Agricultural sector.

The employment and incomes generated from the Agricultural activities are critical not only for eradicating poverty and improving the quality of life but also for generating demand for manufacturing industries, yet the land and labour productivity is very low. The challenges of food insecurity and poverty are compounded by environmental degradation which Uganda is facing. In confronting these socio-economic challenges, the Agricultural sector has a lead role to play. For the agricultural sector to be able to bring about the economic impetus needed to eradicate poverty, ensure food security and protect the environment. It would have to be significantly transformed by shifting

the current dominant subsistence oriented farming systems towards more market oriented production based on knowledge, greater specialization, farmers' empowerment through exchange visits and capturing of economies of scale. Such transformation cannot be achieved without the sound application of modern technologies like irrigation and water management, better agronomic practices, food nutrition, farmers' empowerment etc.

2.2.2 National Agricultural Policies and Strategies.

For the last 15 years, Uganda Government has been implementing macro-economic and civil service reforms aimed at improving the welfare of the people in terms of incomes, food security and socio-economic welfare. These include privatization, liberalization, decentralization and good governance. In this regard the Government developed the following;

- Poverty Eradication Action Plan (PEAP)
- The Plan for Modernisation of Agriculture (PMA)
- Zoning of Agricultural Productions
- The Rural Development Strategy
- The National Agricultural Advisory Services (NAADS)
- Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) Development Strategy and Investment Plan.

2.2.3 Institutions linked with the proposed technical cooperation project.

Various institutions will be linked to the project and they will play vital roles as follows;

	Institution	Mandate	Activities	Linkage with Project	Related laws & regulations
1	Ministry of Agriculture Animal Industry & Fisheries (MAAIF)	To support, and guide all agricultural activities	Plan, supervise, monitor & evaluate the Project.	Implementation of Project	- Land Act - Food & Nutrition Policy - Wetland policy
2	Ministry of Local Government	Mobilization of community	Group sensitization	Sensitization	- Local Government Act
3	National Environment Management Authority (NEMA)	Environment protection	Environment audit.	Environment monitoring	- Environment Management Policy
4	National	Agricultural	Agricultural	High	- NARS Bill

	Agricultural Research Systems (NARS)	research	research	yielding varieties of rice, vegetables, and superior species of fish	
5	National Agricultural Advisory Services (NAADS)	Agricultural extension	Group formation and training	Training	- NAADS Act.
6	Doho Rice Irrigation Scheme	Rice / Fish / Mushroom production	Implementation	Project implementation	- Land Act
7	SG2000	NGO	Training	Training	Privatization
8	Department of Agricultural Extension (DOAE) of Ministry of Agriculture and Cooperative (MOAC) Thailand.	Agricultural extension and policy	Training	Asian partner	———
9	JICA	Technical cooperation	Funding and training	Cooperation	———

3. Problem Analysis.

As mentioned before, poverty is a key problem in Uganda mainly affecting the rural population, which is dominated by women. The contribution of Agricultural Sector to the National Economy is fairly high and yet its share from the total National budget is low. The employment and incomes generated from the Agricultural activities are critical not only for eradicating poverty and improving the quality of life but also for generating demand for manufacturing industries. Therefore, there is need for transforming agriculture through sound application of modern technologies like

irrigation and water Management, better agronomic practices, food nutrition, farmers' empowerment etc.

3.1 Problem.

3.1.1 The key problem is that Farmer's income is low.

3.1.2 Causes of the problems:-

(i) The farmers' skills and knowledge are still low.
(ii) The technical capacity of the Extension workers is still inadequate and they lack appropriate facilitation like transport, demonstration materials etc.
(iii) The farmers Association and the various formed groups are still relatively weak.
(iv) Farmers lack appropriate production tools especially the small tractors for proper land preparation and machinery for processing of their produce for better market.
(v) Food insecurity and poor Nutrition among the farmers.
(vi) Water management still poor due to worn-out irrigation
(vii) Infrastructure i.e. limited control of irrigation due to broken down facilities.

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3.1.3 Expected Counter Measures.

Training shall be conducted about fish culture in relation to irrigated rice cultivation, mushroom, Agricultural produce, processing and marketing.

3.1.4 Reasons for selecting the above Counter Measures.

Trial activities in the policy Research Project (PRP) have been progressing successfully in the relevant fields of rice cultivation integrated with fish culture, and others as indicated by the results/achievements of the PRP already mentioned in serial N0.1 (Introduction).

4. KNOWLEDGE CO-CREATION

Technical cooperation between Uganda, Thailand and JICA is desired because of the positive results of the PRP, which were presented in **Introduction.**

5. PROJECT DESIGN

5.1 Project Purpose:

5.1.1 The purpose of this project is to contribute towards increasing incomes of farmers and ensuring food security and Nutrition among farmers. This is in relation to the key problem of Farmers' Low Incomes as identified in the Problem Analysis.

5.1.2 Specific Objectives.

- To improve the technical capacity of 15 (Fifteen) Extension Staff including those in the Sub-counties of Mazimasa and Kachongha Sub-County through training.

- To improve income generation skills and knowledge of 400 (Four hundred) households, through training. Emphasis will be on rice cultivation, rice processing, fish rearing, vegetable growing, mushroom growing and marketing
- To introduce integration of Fish rearing in Rice paddy fields in Doho Rice Irrigation Scheme. (200 Acres of rice/fish paddy fields, an additional of two ordinary ponds, fish breeding unit by the end of 2008 2nd Season.
- To improve the performance and management of the Farmers Association and Farmers Groups through training and field visits. One (1) strong Farm Association and 10 (ten) strong water users groups as well as women groups will be established.
- An Agricultural Technology Transfer Center is established at Doho Rice Irrigation Scheme.

5.2 Target Group and Areas

The Project targets 400 (four hundred) farmers and 15 (Fifteen) Technical Extension Staff in Doho Rice Irrigation Scheme and Staff in neighbouring Sub-Counties of Mazimasa, Kachongha and Butaleja Sub-Counties in Butaleja District.

5.3 Expected Outputs

5.3.1 Farmers' skills and knowledge for enhanced income generation are improved

5.3.2 Technical capability of Extension staff is enhanced**.**

5.3.3 Rice cultivation integrated with fish rearing is established at Doho Rice Irrigation Scheme.

5.3.4 Agricultural Technology Transfer Centre/Information Center is established at Doho Rice Irrigation Scheme.

5.3.5 Farmers' Association, Water Users' groups and women group strengthened.

5.4 Activities to produce the Expected Output:-

Output 1: Farmers' income generating skills knowledge are enhanced, focusing mainly on rice-fish culture.

Activities: 1.1. Mobilization and sensitization is conducted.
1.2. Plan of training is formed.
1.3. Training workshop is conducted.
1.4. Fishponds are established.
1.5. Fish breeding unit is established.

Output 2: Extension Workers technical skills enhanced.

Activities: 2.1. Mobilization and sensitization is conducted.
2.2. Plan of field training in Thailand is formulated.
2.3 Extension staff train the farmers.

Output 3: Farmer's Association and Farmers Groups performance is improved.

Activities: 3.1 Mobilization and sensitization is conducted.
3.2 Plan of training workshop is formulated.
3.3 Training is conducted.

Output 4: Agricultural Technology Transfer Centre/Information Centre is established at Doho Rice Irrigation Scheme.

Activities: 4.1 Mobilization and sensitization is conducted.
4.2 Plan of training workshop is formulated.
4.3 The Centre is established.

Output 5: Project Implementation is progressing well.

Activities: 5.1. Project implementation Unit is established.
5.2. Project implementation starts.
5.3. Progress of project implementation is monitored throughout the process.
5.4. Project impact is evaluated.
5.5. Final Project Evaluation and Reporting.

5.5 Inputs:

5.5.1 Uganda Side Training Facilitators.

- Counterpart staff five (5) for Irrigation, Rice cultivation, Fisheries, Extension and Home Economics and one Project Coordinator.
- Facilities: Training venue at Doho Rice Irrigation Scheme, excluding accommodation of participants.
- Office for Resource Persons.

5**.5.2. Thailand Partner Side:**

- Arrangement for field in Thailand.
- Resource Persons for fish farming in rice paddy fields, and mushroom growing.

5.5.3 JICA Side:

- Budget Support (400.000 US $)
- One Resource Person for water management and rice cultivation.

5.6 Important Assumptions:

- The will of the Government of Uganda and farmers on improving rice/fish-farming community is maintained.
- There is no drastic drop of rice and fish price.

- Doho Rice Irrigation Scheme is jointly managed by the Government and the Farmers' Association.

5.7 Project Implementation Framework.

No.	Organisation	Status	Person/Institution	Role
1.	Ministry of Agriculture, Animal Industry and Fisheries.	Responsible	Mrs Rhoda Tumusime *Commissioner Planning.*	Agricultural Planning, Monitoring and Evaluation.
2.	Ministry of Agriculture, Animal Industry and Fisheries.	Responsible	Mr.Rusoke Charles Senior Agricultural Officer - *Farm Development. (Entebbe)*	Head of Programme **AAKCP**(Quality Standard assurance, monitoring and evaluation
3.	Doho Rice Irrigation Scheme.	Responsible on the ground.	Mr.Mukandya Richard Scheme *Manager.*	Project Coordinator
4.	Doho Rice Irrigation Scheme.	Responsible		Training
5.	NAADS.	Cooperating		Training
6.	NARO.	Cooperating		JICA Experts training on rice.
7.	SG.2000	NGO-Cooperating		Training
8.	ASIA.	Partner.		Training
9.	JICA.	Partner.		Budget Support, Coordination and Advising.

5.8 Tentative Schedule of project Implementation

No.	Outputs	Activities	Period Time Table 2007/2008.											
1.			10	11	12	1	2	3	4	5	6	7	8	9
	Key Stakeholders mobilization.	Meeting of stakeholders.	0	0	0	0								
		Identifying target Farmers Groups.	50	0	0	0								
2.	Study visits Training of extension workers and	Technical Staff and Framers.							0	0	0			

	selected farmers.													
3.		Workshop for extension workers.												0
4.		Training for selected farmers.												0
5.		Thailand experts field visit to Uganda.												0
		Supporting activities of establishment of Agricultural Technology Transfer Centre.												0
			2008/2009											
			10	11	12	1	2	3	4	5	6	7	8	9
6.	Monitoring and evaluation	Writing report on evaluation.		0		0		0		0		0		0
	Final Project Evaluation Report.												0	0
		Writing final project evaluation report.												0

6 Plan of Operation.

a) Monitoring and Evaluation

b) Sequence of activities

(i) Mobilization and sensitization of stakeholders. The Scheme manager and Chairman DORSFA will convene sensitization meeting.

(ii) Study mission (technical staff and some farmers) dispatched to Thailand. Three Extension Staff to go for a 3 (three) month training and 3 (three) Farmers Groups representatives.

(iii) Establishment of Agriculture Technology transfer /confirmation center. Training of trainers will be conducted and training equipment will be

purchased. Training halls will be renovated by Ministry of Agriculture, Animal Industry and Fisheries (MAAIF).

(iv) Training workshops in various disciplines

(v) Establishment of fishponds. The project manager in liaison with Fisheries officers to guide farmers to make fishponds.

(vi) Introduction of fish fries

(vii) Introduction of mushroom growing.

(viii) Establishment of a fish-breeding center.

(ix) Monitoring the progress by JICA, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and Project Staff and Doho Rice Scheme Farmers' Association (DORSFA).

(x) Evaluating the impacts of the project Staff, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and JICA.

(xi) Final project evaluation. Project Staff, JICA and Ministry of Agriculture, Animal Industry and Fisheries (MAAIF).

7 Project Justification:

7.1 Relevance

Recognizing the important role agriculture plays in the economy of Uganda, Government has embarked on a number of policy initiatives with a view to modernizing agriculture maximizing agricultural production, reducing poverty and hence improving on the quality of life.

In the Government formulated Plan for Modernization of Agriculture (PMA) as a strategy for eradication of Poverty, the transformation of agriculture from subsistence to commercial production is paramount. PMA priority areas of action include natural resource utilization and management, enhancing of production through Irrigation farming and improvement of extension delivery services etc.

It is at this point in time, that the Doho rice irrigation scheme will play a vital role in the realization of the above Government goals.

Details about Doho Rice Irrigation Scheme:

(i) Doho Rice Irrigation Scheme, located in the new district of Butaleja- Eastern Uganda, it covers a gross area of 1,000 Ha (2,500 Acres) and net productive area of 952 Ha (2,380 Acres), which are divided into 6 (six) blocks i.e. Blocks 1 (one) to 6 (six). Block 1,2,4 and 5 are further subdivided into A and B for ease management. Hence essentially there are ten Blocks.

The Scheme directly benefits 2,350 Farm Families; however, the total number of beneficiaries including those who don't own rice plots but participate in providing labour, in rice processing and marketing, transportation, in booming business facilitated by income from rice etc goes up to 60,000 (sixty thousand)

people. Rice is grown two seasons in a year is from April to August and from October to February for the first and second season respectively. There is reliable source of irrigation water from R. Manafwa through out the two growing seasons.

The scheme has: -

(i) Contributed heavily to the food and social security of the country.
(ii) Improved on the economic status of the people evidenced by the fast growing trading centers near the schemes.
(iii) Contributed to the District local revenue in terms of the high payment rates of the graduated taxes and licenses from the sub counties near the scheme.
(iv) Provided gainful employment directly and indirectly to over 60,000 beneficiaries.

With all these multiplier benefits, the importance of improving the capacity development of extension workers and of this scheme Farmers groups increase the knowledge and skills of farmers income generation cannot be doubted. The project proposal will raise farmers' incomes with the national development policies, needs of the target groups and Japan development assistance policies.

Background on Fish Farming in Uganda.

(i) Capture Fisheries are mainly for factory package and Exported to other European countries. It therefore leaves a very big room for Aquaculture industry in the real future; Aquaculture farming is soon going to be useful in supplying the fish processing factories with raw materials required in the processing facilitations..
(ii) Fish is widely eaten by most indigenous people; and there is high demand by neighbouring countries (Kenya, Sudan and DRC Congo).
(iii) According to Government policy fish farming can help to boost the program for Poverty Eradication Action Plan (PEAP) and Plan for Modernization of Agriculture.
(iv) Fish is the only cheapest source of animal protein.
(v) Bearing in mind that Tororo and Butaleja districts are very far away from the lake, Aquaculture could be the only option to supply fresh fish to the named districts.
(vi) Kajjansi Research Development Centre (Uganda) is in conjunction with USAID has started producing formulated fish feeds.

On the basis of the above six points, its clear that fish industry in Uganda has a very big potential and market which is very mush assured.

Asia –Africa cooperation is appropriate as a modality to tackle with the selected problems because its approaches combine use of the external knowledge experiences with the identification and improvement of the local indigenous knowledge.

8. Impacts

Elements Contribution	*Expected*
Policies	Project to streamline and harmonize policies regarding groups and associations.
Institutions	Project to promote linkage and harmonization of laws, regulations, guidelines, standards regarding groups / Associations with various Institutions e.g. Central Government, Local Government, private firms, NGOs, etc.
Target groups	Project to improve livelihood of groups.
Economy	Poverty alleviation through economic growth.

9. Project Sustainability

Implementation of Project will be in tandem with the Rural Development Strategy (RDS) through collaboration of several stakeholders at different levels. The major stakeholders and their roles and responsibilities will be as follows.

- **Farmers:**

  Farmer group representatives will identify production constraints / opportunities and participate in utilization of improved technologies (bottom up approach).

  Youths will be involved in all project activities for sustainability of the project maximum benefit from their role.

- **Local Government:**

  Formulate development plans.

  Provide guidance to farmers in technologies need identification and enforcement of by laws for efficient and effective implementations of improved technologies.

- **Non Governments (NGOs):**

  These will organize farmers in to groups and higher level associations as well as build capacity for collective implementation of activities.

- **Private Sector Agencies:**
  These include private sector service providers. They facilitate participatory technology development and develop farmer capacity to utilize improved technologies.
- **NARO/NARS:**
  NARO serves a source of technological input as well as participate in the process of technology adaptation.
- **NAADS:**
  This will play a pivotal role of coordinating all activities of private service providers.
- **MAAIF:**
  This will supervise, promote, support and guide all Agricultural activities in Uganda with special emphasis to farmer's group guidance.

10. Monitoring and Evaluation Framework (draft)

Element	Outputs	Indicators	Targets at end of Project.	Responsible Person
Participation of stakeholders in improvement of irrigation scheme management	Key-stakeholders and target farmer groups are willing to improve management of Doho Rice Irrigation Scheme.	- Number of meeting held between Doho Rice Irrigation Scheme Office and executives of Doho Rice Irrigation Scheme Farmers Association on improvement of irrigation scheme management during the project period (Oct 06 – Sept 08 2006) - Percent of farmers paid irrigation fee by Sept 2007.	- At least one meeting per month - At least 90% of the farmers pay irrigation fee by the end of 2006 early season	Doho Extension Staff (DORSFA)

		Percentage of Farmers registered with the Farmers' Association.	At least 80% of farmers registered as members of the Farmers' Association.	
Capacity development of key-stakeholders	Ugandan key-stakeholders understand the direction of irrigation scheme management.	- Quality of report presented by the members who participate in the study tour in Thailand - Trust among Doho Rice Irrigation Scheme Office, Doho Rice Irrigation Farmers Association and rice farmers	- Informative report on the study tour and its possible application in Uganda - At least one field day in every season by the end of 2007.	MAAIF (Personnel Department)
Capacity development of extension workers and selected farmers	Extension workers and selected farmers adopt the contents of training (e.g. farmers association, rice cultivation, rice-fish culture, agro-processing).	- Percent of ex-participant farmers who demonstrate the contents of training.	- At least one demonstration per participant on rice production, processing or marketing technologies.	District Local Government

Capacity development of extension staff	Evaluate the short-term impacts of the training among ex-participants and other farmers.	- Number of meetings on irrigation scheme management and rice related production technologies organized by ex-participants at the block level.	- At least 2 meetings per block per season after the training workshop. (By the end of 2007).	District Local Government
Impact of the intervention	Preparation of a project proposal for extending the positive impacts of interventions to within and beyond Doho Rice Irrigation Scheme.	-Quality of the project proposal.	- One attractive project proposal for rice farmers in Doho and other irrigation schemes.	Project Management Unit and Consultants

Note: The monitoring and evaluation framework will be modified with progress of identifying target groups, study tour in Thailand and training of stakeholders at Doho Rice Irrigation Scheme.

11. Estimated budget for project Implementation.

	Item	*Estimated Cost*
(i)	Extension staff/Farmers Study Mission in Thailand	US$ 60.000
(ii)	Thailand Experts Field visit to Uganda and training.	US$ 40.000
(iii)	Training workshop for extension Staff, water users groups, women and other groups.	US$ 100.000
(iv)	**Project administration Implementation Coordination, Supervision, monitoring** an**d evaluation of the whole period** The cost for this item is for preparation and follow of the training courses including field visits, reporting; supervision of	US$ 50.000

activities and monitoring and evaluation.
The money will not be used for local costs
which are covered by Government of Uganda.
Coordination, supervision, monitoring
and evaluation for the whole period
of 24 months.

(v)	Contingency (5%)	US$ 20.000
	Grand total:	**US$ 400.000**

US Dollars Four hundred thousands only.

N.B Budget is to include the following items;

(i) Series of trainings
(ii) Manuals for extension workers and farmers – rice / fish culture, home economics, products processing
(iii) Fish pond construction
(iv) Fish feeds
(v) Agricultural organic farming inputs (compost farm yard manual)
(vi) Some agricultural tools for example; one walking tractor
(vii) Transport for project implementation and monitoring
(viii) Power point projector for training purposes
(ix) Camera for covering project activities photographs
(x) stationery
(xi)

N.B. *Annexes on staff organization chart for Doho Rice Irrigation Scheme and other missing information will be given in the final project proposal.*

ジンバブエ

CAPACITY BUILDING FOR AGRICULTURAL EXTENSION IN ZIMBABWE

AN OPERATIONAL MANUAL FOR AGRICULTURAL EXTENSION WORKERS

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Acknowledgements

Gratefully acknowledged is financial support from the Government of Japan, through the Japan International Cooperation Agency (JICA) under the Asia Africa Knowledge Co-Creation Program – Rural Community Development Subprogram (AAKCP-RCDS), for the participatory workshop, drafting, production and printing of this manual. Special thanks to the our Asian Partner Organization under the AAKCP, Kasetsart University and Ministry of Agriculture and Cooperatives of Thailand for dispatching a three-member team which participated and contributed meaningfully at the Agricultural Extension Capacity Building Workshop held in Masvingo Province. Special mention goes to the JICA Regional Support Office for Eastern and Southern Africa (ReSOESA) team from Nairobi, Kenya for gracing the occasion.

The manual is a product of stakeholder participatory discussions for building capacity within the agricultural extension system in Masvingo Province. Forty-three participants from various organizations took part in the Agricultural Extension Capacity Building Workshop which led to the birth of this manual. The workshop attracted participants from Field Extension staff, Agricultural Research Stations, other Agricultural Departments in Masvingo, Agricultural Colleges, AREX Provincial and Head Office, JICA Zimbabwe Office, JICA Regional Support Office for Eastern and Southern Africa in Nairobi, Kenya, the Embassy of Japan in Zimbabwe and Thailand's Kasetsart University and Ministry of Agriculture and Co-operatives. Below is a list of contributors to the development of this manual.

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Preface

This edition on *Capacity Building for Agricultural Extension in Zimbabwe: An Operational Manual for Agricultural Extension Staff,* is a milestone in the development of rural communities in Zimbabwe. This operational Manual is an initiative of the Government of Japan, through the Japan International Cooperation Agency (JICA), which is promoting South-South cooperation in the area of development cooperation. The importance of South-South cooperation, especially between Asia and Africa, was reaffirmed at the third Tokyo International Conference on African Development (TICAD III) held in September 2003. The approach was found to have great potential in moving forward and meeting the challenges being faced by Africa. In November 2004, JICA facilitated the holding of the Asia-Africa Partnership Workshop (AAPW) which was held at the African Institute for Capacity Development (AICAD) in Nairobi, Kenya to discuss the possibilities of further collaboration between Asia and Africa. The importance of knowledge and experience sharing between Asia and Africa was emphasized at the workshop to foster their respective development. In March 2005, JICA launched the Asia-Africa Knowledge Co-creation Program (AAKCP) with the aim of creating a platform where knowledge and experience can be shared for mutual benefit among cooperating Asian and African Organizations.

The AAKCP aims to provide a mechanism in which Asian and African Knowledge and experiences can be shared, which will in turn enable each participating organization to formulate methods of development that are suited to its own respective circumstances. The AAKCP is an umbrella program where several sub-programs are being promoted in such areas as RCD, Private Sector Development, Education and Health among others. The program consisted of a system of seminars and Policy Research Projects (PRPs) jointly implemented with an Asian Partner Organization (Kasetsart University in Zimbabwe's case) with the objective of turning shared knowledge into practical knowledge with such tangible products as operational manuals for field extension staff.

The Agricultural Extension Capacity Building Workshop was held at Kyle View Holiday Resort in Masvingo from the 15th to the 17th of March 2006.. The aim of the AAKCP-RCDS Zimbabwe Project was to produce, in collaboration with Asian partner organization (Kasetsart University of Thailand), an Operational Manual for agricultural extension staff in Masvingo Province. The workshop attracted participants from Field Extension staff, Agricultural Research Stations, other Agricultural Departments in Masvingo, Agricultural Colleges, AREX Provincial and Head Office, JICA Zimbabwe Office, JICA Regional Support Office for Eastern and Southern Africa in Nairobi-Kenya, the Embassy of Japan in Zimbabwe and Thailand's Kasetsart University and Ministry of Agriculture and Co-operatives. The operational manual is therefore, a product of immense contributions by all the participants at the workshop.

The manual comprises mainly of three sections, namely, Crops, Livestock, and Agricultural Engineering and Economics Sections. It has been designed to cover the agronomic, animal husbandry, and farm practices in general, that are common in Masvingo Province and other smallholder farming areas of the country. The manual is expected to be very helpful to the field extension staff in their day-to-day interaction with farmers.

Table of Contents

Introduction

The majority of the Zimbabwean population is dependant on agriculture for employment and income generation. It follows therefore that raising production and productivity of Agriculture, particularly crop and livestock production, is a *sine qua non* for raising the standard of living of the average person in the rural community and the agricultural sector. Since the attainment of independence by Zimbabwe in 1980, there has been general emphasis on agricultural commodities and technologies suited to small-scale farming in rural communities but agricultural production has not responded adequately.

Currently government efforts are directed towards irrigation infrastructure development, provision of inputs and working capital needs for farmers to boost production, infrastructure rehabilitation and development and capacitating institutions that provide support services to agriculture. The Department of Agricultural Research and Extension (AREX) is one vital link to the development of the agricultural sector in Zimbabwe. It is therefore imperative that extension in Zimbabwe be strengthened to adequately provide for the needs of farmers following biased extension provision to communal areas of Zimbabwe during the colonial era.

This operational manual entitled "*Capacity Building for Agricultural Extension in Zimbabwe"* is a comprehensive compilation meant to aid field extension personnel in their training and interaction with farmers. The Crops Section describes and explains important agronomic issues that are of essence to smallholder agriculture in the country. It is subdivided into five subsections which are: Cereal Crops, Small Grains, Cash Crops, Oilseeds and Horticultural Crops. The Livestock Section focuses on the technical issues of animal husbandry. The last section on Agricultural Engineering and Economics tackles technical issues on agricultural production as well as agricultural finance and marketing concerns.

CROPS SECTION

I. CEREALS

Cereal crops are the main staple for the Zimbabwean diet. They provide the starch/carbohydrate component of the daily diets. The major cereals grown in Masvingo are maize, sorghum, pearl millet, finger millet (small grains) and wheat. All these cereals also play a very important role in the livestock industry for stock feed production. Wheat is used mainly in the confectionery and bakery industry.

MAIZE

OPTIMAL GROWTH REQUIREMENTS

Soils

Maize can be grown on a wide range of soils, but of importance, the soil should be well-drained as the crop is sensitive to water logging. Thus, ideal soils range from sand, sandy loams to heavy clays. While the most suitable are heavy-textured which are inherently fertile, on light-textured soils success is coupled by applying correct levels of fertilizer followed by moisture conservation techniques for marginal areas like Masvingo Province.

Rainfall

The crop requires an annual rainfall of above 600mm, well-distributed in the season of growth. Maize can withstand severe moisture stress early in its vegetative stages but after 5 weeks stress will cause yield reduction.

Stress at germination results in poor emergence, hence poor crop stand, or no crop stand in extreme cases. Stress at tasselling delays silk emergence while pollen is shed normally, hence poor synchronization for fertilization process. Moisture stress at grain filling has the worst effects of poorly-filled grains which result in maize meal of poor quality (cooked sadza from this mealie-meal tastes like it did not cook well).

Temperature

The crop requires warm conditions and is sensitive to frost. The ideal temperature is 24^{o}C. The lower limit is 15^{o}C while the upper limit is as high as 30^{o}C. Too low a temperature results in retarded growth and high incidence of diseases such as Maize Streak Virus, or even crop damage by frost, while too high a temperature results in plants scorching.

Rotations

Maize fits well in most rotation systems with crops like legumes, cotton and tobacco. Monoculture is highly discouraged for pest and disease management.

CULTIVAR SELECTION AND RECOMMENDATIONS

Hybrids

These are improved varieties which are a product of two known parents. Seed for these can not be recycled as yields drastically go down. These require high management and inputs for good performance.

Open Pollinated Varieties (OPV)

Seed can be continuously recycled. They can perform well even with less inputs and management. Varieties are always changing and there is a need for the Extension Staff to keep getting updated information from seed companies representatives.

Seed Sources

It is advised that farmers buy seed from reputable seed companies e.g. Pannar, Seed Co. Pioneer Hi-bred, National Tested seeds and local seed banks for OPVs.

Seed Production

Farmers are encouraged to have local seed banks for open-pollinated varieties which are easy to multiply at community level. The Crop Breeding Institute Department of Arex can be contacted if farmers have interest in seed multiplication.

LAND PREPARATION

Methods of Land Preparation

Conventional Tillage: Complete inversion of the soil to produce a fine seed bed using implements such as the ox/tractor drawn plough, hand hoe etc

Conservation Tillage : A field preparation practice which does not invert the soil and leaves about 30% plant residue on the surface after planting .Includes all such practices such as strip tillage, furrow planting and minimum tillage .It has the following advantages:

- maintains soil structure
- faster thus farmers can plant larger areas early in the season
- farmers with weaker animals at beginning of season can successfully use method
- farmers without draft power are able to crop
- improved soil water holding capacity because of the residue

FERTILIZER APPLICATION

For a farmer to know the actual rates to apply, it is important to know the maximum yields possible in his area and the average rainfall, as well as, the nutrients present in the soil. It is therefore advised that farmers have their soils analyzed if they need to be precise; otherwise they rely on general recommendations.

Organic Fertilizers

This includes animal manure, anthill, and humus.

Manure should be treated to improve quality, especially with regards to nitrogen content. This can be achieved by putting manure in pits and covering with soil or bags as early as June. Then

after manure is spread in the fields it should be immediately incorporated to reduce nutrient losses.

Inorganic Fertilizers

Chemically manufactured e.g. compounds D, L and straights e.g. A.N, urea.

Rates and Application Timing

Basal Fertilizers: Compound D, Maize fertilizer, or manure. The fertilizer is applied at planting usually incorporated in the soil. If for some reason it is not applied at planting side placement can be done within two weeks after planting by digging, applying, then covering, making sure the roots are not damaged. Rates are as in Table 1 below.

Fertilizer Rates for the Different Farming Regions in Masvingo Province

Region	Type	Rate	Cup number /size
3	Compound D Organic manure	150–200 kg/ha 6–8 t/ha	5 1 full sack per every 9m
4	Compound D Organic manure	100–150 kg/ha 4- 6 t/ha	3 1/2-1 sack per every 9 m
5	Compound D Organic manure	50–100 kg/ha 4-6 t/ha	3 same as above

In the southern parts of the province (Chiredzi) the soils are inherently fertile, basaltic clays, such that fertilizer is not commonly applied.

Topdressing Fertilizers

It is preferable to split apply in sandy soils and apply once on heavy soils since incidence of leaching is low on these. Fertilizer should be applied when the soil is moist to avoid crop burning through physiological drought. Ammonium nitrate is side dressed while urea is side dressed but covered since it is highly volatile. Top dressing is usually done between 4 and 6 weeks after planting and when crops show signs of nitrogen stress. Rates are as in Table 2 below.

Fertilizer Rates for Different Farming Regions

Region	Type	Rate (kg\ha)	Cup Size
3	A.N Urea Organic	75-100 50-75 100 - 150	Half of cup size 5 2 5
4	A.N Urea Organic	50 – 100 75 75 – 100	2 2 2
5	A.N Urea Organic	+ /- 50 - -	Half cup size 2 - -

Liming

Work done by research has shown that generally soils in the communal areas are becoming acidic due to the continued use of chemical fertilizers without any corrective measures thereafter.

However, liming requirements can only be determined by the soil pH status. For maize on high pale soils (granite sand veld) pH should be kept at 4.7 on $CaCl_2$ scale, while on all the other soils it should be at 5.5–6 on the same scale.

Nutrient Deficiency Symptoms

Nitrogen Deficiency: Yellowing of leaves and stunted growth.
Phosphorous Deficiency: Reddish–purple discoloration of leaves.
Potassium deficiency: Firing or drying of leaves the tips inwards followed by subsequent drying of whole leaf.
Soil acidity: Stunted growth and overall paling.

PLANTING

It is advisable for farmers to plant with the first effective rains. Planting can be at the depth of 2 – 5 cm depth depending on moisture availability. Seed can be soaked to enhance quick emergence. This can be done by soaking the seed overnight.

Seed Rates

Achieving an optimum plant population is a critical factor in maize production .25kg of seed is required to plant 1 ha of maize. The plant populations vary by water availability and region. Below are some recommended plant spacing for the different regions.

Region	Spacing
3	90cm inter row and 30 cm in row
4	90 cm inter row and 45 cm in row
5	90 cm inter row and 45 cm in row

Methods of planting

Hand planting and mechanical planting using ox-drawn or tractor-drawn planters

WEED CONTROL

Manual Weed Control e.g. hoe weeding and hand pulling.
Mechanical weed control e.g. use of cultivator, plough.
Chemical weed control: Involves use of herbicides.

Types of herbicides

Chemical name	Trade name	Weeds controlled	Stage of application	Persistence	Comments
Glyphosate	Roundup	All weeds	Post-emergence	VS	Systemic herbicides suitable for conservation farming. Do not apply near sensitive green material.
Metalachlor	Dual	Annual grasses broadleaved.	Pre-emergence	S	Mix with Atrazine for better broadleaf control.
cynazine	Bladex	Broadleaf and some grasses	Pre-and post-emergence	S	Not recommended for sandy soils.
MCPA-K	MCPA	Broadleaf weeds	Pre- and directed post-emergence	S	Apply after 12 leaf stage

Paraquat	Gramoxone	Annual grasses and broadleaf weeds	Post-emergence	Nil	Contact herbicide. Dosage depends on size of weed. Suitable for conservation tillage.
Atrazine	Atrazine/ Atranex	Broadleaf and some grasses (rapoko grass)	Pre-and post-emergence	L	Subsequent broadleaf weeds may be at risk due to long residual activity.

Key: L – Long, M - Medium, S - Short, VS – Very Short. **N.B:** for rates refer to manufacturer's instructions

Biological Control

This involves the use of other plant material to control weeds e.g. use of pearl millet as a trap crop for witch weed (striga) control. Another example is the use of sunflower in rotation so as to break the cycle of striga (witch weed).

Common Pests

Pest	**Maize Stalk borer**
Damage caused	Feeds by boring in the funnel leaving holes on leaf surfaces.
Method of control	❑ Chemical control using Dipterex, Kombat, Carbaryl ❑ Cultural control through deep ploughing and burying of stover

Common Diseases

Disease	**Symptoms**	**How spread**	**Favoured conditions**	**Control**
Maize Streak Virus	Long white to yellow streaks along the leaf blade	Leaf hoppers after they have suck infected plants	Close rotation of grassy crops	- Spraying hoppers with chemical e.g. dimethoate. - Seed dressing with chemicals such as Gaucho. - Rotation with non grassy crops. - Roguing affected plants. - Use of tolerant varieties e.g SC627 ,SC403 - 2-3 meter discard boarder to deter the hoppers from re-infecting other plants or fields.
Grey Leaf Spot	Pale brown to grey lesions on leaves and stems	Spores spread by wind	Wet and humid conditions	- Use of tolerant varieties e.g SC405 - Burn and plough infected plant debris. - Rotate with non host crops e.g. soyabean, groundnuts. - Chemical control e.g. use of tilt, score.

HARVESTING AND PACKAGING

Harvest indices such as, physical appearance (yellowing to browning of leaves), days to maturity for variety, and moisture content are commonly used. Harvesting can be done using machine or hand. After it has reached the proper moisture content (12%) it should be packed. For packaging currently 50kg bags are recommended for the market.

STORAGE AND PROCESSING

Maize can be stored in granaries, on cob, or bulky in tanks or silos.

Common Storage Pests and Control

Pest	Control
Maize weevil	❑ Good storage hygiene ❑ Chemical control e.g. Actellic Super, Shumba Cooper ❑ Traditional methods e.g. Zumbani, gum tree leaves

Stock feed production

Silage can be made from the maize stover, or the stover can be kept for dry season feeding of livestock. On the other hand, crushed maize grain can be used for crushes which can be mixed with concentrates for enterprises such as poultry, piggery and beef farming.

Residue Management

Deep ploughing residue will give a source for organic fertilizer for the subsequent crops and at the same time bury some pest stages hence destruction of life cycle. On the other hand, animals can be grazed on the stover.

Marketing Strategies

Maize is a controlled product and only marketed through the Grain Marketing Board (GMB).

WHEAT

OPTIMUM GROWTH REQUIREMENTS

Soil Requirements

Wheat can be grown on a wide range of soils, but deep, heavy-textured soils with good organic matter are preferred. Other soils can be used as long as they are well-drained. However, on light soils high level of fertilizer and irrigation management is required. Poorly drained soils should be avoided at all costs as wheat is very sensitive to water logging.

Water Requirements

Requires about 600mm depth of water per hectare i.e. 6 megalitres/ha. The moisture sensitive stages are during heading, flowering and early grain fill such that drought during these periods reduces grain number and weight. Water stress during early growth can reduce yield by reducing the number of ears. Rainfall during and after the hard dough stage can cause germination of grain in the ear thereby reducing quality.

Temperatures

This is the main factor affecting development and yield of wheat in Zimbabwe. Wheat develops well and gives higher yields under cooler than warm conditions. The lower the temperature, the longer the duration of spikelet formation and correspondingly a higher number of spikelets per ear. The higher the temperature after flowering, the shorter the period of grain filling, hence the lower the final grain weight. Thus late planted crops after mid May in the lowveld yield less than early crops because the grain filling period coincides with the hot September–October weather.

Frost may actually improve tillering during the early stages of wheat, but after booting frost can cause floral sterility thereby reducing grain set. Severe frost after grain set may cause moisture in grain to freeze, hence poor test density.

CULTIVAR SELECTION AND RECOMMENDATIONS

Farmers are advised to use seed from recognized dealers so as to maximize on yields. But of major concern when selecting varieties are issues such as disease tolerance, yield potential and other characteristics such as resistance to lodging and ear sprouting.

LAND PREPARATION

Conservation tillage is highly advisable because the time available for preparations is short given that the lands will be cropped to another crop prior. Conservational tillage is ideal as it maintains nutrients such as phosphates available for the crop.
Conventional tillage can also be done and it allows for a fine tilth.
Rolling can be necessary if the tilth is rough, or planting is on sandy soils.

FERTILIZER APPLICATION

Just as for any other crop enterprise, it is highly advisable for farmers to have their soils analyzed.

Application Rates and Timing

Generally, 600kg/ha of compound D all applied by hand or machine at planting, while topdressing is recommended at 300kg/ha Ammonium nitrate, applied at around 4 weeks after planting, or as crop shows signs of nitrogen deficiency. It can be split or applied all at once. Compound D can be banded if the crop is in rows, but if broadcasted then it can also be broadcasted and incorporated at planting. Topdressing can also be either broadcasted or banded depending on planting system.

pH and Liming

Optimum range is 5–6 on sand and 5.3–6.3 on clay loam and clay. pH should be checked regularly, so that liming is done on time if found necessary. It should be noted that unless the land has been limed to correct the pH, the crop will not be able to utilize the fertilizer to full effect.

Nutrient Deficiency Symptoms

Nitrogen: Yellowing and general stunted growth.
Phosphorous: Stunted plants with dark-green colour. Severe deficiency causes purpling or browning of leaves starting with the older growth from tips of leaves inwards. Eventually, tips turn dark brown and die.
Potassium: Yellow to bronze discolouration and subsequent drying off of tips and margins of older leaves.
Soil Acidity: Stunted growth and general paling.

PLANTING

Planting Dates

Typical planting time for wheat in Masvingo is between late April and mid May. This is with the aim of making full use of the cool winter months during the growth before temperatures begin to rise in October avoiding this to coincide with grain filling.

Seed Rates and Spacing

When deciding on spacing one has to take into account the following factors:

- Desired plant population
- Average seed weight of seed lot
- Seed germination percentage and field losses at establishment

The aim is to produce maximum productive plants. The later the planting the higher the rate to compensate for the reduced tillering associated with such. As a general guide 100–130 kg/ha seed is required for broadcasted and 80–100kg/ha for drilled planting. This seed can be planted at the depth of 1-2 cm making sure that no seed is left exposed for birds, and rodents will eat it away.

Methods of Planting

Wheat can either be broadcasted by hand, tractor mounted vicon, drilled by hand, or tractor mounted well-calibrated planter.

WEED CONTROL

Weeds are not a serious problem in wheat as their growth is favoured by the summer conditions. Also if the wheat is planted at the ideal population then it smothers these. But options still exist in case of infestations and these are as follows:

*Manua*l: Involves pulling by hand
Chemical: Involves use of herbicides
Cultural: High plant populations suppress weed infestations

Wheat Herbicides

Herbicide	Application stage	Weeds controlled	Comments
Banvel +MCPA	3 – 5 leaf stage for crop and less than 4 leaves for weed.	Broadleaf weeds and grassy.	Do not apply after 5 leaf stage.
Basagran	Any crop stage.	Broadleaf.	Warm and humid conditions required.
Bladex + MCPA	3 – 4 leaf stage for crop.	Broadleaf and some grassy.	Do not apply before 3 true leaves or after early tillering. Avoid using on sandy soils. A slight chlorosis may occur after use.

COMMON DISEASES AND PEST CONTROL

Common Pests

Pest	Quelea	Leaf Hoppers
Damage	Birds eat the grain from head	Transmit Maize Streak Virus disease
Control	Chemical control using queleatox Bird scaring	- Spraying hoppers with chemical e.g. dimethoate. - Rotation with non grassy crops. - Roguing affected plants. - 2-3 meter discard boarder to deter hopper movement.

Common Diseases

Disease	Maize Streak Virus	Leaf and stem Rust
Symptoms	White to yellowish discoloration on leaves.	Reddish–brown elongated pustules on stems and leaves.
How spread	Infected hoppers sucking sap of uninfected crop transmit the virus.	Spores blown by wind from areas of infection.
Favoured conditions	Close rotation of grassy crops	Wet and humid conditions.
Control	Spraying hoppers with chemical e.g. dimethoate Seed dressing at with chemicals such as Gaucho Rotation with non grassy crops Roguing affected plants 2-3 meter discard boarder to deter the hoppers from re-infecting other plants or fields	- Use of tolerant varieties e.g. Pan 3492. - Burn and plough infected plant debris. - Rotate with non host crops e.g. soyabean , groundnuts - Chemical control e.g. use of tilt, thiovit.

HARVESTING

In the field harvesting is done when the stem below the ear has turned grey-brown. Moisture at this stage should be around 12–14%. Harvesting at high moisture leads to loss. This can be done by hand using sickles (at small scale) or by machine (combine harvesting). It should be noted that without careful choice of harvesting equipment and skillful operation of it the farmer may lose a very high proportion of the crop through poor techniques.

Packaging

Bag sizes keep changing but the current standard is 50kg when packing for G.M.B so size of packaging can vary depending on whether it is farm level storage or delivery to buyer.

MARKETING

Wheat as a controlled product is marketed through the Grain Marketing Board (GMB).

II. SMALL GRAINS

SORGHUM, PEARL MILLET AND FINGER MILLET

OPTIMAL GROWTH REQUIREMENTS

Soils

They thrive on a wide range of soils and higher yields obtainable from fertile well drained soils but can still grow on relatively poor soils. pH range of 5-6.5.

Rainfall

Very drought tolerant and can withstand moderate to harsh conditions with minimum requirement of 300–400mm per annum hence can be grown in the very dry areas where maize can not thrive of which Masvingo is one such province. But of the 3 small grains Pearl millet is even hardier such that it can even grow with as little as 200–300 mm per annum.

Temperatures

Hot warm conditions preferred with temperature ranges of 15-30^{o}C .During flowering too high temperatures are experienced sorghum may fail to head well. Early frost on immature grain also affects all the 3 small grains and can causes drastic yield losses.

CULTIVAR SELECTION AND RECOMMENDATIONS

Most of the local varieties are open pollinated and low yielding while the hybrids are higher yielding.

LAND PREPARATION

Just like any other crop, land should be ploughed after harvesting of previous crop to a depth of about 20–25cm .This is to allow for moisture conservation and decomposition of crop residues. A finer seedbed is required because the seeds are small.

FERTILIZER APPLICATION

Soil analysis is necessary to determine soil nutrient and pH status but the general recommendation is for 5–8 tonnes/ha organic manure, or 30–100 kg compound D at planting. Top dressing can be applied 4–5 weeks after crop emergence. Fertilizer use is especially advised for the lighter soils, while for the heavy rich basalts of Chiredzi and parts of Mwenezi, then there will be no need to fertilize.

Nutrient Deficiency Symptoms

They are the same as for maize.

PLANTING

It should be noted that when choosing a planting date the main aim should be to avoid ripening of crop in the rains. Dry planting in October is advised for areas with very short seasons. If planting is done with the rains it is advisable to do it with the first effective rains. For areas with relatively longer seasons then planting can still be done even in December.

Seed Rates

Five (5) – 8 kg is required to plant 1 ha. Spacing can be at 90cm inter row by 20 cm in row for pearl millet and sorghum, while for finger millet inter row is 45 cm and as low as 15-10 cm in row. However much depends on the variety with wider spacing used for profuse tillering varieties. Seed for these has to be planted to a depth of 25–35 mm if soil is moist and up to 45 mm if dry, so that light showers will not cause rotting.

Methods of Planting

It can be done manually or by machine. A tractor drawn planter can be used to drill seed and fertilizer.

Types of Planting

Dry planting – that is planting a week or two before the anticipated start of season.
Rain planting – is planting with the first effective rains (25 – 30 mm depending on soil type).

WEED CONTROL

Clean cultivation of the field is important especially during early stages because the crops are poor weed competitors. Two to three weedings are considered adequate depending on weed pressure. Control can be achieved either mechanically or by chemicals.

Mechanical control involves use of machinery e.g. ox drawn or tractor drawn cultivator
Chemical control involves the use of herbicides such as atrazine, lasso or dual. Herbicides used in maize can be used in the small grains.

DISEASE AND PEST CONTROL

Common Diseases

Disease	Smut	Ergot
Symptoms	Over development of spikelets and seeds burst exuding black dusty spores.	Heads covered with thick black substance which releases spores when it bursts.
How spread	Soil and wind borne	Wind and soil borne.
Control	Seed dressing with chemical e.g. Thiram. Burn or destroy crop residue. Rouging out infected plants.	Seed dressing with fungicide such as Thiram, Captan at planting. Crop Rotation.

Common Pests

Pest	Quelea	Stalk-borer	Aphids
Damage	Feeds on grain	Feeds by boring in the funnel leaving holes on leaf surfaces	Sucks sap and attracts growth of sooty mould which reduces photosynthetic area.
Control	Bird scaring. Chemical sprays of queleatox.	Chemical control using Dipterex, Kombat, Carbaryl. Cultural control through deep ploughing and burying of stover.	Chemical sprays with Dimethoate.

HARVESTING

This is done when the grain has become hard with dark brown layer at the bottom. Harvesting is done by cutting heads with a knife and dried ready for threshing. Sorghum can also be harvested

by combine. If a farmer has grain dries he can harvest at 18 – 20 % moisture then dry to the G.M.B required 12 %.

Packaging

The standard packaging for the market is in 50-kg bags but for on farm storage farmer can pack in any available material and size as long as the material allows for free air circulation to avoid rotting of grain.

MARKETING

The marketing of small grains is not controlled but residuals (surplus with farmers) are marketed through the G.M.B.

III. CASH CROPS

COTTON

Cotton falls in the Gossipium species and is mainly used in the textile industry. Cotton seed can be processed into cooking oil and by-products are used as livestock feeds such as cotton cake.

OPTIMUM GROWTH REQUIREMENTS

Soils

Cotton requires light to medium well-drained fertile soils with high moisture holding capacity.

Rainfall

The crop does well in low to moderate rainfall (400–800mm) and under irrigation. It is drought tolerant and can be grown in marginal areas.

Temperatures

Temperatures in the range of 25–35^{o}C

CULTIVAR SELECTION AND RECOMMENDATIONS

Selection of cultivars to grow should be based on length of time to maturity, lint size, quality of seed in terms of oil content, general weight (boll size), resistance to diseases and market requirements. Farmers are encouraged to buy current seed supplied with information on seed source and time taken from planting to maturity (i.e. short or long season variety)

LAND PREPARATION

Only conventional tillage is encouraged in Masvingo Province. This involves ploughing to produce seedbed of fine tilth with a depth of 200 – 300mm. planting rows can be marked at inter-row spacing of about 90cm.

PLANTING

The planting dates for cotton range from the 5th of October to the 15th of November so as to make effective use of the first rains.

Seeding Rates

Cotton is a poor germinator; therefore, 20–25kg of seed should be used for one hectare to achieve a good crop population and stand. The seeds should be planted at 10–20mm depth.

Methods of planting

There are three common methods which can be used, namely: tractor or ox-drawn planter, direct sowing in planting rows and station planting using a hoe. Cotton can be dry-planted before onset of the rains or planted in wet soils during the rainy season.

FERTILIZATION

Soil Analysis

Soils must be sent for analysis by the Soil and Chemistry Research Institute for effective fertilization. Soil pH requirements for cotton range from 5.0–6.5.

Organic Fertilizers

Cattle manure is the commonly used organic manure, but research is still needed on the appropriate quantities for application. The manure must be incorporated into the soil before planting for good results.

Inorganic Fertilizers

Compound L or a basal fertilizer should be applied at 200-300kg/ha before, or during planting through banding, drilling or using a planter. Ammonium Nitrate (AN) is a top dressing fertilizer which should be applied at 100–200kg/ha either through banding or broadcasting. The application of AN should be split; 20% at 9 weeks after planting and 80% at flowering stage.

Nutrient Deficiency and Symptoms

Nutrient	Deficiency Symptom
Nitrogen	Stunted growth and yellowing of leaves
Phosphorus	Poor root development
Potassium	Yellowing and defoliation of old leaves
Boron	Poor boll development, Falling of the bolls

WEED CONTROL

There are basically four types of weed control which farmers can use namely manual, mechanical, chemical and biological.

Manual

This is the most common and is done using a hoe.

Mechanical

Also common and is done using a cultivator. The cultivator can be ox- or tractor drawn.

Chemical Weed Control

This involves the use of herbicides before planting (pre-planting), soon after planting but before emergence (pre-emergence) and after plant germination (post emergence). Examples of these herbicides include Trifluralin (pre-planting), Bladex FW, Alachlor EC, Dual 720 EC (pre-emergence) and Gramoxone (post emergence).

Biological Control
This involves the concept of Integrated Pest Management (IPM).

DISEASE AND PEST CONTROL

Disease	Symptoms	How Spread	Favoured Conditions	Control
Damping-off and Sore shin	Damaged plants Weak and unthrift	Fungus	Excessive capping. Cool wet conditions. Fertilizer burn. Too deep planting. Misuse of herbicides.	Seed treatment with vitavax or brassicol. Apply brassicol in the furrow at planting.
Bacterial Blight	On the leaf appear small water soaked angular leaf spots which enlarge and turn black with age.	bacteria	Excessive wetness	Planting resistant varieties. Practicing crop rotation. Use acid delinted seed to avoid carryover from season to season.
Verticilium Wilt	Wilting of leaves followed by chlorosis and scorching of the interveinal and marginal leaf area.	Fungus	Cool wet conditions	Resistant varieties Crop rotation Remove affected plants and burn them
Boll Rot	Rotting of bolls	Fungus	Damp weather	Controlled use of Nitrogen. Effective insect control Rotation and efficient plant residue disposal

Pest	Symptoms	How Spread	Favoured Conditions	Control
Bollworms (Red Heliothis, Spine, Pink Heliothis)	Rotting of bolls	Moths		Chemical e.g use of Carbaryl, Thiodan, Karate.
Leaf Eaters (Semi-looper, Leaf worm, Elegant grasshopper)	Damaged leaves			Carbaryl, Thioden, Lavin.
Stem-feeding (Cutworms)	Damaged stems at or just below the soil surface			Dipterex, Carbaryl, Thioden.
Root Feeding (Termites, False wireworms, Nematodes)	Damaged roots			Thioden.
Sucking Pests (Aphids, Jassids, Whiteflies, Cotton stainers, Thrips, Red spider mite)	Curling leaves, Drying of leaves Stained lint, Damaged seed			Karate, Dimethoate, Rogor, Acaricides for red spider mite control e.g Mitac ,Tedion N.B farmers need to continuously check the acaricide rotation scheme.

Beneficial Insects
Some insects are beneficial to the crop because they are predators to pests (biological control). These insects include spiders, lacewings, ladybirds, syphids, phonoctonous, etc.

HARVESTING
Cotton harvesting should begin when the bolls split and lint start hanging out of the boll. Harvesting is done manually by picking using hands. This ensures good quality cotton lint.

GRADING AND PACKAGING
Cotton should be sorted according to quality of lint and seed. It should be ranked from grade A to D, according to quality. Packaging for the marketing should be done in standard 200kg hessian bags.

STORAGE AND MARKETING
Harvested cotton lint should be stored away from termites and moisture. Cotton bags should be stored on rakes. Cotton is sold to reputable merchants at marketing points distributed in most districts of the country. It can also be grown and sold under contract arrangements.

IV. OILSEEDS

INTRODUCTION
Oilseeds are important food crops as protein and fat sources and confectionary industry. The residue can be used as animal feed. There are four important oilseeds namely groundnut (*Arachis hypogea*), sunflower (Helianthus annuus), soyabean, (*Glycine max*) and Jatropha (*Jatropha curca*s).

GROUNDNUTS

OPTIMAL GROWTH REQUIREMENTS

Soil Type
Best results are obtained from deep, well-drained soils of pH between 5.3 and 6.5 ($CaCl_2$). These include sand, sandy loam or loamy sand soils.

Rainfall
Groundnuts do well with 450 mm or more of evenly-distributed rainfall during the growing season.

Altitude and Temperature
Below 900 MSL and 30^{o}C mean temp with daytime temperature of up to 35 ^{o}C and nighttime temp down to 25^{o}C.

CULTIVAR SELECTION AND RECOMMENDATIONS

Cultivated Varieties

Short Season	Nyanda, Natal Common, Valencia R2, and Falcon
Medium Season	Swallow
Long Season	Flamingo, Makulu Red, and Egret (grow under irrigation).

Seed Availability and Sources

Seed harvested from previous crop can be used, but it is important to purchase certified seed at regular interval, preferably 2-3 years. Farm-saved seed should be stored in shell in cool dry condition and shelled before sowing.

LAND PREPARATION

Methods of Land Preparation

Conventional tillage

Lands must be well-ploughed and the soil in good tilth.

Conservation tillage

This is a method of tillage where a furrow is just opened for seed placement.

FERTILIZATION

Soil Analyses

Soil analyses are recommended. Groundnut will not grow well or fix nitrogen in acidic or infertile soils. Groundnuts grow well with residual fertilizer, so it should be grown in rotation with cereals such as maize and sorghum.

Organic Fertilizers

Manure can be applied before sowing but it tends to raise the soil pH.

Inorganic Fertilizers

Farmers can apply compound fertilizers (compound C, D, L, or single super phosphate).

Soil pH

If the pH is below 5.3, 200-300kgs/ha of lime (Calcium Carbonate) should be applied. If the pH is above 6.5, Magnesium Sulphate should be applied.

Rate and Application Timing

Basal fertilizers should be broadcasted at the rate of 150-250kg/ha using Single Super Phosphate (19%P_2O_5), or Compound L (5:18:10+0.25%boron), at or before discing and sowing.

Top dressing – At the pegging stage (50%flowering or 7-8 weeks after germination), 100-300kg/ha of Gypsum should be applied. Gypsum is particularly important if the crop is grown with manure or a concentrated compound fertilizer instead of single super phosphate.

Nutrient Deficiency Symptoms

Nitrogen Deficiency	Lower leaves turn yellow and the groundnuts are stunted.
Phosphorus Deficiency	leaves turn purple and poor root development**.**
Potassium Deficiency	In early growth stages, irregular yellow mottling around the edge of leaflets appears particularly in the lower leaves. The chlorotic areas merge to form continuous borders around the tips along the sides of the leaves. Death or necrosis of the chlorotic areas follows, with a downward cupping of the leaf edges. Extreme deficiency tends to produce wrinkled and misshaped seed. Maturity is delayed.

PLANTING

Crop Establishment

Maturity group	Production	Planting date	Lifting date	Seed required (kg/ha)	Plant population	Spacing (mm)	Planting depth (mm)
Short season	Rain fed	14-30 Nov	25 Feb – 10 Mar	80-120	250,000 – 300,000	450x(50-75) 300x(75-100)	50-80
	Irrigated	14-30 Nov	20-30 Mar	80-120	250,000 – 300,000	50 – 75	50 - 80
Long season	Rain fed	As early as possible with first effective rain	Around April	80-120	125,000 – 150,000	100 -150	50 - 80
	Irrigated	8-23 Oct	7-22 Mar	80-100	125,000 – 150,000	100-150	50-80

Irrigation should bring soil moisture to field capacity to a depth of 900-1,200mm, either before or immediately after planting. The quantity of water will depend on soil moisture status and texture.

Seed inoculation – 80-100kg of seed/80g. or a pack of rhizobium innoculant.

Method of Planting

Hand planting and mechanical planting using ox-drawn or tractor-drawn planter.

WEED CONTROL

As soon as the weeds appear, use the hoe. Once flowering starts, weeds should be hand-pulled to prevent damage to developing pegs and pods.

DISEASE CONTROL

The two most important groundnut foliar diseases in Zimbabwe are early leaf spot (*Cercospora arachidicola*) and web blotch (*Phoma arachidicola*). These diseases are responsible for yield losses of 30-50%. Early leaf spot is a serious problem on rain fed groundnut, but web blotch is serious only on irrigated crops. Effective disease control should include the combined use of suitable varieties e.g., Natal Common and good cultural practices. Chemical can also be used, but they are very expensive. If you are in low potential areas, where yield are low, it is not profitable to spray.

PEST CONTROL

Semi-looper caterpillars are often a problem during the flowering and seed filling periods. They eat the leaves and sometimes the pods. They are normally killed by a viral disease. The dead caterpillars are black and can be collected, crushed, mixed with water and sprayed around the field to help control other caterpillars. Monochrotophos, Carbaryl, and Endosulfan can be used for control.

Aphids transmit the virus, which caused the groundnut rosette. It is very important to control the aphids. Rosette may not occur at serious levels every year, but yield losses can reach 100% during disease epidemics. Late-sown crop, especially where plant stands are poor, are at greatest risk. Dimethoate 40%ec or Endosulfan 35%ec can be sprayed.

Other common pests include ***cutworms*** (use Carbaryl), ***Hilda*** (use Monochrotophos), ***leafhoppers*** (plant early), and ***termites*** spot spray with Chloropyrifos).

HARVESTING

Lifting – Commence lifting at 40-50% pod maturity. A delay in lift beyond 80% stage will result in severe loss due to pod retention in the soil and the kernel discoloration. Regardless of maturity, lift when the crop is 90% defoliated. If sprouting becomes evident the crop should be lifted at all costs (mature or immature).

Curing – 2-3 days after lifting it is safe to start curing. A-frames racks and cocks can be used to hang the groundnut. Ensure protection from direct sunlight. Good circulation within the A-frames is important.

Method	Description	Number per hectare
A-frame Rack	The wooden frame is 2.75m. long, and the sides of the equilateral triangle forming the 'A' are each 2.75m long. One frame is positioned on the centre line of 3 beds and stores the groundnut contained within 65 m of bed i.e. $\pm$ 32 m. both sides of the frame	30 (6.5t/ha unshelled)

Storage

Bags should be stored under cover in cool, well-ventilated sheds. Storage under tarpaulins should be avoided where ventilation is restricted.

Common storage pests

For the rodents use rat killer or cats. For termites use ant killer.

Residue Management

Compost making or stock feed.

SOYABEAN

OPTIMAL GROWTH REQUIREMENTS

Soil type

Best results are obtained from deep, well-drained soils of pH between 5.3 and 7.0 ($Cacl_2$). These include sandy-loam, loamy-sand, clay-loam or heavy-clay soils provided they are well-drained.

Rainfall

Average 550 to 600 mm if well distributed during the growing season. Moisture is critical at emergence (1 to 7 days after sowing, at flowering (55 to 75 days after planting) and pod filling (95 to 125 days after planting)

Altitude and Temperature

Below 600 to 800 MSL and 30^{o}C mean temperature with daytime temp up to 35^{o}C and nighttime temp down to 25^{o}C.

CULTIVAR SELECTION AND RECOMMENDATIONS

Factors to consider when selecting soyabean variety:

- Adaptability to local conditions
- High seed yields
- Resistance to lodging and pod shattering
- High pod clearance
- Rapid stem dehydration
- Resistance to diseases

Varieties recommended in Masvingo province include Storm, Mhofu, Bimha and Kana.

Seed Availability and Sources

Seed obtained previous crop can be used, but it is important to purchase certified seed at regular interval, preferably 2-3 years.

LAND PREPARATION

Methods of Land Preparation

Conventional tillage – Land is well-ploughed and the soil left in good tilth. It is usually done prior to onset of the rains and at least one crop of weeds is removed before planting

Conservation tillage – Just open furrow for seed placement.

FERTILIZATION

Soil Analyses

Soil analyses are recommended. Soyabeans will not grow well or fix nitrogen in acidic or infertile soils. Soyabeans grow well with residual fertilizer, so it should be grown in rotation with cereals such as maize and sorghum.

Organic Fertilizers

Manure can be applied before sowing, but it tends to raise the soil pH.

Inorganic Fertilizers

Farmers can apply compound fertilizers (compound D, L, Omni L, Single Super Phosphate or Triple Super Phosphate).

Soil pH

If the pH is below 5.0, 300 to 500kgs/ha of lime should be applied every 3 to 4 years if there is no soil analysis.

Rate and Application Timing

Broadcast lime prior to planting preferably soon after harvesting and plough it under during autumn ploughing. Cattle manure can be used instead of lime.

Top dressing – Additional nitrogen is not necessary if the inoculation is successful. It could, in fact, be harmful to bacteria.

Nutrient Deficiency Symptoms

Nitrogen Deficiency	Lower leaves turn yellow and the soybeans are stunted**.**
Phosphorus Deficiency	Leaves turn purple and poor root development**.**
Potassium Deficiency	In early growth stages, irregular yellow mottling around the edge of leaflets appears particularly in the lower leaves. The chlorotic areas merge to form continuous borders around the tips along the sides of the leaves. Death or necrosis of the chlorotic areas follows, with a downward cupping of the leaf edges. Extreme deficiency tends to produce wrinkled and misshaped seed. Maturity is delayed.

PLANTING

Timing of Planting

Late November to early December in Lowveld and late November in Middleveld. High yields are achieved by planting early, but severe losses can be incurred as a result of late rains.

Spacing

In row spacing 5 to 7cm, inter row 45 to 60cm. Planting depth is 2.5cm for heavy soil and 4.0 cm for light texture soil.

Seed Rate

Seventy (70) to 100kg/ha (350,000 to 400,000 plants/ha)

Irrigation

Bring soil moisture to field capacity to a depth of 900-1,200 mm, either before or immediately after planting. The quantity of water will depend on soil moisture status and texture. Under rain-fed, the soil must be moist for better crop establishment.

Seed Inoculation

Mix 1 packet (80g) of Rhizobium inoculant with a litre of water for dressing every 80 to 100kg of seed. Use the whole packet for all seed below 80kg since there is no side packet of Rhizobium should be used when packet is opened.

Method of Planting

Hand planting and mechanical planting using an ox-drawn or tractor-drawn planter.

WEED CONTROL

Weed the crop 2 weeks after emergence and keep clean of weeds until crop canopy covers the ground underneath. Herbicides can also be used such as Lasso, Dual (pre-emergence) and Classic25DF and Basagran (post-emergence).

DISEASE CONTROL

The three most important soyabeans foliar diseases in Zimbabwe are ***Early leaf spot*** (*Cercospora sojina*), ***Red leaf blotch*** (*Pyrenochaeta glycines*) and ***Soyabean Rust*** (*Phakopsora pachyrhizi*).

Effective disease control should include the combined use of suitable varieties. Chemicals such as Folicur, Score can be used for rust control, but they are very expensive. In low potential areas, where yields are low, it is not profitable to spray.

PEST CONTROL

Semi-looper caterpillars and ***American bollworm*** (*Heliothis armigera*) are often a problem during the flowering and seed filling periods. They eat the leaves and sometimes the pods. The dead caterpillars are black and can be collected, crushed, mixed with water and sprayed around the field to help control other caterpillars. Monochrotophos, carbaryl, Thiodin bait and Endosulfan can be used for control.

Aphids transmit the virus, which caused the rosette. It is very important to control the aphids. Soyabean mosaic virus can be transmitted by aphids, Late-sown crop, especially where plant stands are poor, are at greatest risk. Dimethoate 40%ec or karate can be sprayed.

Other common pests include ***cutworms*** (use Carbaryl), ***Snout beetle, stink bugs, semi-loopers, nematodes*** and ***termites*** spot spray with Chloropyrifos.

HARVESTING

Hand harvesting – Use sickles to harvest by cutting plants near ground level preferably in the morning (Up to about 10:30 am to avoid shuttering.).

STORAGE

The seed can be stored in granaries under thatch after drying, to less than 11.5% moisture. Hessian bags store and maintaining seed viability better than polythene bags.

Residue Management

Compost making or stock feed production.

PROCESSING

Soyabeans can be processed into Soya flour, Soya milk, Soya bread, Soya bean cake, Soya bean scones, Soya maputi.

JATROPHA (*Jatropha Curcas L)*

Jatropha Curcas L is a shrub or small tree (Max. height 7-8m) with thick glabrous branchlets. The tree has a straight trunk and grey or reddish bark, masked by large white patches. The flowers are pale green, yellow green and 7-8 mm in diameter. The fruit is a dark brown, almost spherical capsule, 15-40 mm in diameter. On the tree the fruit is indehiscent. The pericarp or shell contains one, two or three seeds separated from one another by the septums of ellipsoids, scarcely lobes capsule about 2.5cm long and black when ripe.

OPTIMAL GROWTH REQUIREMENT

Soils

Jatropha trees grow well in soils of average to marginal quality, stony to clayey. It is cultivated on poor soils with a pH of 4.5 to alkaline.

Rainfall

Grows well in hot, dry areas and can endure long periods without rain. Economic returns can be obtained with 200-250mm rainfall. For high yields, the crop needs 900-1200mm rainfall or irrigation.

Temperature

Jatropha Performs best under high temperatures of mean 20-28^{o}C, prefers cool soils, but this is not a limiting factor. The plant can survive light frost.

CULTIVAR SELECTION AND RECOMMENDATIONS

Only one variety is available in Zimbabwe, which grows well in Natural Regions II, III, IV and V, but in cooler regions it will not grow as fast as in hot regions.

LAND PREPARATION

Method of land preparation

There is no need for ploughing or ripping (unless a known compaction problem exists). Dig a hole of sufficient size to take the seedling.

FERTILIZATION

There are no reports on the nutrient analysis for curcas nuts. The nutrients removed by a yield of 200kg seed are estimated at about 80kg N, 18kg P_20_5, 12kg CaO and 10kg MgO. General recommendation are 50g of Compound D, 25-30g of AN, 120g of SSP, and 16g of Muriate of Potash per planting hole.

PLANTING

Plant cuttings

Should be 45cm long and place $^{2}/_{3}$ of the cutting into the soil. The spacing should be as follows:

- 20cm or less for live fences or hedges.
- 2m X 2m for seed production Plantations under irrigation.
- 2.5m X 2.5m apart. In dry land production.

Direct (*In-Situ*)

The seed may be placed in the ground on the chosen site when moisture conditions are ideal. The seed is placed at about 20mm under the soil surface. Emergence takes place in 10-20 days depending on moisture and temperature conditions.

Seeding into Sleeves

Use plastic sleeves filled with soil. Plant 20-25mm deep, and then water regularly to avoid drying out in 10-20days. The size of sleeve are not critical. Approximately 80mm diameter and 120mm deep is quite adequate. Larger sleeves- used if the seedlings are kept in the nursery for more than two months.

Nursery
Establish seedlings around July/August for November/December transplanting.

WEED CONTROL
There is little competition between Jatropha and weeds. The major weeds are *Lantana camara* and *Dichrostachys cineria.* These were reported in Cape Verde. Jatropha is relatively deep rooted and weeding should be done in the early stages of the crop to ensure a quick 'get away'.

DISEASE AND PEST CONTROL
Common Pests and their Control
Relatively few pests and diseases are known to affect Jatropha. Scale insects and mealy bugs (*Homoptera coccidea*). Literature indicates that termites do not attack Jatropha. However, work done at Cotton Research Institute in Kadoma shows that termites will attack Jatropha shrubs particularly if no other vegetation is available. Red spider mite (*Tetronychus spp*.), golden flea beetle (*Halticinae spp*.) has been found on stressed Jatropha plants. Malathion 1% is used to treat the seed in storage against weevils. At Chiredzi Research Station leaf minor damage has been recorded. Nothing is written about post harvest damage by insects, mould, rodent or birds. In Zimbabwe grain weevils, sitophilus, were found in the seed.

Common Disease and their Control
Powdery mildew is a disease that has been recorded in Jatropha. The fungus "frog eye", *Cercospora,* have been observed on seedlings.

HARVESTING
Jatropha takes 3-4years to maturity when seeds are used. Cuttings take 1-2 years to reach pick production.

Signs of Maturity and Picking
Fruits production starts in 12 months but reaches pick in 3-4 years. Fruits turn from green to yellow when ripe. Pluck off Fruit capsules when they turn yellow. The seeds are picked by hand. A person can pick 3kg/hour per day. 4-5kg fruits per plant are harvested and approximately 3-3.5 kg of seed (500-1750kg/ha shelled).
The productive or economic age is about 30 years. Two harvests per year were recorded in Cape Verde (June-July and October-November).

STORAGE AND USE
Dry fruits can be shelled manually or using a shelling machine and stored at 10% moisture content.

Uses
- Plant oil as a diesel fuel substitute
- Plant oil used for soap manufacturing
- Lubricant in diesel engines
- Used to replace paraffin for illumination, cooking and refrigeration.
- Other uses of Jatropha include:

- as a purgative
- to induce vomiting (poisoning)
- as a contraceptive
- as an agent to kill intestinal worms
- as an ointment for wound healing
- as a stimulant for hair growth

SUNFLOWER

The cultivated Sunflower *(Helianthus annuus* L) belongs to the Compositae family. It has strong taproot and large lateral spread sub surface roots thus relatively drought tolerant. The crop is grown primarily for seed oil expressing and for bird feed purposes.

OPTIMAL GROWTH REQUIREMENT

It does well on well-drained clay loam soils with success on sandy soils under heavy fertilizer applications. Soil pH should be 5.3 or above and liming is advised if pH is lower.

Rainfall

Rainfall between 500–600 mm and well-distributed is ideal. Above 800 mm kernel yields tend to be reduced due to prevalence of diseases and possibilities of premature lodging. It is critical for soil to be moist for a period of 20 –30 days from just before flowering, during flowering and early seed filling stages. Continuous rain after flowering downgrades yield and oil content due to head rots.

Temperature

Sunflower does well under a wide range of temperatures and is tolerant to frost up to the six leaf stage. It performs best under high temperatures of mean 20-28^{o}C.

CULTIVAR SELECTION AND RECOMMENDATIONS

Varieties

Hybrid or open-pollinated varieties (OPV) can be used for sunflower production. Hybrid seed is generally expensive than OPV. However, it has higher yields and oil content, and at the same time produces a more uniform plant stand.

LAND PREPARATION

Method of land preparation

Same as for crops like maize.

FERTILIZATION

The crop is an efficient user of residual fertilizer, thus usually grown after a well fertilized crop such as maize to exploit the residual fertility. But if the maize residues of the preceding crop have been removed then more fertilizer should be applied. Sunflowers have a high boron requirement, so for efficient grain filling a boron containing fertilizer is highly recommended. Compound L should be applied at rate of 200 kg/ha banded in the furrow at planting. After about 4 weeks after crop emergence then top dressing ammonium nitrate is applied at rate of 100kg/ha .Top dressing can be split to two 1 applied at 4 weeks and the next at 8 weeks.

PLANTING

Seed Rates

The planting seed rate for hybrids is about 5 kg/ha while for OPVs a higher rate of about 7kg/ha is advisable. Planting should be in such a way as to avoid periods of excessive moisture or deficit. For high potential areas in row spacing of 20–25cm and inter row 90cm, while for the low potential areas e.g. natural region 5 , in row 30cm and inter row 90cm.

WEED CONTROL

Generally sunflower grows slowly during the first 4-6 weeks such that poor weed management at this stage can drastically reduce yields. Mechanical and chemical weed control options are possible.

Mechanical control involves use of machinery such as tractor drawn cultivators or hand hoes, while chemical control pre-emergence herbicides such as Lasso, Dual 720EC and Dual 960EC, and post emergence herbicides such as Fusillade super, can be used. However, herbicide control for sunflower is profitable only on large scale production.

DISEASE AND PEST CONTROL

Common pests and their control

Pest	Damage caused	Control
Nematodes	Generally weak plants which subsequently die.	Rotation
Cutworm	Feeds on young plants.	Use lands that have been free of weeds for at least 6 weeks. Baits with Endosulfan.
Tip wilter	Suck sap from stem behind the head resulting in head drooping.	Removal by hand. Spraying Endosulfan or carbaryl
Seed bug	Feeds on developing seed causing it to shrivel.	Spraying with chemicals used for tip wilter

Common diseases and their control

Disease	Downey Mildew	Sclerotinia rot	Sunflower Rust
Symptoms	Dwarfing and thickened club like root and yellowing of leaves at seedling stage. White cottony masses observed at lower and sometimes upper surface during periods of high humidity.	Rotting of infected tissues producing white cottony mycelia and large black sclerotia.	Production of cinnamon – brown pustules on leaves.
How spread	Spores	Carried over seasons by sclerotic and can be transported to new fields with seed.	Air movement
Favoured conditions	Humid and warm	High temperatures and humidity	Hot and humid
Control	Chemical sprays using fungicides. Rotation with non susceptible crops.	Rotations with non susceptible crops. Rouging out infected plants and burn.	Good rotation Burying crop residues

NB: ***It should be noted that pollination of sunflower is highly depended on bees so where chemicals are used it should be before flowering and should be done in the late afternoon only***.

HARVESTING

It should commence as soon as the sunflower head turns yellow and the bracts are brown. It is advisable to avoid letting the seed drying on the plant as losses due to bird and mice will be high. On a small scale sticks are used to thresh sunflower and once harvested it should be dried to 9.2% moisture content.

STORAGE AND USE

It should be stored in a dry and well aerated environment. Sunflower is mainly used for expressing edible oil .This is done using oil expressers. The by product (cake) is fed to livestock such as pigs ,cattle and poultry.

MARKETING

The crop is mainly marketed to oil processing and stock feed manufacturing companies as well as small oil expressers.

V. HORTICULTURAL CROPS

FRUIT VEGETABLES: (Fruit Part of the Crop Consumed)

TOMATO

Tomato is one of the popular garden vegetables in the world and area under its cultivation is enormous. They are not only low in calories, but also a good source of vitamins C and A.

OPTIMUM GROWTH REQUIREMENTS

Soil Requirements

Tomato can be grown on many different soil types, but fertile, well drained and supplied with good moisture holding capacity and pH of 5-6.5 on $CaCl_2$ are ideal.

Water requirements

Generally tomato has a high water requirement, but excessive rainfall/water can be damaging to the crop. Established plants can be watered at the rate of 20–25mm per week depending on soil type. Water application should be effected as far as possible without wetting the leaves. On the other hand, distribution has to be even otherwise problem of cracking or blossom end rot will be experienced.

Temperature

Tomato is a warm season crop, so temperature is an important factor of production because the crop is sensitive to low night temperatures.

PRODUCTION METHODS

In situ

Crop matures earlier, but management practices are difficult. Seed rate of 6kg/ha.

Seed bed

- Select new (or land not grown to a solanacea in previous season) isolated and keep weed free Seed rate ranges 250–350 g /ha. Sow in 60 m^2 bed at spacing of 5 cm in row and 10 cm inter row.
- Ensure any crop residues are destroyed.
- Sterilize working equipment with 2% formalin if disease is present.

PLANTING

When planting out in the field recommended spacing range: 30 – 50 cm in row and 1.5 – 2 m inter row.

FERTILIZER APPLICATION AND LIMING

- ✓ Liming can be done if soil pH is below 5.0 ($CaCl_2$)
- ✓ Manure can be used at the rate of 25–50 t/ha at planting.
- ✓ Basal dressing of compound S (6:17:7)1000–1500 kg /ha.
- ✓ Top dress with 100 kg/ha each of A.N (34 %N) potassium sulphate when first fruits are marble size and thereafter at 3 week intervals.

WEED CONTROL

Same as potato.

COMMON PESTS AND DISEASE CONTROL

Common Diseases and control

Disease	Symptoms	How spread	Favored conditions	Control
Late blight	Growth of greasy, grey-green areas on leaves; they turn brown and thin eventually. Symptoms may develop fast, turning entire plant black and killing it within days. Despite its name, late blight can appear early or late in the season.	Spores can be spread by wind.	hot and humid	Chemical - use of fungicides, copper oxychloride and dithane M45. Cultural – use certified clean seed also avoid proximity to infected crops and dump sites.
Early blight	Dark brown, irregular spots appear on lowest, oldest leaves. As spots mature, they develop concentric rings, usually surrounded by a yellowish area. Will infect leaves, stems, and fruits.		hot and humid	Trellis tomatoes to avoid direct contact of leaves with the wet soil. Try not to grow tomatoes or their relatives in the same spot more than once every 3-4 years.Avoid overhead watering.
Damping off	Young plants appear pinched at soil level and subsequently	Soil borne	Continuously humid conditions	Drenching with fungicide e.g. Thiram.

	collapse and die.		at the soil surface	Seed treatment before planting. Do not start seeds in soil that has a high nitrogen level. Add Nitrogen fertilizer after the seedlings have produced their first true leaves. Allow the surface of the soil to dry between watering.

Common Pests

Pest	Damage caused	Method of control
Red Spider Mite	Suck out of the cell content. Feeding causes small yellow patches on the upper side of the leaf, especially between the main veins, near the leaf stalk. Affected area turns yellow to bronze color, then brown, leaves are dropped and the plant eventually dies. The mites and its webbing, just visible to the eye, can be seen on the underside of the leaf. Spider mites may also cause spots on the fruits.	**Cultural practices** - Burning of infested plants can be successful during the early stages of infestation when the mites concentrate on a few plants. The separation of infected crops and newly planted crops or nursery areas and the burning or removal of infected crop residues and weeds, helps to minimize the problem. **Chemical control** Care should be taken when considering chemical control. Thorough understanding of the different available chemical formulas and their cost-effectiveness is required. Some of the available systemic pesticides have shown to increase red spider mite reproduction. In addition, red spider mite species rapidly develop resistance against the most common used pesticides and acaricides. It is therefore recommended to rotate acaricides with different chemical compositions. Spraying should be done weekly and at an early stage of infestation to be effective.
Leaf eaters (e.g. loopers)	Feed on leaves, fruits or flowers.	Can be controlled by contact chemicals such as carbaryl or endosulfan.
Aphid and white fly	Suck sap hence destroy leaf structure and quality. Also transmits virus diseases	Chemical – e.g. dimethoate.
Cutworm	Severs plants at ground level and holes out exposed tubers	Apply Dursban as a drench Carbaryl or Malathion Baits.

HARVESTING

Stage of picking depends on distance to the market, storage period and whether they are to be used fresh or processed. Fruits must be handled gently to avoid bruising. The maturity stages are:
Pale blossom end: blossom end shows cream streaks, skin tougher. Fruit can be stored for a week or more.
Pink blossom end: blossom end has attained a pink colour and can be stored for about 4 days.
Pink stage: Fruit almost ripe or to be fully ripe within a day or two after harvesting.
Ripe stage: virtually ripe but still firm and can be marketed immediately.

MARKETING

Fruits are graded according to uniformity of ripening, size and colour as well absence /presence of blemishes and packaging sizes usually vary depending on market.

BUTTERNUT

Butternut belongs to the curcubit family of vegetable crops. It is believed to have originated in America and spread to other continents by travellers. It falls under the botanical group of *Curcubita moschata.* The crop is a very nutritious vegetable whose fruits can be used with rice dishes and for making starter dishes such as soups.

OPTIMAL GROWTH CONDITIONS

Soils: Can be grown successfully on a wide range of soils, but fertile soils with adequate drainage are ideal as butternut is quite sensitive to oxygen deficiency in the soil. The ideal soils are sandy loam or silty loam which warm up rapidly.

Water Requirements: Requirement is very high but high humidity encourages leaf diseases and may affect flower production. The frequency of irrigation is largely dependent on soil type and weather conditions. In general, for sandy soils with dry weather, the fields should be irrigated at least every other day if not, more often. The best test for the need of irrigation is to dig down and squeeze a handful of soil; if the soil comes apart - i.e. does not stay in a ball upon the release of pressure, irrigation is needed.

Temperature:

Butternut is more tolerant to high temperatures thereby making it adapted to low lying areas. It therefore can be grown in areas which are hot enough such as places where watermelons and muskmelons can grow well. The temperature ranges for optimum production are 18 - 21^0C night and below 29^0C day. This restricts the production to the summer months with winter production possible in the Lowveld areas or rather in the hot areas. The crop is very susceptible to frost.

FERTILIZER APPLICATION

It is recommended that 10-15t/ha of compost or manure should be incorporated about a month before planting or alternatively 600 kg/ha of compound D, and 100 kg/ha A.N topdressing should be applied after the first fruits have formed.

PLANTING

Butternut can be planted from April–August and late July–mid November at higher altitudes. Winter production is possible in low lying areas and this can be during the period March - August with early production at high altitudes by sowing from early July to August. The seed required is 2.5-3.5 kg/ha. It can either be planted in basins/hills or in furrows.

Basin: - these have a diameter of 600-1200 mm with their centre higher than the surrounding soil. These are a labour intensive planting method and not recommended. Furrows: - Seeds are planted on the side of the furrow. The furrows can be planted by drilling.

WEED CONTROL

Done mechanically by use of hoes.

DISEASE AND PEST CONTROL

Common Diseases and control

Disease	Symptoms	Favored conditions	Control
Anthracnose	Black angular spots appear on the leaves with black streaks on stems and leaf stalks. Sunken lesions on the fruit producing spore masses under moist conditions.	Common and severe during the rainy season.	Spray Control can be effected with Maneb, Mancozeb, and Chlothalonil, Zineb.
Powdery mildew	White mealy blotches on leaf surfaces	Warm and humid	Spraying with at weekly intervals during susceptible periods with carbendazim or benomyl. NB:***Sulphur should not be used***
Downey mildew	Circular to rectangular small brown spots surrounded by a yellow halo appear on the leaves. The spots are biscuit brown on the underside of the leaves or covered with a fungus and appear scattered. Under serious infections the leaf dies from the edges inward resembling frost damage.		Control can be done using Sulphur Mancozeb or Zineb. If done during the earliest stages of the disease they will provide adequate control.
Mosaic	Leaves show dark green to light green mosaic with a blistered surface. Under severe cases the plants remain stunted and do not bear fruit and leaves will be malformed and curled.		Aphid control is of utmost importance in curbing the spread. Infected plants should be immediately removed and destroyed.

Common Pests

Pest	Damage caused	Method of control
Pumpkin fly	Dry indented patch on fruit and subsequent rotting.	Chemical sprays at beginning of flowering – e.g. Malathion baits.
Aphids	Transmit mosaic virus diseases.	Control can be done using Dimethoate, Diazinon or Metasystox.

HARVESTING

Fruits are harvested on a size basis in the region of 15cm length for the fresh market. The seeds should be soft and fruit green for slicing cucumbers. It must not be allowed for fruits to ripen on the mother plant as this stops development of new fruits.

Storage under shady conditions e.g. under a tree, is ideal. This should be accompanied by well ventilation. Fruits showing signs of rotting should be removed.

MARKETING

Graded according to size before marketing and packaging sizes usually vary depending on market.

CUCUMBER

Cucumbers originated in India where they have been cultivated for 3000 years. The cucumber *(Cucumis sativus)* is a member of the gourd family (Cucurbitaceae) as are melons, squash and pumpkins. Cucumbers grown for pickling (picklers) and those grown for fresh market (slicers) are the same species. Fruit of fresh market cucumbers are longer, smooth rather than bumpy, have a more uniform green skin color and a tougher, glossier skin than fruit of picklers.

OPTIMAL GROWTH CONDITIONS

Soils: Can be grown successfully on a wide range of soils but fertile soils with adequate drainage are ideal as cucumbers are quite sensitive to oxygen deficiency in the soil. Highly suitable are the sandy loams of pH ranges 5.3–6.8 $CaCl_2$.

Water Requirements: Requirement is very high but high humidity encourages leaf diseases and may affect flower production. The frequency of irrigation is largely dependent on soil type and weather conditions. In general, for sandy soils with dry weather, the fields should be irrigated at least every other day if not, more often. The best test for the need of irrigation is to dig down and squeeze a handful of soil; if the soil comes apart - i.e. does not stay in a ball upon the release of pressure, irrigation is needed.

Temperature: Adapted to warm climates. Optimum range is 21–28^{o}C.

CULTIVAR SELECTION AND RECOMMENDATION

The varieties are close to the same in features. Examples: Ashley, Cherokee 7 Victory, Fletcher. They all mature in about 10- 11 weeks only Fletcher has superiority for Downey mildew resistance.

LAND PREPARATION

Soils should be plowed at least 15 cm deep and disced or rotavated to break up large clods. On the other extreme, poor moisture-holding soils would benefit by a liberal application of manure or other organic matter incorporated into the soil. If a soil amendment such as lime is needed, it should be applied broadcast before plowing and incorporated 15-20 cm into the soil 8-12 weeks before planting. This allows the lime to react with the soil to correct pH assuming sufficient moisture is available in the soil. In case a nematicide is used, the field should be treated at least two weeks before planting for light soils and three weeks for heavy soils.

FERTILIZER APPLICATION

Cucumber responds well to organic manure the manure should be well decomposed.
The general recommendation for inorganic fertilizers is as follows: 600kg/ha compound D and 100kg/ha Ammonium nitrate after first fruits are formed.

Nutrient Deficiency Symptoms

	Nutrient	Deficiency Signs/symptoms
Nutrient Deficiency Symptoms	Nitrogen	Mature leaves yellowish-green to yellow; stems slender, hard and fibrous; fruits light in color, pointed at blossom end; roots stunted, later turning brownish then dies.
	Phosphorus	Mature leaves dark-green changing to dull-green; stems slender; fruits dull-green to bronze.
	Potassium	Mature leaves bluish-green near veins, bronzing and necrosis of leaf margins; young leaves are puckered or crinkled; fruits constricted at stem end, plant growth slow.
	Magnesium	Inter-venal chlorosis on mature leaves, veins green; mature leaf edges brittle and ragged.
	Nutrient	**Deficiency Signs/symptoms**
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	Potassium	Mature leaves bluish-green near veins, bronzing and necrosis of leaf

		margins; young leaves are puckered or crinkled; fruits constricted at stem end, plant growth slow.
	Magnesium	Inter-venal chlorosis on mature leaves, veins green; mature leaf edges brittle and ragged.

PLANTING

Cucumber can be planted from April–August and late July–mid November at higher altitudes. It can be planted on basins, ridges, or furrows. For the basin method, spacing of 60-120 cm in row and 120–180 cm inter row is recommended. The furrow system can be single or double row. For the single row system, in row spacing 30–75 cm and 120-150 cm inter row while for double system 30 cm in row and 75cm inter row. It can also be planted on hills and spacing as for the basins is used.

WEED CONTROL

Done by use of hand hoes.

DISEASE AND PEST CONTROL

Common Diseases and control

Disease	Symptoms	How spread	Favored conditions	Control
Cucumber Mosaic Virus	General stunting	aphids	Dry and hot	Spray aphids. Rouging out infected plants.
Powdery mildew	White mealy blotches on leaf surfaces		Warm and humid	Spraying at weekly intervals during susceptible periods with Carbendazimor Benomyl. **NB:*Sulphur should not be used***.

Common Pests

Pest	Damage caused	Method of control
Pumpkin fly	Dry indented patch on fruit and subsequent rotting.	Chemical sprays at beginning of flowering – e.g. Malathion baits.

NB: Field slicing cucumbers are dependent upon honeybees for flower pollination and all of the organic pesticides are toxic to them; therefore, if these pesticides need to be applied to the crop, it should be applied in the late afternoon when the honeybees are less active in the fields.

HARVESTING

Fruits are harvested on a size basis in the region of 15cm length for the fresh market. The seeds should be soft and fruit green for slicing cucumbers. It must not be allowed for fruits to ripen on the mother plant as this stops development of new fruits.

After harvesting, they should be stored in water-free, well-ventilated room or structure while it awaits delivery to the market. Direct sunlight can cause `sun scald,' which reduces fruit quality.

MARKETING

Graded according to size before marketing and packaging sizes usually vary depending on market.

TUBERS /BULBS AND ROOTS

IRISH POTATO

Grown mainly for its tubers which can either be boiled and prepared in many other ways, or dehydrated and ground to make flour. Irish because of its popularity in Ireland.

OPTIMUM GROWTH REQUIREMENTS

Soils:

It can be grown successfully on a wide range of soils provided they are well drained. Best results are obtained from medium textured loamy soils with high organic matter and a rooting depth of 60cm. Heavy soils of mica origin tend to harden thereby producing deformed tubers due to the resistance experienced by the expanding tubers.

Rainfall:

It requires a constant water supply of about 600–900mm. Dry periods drastically reduce tuber yield and quality. On cut seed tubers watering should, however, be done with care until the plants are strong and growing vigorously. The water supply should be gradually reduced as crop approaches maturity.

Temperatures:

Cool weather crops which grows well within range of 15–21^{o}C with tuber formation becoming poor at very high temperatures such as 32^{o}C. For maximum tuber formation cool night temperatures of around 15-18^{o}C are ideal.

CULTIVAR SELECTION AND RECOMMENDATION

Numerous varieties are available in 2 categories viz : ware (table) and processing varieties. Some varieties are good for both purposes.

Variety	Characteristics
Montclaire	Late maturing, white fleshed tubers, multipurpose. A star where late blight is a threat. Yield ranges 13–20t/ha.
BP1	Medium maturing, earliest maturing variety available in Zimbabwe. White fleshed tubers, susceptible to late blight and viral diseases. Yields 13–20t/ha.
Pimpernel	Normally grown under contract for processing companies. Late maturing, red skinned and yellow fleshed tubers. Processing variety. Good tolerance to late blight but fairly tolerant to viral diseases.
Amethyst	Late maturing variety, high level of tolerance to blight. Yield ranges 15–17t/ha.
Jasper	Very late maturing, high tolerance to late blight. High yielder.
Garnet	Processing. Good yielder.

LAND PREPARATION

A fine tilth is required for good crop stand establishment. Land should be ploughed to a depth of about 25 cm and disced to break clods it can then be harrowed depending on achieved tilth. Compacted profiles should be ripped to ensure good drainage and maximum root penetration. Virgin soils, green manured fields and leys should be prepared several months ahead of a crop to allow for adequate decomposition. Where nematodes are known to be a problem the land should be fumigated. Where a crop is to be planted on ridges, the land should be ridged first then fumigation follows and after fumigation 14 days should lapse to ensure effectiveness.

Fertilizer Application

Irish potato is relatively a heavy feeder and responds well to well rotted organic manure. Excessive nitrogen prolongs tuber initiation, haulm maturity thus prolonging harvesting time. This will reduce tuber dry matter hence cooking quality. Phosphorous encourages early tuber growth and gives good skin strength and also counteracts blight susceptibility. Potash enhances production of tuber with low dry matter less likely to bruise and reduces incidence of blackening after cooking.

General guide: 300–450 kg/ha compound S applied at planting and 500-600 kg/ha ammonium nitrate (AN) applied at about 2-3 weeks after planting.

Soil pH

Irish potato is susceptible to alkaline conditions which result in scab. Ideal pH is 4.8–6 but in lands where scab is known to be a problem the pH should be as low as 5.2. Where liming is required, it has to be done during the 3 –4 year rotation cycle.

PLANTING

Potato can either be planted on flat or on ridges. On ridges, it should have row spacing of 90 cm and in row 20-30 cm. On the flat, row spacing can range from 75–120 cm. Much, however, depends on soil fertility and cultivars. Seed rate is also dependent on variety, tuber size and market, but generally ranges from 1.8–4.5t/ha.

WEED CONTROL

The crop should be kept weed free for the first two months because it is very susceptible at this stage. During this time cultivation should be shallow to avoid root damage and after 2 months mechanical cultivation should be avoided to avoid tuber damage since potato is a shallow rooter. It should be noted that earthing up is integral part of weeding so as to cover up developing tubers and protect them from greening ,tuber moth and late blight.

Chemical weed control can also be done using herbicides :
EPTC – controls water grass .Not recommended for heavy soils.
Terbutryne – controls broad leaved weeds and annual grasses. It should not be used on sands as it becomes phytotoxic.
Sencor – a pre-emergence herbicide for control of grasses and broad leaved weeds.
Dual - for control of grasses.

DISEASE AND PEST CONTROL

Common Diseases and control

Disease	Symptoms	How spread	Favored conditions	Control
Late & Early Blights	Grey to brown leaf and stem lesions	Spores can be spread by wind	High temperature and humidity	Chemical- use of fungicides Copper Oxychloride and Dithane M45. Cultural – use certified clean seed also avoid proximity to infected crops and dump sites.
Common scab	Raised corky brown tissue on the tuber surfaces	Soil borne	Alkaline conditions	Maintaining pH at around 5.2. Avoid soils with low organic matter.
Damping off	Young plants appear pinched at soil level and subsequently collapse and die	Soil borne	Continuously humid conditions at the soil surface	Drenching with fungicide e.g. Thiram. Seed treatment before planting tubers Avoid over watering.
Potato Virus X and Y	Stunted plants, small leaves, crinkled with mottling and necrosis	Peach aphid		Use of disease free certified seed Isolate fields from potato dump sites. Rogue infected plants.

Common Pests

Pest	Damage caused	Method of control
Aphid	Suck sap hence destroy leaf structure and quality. Also transmits viral diseases	Chemical – e.g. Dimethoate.
Cutworm	Severs plants at ground level and holes out exposed tubers	Apply dursban as a drench Carbaryl or Malathion Baits
Potato tuber moth	Larvae tunnel into tubers as well at stems rendering tubers not suitable for sale	Spraying malathion Earthing up

HARVESTING

Three to four months after planting all the haulms are destroyed to enhance tuber hardening and firming as well preventing late blight from entering the tubers. Firming usually takes about 3 weeks after haulm destruction, so lifting can commence thereafter. After harvesting, they should be stored in water free well-ventilated room or structure. They should be stored in a dark environment to avoid sprouting and greening. Ideal temperature in storage is 3-5^{o}C .At higher altitudes the potato can be kept in the soil without any sprouting problems only that there is high risk of entry of tuber moth.

MARKETING

Tubers are graded according to size before marketing, and packaging sizes usually vary depending on market.

SWEET POTATO

Grown mainly for its tubers which can either be boiled and prepared in many other ways, or dehydrated and ground to make flour.

OPTIMUM GROWTH REQUIREMENTS

Soils:

Sandy to sandy loams with a heavier well-drained sub soil are ideal. Sandy soils give a better quality tuber with a superior colour and smoother skin than do heavier soils. The crop is also less susceptible to weevils than those from heavy soils, which are exposed to cracking as the heavy soils dry out. Tubers in deep sandy soils tend to be slender while a compacted sub soil aids in production of better shaped tubers.

Heavy soils if well drained can also be used, but difficulties usually experienced when harvesting. Heavy top soils tend to produce heavy vine growth and a light crop with a predominance of badly shaped tubers. Sweet potato is very susceptible to water logging such that in the poorly drained soils it is advisable to plant the crop on ridges.

Soil pH for optimal production is 5.5–6.5 but production can still occur within the range of pH 5–6.3 .Alkaline pH above 7.5 and black soils should be avoided at all cost. Very high pH will cause cracking of tubers and the crop is fairly tolerant of acidity.

Rainfall:

It requires a constant water supply of about 600–900 mm. Dry periods drastically reduce tuber yield and quality. On cut seed tubers watering should, however, be done with care until the plants are strong and growing vigorously. The water supply should be gradually reduced as crop approaches maturity.

Temperatures:

Sweet potato requires warm, sunny growing conditions about 120 frost-free days. The crop is tolerant of high and low temperatures resulting in retarded growth. Temperatures lower than 10^{o}C result is leaf yellowing and subsequent death of plants. So this means the crop can be grown well in most parts of Zimbabwe during summer.

CULTIVAR SELECTION AND RECOMMENDATION

Good improved varieties can be obtained from Horticultural Research Centre in Marondera and Chiredzi Research Station in the lowveld.

LAND PREPARATION

A fine tilth is required for good crop stand establishment. Land should be ploughed to a depth of about 25 cm and disced to break clods, it can then be harrowed depending on achieved tilth. Compacted profiles should be ripped to ensure good drainage and maximum root penetration.

FERTILIZER APPLICATION

The crop responds well to organic manure, particularly if grown on light sandy soils, so 30–50t/ha compost or cattle manure is recommended. Amount of fertilizer requirement depends

upon soil type and residual fertility. Too much nitrogen will cause excessive vine growth at the expense of root production response is positive only in nitrogen deficient soils.

In general, the following fertilizer rates can be used: 120kg AN, 250 kg SSP and 80 kg MOP or 400kg compound M. In cases where high rates of organic matter have been used, the rates for nitrogen and potassium can be reduced.

PLANTING

For optimum yields planting out should be in spring. Delayed planting out has serious yield reduction implications on the highveld. In the warmer regions of the country it is possible to continue planting out up to February.

Recommended spacing is usually 1.0–1.5m inter row and 25-60cm in row. Much also depends on the variety, tuber setting characteristics, market preference, soil type and water supply. In rich soils, closer spacing is advisable to avoid too big tubers. Closer spacing is recommended if delayed harvesting is anticipated and if variety forms large tubers. Planting is usually done on ridges for ease of harvesting and improved drainage. Care should be taken to form large low ridges since high narrow ridges dry out quickly.

WEED CONTROL

The crop should be kept weed free for the first two months because it is very susceptible at this stage through this time cultivation should be shallow to avoid root damage

DISEASE AND PEST CONTROL

Common Diseases and control

Diseases	Symptoms	Control
Scurf	Superficial discoloration of tubers causing shrinkage.	Crop rotation. Use clean planting material.
Sweet potato mosaic virus	Mottling, vein coloring and leaf distortion.	Select healthy plant material.
Charcoal Rot	Brown decay of tubers in storage with noticeable black sclerotia.	Crop rotation.

Common Pests

Pest	Damage caused	Method of control
Sweet potato weevil A problem pest for the crop in Zimbabwe. Can cause considerable damage to the tubers.	Larva of this weevil feeds upon the tuber tissue until it pupates. Attack most problematic in shallow rooting cultivars.	Best control option for this pest is hygiene and rotation because chemical control difficult since the larva will be inside the tuber. Gamma BHC dust can be applied to affected crop.

HARVESTING

Three to 4 months after planting depending on cultivar, harvesting can be done. Tubers are ready when the cut surface dries to a white colour. The cut surface of immature turns brown and does not dry out readily. After harvesting, the tubers can be left in the field to cure. Tubers cure best at

25-30^{o}C at a relative humidity of about 80–90%. Curing encourages wound healing and removal of soil adhering to the tubers. It also allows conversion of starch into sugar.

Storage
Sweet potato can be stored in the field until required, but if vines have been destroyed tubers should be removed within 3 months to avoid deterioration in quality. If soil is wet they will start to sprout. Sweet potato can keep in store under cover for 4-6 months under ideal conditions. They are kept in store at 12-15^{o}C at humidity of about 80%; this inhibits sprouting and prevents excessive moisture loss from tubers.

MARKETING
Tubers are graded according to size before marketing, and packaging sizes usually vary depending on market.

BULB ONION

By value, onions rank in the top 10 vegetables high in food value, intermediate in protein and rich in calcium and riboflavin.

OPTIMAL GROWTH CONDITIONS

Soils

Onions can be grown successfully on a wide range of soils, but fertile soils with adequate drainage are ideal. Soil tests are recommended to determine amounts and types of soil nutrients necessary to obtain a realistic yield goal. Ideal soil pH for onion production is 6.6.

Rainfall

Onions must have an adequate supply of moisture in the top 10cm of the soil profile because onions are shallow rooted crops. Onion fields are generally irrigated immediately after planting and as necessary, thereafter to maintain moisture levels until seeds germinate.

After transplanting, most onion varieties will require about 25–30 mm of water to attain maximum yields, depending on soil type and weather conditions. As onions begin bulbing, irrigation may be necessary every 7-10 days. More frequent irrigation at this point promotes good growth and helps keep the soil firm around the onion bulb since dryness results in cracks in soil and inconsistent soil pressure around the onion bulb resulting in misshaped onions. In general, over or under irrigation may lower yields. Foliage of over irrigated plants has an unhealthy yellow colour.

As onions begin to mature, irrigation should be stopped to allow the soil to dry before harvesting, irrigation should be discontinued when 10 percent of the tops have begun to break over, as this is an indication of bulb maturity. If moisture is not reduced as onions near maturity, softer onion bulbs may result. Softer onion bulbs break down faster and result in greater storage problems.

Temperature
Onions are a cool season plant which grows well in a wide range of temperatures. Young onion plants are highly resistant to frost. High quality onions require cool temperatures during early development and warmer temperatures during maturity. Pungency increases with higher average growth temperatures.

CULTIVAR SELECTION AND RECOMMENDATION

Hybrid onions are recommended because they are more uniform and higher yielding than standard varieties. Variety selection will depend on two main factors: (1) type of market for which the onions are being produced and (2) environmental growing conditions. If onions are being produced for onion rings, yellow varieties that produce an onion bulb from 3 to 4.5 inches in diameter should be selected. If onions are being produced for the hamburger market, then white varieties that produce an onion bulb from 2 to 3 inches is recommended. Examples of varieties:

Texas grano – takes about 7 months to maturity, light cream flesh.

Yellow granex (F1 hybrid) – takes about 6 months to maturity. Yellow scales, cream flesh.
Seed sources: Seed is available from recognized agricultural dealers.

LAND PREPARATION

A fine tilth is required for good crop stand establishment. Land should be ploughed to a depth of about 25 cm and disced to break clods. It can then be harrowed depending on achieved tilth. Compacted profiles should be ripped to ensure good drainage and maximum root penetration.

FERTILIZER APPLICATION

Manure can be used in onion production, but it is advisable for it to be applied to the crop preceding onion if used at planting time, then it has to be incorporated 6 weeks before planting at rate of 30–50t/ha and ploughed in. Excess application of manure can result in delayed maturity and thick necked bulbs which do not heal after maturity, thus do not store well.

The general recommendation for inorganic fertilizers is as follows: Ammonium nitrate 150–200kg/ha; SSP 150-200kg/ha; sulphate of potash 120-180kg/ha, all applied to the soil before planting. A side dressing of 100kg/ha of AN applied at 4-5 weeks after transplanting.

PLANTING

Onion can be established from seedlings or transplanting sets. Transplanting sets result in earlier maturity and earlier harvest. However, transplanting sets is more costly and labor intensive. Most producers establish commercial plots using seedlings. The best time to sow is March and April as sowings done early tend to bulb prematurely. Seed for sett production is usually sown in July/August harvested in October/November for drying and stored until planting time.

In the nursery seed is sown at spacing of 7-10cm between plants in rows 30 cm apart. At rate of $10g/m^2$ on $300m^2$ (3 kg seed). This seedbed size can plant a field of 1 hectare.

It should be noted that depth of planting onion seedlings or transplanting onion sets has a dramatic impact on the shape of the mature bulb. The onion bulb forms immediately above the onion stem plate, which is formed at the point where the seed germinates.

Onion bulbs may form above or below the soil surface depending on the placement of the seed and the subsequent movement of the soil (due to cultivation) after seed germination. Deeper planting results in longer, narrow bulbs while shallow planting tends to produce flatter bulbs.

WEED CONTROL

Onion plants have shallow roots and relatively few, slender leaves, which makes it a poor weed competitor. Thus, chemical and mechanical weed control are critical to high yields. Usually a combination of both methods is successful. Weed pressure can be especially damaging to young onion plants because they are slow growing, have shallow roots and do not have enough foliage to adequately shade the ground. Depending on weed pressure and success of chemical control, several cultivation trips may be necessary. All cultivation must be very shallow or it may damage onion roots and cause plant damage.

A combination of pre-emergence and post-emergence herbicides may be used for onions.

Onion Herbicides

Herbicide	Application stage	Weeds controlled	Comments
Afalon (Iinuron)	5-20 days after transplanting or within 10 days of planting setts	Most broadleaf weeds	Do not apply on light soils. Do not irrigate 24 hrs after application Residual effects up to 3 months.
Ronstar (Oxdidiazon)	Immediately after planting seedlings or setts	Annual grasses and Broadleaf weeds	Followed by immediate irrigation. Residual longer than 3 months
Totril (Ioxynil)	After weed emergence and after 2-3 leaf stage of setts	Broadleaf weeds	Not for use on setts. Do not irrigate 24 hrs after application.

DISEASE AND PEST CONTROL

Common Diseases and control

Disease	Symptoms	How spread	Favored conditions	Control
Purple blotch	Small irregular white patches on foliage enlarging to necrotic lesions with purplish centers.	Spores can be spread by wind.	Warm temperature and high humidity.	Chemical preventive sprays of Dithane m45 at 5- 10-day intervals. Cultural – rotation.
Downey mildew	Grey discoloration on the leaves.		Cool and humid	Spraying with Dithane M45 at weekly intervals during susceptible periods

Common Pests

Pest	Damage caused	Method of control
Thrips	Suck sap of leaves leaving them silvery and speckled.	Chemical sprays – e.g. Endosulfan Soil chemical application – Disulfoton at planting
Cutworm	Severs plants at ground level and sometimes penetrate sides of maturing bulbs.	Apply Dursban as a drench Carbaryl or Malathion Baits

Physiological Disorders
Thick neck: plants fail to mature well. Condition induced by over watering in early stages as well as excessive nitrogen application and low plant populations.

Bolting: inherited feature so choice of cultivar critical. Also, temperature fluctuations cause the problem. Early sown crops have a higher risk.

Split bulbs: Genetic, climatic and management influenced. Early sowing increases risk.

HARVESTING AND STORAGE

Onions are mature and ready to harvest when their tops fall over. If bulbs are going to be stored following harvest, they should be allowed to dry and cure before harvesting. However, unlike potato, onion bulbs should not be left in the ground until tops dry completely, or bulbs are likely to develop roots, which will decrease their market value. After harvesting, they should be stored in water-free, well-ventilated room or structure. Onion tops should be left in place to protect the top of the onion bulb from direct sunlight. Direct sunlight can cause `sun scald,' which reduces bulb quality.

MARKETING
Tubers are graded according to size before marketing and packaging sizes usually vary depending on market.

LEAFY VEGETABLES

Kale, Rape, Swiss Chard

These crops are grown mainly for the leaves as they are rich in nutrients and vitamins such as vitamin A, thiamine and Ascorbic acid. Rape and kale belong to the same family as cabbage, while Swiss chard is in the beet family. Swiss chard is just like spinach only spinach is common in the temperate climates.

OPTIMUM GROWTH REQUIREMENTS
Soils
Leafy vegetables can be grown successfully on a wide range of soils provided they are well-drained. Best results are obtained with fertile (high organic matter) friable soils such as sands and loams with pH ranges of 5.5–6.5.

Rainfall
These crops have high water requirement due to the extensive leaf area. Thus periods of drought and excessive soil water should be avoided as this will affect leaf quality.

Temperatures: Cool weather crops with best minimum of 20^{o}C.

CULTIVAR SELECTION AND RECOMMENDATION
Numerous varieties are available for kale viz:
Thousand headed kale: leaves not curled and very tolerant to cool weather.
Choumoellier: Tall growing annual with thick stem and plain leaves. Adaptable to a wide range of soils produces high yields and good quality.
Curly kale e.g. commonly called viscose.
Rape: common variety is English giant.
Swiss chard:
Fordhook giant – dark-green and savoy shaped wrinkled leaves
Lucullus: light-green and flat-leaved.

LAND PREPARATION
A fine tilth is required for good crop stand establishment. This can be done by use of hoes or tractor drawn implements.

FERTILIZER APPLICATION
The crops are relatively heavy feeders and respond well to well rotted organic manure. Manure can be applied at rate of 30–50t/ha broadcasted or banded at planting. It can however be supplemented with other compound or straight fertilizers. Between 700 and 800kg/ha compound L worked into the soil 4 weeks before planting. Two to three top dressings of 100kg/ha AN applied every 2–3 weeks thereafter, especially after harvesting to reboost the plants.

It should be noted that crop condition in this case leaf colour dictates necessity for further top dressings. Since basics are very sensitive to boron deficiency it is advisable that a boron containing basal fertilizer be always used or alternatively boron sprays thereafter. For Swiss chard recommended inorganic supplements are: 450kg/ha SSP and 250kg/ha MOP all broadcasted and ploughed in with manure prior to planting. AN is usually applied in splits with the first just after planting and the second when plants are about 10 –15 cm high.

PLANTING
Swiss chard is best grown in late autumn through winter to spring while it is possible to grow in summer; the leaves are small and tend to be badly attacked by leaf spot disease. Kale and rape can be grown throughout the year, but ideal planting can begin early February in cooler areas of the country and in April for the warmer parts. The crops can be sown in situ, but the common practice is to raise seedlings in seedbeds. The general principles of nursery management for vegetable crops apply.

Seed rate for in situ is 3-5 kg/ha while for nursery is 0.5kg/ha for kale and rape. Final field spacing should be around 15cm in row by 45cm inter row. For machinery, wider spacing should used. For Swiss chard, field spacing of 36-50cm inter row and 7cm in row should be used.

WEED CONTROL

The crop should be kept weed-free and this is mainly achieved by hand hoe weeding. At any time, cultivation should be shallow to avoid root damage.

DISEASE AND PEST CONTROL

Common Diseases and control

Disease	Symptoms	How spread	Favored conditions	Control
Black rot & soft rot	Tan-colored, v-shaped areas along leaf margins and necrosis in the main leaf lamina. Leaf veins darkened.	Infected seed, Plant to plant through splash from infected manure, or infected soil.	Wet and warm weather	Seed treatment. Removal infected plant and burning. Avoid feeding infected plants to animals. Avoid using a seedbed that had been put to brassica. Enhanced soil fertility to give vigorous plants. Rotation –plant brassica once in 3 years.
Leaf spot (Mainly in Swiss chard)	Small light brown circular spots with dark edges. Can be numerous to give leaves a scorched appearance.		Wet warm weather	Dust with Captan
Damping off	Seedlings appear pinched at soil level and subsequently collapse and wilt.	Soil borne	Continuously humid conditions at the soil surface	Sow seeds thinly Drenching with fungicide e.g. Thiram every week or dress seed before planting. Avoid over watering.
Downey mildew	White fluffy fungal growth on underside of cotyledon leaves Small dark irregular markings			Chemical sprays with fungicides such as Mancozeb. Dip seedlings in fungicide at transplanting.

Common Pests

Pest	Damage caused	Method of control
Aphid	Suck sap hence destroy leaf structure and quality.	Chemical – e.g. Dimethoate Integrated Pest Management (IPM).
Bagrada bug	Suck sap and cause leaves to wither.	Chemical- e.g. use of Dichlovors.
Diamond back moth	Caterpillars feed on underside of leaves causing leaf shot hole effect.	Integrated Pest Management (IPM). Hand picking and squashing larvae can prevent damage on small plots. Inter-planting with tomato or chilli repels diamondback month adults Spraying of neem formulation can reduce population Use of Malathion and Thiodan 50WP.

HARVESTING

Time to maturity depends much on fertility management. A well-managed crop of rape can be harvested from 4 weeks after planting, while for kale it is quite longer e.g. Choumollier takes about 100–120 days to maturity.

MARKETING

These vegetables are usually sold in bundles of different sizes as determined by the market.

LIVESTOCK SECTION

I. CATTLE PRODUCTION AND MANAGEMENT

BEEF PRODUCTION SYSTEMS

A lot of factors can be considered when one is choosing the production system to adopt. These factors include:

- Profitability of the production system
- Efficiency of production
- Market availability
- Agro – ecological situation
- Feeding
- Farm carrying capacity
- Predators
- The farmers personal interest

EXTENSIVE AND INTENSIVE BEEF PRODUCTION

The extensive system of production is practiced on ranches (where no cropping is done).
The aim is to produce maximum quantity of beef per hectare.
The available veld is used efficiently and less of supplementary feeding to add to the profitability.
The farmer can be involved in buying and selling slaughter stock.
Cattle are acquired and run on the veld for a year or two and sold.
Breeding can also be practiced and later selling the stock at various ages.
Intensive beef production involves a lot of inputs.
This system is practiced on farms with irrigated pastures.
The farmer can practice buying and finishing.
Under this system there is limited grazing but good cropping potential.
Cattle are bought and finished in feeding pens.
This form of production is done on a big scale.
Knowledge of the suitability of different classes of stock for feeding purposes is important.
Intensive breeding practices can also be done.
Here the farmer breeds his or her own stock for sale at various age groups.

COMMON BEEF CATTLE BREEDS

There are basically two types of cattle, the Bos taurus, and Bos indicus. In Zimbabwe the Bos indicus is represented by the Indian Zebu, which includes Brahman and African Zebu which includes the Boran. The Bos taurus includes the European/continental (e.g. Charolais, Simmental, Limousine etc)
British (e.g. Hereford, Sussex, Angus etc and Sanga (e.g. Mashona, Nkone and Tuli. Lastly there are the composite (systhetic) breeds, these are the Brangus, the Santa Geudis, Beef Master and Bonsmara.

SOME IMPORTANT CHARACTERISTICS OF BEEF BREEDS

Breed	Characteristic
Mashona	• Small framed • Better disease resistance • Excellent cow fertility and calf productivity • Mature early • Selective grazers and can browse
Tuli	• High fertility • Resistance to ticks • Good drought tolerance • Produce good carcasses • Hardy and can withstand dry dusty environment
Ngoni	• Medium size • High fertility • Hardy and can withstand harsh conditions
Brahman	• Big and very good mature body size • Minimum calving difficulties • Good cow fertility and productivity • Good disease resistance
Simmental	• Good mature size and high dressing percentage • Good milk producers therefore good for production of weaners • Sensitive to harsh environments but adapt easily
Sussex	• High disease resistance • Good fertility with medium productive life • Offers hybrid vigour when crossed with Brahman • Adapted to dry conditions of Natural regions of IV and V

BREEDNG

Physical bulling of cattle is the most common method of cattle production in Zimbabwe. Fertility and conception rates are higher with pasture breeding due to better heat detection, more accurate timing of mating, increased semen dose and longer life span of fresh semen. This method is also the easiest and cheapest.

However, this method has got some risks such as of Veneral diseases such as Trichamonia, uterine infections, Contagious abortion and Vibriosis. Because bulls move from paddock to paddocks and meet more cows, they pause a high risk of disease transmission. These problems reduce the conception rate or cause permanent infertility. Repeated and regular testing of bull and vaccination can reduce the risks of diseases. The bullying ratio is usually 1bull to 20 cows.

Guide to Breeding Season

Area	Bulling Season	Calving Season
High veld	Mid-Nov to mid-Feb	September to November
Low veld	Mid-Dec to mid-March	October to December

Heat Signs

Coming into heat (8hrs)	Standing heat (18hrs)	Coming out of heat
Stands and bellows	Stands to be ridden	• Will not stand to be ridden but attempts to mount
Smells other animals	Bellows frequently	• Smells other cows
Attempts to ride other cows but will not stand	Nervous and excitable	• May have clear mucus discharge from vulva
Vulva moist, red and slightly swollen	Rides other cows	
May have clear mucus discharge from vulva		

ARTIFICIAL INSERMINATION (AI)

Equipment required:

- Flask with liquid nitrogen
- Semen: keep frozen, contained in straws
- Inseminating pistolet
- New sheath for the pistolet
- Long plastic gloves
- Cotton wool/paper towels
- Scissors
- Carbolic soap or other lubricants (liquid paraffin, baby oil, cooking oil, etc)

Importance of AI

- Planned mating
- Batch mating of cows by appointment/at specific time
- Control the spread of diseases
- Regulates calving time
- Increases the rate of genetic progress in a herd
- Reduces the time needed for oestrus detection

Disadvantage of AI

- It is very expensive
- Requires highly technical skills

PREGNANCY DIAGNOSIS (P.D)

This is the checking to find if cows are pregnant or not at 6-10weeks after end of bulling season. Several methods of pregnancy diagnosis can be used, and these include palpation of the pregnant uterus through the rectum, determination of progesterone concentration in milk around 24 days after breeding and ultrasonography.

The rectal palpation method involves palpating the uterus though the rectal wall to detect the uterine enlargement occurring during pregnancy. This method can be performed at an early stage of pregnancy (about 10 days) is accurate and the result is known immediately.

P.D though determination of milk progesterone concentration depends on elevated levels of progesterone beyond the normal ovulation of the oestrus cycle. This method is mainly suitable for pregnancy diagnosis in dairy cattle in which daily collection of milk is feasible.

Ultrasonography is a modern technique which can be used for both P.D and sex determination. This method involves placing a probe in the rectum of a cow, which generates sounds waves inaudible to the human ear (1-10 MHz). The sound waves are transmitted through and reflected from different tissues of the body at different rates. These differences can be detected by other components of the ultrasounds scanner and displayed as recognizable wages or a screen. This method is 100% accurate after 30 days of pregnancy. However, the equipment used (ultrasound scanner) is expensive and may not be available to some veterinarians.
P.D is done as a management tool for the following reasons:

- Help in culling and selection of employ cows
- Enables selective feeding of the breeding herd according to pregnancy status and age as so reduces the feed bill.
- Helps detecting and treating of infertility problems
- Avoiding the slaughter of in-calf animals
- Indicating of calf losses from birth to weaning where there is no accurate record of birth.

PARTURATION (GIVING BIRTH)
Parturition (calving) is triggered by the foetus and is completed by a complex interaction of hormones, the nervous system and mechanical factors. Most signs of approaching parturition (labour) relate to changes in pelvic ligaments, enlargement and swelling of the vulva, consistency of the cervical mucus plug and mammary activity (udder enlargement and distention of teats with milk). A day before calving, the cow may become restless and keep to a small isolated area.
Parturition can be described in 3 stages, dilation of the cervix, expulsion foetus and expulsion of the placenta.

Dialation of the Cervix
This stage last for 2-6 hrs in heifer and may be restless and show signs of abdominal pain. The foetus progresses through the dilated cervix and one of the foetal sacs (allantochorion) raptures releasing urine –like fluid and this marks the end of this stage.

Expulsion of the Foetus
It last for 30-60 mins. The foetus is propelled through the birth canal and appears at the vulva. The amnion ruptures more effort results in emergency of he head and chest. The umbilical cord breaks as the foetus/dam moves. The calf is the delivered and it takes at least 45 mins for calf to stand and suckle

Expulsion of the Placenta
This stage is caused by rhythmic uterine contractions and lasts about 4-6hrs.If the placenta is retained, it may affect reproduction performance by increasing the length of postpartum anoestrus, days to first breeding, and days open.

Dystocia (Difficult Birth)
Dystocia in general refers to calving difficulty. There are many causes to this problem. It may occur when calf is too large due to breeding of heifer to bull of large, coarse-boned breeds. And

the situation may be worsened if the heifer is fed high levels of feed intake during the last three months of pregnancy.

- Malpresentations of calf can also result in Dystocia
- Deformed calves (rare)
- Defects of the mother (rare)

Treatment of Dystocia

If the calf is oversized a veterinarian should be called. Marginal cases should be assisted as soon as possible. Ropes should be attached to the calf's feet above the feet lock joints and pulled when the cow strains. Changing the direction of the pull form one side to the other may help. For malpresentations such as front feet out but head turned back and beech presentation a veterinarian should be called to assist the presentation. After delivery, afterbirth pessaries should be inserted. If the cow is weak calcium borogluconate should be injected intravenously if possible.

CARING FOR THE NEWLY BORN CALF

Calf rearing is an important aspect in beef production because it is a source of replacement for the herd. Housing, feeding, health and general hygiene management will have a bearing on the successful raising of the calf.

Feeding

At birth the calf should receive enough colostrum through suckling during the first hour of life. Colostrum is vital for disease resistance since newborn calves acquire both immunity against diseases as well as certain minerals and vitamins from it. It also has a laxative effect, which is important to clear the calf's digestive tract in the first few days of life.

Colostrum Replacers

- 1whipped egg
- 0,3L of water
- 0,6L of whole milk
- 0,25ml caster oil

Storage

- Freeze
- Fermentation-affect absorption of antibodies. To increase absorption add a teaspoon of sodium bicarbonate to each litre fed.

Dipping the Navel

Immediately after birth, the calf's navel must be dipped in 20% iodine solution to avoid infection of the calf's digestive tract in the first few days of life.

Checking for Abnormalities

Calves should be checked for abnormalities such as umbilical hernia, abnormal teats and a calf or convex palate. The calf must be kept in a dry environment, which is well ventilated.

NUTRITION

There are six basic essential groups of ingredients in feed and these are water, carbohydrates, proteins, fats, minerals and vitamins. These nutrients are necessary if animals are to live normal, healthy and productive lives. These nutrients are required in different proportions and their requirements should be considered when balancing rations or planning supplementary feeding

Water

Constitutes the largest proportions of the body and it has many important functions to perform in living organism. Water is taken as free water from normal water supplies or as part of the succulent feed it consumes, the animal also gets water from chemical reactions in its muscles. The animals should have enough clean water available at all times, all year round.

Carbohydrates

The bulk of the energy requirements of the animal come from the carbohydrates portion of the feed. An important source of carbohydrates is the sugar and starch derived from the cellulose through the digestion process of ruminants. The most common and practical source of starch and sugar are crops like maize, sorghum and wheat, and some of their milling products. Energy requirements of cattle come from grazing and natural herbage, which has an energy content of 45% -55%. Energy is required by cattle for movement, maintains of body temperature, growth, reproduction, milk production and fattening up. Fats and oils and proteins also supply energy to cattle.

Proteins

Proteins are found in all living cells and are essential to life in all forms .The major roles played by proteins are in the formation of muscles, bones, internal organs, milk and repairing of worn body tissues. Ruminants enjoy the advantage that they do no require high quality nitrogen. The rumen microorganisms can synthesize all essential amino acids provided all the basic requirements are present in the diet. The most common and richest sources of proteins are cotton seed cake, groundnut oilcake and soybean meal. Lucerne and bean hay have also reasonable proteins. Ruminants can also utilize certain nitrogen containing compounds, which are not proteins. The compounds can be transformed to ammonia which can be combined with other substance by the ruminal flora to synthesize microbial protein .The protein is released to the host animal when the microorganism die lower down in the digestive tract. Urea is the most common non-protein compound used in animal feeds. It can be poisonous if fed in excess .It should be included at a rate of 2%. A bottle of vinegar /molasses, 1:1 mixture administered may serve the animal poisoned by urea if the condition is not too advanced.

Fats and Oils

They differ at normal air temperature they are similar to carbohydrates in composition except that they have higher carbon content thus they are much concentrated energy forms than starches and sugar. Fat content of natural feeds ranges from 1% in grass to 40% in whole groundnuts .6 per cent is regarded as the maximum tolerance for animals.

Minerals

It constitutes 3% of the animal’s body. The exact requirements are not known but levels are below which the animals lose efficiency in all facets of life are known. Since minerals in the soil are made available to animals through grasses and other plants, soil deficiency will be reflected

in the performance of the cattle. The greatest need for supplementation is during the rainy seasons of the year when grasses are prolific and absorption of soil nutrients by plants is insufficient.

Salt
It stimulates appetite and has many regulatory to functions in the body. If it lacks, animals will start licking the soil in blackish places or on anthills, ash heaps etc. Under these circumstances, they might eat poisonous plants or toxic materials, which they normally would not eat.

Calcium (Ca)
Vital ingredient in bones and teeth formation. When animals are fed calcium below their requirements they will drain the mineral from their bones which acts as reservoir .In lactating cows milk fever is a direct result of calcium deficiency. Veld grasses, legumes, pastures and crop residues normally contain enough calcium, while grain and other concentrates are often deficient in calcium.

Phosphorus (P)
P deficiency is very common throughout the world. P deficiency relates to animal's appetite (pica).The soils in Zimbabwe are deficient in P and hence it is necessary to make additional phosphate available to stocks throughout the year.

Vitamins
Veld and pasture grazing normally produce enough quantities of fat-soluble vitamins. Only frosted grass cannot provide the necessary vitamin A because there is no carotene available at that stage.

Roughages, Succulents and Concentrates
Various forms of feed used on the farm should be clearly identified and their purpose and application well understood.

a) *Roughages*
These are fibrous feeds suitable and essential to ruminants. Veld and pasture grazing, hay and cheap crop residues are the most common cattle feeds. Protein content of roughages varies from 12% in good hay to 1% in dead veld grasses.

b) *Succulents*
These are feeds with high moisture content and they are palatable. They have to be supplemented by concentrates because the animals are not able to take in enough of the low concentrates, very moist feeds to provide for all its needs.

c) *Concentrates*
These are feeds low in fibre but rich in digestible nutrients. They are high in feed value, 70% TDN and more but low in moisture content.

d) *The Basic Feed (Veld)*

Veld is the natural vegetation that has not been replaced by cultivation and which is used for some form of pastoralism (Danckwetts, 1989). On this basis about 90%of the large-scale commercial farming areas of Zimbabwe can be classified as veld. The natural grassland provides most of the food, which cattle eat. Veld grazing is not a uniform entity but various widely determined by season of year, rainfall, soil fertility and previous use. Veld grazing is grouped into three major sub-divisions, the sweet, mixed and sour veld areas. In Zimbabwe they roughly coincide with the topographic division into the high, low and middle veld. The veld with its components of trees, shrub, herbs and grasses provide basic diet for beef cattle. Young grasses have a high nutritive value that declines as it matures.

VELD MANAGEMENT

Important factors to be considered:

- Rest about 40 days
- Duration of grazing about 14 days
- Litter cover (less than 12%)
- Bush control

Planted Pastures

These can be only established effectively through proper cultivation. They require fertilization at the start and will be come unproductive and revert back to natural veld if not fertilized regularly in line with the way in which it is used. Examples of grasses which can be cultivated includes Bana grass, Kikuyu, Star grass, etc

Supplementary Feeding

The objective in supplementary feeding is to feed ruminal flora through the ruminant's mouth and if the organisms are properly maintained they will in turn feed their host through the transformation of cellulose into sugars and starches while also supplying vitamins and nitrogen. In order to apply the principle of supplementary feeding efficiently, there should enough roughage in the veld. Animals must take prescribed quantities in a relative short term so that they do not waste valuable grazing time. The animals can be fed liquid urea and molasses mixture, blocks, meals or cubes. Supplementary feeding is employed to increase the number and quality of the weaners produced, thus preference should be given to deserving breeding stock. Older cows bearing consecutive calf should be noted for supplementary feeding. In calf heifers should also be assisted, as they require nourishment for the foetus and for growth. Yearling heifers should be given little assistance through the winter to overcome the shock of weaning to prevent them from loosing weight. The winter supplementary feed requirements for different classes of stock expressed in minimum digestible protein per day are as follows:

Class of stock	**Digestible protein (g/day)**
In-calf 2+3 year old cows	250g
Mature cows bearing Consecutive calf	150-200g
Yearling heifers	200g
Weaners	100g

II. DAIRY PRODUCTION

MILK PRODUCTION

Preparation for Milking
The cow should be brought to the milking yard with minimum noise. There is no place for sticks whips or electric producers on a dairy farm.
Extreme patience to be practiced when bringing in heifers for the first time into the parlour. Muddy conditions must be avoided at all cost. Animals can be split into groups to reduce time spent away from grazing.

Milking Let-Down
It involves a series of events. This process is initiated by a stimulation of nerves resulting form some event that the cow associates with being milked. The stimulus causes the release of oxytocin from the posterior pituitary a small gland at the base of the brain. Oxytocin is carried by the blood to all parts of the body. It takes between 45 sec and 60sec for the oxytocin to be carried to the udder where it produces contraction of the myoepithelial cells. Oxytocin loses its effectiveness within 6-8minutes and if the milk is not removed from the udder it will move back onto the lumen of the alveoli in the secretary tissue.

Hand Milking
With hand milking the milk fills the teat cistern, which is then ejected by squeezing pressure of the hand. Hand milking is practiced on small –scale dairy farms while machine milking is preferred on commercial dairies. On commercial farm hand milking is required on occasions such as stripping out a mastitic quarter. The advantage of hand milking is that with the close contact of the milker with the cow, milk ejection reflex is more stimulated and the cow is satisfactorily milked out.

a) Machine Milking
Milking using a machine involves seven basic steps

- Wash the cow's udder
- Use a strip cup to detect abnormal milk
- Apply teat cups within 1-2 minutes
- Check the udder of the cow when she is nearly milked out and practice a minimum of machine stripping
- The cups are the rinsed out with a back flushing unit
- Dip the teat ends in an effective teat dip

b) Milking Machine Maintenance

Daily Maintenance Checks
Check should be carried out on:
1. Vacuum Pump
Heart of the machine is the vacuum pump and hence warrants daily checking. The pump should never be left to run dry or it might seize up. Waste oil from the pump should never be re-used. The oil should be kept at the correct level.

2. The Interceptor traps
After each milking the interceptor trap should be checked to see if it contains any liquid and emptied.

3. Vacuum Regulator
It maintains a steady vacuum level by admitting the correct amount of air consistent with the prevailing milking conditions.
Checking the vacuum regulator listening to the regulator and if its working properly it should emit a regular hissing noise with no "hiccups" or breaks.

4. Pulsators
Incorrect pulsation causes severe teat damage and aggravates mastitis
Check the speed at which the adjustable master and individual pulsators operate and adjust them.
Check the inlets particularly be air bleach in the claws.
Check the pulsation rate by blocking off all but one teat cup should be blocked off and a thumb used to block the final one. Count the number of times the liner collapses round the thumb in one minute.

Monthly Checks and Maintenance
1. Vacuum regulator – dismantle the vacuum regulator and clean the valve, its seating and the air inlet screen if one is fitted. Pulsations – clean all pulsators air inlets and ensure there is no dust or dirt hindering the pulsators movements.
2. Vacuum Line- the vacuum should be cleaned out to prevent build up of milk residues and bacteria
3. Milking Pump- check the non-return valve in the milk pump to ensure it is not worn out and in danger of breaking.
4. Plate Coolers
Open plate coolers and clean.

Common Diseases in Dairy Cattle

DISEASE	CAUSE	SIGNS/SYMPTOMS	TREATMENT	PREVENTION
Milk fever	Deficiency of Ca in the plasma	Paralysis, shock bloating and cardiac rest	Injection of Ca 6-12g	Feed a low Ca for 3 wks start feeding mineral supplement for 2-3wks before and after calving
Ketosis	Cow mobilizes fat serves	Lethargy, dullness and lack of appetite	Administration of glucose Corticosteroid injection Anabolic steroid injection	Cow should be in optimum condition when calving
Acidosis	Feeding of too little good roughage	-Drop of pH in the rumen -Dullness -Does not chew cud -Grind teeth -Eyes sunken	Treat with antacids Management hydroxide, Calcium carbonate	Any to a high energy diet should be gradual

Bloat	Excessive accumulation in the rumen and reticulum	-Physical obstruction to eructation by a foreign body -High E diets	Bloat guard Use milk with dettol Dose 150ml vegetable oil just prior to grazing on a new lush pasture	Ensure plastic bags, litter are picked up
Mastitis	Bacteria	-Inflammation of the udder -Coagulated milk		-Keeping clean environments --teat dipping

III. CALF MANAGEMENT

FEEDING CALVES

A calf's ability to absorb colostrums declines rapidly and at the same time the level of antibodies declines with each successive milking.

The basic principles are:

i. Calves must be fed at regular set times from clean buckets. Clean means wash and sterilized.
ii. When restricted levels of milk are fed or high dry matter milk replacers are used the calf will get insufficient liquid in its feed for its daily requirements and water must be freely available. Ideally milk or milk replacers should be fed at body temperature.
iii. Calves have to be taught to suckle form the bucket by carefully using one's finger previously dipped into milk and gently guiding it into the bucket.
iv. It is necessary for the calf to start eating concentrates (calf starter meal) at an early age.
v. All food offered should be fresh
vi. Clean fresh water should be freely available to calves from 3 weeks of age.
vii. It should be replaced once or twice daily.
viii. Overfeeding with whole milk must always be avoided otherwise scours may develop.
ix. All changes in diets must be made gradually.

WEANING THE CALVES

Eight Week Weaning (Conventional System)

The calf is fed whole milk for 8 weeks of quantities at around 8-10% of its birth mass. Quantity of milk fed can be reduced gradually from the 4^{th} week depending on the desired growth rate and the rate at which the calf is eating concentrate. If by 4weeks of age the calf is not consuming at least 2kg of meal everyday the milk should be reduced by one litre a week to encourage the calf to take dry matter/meal.

Liquid Feeding Levels of 8 Weeks Weaning

Breed	Quantity
Holstein – freisland/Freisien	4-3.5
Ayrshire – Guernsey	3-3.5
Jersey	2-2.5

Calf starter meal (16% cp) good quality hay and water must be made available after the 1st week.

Early Weaning (3-6weeks)

For early weaning a starter with high protein level (19% CP) adding sweetener such as molasses 8% can improve starter intake and reduce dustiness.

Good quality hay by the end of the 1st week which should not exceed 20% of the dry feed total – will help to wean early.

Milk feeding is restricted to 6-7% birth mass. The lower milk intake encourages dry feed consumption

Liquid Feeding Levels for 5 week Weaning

BREED	QUANTITY (litre/day)
Holstein – Freisland?Freisien	2.8-3.0
Aryshire – Guernsey	2.3-2.5
Jersey	1.7-2,0

Weaning at an early age entails particular care and attention and the highest quality feeds so that when a farmer chooses a weaning method he/she must be aware of the labour, time and management involved.

The Henderson Method (Weaning At 3weeks)

AGE	FEED GIVEN
Birth to 2 day	Colostrum
3-24 days	2-7.5litres/day in two meals
24 days and above	Nil

CALF CASTRATION

Knife Method

The method involves using a sharp knife or razor to remove the testicles of the calf, but care should be exercised.

Burdizzo

Using the burdizzo, involves cutting the spermatic cord using a blunt instrument by pressing.

Elastrator Bands

Should be used at an early age using rubber rings to cut- off the cord.

CALF DISBUDDING

Hot Iron and Caustic Paste

When dehorning the hail around the horn button must be clipped and the button scrapped so that the growing cells will be exposed. Dehorning can be carried out by heat or caustic soda. The safest and most effective is hot iron dehorning. The horn should not be burned too deeply – the application must be stopped when there is a slight oozing of blood and the button looks black.

Vaccination and Dosing Programme For Calf Diseases

DISEASE OR PARASITE	TREATMENT PROGRAMME	REMARKS
Bacterial diseases	4-6 months	Annually if infected
Anthrax	3-10months	Once only to heifers
Contagious abortion	3-6months the 1month later	Annually thereafter if a problem.
Quarter Evil	6-9 months	
Viral diseases	6months or older	Annually if a problem
Lumpy skin disease	3months or older	Annually if a problem
3 day stiff sickness	6months	Annually if a problem
Rabies	3months or older	2 injections 30days apart them annually
		Annually if a problem
Rift valley fever	6months or older	
Internal parasites		
Roundworms	2,4,6,9 and 12 months	Watch for symptoms or irrigated pastures
Flukes	Start in September, again mid-March	in housing after weaning.
Tapeworm	1,2, and 5months	

IV. PIG PRODUCTION

Pigs are simple stomached farm animals. *Suis scrofa* is the Latin name of European pig whilst *Suis Vittatus* originates from Asia.

Order : Artriodactctyla
Suborder : Suiformis
Family : Suidae

BREEDS

There are several breeds of pigs found in the world namely Large white, Landrace, Duroc, Welsh, Hampshire and the Mkota indigenous to Zimbabwe.

Duroc

- Originated from USA and it is brown in colour
- Developed from old European breeds crossed with Mediterranean breeds
- Average litter size of 10
- Has slightly hanging ears
- Excels all other breeds in terms of muscle quality
- Has lowest incidence of stress

Mukota

- Indigenous to Zimbabwe
- Hardy, very small and small mature mass(110kg)
- Poor fertility

- 4-8 piglets per litter
- Coat colour ranges from reddish brown, black and white or spotted

Landrace
- White in colour
- Ears dorso-ventral (dropping)
- Cross breed (Large white and Sweden breed)
- Developed specifically for bacon
- More eye muscle compared to large white
- Has weak legs
- 10-13 piglets

Large white
- White in colour
- Erect ears and ditched face
- Has strong legs and is produced specifically for meat
- Produce lean carcasses
- 12-14 piglets per litter

HOUSING FACILITES
Pig must have housing that has:
- Warmth
- Good ventilation
- Feeding space
- Watering space
- Comfortable sleeping space
- Good drainage

Pig houses can be designed in so many different ways from fully closed artificially controlled climate houses found in temperate climates to the more open houses found in the topics and sub-topics. The type of farming system determines the house.
There must be different houses for different classes of pigs
- Rearing pens
- Dry sow housing
- Boar pen
- Pens for sick pigs
- Feed store
- Finishing and fattening pens

HEAT DETECTION
The pressure test and/or riding test can be used for heat detection.
Sow or gilts namely show heat signs when they are on heat.

Pressure test
Sow stands when pressure is applied between the shoulders from behind.
Heat signs include:-

- ❖ Restlessness – hyperactivity
- ❖ Reddened vulva
- ❖ Mucous discharge (bull string)
- ❖ Mounting of other gilts (the one which stands when mounted is the one on heat)

It is important to have observant heat detectors because heat only last for 50-60hrs and the optimum period of fertility is the last 24hrs there mating should be done 12hrs after outset of standing heat and again 12hrs later.
As a tenet heat detection should be done twice a day

PREGNANCY TESTING

- ❖ After mating has been done, the sow or gilt should be observed for heat signs from day 18-22 after serving.
- ❖ If heat signs occur then the sow or gilt will not be pregnant
- ❖ A sow that fails to conceive after 2 consecutive services should be culled.

FARROWING

The sow/gilt should be placed in a furrowing pen 1wk before furrowing A peaceful ambience is ideal for a furrowing pig because the hormone responsible for furrowing (oxytocin) has the same binding site as adrenalin, which is produced in times of stress.

Signs of furrowing

When the following signs occur the sow/gilt will be about to furrow:-

- ❖ The sow/gilt makes a nest from the bedding
- ❖ The teats are turgid (normally happens 24hrs before furrowing)
- ❖ Blood stains come out of the vulva (normally happens 2 hrs before farming)
- ❖ Frequent urination

Furrowing usually takes 4-6hrs with an internal of 15-30minutes between each piglet.
Assistance is normally given when it is necessary for example if the internal between each piglet is >45mins.Injection of oxytocin and pulling could be done The coming out of the placenta should signal the end of the furrowing

AFTER FURROWING

The sow should be examined to establish whether every teat is producing milk and that the condition of the udder is normal. The sow should not be fed on the day of furrowing but has to be provided with plenty of water. Feed should be offered starting on the second day offering 1kg to begin with an gradually increasing the ration until she consumers 2kg of feed for maintenance plus half a kilo for every piglet in her litter by the 10^{th} day. The sow should continue to be fed at this rate until weaning, unless it becomes too fat or shows signs of loosing weight at which point the ration should be altered.

PIGLET MANAGEMENT

The creep area should be kept at temperature of 26-36˚c but not for the sow.

Navel Cord Care
The piglets should have the umbilical cord out so that it is 2.5 -5cm.

Clipping of Needle Teeth
Canine teeth should be clipped as they might cause biting and tearing of teats of the sow.

Tail Docking
To avoid a tail biting problem the tail can be cut. Tail biting is normally a sign of stress and will not happen when the piglets are comfortable.

Iron Injections
Iron injection should be done on the day of birth because there is poor transport of iron across the placenta and therefore piglets might suffer from anemia. However tablets or red soil can be used instead of iron injection.

Castration
Castration is the removal of testicles it is normally done using the knife method between day 10 and 21 after birth. It prevents genetically inferior makes from reproducing.

Pig Sty Hygiene
It is important that the floor of the pen should slope so that excess water common off allowing the pen to stay dry. If water does collect in the pen, it is important to dig a drainage furrow or ditch, leading out of the pen. Pigs always dung in the same place. It is important to make sure that the mess is cleaned out at least twice a week, to lessen the risk of disease. Food and water constraints must be cleaned thoroughly at least twice a week.

External Parasites Control
Mange mites
Mange is a skin disease caused by ***Sarcoptic scabei***. The mite burrows deep under the skin and deposits eggs. The eggs hatch into larvae in 3-15days. The burrowing into the skin makes the animal fuel like scratching and scratching causes wounds and this causes the skin of the animal to be scaly. Farmers should develop a mange treatment (control) programme of using acaricides or injectible such as Ivomec.

Pig lice
An insect *Hematopinus suis* lice sucks blood and causes bite wounds. The wounds appear as red spots on the skin just like for mange. Acaricides can be used for treatment and/or injectibles such as Ivomec.

PIG DISEASES
- Brucellosis
- Leptosiosis
- Erysipelas
- Transmissible gastric enteritis
- Salt poisoning

V. POULTRY PRODUCTION

INDIGENEOUS POULTRY MANAGEMENT IN COMMUNAL AREAS

Poultry is a broad name given to birds kept for human consumption. In Zimbabwe poultry involves indigenous chickens, guinea fowls, pigeons, geese, ducks and ostrich. The present system of poultry keeping by communal farmers provides valuable protein food at virtually low cost under the free range management.

FEED SOURCES

Home – grown feds form the bulk if not all the source of feed for indigenous poultry. Small grains such finger millet (Rapoko), pearl millet (Mhunga) and Sorghum are the main energy sources in home-made poultry rations while maize is also used but rarely since the bulk of it is used for human consumption. Low-grade groundnuts, Cowpeas, Soya peas and pumpkins seed are the major protein bases. At times very rarely

Commercial feed is bought and mixed with other feedstuff. Where cowpeas and pumpkins seeds are used, the seed should first roast. Roasting not only improves flavors but also intake by the birds also inactivates lectin. Lectins, which are thermo –labial proteins that binds sugars and interfere with protein digestion through binding with typsin and chymotrypsin.

HOUSING

Housing provides shelter and confines birds during and after harvesting to prevent danger of crops. The most hygienic poultry house would consist of a concrete platform a few poles or brick pillars supporting a tin roof, and wire mesh around up to the roof, with a door, which can be locked for the night. Hygienic feeders and water troughs should be provided if supplementary feeding is to be done. However the main problem is the accumulation of fowl ticks and expenses cannot be avoided here if one needs to avert high mortality. The control of fowl ticks, through fumigation and vaccination fowl pox and fowl typhoid could be done to increase productivity

MORTALITY

Mortality during the rearing of the young birds is high due to poor management. Bacterial infection such as fowl cholera, fowl typhoid appears to be more prevalent in communal areas. In addition, natural enemies such as snakes, dogs, may cause mortality to young birds.

VI. SHEEP MANAGEMENT TECHNIQUES

SELECTION FOR BREEDING

Desirable Characteristics: Ram

- Complete absence of any physical defects e.g. twisted legs
- Should be the heaviest in the flock with a wide chest, straight body and strong legs.
- He should be a twin
- Good semen, no sperm abnormalities

Ram: Ewe Ratio

A single ram is required for at least 50 ewes. The number must be increased under extensive production system. A reserve capacity of 10% can be put in place for instances when problems arise, with the rams running with the flock. The ram must be fed a good quality feed throughout the year to keep in shape for the mating season.

Desirable characteristics: Ewe

- She should be a large animal with a well developed body
- She should be a twin
- The legs should be long
- Udder should be well formed
- She should be docile with good mating abilities.

LAMBING

- Provide quite shady maternity camp, shelter and sufficient small pens for "mothering up"
- Do not aid lambing ewes unless they are in trouble.
- Do not return ewes and their lambs to the main flock until the lambs are suckling strongly.

NEONATAL CARE

- At birth, disinfect lamb's umbilicus using iodine solution to prevent infection
- It is important that the lamb gets the first milk or colostrum from the mother. The greatest mortality in lambs occurs within the first three days of birth through starvation.
- Ensure everyday that every lamb has a mother or foster mother.
- The lambs must not be exposed to severe environmental conditions
- Docking within 4 days of birth so as to allow fat distribution throughout the body.
- Castrate within 3 days if using an elastrator, or within 3 weeks if using the knife. Burdizzo castration is carried out at 3months of age.

FEEDING

a) **Ram:** good quality grazing is adequate in summer. In winter, feed 1.5kg per day concentrate supplement containing both energy and protein, as grazing will be generally poor.
b) **Ewe:** with adequate grazing, it is not necessary to supplement ewes, except when they become pregnant.
c) **Lamb:** young lambs can be creep fed with concentrate supplement to obtain maximum growth rates. This can be introduced as soon as possible after birth.
   After weaning, lamb can be grown out and finished off on good grazing in spring. When there is not enough grazing, they have to be penned and fattened. Their diet should contain 13-15% CP and 10-20% roughage. They must be sent for slaughter after attaining +/-39kg live weight. This can be achieved in eleven weeks.

VII. GOAT MANAGEMENT TECHNIQUES

Goats are important factor in the subsistence economy of the communal areas. For the past years goats were being regarded as the "poor man` s cow" but in recent years the interest in goats has been stimulated by reports from various organization like Research Stations about their importance. In 1983 a Goat Producers Association was formed and researches are currently being contacted at UZ, Matopos and Henderson Research Stations. Since these animals are hard, they are able to adopt any weather conditions within the country.

BREEDS AND BREEDING

1. Indigenous: They vary in type, ranging from small stock animals on the north of the country to large – framed, tall animals in the southern Lowveld. Mashona and Matebele are the major breeds that are native to Zimbabwe. Colour patterns also vary which include black white and red and all conceivable combinations. The coat types range from smooth to extremely longhaired. Most indigenous breeds are reared for meat and skins.

2. The Boar goat: - it is an improved meat breed of South Africa origin. The breed has been introduced to Zimbabwe by white farmer during the colonial era. It is a large well-muscled goat with a short coat, white with red/ grey marking on the head. Twin and triple births are common and do generally have a good milk supply. Since the breed is hardy it can be produced even under extensive conditions.

3. Milk goats: the 4 most common overseas breeds are the Saanen, Alpine, Toggenburg and Nubian of which only the Saanen occurs in any number in Zimbabwe. The Saanen is fairly large, docile white animal with a good milk supply and well suited to intensive management of smallholdings.

SELECTION OF BREEDING STOCK

The following are the characteristics of goods breeding stock:

- Good health
- High vigor
- High growth rate
- High meat to bone ratio

It is advisable to purchase breeding stock form reputable breeds with breeding records.

1) Breeding Doe

- They should have 4 functional teats
- Larger breeds mature later while a low plane of nutrition lengthens maturity time.
- Puberty – 6months or less
- Breeding age 12-18months/2/3 mature body mass
- Oestrus cycle – 21 days

2) Breeding Bucks

- Bucks mature at 6months
- The mating is buck to 40/50 does

Allow a maximum of 7 mating per week for mature does and 2 moths per week for growing does.

KIDDING
When the doe/ewe is about to kid she should be placed in a clean, dry paddock/small enclosure. Although they don't usually experience difficulties during kidding it is advisable to keep an eye on them to protect them from predators. When a doe gives birth to more than one kid, those born first may be placed in a low box so that the doe can see and lick them without any danger of overlying them.

i. After birth: immediately dip the navels of the kids in a suitable disinfectant such as iodine solution, to prevent infection.
ii. Colostrum: ensure that the kids suckle within the first 6 hours form birth to get colostrum for immunity

MILKING
Check if doe is producing milk. If not feed the kid with a milk replacer or foster it to another doe that has kidded. Milk feds should be according to the following programme.
Week 1 – 1litre/day divided into four feeds
Week 2 – increase gradually to 2.25 litre/day in 3feeds
Week 5 – 14 -2,25litres/day in two feed.
Good quality hay and clean water should be available to the kids from an early age and from 1month they should be introduced to a little grain/meal.

HOUSING
Provide clean housing, which is clean, draught –free and well ventilated.
During the first two weeks of life, leave the kids in pens when the does go out. This protects the kids coming into contact with diseases and predators.

DEHORNING
It is normally done on dairy female breeds. It must be done at an early age while the horns are still in the brood stage.

HOOF TRIMMING – will probably be required if goats are kept on soft pastures. Overgrown hooves must be cut back regularly using seccateurs or a sharp knife or a rasp.

FOOT ROT- commonly affects goats under wet muddy conditions during the rainy season. They should be walked twice a day through a footbath contain 10% formalin or 5% Copper sulphate solution.

VIII. RABBITRY

Rabbits will produce rapidly under proper breeding management. However, in low scale, extensive production systems it is important to control the rate of reproduction to suit the level of feed available. Reproductive rate can be controlled by increasing the weaning age and the time between kindling and the next mating.

SELECTION OF BREEDING STOCK

The following are the characteristic of good breeding stock:

- Good health
- High vigor
- High growth rate
- High reproductive rate
- High meat to bone ratio

It is advisable to purchase stock from reputable breeder with breeding records.

Breeding Does

- Should have 8 functional teats
- Mature 6 months
- Should weigh 3.6kg at 6months
- Larger breeds mature late while low plane of nutrition lengthens maturity time

Breeding Bucks

- Mature at 6 month
- Mating ratio is 1 buck to 10 does
- Allow a maximum of 7 mating per week for mature does and 2 mating per week for young does.

MATING

- When a doe is ready for mating, she becomes restless and stamps her feet on the floor.
- It is not necessary to wait for the doe to be on heat as she will accept the buck at anytime
- Always take the doe to the buck's cage
- If the doe is taken to the buck when she is ready mating will take place immediately
- Avoid mating pregnant does as they will abort.

PREGNANCY

- Gestation period is 28-35days
- During the fourth week of pregnancy, provide a nest box with soft bedding.
- A few days before kindling the doe plucks some of its fur and lines the nest box
- Check the pregnant does every morning and evening
- If a doe makes a nest on the floor it must be removed and placed in the nest box.

KINDLING

- The recommended litter size is 8
- Large litters need fostering
- Newly born rabbits are blind, deaf and hairless and need to be handled carefully
- Cull weak young rabbits within 24hours of birth
- The recommended number of litters is 4/year

FOSTERING

Fostering is the removal of excess rabbits in a litter to another doe with a smaller litter.

This is only possible when the two does kindle on the same day
Fostering should be done on the first day of life.
Before handling the young rabbits, rub Vicks on the nose of the foster doe so that she does not detect the smell of the young rabbits being fostered to it.
Urine or droppings of the foster doe ca be used instead of Vicks with the same effect

WEANING
In extensive systems young rabbits are weaned at 7 – 8weeks
The weaned does are re-mated after 8 weeks
Controlling the time of weaning helps to control the reproductive rate of the rabbits

CULLING
When a doe continuously refuses the buck, it must be culled
When a doe is too old or can no longer produce it must also be culled.

FEEDING
Rabbits can be fed a wide variety of feed stuffs. Economic ventilation will be determined by availability cost and quality. In nature they exist on a truly vegetarian diet. Good quality green and hay are quite satisfactory for low scale production but will not give fast growth and commercially viable results. Most green in the form of vegetables, cabbages, leaves and weeds can be feed.
NB: Avoid the feeding of potato leaves, tomato plants and nearly all plants that grow from bulbs.
Commercial pellets containing 18-20%CP and not less than 13-15% crude fibre will provide a completely balanced ration. From 8 weeks onwards a growing rabbits is fed approximately 100grams of rabbit pellets daily plus hay. A pregnant doe should be restricted to about 115g of pellets per day and hay must be fed to appetite. Hay is reduced gradually 18days after mating until the doe is fed ad-lib with rabbit pellets only, which continues until she is removed form her litter. Working bucks are always fed with balanced rabbit pellets and hay ad-lib. Breeding animals should be monitored at all times to ensure they are not overweight or underweight. Change of diet should be gradual

WATER REQUIREMENTS
- Clean fresh water should be always available
- An adult rabbit consumes a liter of water every day
- Up to 3.5 liters for a doe and her 8-week old litter
- Drinkers should be simple to clean nipples can be used in large units.

IX. AQUACULTURE

This is the science, which deals with methods of growing (cultivating) animal and vegetable life in water. Fish farming is a type of aquaculture. In Zimbabwe Fish farming is divided into two warm water and cold-water fish. Warm water fish are cultured in most parts of the country except in the Eastern Highlands where cold water fish are cultured.
Fish is a valuable source of protein, which, if locally available, could result in improved living standards through improved protein consumption and/or increased earnings through sales.

FACTORS TO CONSIDER ON ESTABLISHMENT OF A POND FOR WARM WATER FISH

- Perennial water supply
- Good clay or loam soil, deep soil free from rock at the bottom
- Shelter from strong winds
- The size which is determined by the number of ponds or the culture system desired.

CONSTRUCTION OF A POND

There are two designs of ponds

- Seepage pond
  Constructed by digging down to a point below the water table. This is suitable in areas were the water table is high.
- Contour pond
  This is created by erection of a wall along the contour of the land and thereby capturing runoff from the land.

There should be 3 types of ponds that is

- Breeding ponds
- Stocking ponds
- Rearing ponds

FISH BREEDS

Amongst the fish present in Zimbabwe, the Cichlides are the recommended for warm water pond culture.

Cichlides found in Zimbabwe

Oreochromis mosambicus (Mozambique bream)
Oreochromis macrochir (Green- headed bream)
Oreochromis nilotica (Nile bream)
Tilapia rendalli (Red breasted bream)
Serranochromis codringtonii (Green Happy)

STOCKING OF FISH

The initial stocking rate is 2-3 fish per m^2 or 20 000 – 30 000 fish per ha, but a stocking rate of up to 40 000 fish per ha can be attained if the level of management is good. It is recommended to stock 1:2 males to females if there are some limiting factors in management.

POLYCULTURE
Polyculture can be practiced when *Oreochromis macrochir* (a vegetarian fish) habitats the top, *Oreochromis mosambicus* (a zooplankton feeder) habitating the middle of the pond whilst *S. codringtonii* (snail eater) will be habitating at the bottom of the pond.

SEXING FISH
Sexing fish is normally done at commercial level through the use of hormones injection.
If *Oreochromis mosambicus* and *Oreochromis nilotica are* crossed 100% male hybrids are obtained. These monosex male hybrids grow faster than females. It is difficult to sex fry (young fish).

FEEDING
Oreochromis spp feed on algae. It is important to maintain a high algae population in the pond. This can be done application of lime, phosphate and manure.

Liming
Ground limestone 1140kg/ha
Agricultural lime 2270kg/ha
Hydrated lime 114kg/ha
Quick lime 200kg/ha

Phosphates
Basic slag 23 – 30 kg /ha
Single super phosphate 114kg/ha
Granular double 57kg/ha

Organic Manure
Cow manure 1000kg /ha
Chicken manure 114 – 228 kg/ha
Supplementary feeding
This improves the growth rates of fish in ponds. More weight of fish can be harvested as compared to ponds receiving manure only. Examples of these feeds are vegetable and kitchen wastes, cereal bran, crushed maize, spoiled fruits, oilseed cakes, slaughterhouse wastes and brewery wastes, and many other on-farm feeds.

HARVESTING
Fish should be harvested after attaining the desired weight. The mass at harvesting should average 120 grams per fish. This can be achieved at eight months. Older fish do not put on much weight after this period.
Harvesting should be done to maintain correct stock levels. There are 4 ways of harvesting fish:

- Rod and line
- Traps (wire mesh or netting)
- Pond drainage
- Netting

MARKETING

The biggest problem experienced with fish is that of perishability, it is important therefore to have a ready market if refrigeration is not available if one intends to sell fresh fish .As part of processing fish, in preparation of marketing they are supposed to have gills and entrails removed because of high bacterial count within them.

STORAGE

Fish can be stored after they have been preserved. They are many ways of fish preservation. Some are listed below:

- ❖ Deep freezing
- ❖ Drying
- ❖ Smoking

X. APICULTURE

The maintenance of bees for the benefit of man.

VALUE OF BEES

- ➢ Pollination
- ➢ Food
- ➢ Commercial value
- ➢ Preparation of medicine
- ➢ Bees waxes used in candle and shoe manufacturing
- ➢ Royal jelly used in medicine and cosmetics

BIOLOGY OF BEES

We have three castes

- The queen
- Drones
- Workers

The Queen Bee

It is the mother and head of the colony. She is 1.5 times larger than the worker bee. She has short wings, which only cover half of the body. She has a long sting and is not barbed and that's why it can sting several times.

Drones

They are the only males in the colony. They are produced parhenogenetically. They do not have a sting so cannot defend the colony. They don't have pollen baskets and they cannot collect pollen or nectar. Their function is to meet with the virgin and they die.

Worker Bees

They are all females and their function is to collect and carrying nectar, pollen and propolis to the hive. These also guard and defend the hive but each time the bee sting something it dies. They clean the hive and build wax combs.

BROOD DEVELOPMENT
The table gives duration of development from eggs to perfect insect.

Types of Hives
- Anastromo Greek Basket
- Kenya Top Bar hive
- Standard Langstroth bee hive

Feeding Bees
- Once a swarm of bees has been caught and hived. Feeding is recommended to help the bees to establish themselves and build up combs rapidly.
- The earlier they build the sooner the breeding starts and the chance for reaping a good crop of honey.
- Bees may fed in many ways and many kinds of feeders are available
- The most economical and satisfactory, most easily available container is a 500g jam/peanut butter jar with a screw top [glass jars]
- 10-15 holes about 1mm in diameter are punched in the lid from the top
- Once the jar has been filled with the syrup and the lid screwed down, it should be placed upside down on the inner cover of the hive in such a way that the jar top fits over the hole provided
- An empty brooder chamber or an empty super should then be placed over the feeder and covered with the top cover of the hive.

Preparing the syrup
- 2 parts white refined, 3 parts water by volume and 2% iodine salt
- The sugar and salt are poured into boiling water and stirred until all the sugar has dissolved

NB: the syrup must be boiled because bees do not like a syrup tasking like caramel

Water
- Bees should be given plenty of water. It should be placed where there is sunlight

Pollen
- Provides protein in a bee's diet necessary for development of larvae and full development of young and adults. Lack of it can lead to paralysis

Propolis
This is resinous substance collected from plants, which is found around wounds on plants and sometimes around buds. It is used to seal small cracks and holes in the colony for reinforcing and strengthening old combs and covering dead bodies, which are too big to be removed. Propolis contains chemicals called turpines which act to limit bacteria and fungal growth.

HARVESTING, PROCESSING AND MARKETING
A frame of honey contains thousands of capped cells side-by-side and back-to-back. It can be harvested as [1] extracted honey
[2] Comb honey

Extracted Honey- is the liquid honey removed fro the combs. The comb is then returned to the bees for refilling.

Comb Honey-marketed in the comb, which is part of the product. It is produced in two forms
[i] Section comb honey

[ii]Bulk comb honey- this is later processed into **Chunk** and **Cut** honey

Bulk Comb Honey

- Usually produced in shallow supers similar to those in the production of extracted honey.
- The only difference between bulk and section honey is the size of the combs , the bulk comb honey slabs weigh 1.6-1.8 kg and section honey 370-460g.

Chunk honey

- Bulk comb honey is cut into rectangles which fit into the mouth of a glass jar
- The remaining space in the jar is then filled with liquid honey which has previously been heated to 65.5˚C and then cooled to room temperature

AGRIC. ENGINEERING & ECONOMICS SECTION

I. AGRICULTURAL ENGINEERING

TYPES OF FARM EQUIPMENT

Ox-drawn Implements
Ox-drawn plough, cultivator, scotch cart, ridger, tie maker, planter, harrow.

Tractor drawn
Disc plough, disc harrow, ridger, ripper (chiesel plough), trailers, sprayers, fertilizer spreader, planter, row marker, grass mower, sheller, tractor-driven water pump

Manual
Hoe, row marker, seed driller, knap sack sprayer, hand operated sheller, shovel, pick, fork, axe, oil presser, peanut butter mill, injector gun, vet equipment, wheel barrow

Other
Combine harvester, cutter bar, motorized equipment (ULV, electric motors, diesel engines, etc)

UTILIZATION, STORAGE AND MAINTENANCE OF FARM EQUIPMENT

Cultivator
It is a multi-purpose equipment whose main use purpose is weeding crops below knee height, but can also be used for row marking.
Tines are metal shanks which hold the shares or working points. There are two types: *rigid tines*, which maintain constant depth, and *spring tines*, which are flexible and used for pulverizing the soil. The number of tines on a cultivator varies (3 and 5 are common).

Ox-drawn Plough
The animal drawn single furrow plough is widely used not only in Zimbabwe but throughout Africa. The mouldboard plough is the most common primary tillage implement. Soil loosening and clod disintegration in a field increases with speed of draft power. The traditional bolted together construction is ideal for easy replacement of any of the component parts that are interchangeable with other ploughs of similar design.

Parts of a Standard Mouldboard Plough

i) *Beam*:-part to which power is applied and other parts are attached.
ii) *Share*: - horizontally cuts and loosens the soil from the underside.
iii) *Landslide*: - a flat bar which receives the side force due to the turning furrow slice, and thus stabilizing the plough.
iv) *Mouldboard*: - a curved plate which turns and inverts the soil.
v) *Frog*: - joins the share, beam, mouldboard and landslide together.

vi) *Hake* or Clevis: - adjusts depth and width of cut by moving the hitch point and chain position vertically and sideways, respectively.
vii) *Wheel* or *Skid*: - steadies the plough and ensures uniform ploughing depth.

Plough Adjustment

i) Depth adjustment (vertical hake regulator or depth clevis)
- Raise the depth wheel as much as possible.
- Raise hitch point for deep penetration or lower it for shallow penetration.
- At required depth, lower wheel until it touches the soil surface.

ii) Width Adjustment (Horizontal hake regulator or cross clevis)
- For wider cut, move hitching point towards ploughed land.
- For narrow width, move hitching point towards unploughed land.

NB***: Hitch assembly should not be removed from the plough.***

Planter

Needs calibration for inter- and intra row spacing and should be fitted with a row marker for demarcation of the next planting line.
Consists of: i) a *depth clevis*, which is used as a hitching point and provides depth adjustment for seed and fertilizer placement into the soil,
ii) a *runner*, which opens furrow for seed and fertilizer placement,
iii) a *wheel*, for driving the metering mechanism through the pitman or the chain drive and covering the seed and fertilizer,
iv) *Seed/Fertilizer tube*:- directs seed/fertilizer from the unit to the opened furrow, and
v) *Seed hopper*: - for holding and dropping seed at adjusted rate.

Tractor-drawn Plough

There is need to pay proper attention to hitching and adjustment for with and depth of cut. The need to pay attention to hitching and calibration is not only for the plough but infact all tractor drawn equipment.

Manual Equipment

All manual equipment and tools need to be cleaned soon after use to prevent rust. Need proper selection of components such as nozzles for sprayers.
NB: Whenever a farmer is using a ULV (Ultra Low Volume) sprayer, he or she must have two sets of dry cells. Each set must rested after every one hour for them to serve quite longer.

SOURCES OF THE EQUIPMENT

Farmers should purchase their equipment from reputable suppliers who offer back-up services and should always seek advice from the Department of Agricultural Engineering on all issues concerning purchasing, use and maintenance of farm equipment.

DRAFT POWER

Types

The main types of draft power used in Zimbabwe are donkeys and cattle.

Dimensions of Yokes, Harnesses and Chains

Type of Yoke	Length (m)	Distance between Skei Pairs (cm)	Diameter of the yoke (cm)
Plough	1.5	90	7-10
Cultivator	2.4	180	7-10
Cart	1.7	110	7-10

Chains – Front chain should be **2.7m** long and rear chain should be **2.9m** long when using four animals

.

NB: *Note that when using four animals the rear and front yokes must be different in terms of the angle of the skei and the clamp. The front yoke skei holes should be drilled at 90 degrees whereas the rear yoke should be drilled at 75 degrees backwards. This is because the front chain pulls the back yoke from underneath thereby twisting the yoke forwards and bringing the skeis to vertical positions.*

Harnesses

It is recommended that donkeys be harnessed and not yoked. On cattle, harnesses should only be used when operating with one beast.

FARM STRUCTURES

For design, construction and maintenance of farm structures such as green houses, tobacco barns, grading shades, granaries, milking parlors and small stock pens, farmers should seek advice from agricultural engineers and technicians based at district level, who can also provide bill of quantities for standard models to farmers.

POST HARVEST EQUIPMENT

A variety of post harvest machinery such as solar driers for vegetables and fruits, peanut butter hand and electric mills, oil pressers, and other food processing machines are available with various suppliers of agricultural equipment including the Department of Agricultural Engineering. Advice on purchase, design, use and maintenance can be sought from agricultural engineering specialists located in each district.

II. SOIL & WATER CONSERVATION

SOIL & WATER CONSERVATION METHODS

Biological Methods

- Intercropping
- Planting vetivar, star and runner grasses and hedges in soil erosion threatened areas especially along contours, storm drains, gullies, water ways, etc.

Mechanical Methods

- Infiltration pits in the contour drain to retain water soil from flowing out.
- Silt traps for rill reclamation

- Check dams for improved water percolation and retention in the soil
- Contour ridges for directing excess runoff water from crop fields to prevent erosion.
- Stone checks and terraces (sometimes used in combination with vertivar grass) for soil erosion prevention.
- Rain water harvesting from roof tops.

Good Cultural Practices

- Ploughing across the slope to reduce run off and erosion
- Crop rotation
- Destocking and controlled grazing
- Reforestation or avoiding deforestation
- Preventing veld fires

SITE SELECTION FOR WATER BODIES

Characteristics of a Good Dam Site

- Flat or gentle slope
- Strong foundation especially a rock
- A good dam site should be narrow, U-shaped, deep and long.
- There must be potential for strong spill way
- Availability of non-porous (construction material)soils within the catchment area e.g. anthill soils.
- Avoid sodic and calcium
- Catchment area should be at most 5 square kilometers
- Site should suit the desired or intended use

Rules and Regulations in Water Body Construction

The site has to be surveyed, designed and construction-supervised by engineers.
Permission should be sought from the local government before a dam is constructed
Catchment area should not be more than five square kilometers and dam wall must not exceed 8 metres in height.
NB: Dams of volumes in excess of 5 000 cubic metres require a water permit. From the Zimbabwe National Water Authority (ZINWA).

Siting of Fish Ponds

Fish ponds should be sited where there is high potential of natural filling with water
There should be no threat of infection with toxic materials.

MAINTENANCE & REPAIR OF WATER BODIES

- No trees or shrubs should be allowed to grow on dam walls
- Prevent anthills from growing on the wall
- The dam wall should be fenced off.
- Avoid polluting the dam with chemical and other pollutants
- Grass should be planted on the dam wall

- The catchment area must be well managed to prevent dam siltation.

BASIC SURVEYING PRINCIPLES

Equipment

- Levels including airframes and line levels
- Staff, Tripod stands, Ranging rods, Bonding Rods, Tape measure, Record book
- Sketch book

Dimensions of Contour Ridges and Storm Drains

Contour ridges are meant for safe discharging excess water from arable land.

Length in Metres	**Soil Type**
200	Vlei soils
250	Light soils prone to siltation
300	Medium soils
400	Heavy Soils

Gradients and Dimensions of Contour Ridges and Storm Drains

Parameter	**Contour Ridge (m)**	**Storm Drain (m)**
Channel With	1.70	3.0
Channel Depth	0.23	0.50
Embarkment Height	0.23	0.50
Embarkment Width	1.70	2.60
Gradient	1:250	1:200

III. AGRIC FINANCE & MARKETING

AGRICULTURAL FINANCE

The Concept of Farm Budgeting

Budgeting is the forecasting of income and expenditure. Types of Budgets include, Gross Margin, Partial, Break-even, and Cash Flow Budgets.

Gross Margin Analysis

Gross Margin is the difference between Gross Income and Total Variable Costs for a particular enterprise. Comprises of input requirements per unit of limiting factor e.g. per hectare of land, rates of application and the costs of the inputs, the expected output and the respective income. The return per dollar invested can be computed to see the opportunity cost of investment in that particular enterprise.

Sources of Credit

In Zimbabwe there are various institutions which provide loans for agricultural purposes.

Enterprise	Possible Sources of Credit
Livestock	Cold Storage Company, AGRIBANK, Reserve Bank of Zimbabwe, Livestock Development Trust(LDT), Commercial Banks, Small Enterprises Development Corporation (SEDCO)
Summer Crops, Tobacco, Sugarcane	Agricultural Development Bank of Zimbabwe Agribank), Reserve Bank of Zimbabwe (RBZ), Grain Marketing Board (GMB), Contracting Companies, etc
Irrigation	Reserve Bank of Zimbabwe (RBZ), Contracting Companies,
Farm Machinery and Implements	Farmers' Organizations such as Zimbabwe Agrodelears Association (ZIADA), Farmers Development Trust (FDT), District Development Fund (DDF), ARDA.

Loan Application
Farmers must come up with bankable projects through drafting of comprehensive cash flow budgets. The project proposal and cash flow should meet the requirements of the credit provider. Agricultural and other commercial banks in Zimbabwe offer short-term (6 months), medium term (one year) and long-term (18 months) loans to farmers.

Debt Servicing
Farmers should be encouraged to repay loans to credit providers in order for them to be able to continue accessing more credit and allow the credit providers to expand and serve more farmers.

FARM RECORDS/ACCOUNTING
It is imperative that farmers keep records of all activities they undertake on their farms. There are basically two types of records which are financial and physical records.

Financial Records
Are those records involving money flowing into and out of farm activities e.g. income and expenditure. These should reflect all the financial transactions taking place on the farm.

Physical Records
Include all information on stock of assets, livestock numbers and dates of operation. There is therefore need for a farm diary where all these records are kept.

INSURANCE
Refers to protection against all types of risks. Farm machinery such as tractors and crops such as tobacco need insurance against such risks such as fire, hailstorms, etc.

PRODUCTION ECONOMICS
Farmer's goals and objectives such as food self-sufficiency, pride or profit maximization should be taken into consideration. A Farmer needs to be assisted in making the best decision in allocating his or her resources to maximize his or her objectives and goals.

FACTORS OF PRODUCTION

The major factors of production in agriculture are Land, Labour and Capital and Management or Entrepreneurship.

Land

Land is in limited supply and therefore should be put to maximum possible use in order for the farmer's objective to be achieved.

Labour

Different enterprises require different amounts of labour. The quality and availability of labour should be taken into consideration when planning to venture into a particular enterprise.

Capital

In choosing the appropriate resources to undertake any particular enterprise, farmers have to make sure that they have the appropriate capital equipment.

Management/Entrepreneurship

Farmers should have the ability to run the farm as a business. This means relevant skills and expertise should be acquired either through training or employing skilled labour and personnel.

Other Factors of Production

Other factors which influence agricultural production include Government Policy, Social-Cultural, Inputs and Outputs Markets, Enterprise compatibility.

AGRICULTURAL MARKETING

Farmers should be encouraged to consider the four "Ps" of marketing which are Price, Product, Place and Promotion. Price – farmers should sell at least to break-even so that they do not incur losses. Product – farmers have to produce products or commodities that are demanded on the market. Place – they should know the place where their produce is required i.e. market. Promotion – advertisement of products help enhance demand and hence better prices.

Marketing Organizations

There are product-specific marketing organizations that specialize in purchasing and processing of farmers' products.

Marketing Identification

Farmers should be encouraged to carryout market research so that their products fetch the highest possible price. It is imperative to address the what (form), when and where to sell their commodities. Farmers should be encouraged to minimize the length of the marketing chain so as to earn more from sale of their commodities. Value addition at farm level should be encouraged for improved incomes for the farmers.

Marketing Systems

Contract production and marketing, Auction, marketing institutions e.g. GMB, and open or free marketing systems are available options for farmers market their produce.

Marketing Regulations

There are commodities such as maize and wheat which are controlled in terms of price and movement across regions in the country and internationally. The marketing regulations should be followed to avoid running into problems with national laws.

Marketing Functions
Encompasses a series of events that take place from the point of production to the final consumer e.g. transportation, packaging, storage, processing, manufacturing, etc.

IV. IRRIGATION DEVELOPMENT

PRELIMINARY FEASIBILITY STUDY
To develop an irrigation scheme or project, there is need to carry out a feasibility study. The following information entails a preliminary feasibility study that should be carried before an irrigation project is established.

Background Information
Location of the area, Land Ownership Patterns, and Size of Area to be covered

Land and Soils
General Slope, Soil type, texture and structure, Vegetation, and Depth of the soil

Agriculture
Current Land use, Proposed Land Use, Cropping and Marketing Programmes

Climate
Prevailing Rainfall Patterns, Temperature and Humidity, and Wind

Water Source
Type of the source and Distance from the field

Irrigation Requirements
Possible Methods, Best Choice and Justification, and Bill of Quantities
NB: *To establish an irrigation scheme which exceeds 20 hectares there is need for an Environmental Impact Assessment to be conducted.*

Operation and Maintenance
There is need for irrigation scheduling to regulate use of water. Water bodies and conveyance systems should be maintained. Irrigation Management Committees (IMCs) have to be set up. Cropping programmes should suit identified markets and recommended crop rotations. There is need for conservation layout. The entire irrigation area needs to be fenced off all types of livestock. Constant checking on the entire irrigation equipment and facilities for break downs

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