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Module 13: Risk Mitigation and Adaptation in Extension and Advisory Services

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In 2012 GFRAS developed the "New Extensionist" document, which details the role that extension plays in an agricultural innovation system, and the strategies and capacities needed (at individual, organisational, and system level) http://www.g-fras.org/en/activities/the-new-extensionist.html. Based on this document the GFRAS Consortium on Extension Education and Training emerged to promote the New Extensionist, mainly through training, curricula review, and research on extension.

The Learning Kit contains 13 modules designed for self-directed, face-to-face, or blended learning and can be useful resource for individual extension field staff, managers, and lecturers.

The Risk Mitigation and Adaptation in Extension and Advisory Services module is developed as part of the New Extensionist Learning Kit http://www.g-fras.org/fr/652-the-new-extensionist-core-competencies-for-individuals.html.

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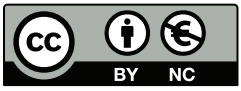

Contents

1. Before you begin

1.1 General instruction

This module should be used in conjunction with the workbook provided. As you read through the module, you will find different visual features that are designed to help you navigate the document.

Figure 1: Icons used to highlight important information throughout the manual

The module makes use of keywords (difficult or technical words that are important for you to understand). To ensure that you receive the full benefit from the module, keywords will be marked the first time they occur and defined in a box containing the keywords symbol. Make sure that you read the definition of any words that you are unsure about.

1.2 Activities

Each session in the module will contain various types of activities to help you become knowledgeable and competent. The module contains three types of activities:

A **pre-assessment** is to be completed before reading through the module overview and introduction, and a **post-assessment** is to be completed once the entire module has been covered. This will measure the degree to which your knowledge has improved by completing the module.

Each session contains one or more **session activities** to be completed, in the workbook, where indicated in the module. These activities measure your ability to recall and apply theoretical knowledge.

At the end of each study unit a **summative assessment** needs to be completed. These assessments are longer than the session activities and will test your knowledge on all the work within the study unit.

1.3 Assessment instructions

Keep the following in mind before doing any of the assessments:

- All assessments are to be completed in the provided workbook.
- The manual contains all relevant information you will need to complete the questions, if additional information is needed, such as the use of online sources, facilities will be made available.
- Work through the activities in a study unit and make sure that you can answer all the questions before attempting the summative assessment. If you find that you are not certain of any part of the training material, repeat that section until you feel confident.
- The summative assessment must be done under the supervision of your trainer at the end of your learning period.

Module 13: Risk Mitigation and Adaptation in Extension and Advisory Services

Module outcomes

After completing this module, you will be able to:

1. Discuss the basics of risk management and adaption in extension;
2. Explain the concept of risk, uncertainty, resilience and adaptation;
3. Map, analyse, and evaluate risk and adaptation;
4. Discuss the obstacles and opportunities arising from risk and adaptation planning;
5. Describe what is meant by climate change and variability;
6. Explain the impact of climate change and climate-induced extreme events;
7. Describe the role of Extension Advisory Service (EAS) in risk assessment and adaptation planning; and
8. Use risk management and adaptation tools.

Module overview

This module aims to familiarise you with risk management and adaptation planning in EAS. You will be introduced to the concepts of risk and uncertainty in order to better understand the impact of factors such as market and climate variability in the agricultural sector. You will also be provided with skills, tools and knowledge to address these factors through the use of risk management and adaptation strategies. Remember that this module not only focuses on improving your own risk management capacity but also focuses on your ability to improve the capacity of rural farmers; a primary goal of EAS.

Module introduction

Extension professionals in Africa work under complex and uncertain environments (ecosystem, socio-economic or political). Equipping extensionists with **risk management** and **adaptation** skills is key to minimising negative agricultural impacts triggered by unforeseen shocks such as a sharp swing in product and input prices and extreme weather/climate events. This module will focus on approaches to risk and adaptation management, assessment and developing **intervention** of risk in the agricultural context, **resilience** in the context of risk, understanding how improved risk planning can increase identification and adaptation of farming strategies, climate change concepts, and how extension professionals can be equipped to better manage risk and uncertainty. The module presents selected standard approaches and tools for assessing climate change risks and adaptation measures. The material in this module draws on lessons learned from different regions and derived from various **open access platforms**.

Risk: Refers to an action undertaken for gain where the outcome is uncertain and carries the potential for failure or loss. ISO 31000 is the effect of uncertainty on objectives.
Risk/adaptation management: The ability to identify, assess and prioritise risk and adaptation to identify areas of uncertainty.
Adaptation: The process by which changes are made to minimise or prevent the negative effects of external influences.
Intervention: The act of placing yourself in a position to assist other parties in managing or dealing with problems.
Resilience: Ability of individuals, communities and organisations to adapt to and recover from hazards or shocks.
Open access: Generally refers to research outputs that can be freely used and are not restricted by copyrights or licences.

Note that although this module discusses risk at an individual level, risk management is normally performed at an organisational level to identify key risk groups and better manage resources.

Complete the pre-assessment in your workbook.

Study unit 1: Introduction to risk and risk management

Study unit outcomes

After completing this study unit, you should be able to:

- Describe the concept of risk, uncertainty and risk management;
- Identify and map different types and sources of risk;
- Perform basic quantitative risk analysis; and
- Explain concepts around risk evaluation, problem solving and decision making.

Study unit overview

This unit provides an introduction to the principles and concepts of risk and risk managements, namely: exploring, making, and acting on decisions under uncertain conditions.

- Identifying risk, or discovering the source(s) from which a potential risk may arise;
- Measuring risk, or evaluating the impact on an individual or an organisation in the event of a potential risk occurring; and
- Managing and controlling risk, or selecting the most effective method(s) to deal with a potential risk.

Study unit introduction

In order to effectively manage risk you will be required to identify and prioritise potential risk events and help farmers in developing risk management strategies/plans. In addition, you will need to develop risk management methods, tools and techniques within the context of EAS as the risks faced by farmers can vary greatly between different groups based on perceptions of risk, farming techniques and crops used, and climate and local market structure.

Session 1.1: Understanding risk and uncertainty

Session outcomes

After completing this session, you should be able to:

- Explain the link between risk and uncertainty; and
- Identify the various risk determinants.

Risk and uncertainty

Risk and uncertainty are often incorrectly used as interchangeable terms. In reality, risk is a measure of uncertainty, where uncertainty refers to situations in which the outcome is unknown. It is important to note that uncertainty does not differentiate between positive or negative outcomes, merely indicating the potential for more than one outcome occurring. Risk on the other hand, looks specifically at actions in which there is the potential for negative outcomes.


Complete Activity 1.1 in your workbook.

Risk exposure: The degree to which individuals are exposed to risk, see 'vulnerability'.

Risk determinants

Although the example used thus far has been relatively simple, the reality is that farmers face a variety of complex risks, with the degree to which they are exposed to these risks referred to as **risk exposure**. The most common risks affecting farmers can be categorised as production, market, financial and institutional risks and it could be easily assumed that preventing exposure to these risks would be beneficial to farmers, but many of these risks are a normal part of the economic process.

Fluctuations in the market value of crops is a common risk farmers are exposed to across the globe and is caused by:

- Changes in demand (such as during special calendar events);
- Increased competition from other producers driving down sales prices; and
- The amount of the crop available on the market and the amount already sold.

These aspects are related to **supply and demand**, the process in which shifts in public desire for specific crops change the perceived value of crops, either increasing or decreasing their selling price.

Vulnerability determines the level of risk the farmer is under from risk sources. One of the first steps in extension risk management is gaining the ability to identify which risks the farmer is exposed to and determine their vulnerability to these risks. Farmers who do not diversify their crops increase their vulnerability to market (crop price variation), production (disease and adverse weather) and financial risks. There is a lower likelihood of all crops losing market value if you plant multiple varieties, and diseases specific to certain crops will not affect other crops.

Supply and demand: The process in which shifts in public desire for specific crops change the perceived value of crops, either increasing or decreasing their selling price.
Vulnerability: An inability to deal with or adapt to adverse effects.
Risk assessment: The process of comparing and identifying key risks.

Complete Activity 1.2 in your workbook.

Risk analysis and evaluation

Activity 1.1 showed how a choice between a decision with a more favourable outcome (short path with higher profit) but a higher uncertainty, often needs to be weighed against a less favourable outcome that carries less risk. This process is known as a **risk assessment**, with the determination of the level of risk involved

known as **risk evaluation**. Risk evaluation requires identifying the severity of risk **hazards**, the impacts associated with negative outcomes (also referred to as shocks and stresses) and the likelihood of these negative outcomes occurring.

A useful tool in risk evaluation is the risk matrix which allows to assign a severity and likelihood level to hazards. Generally, the risk matrix consists of a table with the likelihood in the left column and the severity of the outcome in the top row. The risk is given based on the likelihood and outcome as shown in Table 1.

Risk evaluation: The process of determining the degree of risk based on impact and likelihood.

Hazards: The negative outcomes associated with the impacts from risk.

Table 1: The risk assessment matrix

Negligible		Outcome				
		Minor	**Moderate**	**Major**	**Severe**	
Likelihood	**Very likely**	Acceptable	Medium	High	Very High	Very High
	Likely	Low	Acceptable	Medium	High	Very High
	Possible	Low	Acceptable	Medium	High	High
	Unlikely	Low	Acceptable	Acceptable	Medium	High
	Very unlikely	Low	Low	Acceptable	Medium	Medium

The risk matrix is useful because it can be adapted for different scenarios by modifying the meaning of the outcome levels as shown in Table 2.

Table 2: Modified outcome levels of the risk matrix

	Exposure	Environmental
Negligible	Almost no farmers affected	Low impact on environment
Minor	Isolated groups affected	Isolated cases of impact
Moderate	At least half of farmers exposed	Significant effect on environment
Major	Commonly experienced by farmers	Widespread impact
Severe	Most of farmers affected	Environmental disaster


Complete Activity 1.3 in your workbook.

Session 1.2: Risk perception and human behaviour

Session outcomes

After completing this session, you should be able to:

- List the factors that influence risk perception; and
- Describe the link between risk perception and behaviour.

Risk perception

Your perception of risk (identification of hazards) is dependent on your experience and knowledge of risk. As a result, individuals will often have very different views on what constitutes a risk, with two people identifying the same situation as having a different level of risk. It needs to be noted that your experience of risk can be either theoretical, learned information or a second hand understanding of risk, or personal experience (i.e. exposure to and experience in the control of risk).

Risk perception and behaviour

The understanding of risk perception is directly linked to the concept of human behaviour: the combination of physical and emotional behaviour that defines individuals and how they interact with their environment. Your personal history, social and economic status and intelligence all affect how you view the world and the decisions you make.

The simplest decision when viewed through the eyes of someone else may carry significant risk. Consider two individuals walking past a coffee shop; one may have enough financial security to order his favourite caffeinated beverage but the other might have a tight budget and ordering a caffeinated drink may affect their ability to afford their rent at the end of the month. This highlights

the subjectivity of risk and the idea that perceptions of risk are dependent on who perceives it.

Perception versus statistical risk

The above aspects tie into the idea that risk can be measured based on statistical risk, which is the statistical probability of an event occurring, or an individual perception of risk. For example, if you were to swim in an area where there is the risk of a shark attack, you may avoid swimming there due to your personal perception of the risk. However, the reality is that you are 132 times more likely to drown than be attacked by a shark (according to a study by the University of Florida in 2001). Does this mean that you stop swimming all together?

At this point, it is important to manage your own perception of this information compared to the actual meaning thereof, as some would now consider that this represents a high risk of drowning. Looking at the actual numbers, you will see that on average 1 in 3.5 million beachgoers die due to drowning and 1 in 264 million beachgoers die due to shark attacks, representing a very small chance of either occurring.

The understanding and interpretation of statistical data on risks can often assist you in making risk management decisions that are not affected by your own perceptions of risk. Although risk data tends to be in the form of **aggregates** (models providing average risk information regarding a system as a whole), and often vary significantly from what is experienced at a farm level, they do provide useful information with regard to the economic environment and weather patterns in a certain area. This data can also show many interesting trends such as the fact that price risk, due to market changes, is lower than that of yield risk (farmer output), and the fact that price risk is lower in countries with an active international market (OECD,

Aggregates: Models providing average risk information regarding a system as a whole.

2011). You should now be able to see how the use of statistical data and its interpretation, while taking into account the local context, can be vital to effective risk management.

Farmer risk perception

It is your role as an extension provider to assist farmers in understanding what the actual risks from factors such as variations in prices, weather conditions and disease actually are. This will require consultation with members of the rural community to understand their ability to interpret risk and their exposure to risk, as well as with other extension providers to ensure that your own perceptions of risks are correct.

From these discussions you can see that risk management should ideally be a team approach with input from multiple individuals, ensuring that risks are fully defined and not skewed by any personal perceptions.


Complete Activity 1.4 in your workbook.

Session 1.3: Risk identification, measurement, analysis and evaluation

Session outcomes

After completing this session, you should be able to:

- Apply your knowledge of risk to identify, measure, analyse and evaluate risk in terms of practical examples.

Introduction

So far, you have learnt that:

- The identification of risk involves increasing your risk perception based on experience, knowledge and the input of others; and
- Individual risk is dependent on levels of exposure and vulnerability to risks, with the level of the risks dependent on both severity and uncertainty.

This section will look at common risks faced by farmers in order to improve your risk identification, analysis and evaluation and mitigation skills.

Risk management

Risk management can be broadly divided into:

- Risk identification: The process by which risks are identified based on the exposure and vulnerability of individuals and the context they find themselves in;
- Risk evaluation: The process by which identified hazards are measured in terms of their severity and likelihood; and
- Risk assessment and mitigation: The process by which major risks identified in the evaluation phase are analysed in order to take steps to decrease their likelihood and severity.

In order to assist you in improving your risk management skills, this section will focus on flash floods and how to apply risk management to this scenario.

Case study 1: Flash floods

Flash floods are defined as sudden local flooding caused by heavy rains, with increased occurrence and severity seen in low-lying areas and areas with dry, barren soil. The accumulation of water from high rainfall sites or even from snow melts results in fast moving volumes of water downstream, with the speed of the flow dependent on the thickness of ground cover, changes in elevation and quantity of water upstream. The most devastating cases of flash floods often occur when water builds up to such a degree that rivers and dams burst their banks, releasing massive floods of water that produce large scale destruction, picking up sand, clay, rocks and even boulders as it travels. Such a case was seen in Kedarnath India in 2013 where heavy rains, landslides and the city's low-lying position resulted in a flash flood which left over 5 000 people dead and required the evacuation, by airlift, of over 100 000 people.

Although the above is an extreme case, every year people lose their lives to flash floods, with those that survive often experiencing considerable damage to their possessions and property. In the case of rural farmers, the risks to crops can be severe, with floods starving the soil of oxygen and nitrogen, and increasing the spread of disease—especially in cases where the water level remains flooded for periods longer than 24 hours. Even in the cases of adequate drainage, plants intolerant of flooding will show reduced root growth and reduced resistance to disease, which will have an effect on crop yields at harvest. This is especially important when considering the growing stage of the crop, as young crops will be affected more than mature crops during a flood.

Step 1: Risk identification

The first step in risk identification is identifying activities that increase exposure to risk and identifying the associated hazards.

From the discussion on flash floods you can already identify the following conditions or activities that increase exposure to risk:

- Agricultural activity that reduces ground cover;
- **Deforestation**;
- Extreme dry and wet season cycles; and
- Farming in low-lying areas.

Dry and wet season cycles and farming in low-lying areas represent natural conditions that expose farmers to risks.

The next step is to look at possible hazards farmers are faced with by the risk of flash floods. It is good practice at this point to also include the severity of the hazards, as shown in Table 3.

Table 3: Severity of certain hazards to farmers

Hazard	Description	Severity level
Destruction of crops	Dependent on the number of crops lost.	Minor to severe
Reduced yield due to stunted development and disease related to flooding	Dependent on a number of crops affected and degree of effect. Note that the loss on crop yield due to disease and stunted development can often be more significant than the initial loss of a few crops.	Moderate to severe
Damage to property	Can range from superficial damage to complete loss of property.	Negligible to severe

Hazard	Description	Severity level
Loss of life	Any outcome that would result in the loss of life should be assigned a severe warning.	Severe

Step 2: Risk analysis/evaluation

Up to this point, a general view on flash floods has been taken in order to determine hazards and exposure factors that increase farmer risk. Looking at the investigation so far, you can see that risk determination is far from simple, involving many factors that contribute to the actual risk level within the current context. The activity below will be used to develop your risk analysis skills within a more defined context.

Deforestation: the removal of forests or trees, often permanently, due to human activity.

Complete Activity 1.5 in your workbook.

Complete Activity 1.6 in your workbook.

Step 3: Risk assessment and mitigation

At this point you should be familiar with determining risk levels based on likelihood and severity of hazards. In order to take steps to mitigate risks, the process of implementing changes which lower the potential risk or severity of risk hazards, you will need to identify high risk groups. High risk groups are those with a significant likelihood of being exposed to hazards.

Through the identification of risk groups you can use resources effectively, implementing mitigation methods in areas that will receive the greatest benefit. In the case of flash floods this can

be the difference between not having enough funds to reinforce the river bank and having enough funds to reinforce high risk areas protecting those most at risk.

In order to mitigate risks it is important to look at the conditions and activities that result in risk exposure. Table 4 outlines the exposure factors identified in step 1 as well as possible mitigation methods.

Table 4: Exposure factors and the methods to mitigate them

Exposure factors	Mitigation methods
Agricultural activity that reduces ground cover	• Education programmes will be required to improve agricultural practices and ensure farmer understanding of the risks involved.
Deforestation	• Educational programmes to improve risk awareness of deforestation; and • Reforestation initiatives.

Exposure factors	Mitigation methods
Dry and wet season cycles and farming in low-lying areas	Due to the constant risk of flash floods from these factors, steps need to be taken to: • Protect areas through the use of ground works to divert flood water flow and reinforce river banks; • Promote the planting of flood resistant crops and protecting crop yields from the effects of flooding; • Increase ground cover to decrease the severity of hazards; • Relocate farmers to safer areas (in extreme cases); • Provide safe areas and organising flood relief programmes during seasons when there is a risk of flash floods; and • Change planting cycles and crops planted to reduce the risk that seedlings are affected by flash floods.

Concluding remarks

In this study unit you have been introduced to how managing uncertainty, and the associated risks, are part of the lives of rural farmers. In your career you will be required to identify and manage risks while taking into account the effects of factors such as individual risk perception, exposure and vulnerability. Although you are now equipped with the basic tools for risk management, future risk management efforts will require you to further research the risks within your context to improve your knowledge. To develop your risk management skills you will need to work with others and gain practical experience to truly identify risks and manage them.

For further reading on risk management refer to the Southern Extension Risk Management Education site.

Complete the summative assessment in your workbook.

Study unit 2: Understanding adaptation in the context of climate change

Study unit outcomes

After completing this study unit, you should be able to:

- Explain adaptation in the context of climate change and variability and socio-economic change;
- Explain how you will engage the community in a conversation around climate change adaptation;
- Perform assessments and evaluations to identify vulnerabilities and climate change; and
- Incorporate adaptation recommendations and actions into community plans.

Study unit overview

This study unit looks at climate change in the agricultural sector, starting with what defines climate and weather and how these factors affect the lives of individuals. You will be provided the skills needed to identify the degree to which groups are at risk and the potential impacts of these risks both at an individual and socio-economic level. The study unit will conclude with a look at the key steps in adaptation planning and implementation.

Study unit introduction

Climate change poses serious wide-ranging risks to **economies**, **society** and **ecosystems**. These risks include:

- Damage to coastal **infrastructure** resulting from sea level rise and risk of frequent storms;
- Shifting patterns of infectious diseases as a result of increased temperature; and

- **Increased food insecurity** resulting from increased risk of storms, droughts, and floods.

Adaptation refers to how you respond to (or prepare for) change within an ecosystem, socio-economic or political space, in order to reduce the negative impacts and take advantage of opportunities arising from abrupt change. Adaptation has been and will continue to be a strong component of human survival as the effects of natural variability and climate change manifest themselves.

The ability to make these adjustments is called **adaptive capacity.**

Some communities demonstrate incredible resilience through their ability to absorb disruptions caused by extreme climate change and market forces requiring the need to make adjustments while still retaining their functionality, structure and identity. The response to these changes is associated with the households or communities vulnerability and their ability to cope with negative impacts. Some examples of adaptation are:

- Developing alternative methods of farming such as greenhouse gardens;
- Installation of nets in windows to allow air flow in hot season while keeping out mosquitoes;
- Construction of all-weather roads;
- Sharing resources and information about risks and solutions; and
- There are two main types of **adaptation** (discussed in further detail below).

Reactive adaptation is your immediate response to change. This type of adaptation is often used to regain stability. It is sometimes not the best response when your past understanding doesn't correspond to current environmental and socio-economic conditions.

Proactive adaptation is more likely to reduce long-term damage, risk and vulnerability caused by change. Proactive adaptation

involves long-term decision making, which improves your ability to cope with future climate change. Periodic assessment and risk management strategies help make this response the most effective.

Economies: The state of a region in terms of the distribution, production and consumption of goods and services.
Societies: Linked groups of individuals living and interacting in an area.
Ecosystem: A grouping of organisms and their local environment.
Infrastructure: Comprises the physical structures, systems and organisations that allow a system to operate.
Food security: The level to which individuals or groups are able to meet their minimum food needs to maintain their health.
Adaptation: The ability to change to meet external challenges while reducing or preventing any negative impacts associated with said challenges.
Reactive: The ability to respond to current challenges or changes.
Proactive: The process of taking action now to be better prepared for events in the future.

Session 2.1: Understanding climate science

Session outcomes

After completing this session, you should be able to:

- Explain and differentiate between the terms weather, climate, climate change, climate variability, extreme events; and
- Describe the principle of vulnerability and the factors involved in determining it.

Climate and weather

In order to understand climate science, you will first need to become familiar with the terminology of the field. When discussing climate change, weather refers to what is happening in the atmosphere at a given time for a particular place. This can be seen when looking at any weather forecast where specific atmospheric conditions such as temperature, precipitation, pressure and wind speed are given for specific locations and times. Normally, this is done for short periods of one day to a week.

Climate refers to conditions in the atmosphere over a longer period of time, usually specified for a much larger area and based on weather statistics gathered over a number of years. Over the years, daily weather data has been used to identify patterns in temperatures and rainfall between different months and seasons.

Variation, climate change and extreme events

Changes in temperature and other conditions that you can directly sense in a specific area is known as **weather variation**.

Weather variation: Changes in atmospheric conditions for a specific location over a short period of time.
Climate variation: The study of the change in weather for an area of any size over a long period of time.
Greenhouse gases: Gases that contribute to the process of heating up the atmosphere by trapping the sun's rays, known as the greenhouse effect.

In contrast, **climate variation** is the fluctuation of the climate for an area of any size over a longer period of time such as months or seasons. However, in the case of droughts or seasonal variation you are able to sense a change in climate, climate change can measure variations that are much harder to determine using your own senses.

Climate variations in the short-term may be clues as to the direction in which climate change will occur. For example, reductions in rainfall and increases in temperature may suggest an increased potential for drought in the future.

Climate change is a change in climate over a long period of time (up to several decades). Climate change includes changes in temperatures, changes in precipitation, winds and other factors. Climate change can be caused by natural phenomena, such as variation in the Sun's orbit, and by human activities such as the production of **greenhouse gases**. Since the Industrial Revolution began around 1750, human activities have contributed substantially to climate change by adding carbon dioxide (CO_2) and other heat-trapping gases to the atmosphere.

A greenhouse gas is any gas in the atmosphere which absorbs and emits heat in the form of thermal radiation. If it were not for the greenhouse gases trapping heat from the Sun in the atmosphere, the average temperature on earth would be roughly -18°C. Unfortunately, human production of greenhouse gases is increasing the levels above what is natural, risking future increases in the Earth's average temperature which will affect ecosystems, biodiversity and human populations across the globe.

Extreme events refer to atmospheric conditions which are unexpected, unusual or severe. Extreme climatic events refer to longer periods of atmospheric change such as drought or high rainfall periods, which significantly differ from the climate data of previous years. In contrast, extreme weather events are normally sudden, relatively short-lived changes in atmospheric conditions such as heat waves, periods of high temperatures often associated with forest/veld fires, cold snaps (sudden drops in temperature) or floods that arise from drastically increased rainfall levels.

Although the term global warming is often used when discussing humankind's negative impact on the environment, this term often leads to misunderstanding. The reality is that the name comes from the identification of unexpected rises in temperature through climate data to measure the effect of human activity in terms of greenhouse gases. Taking into account the fact that weather patterns and climate cycles in one area change those of neighbouring areas, it is reasonable to conclude that an area experiencing the coldest winter in 50 years could just as easily be linked to global 'warming' as an area experiencing a drought.

Vulnerability

Vulnerability to climate change is the degree to which the environment and humans are susceptible to, and unable to cope with adverse impacts of climate change. In this case, the term 'vulnerability' may therefore refer to vulnerable systems in which a flaw or shortcoming exposes people to risks. An example of a vulnerable system would be a coastal system. Its location and lack of infrastructure can be considered vulnerabilities which expose it to flooding due to tidal waves or tsunamis and large coastal waves. The impacts this system is vulnerable to are:

- Damage to structures;
- Loss of agricultural land;
- Loss of life; and
- The social and economic impacts caused by a forced migration of the population out of the city to flee the disaster zone.

Vulnerability is determined based on the following five criteria.

Magnitude

The magnitude of an impact determines the effect of the impact based on its scale (the number of people or size of an area affected) and intensity (the degree of damage). Magnitude can also be determined based on the degree of financial loss and level of damage caused by the impact.

Timing

Timing refers both to how far from now the event will occur and how frequently an event occurs.

Persistence and reversibility

The persistence of an impact determines how likely it is to go away, with persistent events continuing for long periods of time. Reversibility refers to the ability to return a system to the way it was before the event. An **irreversible** event is one in which the impact cannot be undone.

Likelihood and confidence

Likelihood refers to the probability of an event occurring, with **confidence** measuring how accurate people think these predictions are. Confidence is dependent on both the degree to which research has been performed (number and quality of studies) and how this information is communicated to the public.

Irreversible: A process that cannot return to its original state.
Confidence: The trust individuals have in the accuracy of facts or processes.

A key aspect in communicating vulnerability to clients is your ability to help them to understand what the likelihood of events are and how these probabilities were determined. An example of this can be seen when looking at global warming, where even though many studies have shown clear correlation between people's activities and climate change, sections of the public still refute it due to the complexity of the studies, poor communication and misunderstandings, such as the one previously mentioned with regard to the term 'global warming'.

Potential for adaptation

When looking at climate change you will need to determine the potential for adaptation of different groups. You will need to predict how different groups will react during and after impacts since two groups affected by the same impact may be affected in different ways due to the infrastructure they already have in place and the resources available to them. An example of this would be improving drought relief services in one group over another due to the fact that the other group is more financially secure and already has a degree of protection against droughts.

Importance of the system at risk

In order to determine the importance of a system you will need to look at how impacts in one area would affect neighbouring

regions. An example of this would be improving the flood resistance of an area of lower likelihood of flooding over that of an area with a higher likelihood due to it forming an integral part of the local market structure (warehouses) or including key infrastructure such as hospitals and schools.

 Complete Activity 2.1 in your workbook.

Session 2.2: Climate change and agriculture

Session outcomes

After completing this session, you should be able to:

- Describe how climate change affects agriculture; and
- Describe why it is important that farmers need to take into account future variation in climate in order to prevent future vulnerability.

Introduction

Agricultural adaptation to climate change depends on current access to, and development of technological potential (like irrigation technologies), water resources, biological responses, and the capability of farmers to detect climate change and undertake any necessary actions for adaptation.

It must be noted that climate change is only one piece of the risks farmers face. The video at the link below highlights many of these challenges.
https://feeding9billion.com/video-resources/the-challenge-of-small-scale-farming-in-the-developing-world/

Adaptation challenges

Agriculture in Africa faces two interlinked climate adaptation challenges. The first relates to increasing the resilience of crops (planting drought resistant crops) and adapting farming methods to the region's highly variable climate and the occurrence of extreme events.

The second concerns the development and incorporation of long-term climate change adaptation strategies in agricultural development planning, management and governance. Effective adaptation strategies and actions should aim to enhance the well-being of communities in the face of climate variability, climate change and a wide variety of biophysical and social possibilities that are not always easy to predict.

Global warming and agriculture

Climate change in agriculture cannot be discussed without also looking at global warming. Research has shown that carbon dioxide, a greenhouse gas, is currently at its highest concentration in 650 000 years. With sea levels increasing by 3,4 mm per year, the average temperature of the planet has increased by 0,7°C in the last 100 years and the warmest years in recorded history have occurred in the last two decades. These signs, in conjunction with increases in human development, indicate that even greater changes are expected in the near future. These changes may seem relatively small, but studies looking at a change of 1,5–2 °C, done by the European Geosciences Union in April 2016, showed that:

- The mediterranean will lose 9%–18% of its available freshwater sources;
- There will be significant losses in the yields of vulnerable crops such as maize, soy and wheat; and
- The destruction of tropical coral reefs will occur. These are essential for fish populations and will gravely affect the livelihoods of rural fishermen.

As discussed in a global climate change article published by NASA (see link on p. 32), these average increases include much more severe temperature changes, on the scale of 5°C–10°C. 'A half degree averaged out over the whole world can mean much more of an increase in some locations and at certain times.'

A study by the University of Southampton showed that a lesser increase of 1°C would see the failure of anchovy fisheries in

South America, sharp falls in grain yields in North America and Asia, shorter winters and longer summers in Asia and poor rice crops in Southeast Asia.

Table 5 shows research from the University of Reading which outlines global changes expected by the year 2050, based on the predicted 1,8°C–4°C increase expected by the year 2100. Note that although not all changes due to global warming are negative, such as improved temperatures in cold regions promoting the planting of crops, it is the potential risk associated with further increases in temperature and the overall global effect that makes this such an important issue.

Evaporation: The process whereby liquid on the surface of an object turns into a vapour due to increases in surface temperature.
Transpiration: Refers to moisture loss through the pores of plants through evaporation.

Table 5: Expected global changes due to global warming by 2050

Climate component	Expected changes by 2050	Confidence of prediction	Effects on agriculture
CO_2	25%–67% increase	Very high	Good for crops, increased photosynthesis, and reduced water use
Sea level rise	Rise by 10–15 cm increased in south and offset in north by natural subsistence/ rebound	Very high	Loss of land, coastal erosion, flooding, and salinisation of groundwater

Climate component	Expected changes by 2050	Confidence of prediction	Effects on agriculture
Temperature	Rise by 1–2°C. Winters warming more than summers. Increased frequency of heat waves	High	Faster, shorter, earlier growing seasons, range moving north and to higher altitudes, heat stress risk, increased **evaporation** and **transpiration**
Precipitation	Seasonal changes by ± 10%	Low	Impacts on drought risk and soil workability, water logging irrigation supply, and transpiration
Storminess	Increased wind speeds, especially in north. More intense rainfall events	Very low	Lodging, soil erosion, and reduced infiltration of rainfall

Climate component	Expected changes by 2050	Confidence of prediction	Effects on agriculture
Variability	Increases across most climatic variables. Predictions uncertain	Very low	Changing risk of damaging events (heat waves, frost, droughts and floods) which affect crops and timing of farm operations

Refer to the following websites and videos for more details on the current and future effects of climate change and global warming.

- http://video.nationalgeographic.com/video/101-videos/global-warming-101
- http://climate.nasa.gov/effects/
- http://climate.nasa.gov/news/2458/why-a-half-degree-temperature-rise-is-a-big-deal/

From this discussion you can see that the future in terms of climate is unstable. This makes your role as an extension practitioner more vital than ever to ensure that farmers adopt farming practices that will reduce their vulnerability to not only current climate concerns but also to future changes.

Complete Activity 2.2 in your workbook.

Session 2.3: Climate change and socio-economics

Session outcomes

After completing this session, you should be able to:

- Explain the concept of socio-economics and how it relates to climate change; and
- Explain the principle of capital and its importance for climate change.

Introduction

Agricultural production and income is dependent on climate due the direct effect of weather on crop yields. Extreme climate events can have a significant negative effect on rural households due to limited available resources that prevent farmers from fully recovering after these events. These impacts are most commonly described in terms of economic impact on a community, with the degree of impact based on the community in question. This is known as socio-economics, where 'society' refers to the aspects shared within a community such as work, home life, education and politics.

Climate change and capital

Socio-economics is important when looking at the effects of climate change due to the importance of capital in determining a group's ability to prepare for, adapt to, and recover from climatic events. In general, capital refers to a group's ability to produce goods and services, where groups with high capital are more able to adapt to changes and ensure production.

This capital can be divided into the following five categories.

Human capital

Human capital refers to the skills of individuals within a group that are necessary to achieve specific outcomes. A group with high human capital would, for example, be farmers who have been given the necessary training to identify risks and implement adaptation measures to deal with climate change.

Social capital

Social capital refers to the connections and relationships within a group. Groups with high social capital would be able to work well in the case of extreme events, organising relief operations and ensuring that everyone is taken care of.

Natural capital

Natural capital refers to the natural resources available to a group. This can include the quality of the soil, water sources, air quality and living organisms. The natural capital plays an important role in resisting climate change. An area with abundant water sources will be able to resist longer drought periods than an area with limited water sources.

Physical capital

Physical capital refers to man-made items such as buildings, machinery and other equipment. This can be in the form of warehouses, schools, hospitals, trucks and farming equipment to name a few. Since these items have an important impact on both the quality of life and production potential of communities, they are items of high socio-economic importance. A community with a hospital for example, is at lower risk of deaths due to heat waves and injuries from other extreme events than one without a hospital.

Financial capital

Financial capital refers to both the money available to communities in terms of aid from government or other

organisations, and that of the individuals themselves. A large section of the rural community farmers have low financial capital with all their money invested in their current crops. As a result of this, they normally do not have the finances available to adapt to and recover from to negative climate impacts. This is by far one of the most important aspects that needs to be overcome when assisting farmers in adapting to climate change.

 Complete Activity 2.3 in your workbook.

Session 2.4: Climate change and health

Session outcomes

After completing this session, you should be able to:

- Provide examples of how climate change is influencing the spread of disease and pests.

Introduction

The vulnerability of a community or individuals to increased disease burden is dependent on various factors such as:

- The severity of the exposure to the risk;
- The current level of disease burden (sensitivity); and
- The capacity of the health care system.

There is some evidence base linking health with climate change and variability.

Malaria

There is significant evidence linking climate change to the distribution patterns of malaria in regions. Projections currently show that the suitable habitat for malaria-transmitting mosquitoes is extending further south from the Equator. This is as a result of increases in temperatures making areas more favourable for mosquitoes which breed in warm regions.

Food- and waterborne disease

Instances of waterborne diseases are on the rise, resulting in an increase in cases of disease and poisoning as a result of water contamination. This is because of increases in temperature that promote the breeding of microorganisms and parasites related to diseases such as cholera, schistosomiasis and salmonellosis.

Similar to what is seen in mosquitoes, increases in other pest species such as flies and rats, which prefer warm environments, also pose a risk due to their roles in spreading disease.

Health and infrastructure

As water sources decrease, the risk of dehydration increases as well as the potential for disease due to the increased demands on sanitation systems to process waste. Improved infrastructure will therefore be needed to address the processing of waste and the supply of clean drinking water to people.

System improvement is also needed in cases where climate change results in increased rainfall and risks of flash floods. This is essential to prevent the buildup of standing water, a common breeding ground for disease-causing organisms, parasites and mosquitoes.

Additional considerations

The burden of disease due to HIV/AIDS will also increase, as exposure to some opportunistic diseases becomes more prevalent in people with compromised immune systems.


Complete Activity 2.4 in your workbook.

Session 2.5: Example of an adaptation planning and implementation approach

Session outcomes

After completing this session, you should be able to:

- Explain the steps involved in setting up and implementing an adaptation approach.

Introduction

This section looks at how to plan for adaptation and implement adaptation approaches. The steps listed below are guidelines and may need to be adapted based on your context. Note that the following approach was adapted from a Japanese committee on approaches to climate change and adaptation. It is available at:

https://www.env.go.jp/en/earth/cc/adapt_guide/pdf/approaches_to_adaptation_en.pdf

Step 1: Share knowledge and approaches to adaptation, and examine existing measures

- Share knowledge and approaches about the need for, the importance of, and concepts relating to adaptation; and
- Compile information about adaptation-related aspects of existing policies and measures, and identify areas where gaps exist.

Step 2: Assess the risks associated with climate change impacts

- Collect and analyse existing, readily available monitoring results information; and
- Assess risks of climate change impacts using existing information (identify high risk events and areas).

Step 3: Promote communication, and decide on adaptation plans, programmes, and measures

- Share risk assessment results with stakeholders; and
- Determine the necessity of adaptation measures, consider their levels of importance, and prioritise adaptation planning and implementations.

Step 4: Start with the most feasible initiatives

- First, initiate urgent response measures to prevent and or mitigate short-term impacts;
- Next, consider adaptation measures where socio-economic benefits are clearly higher than costs; and
- Track and assess progress and effectiveness of adaptation measures (overall assessment of progress).

Step 5: Consolidate risk assessments and adaptation measures based on monitoring and the latest knowledge

- Identify areas and items requiring priority monitoring and consider and improve methodologies and arrangements for them;
- Improve future projections using the latest research results and local monitoring data; and
- Reassess risks, review and integrate adaptation measures.


Complete Activity 2.5 in your workbook.

Concluding remarks

Climate change not only affects crop yields through extreme events but will also affect rural capital levels, requiring implementation of adaptation measures that not only maintain production but also promote aspects such as disease control and conservation of resources. In completing this module you have been introduced to many of these risks and the need for adaptation. The following study unit will build on this knowledge by introducing you to the role of EAS in adaptation and risk management.

Complete the summative assessment in your workbook.

Study unit 3: The role of EAS in adaptation and risk management

Study unit outcomes

After completing this study unit, you should be able to:

- Describe the role of EAS in risk assessment and adaptation planning; and
- Name and elaborate on best practices on risk assessment and adaptation planning.

Study unit overview

This unit will look at the role of EAS in mitigating risks and uncertainty at the farmer level. In order for you to communicate these risks to farmers you will be provided with an explanation of climate and market forecast systems used to predict future impacts as well as best practice methods for setting up mitigation and adaptation plans. A number of case studies will be provided to further your understanding of the topics covered.

Study unit introduction

Effective use of risk management and adaptation tools in extension services can make a significant positive contribution to the agriculture system. Tools can be used by farmers to share best practices on adaptation to risk and specific information needs related to climate change adaptation. It is the role of EAS to provide farmers with the capacity needed to apply these tools and identify risks.

Session 3.1: Role of EAS in mitigating risks and uncertainty

Session outcomes

After completing this session, you should be able to:

- Describe the role of EAS in mitigating risks and uncertainty; and
- Explain how EAS needs to address these factors at a farmer level.

Introduction

Risk management and adaptation skills are important in the design and implementation of new extension systems that incorporate the risks and uncertainties faced by farmers. It is the role of EAS to find opportunities, knowledge and capacities to manage risks at the farmers' level with a focus on:

- Communicating risk;
- Communicating adaptation measures; and
- Training on how best to mitigate risk.

The role of EAS at the farmers' level

Farmers are exposed to multiple risks. Their ability to identify and adapt to these risks is critical to the stability of the agricultural sector. Risks faced by farmers are normally caused by:

- Changes in soil and water conditions due to climate change;
- Effect of climate change on seasonality of planting and harvesting;
- Price and market uncertainty;
- Increases in pest and disease levels; and
- Extreme events.

These topics can often be very complicated, requiring education programmes suited to the capacity levels of local farmers to be created. The importance of relating how risks can impact farmers at a local level in terms of finance, health and well-being are key to making risk management relevant to farmers. Once these aspects are in place, further capacity development can take place. Extension should promote the sharing of information between farmers in order to highlight the benefits of different approaches and get farmers to communicate the risks they need to address.

Improving the awareness and understanding of risk is key to avoid resistance to new farming methods and to ensure risk adaptation. Since switching from traditional methods, newer unfamiliar methods can be seen as a risk. It is important for farmers to have the necessary risk management skills to make these decisions.

Training systems can be useful to share knowledge between farmers and to introduce farmers to new technology, approaches and concepts that can assist them in managing risk. The aim of EAS is to ensure the increase in farmer risk management capacity, allowing for independent action. As a result of this, EAS should be involved in linking farmers with institutional support and the creation of policies to ensure successful risk management.

In order to reduce price risks, the Government of India initiated a system of price monitoring that generates and publishes price data on various agricultural commodities daily. However, the use of this data for farmers, much like in the case of meteorological data in precision farming, first requires conversion of the information into knowledge that farmers can use. Further scaling up of the markets that are subject to high price fluctuations in particular may also be needed if this effort is to contribute to reducing price risks faced by farmers. Extension systems could play a significant role if the capacity of extension workers is developed to the point where they are skilled in translating such information into context-specific content for their stakeholders.
Source: http://www.agriskmanagementforum.org/content/adapting-risk-how-can-extension-systems-help

Complete Activity 3.1 in your workbook.

Session 3.2: Climate and market forecasts

Session outcomes

After completing this session, you should be able to:

- Describe how climate forecasts can assist farmers in managing risk; and
- Describe how market forecasts assist farmers in selecting crops.

Introduction

Both market and climate forecasts are concerned with the prediction of a future event, its characteristics and trends. These predictions are based on current as well as previously recorded patterns. Although not always accurate, the use of forecasts allows you to analyse risk with high confidence.

Climate forecasts

Hurricane, typhoon and cyclone all refer to the same weather phenomenon but vary in name from place to place. They are generally defined as large low pressure zones with storm conditions.

Climate predictions include both short- to medium-term prediction of atmospheric and oceanic conditions for specific areas, normally referred to as weather forecasts, and long-term predictions for climate on a global scale.

Climate forecasts not only predict future temperatures and precipitation but can also be of assistance in determining extreme weather events such as droughts, heat waves and hurricanes. The Climate Prediction Centre (CPC) in the United

States (U.S.) is able to predict temperatures a
precipitation for up to three months in advance, with identifications of upcoming heat waves within 14 days. These forecasts can provide farmers with enough time to protect their crops from adverse weather conditions such as frost or heat waves that are predicted.

When looking at climate, you need to take into account tropical hurricanes, which have a significant effect on global weather patterns and pose a risk to coastal communities. These rapidly rotating storm systems form over warm regions in the ocean, with close to a hundred hurricanes recorded every year. As a result, groups such as the CPC monitor ocean conditions to assist in tracking cyclones, providing early warning systems to coastal communities in case of extreme events. The Pacific Ocean contains a warm ocean water band known as El Niño, which can significantly change the course of storm systems.

Frost damage results from the formation of ice on plants during cold and humid weather, normally at night. With enough warning before frost events, farmers are able to water the soil a day or two in advance or cover the ground around the plants. Both methods increase the soil's ability to retain heat absorbed during the day, preventing frost formation.

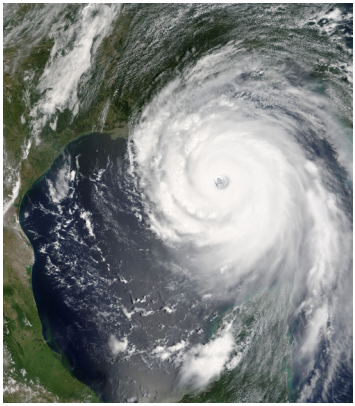

Figure 1: Hurricane Katrina in North Atlantic, 2005

Market forecasts

Similar to the way in which climate forecasts measure weather patterns, market forecasts are aimed at predicting market conditions (supply, demand/preference and competition) in the future. Most commonly, forecasts are done to ensure that crops or products currently being considered for production or planting will retain or increase in value once they are ready for market.

For many rural farmers the profits from their crops are barely enough to feed their families and ensure they have enough capital to plant again in the next season. As a result, a drop in crop market value can often see farmers losing their livelihoods.

Unlike climate forecasts, market forecasts are extremely susceptible to external influences with changes in policy, government structure, war, financial crisis and even the effects of climate resulting in drastic changes to market prices.

Due to the global nature of markets aspects such as the financial crisis in 2007–2008 and the 2016 Brexit Vote, which resulted in britain leaving the European Union (EU), results in stock values and commodity prices decreases across the globe. These events can have significant impacts on rural farmers who form part of markets reliant on foreign export and import.

It is the role of EAS to assist farmers in understanding these forecasts to ensure that they select crops which are forecasted to provide decent returns in the future. Due to the long time periods between planting and sale, forecasts provide a degree of risk mitigation for an uncertain future.

Complete Activity 3.2 in your workbook.

Session 3.3: Best practices

Session outcomes

After completing this session, you should be able to:

- Describe how adaptation strategies are applied in real world situations; and
- Use adaptation strategies to both address current and future risks.

Introduction

In this section you will look at a number of adaptation strategies that form a key component in risk mitigation. Note that adaptation strategies are risk mitigation approaches that focus on decreasing the vulnerability of communities to changes, both in terms of sudden climatic change and change related to the economic system. As such, adaptation strategies are key in areas with increased vulnerability to extreme events or poor communities that are unable to cope with market variance and the rising costs of living.

Adaptation strategies for extreme events

Since extreme events often result in sudden and considerable loss of life and damage, the process of recovery can be extremely costly and can require long periods of time to take place. By having adaptation strategies in place the initial damage and loss of life and recovery periods can be reduced. Table 6 lists some common extreme events as well as appropriate adaptation strategies.

Table 6: Common extreme events and their adaption strategies

Extreme event	Adaptation strategy
Heat waves	• Early warning systems based on climate forecast techniques; • Creating public infrastructure to address these conditions such as care facilities and cooling centres; • Buildings with climate control where the the public can gather to escape the heat; and • Public outreach/education approaches to inform the community of available assistance in case of a heat wave and how best to prepare for heat waves.
Adaptation to drought	• Public outreach/education such as supplying farmers with access to, and information about drought resistant crops; and • Providing infrastructure to ensure there are additional water reserves stockpiled in case of droughts.

Extreme event	Adaptation strategy
Flooding	Improving infrastructure by: • Adopting green approaches which reduce the effect of construction projects on the local plants and wildlife and prevents the loss of ground cover; • Limiting development in **floodplains**; • Moving existing buildings to areas above the flood level; • Building protective infrastructure such as walls near rivers, storm water drains and dams; and • Preserving/restoring wetlands, as they are important natural ground cover that reduce the impact of flood water.
Wildfires (often noted during heat waves)	• Managing vegetation through controlled burning to reduce the amount of old, dry vegetation during dry seasons; • Creating wildfire response initiatives such as: ◦ Evacuation plans; ◦ Fire prevention/control teams; ◦ Medical response; and • Creating safe zones such as shelters for those escaping wildfires.

Floodplains: Floodplains are areas close to bodies of water, such as rivers or streams, and thus have the greatest risk of flooding.

Case study 2: Flood risk challenges in Jamaican towns and communities

Increases in Caribbean storm patterns and hurricanes due to climate change pose a significant risk to communities in the form of flooding. Flooding in Jamaica results in significant damage to infrastructure in coastal areas and floodplains. Work by the Climate and Development Knowledge Network (CDKN) has seen the initial development of flood adaptation strategies. These strategies focused on creating flood hazard maps identifying present and future flood risk areas. This strategy formed part of the creation of a larger Regional Climate Model (RCM) project, aimed at analysing temperature and rainfall data in the Caribbean. The model allows for identification of vulnerable communities and infrastructure with future goals aimed at:

- Improving and building flood resistant infrastructure;
- Linking this risk data with policy making to save lives and reduce the loss of livelihood and damage to property; and
- Promoting the understanding and correct use of the data by disaster coordinators at local and national levels.

Adaptation strategies for improved livelihoods

By far the most common problems faced by farmers are those due to market fluctuations, food pricing and service delivery. With most rural farmers dependent on the success of their crops to ensure their livelihoods, adaptation strategies aimed at risk mitigation is key to their survival. The following approaches are key to successful adaptation strategies:

- Adopting more water and energy efficient practices;
- Developing local market systems by:
  - Improving market access and understanding of how markets operate; and

  - Creating a more transparent market environment to assist farmers in understanding the value of their crops.
- Using educational approaches and training to:
  - Increase efficient use of available resources; and
  - Assist farmers in increasing yields through new farming practices and crop types (crop diversification), in order to improve resistance to crop price fluctuation.

Case study 3: Urea deep placement in Nigeria

Adaptation strategies are not always aimed at specific risks or problems. Many strategies are used to increase the resilience of farmers by improving their livelihoods and incomes. One such example is the implementation of the the urea deep placement system in rice farming in Nigeria. The system developed by the International Rice Research Institute, works by placing 1–3 gram nitrogen briquettes 7–10 cm below the soil. This method has been used successfully in Bangladesh with South-South collaboration in Nigeria aiming to replicate the programme. Results have shown:

- 25% increases in yields;
- 25% decrease in urea yields;
- 40% reduction in nitrogen loss; and
- 50% increase in nitrogen uptake.

As a result of this programme farmers are increasing their yields and incomes. This benefits the government as well, with an estimated saving of US $22 million in urea imports and US $14 million in government subsidies.

For more information on these adaptation strategies and others refer to the following links:

- http://www.fao.org/climate-smart-agriculture/en/
- http://pacinst.org/publication/community-based-climate-adaptation-planning-oakland-case-study/
- http://c4d.ca/ccad-case-studies/
- http://cdkn.org/resource/strengthening-disaster-risk-management-india-review-state-disaster-management-plans/?loclang=en_gb
- http://cdkn.org/resource/inside-story-climate-change-flood-risk-challenges-jamaican-towns-communities/?loclang=en_gb

Complete Activity 3.3 in your workbook.

Concluding remarks

You should now have a clear understanding of the role of EAS in adaptation and risk management. The examples in this section have illustrated how risk management programmes such as those seen in India, Jamaica and Nigeria have decreased the vulnerability of farmers to climate change in order to secure their livelihoods. Your understanding of forecast systems and adaptation strategies are key to ensuring the success of farmers both now and in the future.


Complete the summative assessment in your workbook.

Study unit 4: Tools for assessing risk and identifying adaptation strategies

Study unit outcomes

After completing this study unit, you should be able to:

- Demonstrate the use of basic risk management and adaptation tools.

Study unit introduction

Since the earliest days of recorded history humankind has relied on the prediction of weather to ensure survival, using simple techniques such as analysing cloud patterns to unreliable methods like astrological predictions. It was only after the 1800s with the development of telegrams that mankind was able to share weather information over great distances. It was this ability that allowed for the study of weather patterns and gave rise to climate forecasting as you know it today.

The advent of the Internet, mobile devices and personal computing has increased people's ability not only to communicate with others but also the way in which they communicate. The simple act of being able to send someone an image or diagram prevents the need for lengthy discussions. The ability for individuals to access and share this information has resulted in a more closely connected society with a higher social and human capacity in terms of risk vulnerability. It is the duty of extension providers to bring these resources to the poorest members of society in order to share in the benefits.

Study unit overview

In this unit you will be introduced to various risk adaptation and management toolkits, resilience toolkits aimed at adaptation methods, climate and socio-economic forecast tools needed for determining vulnerability, and data collection and visualisation tools that you will need to share information with those in need.

Session 4.1: Adaptation and risk management tools

Session outcomes

After completing this session, you should be able to:

- List the tools available for adaptation and risk management as well as explain their purpose.

Community-Based Adaptation (CBA) toolkit

The CBA toolkit is a collection of tools that assists in the development of community-based adaptation projects. The toolkit provides step-by-step guidance and recommendations on topics such as analysis, design, implementation and information and knowledge management within adaptation.

The toolkit can be found at:
http://www.careclimatechange.org/tk/cba/en/quick_links/tools/tools.html

Food and Agricultural Organization (FAO) e-learning tool – CBA and climate change

This toolkit is similar to the CBA toolkit above, with an additional focus on climate change. The e-learning tool Planning for Community Based Adaptation (CBA) to Climate Change supports training on community-based climate change adaptation in agriculture. The tool links research-based knowledge on climate change impacts with examples and experiences on CBA drawn from FAO field projects and a range of country-specific case studies. The intended outcome of the tool is to assist all actors who face the challenge of initiating and facilitating adaptation processes at community level.

The toolkit can be found at: http://www.fao.org/climatechange/67624/en/

The adaptation toolkit

It provides a variety of adaptation tools and resources for assessing and planning for climate change impacts. The toolkit allows a community to choose the path to take, starting with where they currently are in assessing and planning.

The toolkit can be found at: http://des.nh.gov/organization/divisions/air/tsb/tps/climate/toolkit/

weADAPT toolkit

The weADAPT toolkit is a collection of open source modules ranging from climate risk communication to risk management and systems modelling. It is developed and refined through different training workshops and short courses on climate information analysis, vulnerability assessment and adaptation planning. The modules are under a process of continuous revision and are a good source of up-to-date information.

The toolkit can be found at: https://www.weadapt.org/knowledge-base/climate-adaptation-training

Risk management toolkits

Although most risk management toolkits are aimed at the business sector, a number of groups provide risk management tailored for the agricultural sectors. The Agri-food Management Institute (AMI) in association with Farm Management Canada (FMC) have created one such toolkit aimed at farmers with simplified, hands-on processes for farmers to implement. In order to acquire the toolkit you will need to contact either the AMI or FMC at the following links:

- http://www.takeanewapproach.ca/contact-us.htm
- http://www.fmc-gac.com/contact

For a general overview on risk management that includes an appendix of useful information and evaluation forms, refer to the Risk Management Toolkit by Oldham Metropolitan Borough at the following link:
http://inspiredindividuals.org/wp-content/uploads/2012/06/risk_management_toolkit.pdf

Complete Activity 4.1 in your workbook.

Session 4.2: Resilience tools

Session outcomes

After completing this session, you should be able to:

- Identify tools available for determining community vulnerability.

Introduction

This section looks at a number of useful toolkits that can be used to determine the resilience of communities and provide suggestions for improving resilience.

Climate resilience toolkit

The climate resilience toolkit hosted on the The National Oceanic and Atmospheric Administration's website provides a comprehensive analysis of climate change. It also provides resources and strategy frameworks to address your context. The toolkit provides:

- Steps for building resilience frameworks;
- Case studies;
- Science-based tools;
- Easy-to-understand topic explanations;
- Access to resource papers, expertise in the field and training courses; and
- Climate evaluation tools.

The toolkit can be found at: https://toolkit.climate.gov/#explore

Climate Resilience Evaluation and Awareness Tool (CREAT)

The CREAT toolkit, created by the U.S. Environmental Protection Agency (EPA) allows for the identification of sources of drinking water and wastewater utilities that are at risk from climate change. It also allows for the evaluation of possible climate change-related extreme events and provides suggested adaptive measures that can be implemented.

The toolkit can be found at: https://www.epa.gov/crwu/assess-water-utility-climate-risks-climate-resilience-evaluation-and-awareness-tool#Overview

Household Assets Vulnerability Assessment (HAVA)

The HAVA toolkit, previously the Household Vulnerability Index (HVI), allows for the determination of the impact of HIV/AIDS on household agriculture and food security. The tool allows for the measuring of vulnerability levels over time to track the progress of adaptation measures.

The Food, Agriculture and Natural Resources Policy Analysis Network can be contacted for more information at the following link: http://www.fanrpan.org/contacts/

Complete Activity 4.2 in your workbook.

Session 4.3: Climate and socio-economic forecast tools

Session outcomes

After completing this session, you should be able to:

- Identify available forecasting tools and their purpose.

Climate forecast tools

Climate forecast information such as that discussed in Section 3.2 can be obtained from most weather agencies, with short-term to long-term predictions of temperature, rainfall and extreme climate events. Useful sources are the:

- Global Forecasting Centre for Southern Africa which provides long-term seasonal weather forecasts and drought monitoring facilities (http://www.gfcsa.net/csag.html); and
- National Weather Service: Climate Prediction Centre, America, which provides short-term and long-term weather forecasts and hurricane tracking as discussed in Section 3.2 (http://www.cpc.ncep.noaa.gov/).

Socio-economic forecasts

Socio-economic forecasting is similar to that discussed in the section on market forecasts but in contrast looks at the total economic environment and how it affects the livelihoods of individuals. These sources of information are normally generated for specific countries by research institutes. They provide information of how economic growth such as changes in the value of all goods and services in a country (known as the gross domestic product (GDP)) affects the livelihood of individuals. These effects are normally in the form of increases or decreases in basic goods and utilities.

Many institutional and government sites supply information on the socio-economic status of countries, as this information is a key part in government decision making (policy and reforms). Examples of these can be found at the following links:

- Long-term socio-economic forecasts for different states in the U.S. (http://www.dot.ca.gov/hq/tpp/offices/eab/socio_economic.html);
- Gauteng Provincial Government Socio-Economic review and outlook 2015, South Africa (http://www.treasury.gpg.gov.za/Documents/Socio-Economic%20Review%20and%20Outlook%202015.pdf); and
- Socio-Economic Forecast: Economic Projections for the Maui County (http://www.co.maui.hi.us/DocumentCenter/Home/View/10497).


Complete Activity 4.3 in your workbook.

Session 4.4: Data collection and visualisation tools

Session outcomes

After completing this session, you should be able to:

- Describe the various methods of data collection; and
- Explain how data visualisation can assist in sharing information.

Introduction

In order to effectively evaluate your context and communicate your findings, you will need tools to better gather data and visualise the resulting information. You can use data collection tools to effectively gather information by allowing for only the collection of relevant information to the task at hand. In addition, data visualisation tools allow you to sort data and create visual representations which can be important in identifying trends or simplifying the results for others to understand.

Data collection tools

Data collection tools can range from simple pen and paper techniques to complex computer-assisted data collection software. Even though the way in which data is stored may differ, the gathering of data still requires obtaining information from specific individuals or organisations. The following tools can be used for this collection process:

Case studies

Case studies are normally used for more complex studies, where different sets of information need to be gathered and analysed in order to answer specific questions relating to 'what' and 'why'.

This can be related to why a group is being exposed to certain risk levels, why certain crops are no longer yielding the same results, what is causing decreases in yields or what can be done to address the problems being faced by certain communities.

Checklists

You can use checklists to create uniformity between data gathered from different sources and by different data collectors. By creating these lists, different groups can be compared based on the same criteria. An example is a checklist that looks at the resources available to different groups or the risks groups are exposed to. Data can then be compiled on which groups have access to running water, building materials and fertiliser or which groups have been exposed to heat waves, floods or disease. This can be a very useful approach in identifying vulnerable groups.

Interviews

Interviews both at an individual and group basis (such as meetings) allow for information and views to be shared. This approach allows for a better understanding of the needs and worries of individuals and their feelings about these topics. Many projects have failed due to resistance to new approaches because people's fears were not addressed or the approaches were misunderstood.

Observations

Observations are used to gather data from what is seen. This can be in the form of gathering data about farming practices in a community by observing the farming process from planting to harvest or determining if an adaptation strategy has been successful by observing its implementation by farmers. Observation can be vital in determining the success of a project after its implementation or identifying underlying needs of a community. It should however be noted that observations can be subjective with interpretation of observed events varying from

individual to individual. For better results this approach should be combined with a checklist-style approach.

Surveys and questionnaires

Surveys normally include sets of standardised questions that are designed to collect specific information. This approach is usually performed to gather demographic information such as ages, occupations, earnings and so on, or to determine opinions and attitudes. Questions are normally in the form of short answers or questions in which the individual answering the question ranks his opinion or attitude (for example, 'strongly agree' to 'strongly disagree').

Note that the type of tool used is dependent on the information that needs to be gathered, for example, for the determination of local crop preferences the use of observational or survey-based approaches would be preferred over case studies on average regional preferences. In addition, the education level of the group needs to be considered, with verbal interviews being more appropriate for groups with low literacy levels than the use of surveys or questionnaires.

Data visualisation tools

A key component of data gathering is the ability to compile the data in a visually understandable way. A list of numbers may have meaning to you but will require time and effort to be understood by others. In addition, visual representations of data can be better understood by those with lower levels of education and literacy. The remainder of this section looks at examples of visualisation tools and their application.

Graphs, charts and diagrams

The most common form of visualising data is in the form of graphs, charts and diagrams, with graphs commonly used to show changes in values over time, charts to represent the

relationship between different values, and diagrams to show how different components relate to one another.

Figure 1 shows a pie chart indicating how different groups relate to one another. The groups can represent anything from farmers to organisations, with the values representing aspects such as number of female-headed households, number of farmers with access to reliable water sources or even the number of heat waves experienced by each group in the last 20 years.

Group A	12
Group B	8
Group C	45
Group D	32
Group E	16
Group F	5
Group G	55
Group H	6
Group I	22
Group J	12

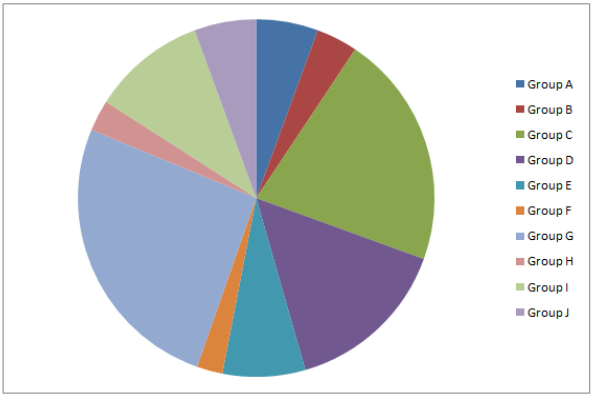

Figure 1: An example of a pie chart

Assume that the groups are different communities and the values represent the number of farmers in each. You can now quickly see that group G has as many farmers as groups H, I, J and A combined with group G the largest group, and group H the smallest. This method allows for individuals to compare complex data sets (in most cases larger than what is shown here) regardless of their education level.

Similarly, graphs can be used to track how values change over time such as in the graph below. The graph in Figure 2 clearly shows an upward trend in the number of heat waves in the area, not as easily identified from just looking at the values.

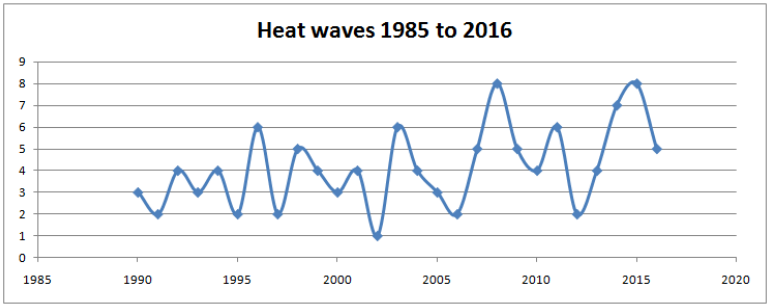

Figure 2: An example of a line graph

Although not linked to numerical data, diagrams are important in showing the interactions between different components in a system. Figure 3, originally discussed in Module 1, was used to clearly show the links between the older AKIS and newer AIS approaches in extension without the need for a lengthy discussion. This illustrates one of the most important aspects of diagrams: the ability to explain complex concepts through simple imagery.

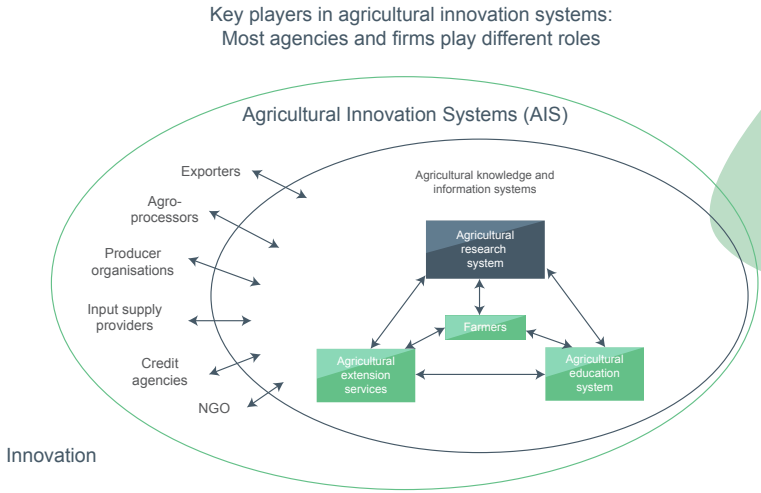

Figure 3: Diagram showing the relation between the AKIS and newer AIS approaches

Note that the previously mentioned methods represent only a limited number of options available with additional visualisation tools such as weather maps, step-by-step instructional pictures and many others all being valid choices. Even the aforementioned graphs, diagrams and charts represent only a small number of styles available, with the remainder left for self-study and their use dependent on personal preference.

Visualisation tools

Creating these visual representation of data can be done by hand but this is a time consuming process, with many software packages allowing for the quick creation of figures from compiled data. Examples of this software are programmes such as:

- Paid products:
  - Microsoft Office:
    - Provides a number of data analysis and data visualisation packages such as the included Excel and Powerpoint programmes; and
    - This product is not free.
- Open source/free visualisation tools:
  - Chart.js:
    - Simple programme with a limited number of chart types; and
    - Good for small projects.
  - Tableau:
    - Incorporates charts, graphs, diagrams and maps; and
    - Easy to use and flexible.
  - Apache, OpenOffice and LibreOffice:
    - Very similar to Microsoft Office; and
    - Offers many of the same tools.

Concluding remarks

The tools covered in this section will form the basis for the development of your own risk management and adaptation toolkit. As an extension provider you will be exposed to ever-changing risk and adaptation requirements, with your ability to gather, interpret and share your findings with the rural community key in building climate and socio-economic resilience. It is now your duty to keep up with the latest techniques and tools to ensure you are able to meet these challenges.

 Complete the summative assessment in your workbook.

 Complete the post-assessment in your workbook.

Glossary

Word	Definition
Adaptation	The process of changing a function or behaviour in order to deal with change.
Adaptation	The ability to change and meet external challenges while reducing or preventing any negative impacts associated with said challenges.
Aggregates	Models providing average risk information regarding a system as a whole.
Climate variation	The study of the change in weather for an area of any size over a long period of time.
Confidence	The trust individuals have in the accuracy of facts or processes.
Deforestation	The removal of forests or trees, often permanently, due to human activity.
Economies	The state of a region in terms of the distribution, production and consumption of goods and services.
Ecosystem	A grouping of organisms and their local environment.
Evaporation	The process whereby liquid on the surface of an object turns into a vapour due to increases in surface temperature.
Food security	The level to which individuals or groups are able to meet their minimum food needs to maintain their health.

Word	Definition
Greenhouse gasses	Gasses that contribute to the process of heating up the atmosphere by trapping the Sun's rays, known as the greenhouse effect.
Hazards	The negative outcomes associated with the impacts from risk.
Infrastructure	Comprises the physical structures, systems and organisations that allow a system to operate.
Intervention	The act of placing oneself in a position to assist other parties in managing or dealing with problems.
Irreversible	A process that cannot be returned to its original state.
Open access	Generally refers to research outputs that can be freely used and are not restricted by copyrights or licences.
Proactive	The process of taking action now to be better prepared for events in the future.
Reactive	The ability to respond to current challenges or changes.
Resilience	The ability to deal with difficult conditions.
Risk	Refers to the an action undertaken for gain where the outcome is uncertain and carries the potential for failure or loss. ISO 31000 is 'the effect of uncertainty on objectives'.
Risk assessment	The process of comparing and identifying key risks.

Word	Definition
Risk evaluation	The process of determining the degree of risk based on impact and likelihood.
Risk exposure	The degree to which individuals are exposed to risk, see 'vulnerability'.
Risk/adaptation management	The ability to identify, assess and prioritise risk and adaptation to identify areas of uncertainty.
Societies	Linked groups of individuals living and interacting in an area.
Supply and demand	The process in which shifts in public desire for specific crops change the perceived value of crops; either increasing or decreasing their selling price.
Transpiration	Refers to moisture loss through the pores of plants through evaporation.
Vulnerability	An inability to deal with or adapt to adverse effects.
Weather variation	Changes in atmospheric conditions for a specific location over a short period of time.

Resources

The following resources were used in writing this manual:

- University of Florida (2001) Beach Injuries and Fatalities, 10 February, [Online], Available:https://www.flmnh.ufl.edu/fish/isaf/what-are-odds/risks-comparison/beach-risk/ [28 July 2016].
- Ostrom, L.T. and Wilhelmsen, C.A. (2012) Risk Assessment: Tools, Techniques, and Their Applications, Hoboken: Wiley.
- OECD (2011), Managing Risk in Agriculture: Policy Assessment and Design, OECD Publishing. http://dx.doi.org/10.1787/9789264116146-en
- Reid, H., Ampomah, G., Olazabal Prera, M.I., Rabbani, G. and Zvigadza, S. (2012) Southern voices on climate policy choices: Analysis of and lessons learned from civil society advocacy on climate change, London: International Institute for Environment and Development.
- Oettle, N., Koelle, B., Law, S., Parring, S., Schmiedel, U., van Garderen, E.A. and Bekele, T. (2015) Participatory Adaptation Handbook: A practitioner's guide for facilitating people centred adaptation, Hamburg: Indigo development and change.
- Swanson, B.E. Developing Innovative Extension Systems to Help Small-scale Men and Women Farmers

Other modules of the New Extensionist modules are:

1. Introduction to the New Extensionist
2. Extension Methods and Tools
3. Extension Programme Management
4. Professional Ethics
5. Adult Education for Behavioural Change
6. Knowledge Management for RAS
7. Introduction to Facilitation for Development
8. Community Mobilisation
9. Farmer Organisational Development
10. The Role of Extension in Supporting Value Chains
11. Agricultural Entrepreneurship
12. Gender in Extension and Advisory Services
13. **Risk Mitigation and Adaptation**

Other related modules developed by GFRAS are on:

- Evaluation of Extension Programmes
- Policy Advocacy for RAS