Module 4

Manage a Feedlot

Learner Guide

Course Name	National Certificate: Animal Production SAQA ID: 48979
Module Name	Module 4 Manage a Feedlot
Module Code	19400
Version No	V3
Status	Complete
Unit Standards	116321; 116649; 116312; 9015; 119459
NQF Level	4
Credits	163

Table of contents

Dear Learner

This Learner Guide contains all the information to acquire all the knowledge and skills leading to the unit standard:

ID:	Unit standard title:
116321	Procure and manage agricultural input
116649	Control feedlot production unit
116312	Implement a data collection plan
9015	Apply knowledge of statistics and probability to critically interrogate and effectively communicate findings on life related problems
119459	Write/present/sign for a wide range of contexts

You will be assessed during the course of your study. This is called formative assessment. You will also be assessed on completion of this unit standard. This is called summative assessment. Before your assessment, your assessor will discuss the unit standard with you. It is your responsibility to complete all the exercises in the Assessor Guide. The facilitator will explain the requirements of each exercise with you. You will also be expected to sign a learner contract in your assessor guide. This contract explains responsibility and accountability by both parties.

On the document "Alignment to NQF", you will find information on which qualification this unit standard is linked to if you would like to build towards more credits against this qualification. Please contact our offices if you would like information with regards to career advising and mentoring services.

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Key to Icons

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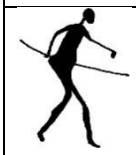	Personal Reflection
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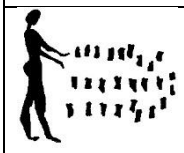
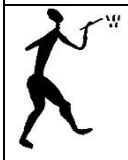
	Summative Exercise
	Activity

Alignment to NQF

Element of programme	
1. Name of programme	Manage a Feedlot
2. Purpose of the programme	Form part of the qualification to equip learners in Plant Production
3. Duration of the programme	10 days of facilitation; 500 notional hours
4. NQF level	4
5. NQF credits	50
6. Specific outcomes	See Unit Standard Guide
7. Assessment criteria	See Unit Standard Guide
8. Critical cross-field outcomes	See Unit Standard Guide
9. Learning assumed to be in place	See Unit Standard Guide
10. Essential embedded knowledge	See Unit Standard Guide
11. Range statement	See Unit Standard Guide
12. Recognition of Prior Learning (RPL)	RPL can be applied in two instances: Assessment of persons who wish to be accredited with the learning achievements Assessment of learners to establish their potential to enter onto the learning programme.
13. Learning Materials	Learner Guide, Assessor Guide with Model Answers, Facilitator Guide, Learner PoE Workbook
14. Links of the programme to registered unit standards, skills programmes, or qualifications	Registered qualification: Title: National Certificate: Plant Production ID: 48979 Credits: 163

Learning Unit 1: Procure Agricultural Input

Unit Standard	
116321	Procure and manage agricultural input
Specific Outcomes	
SO 1: Check, receive and store a range of agricultural inputs appropriately. SO 2: Check updated records and identifies shortcomings where applicable. SO 3: Order stock and process payment. SO 4: Schedule the re-ordering of agricultural inputs. SO 5: Issue various agricultural inputs from stores timely to prevent deterioration, spoilage and waste. SO 6: Enforce legislation regarding handling and storage of agricultural inputs. SO 7: Inspect and organise maintenance of equipment facilities and infrastructure.	
CCFO's	
Identifying	Working
Organise	Communicating
Demonstrating	Contributing

Introduction

Key concepts in stock control

It is important for any business to know how much and what type of stock they have on hand. **Stock** refers to all the goods a farmer has in storage. It includes all the agricultural inputs required for production of the crop. The aim of **stock control** is to balance the amount of inputs the farmer has in the store against the amount of the inputs used during the production cycle. The production cycle is different for different crops, and therefore the type and amount of stock as well as the period of storage will differ between crop types.

A manager will try to maximise the **stock turnover** while carrying the least amount of stock possible. Stock turnover usually refers to a retailer that sells the stock to an end user. However, stock turnover is an important concept in the farm situation as well. This is because most agricultural inputs have a limited shelf-life. Pesticides for example have a 2-year shelf live, after which they should not be used, unless an analysis has been performed to certify that the pesticide is still usable. The disposal of obsolete pesticides is extremely expensive, and therefore stock of pesticides should not be allowed to build up. The compounds should be used on the First in Fist out (FIFO) principal. This means that the first batch of a particular batch of pesticide that comes into the store must be used first. This principal applies not only to pesticides, but also to fertilisers, seeds and any other input that may be required. Efficient stock control, including **stock rotation** systems, means that old stock does not accumulate.

Stock requires control, because a shortage of stock may lead to a lack of pest control or fertilisation at critical periods. Overstocking of inputs may lead to stocks becoming obsolete, which may have serious implications on running costs of the operation. Effective stock control will minimise shrinkage by reducing errors, waste and theft. Efficient stock control reduces the risk of accidents and injury through good housekeeping, as well as reducing the costs of insurance, workers compensation payments and the time lost though injury. Farm stores will each have its own stock control systems and procedures that must be followed. It is important that all personnel that work on the farm know and understand these procedures.

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Key terms

Damaged stock: This reveres to stock that has been damaged, broken or soiled during delivery or while in the store.

Dispatching inputs: Implies the distribution of inputs to the relevant individuals for use at a specific time and on specific fields or orchards.

Electronic Data Interchange (EDI): Electronic stock recording system where a computer is linked to dispatch and receiving areas, which will automatically record and update stock levels.

First In First Out (FIFO): A stock rotation system, which requires the inputs that are bought first must be used first.

Incoming inputs: Those inputs, which have been ordered and are delivered to the store.

Lead-time: The period of time between when goods are ordered and when they are delivered to the store.

Minimum stock levels: A predetermined minimum number of stocked items which, when reached, will trigger ordering of new stocks.

Obsolete stocks: Old stock which is out of date (has expired).

Replenishment: The replacement of stock in the store that have been issued and used during the season.

Seasonality: A concept relating to the demand of inputs which is governed by the seasons. E.g. some growth regulators are applied very early in the season and are only required at this specific time. Post-harvest chemicals again are only required at harvest and may not require storage during the rest of the season.

Shelf life: The time a product will remain intact under normal storage conditions.

Shrinkage: The difference between the present value of the stock and the value that the stock should have.

Stock: All the inputs a farmer retailer holds in store.

Stock rotation: A stock control system that implies the selling of old stock before the fresh stock is sold.

Stocktaking: There are several types of stocktaking: Full stocktaking: where every item in a store is counted. Cyclical stocktaking: where only part of the stock is counted at any one time, but on

a regular scheduled basis. Spot-checks implies the counting of a specific group of stock where differences occur.

Receiving agricultural inputs in an agricultural storage facility

Ordering agricultural inputs and requirements

Most agricultural inputs can be viewed as consumables. Consumables are the inputs required during the season to ensure crop growth. Consumables include pesticides, fertilisers and seed. It also includes packaging materials where crops are processed or packed on the farm. Remember, components such as packing material will not be stored together with pesticides.

The resources that are used in farm production include chemicals; equipment (tools and implements), feed and seed are collectively called agricultural inputs. Most farm inputs are purchased from co-operative or specialised dealers. The volumes of inputs purchased are normally high and it has to be stored on the farm before being used. Equipment is normally expensive and requires storage when not in use to ensure they last for prolonged periods of time.

It is important that when inputs are received, they are correctly identified on the order and the invoice. The store man must be able to identify what is being received, so that the products are sorted in the correct storage areas. In some cases, the various inputs may be stored in separate stores, and here the segregation process must be followed correctly. It is important that the site-specific segregation procedures for the farm are followed to ensure that the inputs are placed in the relevant areas. In the case of most stocks kept in a farm's store, the quality criteria are very important, especially for agricultural inputs. The quality of packaging materials is also important, but will generally not lead to harvest reduction. In the case of inputs such as pesticides, fertilisers and seed, quality criteria must be set and adhered to. The criteria may differ between different crop types in the specific agri-business. There are however a number of generic principals that must be adhered to. The criteria below are not discussed in-depth, but it is important that site-specific criteria for receiving inputs are followed regarding the product's specifications.

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Shelf life

All pesticides and fertilisers and seed have a distinct expiry date. If the expiry date on pesticides is exceeded, the pesticide may not contain the correct amount of active ingredients. Lack of active ingredients will lead to a loss in pesticide efficacy. The solvents in the compound may also have evaporated during storage causing the formulation being over-concentrated. This will lead to too much active ingredients being applied in a mixture which can harm animals or a crop.

Open containers

No agricultural inputs should be used from containers that have been opened or partially used unless the usage is recorded. The reason is that the contents of these containers are unknown. If for example a granular herbicide has for some reason, been stored in a fertiliser bag, crops may be damaged or killed if such a product is used.

Unlabelled containers

The principals concerning open containers also apply to unlabelled containers. A container without a label is of unknown origin and the contents of an unknown product. Both unlabelled and opened containers must be disposed of correctly.

Product safety

All inputs will be labelled with information on the safety of the product. It is essential that these guidelines be followed. If the label does not state the product's safety and safe handling guidelines, a product safety data sheet must be obtained. Chemicals lacking safety information should not be placed in storage.

Product specifications

Agricultural inputs will be ordered according to specific specifications. It is therefore critical that the information on labels specifies the brand's name, its active ingredient and concentrations etc. The delivery should not be signed off if the order and delivery do not coincide regarding type, quality and quantity.

If you need information or assistance regarding agricultural inputs, use the following channels or contact the following institutions.

- Department of Agriculture

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- SA Institute for Agricultural Extension
- Agricultural Research Council (ARC)
- Your local Co-operative or Agrimark
- Agri SA
- The South African Pest Control Association (SAPCA)
- Suppliers of Agricultural Chemicals such as Aventis, Bayer, Agricol, UAP, Terrasson and many more.
- Sector and National Trade Magazines – such as Farmer's Weekly and Landbou Weekblad.
- Annual trade shows.

These institutions can help us with the information regarding differentiation between items as well as quantification of items. Only registered persons may recommend and supply certain inputs. Therefore, ensure that inputs are only purchased from registered and / or accredited distributors where required. This means that the organisations can help you identify the specific item you require, as well as the amount or volume you may need. When evaluating inputs, the main criteria that need to be focussed on are the specifications of the product, its legal standing price and its history. Only then should one look at the aspects such as delivery time, available stock and price.

This is especially important in the case of pesticides and fertilisers. Where these are evaluated it is important to establish whether the product in question is legally registered for the specific crop and purpose it is to be used. (The DoA specifies that the compound must be registered). The registration confirms that the product has been tested and proven to show efficacy, (this means the product actually works) and that it will conform to the label specifications. This is especially important where a pesticide is used. If the product contains more active ingredient than specified, the residues remaining will be higher than the label specification. If it is lower the product will not work as well as specified.

Substituting pesticides

There are a number of generic products of many inputs available in the market. The herbicide Roundup contains the active ingredient glyphosate. This active ingredient is also available in approximately 14 other generic formulations which mean that the costs of most of these

formulations are similar and the choice of compound is not likely to have a tremendous effect on the budget. This is however not the case for all pesticides. Many generic pesticides are much cheaper than the original compound.

One must keep in mind that a less costly product does not mean the product is inferior. In many cases the product is as good as the original compound. However, a generic product must be registered under Act 36 of 1947 of the DoA before it is to be used. Unregistered products may damage crops or may not show the efficacy, as one would expect. Always check if a product is registered before using it.

Substitution of recommended fertiliser

Recommended fertilisers and chemicals for foliar sprays, for example, can be substituted with an equivalent elemental base. Provided that:

- The chemistry of the replacement chemical and its reaction in the soil and on the leaf, will not create unwanted side-effects; and
- The recommended mass or volume is adjusted to compensate for variations in concentration of the active ingredient/s.

The person responsible for the formulation of the fertilisation program should be consulted before substitutions are made. Fertiliser manufacturers may also be able to assist in this regard.

The rate of application for the replacement fertiliser is calculated as follows:

- The rate of application for recommended product multiplied by the % active ingredient in recommended product, divided by the % active ingredient in replacement product.
- Rate of application for replacement product

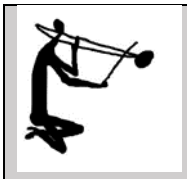
Example:

Fertiliser Substitution

Borate A, containing 16% B, can substitute Solubor®, containing 20% B. The application rate must be changed accordingly, i.e. if 150g per 100l was recommended, 187.5g Borate A per 100 litres water should be applied, calculated as follows: 150x20/16 = 187.5

LAN (28% N) can be substituted by ammonium sulphate (21% N) but keep in mind that the acidification of ammonium sulphate is more than twice that of LAN. The calculation in this case is: 500g LAN x 28/21=667g ammonium sulphate

Double super phosphate (20% P) can be substituted by twice as much single super phosphate (10,5% P)



Individual Formative 1:

Receiving and processing incoming stock

When agricultural inputs are delivered to a farm store, there are several tasks that should be completed. As the delivery arrives, all cartons (boxes), bags, pallets and other items should be placed on the floor and checked. All boxes should be checked off against the invoice following to policy, procedures and guidelines of the specific site, industry or farm.

In most cases the policy is likely to include:

- Count the boxes to check if the correct number has been delivered.
- Separate unopened boxes i.e., those that are sealed and labelled containing only one type and kind of input (e.g., a box containing 25, one litre bottles of Roundup herbicide), from opened, mixed boxes (i.e., those containing different items in one box.
- Sealed boxes can be counted unopened. Mixed cartons should be opened, and the contents checked. If time allows check the contents of whole boxes as well.
- Open damp or damaged boxes and check the contents for damages and breakages. If cartons have been tampered with, their contents should also be checked. Any damaged

or tempered with contents must be returned to the supplier following the site procedures.

- Check the goods for quality and expiry dates. If expiry dates have been exceeded return the goods to the supplier, following the site procedures.
- Any discrepancies should be recorded on the invoice following site procedures.
- It is a good policy to check the invoice against the order at first and then check the contents.

All these checks should be done before the delivery note or invoice is signed off. When checking a delivery in upon boxes, employees should not allow themselves to be rushed or hurried by the delivery driver.

All deliveries must be checked thoroughly. The only way to ensure that the correct quantity and undamaged goods are received is to check every box and container within the box or pallet. The following points should guide towards ensuring deliveries are properly checked:

- When receiving multiple deliveries at the same time, each delivery must be checked separately and in an orderly manner.
- All stock should be accurately recorded and checked against all original order documents.
- All shortages, excess, missing and damaged goods should be noted on the delivery note as well as original order documents, following site procedures.
- All differences must be reported to the supervisors or store manager according to site procedures.

Storage and segregation

The various different inputs should be separated within a store. Depending on the actual commodity being stored, the systems used in different stores may differ. In the case of pesticides, it is useful to separate the herbicides, fungicide and insecticides by placing them in different designated areas within the store. This will help to ensure that an herbicide is not accidentally issued instead of an insecticide. When stacking pesticides, the powered and granular formulation should always be stored away from the liquid formulations. Store the dry formulations on an upper shelf and liquids below. This ensures that should a liquid container

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leak, it will not contaminate the dry products. When stacking containers, there are a number of rules to be followed. These rules are set out in the table below.

Container type	Number of layers allowed on a base plate	Number of packages allowed on a pallet
Steel drums = 200 l	1	3-4
Steel drums < 200 l	2	3-4
Fibre drums = 200 l	1	3
Fibre drums < 200 l	2	3
Plastics drums = 200 l	1	2
Plastics drums, 200 l	2	2
Paper bags	4-5	3
Plastics bags	4-5	3
Fibre case containing tins	4-6	3-4
Fibre case containing soft packages	4-6	2
Wooden cases	2-4	3-4

As a general rule, systems of storage should be flexible and adaptable.

Stacking positions and heights

Stock should be arranged to use the oldest first ("first in - first out" principle) and to prevent obsolete stock from accumulating. Containers should be arranged to minimise handling and thus avoid mechanical damage giving rise to leaks. Floor spaces should be neat, with marked gullies (1-m wide) between shelves or stacks that permit easy inspection and allow free airflow. This also enables immediate clean-up in the event of any leakage or spills which can be easily seen. When using shelves for smaller packs, always place dry formulations on the upper shelves, and the liquids below. This will ensure that leaking liquids will not contaminate the powders. Climbing on pesticide containers to reach other containers should not be permitted as damaged or corroded metal drums can easily give way under a person's weight. Containers should not be placed directly on the floor but rather onto dunnage (construction of bricks and timber allowing for a gap between the timber and floor). This will allow the identification of leaking or corroding containers. Dry formulations should be kept in boxes to avoid clotting. Where the chemicals are packed in glass, these should also be kept in boxes to prevent breakages. When inputs are packed on pallets, the total pallet height should not exceed 107 cm.

Pesticide ordering and shelf-life

The shelf-life and rate of use must be taken into account when ordering inputs. Do not order more than one year's requirement. The date of manufacture and shelf-life should be visible on

the outside of the container. If a larger quantity is ordered than can be used during the period of shelf-life, outdated stocks will accumulate and present disposal problems.

Stock inspection and shelf-life

Stocks in a store should be inspected regularly for signs of deterioration, such as clotting of powders, sedimentation of liquids and discoloration through oxidation. Shelf-life declines rapidly after containers have been opened and left partially empty. Stock turnover must be organised to ensure that the contents of a container are used as quickly as possible once the container has been opened. Unsealed containers of dusts and wettable powders should not be kept for more than one year.

Containers are not only subject to deterioration caused by external factors (climatic, biological and mechanical), but can also be corroded internally through the action of the pesticides they contain. Emulsifying concentrate formulations are particularly likely to affect weak spots, especially along seams or where there are imperfections on the internal coating of the container. Some pesticides increase in acidity during storage, and this makes them more likely to corrode containers from within. Discoloration of pesticides is a sign of corrosion and should be looked for during stock inspections.

	**Individual Activity 2**:

Manage and control stock levels and stock records

Managing stocks and stock records

It is important that a record is kept of the stocks that are received. In most cases the stock receipt systems and stock dispatch systems are synchronised. This will help in the decision-making process of when and what should be ordered. It also allows for less reliance on stocktaking and to ensure stock levels are kept up to date. Records are needed to run an operation productively.

What follows are guidelines on what a record keeping system should take into account:

- Minimum stock levels
- Maximum stock levels. x Standard orders and regular orders.
- Order level: - the level of stock at which a standard order must be placed before the minimum stock level is reached.
- What do you want the system to do
  - Determine the value of stock at any time
  - Ensure sufficient stock at all times (confirm with the sections to achieve this)
  - Compare actual stock with stock records to detect theft or out-of- date stock. (Discuss theft and abuse of stock).
- Stock analysis: - have a categorical list of all stock in the store which can be controlled by a computer data system and a backup manual system e.g.
  - Dangerous materials
  - Seed stock
  - Animal feed
  - Rations for staff
  - Mechanical
  - Maintenance stock

A supervisor or manager of an agricultural inputs store is responsible to ensure that inputs required on the farm are stocked correctly. It is further his/her responsibility to ensure that all the stock is kept at the levels required by the farm. To help the supervisor/manager determine these levels, stocktaking is done regularly.

Stocktaking is the physical counting of all the stock that is in a store at a particular time. These figures generated are then compared to the stock records kept over a certain period. Conducting stocktaking allows farm personnel to accurately record what is actually in their stores.

There are three main ways that stocktaking is conducted:

- A full stocktaking where every item in the store is counted. Full stocktaking are generally undertaken yearly or six monthly.
- A cyclical stocktaking, where only part of the stock is counted at any one time, but these counts are carried out on a regular, scheduled basis. In a store stocktaking of pesticides

may be taken weekly during the spraying season because of the need of various compounds during the period.

- Spot checks, where, in a particular area of the store, stock is checked for discrepancies.

Stocktaking will only be beneficial if it is carried out accurately. Stocktaking can be carried out using stock sheets or tally sheets (where stock numbers are recorded manually), or by using electronic recording equipment. These are generally portable electronic hand-held units that can record barcodes, prices and quantities.

A store supervisor or manager does not necessarily take part in stocktaking. It is the task of the manager to design and implement a stocktaking schedule. The schedule can be made up of all three types of events, but these will not be implemented simultaneously. The manager will determine the number and time of full stocktaking during a season. It may be sufficient to do a full stocktaking once during the season, whereas cyclical stocktaking may be required on a regular basis for fertilisers and pesticides during the active growing season, or periods where pest management is required. Different farms, sites and industries will have different policies and requirements concerning stocktaking. It is important that the manager implements these policies, and ensures all employees follow them.

Once stocktaking has been conducted, the manager will compare these with the actual stock records. These may be paper or electronic copies, depending on the system used on the farm.

Any discrepancies in the stock should be recorded and reported to the relevant person. Totals should be signed and then recorded so that accurate crosschecking of the actual stock counts against the recorded stock records can be conducted. If the actual stock figures do not coincide with the record system (or book stock) then this may indicate to inventory control or documenting problems.

Problems that may arise include:

- Stock counting was incorrectly.
- Inaccurate stock recording at delivery, e.g., invoice errors, short deliveries, mistakes in recording, damaged stock, unordered stock and returns.
- Calculating mistakes when reconciling the recorded stock records.

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- Mistakes in recording discounts, markdowns or waste.
- Theft by customers, staff or vendors.

If problems like these are identified, it is the responsibility of the stock controller or store manager to identify the source of the problem and implement systems that will ensure these do not re-occur. Once final stock levels for various inputs have been determined, these figures must be reported to the section supervisors. These could be the farm manager and supervisors responsible for pest management, the fertiliser programme or dairy. These people again are responsible to the management structure of the farm. It is imperative that the management structure is clear to all parties involved. The stock levels must be reported to those responsible for the use of these stocks, so that they can determine whether more stock may be required.

Group Activity 3

Order stock and process payment

Order and Reorder stock and process payment

Minimum stock levels

A store that is constantly out of stock will cause the farming enterprise a loss in profit. This is because the inputs will not be available when they are required. The opposite is also true. If a store has too much stock and cannot use it quickly enough, the old stock builds up and will eventually become obsolete and must be disposed of.

Stores need to have sufficient stock to maintain requirements, but not so much that there is a stock build up. The best way of ensuring an appropriate level of stock is to use an efficient stock ordering and maintenance system. By planning stock orders, the problems of too much or too little stock can be minimised. Factors such as what, how much and when to order stock must be considered so that it arrives in time to fulfil the need.

The first step in the planning process is to identify the store's minimum stock levels. The minimum stock level of any item is the lowest quantity of that stock that should be kept at all

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times. When the number of items in a particular line reaches a set minimum level then more of that stock is ordered. This process means that the shelves should never empty and there should never be any excess stock or that the store should not run out of stock. In the case of a farm store the minimum levels of a particular input may vary with the growing season.

For example, if a fertiliser is applied to a crop three times during the season and the volumes are the same, the critical time and the minimum volume required would be that for a single application. The critical time during the season for the stock to be kept would be 2 – 3 weeks prior to the planned application date, as conditions may change requiring an earlier application.

Ordering stock

A factor to be considered in the process of ordering stock is when to order stock so that it arrives in time. The time it takes from when an order is placed with a supplier to when it arrives in the store is called the lead-time. The lead-time can be anything from overnight to several months, depending on the type of stock, the supplier and minimum order requirements. Knowing the lead-time enables the timing of orders to be more efficient. Once the need for ordering more stock has been established, there are several ways of completing the order.

Manual ordering involves counting the stock to establish minimum stock levels, recording the stock levels in a stock book or on stock cards, calculating the quantity to be ordered and then placing the order with the supplier. Handheld electronic equipment scans the barcodes, and the stock levels are entered manually. This information can be downloaded or entered into a computer from which orders are generated. The number of people ordering stock should be kept to a minimum. This reduces the risk of over/under ordering, reduces mistakes and eases the following up of undelivered orders more efficient. Any undelivered stock should be entered into the stock recording system as soon as possible, and be followed up immediately by the person who ordered the stock.

Stock may not be delivered for a number of reasons, for example it may be:

- No longer available
- Out of season

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- Placed on back-order
- Undeliverable because of transport problems x Subject to quotas
- Stolen

Substituting stock items

In many cases the stocks order can be substituted with other comparable inputs. It is essential that the quality criteria be adhered to when substituting. This aspect is discussed in Session 1.1. Always determine the price of the item to be substituted as the price may influence the farm budget for the item.

	**Group Activity 4**

Issue various agricultural inputs from stores timely to prevent deterioration, spoilage and waste

Dispatching stock

Agricultural inputs, as you now by know, are kept as stock in a store. When these inputs (pesticides for example) are needed for spraying a crop, somebody must withdraw it from the store before it can be dispatched to the spraying team. In conquering this problem some form of control must be in place. (It must be stressed that each farm is likely to have its own procedures and systems intact). Now, according to the system, everybody knows who is doing what and how. There is a system in place that will track the requisition, dispatch, use and return of unused items to the store as different forms will be completed at different stages.

A system is likely to consist of a requisition form, completed, approved and taken to the store.

- The requisition will request:
  - Identity of the person requesting the input
  - The volume of the input required

  - The reason why it is required
  - The field or orchard that it is to be used on
  - The size of the field and intended application rates
  - Possible approval from the responsible person (farm manager of field (block) manager).
- The input required, as well as the volume required is noted in a log.
- The person requesting the input, verifies that it has been collected.
- The person makes use of the input.
- The remaining input is returned to the store.
- The remaining (unused) input is recorded in the log system.
- A note is made of containers that have been opened and the containers duly labelled and sealed.
- The empty containers, which had been used, are also returned to the store
- The empty containers are disposed of in accordance with national legislation.

Stock rotation Rotating stock implies the moving of old stock to the front of a shelf to make way for fresh stock, which will now be stacked at the back of the shelf. Using this system means that the old stock is used firstly preventing the build-up of out-of-date stock. This principle is called First in First Out (FIFO).

When rotating goods that may expire, the expiry dates must be monitored to ensure that outdated stock is not placed in with the current stock. When collecting stock from the storage area, the oldest stock should always be issued. This ensures that there is a constant turnover of stock and reduces waste resulting from an accumulation of outdated items.

Excess stock should be placed in the storage area, or it should be disposed of correctly. The store should have a disposal policy, which takes into account the relevant legislation and industry codes of practice, particularly when dealing with dangerous goods such as chemicals. Stock should be regularly rotated, and the storage area should always be kept clean and tidy. This is particularly important for items such as seed as it reduces the incidence of mice and other vermin. Vermin and insect control should always be carried out to comply with the legal requirements of the relevant Occupational Health and Safety (OH&S) and Health legislation, industry and site-specific policies and national legislation on agricultural inputs. Safe lifting and

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carrying techniques must be used at all times and should be in line with the stores OHS policies and legislative requirements.

	**Group Activity 5**

Enforce legislation regarding handling and storage of agricultural inputs

Introduction

The concepts discussed may appear familiar. This is because it is the same basic information that is supplied in the Level 3 Documentation. The information and legislation does not change, what is important is that it is the responsibility of the supervisor or manager to ensure compliance to these. Management and must know the content of these regulations before compiling and conducting instructions to staff. It is the responsibility of supervisors to ensure that the requirements of all acts can be followed on the farm by providing relevant training, relevant equipment, and adequate infrastructure and correct safety equipment. Where a supervisor finds a problem regarding any of these issues, it must be reported in writing. Farms should have procedures in place to ensure that these documents can be officially documented and records kept. Once a formal complaint has been logged, ensure that you keep a copy of the documentation as proof that you have made such a complaint. Develop a schedule for inspections in stores to check if the goods are correctly stored. Develop a schedule to test the staff on the legislation that applies to them in order to ensure that they comply.

The majority of inputs used on a farm are chemicals. These chemicals include pesticides, fertilisers, cleaning agents and disinfectants. In some cases, it could also include acids and other corrosives. This session concentrates on the chemical inputs used on farm. The most important law that need to be adhered to are the Occupational health and Safety Act, the Agricultural Inputs Act and the regulations on transportation of hazardous goods.

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	**Group Activity 6**

Toxicity of chemicals used on farm

The toxicity of a chemical is identified as the amount of the compound that a person has to ingest to induce a negative effect. In the worst-case scenario, the effect would be death. The word hazard refers to the ability of a pesticide to cause harm. The main hazards associated with pesticides are the toxicity and flammability. The word risk refers to the possibility that a person handling the product if used according to the manufacturers' directions will encounter the hazard accidentally. The directions referred to includes storage, transport and use. The risk is due to either a single or repeated exposure to the pesticide over a short period. Safety refers to the degree of freedom from risk. Safety precautions on labels are intended to reduce risks to acceptable levels

There are three key words normally used to identify the toxic properties of a chemical. These are:

- **CAUTION** refers to chemicals with a toxicity of approximately 30 - 500 g that could be fatal or harmful if taken in by an average man of 80 kg.
- **WARNING** refers to chemicals that if a 5 to 30 g is taken in, it would cause death to an adult man.
- **DANGER** refers to a chemical that 5 g and less is taken in it could lead to death in an average adult (80 kg) man.

This information should make one consider what the possible effect of chemicals could be on your health. These warnings posted on labels only take the acute effects into account, i.e. where death is induced. It does not consider the potential long effects such as cancer or reproductive malformations. Some common ingredients of commercial household products and their hazards are given below (Table 5.1)

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Table 5.1 Potential hazard of some common chemicals

Chemical	Potential Health Effects
Ammonia	Fatal when swallowed
Ammonium Hydroxide	Corrosive and irritant
Bleach	Fatal if ingested
Chlorine, such as used in disinfectants	Number one cause of poisonings in children
Formaldehyde	Highly toxic; known carcinogen
Hydrochloric acid	Corrosive, eye and skin irritant
Hydrochloric bleach	Eye, skin and respiratory tract irritant
Nitrobenzene	Causes skin discoloration, shallow breathing, vomiting, and death
Petroleum Distillates such as paraffin, turpentine etc.	Highly flammable; suspected carcinogen
Phenol	Extremely dangerous; suspected carcinogen; fatal if taken internally
Propylene Glycol (anti-freeze)	Affects the immune system
Sodium hypochlorite	Potentially fatal
Trichloroethane	Damages liver and kidneys

It is important that one is prepared for the use of any chemical, and that the proper safety and protective wear is used. Never eat, drink or smoke whilst using chemicals or cleaning agents. Always treat cleaning chemicals as if they are pesticides. Locate, identify, and label poisonous products within your home and work environment clearly so that everybody could understand that these are dangerous chemicals.

Pesticide toxicity

The registration of a pesticide places a pesticide in one of four hazard groups. The Hazard groups are based on their toxicity to humans, as tested on the formulated product. The hazard groups are:

GROUP 1 A	Very toxic, carries a red colour band on the label
GROUP 1 B	Toxic, carries a red colour band on the label
GROUP 2	Harmful, carries a yellow band on the label
GROUP 3	Caution, carries a blue band on the label
GROUP 4	Acute hazards unlikely during normal use, carries a green band on the label

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The safety precautions printed on pesticide labels, are concerned with the "toxicity" hazard to people and the environment, and how these hazards can be reduced.

An indicator of hazard is the acute toxicity of a pesticide or the capacity of a compound to produce injury or death due to a single dose. This dose is expressed as an Acute LD50 value. The acute LD50 is the dose of a compound, which will kill 50% of the experimental group of animals and is expressed mg pesticide per kilogram body mass. Three methods of administering the chemical are generally used, oral (by mouth) dermal (applied to the skin) and inhalation (through the nose). When comparing LD50 values, they should be interpreted such that the lower the LD50 the more toxic the compound is. The grouping of pesticides according to acute toxicity is given in Table 4.2.

Table 5.2. Grouping of pesticides according to acute toxicity

Hazard Group	**LD_{50} for rats (mg/kg body mass)**			
	Oral		**Dermal**	
	Solid	**Liquid**	**Solid**	**Liquid**
Group 1a Very toxic	< 5	< 20	< 10	< 40
Group 1B Toxic	5 - 50	20 – 200	10 - 100	40 – 400
Group 2 Harmful	50 – 500	200 – 2000	100 – 1000	400 – 4000
Group 3 Caution	> 500	> 2000	> 1000	> 4000
Group 4 Acute hazard unlikely during normal use	> 2000	> 3000	-	-

- Strychnine - Group I
- Petrol - Group II
- Aspirin - Group III
- Table salt - Group IV

The LD50 values for pesticides used in RSA can be found in the most recent edition of the "Guide to Use of Herbicides ", “A Guide to the Control of Plant Pests” and “A Guide to the Control of Plant Diseases” available from the Directorate of Agricultural Input, National Department of Agriculture. Detailed information on pesticide safety and responsible use is set out the “Responsible use Guide” of the Crop protection and Animal Health Association.

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Transportation and packaging of hazardous chemicals in the past only large volume containers being transported by road (in excess of 5001) containing hazardous chemicals were subject to the act governing hazardous chemical transport. The law has changed to include all hazardous chemicals, and all tankers carrying hazardous chemicals. The act is now relevant to all classified goods transported in volumes larger that the exempt quantities, all persons and vehicles transporting such chemicals, the operator, the consignor and the consignee. These regulations apply when loading and transporting these chemicals.

All individuals involved in the process of transporting dangerous goods must comply with the regulations of the act. The act states that the consignor must ensure that the goods transported in a mixed load (multi-load) must be compatible. All hazardous chemicals have a United Nations number, which must be displayed on the outside of each container.

All loads of hazardous goods must be accompanied by a Transport Emergency Card (TREMCARD), a dangerous goods declaration; the driver should be in possession of a valid Professional driving permit as well as a clear route plan. Dangerous goods have been classified into nine classes.

These classes are given in the table below.

Class 1	Explosives
Class 2.1 Class 2.2 Class 2.3	Flammable gases Non-flammable, non-toxic gases Toxic gases
Class 3	Flammable liquids
Class 4.1 Class 4.2 Class 4.3	Flammable solids Substances liable to spontaneous combustion Substances that, on contact with water, emit Flammable gases
Class 5.1 Class 5.2	Oxidising substances Organic peroxides
Class 6.1 Class 6.2	Toxic substances Infectious substances
Class 7	Radioactive materials
Class 8	Corrosives
Class 9	Miscellaneous substances and goods

Danger group I	Substances and goods that present a very high risk severe risk
Danger group II	Substances and goods that present a serious risk
Danger group III	Substances and goods that present a relatively low risk
Danger group IV	Substances and goods that present a very low risk

Each container of classified goods that is to be transported must be labelled with the correct trade names and active ingredients and also the following information:

- United Nations Number - a four-digit substance identification number.
- Technical name and description - technical name or generic allocation for the substance.
- Class: - the goods or substance's class code for compound.
- Danger group / Packing group: - the allocation of the goods or substance to a danger or packing group.
- Subsidiary risk: - indication of the goods or substance having more than one hazard. x Packaging method.
- Special provisions.

Legal requirements to be adhered to prior to loading a vehicle

Before a vehicle is loaded with dangerous goods, the act requires that a competent person check the following:

- The vehicle is of the correct type and capacity.
- The vehicle is properly parked.
- The operation takes place in a workplace where all the necessary safety measures associated with the substance are observed.
- There is no spillage from previous contents on the vehicle cargo area.
- No sharp protrusions or faulty fittings are present.
- The vehicle is free of goods or substances that could contaminate the load or create a safety hazard. x Multi loads (or mixed loads) are compatible.
- The goods are stacked and labelled correctly.

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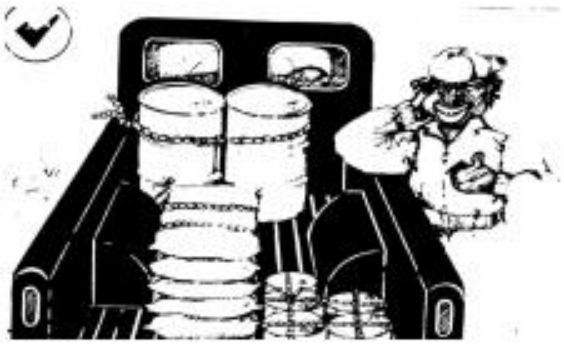
Legal requirements to be adhered to after loading a vehicle

Once a vehicle has been loaded with dangerous goods the act requires that a competent person checked the following:

- The load is secured and washed free of spillage.
- The permissible vehicle and axle mass-loads for the loaded vehicle have not been exceeded.
- Cargo is properly secured and undamaged.
- The correct type and number of warning signs are displayed on the vehicle and the driver carries the tram card/s, dangerous goods declaration, the route plan and any other instructions.

Before the vehicle is allowed to leave the driver should do the following checks.

- Ensure that all the containers are packed, tied, and loaded in such a way that they will not be damaged or leak.
- Check that all containers are sealed and transported upright.
- Ensure that people are not transported with chemicals in the same cab.
- Ensure that no food or drinks are placed in the same compartment as the chemicals.



The principles of the Occupational Health and Safety Act with regards to the storage of agro-chemicals and fertilisers

Safety

- Keep agrochemicals locked away from children and untrained workers or those that cannot read.
- Lock chemicals safely away in a separate store to prevent cross-contamination of food, feed, seed and fertiliser by means of spillage or vapours from volatile chemicals.
- In the case of fire or floods these materials will be confined to one area.

Read the label carefully

- Make sure you do not get poisoned.
- Wash the applicator after you have used it.
- Keep away from the spray drift or dust cloud.
- Do not smoke, eat or drink while applying the pesticide.
- Take a bath when you have finished and put on clean clothes.
- Wash contaminated clothing.

When working with a pesticide you should wear:

- Rubber gloves
- Rubber boots
- A face-shield
- An apron

Do not harm the environment

- Apply pesticides only when it is absolutely necessary.
- Keep to the dosage prescribed.
- Apply pesticides only on windless days.
- Choose pesticides that work quickly or that are safe to wildlife.
- Do not contaminate water either by drift or by washing application equipment.
- Use only pesticides that are prescribed for your particular problem.

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How to store and transport pesticides.

- Always pack or load pesticides in such a manner that the containers will not be damaged or leak.
- Keep the container in a cool place, away from direct sunlight and fires.
- Store pesticides away from food and feed.
- Do not transfer pesticides to containers which normally hold food or liquids, for example soft drink bottles.

Application equipment

- Always use equipment that is in good working condition.
- Service your equipment regularly and fix leaks immediately.
- Clean the equipment properly after use, and do not leave pesticides in the applicator overnight.
- After you have cleaned the equipment, do not empty the washing water into rivers, dams or onto grazing.
- Application equipment must be calibrated properly.

In case of spills, have on hand a:

- Broom.

- Spade.
- Supply of dry fine sand.

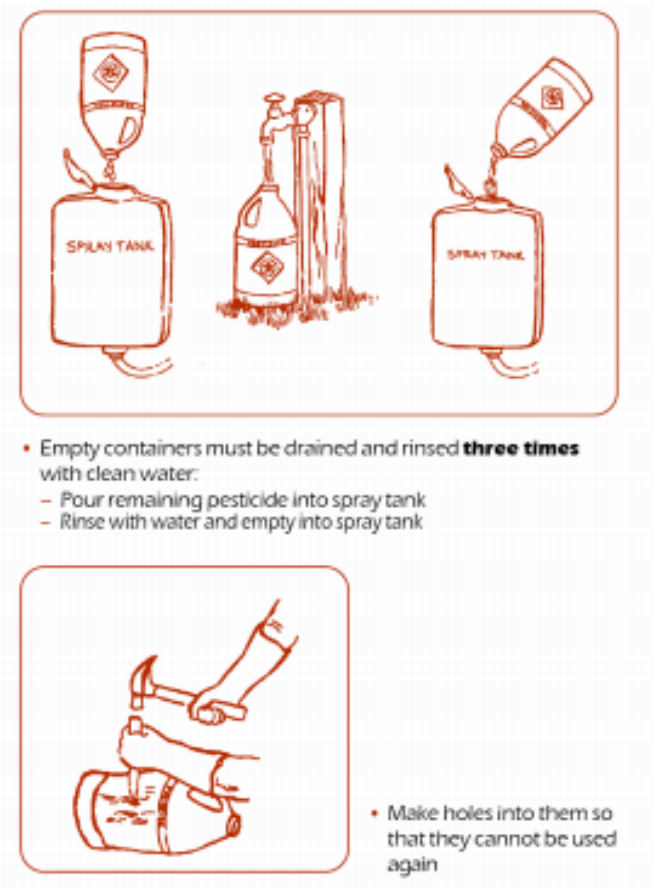
In case of expired or contaminated material, have on hand a:

- Large open-ended containers (1/3 of a 200-litre drum) for disposal of contaminated material and into which leaking containers can be placed.

Protective equipment must be available and used. Protective clothing includes:

- Overalls.
- Rubber gloves.
- Face shields.
- Goggles.
- Boots.

Disposing of Agro-chemical containers in a safe way



- Ensure the container is empty.
- Rinse the container three (3) times with clean water.
- Place rinsing water into the spraying tank and spray out onto the fields.
- Puncture the container and bury it in a specified area.
- Where a collection service is available for the empty containers make use of them.

- Do not dump containers in any place
- Bury them in a pit in the ground far from homes and animal pens
- The pit must be on ground that is relatively high and flat. The soil should not be too sandy

- The pit must be at least 50 m from any water source (river, dam, spring, borehole, etc).
- Line the pit with a 3 to 5 cm thick layer of lime.
- Put flattened containers and other farm waste in the pit in layers of not more than 10 to 15 cm deep.
- Cover the pit between deposits to prevent the contents from getting wet when it rains.
- When the pit is full (50 cm from the top), fill it with compacting soil. A final mound topping will ensure rainwater to run off.
- Erect a signpost in the area to indicate it as a disposal site.

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Protecting users of chemicals against poisoning

Exposure prevention

- Avoid exposure to all chemicals. Never allow any chemicals to come in contact with unprotected skin.
- Always wear protective clothing such as coats, gowns, aprons, gloves, and eyewear or face shields.
- Prevent the inhalation of volatile solvents and oil vapours when working in chemical fume hoods or containment devices or areas.
- Ensure that all visitors also wear eye protection and other appropriate personal protection equipment (PPE).
- Access to the chemical storage facilities must be restricted so that only authorised personnel may enter.
- Signs identifying hazardous chemicals are in use must be put up wherever required.
- Never eat, drink, smoke, handle contact lenses, apply cosmetics, or handle foodstuffs while working with chemicals.
- Never measure off a chemical by means of a siphon pipe.
- Always wear a respirator while using chemicals such as formulated products and diluted compounds.
- Ensure you wear specialised gloves and protective clothing if you work with acids.
- Limit the volume of chemicals (posing special hazards or risks) to the minimum quantities required.
- Keep flammables in a flammable storage cabinet.
- Never leave chemicals on the floor where you are working. x Keep a chemical inventory.
- Outdated and obsolete chemicals must be disposed of following a chemical waste disposal program.
- Ensure that you know how to handle spill control kits.
- Clean spills promptly and decontaminate the areas.
- Always place chemical wastes in appropriate and properly labelled containers for disposal.

All chemicals must be considered as potentially poisonous and handled accordingly. The minimum requirements for safe handling of the chemicals are usually stipulated on the label.

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In the case of most chemicals, it is sufficient to follow a few basic rules as summarised below:

- Always wear rubber gloves when pouring or measuring a concentrate before dilution. Ensure that it is done in such a manner that any fumes or dust will drift away from the applicator.
- Immediately wash off any spillage on the body with soap and plenty of water.
- Wear overalls or other old clothing that will cover most of the body.
- Wash clothes regularly, especially when a pesticide is applied over an extended period of time. Wear a fresh set every new day of application.
- Always keep out of the spray drift or dust cloud during application.
- Never smoke, eat or drink during application. At least, wash the hands and face before doing so during a break.
- Take a bath after completing the application and change into clean clothes. Never continue with another job while still wearing clothes contaminated by a pesticide.
- In the case of highly poisonous pesticides the users must take additional precautions. Special protective clothing in good repair, rubber gloves and boots, headgear, goggles and mask or respirator must be worn. The eyes and respiratory tract must be adequately protected.
- It is a good measure to wear a respirator during the use of any chemical. Ensure the respirator is fitted with a suitable cartridge.

Protective clothing

- Eye protection – There are a number of different types of protective eyewear available. They range from standard clear lenses to UV protective lenses. If you wear eyeglasses anyway, you should wear special protective eyewear made to fit around you glasses.

There are 6 main classes of protective eyewear.

- Safety Spectacles with side-shields.
- Goggles with a rigid body and a cushioned fit.
- Goggles with a flexible fit and regular ventilation window.
- Face Shield with plastic window.
- Goggles with a flexible fit and hooded ventilation.
- Chipping Goggles, the eyecup type.

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The table below indicates which types of eyewear should be used under different

HAZARD	EYEWEAR
IMPACT from flying objects, fragments, particles	1,2,3,4,5,6
HEAT and hot sparks	1,2,3,4,5,6
HEAT only high temperature	5
CHEMICAL splash	3,4,5
CHEMICAL mists and fog	4
DUSTS	3,4,6

Chemical Splash wear are required when using:

- Concentrated acids or bases.
- Corrosive gases.
- Potentially explosive or water reactive chemicals.
- Acute toxic chemicals (liquid or powder).
- 25 ml or more of hazardous liquid chemicals.

- Gloves - The correct gloves should be worn depending on the type of chemical. Glove should be selected based on the chemical resistance of the material that it is manufactured from. The table below indicates the chemical resistance of different materials.

MATERIAL	CHEMICAL RESISTANCE
Natural Rubber	acids, alkalis, salts, ketones
Neoprene	chlorinated solvents, alcohol, alkalis, petroleum products
Nitrile (generally better than natural rubber and neoprene)	chlorinated solvents, alcohol, alkalis, petroleum products
Butyl Rubber (best for gasses)	acids, ketones, esters
Viton (best for solvents)	solvents, PCB, aniline
Polyvinyl Chloride	acids, alkalis, fats, alcohols

- Clothing – The purpose of protective clothing is to prevent contamination of the skin and to prevent contaminants from leaving the working area. Coats and aprons should be worn for light protection, as these will not cover the whole body. Specialised

- Respiratory protection – Respiratory protection is essential when mixing, diluting, or applying pesticides or hazardous disinfectants. Remember a facemask is not a respiratory protection. Facemasks only avoid dusts to enter the respiratory tracts. If you work with toxic and hazardous chemicals you should wear a respirator fitted with a good cartridge. In general, the best cartridge to fit is the agricultural grade cartridge.

Handling chemical spills

Should a chemical spill occur the following must be taken into account?

- Ensure that spills are cleaned up immediately.
- Ensure that emergency washing facilities, such as showers and eyewash stations are available close to the area where disinfectants are regularly used.
- Consult the Material Safety Data Sheets (MSDS) for the appropriate method of dealing with specific spillages. This could include the use of spill trays or absorbent materials. By law all hazardous chemicals must be transported accompanied by a MSDS which is supplied by the manufacturers. The MSDS contains all the toxicity information regarding a compound and how to handle spills. The buyers should insist on a copy of the MSDS being delivered with the chemical.
- Consider environmental pollution during a spill. Prevent the run-off of chemicals into drains, rivers, etc.

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Chemical storage

The storage of chemical should be handled as one would handle pesticides. A system must be available where chemicals are stored in designated areas. The use of each must be recorded so that the volumes used can be traced.

Always ensure that incompatible chemicals are stored separately (see guidelines below).

- Store chlorine-based products separately from acids, oxidising agents and fuel oil.
- Hypochlorite must be stored away from amines.
- Per acetic acids should be kept away from acids or alkalis as they form explosive mixtures.
- Disinfectants should be stored away from fuse boxes, open flames and heat sources.
- Bulk cleaning agents should be kept in clean, dry, well-ventilated and secure places.
- Flammable products (e.g., paraffin or mentholated spirits) should be stored separately.
- Store pesticides separately.
- Always keep an updated log of the contents and use of chemicals in a store.
- Always store chemicals in their original containers with the labels attached. Also label spray bottles clearly and correctly. Never pour chemicals into other containers such as soft drink bottles.
- Never put corrosive chemicals (acids) into spray bottles. x Discard unlabelled chemical containers immediately.
- If the content of a container is unknown, discard it correctly according to the disposal protocols.

Pesticides should always be stored under secure, dry and dark conditions. Pesticides must be stacked separate from other inputs and clearly labelled. Pesticides must never be decanted into other containers.

Ideally mixing should take place near a storeroom with suitable facilities, such as good ventilation, water supply, suitable containers, sand and or sawdust to clean up spills and a disposal area away from a watercourse. Workers should always wear two-piece long sleeve cotton working clothes, boots, gloves and masks during mixing and spraying. Empty containers

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must either be recycled or punctured and buried and must never be used for any other purpose, especially for transport of food or water.

Never eat, drink or smoke when mixing or applying pesticides. All workers must be trained so that they are not exposed to unnecessary risks.

Pesticide registration

All pesticides and fertilisers must be registered under the regulations of Act 36 of 1947, which is the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, governed by the National Department of Agriculture. This process must be undergone before a pesticide is made commercially available. The registration process involves submitting data on the composition, toxicology, pharmacology, efficacy and phytotoxic to the Registrar of Act 36. Trials in which data is generated must be carried out according to guidelines set out by the office of the Registrar. The results must show that the pesticide does control the pest against which it is aimed under a range of environmental conditions before registration is granted. Also, the results should show that the compound would not adversely affect the health of operators and environment.

The registration process has specific requirements for information that should appear on the label. The label is viewed as a legal document and must show:

- The method of application
- The recommended dosage
- The application volume per hectare
- The precautions to be taken to avoid health effects, during mixing and spraying
- The measures to be taken to avoid environmental contamination.

The importance of the label on a pesticide container and the information it contains cannot be overemphasized. The label must be strictly adhered to, so it should be read before the container is opened. It is technically an offence to use or recommend the use of an agricultural remedy for any purpose or in any manner other than that specified on the label on the container.

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No pesticide may be used in any other way that contradicts the Label. This means that the pesticide must be registered for every crop it is to be used on and for a specified target at a specified application rate. Any use of a pesticide not in accordance with the label is a criminal offence and could lead to criminal charges being laid against you. The outcome of this could be a fine or jail sentence.

A pesticide label has a centre panel with two side panels to cater for multilingual labels. Each group of pesticides is identified by a coloured square in the top righthand corner of the centre panel next to the product's name. A colour band at the bottom of the centre panel indicates the hazard group. The label also contains one or more pictograms placed within the coloured band. These are used to communicate important safety information to the user. Three kinds of pictograms are used; those giving Advice; those giving Warnings and those giving information on how to handle and apply the product correctly.

The label further contains the trade name, the registration number (L number followed by Act 36/1947), the name of the active ingredient and its concentration in the formulation as well as the formulation type. In addition, the labels state the name, address, telephone number of the registration holder.

The batch number and date of manufacture/expiry should also be on the label. The directions for use concerning the dosage rate, recommended volume per hectare, registered tank mixes and compatibility will also appear on the label.

The pesticide label

All pesticides sold in South Africa are required to be registered in terms of the Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act No 36 of 1947). According to this act each compound sold must have a label that contains set pieces of information. This label is viewed as a legal document and any application of a pesticide in contradiction to the label recommendations is a criminal violation of the law.

The label serves three important functions:

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- A label is a legal document required by law and no pesticide may be sold without an approved and valid label. One should not use a pesticide that does not exhibit an L registration number on the label.
- The label is an information leaflet that tells the user how to use the product correctly in order to achieve the desired results.
- The label informs a user how to use the product safely and responsibly. This information includes aspects such as:
  - Timing of application
  - How often a compound should be applied
  - The precautions that should be taken
  - The protective clothing that should be worn when preparing or applying spray mixes
  - The measures to be taken in order to prevent pollution the environment
  - The crops on which the compound should be used
  - The dosage rates that are to be used

A pesticide label consists of two parts - the main panel also known as the sales panel and the side panel or information panel. The sales panel serves to identify the product, its legality, the registration number and the registration holder.

The side panel contains information that must be given in the following sequence.

- Warnings
- Precautions (including the "triple rinse" statement)
- Symptoms of human poisoning
- First aid treatment
- Note to physician
- Use restrictions
- Directions for use:
  - Compatibility
  - Mixing instructions
  - General directions:
    - Ground application
    - Centre pivot application

- Aerial application
- Directions for application.

A pesticide label also contains symbols to indicate toxicity.

- Recommendations

- warnings

- Toxicity group classification

	**Group Activity 7**

Equipment management

Introduction

Most facilities have procedures intact when dispatching or returning equipment. Most systems will include a dispatch procedure in which individual pieces of equipment are identifiable. A log is kept of the use of individual pieces of equipment. The equipment is booked out to a person

who acknowledges receipt thereof and its condition and time of receipt. When the equipment is returned it must be checked for defects which are then recorded.

Checking and maintaining equipment

Equipment used on farms includes a wide range of different instruments and containers. All equipment must be cleaned and stored in designated storage areas. The equipment must be kept dry and should not be kept on a dirty floor. The equipment varies greatly between farms and industries. Please note that specific guidelines and procedures existing on sites (farm or industry) regarding storage and maintenance of equipment should be followed. It is also necessary to use equipment manuals as a guide to identify inspection points for specific equipment.

The basic equipment and their maintenance are discussed below. Equipment used in harvesting must not be stored in close vicinity to pesticides, pesticide application equipment or fertilisers.

- Ladders especially used for harvesting tree crops should be kept clean and in good condition, ensuring that pickers do not fall and injure themselves.
- Picking bags used for harvesting fruit in orchards must be kept clean.
- The same principals apply for bins and crates.
- Picking knives and shears which are used when harvesting lettuce and cabbage must be clean and sharp at all times ensuring a clean cut.
- Tools must be washed with a sterilising agent to prevent biological contamination.
- The protective coatings of grafting equipment and tapes must be kept clean and dry at all times.
- Specialised equipment should be checked according to the manual. Should any problems be encountered, the equipment should be sent for repair or service to agents or specialists.
- When equipment has been sent for repairs, it should be check for correctness when returned.
  - Check whether the serial number corresponds with that of the equipment sent for repairs.
  - Check whether defects have been repaired. Should be done by an expert or general user. Do not sign off the repair slip if it not fixed properly.

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	**Group Activity 8**

	**Group Activity 9**

Learning Unit 2: Manage a Feedlot

Unit Standard	
116649	Control feedlot production unit
Specific Outcomes	
SO 1: Oversee herd health and production SO 2: Evaluate production performance SO 3: Oversee pen maintenance programme SO 4: Record livestock pen numbers and movements between pens	
CCFO's	
Identifying	Working
Organising	Collecting
Demonstrating	Communicating
Science	

Oversee herd health and production

Livestock behaviour patterns

The behaviour of cattle is determined by instinct, sensory perception and experience. Instinctual behaviours refer to those that the cow is naturally motivated to perform. Sensory behaviours are those that are the result of something heard/seen/smelt/felt in the environment.

Examples of these different types of behaviour include:

- Instinct or innate, fully developed and complete at first appearance; suckling and standing at birth, those rhythmical behaviours fundamental to the life process (such as breathing and defecation) and freezing or baulking in response to an unfamiliar noise or object. Baulking is when the animal flinches and ceases movement, that is, it is resisting what it is being led to do.
- Conditioned learning or learning by experience, which can be positive, negative or neutral; drinking milk from a bucket, mounting behaviour during copulation, eating concentrates from an out of parlour feeder, responding to a feedout wagon, milk let down during milking as well as responding to a handler. Much of this occurs as the result of sensory perception and investigatory behaviour when cattle are first exposed to an unfamiliar environment.
- Many behaviours are a combination of these influences. Mounting behaviour during copulation is a good example of this, with the novice bull being instinctually driven to attempt mounting, but the technique of mounting improving with experience.

	**Individual Activity 1**

Of the five senses cattle possess, sight is the most dominant. Hearing and smell also play important roles in how cows assess their environment.

As a prey species, cattle have an inherent fear of unfamiliar objects, situations, smells, sudden movements and noises. As well they can experience fearfulness in situations where they are solitary or isolated. Understanding this is critical to managing them in a low stress manner. Cattle are less expressive of pain and injury than humans. Therefore, behavioural indicators of pain that cattle do express are subtle. An animal experiencing pain has compromised welfare, and consequences to their health and productivity are also likely.
The presence of stereotypic behaviours indicate that a cow is in a compromised welfare state, and is feeling frustrated at the inability to behave naturally. In cattle, oral stereotypies, which relate to nutritional and foraging deficits, and ambulatory stereotypies, the result of restricted movement, are common. The intensification of cattle housing, feeding and management contributes to behavioural problems not seen in grazing animals. Frustrations lead to some cows engaging in often repetitive and pointless (stereotyped) behaviour that can be interpreted as a reflection of reduced activity, hence restricted normal behaviour, in intensively managed housing systems.

Tongue rolling and bar chewing are two classic stereotype behaviour problems. Nymphomania, silent heats, and extreme aggression towards humans are other behavioural problems in intensively managed cattle.

Feeding vices can be attributed to boredom following a too rapid satisfying of their nutritional needs. These include dropping feed, feed throwing and water lapping.

The behaviours of cows will change in response to the situations they are in and the handling they experience, resulting in an increased or decreased frequency of common behaviours.
The behaviour of the cow handler has an enormous impact on cow behaviour, welfare, and performance. Negative behaviours produce more fearful cows. Positive behaviour will lead to a relaxed herd of cows that are easier to handle.

A good handler with a considerate, calm, and positive attitude towards cows can lead to 20% higher milk yields over a handler with a poor attitude.

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Non-performing livestock is identified and removed according to feedlot procedure

Non-performing cattle might be a HIGH RISK for causing a violative residue problem. Non-performing cattle should have records carefully reviewed by both the feed yard veterinarian and manager before being released for salvage. Establish a minimum withdrawal (WD) time that reflects the longest WD for any of the products administered. Animals recovering from illness may have organ damage that interferes with the normal clearing of medications. Marketing decisions should not be made solely on the results of a pre-marketing residue screening test. Critical factors to avoid a violative residue include medication selection, dosage, route of administration, volume per injection site and adherence to prescribed withdrawal times. In accordance with FDA regulations for use of prescription animal health products, a treatment protocol must be written (hard copy or electronic) and signed by the feed yard veterinarian.

	**Individual Activity 2**

Knowledge of production stage is applied to change diet fed to enhance production performance

Feed processing

Grain processing is essential. Cracked grain gives approximately 15% better utilisation than whole grain, thereby increasing weight gains and reducing grain wastage. It is best for grain to be coarsely milled, either through a roller mill or hammermill.

Steam flaking of sorghum will further improve its utilisation. Avoid milling the grain too fine as this increases risk of digestive upsets.

Dusty diets can also depress appetite and cause respiratory problems. Small quantities of molasses will increase palatability and reduce dust. Molasses can be fed at up to 10% of the diet.

Introducing cattle to grain: open troughs (or bunks)

Cattle must have grain introduced into their diet gradually. A gradual introduction allows the rumen microbes to adjust to a grain diet thereby minimising the incidence of grain poisoning and laminitis. The following feeding program is a satisfactory method of bringing cattle on to a high grain diet. Cattle should be continually observed during this period for sickness and other health problems.

	% In diet	
	Grain in additives	Hay
Day 1 to 4	20	80
Day 5 to 8	40	60
Day 9 to12	60	40
Day 13 to 15	80	20
Day 16 ---	Final diet	

Feeding

It is desirable that cattle are fed at the same time each day to reduce the incidence of metabolic upsets. In wet weather, it may be necessary to feed two to three times a day to avoid feed spoilage/wastage.

It is *important* that cattle have feed in the troughs at **all times**. Empty feed troughs are a prime cause of grain poisoning.

Do not feed excessive quantities each day, as the feed may become stale. Try and judge the amount fed so that a little is left over each day. This ensures the cattle are not without feed.

If you have to change grains during the feeding period, it is important that it is done over about a 14-day period. This is particularly important going from sorghum to barley, but not as critical for the reverse.

Introducing cattle to grain: self-feeders

Grain intake can be restricted with self-feeders by initially using a narrow opening (for example, 12mm) and then gradually raising the shutters over two weeks. Initial mixes are usually 50:50 grain and hay by weight, to assist the mixture to `flow'.

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The following method for self-feeders has been used successfully in commercial feedlots.

Day 1 to 4: Provide the starter diet in self-feeders with a narrow shutter opening. Hay is fed separately in racks. If necessary, place hay on top of the grain in the self-feeder trough to attract cattle to the grain.

Day 5 to 7: Gradually increase the daily intake of grain by opening the shutters.

Day 8 to 14: Free access to the starter diet. If mixing your own diet, it is preferable to gradually increase the grain percentage of the diet over the next week.

Day 15 on: Free access to the final diet. It is optional as to whether hay feeding in racks continues.

Livestock health status is monitored according to set feedlot norms

When should operations be assessed?

An assessment should only be conducted when the site is operating under normal conditions. For example, do not perform an assessment during a period of disease-outbreak or when another serious factor or factors may be impacting the operation creating “abnormal” conditions whereas the feed yard is not exhibiting “normal” operational conditions (ex: extreme weather conditions, natural disaster, etc.). Additionally, an assessment should not be conducted if doing so, would force animals to be handled or moved during conditions which may be detrimental to animal well-being. Minimally, an assessment should be conducted every three years. Some operations may decide to conduct an assessment more frequently.

Assessment Forms

The assessment forms have been designed in an assessment-flow pattern to help the assessor eliminate backtracking and/or moving inside/outside/inside, etc. However, these forms cannot account for all situations and the assessment-order is only a suggested order, the assessment may be completed in any order as deemed appropriate by the assessor.

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Choosing Pens/Animals to Assess

Efforts should be made to randomly select pens, water troughs, feed bunks and cattle for the assessment. This could include use of the feed yard's "yard sheet" or drawing numbers from a hat or box to identify pens that will be subject to the assessment prior to driving/walking around the feed yard. The yard sheet will also help ensure that pens being assessed are currently occupied with cattle. A minimum of ten pens should be assessed. If a feed yard has less than tens pens with cattle in them, all pens with cattle present should be assessed. Additionally, the assessor of the animals should make an effort to assess pens, water troughs, feed bunks and cattle in areas such as the receiving/shipping pens and hospital(s). The number of those areas assessed will be feed yard-specific and dependent upon the size of the feed yard and types of facilities available.

Recordkeeping and Documentation

The Feed Yard Assessment guide contains references to many types of records including documentation of protocols. You may call protocols, Best Management Practices (BMPs) or standard operating procedures (SOPs). A set of customizable, fill-in-the-blank, sample/template forms is provided as part of this guide. If you do not already have one or more of the documents referenced as part of the Feed Yard Assessment, you are encouraged to use these provided forms "as-is" or make modifications to fit your operation.

Optimal feed intakes are ensured

Diets for all classes of beef cattle should meet the recommendations of the National Research Council (NRC) and/or recommendations of a nutritional consultant. For local recommendations and advice, contact your state agricultural extension as a potential resource.

- Cattle must have access to an adequate water supply. Estimated water requirements for all classes of beef cattle in various production settings are described in the National Academy of Sciences NRC Nutrient Requirements of Beef Cattle.
- Provide adequate feed. Avoid feed and water interruption longer than 24 hours.
- Feedstuffs and feed ingredients should be of satisfactory quality to meet nutritional needs.

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- Under certain circumstances (e.g., droughts, frosts, and floods), test feedstuffs or other dietary components to determine the presence of substances that can be detrimental to cattle well-being, such as nitrates, prussic acid, mycotoxins, etc.
- Producers should become familiar with potential micronutrient deficiencies or excesses in their respective geographical areas and use appropriately formulated supplements.
- Use only USDA, FDA and EPA approved products for use in cattle. These products must be used in accordance with the approved product use guidelines.

Feeding Guidelines for Beef Cows

Body condition scoring of beef cows is a scientifically approved method to assess nutritional status. Body condition scores (BCS) range from 1 (emaciated) to 9 (obese).

- A BCS of 4-6 is most desirable for health and production. A BCS of 2 or under is not acceptable and immediate corrective action should be taken.
- During periods of prolonged drought and widespread shortages of hay and other feedstuffs, the average BCS of cows within a herd may temporarily decline. This is not desirable, but may be outside the cattle owner's control until drought relief is achieved.
- During periods of decreasing temperature, feeding plans should reflect increased energy needs.

Feeding Guidelines for Stocker Cattle

- Stockers are raised on a wide variety of forages (native pasture, annuals, improved pasture) with minimal additional nutrient supplementation.
- On growing forages, stocking rates should be established that meet production goals for growth and performance.
- On dormant pastures, supplement cattle as needed to meet maintenance or growth requirements for the animal's weight, breed, and age as established by NRC guidelines and targeted production goals of the operation.

Feeding Guidelines for Feeder Cattle

Feed yard cattle can eat diverse diets, but the typical ration contains a high proportion of grain(s) (corn, milo, barley, grain by-products) and a smaller proportion of roughages (hay, straw, silage, hulls, etc.). The NRC lists the dietary requirements of beef cattle (based on

weight, weather, frame score, etc.) and the feeding value of various commodities included in the diet.

- Consult a nutritionist (private consultant, university or feed company employee) for advice on ration formulation and feeding programs.
- Avoid sudden changes in ration composition or amount of ration offered. • Monitor changes in weight gain, faeces, incidence of digestive upsets (acidosis or bloat) and foot health to help evaluate the feeding program.
- A small percentage of cattle in feed yards develop laminitis or founder. Mild cases do not affect animal welfare or performance; however, hooves that are double their normal length compromise movement. In these instances, the individual animal should be provided appropriate care and marketed as soon as possible.

	**Individual Activity 3**

Monitoring livestock health status

In beef feedlots, young growing cattle are fed a high-energy diet to produce marketable beef at a low cost of gain. Depending on the starting body weight and age of the cattle, the period of feeding varies from 60 days to 12 mo. The success of a modern feedlot depends on excellent management, a favourable economic climate, and relative freedom from unfortunate events such as disease epidemics or unexpected increases in costs (eg, feed) or decreases in the price received for the final product. The concept of disease should include all of the identifiable factors that cause suboptimal performance: inadequacies in feeds and feeding systems, the purchase of undesirable types of cattle, and clinical and subclinical disease.

The feedlot veterinarian is responsible for maintaining optimal animal health through the following activities:

1) Making regularly scheduled visits to the feedlot. The frequency of visits depends on the size of the feedlot, the time of year, the expertise of the feedlot personnel, whether animals have recently arrived, and the degree to which the veterinarian is contractually responsible for the total animal health program.
2) Being available for emergency visits to the feedlot when disease epidemics are seen.

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3) Performing necropsies during visits and training feedlot personnel to do necropsies at other times.
4) Examining sick animals to ensure that reasonably accurate diagnoses are being made and rational therapy is being given according to established treatment protocol.
5) Regularly examining, analysing, and interpreting animal health and production data and making recommendations in a written report. The effectiveness of detection of sick animals, based on response and relapse rates and case fatality rates, should be determined, and the effectiveness of the processing program for new arrivals, which includes the vaccines used and the medications given, should be examined and analysed regularly.
6) Selecting and prescribing all drugs used in the feedlot, giving specific advice about the use of drugs, and establishing a drug residue-avoidance program.
7) Discussing overall animal health and production performance with the feedlot manager and other consultants, setting animal health and production goals, and monitoring achievement.
8) Comparing the feedlot with other operations. The veterinarian should produce a monthly report that compares processing costs, treatment costs, and death loss by arrival weight and days on feed.

When the consulting veterinarian is not readily available, a local practitioner can serve as a valuable resource for the feedlot. Serving as part of the feedlot's health care team, the local veterinarian can make significant contributions to the animal health program.

The greatest risk for initial introduction of many infectious diseases into a herd is the addition of sub-clinically infected animals, although some risk is also attributable to wildlife carriers. Potential sources of infection may be seen with herd additions, or through intentional or inadvertent movements and contacts. Herds may be classified as "closed" or "open," based on their potential for pathogen exposure. Closed herds restrict the introduction of animals and vehicles from livestock sources as well as contact with other herds and animals. Open herds have a higher risk of introducing pathogens through such practices as introduction of purchased replacements (especially from commingled sale groups), purchase of bulls, direct introduction of high-risk stocker calves (especially into high population densities), and mingling of animals of different backgrounds, through either cooperative breeding programs or poor herd biosecurity.

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In general, all purchased or introduced animals should be separated from the home herd for a reasonable observation period (e.g., 4 weeks); these animals should undergo the same health procedures as the home herd. It is prudent to obtain animals from herds in which the herd health history is known and to have a record of vaccinations and treatments. Before purchasing animals, buyers should be sure that herds have tested negative for paratuberculosis and are free of persistently infected BVD, tuberculosis, and brucellosis. If the herd is free of diseases such as bovine leukosis and anaplasmosis, purchasing only animals from other herds negative for these diseases is vitally important. Pubertal bulls should be tested for trichomoniasis and vibriosis when indicated. For artificial insemination (AI) programs, semen should be used only if it was processed by an approved AI centre with a comprehensive health program for minimizing the risk of transmission of venereal (and other) diseases through frozen semen.

Evaluate production performance

Introduction

Intensive livestock systems differ from most pasture-based systems in that managers exert much greater control over the production cycle and the quality of animals entering the system. Consequently, technical inefficiencies among animals tend to be much more easily eradicated. This is especially so when the intensive livestock system in question operates under experimental conditions. Nevertheless, a range of factors could still cause both technical inefficiency and variations in productivity between animals and across breeds:

- variations in the genetic potential of sires and dams;
- variations in environmental conditions prior to animals entering the backgrounding phase of the production cycle (the phase when feedlot managers take control of the animals);
- catch-up effects when genetic advances between breeds take place at different rates;
- inherent differences in the productive potential of breeds in feed lotting, especially between temperate and tropically adapted breeds where it is expected that the former would be more productive than the latter; and
- different rates of genetic advances between breeds.

The expenses of purchasing a calf and the feed needed to finish it are the two largest variable costs facing the cattle feeding sector. Using less feed to finish a calf would substantially improve profitability in beef production, and may diminish environmental implications. Feed costs are high due to poor growing conditions in major grain producing countries, because of the use of feed grains in ethanol production, and because of increasing competition of land for crop production versus urban development.

Feed to Grain Ratio

The feed to gain ratio (F:G) is a key measure of efficiency. Also known as the feed conversion ratio (FCR), F:G is a measure of an animal's efficiency in converting feed nutrients into increased body mass. F:G is an important variable in the cost to finish an animal. Because of the variability of water content, feed is measured by dry matter (DM).

Imagine two steer calves placed on feed. Both steers are gaining an average of 3.5 pounds per day (1.59kg/day). Over time, we measure that Steer A consumes an average of 21lbs (9.53kg) DM per day, which equates to a 6:1 feed to gain ratio. Steer B consumes 28lb/day (12.70kg/day), a F:G of 8:1, and therefore is less feed efficient than Steer A. Based on a ration cost of $187/tonne* (or 0.085 cents per pound), Steer A costs $1.79 to feed per day. Steer B costs $2.38 per day. If both steers reach their finish weight in 200 days, the less feed efficient animal (Steer B) would cost the producer $119 more to finish than an animal with better feed efficiency (Steer A). *(*Note: this example may not reflect current feed costs.)*

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This example illustrates the importance of improving and maximizing feed efficiency in cattle on feed, which can make or break profitability in the feeding sector.

	Steer A	Steer B
Average Daily Gain (lb)	3.5	3.5
Feed Consumed (DM) (lb)	21	28
F:G	6:1	8:1
Ration Cost* (¢/lb)	0.085	0.085
Cost per Day	$1.79	$2.38
Days on Feed	200	200
Total Cost to Finish	$357	$476

Source: BeefResearch.ca

Diet management

Substituting forage with grains in finishing rations can lead to substantial improvement in feed efficiency. Steers fed higher grain diets grow faster, finish sooner, and produce heavier and fatter carcasses1. Research also suggests that the type and quality of grains and the balance of essential nutrients, like vitamins, proteins, and trace minerals, significantly impact feed efficiency. Balanced rations increase average daily gain and can decrease feed cost per pound of gain. In order to prevent acidosis, it is necessary to appropriately adjust cattle from forage-based feed to high-energy grain-based rations.

Digestibility of grains like corn, barley and oats is improved when grains are processed. By cracking the outer shell of the grain, rumen microbes are better able to utilize grain starch and minerals. Processing also allows grain to be mixed with supplements, and affects palatability and passage rates. However, processing grains too finely leads to acidosis. Finding the ideal method and level of processing contributes to an improved F:G.

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Analysis indicates that production costs would be 10% higher if producers did not use implants, ionophores or beta agonists.

Growth promotants are among the many sophisticated tools used by feedlots and other producers to raise more beef, more rapidly, using less feed, while maintaining high standards of animal health, carcass quality and food safety. Growth promotants include ionophores, growth implants, and beta-agonists.

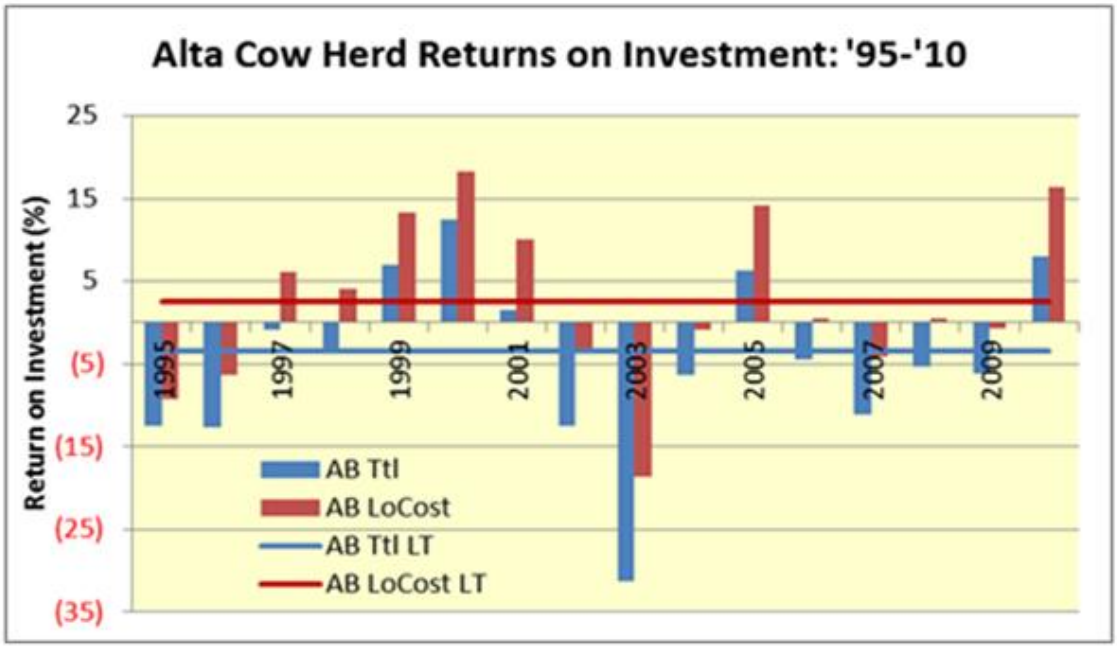
Determining when an animal has reached its finished weight is an important aspect to feed efficiency. Once an animal's rate of gain slows, most of the feed consumed is converted to waste fat rather than useable meat, and therefore is not cost effective. Producers can weigh and track individual animals or pens in order to track gains and determine when finished weight is reached.

Genetics

In addition to management practices that optimize feedlot feed efficiency, selecting cattle that are genetically feed efficient is important. Much research has been done to make genetic

improvements in feed efficiency by measuring Residual Feed Intake (RFI). Advances in producing terminal animals through crossbreeding also maximize gains, grading and dressed yield. Improving the feed efficiency of a herd can mean big savings for producers. A 5% improvement in feed efficiency could have an economic effect four times greater than a 5% improvement in average daily gain (ADG). Since feed costs represent greater than two thirds of total production costs in a beef operation, reducing them can have huge advantages to your bottom line. This information isn't only for the feedlot and backgrounding operation. It is especially true for the cow-calf producer because over 70% of those feed costs are going towards just maintaining the cows over the majority of the year.

The figure below shows how, for the cow herd portion only on a farm, the costs of production resulted in negative returns on investment for the average of all Alberta AgriProfits producers 11 out of 16 years. The low-cost producer (the top 1/3 of the Agriprofits participants) saw negative returns on investment 6 out of 16 years. Considering the tough times in 2003 with BSE and the increasing feed prices from 2006 onward, knowing that 70% of beef production costs



(Figure 1. Agriprofits business analysis program data from Dale Kaliel, Senior Economist, ARD; total cow/calf producers, AB Ttl, compared to low cost cow/calf producers, AB LoCost, (AB LoCost are the top 1/3 of the AB Ttl) and trends over the long term (LT))

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	**Individual Activity 4**

Measuring Feed Efficiency

If you ask an average cattle producer how they measure feed efficiency in their herd, most will say by looking at the feed to gain ratio (Feed:Gain) or the feed conversion ratio (FCR). Basically, this is the calculation of the feed consumed per unit of weight gained. However, what this measure does not tell you is what the individual animals are eating. It only gives you a group average. While a group average might be useful in a feedlot situation, it really is of little value to a breeding herd where you want to make progress through genetic selection. Many beef cattle breed associations have adopted a slightly different method of evaluating individual feed efficiency, called residual feed intake, or RFI.

Residual feed intake is defined as the difference between an animal's actual feed consumed, or eaten, and the animal's calculated feed requirements based on its body weight and ADG during a standardized test period. Essentially, RFI describes the variation in feed intake that remains after the requirements for maintenance and growth have been met. Efficient animals eat less than expected and have a negative or low RFI, while inefficient animals eat more than expected and have a positive or high RFI.

More recently, RFI values have been adjusted for body fatness (RFIfat), thus attempting to render RFI independent of carcass fatness in slaughter cattle and later maturity or fattening in replacement heifers and bulls. Similarly, another measure referred to as residual gain (RG) is adjusted for body size and dry matter intake (DMI). It represents animals with superior gain at equal levels of body weight and DMI. A trait that combines both RFI and RG, referred to as residual intake and gain (RIG), represents metabolically efficient, fast-growing animals that consume less feed. These latter two measures of feed efficiency should also be adjusted for body composition using final off-test ultrasound backfat thickness, marbling score and/or ribeye area. These measures of feed efficiency are heritable and either moderately (RFI vs. RG) or highly (RG vs. RIG) correlated with each other.

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For the beef cow, both the measures of DMI and ADG are related to body size, growth and composition of gain. Thus, selection for improved FCR has resulted in cattle that grow faster (increased ADG), have increased mature size, and increased maintenance and feed requirements. We've already been doing this, and we produced a larger framed cow who ate more. Figure 3 shows the feed maintenance requirements for cows over this 50-year period. While it's true that the cow size increased, so did their feed requirements - substantially.

If you take a look at the show ring heifer champions over the years during this same time period, you'll see a drastic change in frame size from the 50's to the early 80's and a return to a more moderate frame size by the early 2000's.

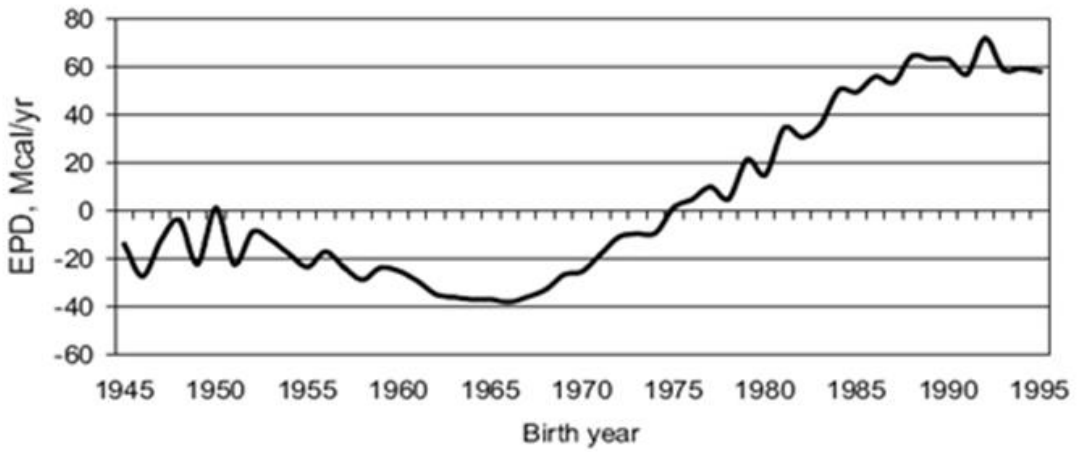

Figure 3. Average EPD (Mcal/yr) for mature cow maintenance energy requirements by birth year in Red Angus cattle (Evans et al., 2002).

What we still don't know about these replacement females is how much they ate for the performance they had. On the other hand, we do know that these breeders selected these heifers based on more than one trait. Structural correctness, conformation, docility, and their ability to breed and raise a calf were all considerations in their breeding programs; so, we can't forget that. Even though we have a great tool to measure feed efficiency in the RFI trait, it has to be taken into account with the other traits of economic value. For a cow-calf producer, fertility is 10 times more important than carcass traits and 5 times more important than growth traits. Single trait selection is never a wise decision nor a practical goal to pursue.

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Seedstock producers and breed associations have effectively used expected progeny differences (EPD's) to improve the genetic merit of their cattle. However, these have been primarily for traits including growth and carcass which have put an emphasis on income and revenue generation leading producers to place a high value and level of importance on these traits to sustain their operation. What has been forgotten to some extent is the selection for factors that could lower costs within the production cycle, like feed efficiency. Measuring and selecting for the *inputs* and not just the *outputs* needs some attention for the beef operation to continue generating income, but also to enhance sustainability and save costs.

Selecting cattle for their feed efficiency using the RFI trait is the best measure we currently have as a direct measure of metabolic efficiency, or energy conservation because it is independent of body weight, average daily gain and backfat thickness. In any population there is variation in feed efficiency, and there will be individuals that can achieve high rates of gain with low feed intakes just as there will be individuals achieving low rates of gain with high feed intakes and others in between. Our challenge comes in measuring cattle for this trait, interpreting the numbers and using the data for genetic progress.

Figure 4 compares the progress that has been made in dry matter intake and the resulting feed costs throughout the 1990's at an Australian Research Centre regarding actual selection for feed efficient cattle by using RFI. The negative RFI (high efficiency cattle) have reduced their dry matter intake per day by close to 0.5 kg resulting in significant feed savings to the beef operation. However, given that multi-trait breeding goals will be pursued by the industry, the researchers assumed an annual rate of response in RFI of -0.08 kg DM/day (0.8%/year) in a 25-year simulation compared to not selecting for RFI. Much progress can be made in improving feed efficiency well into the future as each generation improves after targeted selection for the trait.

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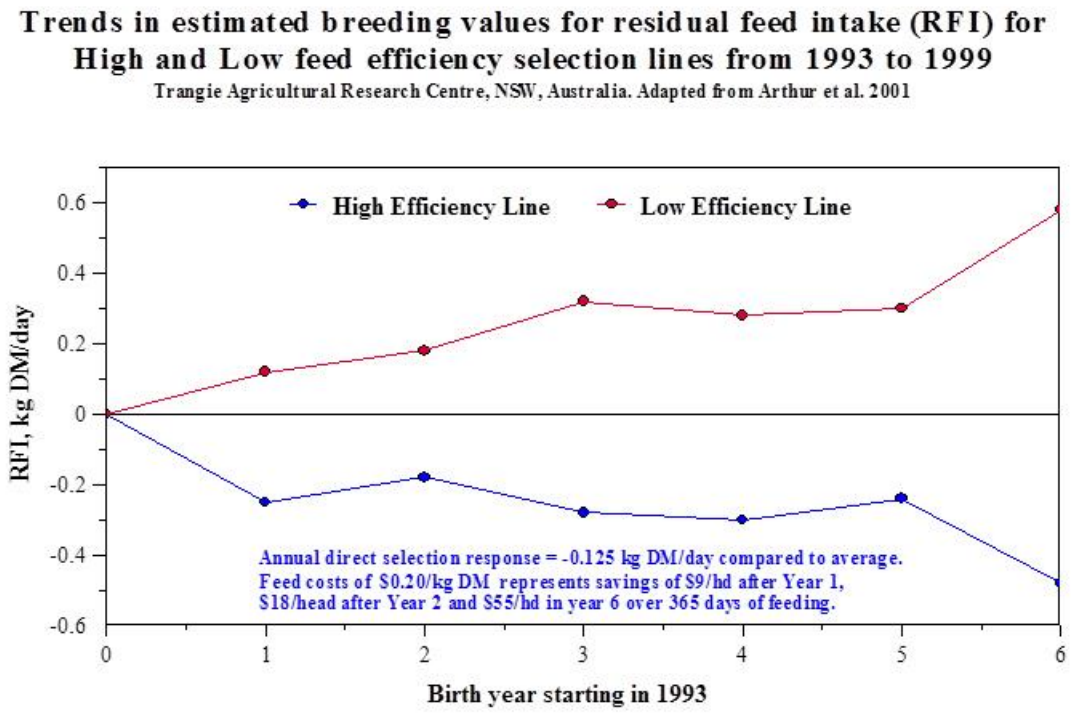

Figure 4

Currently, the easiest way to select for feed efficiency (if you are not testing your own cattle) is to purchase feed efficient or negative RFI bulls to use on your cow herd. Typically, RFI is measured in young cattle (7-10 months of age) in feedlot pens fitted with feeding stations designed to automatically monitor individual animal feed intake over a 70-day test, following a three-week adjustment to their test diet. Cattle are weighed before feeding on two consecutive days at the start and end of the test period and at approximately 14-28-day intervals. They are also measured for ultrasound backfat thickness (mm), rib eye area (cm2) and marbling score at the start (optional) and end of the test period.

The impact of selecting for low RFI

Several researchers have been studying this trait for more than 15 years. They have come to the following conclusions about what selection for feed efficient cattle means to the beef industry. Research has shown that selection for low RFI (efficient cattle) will:

1. Have no effect on growth, carcass yield & quality grade
2. Reduce feed intake at equal weight and ADG
3. Improve feed to gain ratio by 10-15%

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4. Reduce net energy of maintenance and reduce methane and manure production (reducing the carbon footprint of cattle)
5. Have little if any effect on age at puberty
6. Have no effect on calving pattern in first calf heifers
7. Have no negative effect on pregnancy, calving or weaning rate
8. Have little effect on bull fertility
9. Have a positive effect on body fatness or weight particularly during stressful periods
10. Will reduce feed costs

If these ten reasons to select for feed efficient cattle are not enough to convince you it's an important trait to pursue, it is likely because you are concerned about the relationships RFI has to other traits of importance. Because RFI is a relatively new trait, there are questions regarding its effect on other traits and its' repeatability at different stages of an animal's life, on different diets and in different environments.

By looking at the cows below, you likely have a preference for one over the other when their feed efficiency isn't known. When you find out they both weaned calves of similar weights and they both were pregnant, you are probably inclined to find the deep bodied, more feminine looking cow on the right as more appealing. When we look at RFI scores and see the same cow ate 2.83 kg more per day than the average cow in the herd and 5.4 kg than the other cow, you'll probably reconsider knowing the impact on feed costs for a herd of 100's or 1000's of these feed inefficient cattle. These are extremes in a herd and illustrate how conformation alone doesn't tell you the whole story on productivity and performance. Granted, these are large cows, but the concept of feed efficiency is the same for other breeds and sizes of cows. The argument has been made by producers that their 550kg mature cows are all efficient because they are smaller. Remember, RFI is independent of body size and weight, average daily gain and backfat thickness and variation and extremes exist in all populations.

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Figure 7

LOW RFI cow (5 yr-old Hereford-Angus cow in the spring of 2004; RFI adj = -2.64 kg as fed/day; 2003 weight at weaning =787 kg).

HIGH RFI cow (8 yr-old Hereford-Angus cow in the spring of 2004; RFI adj = 2.83 kg as fed/day; 2003 weight at weaning = 755 kg).

Let's now consider some of the relationships between RFI and other traits of importance. Many factors affect the actual feed intake (DMI) of cattle such as body size, growth, body composition, gender, age, season, ambient temperature, physiological status, previous nutrition and diet. Most of these factors are either equal between animals during a standardized feed intake test (e.g., gender, season, ambient temperature and physiological status) or are adjusted for, such as body size, body composition, and growth so that we can make direct comparisons between animals. However, considerable within- and between-animal variation does exist in DMI and measures of feed efficiency.

Diet type and Breed type

RFI measured on a grower diet and then again on a finisher diet is positively correlated, meaning the animals tend to rank similarly on both diets when tested. It is also true of RFI measured post-weaning in heifers and RFI measured again later in life as mature cows. However, other research showed that some animals do re-rank, meaning some will have a positive RFI or be inefficient in one test and then when tested again are efficient or have a negative RFI. This level of re-ranking for RFI, DMI and ADG occurred whether the diet changed from a grower to finisher diet or stayed the same from feeding period to feeding period. Such re-ranking was due to: 1) body weight and feed intake measurement error, 2) animal variation in response to compensatory gain, 3) animal variation in efficiency with animal maturity and,

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4) animal variation in diet digestibility due to differences in feeding behaviour, rate of passage and rumen microbial population. Preliminary data also confirms the moderate to strong repeatability of RFI over different stages of the animal's life. Replacement heifers identified as –RFI and +RFI when they were 8-12 months of age and fed a 90:10% barley silage and barley grain diet (as fed; -0.373 vs. 0.365 kg DM/day) were also -RFI and +RFI when measured again as 4-7-year-old cows and fed a 70:30% grass hay and barley straw cube diet (as fed; -0.375 vs. 0.459 kg DM/day). These results indicate that RFI is consistent across different stages of an animal's life. Although, there may be a need for different test criteria (e.g., forage vs. grain-based diets) when selecting terminal and maternal bulls. Breed types destined for maternal purposes should be tested on forage diets whereas those breed types designed for terminal sire purposes be tested on grain-based diets.

RFI is not related to pre- and post-weaning growth, body size, slaughter weight and carcass traits in beef cattle and the phenotypic and genetic correlations are near zero. Experiments have shown no difference in carcass weight, dressing percentage, or marbling grade between cattle of positive and negative RFI values. However, the muscle of efficient animals was found to be slightly leaner and also have slightly more calpastatin than inefficient steers, which may negatively affect meat tenderness. Tenderness is being monitored in efficient animals to see if these results are repeatable in other cattle populations. RFI is moderately to highly correlated with feed intake and feed conversion ratio (FCR). This implies that selection for -RFI will decrease feed intake at equal levels of body weight, growth and body fatness, and will improve feed-to-gain ratio in feeder cattle and growing replacement heifers.

Methane emissions

The fact that efficient cattle have decreased feed intake at equal levels of body weight, growth and body fatness also imply that selection for low RFI will decrease methane (CH4) emissions (g/animal/day) because methane emissions are proportional to feed intake. Generally, the higher the DMI, the higher the methane emissions are. These estimated reductions in methane emissions of 9-12% also coincide with a 15-17% reduction in manure production. Improvements to feed efficiency will influence the carbon footprint of cattle making beef more sustainable.

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Body condition and adaptability

Observations of beef cows in extensive Canadian winter conditions has shown that –RFI (efficient) cows actually maintain themselves in better body condition score with no differences in productivity compared with their +RFI herd mates. Dams that produced -RFI progeny consistently had 2-3 mm more back fat thickness, on average, over the 12th and 13th ribs and lost less weight during early lactation (pre-calving to pre-breeding) than mothers that produced +RFI progeny. In addition, –RFI (efficient) heifers calving for the first time had lower calf deaths within 30 days of birth than +RFI (inefficient) heifers. Lower calf death loss suggests that the improved early life survival of calves from -RFI mothers may be due to their improved feed efficiency resulting from more available nutrients and a better uterine environment compared with +RFI mothers.

Recent research confirms these findings in that –RFI cows gained more body fat and body weight than +RFI cows when both groups swath grazed forages for the first time during Canadian winters where night-time temperatures dropped below -20° C and animals grazed through the snow from November to March. Previous to this, both –RFI and +RFI young cows had been wintered together in smaller holding areas and fed barley silage to meet their nutritional requirements. Even though efficient cattle have documented lower feeding event duration and frequency and lower feed intake when bunk fed in an RFI test, this does not mean that –RFI animals cannot compete or acquire forages during extensive grazing. Instead, it may imply that efficient animals are more adaptable and less susceptible to stress than +RFI or inefficient animals.

Fertility and productivity

The relationships of RFI on fertility and productivity in heifers and cows have recently been reviewed showing, -RFI and +RFI cows and heifers were similar in culling, pregnancy, calving and weaning rate, calving pattern and kilogram of calf weaned per mating opportunity. However, -RFI (efficient) cows calved 5-6 d later in the year than +RFI (inefficient) cows. When RFI was adjusted for body fatness (final off-test backfat thickness; RFIfat) no differences were observed in percentage of -RFIfat and +RFIfat heifers reaching puberty by 10, 11, 12, 13, 14 or 15 months of age nor in the percentage of calves born by day 28 of the calving season. Calving difficulty, age at first calving, calf birth weight, calf pre-weaning ADG, calf actual and 200-d weaning weight and heifer productivity, expressed as kg calf weaned per heifer exposed to

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breeding, were also similar between -RFI and +RFI heifers. Figure 8 below shows how –RFI (efficient) heifers appear to reach puberty later and get pregnant later in the breeding season compared to +RFI (inefficient) heifers. However, this small difference is likely a feature of the RFI testing procedure itself. Heifers reaching puberty near the start of the test period may actually have greater energy expenditures (5% greater) because they are cycling throughout the test due to their sexual development and greater activity compared to heifers that reach puberty near the end of an RFI test. So, this explains why they may breed and calve somewhat later. What is important is that all the heifers reached puberty by 15 months of age and all heifers were pregnant before 40 days of a breeding season: both suitable management targets.

Bull fertility

Fertility of young bulls, as measured by scrotal circumference, breeding soundness evaluation, calves born per sire and emen characteristics, for the most part has been unrelated to RFI, though several weak associations have been observed with sperm morphology and motility. What this is suggesting is that perhaps the efficient –RFI bulls are younger and have less developed sperm. These observations may also reflect the need to adjust RFI for off-test ultrasound backfat thickness and feeding behaviours in an effort to prevent the selection for later maturing bulls. A study showed there was no difference in the number of calves sired by –RFI bulls compared to +RFI bulls. One must be careful to not interpret poor sperm morphology with infertility, since libido in addition to other aspects of a breeding soundness evaluation are important to ensure any bull, regardless of RFI status, is acceptable to be put into a breeding situation.

Data continues to be collected from collaborative research projects focused on feed efficiency and residual feed intake. Careful interpretation of the data, when applying or adopting the technology to your beef operation, is up to you to make the most of it While there exists a large variation in the range of RFI values in animals, more than 35%, and because the trait is moderately heritable, significant genetic progress can be achieved in breeding programs resulting in cost saving benefits. For now, because we can't possibly test all cattle for RFI, contact your breed association to get a list of RFI tested sires for sale at upcoming bull sales. Introducing sires with a known RFI value is a first step to moving you cow herd toward increased feed efficiency.However, with time and continued improvement in technologies, the

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ability to detect efficient animals will improve and increase our ability to select superior animals.

	**Individual Activity 5**

Oversee Pen Maintenance programmes

Environment Management Plans

To ensure that all environmental impacts are considered when planning a feedlot development, it is useful to develop an Environment Management Plan (EMP) for the feedlot property. This plan may also be valuable in the approval process for feedlot developments in environmentally sensitive areas.

The primary purpose of the EMP is to document how the feedlot development will impact on the relevant environmental factors and how those impacts may be mitigated and managed so as to be environmentally acceptable.

The Environment Management Plan should detail the methods and procedures which will be used to achieve the planned environmental targets and objectives. The plan should allocate responsibilities for the various requirements and should also address both short-term targets and longer-term objectives. The following checklist may be useful in developing an EMP for the feedlot development.

Checklist: Consider impacts on
– Water resources
– Bushland areas and Reserves
– Wetlands and waterways
– Water protection areas Consider site contamination or details of previous land uses which may have contaminated the soil

Address relevant issues from the following list and identify control measures to address environmental impacts:

- Air quality
- Dust
- Odour
- Noise
- Surface water
- Groundwater
- Wastewater Reuse
- Solid and Liquid waste
- Resource Storage
- Pest Control
- Compressed/Liquid Gas
- Discharges to Land
- Discharges to Surface water
- Discharges to Groundwater

Provide information on

- Operating hours
- Timescale for completion of construction works
- Planned timelines for construction and operation
- Site storm water drainage provisions and chemical spill management measures/systems
- Waste management practices

	**Individual Activity 6**

Managing liquid and solid wastes from feedlots

Feedlots must have a wastewater management system, and this system must be operated effectively in respect to all wastewater generated.

The runoff control system must be able to prevent the runoff from

- leaving the feedlot property
- infringing the separation distances
- degrading surface or underground water
- causing the uncontrolled build-up of nutrients in the runoff or effluent disposal areas

Drains

General design features for feedlot drains include

- drains must be lined with material of sufficiently low permeability to minimise the potential for leaching of contaminants into the soil or underground water resources.
- they must have sufficient flow capacity to avoid overtopping.
- they must be free flowing to avoid excessive sediment build up. They must be maintained in a clean weed free condition.
- they must have sufficient bed gradient to effectively convey suspended sediments to the sedimentation system without excessive scouring of the drain bed. Flow velocities will be affected by the drain cross section profile, dimensions, slope and drain bed material. Maximum permissible flow velocities to prevent scouring will depend on the drain bed material.
- they should be topped with a durable all-weather surface to permit access by cleaning equipment.

Drains require regular maintenance to remove weeds and repair erosion and scouring after rainfall events, and require cleaning to remove sediments which have been deposited from run-off. For ease of operation drains should have relatively flat beds and side batters.

Sedimentation Systems

The purpose of a sedimentation system is to remove as much as is practical of the entrained solids in feedlot runoff. The system should be designed and managed to

- minimise the solids passing from the sedimentation system into the storage lagoon. The advantages of this are the reduction in sludge build-up in the storage lagoon and the reduced need to de-sludge the lagoon, and the reduced biological loading of the storage lagoon which reduces the intensity and duration of odour emissions.
- promote free drainage with minimal clogging of the sedimentation weir

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- promote the rapid drying of the deposited material. Rapid drying reduces the intensity and duration of odour emissions
- prevent leakage of effluent into the soils or groundwater. The system must be constructed on low permeability soils, or sealed with suitable clay or a synthetic liner
- allow easy and cost-effective removal of the deposited material.

Three types of sedimentation systems are very suitable for cattle feedlots:

Basin	Wide and shallow with maximum depth less than 1 metre. Sedimentation weir controls discharge into the storage lagoon Free draining with shallow slope (approximately 0.1%) to sedimentation weir. Compacted gravel base to allow mechanical removal of dried sediments.	2 - 3	2.5
Terrace	Wide shallow waterway with slope 0.1 - 0.5%. Sedimentation weir controls discharge into storage lagoon or next terrace 2 - 3 terraces may be constructed in series Free draining with slope to sedimentation weir. Compacted gravel base to allow mechanical removal of dried sediments.	8 - 10	1
Pond	An excavated hole with depth greater than 1 metre. Does not drain completely after rainfall Solids settle to form a sludge layer which must be removed at intervals of 1 - 5 years Pond usually needs to be pumped out to allow de-sludging	2 - 3	6

Sedimentation Control Weir

The function of the sedimentation control weir is to slow the flow of the effluent in the sedimentation system to the critical velocity to allow entrained solids to settle, and also enable the liquid to drain from the sediments deposited on the upstream side. During the process the weir regulates the depth of the ponding within the sedimentation system and the rate of discharge into the storage lagoon.

Sedimentation weirs should be designed to safely discharge design storm events up to the 50-year ARI design storm without overtopping the earthen bank. A minimum freeboard of 900

mm should be provided between the top of the weir and the top of the embankment. Suitable types of weirs are

- the horizontal drop board type - consisting of one, and occasionally two rows of removable drop boards installed within a concrete channel through the bank of the sedimentation system. The boards are wedged apart to facilitate drainage, and the gaps can be progressively widened to hasten drainage from the sediments. The boards can be completely removed to assist cleaning.
- the vertical timber type - consisting of timber boards mounted vertically within a concrete channel through the bank of the sedimentation system. The gaps between the boards cannot be adjusted, and generally the structure cannot be removed to allow access for cleaning.
- the adjustable vertical slot throttle weir - consisting of two steel plates installed across the sedimentation terrace on the upstream side of a short concrete masonry wall. The gap can be adjusted to facilitate drainage, and the plates can be completely removed to allow access for cleaning.

To prevent scouring of the inlet into the storage lagoon energy dissipation structures or a concrete slipway should be installed between the sedimentation weir and the storage lagoon.

Storage Lagoon

The runoff (effluent) from cattle feedlots is generally high in nutrients, salts and organic matter. This effluent can contaminate surface and underground water resources and soils if it is allowed to flow out of the feedlot in an uncontrolled manner, or is irrigated onto agricultural land which is not capable of assimilating the water and nutrients. The effluent needs to be stored until it can be utilised safely. In water pollution sensitive areas, the water protection agency may insist on a greater storage capacity in order to reduce the risk of lagoon overflows.

For protection of the earthen structure, the storage lagoon should have a spillway designed for safely passing a design storm with an average recurrence interval of 50 years at non- scouring velocity. In addition, a 900mm freeboard above the spillway will adequately protect the embankment from over-topping during extreme rainfall events and from wave erosion on windy days.

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Despite the pre-treatment of settling the suspended solids, the runoff will contain a considerable number of organic compounds when entering the storage lagoon. Where practical, the water depth in the storage lagoon should be kept shallow (less than 1.5 metres) to minimise anaerobic breakdown of the wastewater which causes offensive odours.

Evaporation Systems

Evaporation systems must be capable of containing the runoff from the feedlot-controlled drainage area for a 96-percentile wet year. They should only be considered where the annual evaporation exceeds annual rainfall by a large margin and sustainable spreading on land is not feasible - for example in the dry pastoral districts where it is not possible to reliably grow crops and improved pastures.

Evaporation systems are not the preferred option. Evaporation concentrates the nutrients and salts in the stored effluent which makes the consequences of overtopping or lagoon failure more serious, and the concentrated sludge is more difficult to dispose of. The sludge may be mixed with stockpiled pen manure at a rate which permits safe use on agricultural land, or it may be composted with manure or other organic materials. However, depending on the concentration of salts, sustainable utilisation of the sludge on agricultural land may not be feasible. In this situation the most likely disposal option may be disposal into properly engineered landfill.

Solid Waste Management

Manure should be regularly collected and removed from the pens. Regular cleaning under fences and around feed and water troughs is important in reducing fly breeding sites, odour production and dust potential.

Pens should be cleaned and maintained in accordance with the conditions of planning approval or licensing. Pen cleaning operations should remove all accumulated manure down to the pen surface.

Mounding of manure to provide dry laying areas for the animals is not recommended. Mounds interfere with the pen drainage and create wet spots which promotes pen floor breakdown and increased odour production on the up-hill sides of the mounds. Where permanent gravel

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or earth mounds are employed within pens they should be of a design and alignment which does not interfere with the cleaning operations and the drainage of water from the pens.

Effluent and Manure Utilisation

The objective of feedlot waste utilisation is to employ crops, pastures and soils to effectively utilise or assimilate the nutrients, salts, organic matter and water in the wastes in a sustainable manner. The essential features of a sustainable waste utilisation system are

- nutrients are not leached below the active root zone of the crop or pasture. This prevents contamination of groundwater resources.
- dissolved or suspended contaminants are not transported from utilisation areas to watercourses. This prevents contamination of surface water resources.
- effluent and manure are not applied excessively. This prevents the degradation of the chemical and physical properties of the soil which lead to nutrient overloading, salinization, sodicity, acidification, erosion, poor infiltration and waterlogging.
- the productivity of the land used for waste utilisation is enhanced
- neighbouring landholders are not subjected to odour and dust nuisance because of poorly timed and managed waste application practices.

	**Individual Activity 7**

Animal handling infrastructure

Having access to good handling infrastructure / facilities goes a long way to create a safe environment in which to handle animals. Points to bear in mind when designing and constructing handling facilities are:

- Use strong and durable materials that can withstand heavy and sudden weight, are easy to clean and do not readily splinter.
- Ensure that floor surfaces are suitably rough to prevent slipping of animals and humans.
- Construct handling facilities under cover or in a shady and wind protected area so that workers do not tire too quickly, and animals do not get agitated in extreme weather conditions.

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- Fences and gates need to be in a good state.
- Electric fences need to give a good strong signal to be effective - check the volt reading regularly. Avoid chasing animals towards an electric fence. They will ignore the fence and break it.
- Different species need different sizes and shapes of infrastructure.
- All movable parts of the handling facility need to be free moving (grease or oil joints and hinges from time to time)
- All stables, boxes, crates etc. that are to be used to contain animals, need to be thoroughly checked before they are used. Special attention should be given to sharp objects and loose wires in the handling areas.

For successful beef production, certain facilities are necessary. These facilities must simplify the management of the system and limit labour to the minimum. It must be functional and economical and a safe environment for the animals, as well as a safe working environment for the handlers.

Handling facilities

In the planning of handling facilities, the objective of the facility must be taken into account. The handling facility for commercial cattle will possibly differ from that of a facility for a stud-farm and definitely from that of a feedlot. In a well-designed handling facility, animals can be gathered safely, sorted and controlled. Depending on the size and type of the facility, there are basically three essential components in a well-designed facility:

- Sorting pens
- Crush pens
- Working area

Sorting pens

Cattle are collected from the field or feeding pens, before being handled. The size of the sorting pens must be as large as the largest group of animals to be handled at a time. Each animal needs approximately 2m² of space in the sorting pen. The shape of a sorting pen depends on the total lay-out of the facility. In feedlots however, provision must be made for a separate recuperation camp. In large feeding pens, a separate infirmary (sickbay) with a crush pen and special facilities will even be necessary.

Crush pens

Crush pens are used to drive cattle from the sorting pens to the loading platform. It is usually provided with moveable gates, used for leading the cattle into the crush, by making the area behind them smaller. Cattle will move into the crush more effectively if handlers wait until the crush is half filled before they drive in more cattle. This will create enough space for the cattle to follow a leader into the crush. As cattle usually walk along a fence and are inclined to stand in corners, a round crushing corral is usually better than a rectangular one, as it helps with the flow of cattle.

Working area

The working area is at the end of the crush. This is the area where the animals are handled and can contain the following items:

- Neck clamp
- Body clamp
- Scale

The working area must preferably be provided with a roof and concrete floor. The floor must be made coarse to prevent the animals from slipping. If an earth floor is used, it must be such that it can drain easily and not be trampled into slush - it should therefore be thoroughly compacted. The work area components must be arranged in such a way that the openings and gates are combined, to make access to the cattle possible. A gate that swings open from the side in the direction of the crush in order to block off the crush for other animals, but give access to the rump of the animal, is convenient. A comfortable work area must be provided in front of the animal.

Scales

The current emphasis on standardization and increasing economic pressure contributes to the situation where a high number of livestock have to be weighed several times during their lives. High demands are placed on scale operators and psychological and physical exhaustion gives rise to inaccurate results, rough handling of the animals and mistakes in information collected. Special attention must therefore be given to the choice and placing of a scale to ensure easy and effective handling of animals. The four basic categories of scales include:

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- Spring balance scale
- Hydraulic scale
- Oil bath scale
- Electronic scale

	**Individual Activity 8**

Record livestock pen numbers and movements between pens

Introduction

What is it to 'keep records'? The records can:

- Be used in determining profitability of various techniques used at the farm
- Be used to keep your memory on what you did and/or what happened
- Be used in decision making, especially on a strategic level
- Be used to compare the efficiency of use of inputs, such as land, labour and capital, for example when implementing a new / alternative system
- Help the farmer / investor in improving the efficiency of farm's operations

The records should be simple, easy and quick to interpret, and then they can be supplemented with remarks which can explain some unusual events or findings.

What can records be used for?

If a farmer wants to build a financially successful livestock enterprise, record keeping is a must. The records can be used to further develop the farm and the herd, and thereby the sector in the country. For many farmers, it helps to think of their farm as a business, and to see that good care and good management actually also influences the production and profitability of the farm. Records are important in (animal) farming because:

- To keep track of all animals (Identification records)
- Evaluation of livestock for selection (breeding records; financial records; production records)

- Control of inbreeding and aid in breeding planning (breeding records)
- Aid in selecting animals with the right characteristics for breeding (production, health, feed efficiency) to improve the herd or flock
- To rationalize labour
- Aids in feed planning and management
- Aids in disease management; keeping track about treatment (disease records)
- Aids in finding the effective treatments
- To assess profitability/losses (financial records) Improves bargaining power on products, because you can see the investment and the price of the production (financial records)
- Credit/loan access (financial records)

	**Individual Activity 9**

Types of Records

1. Identification Records

An identification method should be cheap, not harming the animal, reliable to read at a distance of at least 2-3 metres and by preference be permanent.

- Identification of the animals is of course not necessary if a farm has only one animal of a certain species, sex and age group.
- Identification of animals is usually through use of numbering, by marking of the animal and by description of certain characteristics of the animal. The latter is the most animal friendly, and can be done in practice by drawing e.g. the different colour spots of the animals, or certain cowlicks, or taking photos. Giving the animals names and keeping a table with the characteristics of the animal and link it to the name can work in many cases.
- Intrusive methods of identification can be subdivided into 2 categories: permanent at the animal itself (which affect the animals most when doing it) and non-permanent.

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- Permanent Identification: Tattooing (ear or under) Brand (Hot iron, freeze and chemicals) Ear-notching, Punching Tags (Ear-tags, Flank-tags, tail-tags and Brisket-tags; permanent if they do not fall off)
- Non-Permanent Identification: Collars or neck or leg straps (chains) Paint and dyes (can be very animal friendly, but if the paint is full of chemicals it is not healthy and is not recommended, please check)

2. Breeding Records

The importance of breeding records is to measure the productive efficiency of the herd and to enable selection. For example, many farmers would like a cow or a goat which gives birth yearly, or a sow 2 litters per year. Therefore, an accurate up-to-date breeding record of each individual female is necessary. An indicator for fertility/efficiency of mating or inseminations is e.g., the number of matings or inseminations needed to get an animal pregnant.

If many matings or inseminations are needed, it can indicate that there is a problem with the female or the male, or it can indicate that the observation of the heats is not efficient, or the semen, the technique of insemination is insufficient, or the feeding is imbalanced. If the cow is taken to a bull, it can be the cow or the bull which has a problem. Data for insemination or service with a male also is needed to be reminded when the female should be prepared before giving birth, e.g., like in the cow's case, to be dried off in time. The most important data in breeding records include:

- Pedigree/parentage (name or other identification of parents and grandparents)
- Fertility (dates of all services (this also allows calculating the number of services per conception), dates of giving birth (allows to calculate the age of first calving/giving birth and the period between successive birth)
- Birth details (number and weight of new-borns, was assistance necessary? Stillborn / perinatal deaths / vitality score)

3. Production Records

These records are useful in measuring the performance of the animals and the herd. It contributes greatly to the economic appraisal of the enterprise. It can help farmers take decisions on investments, based on how many animals produce how much on the farm, so how much surplus can the family expect?

The records can also be used by the whole sector to improve the genetics of the animals in the country, with specific focus on the production.

Production records are kept of:

- Animal products like eggs per hen per week and milk per cow per day in combination with milk quality data, and of
- Animals which are slaughtered, in terms of for example weight, weaning age and weight, daily gain, production period, and how many animals e.g., per litter reached slaughtering.

Production records are also necessary when farmers start selling products together, to know how much is available every day or every week or in a certain period.

4. Feeding Records

Feeding records give information about the amount, type and quality of the feed. Feeding records can be used both for day-to-day management and adjustment of the feed ration. Together with the production data, it can for example be used to adjust if a milking cow needs more concentrate, or help in decisions about examining animals which seem to not grow, but still eat very much. It can also be used for planning of activities related to feed conservation and establishment of grazing areas in the following season. The important feeding records are:

- Produced and available fodder on farm; quantity and if possible quality of the different feeds. Including content of energy, protein and minerals
- A feeding plan which tells how much feed is required per day per animal in different age groups (grown-ups, new-born, pregnant the first time etc.) or per group of animals (hens)
- Left-over feed if any (per head and per feed, if possible)
- Spoilage (per batch)

5. Disease and treatment records

Disease and treatment records are necessary to keep track of the disease events in which each animal is involved during its lifetime. This can guide to better management practices by leading the attention to repeated events or certain vulnerable groups of animals over time (e.g., it can

show how animals almost always need disease treatments during weaning). It provides information about the health status of each individual animal and the whole heard, and it can help ensuring important vaccinations given at the right time.

On basis of the disease and treatment records, success of interventions both for prevention and treatment can also be evaluated. After treatment with de-wormers, acaricides and antibiotics and other medicines, milk, eggs, and meat cannot be eaten by humans for some time. The records are essential for keeping track of this, e.g., when this withdrawal time is over. In organic animal husbandry, the withdrawal time is normally longer than the ordinary withdrawal time (double, or three times). Disease and treatment records can for example involve:

- Disease occurrence and date
- All handlings to cure diseases (also non-chemical treatment)
- Vaccination
- Dipping/spraying
- Treatment
- De-worming
- Post-mortem

6. Financial Records

The records of the costs and earnings related to the animal farming be kept for cash analysis and enterprise appraisal. In most households, the most necessary records are simple overview over the family cash flow, that is, the total economy in the household: what comes in? and what do we buy?

In addition to this, keeping records of the animal enterprises is an important part, because it can show whether it gives an income to the family or not. If records are kept particularly for the animal herd as an income generating commodities, it will help the family to see what they invest in it, and what it costs to produce it. Also, in relation to the animal farm, an investment is more than an expenditure, an investment hopefully enables and improves the production in the future. It is also important to count approximately how many hours of work it has taken in the animal herd, because it can help price setting.

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Economic records are of paramount interest in providing the farmer with information concerning the profitability of his farm. Moreover, they are of great help in decision making at the right time. For example, is it profitable to feed concentrates, is it advisable to apply for a loan or credit to invest in a machinery or technology? Answering these questions is only possible if adequate records are available. Moreover, for tax purposes and for the purpose of getting loans or credit, economic records are required.

Record keeping for Cattle production

Excellent records are the cornerstone of building a financially successful beef/Dairy enterprise and they will be of great help in the development of the Beef/dairy husbandry and beef/dairy industry of any country. In summary, the importance of good record keeping include:

- Aids in efficient management of the herd
- Improves bargaining power on products
- Evaluation of livestock for selection
- Adding value to livestock
- Control of inbreeding and aid in breeding planning
- Aid in culling low performers
- To assess profitability/losses
- Aid in gross margin analysis
- Credit/loan access
- To rationalize labour
- Aids in disease management
- Aids in feed planning and management

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Record keeping for disease management

Some important records for planned disease control include the following:

1. Calf management and disease control records sheet

Calf identification Number			Sire Number		
Date of birth			Dam Number		
sex					
	Kg	Date	Remarks	date	
Birth weight			1st insemination		
Weaning weight			2nd insemination		
Age and breeding weight			Date due to calf		
Average pre weaning growth rate (grams)			Bull used		
Average post weaning growth rate (grams)					
Body condition score			Vaccinations		

2. Cow cards for planned fertility management

Cow No.				
Last calving date	Date of vet examination	Examination remarks e.g. pregnancy diagnosis	Service date	Expected calving date

3. Disease occurrence and treatment record sheet.

Date	Animal no.	Kind of disease	treatment	Remarks

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4. Mastitis management and treatment record sheet

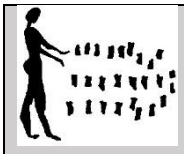
Farm code				1st treatment		2nd Treatment		3rd treatment		4th treatment		
Cow no.	Quarter	Sample	Remarks	date		date		date		date		Sample results
				am	pm	am	pm	am	pm	am	pm	

5. Vaccination records for planned disease control

Date	Vaccination done	Type of vaccine and quantity	Remarks

6. Deworming records for planned disease control

Date	Deworming done	Type of drug and quantity	Remarks

	**Individual Summative 1**

Learning Unit 3: Data Collection

Unit Standard	
116312	Implement a data collection plan
Specific Outcomes	
SO 1: Interpret a data collection plan. SO 2: Implement a data collection plan. SO 3: Interpret and analyse collected data. SO 4: Present collated data coherently	
CCFO's	
Identifying	Working
Organising	Collecting
Demonstrating	Communicating
Science	Contributing

Introduction

What is Agricultural Data?

Agricultural Data Collection – The process of gathering information, such as profit margins per cultivar, pest and disease infestations, weather and climatic information, rainfall, costs, economic conditions – and analysing it to be able to find patterns that will help us work more efficiently, sustainably and profitably on a farm.

Agricultural data could be any of these items listed below:

- Occurrence of pest and disease infestations
- Weather and climatic information – year on year
- Rainfall & Soil sample data
- Costs of agricultural inputs
- Yield data
- Prevailing economic conditions in the sector, country and internationally.
- Production costs per crop
- Soil and fertilisation costs and applications
- Pest and Weed Control application programs and statistics
- Non-target species data
- Crop quality margins
- Agronomic data
- Profit margins per cultivar / per crop / per block / per orchard / per Hectare
- Agricultural photographic data

The reasons why we would see to the accurate collection of Agricultural Data and report on it

Patterns of the environment include rainfall, climate, dry cycles, original vegetation, seasons, movement patterns of animals, etc. Processes of the biophysical environment include the interaction and the relationship between food webs, human activities, soil, climate, water, plants, animals and solar energy.

It is always useful to have detailed records and data in order to ensure that we make optimum decisions in order to maximise profits, production and quality, whilst keeping risks and

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problems to a minimum. Detailed records of data need to be integrated, compared and correctly and accurately reported on, in order to make data useful and applicable in an agricultural setup.

Interpret a data collection plan

Elements of data collection

Let's make sure that you know what the elements of data collection are before we work on the data collection plan:

Collecting Samples

There are various well-known and tried and trusted methods of sampling. Before we explore these different methods, let us first decide what types of things we could possibly sample and what those samples could tell us.

Agricultural Sampling: Removing and/or examining a portion of an entire set (i.e., examining three leaves per plant on 20 plants in a 11-ha field).

Measuring

(It is expected that person doing this unit standard is competent in the units of measuring, and can assure to the performance of measurement under instruction and by delegation of such tasks).

The International System of Units (SI) All systems of weights and measures, metric and non-metric are linked through a network of international agreements supporting the International System of Units. The International System is called the SI, using the first two initials of its French name *Système International d'Unités*.

There are seven SI base units:

- the **meter** for distance,
- the **kilogram** for mass,
- the **second** for time,

- the **ampere** for electric current,
- the **Kelvin** for temperature,
- the **mole** for amount of substance, and
- the **candela** for intensity of light.

There are also other units of measure derived from SI – some of these that you might encounter include:

- the **Newton** for force and the Pascal for pressure;
- the **joule** for energy and the watt for power;
- the degree **Celsius** for everyday measurement of temperature;
- the traditional mathematical units for measuring **angles** (degree)
- the traditional units of civil **time** (minute, hour, day, and year);
- two **metric** units commonly used in ordinary life: the litre for volume and the ton (metric ton) for large masses;
- **knot**, units traditionally used in meteorology;
- the **hectare**
- the **bar**, a pressure unit

Weighing

(It is expected that a person doing this unit standard is competent in the units of weighing, and can assure to the performance of measurement under instruction and by delegation of tasks).

Counting, Observing, Recording

Observing – How and what to observe? Observation is one of the most important aspects of collecting Agricultural Data. It is a skill developed through dedicated action and meticulous methodology. A person doing this unit standard should be able to realize the importance of observation while collecting samples.

Observing: Observation basically means watching something and taking note of anything it does. For instance, you might observe a bird flying by watching it closely. The sciences of biology and astronomy have their historical basis in observations by amateurs, therefore Agricultural data is often much enhanced by focused observation.

Counting – Counting plays a very big role in collecting Agri-data. A farmer may decide to count the number of weeds or pests in a specific area, in order to determine whether or not chemical pest control is necessary.

- We also count the amount of fertilizer, and the number of plants or trees in any given area, in order to determine:
- "How much" fertilizer we should give.
- "How many" fruit it delivered.
- "How much" money we spent to fertilize, pest control, etc. each and every plant.

Recording – Recording may take place in various forms, namely: in written form, in oral form, electronically, digitally, photographically, on tape or cassette. The most important point to remember about the recording of data, is that it should be

- Accurate, and
- Current (meaning up to date).

When this is the case, the integrity of the data is sound. If not, the integrity of the data is compromised and not reliable and might lead to incorrect interpretation and findings, as well as incorrect decisions.

Scouting – Scouting, or monitoring pest populations, is part of an Integrated Pest Management (IPM) system. IPM prescribes treating the portions of a farm or field that have identified higher than threshold levels of pests, rather than treating the whole field, resulting in using less applied farm chemicals. The person doing this unit standard should acquaint him/herself with the methods of scouting on different crops, by sourcing training manuals or production manuals of each crop.

Monitoring – Monitoring would imply to count and observe a certain data package or the collection of data over a certain time period.

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Data collection Plan

The data collection plan would depend on the type of data you would wish to collect. The type of data could be any aspect of agriculture like, pest numbers, plant numbers, soil analyses data, weather data, poultry data, control of stock etc. Steps to compile a data collection plan:

Step	Action	Example
Step 1	Identify the data set	Poultry data – broilers
Step 2	Set the period for data collecting (over a month, a year etc.)	For broilers 1 year
Step 3	The method of collecting (weighing, counting (trapping, sweeping, catching etc), measuring etc.)	Counting eggs
Step 4	Determine the schedule of collecting, implying when during this set period will I see to it that the necessary data is gathered by the ascribed means	Weekly counting eggs from broilers
Step 5	Make a "plan b", meaning an alternative option for when your activities of collecting may coincide with other activities on the farm	Assign a different person to collect the eggs, if your main "collector" of this egg data, is needed to do something else, e.g. drive the tractor, or collect eggs on the following day

Requirement:

The data collection plan should be in writing and visually presented in order for it to be easily understandable and accessible for the person who are responsible for the collection of data, and for the person who are conducting the planning to be at hand for revising and implementation (see example below)

Example:

Budget for record keeping of three-week old broilers on a farm. In order to keep three-week old broilers, the farmers should know that he or she needs a grower house to keep chicken, a feed storeroom, enough water, and the knowledge and skills to look after the birds, how to feed them, how to recognize and guard against disease, and then for the purpose of this

example, how to keep record of them and how to market them. The first step would be to plan the range of data needed to keep the broilers. Thus, the budget for home egg production by the broilers. This type of data or budget would perhaps look like this:

Data Collection Plan		
Complete a budget for a home egg production for one year:		
Expenses:		
Fixed costs:		
Cage:		
12 POL pullets	@ R_____/pullet (chicken)	R_____
Running Costs:		
Feed: ____bags layer mash	@ R_____/bag	R_____
Other Expenses		R_____
	Sub-Total:	R_____
Income:		
Eggs eaten by your household	(_____doz x R_____/doz)	R_____
Sales of eggs	(_____doz x R_____/doz)	R_____
Sale of old hens	(__ hens x R_____/hen)	R_____
	Sub-Total:	R_____
Surplus = Income – Expenses		**R_____**

BROILER RECORD SHEET

BATCH NO: _____Shed no.:_____ Breed: _____

Hatch Date: _____ Starting no.: _____

Feed given (bags)								
Day	1	2	3	4	5	6	7	Total
Week 1								
Week 2								
Week 3								
Week 4								
Week 5								
Week 6								
Week 7								
Week 7								
Week 8								
Total								

Deaths and culls								
Day	1	2	3	4	5	6	7	Total
Week 1								
Week 2								
Week 3								
Week 4								
Week 5								
Week 6								
Week 7								
Week 7								
Week 8								
Total								

Live body weight at 42 days:

No. of birds weighed _____ Total feed intake _____kg/bird

Total weight of birds _____kg Mortality _____ %

Average weight of one bird____kg FCR (food conversion rate) _____

Remarks Mr. Gumede is responsible for collection of feeding data for weeks 7 & 8, since Mr. Poto would be on leave for this period.

_____

_____

LAYER RECORD SHEET

BATCH NO: _____Shed no.:_____ Breed: _____

Hatch Date: _____ Starting no at POL.: _____Age at beginning of period __

Feed given (bags)								
Day	1	2	3	4	5	6	7	Total
Week 1								
Week 2								
Week 3								
Week 4								
Week 5								
Week 6								
Week 7								
Week 7								
Week 8								
Total								

Deaths and culls								
Day	1	2	3	4	5	6	7	Total
Week 1								
Week 2								
Week 3								
Week 4								
Week 5								
Week 6								
Week 7								
Week 7								
Week 8								
Total								

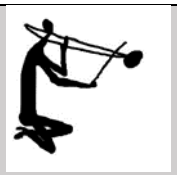
Eggs laid (Saleable = G and Non Saleable = B)								
Day	1	2	3	4	5	6	7	Total
Week 1								
Week 2								
Week 3								
Week 4								
Week 5								
Week 6								
Week 7								
Week 8								
Total								

Eggs laid (Saleable = G and Non Saleable = B)															
Day	1G	1B	2G	2B	3G	3B	4G	4B	5G	5B	6G	6B	7G	7B	Total
Week 1															
Week 2															
Week 3															
Week 4															
Week 5															
Week 6															
Week 7															
Week 8															
Total															

Feed intake _____g/hen/day

Mortality _____ %

RDL
Remains



Individual Activity 1

Implement a data collection plan

Schedule the time of collection of the data

The time of collection of the data should be scheduled to suit the specific type of data which is collected. For insects, the time of collection by means of sweeping would for example be early morning before the insects are agile and fly around, and it should be scheduled on a constant basis, e.g., sweeping early mornings, once a week for 6 weeks.

A person doing this unit standard should be able to supervise the collection of the data and see that it is done at specific times. Depending on the site or set-up where data is collected, a mechanism can be put in place to check of data is collected according to the scheduled times. A logbook can be completed, a check-in –checkout system can be installed, or the person collecting the date can be merely trusted and asked to deliver the data sheet on time, or it can be checked on completion at the appropriate time.

Example:
In the example of broilers (used above), a broiler recording sheet is designed to:

- Mark the date each time you start a new bag of feed
- Mark every time a bird dies or is culled (removed due to sickness)
- Complete the recording sheet every day and deliver to the supervisor

Supervise the collection of the data according to plan

A person doing this unit standard should be able to instruct and advise on the collation of a data sheet, in order to deliver the most relevant data. The person completing this Specific Outcome should be able to instruct and advice on the collation of data for a specific purpose, and the explanation should be given clearly.

Example:

In the broiler example, the farmers have to determine the % mortality as part of his data set to determine his annual income.

He calculates the mortality by not only recording each day's death or sickness, but also combining these numbers to do a calculation.

He was advised to calculate the mortality by dividing the total number of broilers at the start of the programme.

Then he should divide the number of deaths over the period by the number of boilers at the start. (For 200 broilers, 24 deaths / 200 broilers = 0.12).

Mortality is expressed as a %, so he multiplies this figure by 100. (0.12 x 100 = 12%).

He then reports on the percentage mortality.

Identify gaps and irregularities in data collection

Data may often be suggestive and not provide the information, which was required, if not all factors that can have an influence on the issue are taken into account. The data set obtained should provide sensible logical information within the context it was gathered or collected. The data should be gathered while taking note of the specific environmental conditions, functioning state of the apparatus used, timeframe given, and the socio-economic context of the people involved.

Example:

A survey done on whether households do have vegetable gardens or not. The survey was done on a number of households within two specific areas. The data was collated and tabled in order to submit a report to an agricultural investor. The aim of the investor was to determine the focus of future skills training and farming initiatives in the area.

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Reasons	Area 1	Area 2	Total
Respondents no. (out of 30)	14	10	24
Poor access to resources	12	5	17
Lack of fences	4	10	14
Insufficient labor	14	5	19
Seedlings not available	14	1	15
Other means of income	4	8	12
Lack of knowledge	14	10	24
Household plot too small	5	8	10
Soil problems	2	3	5

(adapted from Land Development Unit, 1994-5,)

Interpretation of the data

For the 1st area, the lack of vegetable gardens was described as a result of:

- Lack of fences in the area,
- Poor access to resources, and
- Insufficient labour. For the 2nd area, the lack of vegetable gardens was described as a result of:
- The unavailability of seed was a problem;
- Small plots, and
- The fact that most families had other income.

Gaps and irregularities in the data

A person within this context should be able to advise and fill the gap of the few respondents who answered the questionnaire out of 30 people in each case. In addition, no mention was made concerning the availability of water and compost for gardening purposes, or how the households would require the skills to provide water for gardening.

The low number of people responding to the questionnaire, should also be correlated with their socio-economic status, since in both of these areas, a very high number of people is HIV positive and not physically strong to do the labour, which is probably reflected in the data of the people from area 1.

Let's look at problems that can occur by completing the following activity:

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Types of data	Pests data
Correct Method of collection:	Sampling within individual fields is also done objectively. Surveyors strive to enter a given field without letting field conditions influence their choice of entrance location. Once in a field, a pest is sampled repeatedly along a transect with fixed spacing so as to try to achieve an accurate estimate of the pest conditions in that portion of the field. Sampling is done by sweep netting, trapping, which can include but is not limited to sticky traps, light traps, pheromone traps, trap crops etc., inspecting individual plants, inspecting a certain unit of the ground, or by other means depending on the crop and the target pest. Typically, a surveyor will employ multiple sampling methods in an individual field and will be estimating numbers of multiple insect species as well as the presence of disease or weeds.
Problems that can arise with a specific kind of data:	**(mention 5)**

Types of data	Economic indicator data
Correct Method of collection:	These include indications of items such as the Rand vs Dollar exchange rate, the price of oil, the price of gold and many more.
Problems that can arise with a specific kind of data:	**(mention 2)**

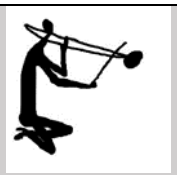
Types of data	Economic indicator data
Correct Method of collection:	These include indications of items such as the Rand vs Dollar exchange rate, the price of oil, the price of gold and many more.
Problems that can arise with a specific kind of data:	**(mention 2)**

Types of data	Diseases data
Correct Method of collection:	**The type of Crop** There are specific crops with very specific disease vulnerabilities. Accordingly, we will try to determine whether our farm's crops are more or less affected than average. **The type of Disease** Only diseases that can cause us to lose our crop of that can have a financial impact on our crop are reported on. **Pathogen** This is the scientific name of the organism that causes the disease in the first place. **Weather station and sensor location** The location of weather monitoring equipment relative to the crop canopy. The sensors that monitor the environmental variables are important, and they should be located within the crop canopy in order to give accurate information. Variables typically monitored include temperature, precipitation, relative humidity, and leaf wetness, wind.
Problems that can arise with a specific kind of data:	**(mention 2)**

Types of data	Agro-chemicals data
Correct Method of collection:	This type of data report should include information such as wind speed, humidity and temperature, every fifteen minutes, types of chemicals applied. Reasons for the application, results of the application. It is important to compare year on year information and statistics. It is also important to have regular stockholding and stock rotation reports, as agrochemicals do not have unlimited shelf life.
Problems that can arise with a specific kind of data:	**(mention 2)**

Types of data	Stock control data
Correct Method of collection:	It is important to have regular stockholding and stock rotation reports, as agrochemicals do not have unlimited shelf life, and some chemicals can be de-registered in time, due to a proven negative effect on the environment, e.g. monocrotophos. (Deregistered in SA in 2005).
Problems that can arise with a specific kind of data:	**(mention 2)**

Types of data	Maintenance information
Correct Method of collection:	Service technicians perform routine maintenance checks on diesel engines and on fuel, brake, and transmission systems to ensure peak performance, safety, and longevity of the equipment. Maintenance checks and comments from equipment operators usually alert technicians to specific problems. With many types of modern heavy and mobile equipment, technicians can plug diagnostic computers into onboard computers to diagnose a component needing adjustment or repair. After locating the problem, these technicians rely on their training and experience to use the best possible technique to solve the problem. If necessary, they may partially dismantle the component to examine parts for damage or excessive wear. Then, using hand-held tools, they repair, replace, clean, and lubricate parts as necessary. In some cases, technicians calibrate systems by typing codes into the onboard computer. After reassembling the component and testing it for safety, they put it back into the equipment and return the equipment to the field. Many types of heavy and mobile equipment use hydraulics, to raise and lower movable parts. When hydraulic components malfunction, technicians examine them for fluid leaks, ruptured hoses, or worn gaskets on fluid reservoirs. Occasionally, the equipment requires extensive repairs, as when a defective hydraulic pump needs replacing. In addition to conducting routine maintenance checks, service technicians perform a variety of other repairs. • They diagnose electrical problems and adjust or replace defective components. • They also disassemble and repair undercarriages and track assemblies. • They weld broken equipment frames and structural parts, using electric or gas welders.

	**Individual Activity 2**

Interpret and analyse collected data

It is important that the learner should be able to identify the data relevant to satisfy his/her objective. By identifying the relevant data, the method of explaining and analysing the data is made easier. By this time, the data collected should be collated – grouped and interpreted and the relevant numbers should be compiled in the form of a report or in some other format and be ready for interpretation and analysis of the data. The learner doing this specific outcome should be able to explain the methods for analysing and interpreting the data, but also be able to interpret initially, or further interpret the data sheet.

Summary:

Recorded collated data formats (adjust to suit your context where you work in)

1. Written format: Graphical presentation; recording sheets or logbooks; tabulate)
2. Electronic format on a computer system
3. As an oral presentation
4. Visual presentation

Is the reporting format selected in a usable format for others?

Can data that is reported on be referred to at a later stage without doubt?

Data reported on should include additional comments or an opportunity to identify inconsistencies in the data sheet or alternative results that occurred as expected.

Tools used in the data collection process should be identified as being impaired or non-functional (electronic tools) and reported on as such.

If we consider an example it becomes more obvious what kind of methods of analyses we are referring to. It depends on the report format of the data set.

American bollworm moths: Light trap data													
	2-Jan-02	22-Jan-02	11-Feb-02	4-Mar-02	25-Mar-02	15-Apr-02	6-May-02	27-May-02	18-Jun-02	8-Jul-02	29-Jul-02	19-Aug-02	TOTAL
L7 - Bt cotton	5	15	34	2	3	15	0	0	*	*			74
L7 - weeds	1	0	1	0	0	4	0	2	0	1			9
L12 - Bt cotton	1	24	30	0	0	18	1	*	*	*			74
L12 - Non-transgenic cotton	*	*	49	2	3	35	0	*	*	*			89
L12 - weeds	9	17	10	0	0	1	1	*	*	*			38
Totals	16	56	124	4	6	73	2	2	0	1	0	0	284

es

ys

good to represent a tendency over time graphically. The learner should adapt his or her method of analyses to suit the data set.

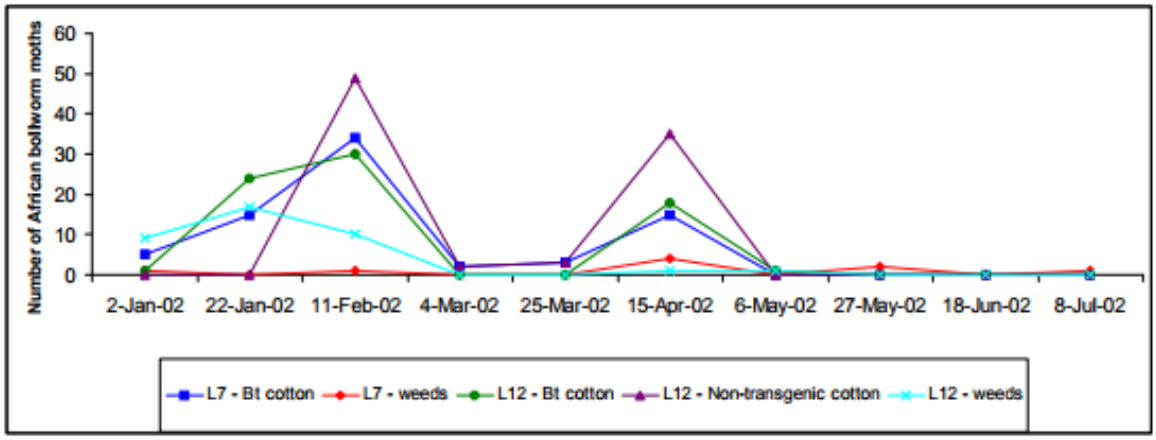


Figure: The number of African bollworm moths caught in the light trap from January to July 2002. (data adapted from Agri-Biotech Research Consultancies cc.)

In this example the data is analysed by presenting it graphically. It is interpreted by observation and studying the data set. In the above example the tendency for bollworms moths on all the cotton types could be observed and was highest on the non-transgenic cotton on two occasions. AC. 3.2.

A check for accuracy would reveal that the y-axis heading of the data set is incorrect and should not read “African bollworm” but “American bollworm” This could lead to confusion and should be corrected and reported on. It should also be explained in the table why some of the values were missing and not necessary zero values. In this case, the light trap batteries were stolen at the various localities. The leaner should be able to advise on the problem and rectify the matter, by making a plan with the batteries and repeat the data set. AC 3.3.

	**Group Activity 3**

Present collated data coherently

When compiling agricultural data and collecting the information that is required, it is important to remember that it is important to choose the methods of data collection carefully in order to make reporting on the data easily understandable and applicable to the objective of data collection. In order to integrate different concepts and conclusions made based on the data set, it is necessary to present the collated data packages together. If it were a series of data gathered at different intervals, the presentation of the data sets in a consistent fashion would demonstrate the tendency in the data series.

Different methods of data presentation and the selection of the most appropriate method

Different methods of presentation are available depending on the data gathered. Most data sets in agriculture is aimed to be presented at decision makers, be it farmers, researchers, supervisors, politicians, trainers, extension officers etc.

At the farming level, the presentation of a set of data would probably be in a simple manner, and would be in line with the competency of the skills of the person presenting the data set. The presentation of the data is also determined by the extent of detail that is presented in the report, or by the person who are being supervised. Often, it may be that the person presenting

the report would also gather the data, write the report and also present the results to his/her supervisor or to the interested parties.

Presenting Data

Simple Ways of presenting data: Transferred verbally with the aid of

- Flip charts
- Written reports
- Reported with drawings on paper, on blackboards, on pin-up boards.

Data report transferred in writing

- In tabular format,
- As a summary

Advanced Ways of Presenting Data:

- Computer print outs e.g., Weather reports, statistical analyses, data logger reports, report of an instrument that measured a specific parameter, scanning reports etc.
- Computer print outs from data that was typed into the computer system and saved to a file for future reference, e.g.
- Excel spread sheets.
- Digital presentation by making use of a visual computer programme, such as Power point presentation (Windows Office software).
- DVD or video presentation of a series of data.
- Presentation by electronic media such as email.

Whichever method of presentation is selected, the importance issue is communication, be it verbally or in writing.

The importance of presenting results accurately and state findings clearly

Results or data should be presented accurately, and the findings of the report should be stated clearly.

A person completing this learning outcome should be able to have a good comprehension of how important it is to present data packages accurately. The incorrect presentation of data could lead to incorrect and irrelevant findings made and further be presented as recommendations. The “accuracy” of the data should be correlated with the necessary skill required to provide the data information and to gather the data. Accurate data helps us to make meaningful decisions and to plan effectively in order to maximise our crop yield and crop quality, for maximum profitability and sustainability (i.e., without damaging our environment).

In order for us to report and present data accurately it is important to remember the following points:

Step	Action Completed	Yes	No
Step 1	Draft specific formats of sample-information collecting forms & reports.		
Step 2	Educate ALL staff that are involved in the data collection process, and be able to trace any missing values to a specific person who was responsible for collection of the data.		
Step 3	Maintain all equipment used for data collection correctly and properly (as to remain in excellent, calibrated working order).		
Step 4	Check and analyse reports and data critically on a regular periodic basis.		
Step 5	Link your presentation to the data sheet. E.g. a graphical presentation displayed as a power point presentation, should be able to link to the excel data sheet where the series presented contains the numbers.		
Step 6	You should be able to repeat the method of data collection and the subsequent presentation, but the results may vary depending on the context.		
Step 7	Draw sensible conclusions from your collated data in your presentation.		

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Example:

In a questionnaire to two groups of inhabitants on gardening problems the following answers were given with regards to the pests attacking garden vegetables:

Table: Indicating percentage of vegetable growers reporting on pests present in their gardens.

Practice	Group 1	Group 2
Respondents no.	14	10
Snails	64	100
Leaf and stem-eating worms	21	30
Diseas	21	10
Aphids	14	20
Dogs	14	10
Moles	*	50
Birds	14	*
Other insects	14	*

Written report presented by e.g., extension officer

All but two respondents reported specific pest problems. The result from the table above shows that snails were the principal pest, followed by leaf-end stem-eating worms (possibly cutworms). A variety of plant diseases included “rotting” while aphids and stray dogs, which trample gardens and dig out plants. In the absence of fencing were troublesome. Strangely enough the second group did not report on moles, which are often a problem in this area. Lastly came the birds (not chickens) and other insects including ants and thrips.

In the above example, the deductions made in the written presentation, are good, but do not provide reasons for the accuracy in the data sheet. An important recommendation or not that should have been reported on could be in this case that the lack of insects to be reported on in the questionnaire as pests, is probably due to the persons answering the questionnaire being unskilled in the identification of insect pests. This would not provide accurate data, though it was correctly reported on as findings, but not explained fully. This example demonstrates that the findings and presentation of data should be explained and be brought into context when,

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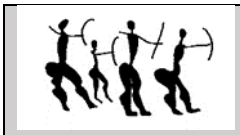
how and by whom the data was gathered. In this case human “error” could have implications in important decisions made if these groups of people need chemicals for pest control or not so. Collection of data packages should also be able to be repeated, thought the results in some instances like weather reports may vary, as well as scouting of insects. Within a specific time, similar results may be obtained.

	**Group Activity 4**

Learning Unit 4: Statistics and Analysis

Unit Standard	
9015	Apply knowledge of statistics and probability to critically interrogate and effectively communicate findings on life related problems
Specific Outcomes	
SO 1: Critique and use techniques for collecting, organising and representing data. SO 2: Use theoretical and experimental probability to develop models. SO 3: Critically interrogate and use probability and statistical models.	
CCFO's	
Identifying	Collecting
Communicating	Contributing

Collecting Data

Data

Data – the word is everywhere! Data processing, databases, numerical data, data entry operation, data banks, and data just about everything else. It's the "in" thing these days – sort of instant prestige (take the word "data" add another noun or two, tack it onto your title, and you've got it). Well despite their prominent place on most office pedestals, data are really sort of everyday fellows.

Data are actually just bits of factual information. Numerical data are bits of factual information stated as numbers – indicating quantities, such as counts or measurements. Data that are somehow related to each other, enough so they can be compared, can be statistical data.

Example:
For example, your salary figure, by itself, with nothing to compare it with, probably would be of little use to a statistician (some of us feel our salary figure is of little use to anyone).

Business Decisions and Data

Today, changes occur rapidly. To take advantage of these changes, decisions with long-term implications must often be made quickly. Information is vital. Farmers, for example, must be conscious of market needs and must determine how to react to changing economic, political, and social situations to maintain a competitive advantage and remain profitable.

The question is whether our decisions, based on the information we receive, are making things better, having no effect, or making things worse. We will argue that decisions based on numerical information or data, if the data are collected and processed correctly, typically make things better.

Consider the following situations where decisions seem to naturally depend on data.

- A survey of customers indicates that a bank should improve the quality of its customer service. What should the bank do? The first step might be to concentrate on the teller-

customer interaction. To improve service, the bank might use data on the lengths of time for teller transactions, the number of customers waiting in line, the teller error rates, the costs of handling exceptional requests, the amount of teller turnover, and so forth. These data could then be used to examine the entire process of providing customers with exceptional service.

- Capital for company projects can be raised by selling bonds or issuing additional shares of stock. The choice of one or the other (or some combination of the two) depends, to some extent, on the likely behaviour of interest rates, inflation, tax policy, and other economic variables. These variables are described by sets of numbers or data. Interest rates may be given by a set of short-term (6-month certificate-of-deposit) and long-term (10-year Treasury note, 30-year Treasury bond) rates. Tax policy may be characterized by a set of tax brackets.
- A drug company has developed a drug for combating the HIV virus that, according to the company, is more effective than current drugs and has fewer side effects. Before the company can produce and market the drug, however, it must receive government approval. Approval from the Medical Council requires that the company successfully complete a set of clinical trials. That is, the proposed drug must be tested, under carefully controlled conditions, on groups of human subjects. Data on the effectiveness and side effects must be collected, analysed, and reported as part of the company's case. As part of its review, the Medical Council must decide whether the company's claims are sound. Were the data collected properly? Were the data interpreted correctly?

Sound decisions involve the collection of pertinent data and the application of appropriate techniques for extracting the information contained in the data.

Statistics and the Scientific Method

The original idea of "statistics" was the collection of information about and for the "state". The word statistics derives directly, not from any classical Greek or Latin roots, but from the Italian word for state.

The birth of statistics occurred in mid-17th century. A commoner, named John Graunt, who was a native of London, began reviewing a weekly church publication issued by the local parish clerk that listed the number of births, christenings, and deaths in each parish. These so-called Bills of Mortality also listed the causes of death. Graunt who was a shopkeeper organized this data in the form we call descriptive statistics, which was published as Natural and Political Observations Made upon the Bills of Mortality. Shortly thereafter he was elected as a member of Royal Society. Thus, statistics has to borrow some concepts from sociology, such as the concept of Population. It has been argued that since statistics usually involves the study of human behaviour, it cannot claim the precision of the physical sciences.

If we knew exactly what was going to happen, when it was going to happen, and to whom it was going to happen, we could prepare for it. Knowing everything makes decision making easy but life less interesting. If Eskom knew how cold it was going to be next winter, it would be simple to plan for the amount of electricity to have available. On the other hand, operating with complete uncertainty is frustrating and often costly. Fortunately, there is a middle ground. Often, we can collect or generate numerical information that, although not eliminating uncertainty entirely, will allow us to learn enough about the underlying situation to perform effectively.

Statistics is the body of methodology concerned with the art and science of gathering, analysing, and using data to identify and solve problems, and to make decisions. Statistical methods should be regarded as valuable tools. They do not replace critical thinking and common sense. However, if used correctly, statistical methods enable us to generate and assemble numerical information in a way that will help us pick out the signals in the fog, make better decisions, and create more rapid improvements in processes and products.

Statistics is a science assisting you in making decisions under uncertainties based on some numerical and measurable scales. It is about obtaining facts from figures, but moreover it is the ability to transform raw numbers (data) into knowledge that can be acted upon. Today's business decisions are driven by data. Statistical skills enable you to intelligently collect, summarise, analyse and interpret data relevant to your decision-making process.

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Statistical concepts and statistical thinking enable you to:

- Represent data in meaningful ways that are understandable by others;
- Identify functional relationships between variable quantities;
- Justify decisions on the basis of data: the decision-making process must be based on the data and not on personal opinion or belief.
- Solve problems in a diversity of contexts. Some would say, particularly from a business perspective, that statistics is the study of variation. The Director of Statistical Methods for Nashua Corporation maintains that the central problem of management, in all its forms, including planning, research and development, procurement, manufacturing, sales, personnel, accounting, and law, is the failure to completely understand variation. What are its causes?

What does it mean?

The director is referring to the differences in numbers of the same type and the failure to understand the information contained in these differences.

Variation can often be summarized in simple graphs. Pictures are often easier to interpret than tables or lists of numbers. Spreadsheet programs can be used to construct familiar displays like bar charts and pie charts. For the former, amounts are indicated by the heights of bars. For the latter, amounts are indicated by the areas of pie slices.

Elements of Data Collection

Collecting data from a complex environment can be time-consuming and expensive. Consequently, it is necessary to have a plan and a systematic collection method that gains maximum information at minimum cost. Every effort should be made to comply with sound data collection principles so that the information received is as accurate and relevant as possible.

There are two types of data:

- Primary data and
- Secondary data.

Secondary data are collected by someone else and are available in published sources. Quarterly profits published in the Finance Week are secondary data. For our purposes, primary data will refer to data collected directly by the investigator or by the organization employing the investigator.

Primary data are collected by a variety of methods: simple observation, personal interview self-enumeration, check sheets, electronic data capture, experiments simulated on a computer, and controlled laboratory or field experiments.

Steps in Data Collection

Certain steps help to ensure data quality. Collecting data properly, particularly data collected as part of a survey, is often an intricate process. Data collection requires careful reflection on the complexities involved in a population structure, the practical feasibility of sampling methods, the coordination and supervision of field work, and finally the processing, analyses, and reporting of the data. We briefly introduce these issues by examining the principal steps involved in the collection of primary data.

Determine the purpose of the study

In order to have a clear goal of the investigation we need to decide on the following:

- What do we hope to learn from the data?
- How are we going to collect the data?
- By defining the purpose of the study as specifically as possible before we even start ensures that we are unlikely to overlook vital information.

Determine the data to be collected

There are two main ways of collecting data: questionnaires and recording of experimental results.

Questionnaires:

In sampling human populations, the main method for gathering data is the questionnaire. A well-designed questionnaire is crucial to the success of a survey.

A well-designed questionnaire is usually anonymous, but allows you to collect background information about the person that is answering the questions. We usually ask questions regarding age, gender, income bracket, number of children or race. These are called **demographic questions**. Demographic data helps you paint a more accurate picture of the group of persons you are trying to understand. For example, if you want to find out what type of chocolate is the most popular, you will probably get very different answers from males or females, teenagers or elderly people.

Two types of questions can be asked in a questionnaire: **open ended** questions or **closed questions**. If you ask: How old are you?" the person answering has to write an answer. This is an open-ended question. The advantage of these questions is that you get a very accurate reflection. The disadvantages are that this type of questionnaire takes longer to complete and that you will find it very difficult to group the responses when you analyse the data later.

You could ask the same question as follows: Mark your response with a cross.

Your age	10-20 years	20-30 years	30-40 years	40-50 years	51 and older

The person answering the questions does not have to write anything, but merely place a cross. This type of question is answered more easily and quickly. Analysis of data is also much faster.

Please see appendix 1 for more information about the different ways you can phrase questions in a questionnaire.

How is our service? Please take a few minutes to complete our survey. Mark your response with a cross					
1. Your age	1 Below 20 years	2 20-30 years	3 30-40 years	4 40-50 years	5 Older than 50 years
2. Your gender	Male	Female			
3. Where do you live?	1 In Nelspruit	2 Within 10 km of Nelspruit	3 10 to 20 km from Nelspruit	4 20 to 30 km from Nelspruit	5 More than 30 km from Nelspriut
4. How often do you visit a restaurant?	1 More than once a week	2 Once a week	3 Once a month	4 A few times a year	5 Hardly ever
5. How friendly are out waiters?	1 Excellent	2	3	4	5 Poor
6. How quickly did you get served?	1 Excellent	2	3	4	5 Poor
7. Appearance of your meal	1 Excellent	2	3	4	5 Poor
8. Quality of the food	1 Excellent	2	3	4	5 Poor
9. What did you like best about your visit to our restaurant?					

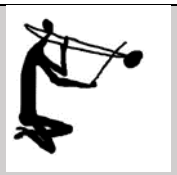
Experimental results:

If we perform an experiment in the field or in a laboratory, then we need to plan how we are going to record our data. We draw up a sample table during the planning phase. The table is then used during the collection of data. We need to decide what our independent, dependent and controlled variables are. For example, Mr Rose, a flower farmer wants to see if a new brand of fertiliser will give him more flowers. He will plant two plots with exactly the same plants, but give them different fertiliser.

The variables are as follows:

Independent variable: fertiliser type (i.e., either type A or type B)

Dependent variable: Number of flowers produced per plant



Individual Activity 1

Determine the plan for collecting the data

The method used for collecting data depends on the money and equipment available, and also on the purpose of the investigation. You must choose a sample design and a sample size.

The choice of the **sampling design** is based on such factors as the structure of the population, the type of information sought, and the administrative facilities and personnel available to carry out the plan. In conjunction with choosing the appropriate data collection method, we determine the required **sample size** by specifying the degree of precision desired in the sample summary measure. Data collection costs money, thus you must choose a sample procedure that you can afford

Example:
Farmer Rose would select two small plots close to each other to conduct his fertiliser trial. He would need to repeat the experiment a few times in order to collect sufficient data for analysis. Perhaps he could select six plots of 1 m2 each, so that he could conduct the trial three times at the same time. Farmer Brown, on the other hand, could select 30 cattle that are similar in size for each treatment. In this way he could get a reasonably good idea which dip works best without spending huge amounts of money and time.

Train personnel

Training is often needed for the people responsible for actually recording the observations and organizing them in files. Training may take several forms and may be ongoing if the data collection takes place over an extended period of time.

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Everyone should understand the importance of the data so that data collection is taken seriously. Why are the data being collected? What difference does it make to the organization? What happens if the data contain errors?

Analyse and report the data

Once the data collection plan is established and the data are collected, the full force of graphic and numerical techniques can be used to interpret the results. Ingenuity in creating plots and careful data analysis can suggest interesting relationships and conclusions that may be considered in additional studies. Data may be reported as lists of numbers, as summary measures, in graphical form, in tables, or as an equation, or they may simply be described verbally. In general, data should be reported so the information is readily apparent to those who will use it to make decisions. If the appropriate presentation method is unclear, ask the user. Alternatively, imagine yourself as the decision maker. Which methods work for you?

Example:
Illustrating the Steps in Data Collection Farmer Green owns six farms. He needs to evaluate how well the managers of the farms are working. As part of this exercise, information is to be collected from farm workers about the performance of their managers. Describe the possible steps in a data collection process.

Solution and Discussion

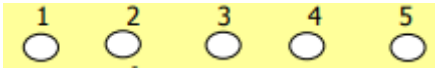
- **State the purpose of the study**. The objective is to get information from subordinates about the performance of their managers. This project is important because changes in organizational structure, salary adjustments, and advancement opportunities will depend on the outcomes. Data will be collected with a questionnaire given to all workers. Responses will be confidential.
- **Determine the data to be collected**. Performance variables might include the following: ability to communicate goals and objectives; accessibility; leadership ability; ability to delegate; commitment to quality; management of resources; interpersonal skills; availability of feedback; and overall effectiveness. Questions related to these variables will be included on the questionnaire. The response to each performance variable question will be indicated on a 5-point scale.

1 2 3 4 5

Almost never Almost always

A sample question follows:

My supervisor: Gives me honest feedback that helps me improve my performance.



In addition, the top of the questionnaire will have a space for the manager's name. The respondent will also indicate the length of time with the current supervisor by checking one of the three response categories: less than 1 year, 1-2 years, or more than 2 years.

- **Describe the plan for collecting the data**. The data will be collected from all workers. A two-person team has been designated to construct and distribute the questionnaire. The questionnaire will be limited to a single page. The team will help workers to fill in the questionnaire, and tabulate and summarize the data.
- **Train personnel**. Each of the team members has completed a short training course on questionnaire construction and ways of dealing with people. Farmer Green has instructed each of the team members on the importance of this project. A draft version of the questionnaire will be tested with a small group of people to be sure the questions are clearly stated and provide the information required.
- **Analyse and report the data**. After the questionnaires are produced and distributed, the team will allow a week for the questionnaires to be completed. As the questionnaires are returned, they will be checked for the manager's name and to see if all the questions have been answered. Data will be entered into a file in a spreadsheet program as the completed questionnaires are received. One member of the personnel team is responsible for data entry. Another member of the team will check a printout of the file for errors. Reports for each manager, including a sample questionnaire and the data summaries, will be prepared and forwarded. Each report will also indicate where the raw data are stored and how they can be accessed. The members of the team will be identified as the authors of the reports.

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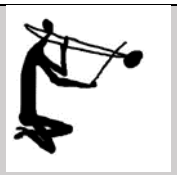

Individual Activity 2

Methods for Collecting Data

A variety of procedures exist for collecting data. Three commonly used ones are:

Observation

Personal interview

Self-enumeration

Observation

Observation entails direct examination and recording of an ongoing activity.

Example:

1. In a study of family decision making, a researcher observed and recorded interactions between husband and wife as they decided on the brand of colour television to buy.
2. In an engineering study, data about the internal temperature of an oven were obtained by reading all instruments inserted ill the oven.
3. In a marketing study, an analyst monitored customer flow in a department store by means of closed-circuit television.

The observation procedure has certain advantages:

- The directness of the procedure avoids problems such as incomplete or distorted recall.
- Data can be gathered more or less continuously over an extended time period.

Limitations of the method include the following:

- The observer (or the instrument) must be free of bias and must accurately record the events of interest. Human observers usually require thorough training so that they will record precisely what they observe and so that different observers will record the same events in the same manner.

- Individuals who are under observation and aware of this fact may alter their behaviour and, as a result, observations of their behaviour may be biased.

Personal Interview

In a personal interview, an interviewer asks questions that are printed on a questionnaire and records the respondent's answers in designated spaces on the questionnaire form.

Example:

1. A household member was interviewed at home about purchases of toothpastes and mouthwashes and about family characteristics, such as income and family size.
2. A household member was interviewed over the telephone about television viewing, including viewing at the moment of call, the station viewed, and number of persons viewing.
3. A company's financial executive was interviewed at the office by a representative of a trade association about the firm's plans for capital expenditures in the coming year.

Both the advantages and limitations of securing data through personal interviews arise from the direct contact between the respondent and the interviewer. Advantages include the following:

- Persons will tend to respond when they are approached directly; hence, the personal-interview procedure usually yields a high proportion of usable returns from those persons who are contacted.
- The direct contact generally enables the interviewer to clear up misinterpretations of questions by the respondent, to observe the respondent's reactions to particular questions, and to collect relevant supplementary information.

There are several limitations of the personal-interview method:

- The interviewer may not follow directions for selecting respondents. For instance, if a member of the family other than the one designated is interviewed, a bias may be introduced into the results.
- The interviewer may influence the respondent by the manner in which the questions are asked or by other actions. A slight inadvertent gesture of surprise at an answer, for example, can exert subtle, undetected pressures on the respondent.
- The interviewer may make errors in recording the respondent's answers;

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Self-Enumeration

With self-enumeration, the respondent is provided with a questionnaire to complete, which often also contains necessary instructions.

Example:

1. A student who graduated from high school recently received a self-enumeration questionnaire through the mail, a page of which is shown in Figure 1.1, to provide information about educational activities since graduation.
2. A new magazine subscriber received a questionnaire through the mail to provide information about age, type of job held, income, and amounts of money spent last year on specified recreational activities.
3. A person completed a certificate of registration for a motor vehicle, supplying information on make, model, and year of car.
4. A purchaser of a toaster filled out the warranty card, giving information on family characteristics and on the primary method by which attention was directed to this appliance (e.g., word of mouth, television commercial).

Both the advantages and limitations of the self-enumeration procedure arise from the elimination of interviewers. The type of interviewer error discussed earlier is thus avoided. On the other hand, the absence of interviewers creates two serious problems:

- When a questionnaire is sent to a household or an organization, there is no control over which person answers the questions.
- The absence of interviewers can lead to low response rates. A low response rate can be a source of serious bias in survey results, because the persons who do answer the questionnaires are often not representative of the entire group contacted. The user of data collected by a self-enumeration procedure should therefore know the rate of non-response as one factor affecting the magnitude of the potential bias.

Where there is a material rate of non-response some follow-up of non-respondents will be valuable. In most well-conducted mail surveys, some or all of the non-respondents are contacted as a routine procedure. Non-respondents may be contacted by means of "reminder" letters, telephone calls, or special personal interviews.

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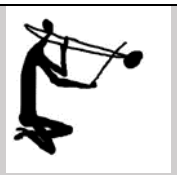	**Activity 3**:

Figure 1.1 Example of part of a self-enumeration questionnaire

3. What was your field of study when you began taking these classes? (*for example, beautician, auto mechanics, IT Technical Support, Customer Management, etc*)	_____ or 117 ◻ No specific field of study
4. What is the full name and address of the learning institution you attend?	Name _____ Address: _____ _____ _____ 118
5a. At the institution you entered in question 4, were you enrolled in a program leading to a formal qualification?	119 1. ◻ **Yes –** Continue with question 5b 2. ◻ **No –** Continue with question 6
5b. How many years of continuous full-time study does it usually take to complete the requirements for the programme you were enrolled?	120 1. ◻ Less than 6 months 2. ◻ 6 months to 1 year 3. ◻ 2 years 4. ◻ 3 years
5c. Did you complete this programme?	121 ◻ **Yes –** When did you complete that program? _____ *Go to question 6* 122 ◻ **No –** When did you last attend classes? _____ *Continue with question 5d*
5d. What are the reasons that you did not complete the programme? (Mark (X) to all that apply)	123 1. ◻ Financial reasons 2. ◻ Academic problems 3. ◻ Took a job 4. ◻ Other – specify _____
6. Since you left high school, have you been enrolled in a college or university?	124 1. ◻ **Yes –** Continue with question 7 2. ◻ **No –** Go directly to question 15a

Organising and analysing data

Introduction

Among the first activities in statistical analysis is to count or measure: Counting/measurement theory is concerned with the connection between data and reality. A set of data is a representation (i.e., a model) of the reality based on numerical and measurable scales.

How data is presented and analysed depends on the type of data collected. Certain statistical methods are valid for certain data types only. Any characteristic being measured or observed (e.g., assessment results, choice of canteen meal) is referred to as a variable. Since data collected for statistical purposes can take on a variety or spread of values that are not pre-determined, these variables are termed random variables. E.g., When measuring assessment results, the values of the data can range from 0% to 100%. The random variable under study is Assessment Result. The individual data values are the values between zero and one hundred. They are also referred to as observations.

The use of measurement

Data may be classified in different ways according to the nature of the random variable under study. Random variables may be classified as:

- **Qualitative**: which yield non-numeric answers. Examples are eye colour, gender, marital status (i.e., married, divorced, single, widowed, living together) This type of information cannot be manipulated mathematically.
- **Quantitative**: which yield numeric responses that can be mathematically manipulated. Data is measured by Quantitative random variables (e.g., Income, Prices, Assessment results).

  Data of random variables can also be classified as:

  - **Discrete Data** (or discrete random variables): are data that can assume specific values only, (usually whole numbers). Discrete random variables are characterised by data that is countable. E.g., The number of employees in an organisation.

- **Continuous Data** (or continuous random variables): are data that can assume any numerical value. Continuous random variables are characterised by data that is measurable. E.g., income, age, time to complete a task, the height of a person.

Data organisation and presentation

There are many ways of presenting data. No one style is appropriate for all types of data. You should select the style so that the observer will be able to understand the features of the data that you want to illuminate. Here are a few types of data presentation styles:

Tables

Lists of numerical quantities. If the data set is "small" just listing the data can be done. As the data set becomes larger this is not a good technique. Remember that people can only look at a very small set of number without "turning-off".

EDUCATIONAL LEVEL IN INDUSTRY				
YEAR	CERTIFICATES	DIPLOMAS	DEGREES	TOTAL
1999	50	20	0	70
2000	70	35	10	115
2001	100	35	15	150
2002	130	50	20	200
2003	200	100	30	330
TOTAL	550	240	75	865

Pictograms

The simplest way of visually representing data is to use pictograms. Pictures are used to compare quantities. This can have the look as a bar graph as well as add some interest to the viewer. Pictograms were dealt with in great detail in earlier modules and you are invited to refer back to work from previous years.

Pie Charts

Used to illustrate proportions of the total amount. The size of each slice shows how much of the total the slice represents. This type of graph is seen quite often in economics. The disadvantage is that the viewer has no idea how big the actual sample size was.

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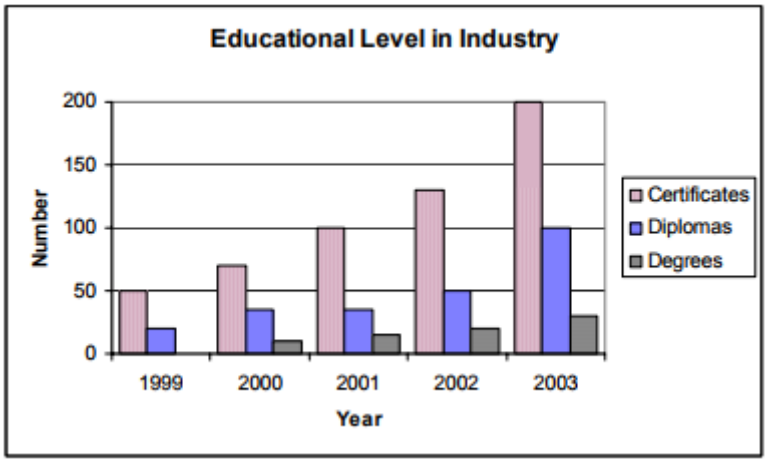
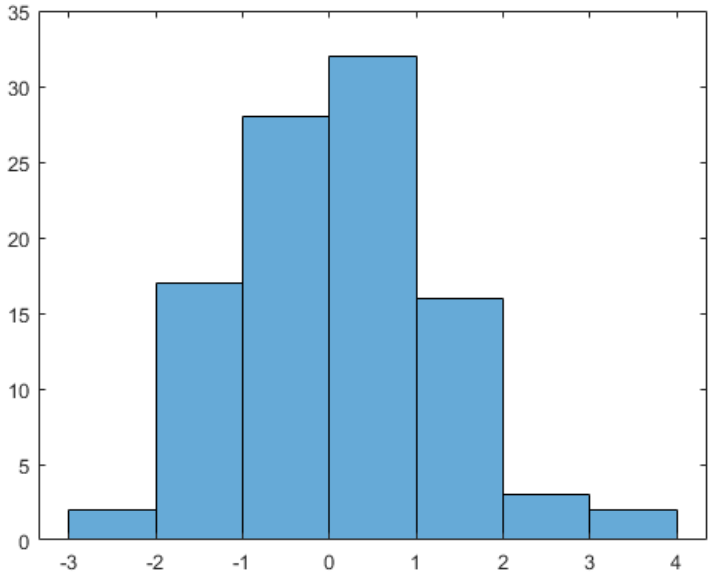
Bar Graphs

(Bar Charts). The length of a bar represents the quantity that is under comparison. There are many types of bar charts, but they all should try to have a uniform width, spacing, and a zero value. Remember that bar charts have gaps between them. (Learning tip: bar graph has a gap in its name!). Bar graphs are used when there is no continuity between data groups. For example: if you are comparing the sales if a number of different types of bakkies you will use a bar graph. There is no continuity between a Nissan bakkie and a Toyota bakkie.



Histogram

A histogram has no spaces between the bars. It is used when there is continuity between the categories selected. A histogram is also used in showing frequency distributions.

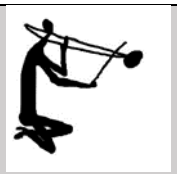


Time Plot (Time Series)

Graphs used to illustrate some characteristic over time. These, and regression plots study two random variables simultaneously. There are many examples of this in economics, e.g. Daily share prices.

- Graphs must be clearly labelled so as to avoid any ambiguity as to what information is being conveyed.
- The reader must also be informed of the source of the presentation so that the data may be authenticated if necessary.
- The ultimate choice of presentation depends on the data type:
  - For qualitative data (nominal and ordinal) use tables, pie and bar charts.
  - For quantitative data (interval and ratio) use histograms or line graphs.

  The latter is useful for looking at trends over time. Graphs can be powerful tools to convey information but can also be confusing to understand. Try to keep them simple and use the type of graph which best illustrates information about the data and its characteristics.

	**Individual Activity 4**

Range

The range is defined as the difference between the maximum and minimum data values.

Example:

Farmer Green has measured the height (in meters) of his calves and has the following data set, arranged from smallest to biggest:

0,7; 0,8; 1,3; 1,5; 1,5

The range of heights is 1,5m – 0,7m = 0,8m

Measures of central tendency

Most measurements are distributed randomly in the range that they were collected in, but most of them concentrate around some sort of "central tendency" or "average". Three measures of central tendency are the mean, median and mode.

Thabo employs 10 workers on his farm. Below are the weekly wages of the 10 workers: R250; R275; R200; R520; R260; R250; R250; R260; R200; R240		
Arithmetic Mean Work out the total and divide by the number of items	Add up all the wages Total = R2705 Mean = total/number of wages Mean = 2705/10 = R270.50	The mean is R270.50
Median The median is the middle-most value. Write all the numbers from biggest to smallest, and find the middle number. If there is an even number of items, then there will be two middle numbers. The median is in the middle of those two numbers.	Write numbers from smallest to biggest R200; R200; R240; R250; R250; R250; R260; R260; R275; R520 The two middle numbers are R250 and R250. Median = (R250+R250)/2 = R250	The median is R250.00
Mode The mode is the number that appears the most often. Write the numbers in order and see which one occurs the most often.	Write numbers from smallest to biggest R200; R200; R240; R250; R250; R250; R260; R260; R275; R520 R250 appears three times.	The mode is R250.00

The Main Characteristics of the Mode, the Median, and the Mean

Fact no.	Mode	Median	Mean
1	It is the value that appears the most often.	It is the middle-most value.	Add all the values and divide the total by the number of items.
2	A distribution may have 2 or more modes. On the other hand, there can also be no mode	Each array has one and only one median.	An array has one and only one mean.
3	It cannot be manipulated algebraically.	It cannot be manipulated algebraically.	Means may be manipulated algebraically.
4	Individual values need to know to calculate the mode	Individual values need to know to calculate the mode	You can calculate it even if you do not know the individual values. You need to know the total and sample size

5	Values must be arranged from smallest to biggest.	Values must be arranged from smallest to biggest.	Values need not be ordered or grouped for this calculation.
6	Tells you what score occurs the most often.	Provides a better measure of location than the mean when there are some extremely large or small observations. Median income is used as the measure for the SA household income.	Very easy to calculate and used the most often when there is a list of numbers.

How spread-out is data?

Sometimes data are not spread equally (i.e., they are skewed), making the mean senseless. In this case the median is a better representation of the central tendency. To get an idea of the spread of data, we calculate quartiles and percentiles.

Quartiles and the 5-number summary

Consider the following list of data: 1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11

The median is 6 1; 2; 3; 4; 5; **6**; 7; 8; 9; 10; 11

The median is the middle most value. The first quartile is the value that lies in the middle of the group of data below the median.

The first quartile is 3 1; 2; **3**; 4; 5; **6**; 7; 8; 9; 10; 11

The third quartile is the value that lies in the middle of the group of data above the median.

The third quartile is 9 1; 2; **3**; 4; 5; **6**; 7; 8; **9**; 10; 11

You can quite clearly see that the median is the same as the second quartile.

The inter-quartile range is the 3rd quartile – 2nd quartile. Here it is 9-3 = 6.

The Inter-quartile range tells us that 50% 0f data lie between the values of 3 and 9.

We can summarise the data set in a 5-number system:

- Minimum value of the data set
- 1st quartile
- 2nd quartile = median

- 3rd quartile
- Maximum value of the data set

Let us prepare a 5-number summary for the data set above:

- Minimum value of the data set 1
- 1st quartile 3
- 2nd quartile = median 6
- 3rd quartile 9
- Maximum value of the data set 11

Example:

Below is a list of test marks of students, arranged in order.

Calculate the 1st, 2nd and 3rd quartiles.

2; 5; 5; 5; 12; 13; 13; 14; 15; 15; 15; 17; 19; 19; 19; 20; 22; 24; 25; 26; 26; 30

First, we calculate the 2nd quartile or median:

2; 5; 5; 5; 12; 13; 13; 14; 15; 15; **15**; **17**; 19; 19; 19; 20; 22; 24; 25; 26; 26; 30

Median = (15+17)/2 = 16

Now we calculate the 1st quartile:

2; 5; 5; 5; **12**; **13**; 13; 14; 15; 15; **15**; **17**; 19; 19; 19; 20; 22; 24; 25; 26; 26; 30

1st quartile = (12+13)/2 = 12,5

Now we calculate the 3rd quartile:

2; 5; 5; 5; **12**; **13**; 13; 14; 15; 15; **15**; **17**; 19; 19; 19; 20; **22**; **24**; 25; 26; 26; 30

3rd quartile = (22+24)/2 = 23

Now comes the 5-number summary:

Minimum value of the data set 2

1st quartile 12,5

2nd quartile = median 16

3rd quartile	23
Maximum value of the data set	30
Inter-quartile range	10,5

Example:

Mrs. Naidoo has set 3 Maths tests for her class. She wants to compare how the learners have fared in the three tests. Below is the summary of her results.

	Test 1	Test 2	Test 3
Minimum	4	4	9
1st quartile	11	17	26.5
2nd quartile/median	26	30	39
3rd quartile	39	41	45
Maximum	50	50	50

Comparing tests 1 and 2, we can see that the minimum and maximum values are the same.
The quartiles for test 2 are much higher than for test 1, showing that pupils fared better in test 2.
In Test 3 the minimum value is higher, showing that the weakest pupil improved.
The quartiles are even higher than test 2, indicating that the class improved overall.
Mrs. Naidoo is happy.

Cumulative frequency tables

You saw in Activity 7 that the calculations of large data sets is very cumbersome. There is a quicker way, namely by using cumulative frequency tables. First, let us revise frequency tables.

Example:

In a certain rural area, a survey was done to see how many dogs people had. The results are listed below.

Arrange these data in a frequency table:
3; 5; 1; 3; 7; 5; 6; 5; 9; 5; 2; 4; 4; 5; 5; 8

First, a tally table is drawn up.
Secondly, the tallies are counted and recorded in the frequency column.

Frequency table:

Number	Tally	Frequency
1	1	1
2	I	1
3	I I	2
4	I I	2
5	~~I I I I~~ I	6
6	I	1
7	I	1
8	I	1
9	I	1
		16

Cumulative frequency table:

Number	Tally	Frequency	Cummulative Frequency	
1	I	1	1	Total of people having 1 dog
2	I	1	1+1=2	Total of people having 2 dogs or less
3	I I	2	2+2=4	Total of people having 3 dogs or less
4	I I	2	4+2=6	Total of people having 4 dogs or less
5	~~I I I I~~ I	6	6+6=12	Total of people having 5 dogs or less
6	I	1	12+1=13	Total of people having 6 dogs or less
7	I	1	13+1=14	Total of people having 7 dogs or less
8	I	1	14+1=15	Total of people having 8 dogs or less
9	I	1	15+1=16	Total of people having 9 dogs or less
		16		

To calculate the median, we use a simple formula. There is an even number of data, thus we know that the median is going to lie between two values. To find out between which values it lies, we say (16+1)/2 = 8,5. This means that the median lies between score number 8 and score number 9. Let us look at the table we constructed in more detail:

Number	Frequency	Cummulative Frequency	Which data items lie here?	
1	1	1	Item 1	
2	1	2	Item 2	
3	2	4	Items 3-4	1st quartile lies between item 4 and item 5. The 1st quartile is 3,5
4	2	6	Items 5 - 6	
5	6	12	Items 7 - 12	Median lies between item 8 and 9. This means that the median is 5
6	1	13	Item 13	3rd quartile lies between items 12 and 13, i.e. it is 5,5
7	1	14	Item 14	
8	1	15	Item 15	
9	1	16	Item 16	
Total	16			

The median is 5

First quartile calculation: 1st quartile lies between (16+1)/4 = 4,25

i.e., between items 4 and 5

From the table we can see that item 4 is 3 and item 5 is 4

Thus, the 1st quartile is (3+4)/2 = 3,5

3rd quartile calculation: The 3rd quartile lies between 3(16+1)/4 = 12,75

i.e., between items 12 and 13.

The 3rd quartile is 5,5.

Cumulative frequency graphs (Ogives)

Let us plot the ogive of the data in the table above.

Number	Cummulative Frequency	Points to plot
0	0	(0; 0)
1	1	(1; 1)
2	2	(2; 2)
3	4	(3; 4)
4	6	(4; 6)
5	12	(5; 12)
6	13	(6; 13)
7	14	(7; 14)
8	15	(8; 15)
9	16	(9; 16)

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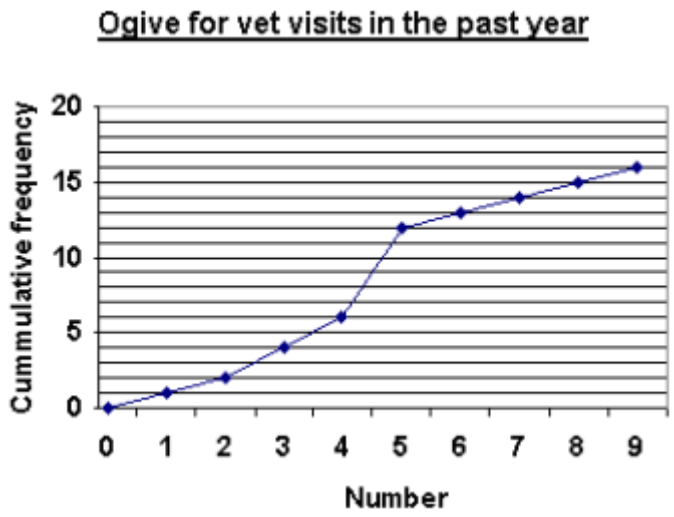

Why Ogives are useful:

- An ogive usually has the shape of a stretched-out S. The better the S shape, the more the data are centred around the middle scores.
- Just by looking at the graph you can tell that the number of farmers interviewed was 16.
- We can use the ogive to estimate quartiles:
  - Median: take (16+1)/2 = 8,5.
  - Draw a horizontal line on the graph at 8,5.
  - Draw a vertical line down from the point where your line cuts the graph's line.
  - Read off the x-value: it is approximately 4,5.
  - 1st quartile: Take (16+1)/4 = 4,25
  - Draw a horizontal line on the graph at 4,25.
  - Draw a vertical line down from the point where your line cuts the graph's line.
  - Read off the x-value: it is approximately 3.
  - 3rd quartile: Take 3(16+1)/4 = 12,75
  - Draw a horizontal line on the graph at 12,75.
  - Draw a vertical line down from the point where your line cuts the graph's line.
  - Read off the x-value: it is approximately 6

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Variance and standard deviation

The measure of how measures are scattered around the mean are variance and standard deviation.

Example:

A farmer wanted to see which plot of land was better for growing trees, plot A or plot B. He measured the height of 7 young trees on each plot.

Plot A: 364cm, 372cm, 364cm, 368cm, 370cm, 368cm, 370cm

Plot B: 304cm, 388cm, 332cm, 432cm, 400cm, 352cm, 368cm

We calculate the mean of each group:

Plot A: 2576/7 = 368cm

Plot B: 2576/7 = 368cm

The means for both plots were the same, so we cannot gain much insight that way.

We now calculate the deviation from the mean for each data point:

Plot A	
Height (cm)	Deviation from the mean
364	368 – 364 = 4
372	368 – 372 = - 4
364	368 – 364 = 4
368	368 – 368 = 0
370	368 – 370 = -2
368	368 – 368 = 0
370	368 – 370 = -2

Plot B	
Height (cm)	Deviation from the mean
304	368 – 304 = 64
388	368 – 388 = - 20
332	368 – 332 = 36
432	368 – 432 = -64
400	368 – 400 = -32
352	368 – 352 = 16
368	368 – 368 = 0

Add up all the deviations for Plot A: 4 – 4 + 4 + 0 – 2 + 0 – 2 = 0

Add up all the deviations for Plot B: 65 – 20 + 36 – 64 – 32 + 16 + 0 = 0

This is also not helping so we need to go one step further.

We re-write the table and add an extra column where we square the deviations from the mean.

For the first value Plot A (364) the deviation from the mean was 4.

We square this number to obtain 16. We do this for every single value.

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See table below:

Plot A			Plot B		
Height (cm)	Deviation from the mean	Deviation ^{2}	Height (cm)	Deviation from the mean	Deviation ^{2}
364	4	4 x 4 =16	304	64	64 x 64 = 4096
372	- 4	16	388	- 20	400
364	4	16	332	36	1296
368	0	0	432	-64	4096
370	-2	4	400	-32	1024
368	0	0	352	16	256
370	-2	4	368	0	0
Total	0	56	Total	0	9872
Mean (Variance)		56/7 = 8	Mean (Variance)		9872/7 = 1410
$\sqrt{\text{mean}}$ = std deviation		$\sqrt{8}$ = 2,83	$\sqrt{\text{mean}}$ = std deviation		$\sqrt{1410}$ = 37,55

Plot A the total is 56. Now we calculate the mean of the square of the deviations i.e., we take 56 and divide by 7 (there were 7 measurements in the sample).

This gives an answer of 8.

This is called the variance.

Variance is defined as the mean of the square of the deviations from the mean.

If we take the square root of the variance, we get the standard deviation. The standard deviation for Plot A is 2,83.

The standard deviation is defined as the square root of the mean of the square of the deviations from the mean. Quite a mouth full!!!

Let us summarise the steps:

i) Add up all the data values

ii) Find the mean.

iii) Calculate the deviations from the mean for each value.

iv) Square the deviations from the mean.

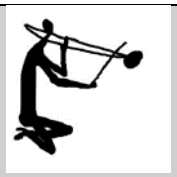
v) Add up all the square deviations from the mean and divide by the number of values. This gives you the variance.

vi) Take the square root of the variance to obtain the standard deviation.

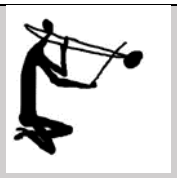
Let us take a closer look at the farmer's result for his trees.

	Plot A	Plot B
Mean	368cm	368cm
Variance	8	1410
Standard deviation	2,83	37,55

Both the variance and the standard deviation show us that there was very little variation in the trees from Plot A. The trees from Plot B, however, had hugely different growths. If the farmer needs to sell fairly uniform trees to logging companies, he would be better off to plant on Plot A. He could do further analysis to see why the trees on Plot B are so very different to one another, or he could use the land for another purpose.



Individual Activity 5

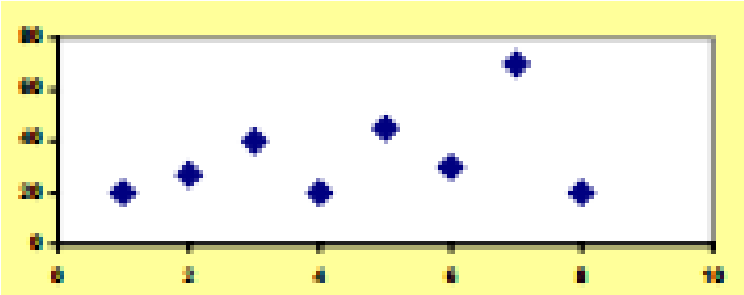


Individual Activity 6:

Scatterplots

Sometimes you have more than one variable to consider at one time. For example, a big company has to decide whether they really get more income if they spend more on advertising. They are trying to compare two variables. We say the data are bivariate.

To see whether income does increase with increased cost of advertising, the company would collect as many data as possible regarding both variables. They would pair the values and write them as (x;y) ordered pairs. They would then plot all these points on a graph. The horizontal axis is the explanatory variable X and the vertical axis is the response variable Y. The result will be scattered points all over the graph. This is known as a scatter plot. Below is an example of a scatter plot.



The purpose of collecting bivariate observations is to answer such questions as: Are the variables related?

If so, does an increase in one variable cause an increase or decrease in the other variable?

What is the nature of the relationship indicated by the data?

Can we quantify the strength of the relation?

Can we make predictions? Studying the x measurements by themselves or the y measurements by themselves would not help us answer these questions.

The scatterplot provides a visual impression of the relation between the X and Y variables. If the points cluster along a line, a linear relation is indicated. Points that band around a curve indicate a curvilinear relation. If the points form a pattern-less cluster, no relation among the variables is indicated.

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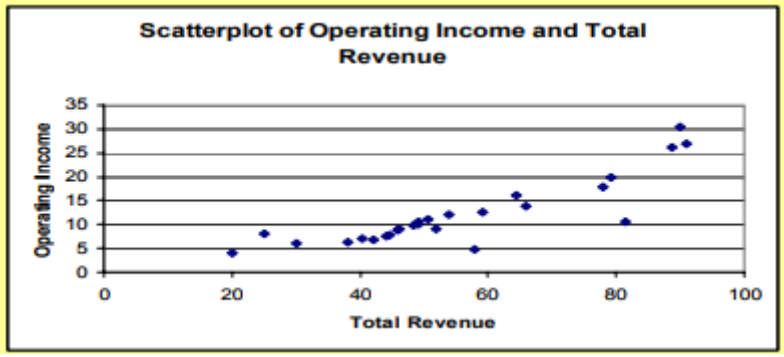
Example:

Constructing and interpreting a scatterplot

Total revenue (millions of Rands) and operating income (millions of Rands) for the n = 26 teams in the Provincial Rugby League for the 2003 – 2004 season can be determined from the data given in the table below. Suppose we believe that total revenue determines or explains, to a large extent, operating income. Plot these pairs of observations as a scatterplot.

Total Revenue	Operating Income	Total Revenue	Operating Income
90	30.4	49	10.5
79.3	20	48.4	9.9
91.1	27	46	9
88.7	26.3	45.8	8.9
81.5	10.7	52	9
50.6	11.1	40.3	7
78	18	44	7.5
59.1	12.7	44.7	7.7
64.5	16	38	6.2
66	13.9	42	6.9
58	4.8	30	6
54	12	20	4
49	10	25	8



Solution and Discussion

The scatterplot of total revenue and operating income for the Rugby League teams is shown in the figure above. Total revenue is the explanatory variable (X variable), and operating income as the response (Y variable).

The points in the scatterplot look as though they lie along a straight line. Low revenue is paired with low operating income. This is what we would expect. When this happens, we say there is a positive association or positive relation between the two variables.

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In addition to providing a graphical description of the association between two variables, scatterplots often reveal information that is not evident from looking at the numbers themselves. The next example illustrates this point.

Example:

Scatterplot illustrating a linear relation with increasing variation.

The following table contains estimated and actual costs (millions of Rands) for 26 construction projects. Plot the bivariate construction cost data as a scatterplot.

Estimated Cost	Actual Cost	Estimated Cost	Actual Cost
575	.918	8.947	13.371
6.127	7.214	3.157	1.553
11.215	14.577	3.540	4.069
28.195	30.028	37.400	27.973
30.100	38.173	7.650	7.642
21.091	15.320	13.700	3.692
8.659	14.837	29.003	29.522
40.630	51.284	14.639	15.317
37.800	34.100	5.292	5.292
1.803	2.003	.960	.707
18.048	20.099	1.240	1.246
8.102	4.324	1.419	1.143
10.730	10.523	38.936	21.571

Solution and Discussion

Let the explanatory variable, X, be estimated cost and the response variable, Y, be actual cost. The (x, y) values are graphed as a scatterplot in the figure below, with the horizontal axis representing estimated cost and the vertical axis representing actual cost.

Example:

The first point to be plotted is (x1, y1) = (.575, .918).

Again, the southwest to northeast pattern of the points indicates a positive association between estimated cost and actual cost; that is, (relatively) high estimated costs tend to occur with (relatively) high actual costs, and (relatively) low estimated costs with (relatively) low actual costs.

If the engineers could explain (predict) construction costs with no error, the estimated cost would equal the actual cost for each project and all the points would lie along the diagonal line

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through the origin. Notice that the points in the scatterplot "fan out" as the values increase. The points corresponding to small projects are closer together than the points corresponding to big (expensive) projects. The deviation (difference) of actual cost from estimated cost appears to increase with the size of the project. The engineers typically come close to determining the costs of smaller projects. They are less successful with the larger ones.

The correlation coefficient – a measure of linear relation

The scatterplot gives a visual impression of the relation between the x and y values in a bivariate data set. In many cases, the points appear to cluster around a straight line.

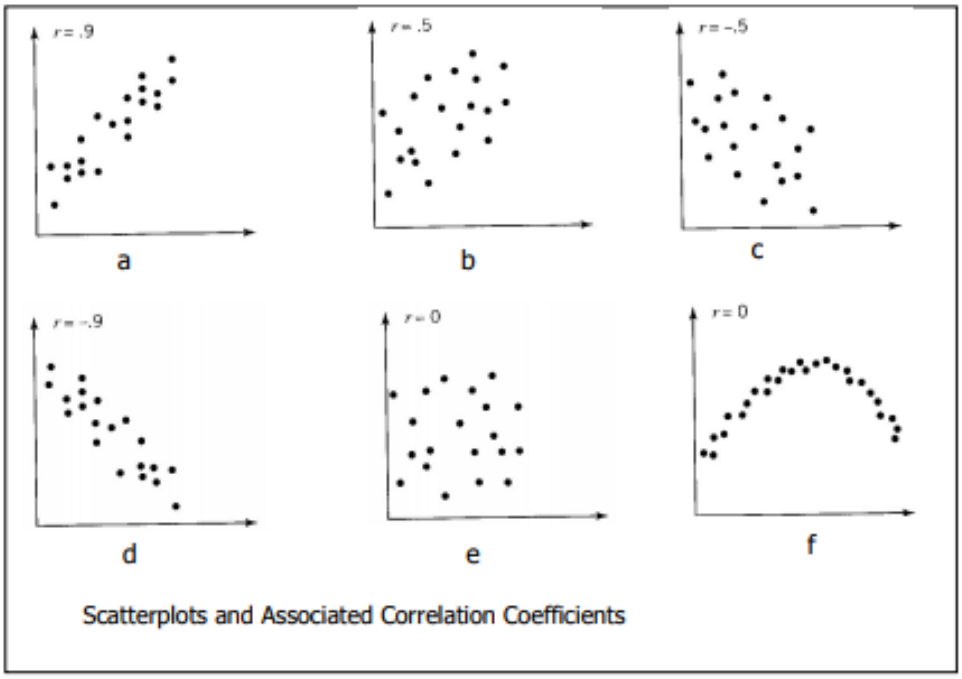
A numerical measure of the closeness of the scatter to a straight line is provided by the sample correlation coefficient.

The sample correlation coefficient, denoted by r, is a measure of the strength of the linear relation between the X and Y variables. The manner in which the correlation coefficient assesses the strength of the linear relation is summarized as follows:

- The value of r is always between -1 and +1.
- The magnitude of r indicates the strength of the linear relation, and its sign indicates the direction. In particular,
  - r > 0 if the pattern of (x,y) values is a band that runs from lower left to upper right
  - r < 0 if the pattern of (x,y) values is a band that runs from upper left to lower right
  - r = +1 if all (x,y) values lie exactly on a straight line with a positive slope (perfect positive linear relation)
  - r = -1 if all (x,y) values lie exactly on a straight line with a negative slope (perfect negative linear relation) A value of r close to -1 or +1 represents a strong linear relation. A value of r close to 0 means that the linear relation is very weak. It is a good idea to interpret r in conjunction with a scatterplot of the bivariate data. If there is no visible relation, that is, if the y values do not change in any direction as the x values change, then r will be close to 0. Also, a value of r near 0 can occur if the scatterplot points band around a curve that is

far from linear. These situations, and others, are illustrated in the figure below. Keep in mind that the correlation coefficient is a measure of a linear or straight-line relation. A value of r close to 0 indicates the absence of a linear relation, but it does not necessarily mean that there is no relationship.

The figure below illustrates the correspondence between scatter diagram patterns and the value of r. Notice that (e) and (f) correspond to situations where r = 0. The zero correlation in (e) is due to an absence of any relation between X and Y. The zero zero correlation in (f) is due to a relation that is quite strong but far from linear.



Scatterplots and Associated Correlation Coefficients

Appendix 1

A. More information about structuring questionnaires

Yes/no questions

Any question on a survey that has yes or no as a possible response is nominal, and so binomial statistics will be applied whenever a single yes/no question serves as the dependent variable or one of the dependent variables in an analysis.

Likert scales

A special kind of survey question uses a set of responses that are ordered so that one response is greater than another. The term Likert scale is named after the inventor, Rensis Likert, whose name is pronounced "Likert." Generally, this term is used for any question that has about 5 or more possible options.

An example might be: "How would you rate your department administrator?"
1=very incompetent, 2=somewhat incompetent, 3=neither competent, 4=somewhat competent, or 5=very competent.

Likert scales are either ordinal or interval, and many psychometricians would argue that they are interval scales because, when well-constructed, there is equal distance between each value. So, if a Likert scale is used as a dependent variable in an analysis, normal theory statistics are used such as regression would be used.

Physical measures

Most physical measures, such as height, weight, systolic blood pressure, distance etc., are interval or ratio scales, so they fall into the general "continuous" category. Therefore, normal theory type statistics are also used when such a measure serves as the dependent variable in an analysis.

Counts

Counts are tricky. If a variable is measured by counting, such as the case if a researcher is counting the number of days a hospital patient has been hospitalized, the variable is on a ratio scale and is treated as a continuous variable. So normal theory statistics, like correlation, is

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used. If a researcher is counting the number of subjects in an experiment (or number of cases in the data set), a continuous type of measure is not really being used.

Counting in this instance is really examining the frequency that some value of a variable occurs. For example, counting the number of subjects in the data set that report having been hospitalized in the last year, relies on a dichotomous variable in the data set that stands for being hospitalized or not being hospitalized (e.g., from a question such as "have you been hospitalized in the last year?").

Even if one were to count the number of cases based on the question "how many days in the past year have you been hospitalized," which is a continuous measure, the variable being used in the analysis is really not this continuous variable. Instead, the researcher would actually be analysing a dichotomous variable by counting the number of people who had not been hospitalized in the past year (0 days) vs. those that had been (1 or more days).

B. Survey Question and Answer Types

So, you've decided that you need a better understanding of the characteristics of people who visit your website, or of some other business-related question. Developing a focused and effective questionnaire will help you to efficiently and accurately pinpoint the information that will help you make more informed decisions.

Developing a questionnaire is as much an art as it is a science. And just as an artist has a variety of different colours to choose from in the palette, you have a variety of different question formats with which to question an accurate picture of your customers, clients and issues that are important to them.

The Dichotomous question

The dichotomous question is generally a "yes/no" question. An example of the dichotomous question is: Have you ever purchased a product or service from our website?

Yes

No

If you want information only about product users, you may want to ask this type of question to "screen out" those who haven't purchased your products or services. Researchers use "screening" questions to make sure that only those people they are interested in participating in the survey.

You may also want to use yes/no questions to separate people or branch into groups of those who "have purchased" and those who "have not yet purchased" your products or services. Once separated, different questions can be asked of each of these groups.

You may want to ask the "have purchased" group how satisfied they are with your products and services, and you may want to ask the "have not purchased" group what the primary reasons are for not purchasing. In essence, your questionnaire branches to become two different sets of questions.

The multiple-choice questions

The multiple-choice question consists of three or more exhaustive, mutually exclusive categories. Multiple-choice questions can ask for single or multiple answers. In the following example, we could ask the respondent to select exactly one answer from the 7 possible, exactly 3 of the 7, or as many as 3 of the 7 (1,2, or 3 answers can be selected).

For this type of question, it is important to consider including an "other" category because there may be other avenues by which the person first heard about your site that you might have overlooked.

Example:

A multiple-choice question to find out how a person first heard about your website is: How did you first hear about our web site?

Television

Radio

Newspaper

Magazine

Word-of-mouth

Internet

Other: Please Specify _____

Rank order scaling

Rank order scaling questions allow a certain set of brands or products to be ranked based upon a specific attribute or characteristic. Perhaps we know that Toyota, Honda, Mazda, and Ford are most likely to be purchased. You may request that the options be ranked based upon a particular attribute. Ties may or may not be allowed. If you allow ties, several options will have the same scores.

Example:

Based upon what you have seen, heard, and experienced, please rank the following brands according to their reliability. Place a "1" next to the brand that is most reliable, a "2" next to the brand that is next most reliable, and so on. Remember, no two cars can have the same ranking.

__ Honda

__ Toyota

__ Mazda

__ Ford

The rating scale

A rating scale question requires a person to rate a product or brand along a well-defined, evenly spaced continuum. Rating scales are often used to measure the direction and intensity of attitudes. The following is an example of a comparative rating scale question: Which of the following categories best describes your last experience purchasing a product or service on our website? Would you say that your experience was…?

- Very pleasant
- Somewhat pleasant
- Neither pleasant nor unpleasant
- Somewhat unpleasant
- Very unpleasant

The semantic differential scale

The semantic differential scale asks a person to rate a product, brand, or company based upon a seven-point rating scale that has two bi-polar adjectives at each end. The following is an example of a semantic differential scale question.

Notice that unlike the rating scale, the semantic differential scale does not have a neutral or middle selection. A person must choose, to a certain extent, one or the other adjective.

Example:

Would you say our website is…

(7) Very Attractive

(6)

(5)

(4)

(3)

(2)

(1) Very Unattractive

The staple scale

The staple scale asks a person to rate a brand, product, or service according to a certain characteristic on a scale from +5 to -5, indicating how well the characteristic describes the product or service. The following is an example of a staple scale question:

When thinking about Data Mining Technologies, Inc. (DMT), do you believe that the word "innovative" aptly describes or poorly describes the company?

On a scale of +5 to -5 with +5 being "very good description of DMT" and -5 being "poor description of DMT," how do you rank DMT according to the word "innovative"?

- (+5) Describes very well
- (+4)
- (+3)
- (+2)
- (+1)
- Innovative
- (-1)
- (-2)
- (-3)
- (-4)
- (-5) Describes Poorly

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Example:

The following question asks you to divide 100 points between a set of options to show the value or importance you place on each option. Distribute the 100 points giving the more important reasons a greater number of points. The computer will prompt you if your total does not equal exactly 100 points.

When thinking about the reasons you purchased our *TargetFind* data mining software, please rate the following reasons according to their relative importance.

Seamless integration with other software _____

User friendliness of software _____

Ability to manipulate algorithms _____

Level of pre- and post-purchase service _____

Level of value for the price _____

Convenience of purchase/quick delivery _____

Total 100 points

The constant sum question

A constant sum question permits collection of "ratio" data, meaning that the data is able to express the relative value or importance of the options (option A is twice as important as option B).

This type of question is used when you are relatively sure of the reasons for purchase, or you want input on a limited number of reasons you feel are important. Questions must sum to 100 points and point totals are checked by JavaScript.

The open-ended question

The open-ended question seeks to explore the qualitative, in-depth aspects of a particular topic or issue. It gives a person the chance to respond in detail.

Although open-ended questions are important, they are time-consuming and should not be over-used.

Example:

An example of an open-ended question might be: (If the respondent indicates they did not find what they were looking for...) What products of services were you looking for that were not

found on our website? If you want to add an "Other" answer to a multiple-choice question, you will use branching instructions to come to an open-ended question to find out What Other….

The Demographic question

Demographic questions are an integral part of any questionnaire. They are used to identify characteristics such as age, gender, income, race, geographic place of residence, number of children, and so forth. For example, demographic questions will help you to classify the difference between product users and non-users. Perhaps most of your customers come from the Northeast, are between the ages of 50 and 65, and have incomes between R50,000 and R75,000.

And by better understanding the type of people who use or are likely to use your product, you can allocate promotional resources to reach these people, in a more cost-effective manner. Psychographic or lifestyle questions are also included in the template files. These questions provide an in-depth psychological profile and look at activities, interests and opinions of respondents.

Appendix 2

Sampling methods

From the food you eat to the television you watch, from political elections to school board actions, much of your life is regulated by the results of sample surveys.

A sample is a group of units selected from a larger group (the population). By studying the sample, one hopes to draw valid conclusions about the larger group. A sample is generally selected for study because the population is too large to study in its entirety. The sample should be representative of the general population. This is often best achieved by random sampling. Also, before collecting the sample, it is important that one carefully and completely defines the population, including a description of the members to be included. A common problem in business statistical decision-making arises when we need information about a collection called a population but find that the cost of obtaining the information is prohibitive. For instance, suppose we need to know the average shelf life of current inventory. If the inventory is large, the cost of checking records for each item might be high enough to cancel the benefit of having the information.

On the other hand, a hunch about the average shelf life might not be good enough for decision-making purposes. This means we must arrive at a compromise that involves selecting a small number of items and calculating an average shelf life as an estimate of the average shelf life of all items in inventory.

This is a compromise, since the measurements for a sample from the inventory will produce only an estimate of the value we want, but at substantial savings. What we would like to know is how "good" the estimate is and how much more will it cost to make it "better". Information of this type is intimately related to sampling techniques. This section provides a short discussion on the common methods of business statistical sampling.

Cluster sampling

Cluster sampling can be used whenever the population is homogeneous but can be partitioned. In many applications the partitioning is a result of physical distance. For instance, in the insurance industry, there are small "clusters" of employees in field offices scattered

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about the country. In such a case, a random sampling of employee work habits might not require travel to many of the "clusters" or field offices in order to get the data. Totally sampling each one of a small number of clusters chosen at random can eliminate much of the cost associated with the data requirements of management.

Random sampling

Random sampling is probably the most popular sampling method used in decision making today. Many decisions are made, for instance, by choosing a number out of a hat or a numbered bead from a barrel, and both of these methods are attempts to achieve a random choice from a set of items. But true random sampling must be achieved with the aid of a computer or a random number table whose values are generated by computer random number generators.

Cross-Sectional Sampling

Cross-Sectional study the observation of a defined population at a single point in time or time interval. Exposure and outcome are determined simultaneously. What is a statistical instrument? A statistical instrument is any process that aim at describing a phenomenon by using any instrument or device, however the results may be used as a control tool. Examples of statistical instruments are questionnaire and surveys sampling.

Grab sampling technique

The grab sampling technique is to take a relatively small sample over a very short period of time, the results obtained are usually instantaneous. However, the Passive Sampling is a technique where a sampling device is used for an extended time under similar conditions. Depending on the desirable statistical investigation, the passive sampling may be a useful alternative or even more appropriate than grab sampling. However, a passive sampling technique needs to be developed and tested in the field.

Probability

What is probability?

Probability is, in essence, the mathematics of chance. How sure can we be that a particular event is going to happen? When we go to bed at night, we can be sure that the sun will rise the

next morning. If today is Monday, then we can be **certain** that tomorrow is Tuesday. The chance that these events will occur is 100%. The probability of these events is 1.

Some events could possibly happen, but it is unlikely. For example: The chance that you win the lotto if you have bought a ticket is very slim, but it could happen. The chance that a lion is seen in the middle of town is very low, but it could happen if the circus was in town. The probability of these events lies between 0 and 1. A probability of ½ means a 50-50 chance of it happening. Then you get some events that will never happen. For example: the chance of throwing a 10 on a normal die is 0%. A die only goes up to 6. The probability of this is 0.

The probability of a single event

Probability of a single event = Number of ways in which an event can occur Number of possible outcomes.

Example:

Sipho's house has 1 lounge, 1 bathroom, 1 kitchen and 2 bedrooms.

What is the probability that Sipho is in the kitchen?

Probability = Number of ways in which an event can occur divided by the Number of possible outcomes

= 1 /5

What is the probability that Sipho is in a bedroom?

Probability = Number of ways in which an event can occur divided by the Number of possible outcomes

= 2 /5

Compound events

Two or more occurrences happen independently of each other

Sometimes two or more events happen at the same time. Let us take the example of Clive and his coloured socks again. This time, Clive is also trying to put on a T-shirt. He has the following items:

	Socks	T-shirts
	2 pairs yellow	3 yellow
	3 pairs red	6 red
	4 pairs black	6 black
	6 pairs white	4 white
Total	15	20

What is the probability of Clive putting on a yellow shirt and yellow socks? We work out each probability separately and then multiply them to get the total probability.

P (yellow socks) = 2 /15

P (yellow T-shirt) = 3 /20

P (socks and shirt) = 2 /15 x 3 /20 = 1 /50

What is the probability that he will wear black socks and a red shirt?

P (black socks) = 4 /15

P (red T-shirt) = 6 /20

P (socks and shirt) = 4 /15 x 6 /20 = 2 /25

Example:

A drawer contains 3 red paperclips, 4 green paperclips, and 5 blue paperclips. One paperclip is taken from the drawer and then replaced. Another paperclip is taken from the drawer. What is the probability that the first paperclip is red, and the second paperclip is blue? Because the first paper clip is replaced, the sample space of 12 paperclips does not change from the first event to the second event. The events are independent. P(red then blue) = P(red) x P(blue) = 3/12 • 5/12 = 15/144 = 5/48.

When two or more occurrences happen independently of each other, then we multiply the probabilities.

Complementary events

In a parking lot there are 20 vehicles. 16 of the vehicles are cars.

What is the probability of the first vehicle leaving the parking lot being a car?

P(car) = 16/ 20 = 4 /5

What is the probability of the first vehicle leaving the parking lot NOT being a car?

P(Not car) = 4/ 20 = 1 /5

Notice that 4 /5 + 1 /5 = 5 /5 = 1 P(event) + P(not event) = 1

Example:

Either one or the other event happening You have a deck of 52 playing cards. The jokers have been removed. A card is drawn from the deck. What is the probability of the card being red or a Jack?

Quite clearly, P(red) = $^{13}/_{52}$ and P(Jack) = $^{4}/_{52}$

But, there are two red jacks in the deck!! You cannot count those twice.

Their probability is $^{2}/_{52}$.

Thus we use the formula:

P(red or Jack) = P(red) + P(Jack) – P(red and Jack)

= $^{13}/_{52}$ + $^{4}/_{52}$ – $^{2}/_{52}$

= $^{15}/_{52}$

If you need to calculate the probability of either one or another event, then you use the formula:

P(X or Y) = P(X) + P(Y) – P(X and Y)

Example:

A pair of dice is rolled. What is the probability that the sum of the numbers rolled is either 7 or 11?

• Six outcomes have a sum of 7: (1,6), (2,5), (3,4), (4,3), (5,2), (6,1) P(7) = 6/36

• Two outcomes have a sum of 11: (5,6), (6,5) P(11) = 2/36

The sum of the numbers cannot be 7 and 11 at the same time, so these events are mutually exclusive.

P(7 or 11) = P(7) + P(11) = 6/36 + 2/36 = 8/36 = 2/9

Example:

A pair of dice is rolled. What is the probability that the sum of the numbers rolled is either an even number or a multiple of 3?

• Of the 36 possible outcomes, 18 are even sums. P(even) = 18/36 = 1/2

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• Sums of 3, 6, 9, and 12 are multiples of 3. There are 12 sums that are multiples of 3.

• P(multiple of 3)= 12/36 = 1/3

• However, some of these outcomes appear in both events.

The sums that are even and a multiple of 3 are 6 and 12.

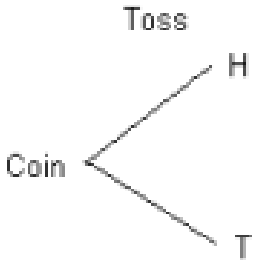
There are 6 ordered pairs with these sums.

P(even AND a multiple of 3) = 6/36 = 1/6

P(even OR a multiple of 3) = 18/36 + 12/36 - 6/36 = 24/36 = 2/3

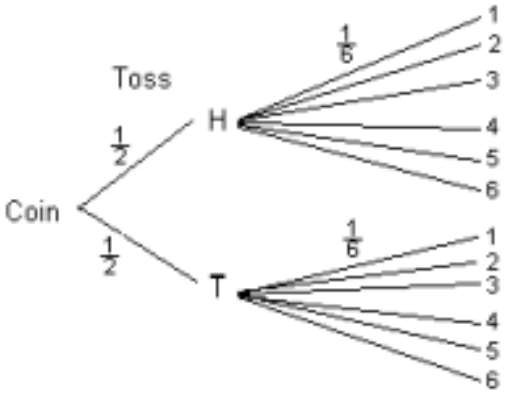
Probability tree diagrams

Suppose you toss a coin. It has a 50% chance of showing heads and a 50% chance of showing tails.



Calculating the probability of certain outcomes

Suppose that you roll a die at the same time as tossing the coin. Now you end up with a large number of possibilities: You could have heads and 1, heads and 2, etc., OR tails and 1, tails and 2 etc. To visualise this, we expand the diagram above:



The probability of tossing heads AND rolling a six is:

P(heads AND 6) = P(heads) x P(6)

= ½ x $^1/_6$

= $^1/_{12}$

To calculate the probability using a tree diagram:

if you move along the arms, then you multiply the probabilities.

Calculating the probability of multiple outcomes

Example:

You want to know what the probability is of calculating the probability of tossing tails and an odd number

P(tails and odd number) = $^1/_{12}$ + $^1/_{12}$ + $^1/_{12}$ = $^3/_{12}$ = ¼ To calculate the probability using a tree diagrams: if you move down a column, then you add the probabilities.

Independent events

Two events are said to be independent if the result of the second event is not affected by the result of the first event.

If A and B are independent events, the probability of both events occurring is the product of the probabilities of the individual events

If A and B are independent events, then P(A and B) = P(A) x P(B).

Example:

A drawer contains 3 red paperclips, 4 green paperclips, and 5 blue paperclips. One paperclip is taken from the drawer and then replaced. Another paperclip is taken from the drawer. What is the probability that the first paperclip is red, and the second paperclip is blue?

Because the first paper clip is replaced, the sample space of 12 paperclips does not change from the first event to the second event. The events are independent.

P(red then blue) = P(red) x P(blue) = 3/12 • 5/12 = 15/144 = 5/48

If the result of one event IS affected by the result of another event, the events are said to be dependent.

If A and B are dependent events, the probability of both events occurring is the product of the probability of the first event and the probability of the second event once the first event has occurred.

If A and B are dependent events, and A occurs first, P(A and B) = P(A) x P(B), once A has occurred).

Example:

A drawer contains 3 red paperclips, 4 green paperclips, and 5 blue paperclips. One paperclip is taken from the drawer and is NOT replaced. Another paperclip is taken from the drawer. What is the probability that the first paperclip is red and the second paperclip is blue?

Because the first paper clip is NOT replaced, the sample space of the second event is changed. The sample space of the first event is 12 paperclips, but the sample space of the second event is now 11 paperclips. The events are dependent.

P(red then blue) = P(red) x P(blue) = 3/12 • 5/11 = 15/132 = 5/44.

Qualities of a good estimator

A "Good" estimator is the one, which provides an estimate with the following qualities:

Unbiasedness

An estimate is said to be an unbiased estimate of a given parameter when the expected value of that estimator can be shown to be equal to the parameter being estimated. For example, the mean of a sample is an unbiased estimate of the mean of the population from which the sample was drawn. Unbiasedness is a good quality for an estimate, since, in such a case, using weighted average of several estimates provides a better estimate than each one of those estimates. Therefore, unbiasedness allows us to upgrade our estimates. For example, if your estimates of the population mean μ are say, 10, and 11.2 from two independent samples of sizes 20, and 30 respectively, then a better estimate of the population mean μ based on both samples is [20 (10) + 30 (11.2)] (20 + 30) = 10.75.

Consistency

The standard deviation of an estimate is called the standard error of that estimate. The larger the standard error the more error in your estimate. The standard deviation of an estimate is a

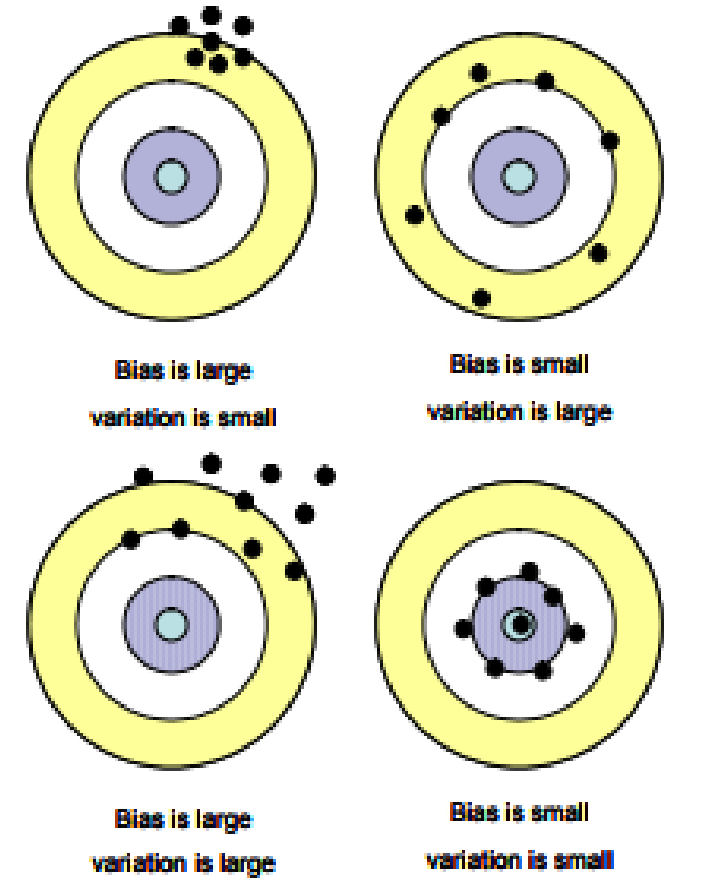
commonly used index of the error entailed in estimating a population parameter based on the information in a random sample of size n from the entire population.

An estimator is said to be "consistent" if increasing the sample size produces an estimate with smaller standard error. Therefore, your estimate is "consistent" with the sample size. That is, spending more money to obtain a larger sample produces a better estimate.

Efficiency

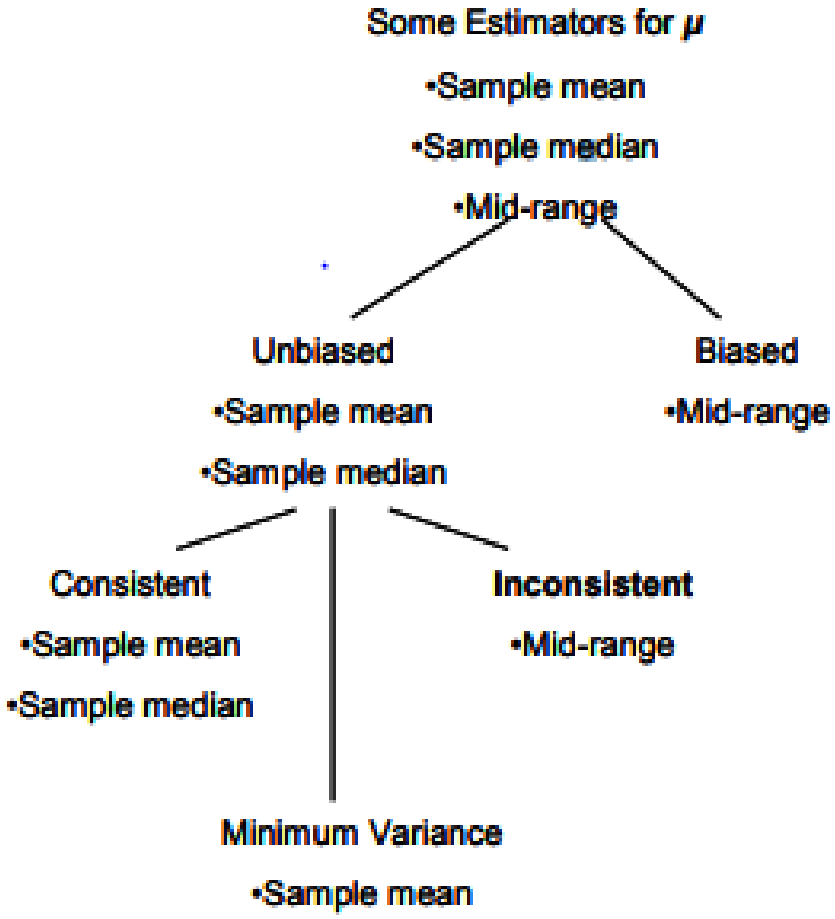
An efficient estimate is one, which has the smallest standard error among all unbiased estimators.

The "best" estimator is the one, which is the closest to the population parameter being estimated.



Accuracy versus Quality of an Estimator using Bias and Variation as Measurable Quantities Respectively

The Concept of Distance for an Estimator The above figure illustrates the concept of closeness by means of aiming at the centre for unbiased with minimum variance. Each dartboard has several samples: The first one has all its shots clustered tightly together, but none of them hit the centre. The second one has a large spread, but around the centre. The third one is worse than the first two. Only the last one has a tight cluster around the centre, therefore has good efficiency. If an estimator is unbiased, then its variability will determine its reliability. If an estimator is extremely variable, then the estimates it produces may not on average be as close to the population parameter as a biased estimator with small variance. The following chart depicts the quality of a few popular estimators for the population mean μ:



The Good Qualities of an Estimator for μ

The widely used estimator of the population mean μ is = $\Sigma x_i/n$, where n is the size of the sample and x_1, x_2, x_3,....., x_n are the values of the sample that have all of the above good properties. Therefore, it is a "good" estimator.

If you want an estimate of central tendency as a parameter for a test or for comparison, then small sample sizes are unlikely to yield any stable estimate. The mean is sensible in a symmetrical distribution as a measure of central tendency; but, e.g., with ten cases, you will not be able to judge whether you have a symmetrical distribution.

However, the mean estimate is useful if you are trying to estimate the population sum, or some other function of the expected value of the distribution. Would the median be a better measure? In some distributions (e.g., shirt size) the mode may be better. If there are outliers, the median is better than the mean as a measure of central tendency.

What is the margin of error?

Estimation is the process by which sample data are used to indicate the value of an unknown quantity in a population. Results of estimation can be expressed as a single value, known as a point estimate; or a range of values, referred to as a confidence interval. Whenever we use point estimation, we calculate the margin of error associated with that point estimate. For example, for the estimation of the population proportion, by the means of sample proportion (p), the margin of error is calculated often as follows:

$\pm 1.96\ [p(1-p)/n]^{1/2}$

In newspapers and television reports on public opinion polls, the margin of error often appears in a small font at the bottom of a table or screen. However, reporting the amount of error only, is not informative enough by itself, what is missing is the degree of the confidence in the findings. The more important missing piece of information is the sample size n; that is, how many people participated in the survey, 100 or 100000? By now, you know well that the larger the sample size the more accurate is the finding, right?

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The reported margin of error is the margin of "sampling error". There are many non-sampling errors that can and do affect the accuracy of polls. Here we talk about sampling error. The fact that sub-groups might have sampling error larger than the group, one must include the following statement in the report: "Other sources of error include, but are not limited to, individuals refusing to participate in the interview and inability to connect with the selected number. Every feasible effort was made to obtain a response and reduce the error, but the reader (or the viewer) should be aware that some error is inherent in all research."

If you have a yes/no question in a survey, you probably want to calculate a proportion P of Yes's (or No's). In a simple random sample survey, the variance of p is p(1-p)/n, ignoring the finite population correction, for large n, say over 30. Now a 95% confidence interval is $p - 1.96\ [p(1-p)/n]^{1/2}$, $p + 1.96\ [p(1-p)/n]^{1/2}$.

A conservative interval can be calculated, since p(1-p) takes its maximum value when p = 1/2. Replace 1.96 by 2, put p = 1/2 and you have a 95% conservative confidence interval of $1/n^{1/2}$. This approximation works well as long as p is not too close to 0 or 1. This useful approximation allows you to calculate approximate 95% confidence intervals.

For continuous random variables, such as the estimation of the population mean μ, the margin of error is calculated often as follows: $\pm 1.96\ S/n^{1/2}$. The margin of error can be reduced by one or a combination of the following strategies:

1. Decreasing the confidence in the estimate – an undesirable strategy since confidence relates to the chance of drawing the wrong conclusion (i.e., increases the Type II error).
2. Reducing the standard deviation – something we cannot do since it is usually a static property of the population.
3. Increasing the sample size – this provides more information for a better decision.

Bias reduction techniques: bootstrapping and jack-knifing

Some inferential statistical techniques do not require distributional assumptions about the statistics involved. These modern non-parametric methods use large amounts of computation

to explore the empirical variability of a statistic, rather than making a priori assumptions about this variability, as is done in the traditional parametric t- and z- tests.

Bootstrapping

Bootstrapping method is to obtain an estimate by combining estimators to each of many sub-samples of a data set. Often M randomly drawn samples of T observations are drawn from the original data set of size n with replacement, where T is less than n.

Jack-knife estimator

A jack-knife estimator creates a series of estimate, from a single data set by generating that statistic repeatedly on the data set leaving one data value out each time. This produces a mean estimate of the parameter and a standard deviation of the estimates of the parameter.

Monte Carlo simulation

Monte Carlo simulation allows for the evaluation of the behaviour of a statistic when its mathematical analysis is intractable. Bootstrapping and jack-knifing allow inferences to be made from a sample when traditional parametric inference fails. These techniques are especially useful to deal with statistical problems, such as small sample size, statistics with no well-developed distributional theory, and parametric inference condition violations. Both are computer intensive. Bootstrapping means you take repeated samples from a sample and then make statements about a population. Bootstrapping entails sampling-with-replacement from a sample. Jack-knifing involves systematically doing n steps, of omitting 1 case from a sample at a time, or, more generally, n/k steps of omitting k cases; computations that compare "included" vs. "omitted" can be used (especially) to reduce the bias of estimation. Both have applications in reducing bias in estimations.

Re-sampling

Re-sampling including the bootstrap, permutation, and other non-parametric tests – is a method for hypothesis testing, confidence limits, and other applied problems in statistics and probability. It involves no formulas or tables. Following the first publication of the general technique (and the bootstrap) in 1969 by Julian Simon and subsequent independent development by Bradley Efron, re-sampling has become an alternative approach for testing hypotheses. There are other findings: "The bootstrap started out as a good notion in that it

presented, in theory, an elegant statistical procedure that was free of distributional conditions. In practice the bootstrap technique doesn't work very well, and the attempts to modify it make it more complicated and more confusing than the parametric procedures that it was meant to replace." While re-sampling techniques may reduce the bias, they achieve this at the expense of increase in variance. The two major concerns are:

- The loss in accuracy of the estimate as measured by variance can be very large.
- The dimension of the data affects drastically the quality of the samples and therefore the estimates.

Sample size determination

At the planning stage of a statistical investigation, the question of sample size (n) is critical. This is an important question therefore it should not be taken lightly. To take a larger sample than is needed to achieve the desired results is wasteful of resources, whereas very small samples often lead to what are no practical use of making good decisions. The main objective is to obtain both a desirable accuracy and a desirable confidence level with minimum cost.

Students sometimes ask me what fraction of the population do you need for good estimation? I answer, "It's irrelevant; accuracy is determined by sample size." This answer has to be modified if the sample is a sizable fraction of the population. The confidence level of conclusions drawn from a set of data depends on the size of the data set. The larger the sample, the higher is the associated confidence. However, larger samples also require more effort and resources. Thus, your goal must be to find the smallest sample size that will provide the desirable confidence. For an item scored 0 or 1, for no or yes, the standard error (SE) of the estimated proportion p, based on your random sample observations, is given by:

$SE = [p(1-p)/n]^{1/2}$

where p is the proportion obtaining a score of 1, and n is the sample size. This SE is the standard deviation of the range of possible estimate values.

The SE is at its maximum when p = 0.5, therefore the worst-case scenario occurs when 50% are yes, and 50% are no.

Under this extreme condition, the sample size, n, can then be expressed as the largest integer less than or equal to: $n = 0.25/SE^2$

To have some notion of the sample size, for example for SE to be 0.01 (i.e. 1%), a sample size of 2500 will be needed; 2%, 625; 3%, 278; 4%, 156, 5%, 100. Note, incidentally, that as long as the sample is a small fraction of the total population, the actual size of the population is entirely irrelevant for the purposes of this calculation.

Pilot Studies

When the needed estimates for sample size calculation is not available from an existing database, a pilot study is needed for adequate estimation with a given precision. A pilot, or preliminary, sample must be drawn from the population, and the statistics computed from this sample are used in determination of the sample size. Observations used in the pilot sample may be counted as part of the final sample, so that the computed sample size minus the pilot sample size is the number of observations needed to satisfy the total sample size requirement.

Sample Size with Acceptable Absolute Precision

The following present the widely used method for determining the sample size required for estimating a population mean and proportion.

Let us suppose we want an interval that extends unit on either side of the estimator.

We can write = Absolute Precision = (reliability coefficient) (standard error)

$= Z_{/2}\ (S/n^{1/2})$

Suppose based on a pilot sample of size n, the estimated proportion is p, then the required sample size with the absolute error size not exceeding , with 1- confidence is:

$[t^2\ n\ p(1-p)] / [t^2\ p(1-p) - {}^2\ (n-1)]$,

where t = t, being the value taken from the t-table with parameter d.f. = n-1, corresponding to the desired 1- confidence interval.

For large pilot sample sizes (n), say over 30, the simplest sample size determinate is:

$[(Z/)^2\ S^2] / {}^2$ for the Mean

$[(Z/)^2\ p(1-p)] / {}^2$ for the proportion,

where is the desirable margin of error (i.e., the absolute error), which is the half-length of the confidence interval with 100(1-) % confidence interval.

Sample Size with Acceptable Type I and Type II Errors

One may use the following sample size determinate, which is based on the size of type I and Type II errors:

$2(Z_{\alpha/2} + Z_{\beta/2})^2 S^2 / \delta^2$

where α and β are the desirable type I, and type II errors, respectively. S^2 is the variance obtained from the pilot run, and δ is the difference between the null and alternative ($\mu_0 - \mu_a$).

Sample Size with Acceptable Relative Precision

You may use the following sample size determinate for a desirable relative error Δ in %, which requires an estimate of the coefficient of variation (CV in %) from a pilot sample with size over 30:

$[(Z_{\alpha/2})^2 (C.V.)^2] / \Delta^2$

Sample Size Based on the Null and an Alternative

One may use power of the test to determine the sample size. The functional relation of the power and the sample size is known as the operating characteristic curve. On this curve, as sample size increases, the power function increases rapidly.

Let δ be such that: $\mu_a = \mu_0 + \delta$ is an alternative to represent departure from the null hypothesis. We wish to be reasonably confident to find evidence against the null, if in fact the particular alternative holds. That is, the type error β, is the probability of failing to find evidence at least at level of α, when the alternative holds.

This implies Required sample size = $(z_1 + z_2) S^2 / \delta^2$

Where: $z_1 = |\text{mean} - \mu_0| / \text{SE}$, $z_2 = |\text{mean} - \mu_a| / \text{SE}$, the mean is the current estimate for μ, and S is the current estimate for σ.

All of the above sample size determinates could also be used for estimating the mean of any unimodal population, with discrete or continuous random variables, provided the pilot run size (n) is larger than (say) 30.

In estimating the sample size, when the standard deviation is not known, instead of S^2 one may use $^1/_4$ of the range for sample size over 30 as a "good" estimate for the standard deviation. It is a good practice to compare the result with IQR/1.349.

One may extend the sample size determination to other useful statistics, such as correlation coefficient (r) based on acceptable Type I and Type II errors:

$2 + [(Z_{\alpha/2} + Z_{\beta/2}(1- r^2)^{½})/r]^2$

provided r is not equal to -1, 0, or 1

The aim of applying any one of the above sample size determinates is at improving your pilot estimates at feasible costs.

Bayesian statistical inference

An introduction Statistical inference describes the procedures by which we use the observed data to draw conclusions about the population from which the data came or about the process by which the data were generated. Our assumption is that there is an unknown process that generates the data we have and that this process can be described by a probability distribution, which, in turn, can be characterized by some unknown parameters. For instance, for a normal distribution the unknown parameters are μ and σ^2.

Broadly speaking, statistical inference can be classified under two headings: classical inference and Bayesian inference. Classical statistical inference is based on two premises:

1. The sample data constitute the only relevant information.
2. The construction and assessment of the different procedures for inference are based on long-run behaviour under essentially similar circumstances.

In Bayesian inference we combine sample information with prior information. Suppose that we draw a random sample $x_1, x_2, ..., x_n$ of size n from a normal population.

In statistical inference we take the sample mean as our estimate of μ. Its variance is σ^2/n. The inverse of this variance is known as the sample precision. Thus, the sample precision is n/σ^2.

In the Bayesian inference we have prior information on μ. This is expressed in terms of a probability distribution known as the prior distribution. Suppose that the prior distribution is normal with mean $\mu 0$ and variance $\sigma 0^2$, that is, precision $1/\sigma 0^2$. We now combine this with the sample information to obtain what is known as the posterior distribution of μ. This distribution

can be shown to be normal. Its mean is a weighted average of the sample mean and the prior mean, weighted by the sample precision and prior precision, respectively.

Thus, Posterior mean = $(W_1 + W_2\ \mu_0) / (W_1 + W_2)$

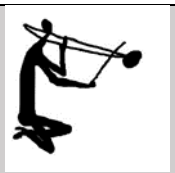
Posterior variance = $1 / (W^1 + W^2)$

where

W1 = Sample precision = n/S^2, and W1 = Prior precision = $n/\sigma 0^2$

Also, the precision (or inverse of the variance) of the posterior distribution of is $W_1 + W_2$, that is, the sum of the sample precision and prior precision. The posterior mean will lie between the sample mean and the prior mean. The posterior variance will be less than both the sample and prior variances.

In this course we do not discuss Bayesian inference because this would take us into a lot more detail than we intend to cover. However, the basic notion of combining the sample mean and prior mean in inverse proportion to their variances will be of interest while being useful.

	**Individual Activity 7**

Learning Unit 5: Writing skills

Unit Standard	
119459	Write for a wide range of contexts
Specific Outcomes	
SO1: Write effectively and creatively on a range of topics SO2: Choose language structures and features to suit communicative purposes SO3: Edit writing for fluency and unity	
CCFO's	
Identifying	Collecting
Communicating	Contributing

1. WRITE EFFECTIVELY AND CREATIVELY ON A RANGE OF TOPICS

When you write about topics, you may be required to write in different styles. It is important that you know what the different styles are and that you are able to write correctly for the type of style.

To begin this section, we will start off by defining the following types of texts:

- Imaginative texts
- Expository/factual texts
- Personal interest texts

Imaginative texts

Imaginative texts can be put into three broad categories, namely:

- **Narrative text** which can be defined as telling a story. Narration describes a sequence of related happenings explaining how something came about. The emphasis is on the event itself and there are two types of narration, namely climacteric, which is usually used in novels, short stories and then straight line which used in technical communication. Narrative text can also be used when writing reports and minutes.

- **Descriptive text** which is describing what you want the reader to see. It conveys what a person senses physically be it taste, touch, sight, smell or sound.

- **Persuasive text** which gives a point of view or opinion. Language has the ability to evoke ranges of association and condition attitudes. Words carry both degrees of seriousness and levels of approval or disapproval and in this way messages are influenced by the sender. An example here is the different effect of calling a band of soldiers 'terrorists' or 'freedom fighters'. The words one chooses are seldom neutral and advertisers, politicians and other propagandists are especially adept at using language to their advantage.

When you determine that you wish to write an imaginative text you must ensure that the text is convincing and appropriate to the topic and purpose. In the case of writing advertising and marketing material you would want to use descriptive and persuasive text to entice your customer to believe that your product or service is the best one to use. This type of text is most appropriate for this purpose. In the same way, if you decide to use the narrative text to

write a report, you should bear the purpose of writing in narrative form, i.e., to write a sequence of happenings.

Expository/factual writing

This type of text is factual. The writer must give information on the topic. This writing makes use of facts and statistical information, cause-and-effect relationships, or examples. Examples of expository/factual writing include newspaper articles, encyclopaedia articles or explanatory essays.

This type of writing usually contains the following elements:

- No emotion
- No imaginative language
- No personal opinions
- Write in 3rd person (no use of pronoun 'I')
- Language is precise
- Use of facts and figures

The following is a recommended structure for expository writing:

- **Introduction:** Introduce the topic, describe or define what you are going to talk about.

- **Main body:** Breaking your writing up into paragraphs is important as it will make it easier for the reader to understand. Explain each of the ideas/points involved in the topic, give examples and use a different paragraph for each different point. Talk about the most important point first and then go to minor points about the subject. The use of paragraphs not only helps your reader to follow your argument, it also makes sure that you have planned what you are going to write.

- **Conclusion:** In the conclusion you should weigh up the points involved and summarise your explanations.

The points above will assist you in ensuring that your expository writing is convincing and well developed with respect to a clear purpose.

Personal interest text

A personal interest text is one that addresses your own personal interest. It may be a letter to motivate your appointment to a certain position, complain about poor customer service or to explain your point of view. You should be careful to put your point across in non-emotional language and use factual examples. Subjectivity and objectivity should be used to enhance the writing and ensure that you maintain your credibility. When writing on personal interests, it is important to be convincing in terms of issues and concerns being addressed within the document. You should adopt a persona for narrative writing and decide if you will use the first-person narrative voice.

Choosing the narrative voice

The First Person

A story written in the first person is told by an "I", where "I" can be the main character, a less important character witnessing events, or a person retelling a story he/she was told by someone else. Using the 'I' can create a sense of closeness to the character. It can be very easy to get the reader to identify or sympathise with your main character when the reader is seeing everything through that character's eyes.

The first person is usually used in narrative texts.

The Second Person

In second person writing, the narrator addresses the central character as "you". This point of view is very rare because it is extremely difficult to write successfully. The reader may feel that they are the one spoken to and will find it difficult to accept that they are doing the things the narrator tells them they are doing. If you choose to tell a story in second person, it is very important to make it clear to the reader who is being addressed, so he/she can trust the storyteller and accept the story as given without taking it personally.

The second person is rarely used when writing texts as it is more complex than first or third person.

The Third Person

Characters are referred to as "he" and "she" in the third person. In this case the narrator (who may be indistinguishable from the author) is not a character in the story. Depending on the type of third person point of view, the narrator may know and be able to tell about the

thoughts and feelings of all characters, or only one character, or he/she may only be able to report what is seen or heard.
The third person is usually used for a formal style of language usually found in business writing.

2. CHOOSE LANGUAGE STRUCTURES AND FEATURES TO SUIT COMMUNICATIVE PURPOSES

Whether you are writing a memo to your co-worker or a report for your boss, you should be clear in what information you want to convey. The text should be appropriate to the topic and purpose, and it should be well developed with regard to its purpose using clear paragraphs. The points in your written text must be logically and deliberately sequenced to build up to a convincing conclusion. The following section should assist you to write a document that is professional with a clear message.

Steps to follow when writing a text

a. Planning

When planning you need to decide what you wish to discuss in your memo or report. A recommended method is to use a list. Proper planning will ensure that you are able to give a clear outline of what you wish to communicate and will help you to avoid communicating any irrelevant information. The elements contained in planning are outlined in the section below.
Determine your objective: You need to decide what information you want to share with the reader, what the purpose of the material is and what you want the reader to learn from your message. Writing can help you achieve the five '**I**s': It can ***inform, inquire, influence, instruct and incite***. You should also consider the content, style and audience when determining your objective.

- **Content:** You should ensure that your message has the right content for your target audience. Don't let unnecessary ideas derail your message, to quote Professor William Strunk Jr., an authority on English usage:

"A sentence should contain no unnecessary words, a paragraph no unnecessary sentences, for the same reason that a drawing should have no unnecessary lines and a machine no unnecessary parts."

- **Style:** When starting to write any document you should ensure that your writing style is appropriate to your purpose and audience. There is a trend in business writing in

that it has become less rigid and more informal. However, you should always ensure that your style is professional in business communication. Style can be formal or informal.

- **Formal style:** A formal style is used when writing reports, official documents and for documents addressing a large audience. When adopting a formal style, you should avoid using personal pronouns, such as 'I' and 'you', and slang should not be used.

- **Informal style:** This is typically used in documents such as memos and email messages addressed to an individual or a small group. This style is dependent on the tone you want to present, and the type of information being shared. You should use an informal style only with individuals you know personally. You should always ensure that you use the formal style when writing for business. Each individual person, however, will develop their own style of writing and you should start by using short words and simple sentence structures so that readers can understand you easily.

- **Audience:** You should ensure that you are writing with a specific audience in mind and that you are providing them with information that is important to them. Evaluating your readers' knowledge of a subject will help you determine the type and amount of information you need to include in a message. Use simple language as you don't want the reader to consult a dictionary to decipher what you are trying to say. If you use complex language with a huge vocabulary you may frustrate your reader. Most people are juggling several tasks at the same time and are interested in receiving only necessary information. By anticipating your readers' probable reaction, you can address any doubts, fears, or uncertainties they might have about your purpose. This increases the probability that they will accept your message.

b. Organisation

A good piece of writing flows like a symphony. You need to ensure that your material is organised so that each topic flows easily and naturally into the next. Ensuring that your thoughts are properly organised enables you to communicate the information in a systematic and logical format that will help the reader understand your message. Effective organisation means that your message is easy to understand.

By proper organising you can ensure that main points will be emphasised and properly supported with evidence. You save the reader's time by presenting information in a clear and easy-to-follow format and you can easily identify areas where you lack information.

The best way to organise your writing properly is to create an outline of the message that you wish to convey. Outlining is the perfect tool to structure your presentation of information. It affords you the opportunity to break large pieces of information into manageable parts and ensure that you cover every relevant issue. Creating an outline also allows you to make sure you present your material in a logical and parallel manner from start to finish.

One excellent method of outlining is to prepare a table of contents, including a list of any tables and graphics, before you start writing the text. This way you can use the topic headings you create while outlining the body of the document. Nevertheless, the real advantage of compiling a table of contents before writing is that you can move sections around much easier than if the paragraphs and sections were already written.

Once you have completed your organising and outlining you should move onto the next step, namely writing your draft.

c. Write a draft

In the draft document you begin to refine your thoughts so that they fall in line with the objectives of your document. It should be written quickly, and you should concentrate on noting your ideas, focusing on the simple concepts first and moving onto the more complex points as you progress. A draft is there to be improved upon and you should not allow it to constrain you.

This will assist you to present your document in a logical and carefully sequenced format.
When you need to present points in an argument to ensure that you build up to a convincing conclusion, the following tips should assist you.

- **Establish your personal credibility:** Tell the reader how you qualified to write about the subject. This will boost their confidence in the importance and validity of your message.

- **Check your facts:** Make sure your facts and figures are accurate. Don't simply write "off the top of your head" with emotion rather than accuracy, as you will lose credibility quickly this way.
- **Be sensitive:** A reader who receives an insensitive message will ignore the information it contains and instead focus on how it made him or her feel, thus defeating the purpose of the message. Always avoid comments that some people might find rude.
- **Write without emotion:** When you write with obvious anger, perhaps even stooping to name-calling, you will likely be considered extreme and uncompromising. If you write in this manner it is very likely that your writing will be ignored, and other people will not wish to be associated with it. Instead of using emotion use examples and facts to present your argument. This will assist you to prove your point and/or help others see another side to a topic.
- **Appeal to emotions:** You want to appeal to people's emotions in a manner that enables them to relate to other people or situations. Often, they will recall something similar they or a friend encountered and thus understand better what you are trying to say.
- **Emphasise your main points:** Stating your main points at the beginning of your document grabs the reader's attention and reinforces the purpose of the message.
- **Project the right image:** Whether you are writing to an employee, manager, or someone outside your organisation, you need to be aware of how the reader will interpret your message. Project a positive image by writing messages that are professional and accurate.
- **Acknowledge the information sources used.**
- **Use clear, short sentences:** Keep your writing precise, even when using a conversational tone. While rambling pieces or scholarly writing have their place, generally you need to keep your writing simple, yet clear and concise.
- **Use clearly defined paragraphs:** Breaking your writing up into paragraphs is important as it will make it easier for the reader to understand. The use of paragraphs not only helps your reader to follow your argument, but it also ensures that you planned what you are going to write.
- **Use humour to make a point:** Most readers are receptive to humour. One or two humorous references, even within a serious piece, will help keep your reader/listener's attention.

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- **Use case histories and examples:** Relating yours or others' experiences give credibility when writing about a cause.

d. Editing and proofreading

Editing is an important step. It will assist you with the following:

- Correct spelling and grammar
- Formatting (logical and readable)
- Relevance of information

If possible when editing, allow a few days between completion and editing, it will allow you to see the material with fresh eyes. Editing will be discussed in more detail in Module 3.

Devices to create rhythmic or tonal effects in writing

The following section will outline devices to create rhythmic or tonal effects and how they can be used.

Punctuation

Punctuation is the use of special signs in writing to clarify how words are used; the term also refers to the signs themselves. In every language, besides the sounds of the words that are strung together, there are other features, such as tone, accent, and pauses that are equally important. In English, stress, pausing, and tonal changes come together in a set of patterns often called intonations. Such features are represented by punctuation, indicated by signs inserted usually between words, and often following the feature they mark.

Definitions for common punctuation

Capital letters (A, B, D) The first word in a sentence must always have a capital letter. A capital letter indicates proper nouns, i.e., specific persons, tribes, nationalities, places, companies, organisations, e.g., Jane Dhlamini, 'African', 'Zulu', 'Johannesburg', National Union of Mine Workers. It is used when using titles, e.g., Doctor de Bruyn, President Mbeki and Mr Brown.

Full stop or period (.) is used to mark the end of a sentence.

Ellipsis (…) is used to indicate the place in a passage where material has been omitted or a thought has trailed off. It is a mark or series of marks (. . . or * * *) used indicate an omission especially of letters or words.

Dash or hyphen (-) is used between parts of a compound word or between the syllables of a word when the word is divided at the end of a line of text.

Colon (:) is typically used to introduce material that elaborates on what has already been said. It is used after a word introducing a quotation, an explanation, an example, or a series and often after the salutation of a business letter. The colon is also used between numbers or groups of numbers in expressions of time (2:30 a.m.) and ratios (1:2).

Semicolon (;) is used to mark separation between elements in a series of related phrases, generally, in a long sentence it is used to connect independent clauses; indicates a closer relation than does a period.

Parenthesis [( )] used to set off a word or phrase from a sentence that is complete without it.

Comma (,) is used to separate words or phrases for clarity and indicates the separation of elements within the grammatical structure of a sentence.

Question mark (?) is placed at the end of a sentence to indicate a question.

Quotation marks (" ") indicate direct quotation or some borrowing, and usually demands special intonation.

Apostrophe (') marking an omission of one or two letters, or a possessive case.

Rhetorical devices

Repetition of certain words: Repetition is used to emphasise a point. The repeated use of the same word or word pattern is used as a rhetorical device. As an example, the repetition of the words “What if…” at the beginning of each line reinforces the speaker’s confusion and fear.

Questioning is another rhetorical device; two common types are:

- **The rhetorical question:** A question where an answer is not expected; often used to involve the audience and create interest. The person who asks, "What kind of stupid plan is that?" expects no answer.

- **The loaded question:** Forcing someone to answer in such a way that they lead the audience to an inappropriately implied message. An example is in a court case, a lawyer asking a man to give either a "yes" or "no" answer to the question "Have you stopped beating your wife?".

Emphasis: Is to stress or to place importance on a certain word. It is prominence given to a syllable, word, or words, as by raising the voice or printing in bold or italic type.
Counterpoints: Are contrasting ideas such as black/white, darkness/light, good/bad.

Themes: Linking devices that hold a text together structurally, e.g., the battle between good and evil: the general idea or insight about life a writer wishes to express. All of the elements of literary terms contribute to a theme. A simple theme can often be stated in a single sentence.
Introduction and conclusion: These are framing strategies and are important when writing text.

Style and tone: When writing you should examine your own responses to the writing. What is it that makes you respond as you do? Are you the author's intended audience? If not, who is? The attitude a writer takes towards a subject or character: serious, humorous, sarcastic, ironic, satirical, tongue-in-cheek, solemn, objective.

Analogy: The comparison of two pairs that have the same relationship. The key is to determine the relationship between the first, so you can choose the correct second pair, as an example hot is to cold as fire is to ice.

Use of stylistic devices to enhance meaning

Stylistic devices used in text assist with enhancing the meaning of your writing. Examples of stylistic devices are outlined below.

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Symbolism: Is using an object or action that means something more than its literal meaning. It is a symbolic meaning or representation; as an example, the owl is seen as a symbol of wisdom.

Imagery: Uses language that evokes one or all of the five senses: seeing, hearing, tasting, smelling, touching. Imagery describes something in detail, using words to substitute for and create sensory stimulation, including visual imagery and sound imagery. Also refers to specific and recurring types of images, such as food imagery and nature imagery. The author's use of visual imagery is impressive; the reader is able to see the island in all its lush, colourful splendour.

Irony: An expression, often humorous or sarcastic, that exposes perversity or absurdity. The intended meaning of the words is the opposite of their usual sense. As an example, Jem and Thabo are saved by Butch, who had ironically been an object of fear and suspicion to them at the beginning of the novel.

Understatement: To make a weaker statement than is warranted by truth, accuracy or importance.

Index: An alphabetical list of names or subjects together with the page numbers where they appear in the text.

Icon: An image or picture which may be used to emphasise a point, e.g., a picture of a book may appear if you are required to read a section in a training manual.

Logos: A name, symbol, or trademark designed for easy and definite recognition, especially one borne on a single printing plate or piece of type.

Hyperbole: A deliberate exaggeration meant to chance our opinion of, or attitude towards, someone or something. As an example, Benny McCarthy is the greatest soccer player that has or will ever exist.

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Visuals: This is an aid that can be seen, examples of visual aids are slides, PowerPoint presentations and charts.

Graphics: Drawing that can be used in the text to illustrate a point. The pictorial representation as used in computer-aided design and manufacture, in typesetting and the graphic arts, and in educational and recreational programmes.

3. EDIT WRITING FOR FLUENCY AND UNITY

We will now take an in-depth look at editing the text that you have written. This was briefly outlined in the previous section.

Characteristics of a high-quality text

Once you have completed your document, you want to ensure that it is a quality document. As a guideline high quality publication have the following general characteristics:

- Correct spelling, punctuation, grammar, and language usage
- Reader friendly organisation and layout
- Appropriate level of readability
- Clear, concise, consistent, and complete information (e.g., satisfies contractual obligations)
- Sound and accurate technical approach, content, assumptions, conclusions, and recommendations
- Adequate note is taken of audience/client sensitivities

Each of these general characteristics of a high-quality publication includes many elements. For example, reader friendly organisation and layout includes elements such as logical and coherent presentation of information, adequate use of white space, appropriate font selection and size, and orderly text alignment. Conducting a quality control review is a matter of checking all of the numerous elements that contribute to the quality of a publication.

Editing your document

Editing is the final touch to your document. It will assist you to ensure that your text is coherent, in a logical sequence and follows a structure. It will ensure that weaknesses and

errors are identified so that you can adjust. Editing focuses on the layout, spelling, punctuation, syntax and that the whole text is checked against the purpose for which it was written.

Editing involves the following:

Checking content: You should verify that all information has been presented and that there is enough supporting evidence for each point. Ensure that the content is appropriate and will promote interest and have impact on your target audience. Check that your text meets the purpose for which it was written.

Logic of text: Ensure your information is presented logically and coherently.

Readability of text: You should ensure that statements are direct and concise with no factual errors or confusing statements. Here are four ways to improve the readability of your writing:

- **Shorten Sentences**. Your audience will probably be able to read quicker and retain more information if the writing is at a lower reading level. A key factor in reading level is sentence length. Longer sentences, especially compound, complex sentences, are more difficult to read than short, simple sentences. It's important to vary the length of your sentences, but unnecessarily long sentences should be shortened. Although not always appropriate, changing sentences from passive to active voice will make them shorter and more direct.
- **Limit Paragraph Length.** Paragraph breaks help with reader comprehension. Readers use paragraphs as a "break" to process the information they have just read. Without regular paragraph breaks, writing looks intimidating and can be exhaustive reading. Limit paragraph content to one general idea when writing, and insert paragraph breaks as needed during revision.
- **Add Bullet and Numbered Lists.** Bullet and numbered lists can help readers absorb a series of items, phrases, or sequential events that might otherwise be difficult to follow, especially if the series is lengthy. Look for opportunities to reformat any series in text to a bullet or numbered list. These lists can help make a page that would otherwise be filled with only blocks of text look less intimidating to readers.
- **Use Transitions.** Transitions connect thoughts and help writing flow from one idea to the next. Without transitions, writing may seem disjointed and difficult to follow.

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Formatting of text: you should check that the layout looks good and that the appearance is readable. When formatting, use the following guidelines:

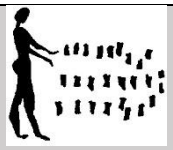
- Place margins consistently at the top, bottom, and sides of your document.
- Use page numbers and include them on every page.
- Use headings to emphasise each section of your document and support the overall flow of information.
- Indent lists to focus the reader's attention.
- Use boldface type to emphasise headings.
- Use generous spacing throughout your document.
- Keep your sentences and paragraphs relatively short.

Grammar, spelling and punctuation in text: Grammatical, spelling, punctuation, and typographical errors can damage your professional image and credibility. Therefore, it's very important to double-check your document for these errors. Do not depend completely on a computer's spelling and grammar check functions. It will often not pick up contextual errors. Ask a friend, colleague or even a professional proofreader to check your work.

Editing checklist

Keeping track of all the elements that contribute to the quality of a text, much less checking these elements, can be an overwhelming task. An excellent way to keep track of the elements that need to be checked is to develop a quality control checklist such as the one in the following table.

	**Individual Activities 1 - 4**

	**INDIVIDUAL SUMMATIVE 2**

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