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To my mother Ruth Phillip d/o Manasse Kijo

Preface

In this book Southern Africa region is synonymous with SADC. The book examines food security situation of small-scale producers, particularly those inhabiting poor sections of urban areas and those inhabiting dry lands in Southern Africa. Case studies and examples drawn from throughout the region are used to demonstrate the precarious and challenging situation facing this sector of the population. Recommendations on viable mitigating measures are made in the various chapters.

The introductory chapter presents a global overview of the need for measures to contain food demand by a rapidly increasing world population that topped 7 billion in 2012 and is expected to grow to 8.3 billion by 2050 and 10.9 billion by 2100. A combination of population increase in the developing world and unsustainable consumption levels in the developed world is envisioned to pose a stark challenge to the agricultural sector over and above the challenges from climate change, bio-energy and land degradation. The chapter observes that Southern Africa experiences one of the highest climate variability in the world, a variability that negatively impacts on food security particularly at the level of small-scale agricultural producers. Thus, globally, and more so in Southern Africa, more focused investments have to be directed towards research that would mitigate impacts of climatic variability and climate change as well as stabilize food supply and enhance food security while mitigating malnutrition. Sustainability as a concept and its relevance in reinforcing food security among small-scale agricultural producers in developing countries and those in Southern Africa is discussed. It is reiterated that eradicating extreme hunger and poverty depends on improving agriculture and enacting policies that support small-scale agricultural producers' productivity and strengthening food processing and fortification.

Chapter 2 discusses policies and legislations governing marketing and food trade in Southern Africa and Namibia in particular. Quoting UN conferences held in 1992 and 2002, the chapter shows that mitigations were envisioned to lie in making markets work through adjusting prices that incorporate fully the cost of environmental degradation, pollution control and impose market-based instruments such as taxes and tradable permit systems. Management interventions targeting agrarian reforms to enhance commercialization while strengthening the position of the small-scale

agricultural producers and adequately addressing poverty and food security were recommended at the end of both conferences. Policies mutually beneficial to trade and interests of SADC Member States and linkages to the global economy influenced by international institutions and the globalization process are discussed in the chapter highlighting protocols aimed at catalyzing foreign and intra-regional investment as well as enhancing cooperation, coordination and harmonization of the financial sectors to protect capital and financial markets as well as free flow of capital across the borders of Member States. Trade organs such as COMESA and SACU that promote trade liberalization in the region and policies and enacted legislations that protect, guide and enhance trade in Namibia's agricultural sector are discussed followed by an overview of Namibia's reliance on food trade to enhance food security.

In Southern Africa, urbanization is growing at an alarming rate due to increasing rural–urban migration triggered by dwindling employment opportunities in rural areas and pull factors that lure the young and able-bodied rural population to towns. Chapter 3 of this book looks at the role that urban and peri-urban agriculture play in enhancing food security among small-scale agricultural producers in Southern Africa urban areas. It is shown that although cities will continue to depend largely on rural agriculture, substantial contribution is increasingly coming from within the urban and urban fringe environments to improve food security of the urban poor.

Chapter 4 examines the role indigenous plant resources play in enhancing food security among small-scale agricultural producers in the dry lands of Southern Africa and Namibia in particular. The plant resources found on small-scale producers' land holdings include medicinal products, products from tree barks, a range of vegetables, a wide range of pulses and grains as well as edible wild fruits. The chapter elaborates on the people's earlier rich heritage, coping mechanisms and ability to live harmoniously with their environment wisely stretching resources from years of abundance into lean years. The chapter decries the weakening of coping mechanisms by 'development' interventions and suggests restoration of these mechanisms through research and domestication of indigenous plant resources. Namibia's efforts in mitigating loss of biodiversity threat are discussed in a case study that lays bare the utilization of indigenous plant resources by many small-scale producers to enhance their livelihoods. The chapter recommends strengthening of existing indigenous technical knowledge through scientific research and continuous documentation to gauge the full commercial value of some of these resources having high economic, medicinal and cultural significance to ensure sustainability and curb species extinction. Furthermore, formulation of a domestication program is recommended for targeted species.

Chapter 5 scrutinizes the role that small stock play in enhancing food security for the small-scale agricultural producers in Southern Africa's dry lands and specifically those in Namibia. Many years of experience and folklore handed down over generations had equipped these people with viable adaptations to the unpredictable weather and harsh environment. Long traditional survival techniques included livestock rearing, keeping a few cattle and mostly small stock such as goats and sheep. They harvested wildlife, wild fruits and vegetables to augment products from the animals they kept and crops they cultivated. The chapter illustrates that in Namibia,

small stock (indigenous goats and sheep) play an important role in enhancing livelihoods and food security as well as easing poverty among the small-scale agricultural producers inhabiting the dry lands.

Chapter 6 discusses interventions that improve land productivity and those that enrich dependable food crops such as cassava which is a cheap source of carbohydrates but nutritionally poor protein source through improved processing and fortification methods and thus mitigate food and nutritional insecurity including severe protein malnutrition rampant in many small-scale cassava growing areas. This is occasioned by inadequate access to animal-based proteins by the majority of the people in the small-scale agricultural sector. Most diets of the small-scale agricultural producers in the cassava growing areas derive their proteins largely from traditional vegetable sources, such as beans and leafy vegetables which are inherently low in protein content. The chapter discusses other dependable crops including pearl millet and sorghum. Case studies included in this chapter recommend intercropping cassava and pearl millet with high-protein legumes such as cowpeas and soybeans and incorporating these legumes during flour processing.

Chapter 7 looks at climate-smart agriculture and discusses the advantages of research that employ a participatory approach that enables small-scale producers to understand and incorporate weather and climatic data into farming activities. The chapter demonstrates that since agricultural activities are vulnerable to variable weather and climatic conditions, agricultural decision-making should encompass weather and climatic information into decisions on land use and land management, selection of plant breeds and crop production practices like land preparation, weeding, pest and disease control as well as harvesting and crop storage. Citing a case study carried out in Limpopo, South Africa, the chapter corroborates that consideration of weather risks such as short-term rainfall characteristics and short-term in-seasonal drought can be used effectively in determining the timing of land preparation, sowing, fertilizer application and pest and disease control. The case study explicitly demonstrates the soundness of the participatory approach where the small-scale agricultural producers work closely with the scientists and extension officials. Additionally, the chapter highlights the benefits accruing from knowledge sharing and creating a conducive environment that encourages dialogue between all stakeholders, i.e. researchers, developers, donors and the small-scale growers themselves.

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I am very thankful to the Project Coordinator of the SADC FIRCOP project Dr. Keoagle Molapong, who gave permission to use information on three case studies contained in the final report of the FIRCOP project in which I served as a member of the Steering Committee. This information appears in Chaps. 6 and 7 of this book. While I have fully acknowledged the source of the information in the text and in the references sections of the two chapters, a special mention here is in order due to the bulk of the data and information extracted from the three case studies.

I wish to acknowledge with many thanks information on the role of small stock in the livelihoods of small-scale producers in Namibia's northern communal areas contributed by Absalom Kahumba of Animal Science Department at the University of Namibia.

I bear full responsibility for the final write-up emanating from the analysis, synthesis and interpretation of all contributed and accessed information.

Josephine Phillip Msangi

Contents

Chapter 1
Population, Agriculture, Poverty and Food Security: An Overview

Abstract There is need for measures to contain food demand by a rapidly increasing world population that topped seven billion in 2012 and is expected to grow to 8.3 billion by 2050 and 10.9 billion by 2100. A combination of population increase in the developing world and unsustainable consumption levels in the developed world is envisioned to pose a stark challenge to the agricultural sector over and above the challenges from climate change, bio-energy and land degradation. Southern Africa experiences one of the highest climate variability in the world; a variability that negatively impacts on food security particularly at the level of small-scale agricultural producers. Thus, globally, and more so in Southern Africa, more focused investments have to be directed towards research that would mitigate impacts of climatic variability and climate change as well as stabilize food supply and enhance food security while mitigating malnutrition. Eradicating extreme hunger and poverty depends on improving agriculture and enacting policies that support small-scale agricultural producers' productivity and strengthening food processing and fortification.

Keywords Rapid population increase • Unsustainable consumption levels • Impacts of climate variability and climate change • Strengthening food security • Mitigating malnutrition • Eradicating extreme hunger and poverty

Population and Agriculture

The world population reached the seven billion mark predicted by the USCB that the world population would exceed the seven billion in March 12, 2012. However, according to a separate estimate by the UN Population Fund it reached this milestone at the end of October 2011. The world population has grown steadily since the end of the 1350 when it was estimated at around 370 million. The highest growth rates were experienced during the 1950s and for a longer period during the 1960s and 1970s. The growth rate peaked at 2.2 % in 1963, and then declined to below 1.1 % by 2012. Current UN projections show the global population is expected to reach between 8.3 and 10.9 billion by 2050 (Wikipedia).

According to the 2008 revision of the official United Nations population estimates and projections, the world population was projected to reach seven billion

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early in 2012, up from the 6.9 billion. At the time, the UN projections showed a continued increase in population with the global population expected to reach between 8.3 and 10.9 billion by 2050. Most of the increase was projected to be in developing countries whose population was projected to rise from 5.6 billion in 2009 to 7.9 billion in 2050. This increase was projected to be distributed among the population aged 15–59 (1.2 billion) and 60 or over (1.1 billion). The population of developed countries was expected to increase slightly from 1.23 billion to 1.28 billion. This would have declined to 1.15 billion but for a projected net migration from developing to developed countries which was expected to average 2.4 million persons annually from 2009 to 2050. It is the combination of population increase in the developing world and unsustainable consumption levels in the developed world that was envisioned to pose a stark challenge to sustainability because, as always, population growth has a marked influence on levels of consumption and the efficiency of resource use (FAO 2009a).

On the other hand, new estimates based on the 2012 revision of the official United Nations population estimates and projections, the world population of 7.2 billion in mid-2013 is projected to increase by almost one billion people within the next twelve years, reaching 8.1 billion in 2025, and to further increase to 9.6 billion in 2050 and 10.9 billion by 2100. These results are based on the assumption that there will be a decline of fertility for countries where large families are still prevalent as well as a slight increase of fertility in several countries with fewer than two children per woman on average (UN 2013).

In the new revision, the estimated total fertility rate for 2005–2010 has increased in several countries, including by more than 5 % in 15 high-fertility countries from sub-Saharan Africa. It is also assumed that future levels of life expectancy at birth will be slightly higher in several countries in sub-Sahara Africa and other developing countries. Longer survival, like higher fertility, generates larger populations. Almost all of the additional 3.7 billion people from 2013 to 2100 will enlarge the population of developing countries, which is projected to rise from 5.9 billion in 2013 to 8.2 billion in 2050 and to 9.6 billion in 2100. Growth is expected to be particularly dramatic in the least developed countries of the world such as those in sub-Saharan Africa and South East Asia. In contrast, the population of the more developed regions is expected to change minimally, passing from 1.25 billion in 2013 to 1.28 billion in 2100, and would decline were it not for the net increase due to migration from developing to developed countries, which is projected to average about 2.4 million persons annually from 2013 to 2050 and 1 million from 2050 to 2100 (UN 2013).

Out of the six permanently inhabited continents, Asia is the most populous with its 4.3 billion inhabitants accounting for 60.31 % of the world population. China and India being the most-populated countries in Asia; together their populations constitute about 37 % of the world's population. The second most-populated continent is Africa with around one billion people, or 15 % of the world's population. Europe's population of 733 million people makes up 11 % of the world's population while the Latin American and Caribbean regions are home to around 600 million or 9 % of world population. USA and Canada's population of around

352 million accounts for 5 % of world's total population while Oceania, the least-populated region, has about 35 million inhabitants or 0.5 % of world's population. Antarctica though not permanently populated, has a small, fluctuating international population, based mainly in polar science stations with summer months recording being higher than winter months (UN 2013).

Agriculture is the backbone of most of the economies in Southern Africa employing over 70 % of the population. Agricultural production and associated processing industries form the major economic sector of most countries in the region. Agriculture supports the main livelihood systems of the rural population and like in the rest of the developing countries; farmers constitute the largest group of natural resource managers. Worldwide, agriculture is expected to feed the increased population that is projected to number 9.1 billion in 2050, while providing income, employment and environmental services (FAO 2009a). According to the same report, this requirement poses a great challenge to world's farmers over and above the challenges from climate change, bio-energy and land degradation. These challenges pose enormous pressure on the agricultural sector to provide food, feed and fiber as well as income, employment and other essential ecosystem services. Making meaningful investments and introducing effective changes to agricultural production systems is a key means of meeting these challenges.

The agricultural sector will require a great deal of modification and adaptation to unavoidable changing climate and dwindling ecosystem resources in order to ensure food security and sustainable development. Most developing countries, those in Southern Africa included will need to embrace change and adapt to climate change. To ensure success, these countries will have to encompass the improvement of land productivity of small-scale agricultural producers by assisting them to adapt to climate change. To embrace methodologies that will lead to an increase in the levels of soil organic matter, of which carbon is the main component. This would translate into better plant nutrient content, increased water retention capacity and better structure, eventually leading to higher yields and greater resilience. While restoration of organic soils enables greater sequestration of carbon in soil, it may reduce the amount of land available for food production. However, according to some researchers, these options can be pursued in the context of, and without adverse affects to, national sustainable development processes (FAO 2009b).

Food Security

The World Food Summit in 1996 adopted the following definition of food security: "Food security exists when all people at all times have physical or economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996). FAO's State of Food Insecurity report (2002) refers to four elements of food security: food availability, food accessibility, food utilization and food system stability. Availability focuses on food production whereas accessibility focuses on the ability of people to obtain food,

either through production, purchase or transfers. Food utilization focuses on the nutritional value of food, the interaction with physiological condition and food safety while food system stability focuses on stability of supply and access, as well as the ability to respond to food emergencies.

In FAO's 2008 State of Food Insecurity report, it is stated that there are nearly one billion people who are undernourished. In this report, it is shown that the overall proportion of the population suffering from undernourishment in sub-Saharan Africa remains persistently high at an average of 30 % but is over 50 % in some of the countries. In this report, it is also stated that undernourishment affects more than a fifth of the population of South Asia (21 %), and many Caribbean countries (23 %). The report goes on to show that food accessibility for many people in developing countries remained closely tied to local food production; the report stressed the importance of agriculture-led growth to increase incomes and reduce poverty and food insecurity in developing countries. Efforts to improve agricultural productivity that will increase farmer incomes can drive demand in other important economic sectors. This dynamic increases economic growth while providing the opportunity to simultaneously lift millions of people out of poverty. The World Bank has calculated that growth in the agriculture sector is 2.5 times as effective at reducing poverty compared to growth in other sectors. More recent research shows that, in sub-Saharan Africa, growth in agriculture is 11 times more effective at poverty reduction than in other sectors (World Bank 2007; Christiansen et al. 2011).

Elsewhere it is reported that countries with large food insecure populations are often also those whose agricultural systems are highly vulnerable to climate shocks particularly in sub-Saharan Africa and South and Southeast Asia (Gregory et al. 2005). Due to the close correlation between local production and food insecurity documented in the FAO reports, investments in the agricultural sector that increase food availability and strengthen the resilience of the food production systems were recommended. Such investments are envisaged to have the capacity to produce immediate positive impacts on all elements of food security in food insecure regions (FAO 2009b).

Investing in the development and maintenance of fishing systems is one viable intervention that can combat food insecurity among many communities across the world. Globally, over 500 million people depend, directly or indirectly, on fisheries and aquaculture for their livelihoods. Fish also provides essential nutrition for three billion people and at least 50 % of animal protein and essential minerals to 400 million people in the poorest countries. However, frequent and intense and extreme weather events are likely to adversely affect this dependable source of food and nutrition for the fishing communities and other members of a society that cannot afford other sources of protein. The income of fishing communities also stands to be adversely affected making malnutrition common place for those who were just getting by prior to the extreme weather events. In Southern Africa the challenge is formidable for coastal and lake regions where over-fishing and poor management of the fisheries are common. Strategies to increase resilience and adaptive capacity require wide-scale implementation and adoption of measures and practices that adhere to the principles of the Code of Conduct for Responsible Fisheries.

Thus integrated farming systems are essential in overcoming food insecurity; systems that promote recycling and reuse of farm products. For example integrating aquaculture within broader farming practices will provide further opportunities, for example sludge produced during the treatment of aquaculture wastewater or pond sediments can be used to fertilize agricultural crops and crop residues such as cabbage leaves and other leafy vegetables can be used as fish feed thus reducing the cost of raising fish in small-scale ponds. Similarly responsible mariculture farming systems that include filter-feeders and seaweeds are excellent production systems as they require little external inputs and can thus be practiced by low income communities; they also provide ecosystem services such as filtering and absorbing excess nutrients in boosting water quality and minimize algal blooms. Moreover, seaweeds can be used for feed, food and cosmetic products and have the potential for bio-fuel production.

The farming of seaweeds, oysters and clams constitute the largest proportion of mariculture production worldwide. The farming of seaweeds has expanded rapidly in recent decades as demand has outstripped the supply available from natural resources. Seaweeds, such as *kappaphycus alvarezii* and *Eucheuma denticulatum,* originally harvested from natural stocks are now cultivated in some of the countries in Southern Africa such as in Zanzibar, Tanzania where it generates income for small-scale farming communities. Another viable system that can be practiced by small-scale farmers is aqua-silviculture where the integration of aquaculture and mangrove forestry is practiced. Although not yet widely practiced in Southern Africa, the potential is very high for countries such as Tanzania and Mozambique where mangrove swamps are a source of shrimps and crabs that support many small fishing communities along the coastal belt.

Aqua-silviculture system involves the integration of mangrove ponds and pens for fish and crabs (Primavera 2000). A good example where this system has registered success is that practiced in the Tambak region of Java where an area of over 300,000 ha which lacked mangroves is a well known location of extensive ponds which boosted yields and led into substantial improvements to socio-economic well-being of the rural population after mangroves were introduced (Sukardjo 1989). Other appropriate interventions that improve the nutritional level of nutrient poor traditional foods such as cassava are called for in increasing food security for the small-scale farming communities in Southern Africa. Such interventions are discussed in Chap. 6 of this book.

Southern Africa experiences one of the highest climate variability in the world. This variability has negative impacts on food security, especially at the level of small-scale agricultural producers (Mellaart 2006; Moeletsi et al. 2011). While climate variability, often characterized by extreme weather events like El Nino and La Nina which lead to droughts and floods cannot be avoided, their effects can be mitigated through intensive research on how different climate scenarios affect crop production in the region. Thus, globally, and more so in Southern Africa, more focused investments have to be directed towards research that addresses the impacts of climatic variability; research aimed at helping small-scale agricultural producers to cope with agro-climatic risks that are projected to escalate due to the effects of global warming and climate change.

High percentage (about 75 %) of the projected growth in crop production in developing countries comes from yield growth and only 16 % from increases in cropping intensity. Some predictions show that productivity of many important staple crops could decline by 2030 in high food insecure regions, particularly in Southern Africa and South Asia where large decreases in agricultural production are projected after 2050 even without the impacts of climate change (Lobell et al. 2008). Continued land degradation and water scarcity will have major negative impacts on future agricultural productivity because salinization of soils, nutrient depletion and soil erosion all reduce the productivity of lands used for agricultural production. Many developing countries are already vulnerable to weather shocks, and without significant investments in agriculture, future climate changes will increase this vulnerability (Parry et al. 2007). Thus, increasing the resilience of agricultural systems is a key means of adapting to climate change as well as increasing food security. Called for also are changes in agricultural technology aimed at increasing land productivity.

Concept of Sustainability as It Affects Agriculture

When IUCN proposed the sustainable development approach way back in 1980 as a World Conservation Strategy, it advanced it as a strategic approach to the integration of conservation and development consistent with the objectives of ecosystem maintenance, the preservation of genetic diversity and sustainable utilization of resources. To further the understanding and implementation of the approach, the UN set up the World commission for Environment and Development (WCED) in 1983 to formulate "a global agenda for change" and 5 years later the UN again convened a conference on Environment and Development (UNCED) held in Rio de Janeiro popularly known as the Earth Summit in 1992. WCED submitted its report *Our Common Future* commonly known as the Brundtland Report in 1987 and UNCED produced Agenda 21.

The WCED report, the key statement of sustainable development, defined sustainable development as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs". It defined environment as not just the biophysical natural domain but also the socio-political human components that constitute a global environment for which there is an interdependent world-linkages among poverty, inequality and environmental degradation. What was envisaged as needed then was the recognition that there was a mismatch between the natural systems' capacity and the humanity's ability to fit its activities into this framework. This called for a need to sustain and expand the environmental resource base to meet humanity's activities. At the time, the sustainability concept was necessitated by the perception that the world was facing a Meta crisis (crises of development, environment and insecurity) while the main components of sustainability were seen as the environment, growth and equity.

There has been much debate on the wholeness of the concept "sustainable" and/or "sustainability" particularly with regards to economic growth. There is a great deal of uncertainty over how to apply the concept and how to assess the implications for any given context to which it is applied. Major issues that have generated a great deal of discussion include the word "needs", intra-generational aspect (i.e. present and future generations) as well as issues of equity. The ensuing interaction between global economy and global ecology entailed environmental degradation fuelled by dramatic population growth and rising poverty levels particularly in the developing world. WECD report advocated sustainable development within the framework of equity; its ideal sustainability was to achieve basic needs for all human kind particularly those living in the fourth world (i.e. averting poverty among those living in absolute poverty in the third world). The report created the impression that equity, growth and environmental maintenance are simultaneously possible with each nation achieving its full economic potential and at the same time enhancing its resource base. However, the main question that has emerged is the variation that spans the globe.

In 1992, the UN commissioned the Earth Summit to review progress made in sustainability and ten years later, the UN convened another world conference in Johannesburg, South Africa in 2002 to review progress accomplished in protecting the global environment and reducing poverty world-wide. From this 2002 conference, several issues emerged among them the need to strengthen decision-making and harnessing science and technology and for managing linkages to the global economy and overcoming obstacles to reforms on the social dimension of sustainable development. Further shortcomings were observed in the areas of unsatisfied social needs including widespread poverty, social exclusion, unemployment and unmet aspirations for better living conditions. These led to less attention being paid to environmental problems and increased unwillingness to shift to more environmentally sound patterns of production and consumption. It was also realized that because of inappropriate incentives to consumers and producers, the higher scale of economic activity had led to pressures on the local and global environment interfering with climate systems and leading to biodiversity loss, water scarcity and over-exploitation of agricultural resources.

Solutions to this state of affairs were envisioned to lie with making markets for agricultural products work for sustainable development through adjusting prices which would incorporate the full cost of environmental degradation, instituting regulations which guard against pollution control and imposing market-based instruments such as taxes and tradable permit systems. Related regulations include instituting taxi on pollutant emitters. Additional solutions were envisaged in the area of harnessing science and technology to avoiding integrative (de-coupling) economic growth and further environmental degradation through innovation adjustment and change to suit different scenarios. Here interventions by governments was seen to be the key to success; interventions such as incentives to agricultural innovators to encourage cleaner technologies including those on agricultural production and product processing. Furthermore, success in this area was said to depend on engaging researchers from different sectors of the economy (multidisciplinary

teams), promoting public/private partnerships, integrating resource management as well as strengthening decision making and implementation as well as embracing emerging concepts such as globalization and their effects on agricultural products trade. More issues observed as requiring attention during this conference were related to human impacts leading to climate change, non-renewable resources exhaustion and inadequate waste management techniques.

Sustainability which has been described as a "fuzzy and ambiguous terminology" is sometimes seen as a bridging concept between conservation and development with several dimensions including avoiding land degradation; conserving biological diversity (watersheds, estuaries and global atmosphere); maintaining ecological services and social economic sustainability (i.e. sustaining and improving human livelihoods) Pauli (2012); advocating the wise use of agrochemicals and fossil fuel inputs to avoid human health impacts and overdependence of finite resources and equity as well as fairness among the developed and lesser developed countries, urban and rural populations, racial and ethnic groups and gender.

Although sustainability is sometimes criticized as a vague concept, conservation and development in agriculture can be implemented by developing indicators for different goals through collaborative processes and seeking sum solutions that are geared towards promoting bio-diversity-related conservation that promotes human livelihood systems and integration. Over time, it has been demonstrated that sustainability and conservation issues are interdisciplinary in nature and require multidisciplinary approach involving the intervention of a wide range of scientists. Problem oriented interdisciplinary research that promotes collaboration among scientific disciplines and stakeholders in the handling of agricultural problems. It requires input from science and technology, participatory approaches which are employed to minimize disagreements and dissatisfaction among the stakeholders. Sustainable and Conservation development issues require knowledge generation and development of new technologies to promote new approaches towards handling and management of the environmental resources including social issues. These issues come out clearly as one reads Chap. 7 of this book where the collaboration of scientists with climatic data and weather monitoring institution, donor community and the local people conducted research and monitored the implementation of relevant innovations and technologies applicable to land productivity and increase in crop yields.

Major sources of terrestrial mitigation from agriculture should include cropland management including improved agronomic practices which will generate higher inputs of carbon residue, leading to increased soil carbon storage. Such practices include using improved crop varieties, extending crop rotations, avoiding use of bare fallow and using cover crops as well as integrated nutrient management that can reduce emissions on-site by reducing leaching and volatile losses, improving nitrogen use efficiency through precision farming and improving fertilizer application timing. Other interventions should look into increasing available water in the root zone through water management that can enhance biomass production, increase the amount of above-ground and root biomass returned to the soil to improve soil organic carbon concentration. Others include soil and water conservation measures

such as the construction of soil or stone bunds, drainage measures and irrigation which constitute important aspects of water management (Parry et al. 2007).

Further mitigations should include tillage management practices with minimal soil disturbance and incorporation of crop residue to decrease soil carbon losses through enhanced decomposition and reduced erosion. Systems that retain crop residues tend to increase soil carbon because these residues are the precursors of soil organic matter. More interventions should include agro-forestry systems because they increase carbon storage and may also reduce soil carbon losses stemming from erosion. Agro-forestry systems include combining crops with trees for timber, firewood, fodder and other products, and establishing shelter belts and riparian zones/buffer strips with woody species. Furthermore, draining organic soils for cultivation should be avoided and soil productivity should be reclaimed through re-vegetation; applying nutrient amendments and organic substrates such as manures, bio-solids and composts; reducing tillage and retaining crop residues; increasing fertilizer use in regions with low nitrogen content (as in much of sub-Saharan Africa) and conserving water.

Poverty and Hunger

According to FAO State of Food Insecurity in the World 2013, a total of 842 million people in 2011–2013, or around one in eight people in the world, were estimated to be suffering from chronic hunger, regularly not getting enough food to conduct an active life. This figure is lower than the 868 million reported during 2010–2012. FAO estimated that nearly 870 million people of the 7.1 billion people in the world, or one in eight, were suffering from chronic undernourishment during 2010–2012. Almost all the hungry people, 852 million, lived in developing countries, representing 15 % of the population of developing counties. Comparatively, there were only 16 million undernourished people in developed countries (FAO 2012).

Statistics in the 2013 FAO report on food insecurity in the world also show that the number of hungry people grew in Africa over the 2010–2012 periods, from 175 million to 239 million, with nearly 20 million added in the last recent years during when nearly one in four people were hungry. Sadly in sub-Saharan Africa, the modest progress that had been recorded during a few years prior to 2007 was reversed, with hunger rising 2 % per year since then. Comparatively developed regions also saw the number of hungry rise, from 13 million in 2004–2006 to 16 million in 2010–2012, reversing a steady decrease in previous years from 20 million in 1990–1992 (FAO 2012).

Poverty is the principle cause of hunger while the causes of poverty are many and varied, including a lack of individual resources and responsibility, unequal income distribution, conflict and bad government policy, exploitation of the less fortunate by people and businesses with power and influence, or some combination of these and others. Hunger and malnutrition, closely related to poverty, have become rural and urban problems in modern social settings. According to the World Bank estimates,

as of 2008, there were 1.345 million poor people in developing countries who lived on $1.25 per day or less. These estimates also show that the number of people in extreme poverty in Sub-Sahara Africa has increased in recent years. Harmful economic systems are quoted as the underlying cause of poverty. Control over resources and income is based on military, political and economic power that typically ends up in the hands of a minority, who live well, while those at the bottom barely survive (Kim 2013).

Conflict contributes to poverty and hunger due to the large number of refugees who lose everything when fleeing from conflicts and end living in squalor in refugee camps. Despite some large-scale repatriation movements, there has been a significant increase in refugee numbers. By the end of 2008, the total number of refugees under UNHCR's mandate exceeded 10 million and the number of conflict-induced internally displaced persons reached some 26 million worldwide at the end of that year. According to UNHCR, the exact number of stateless people is difficult to give, but what is vividly observable is the anguishing and despondency for those affected by conflict which is a cause of hunger. UNHCR estimates show that overall 1.02 billion people suffer from chronic hunger while 36 million people are displaced (UNHCR 2008).

Hunger is also a cause of poverty, because hunger causes poor health, low levels of energy and even mental impairment which lead to even greater poverty by reducing people's ability to work and learn to improve their skills thus leading to even greater hunger. In recent years, climate change is increasingly viewed as a current and future cause of hunger and poverty. Increasing drought, flooding, and changing climatic patterns requiring a shift in crops and farming practices that may not be easily accomplished are three key issues.

Three-quarters of the world's poor live in rural areas and make their living from agriculture. It has been documented severally that hunger and child malnutrition are greater in these areas than in urban areas. Child undernourishment incapacitates children's development for a lifetime as it hinders the development of intelligence; reduces attention and learning capacities and it reduces the vitality of individuals, as well as making them more prone to disease. Moreover, the higher the proportion of the rural population that obtains its income solely from subsistence farming the higher the incidence of hunger and malnutrition i.e. where there are no benefit of pro-poor technologies and access to markets (rural areas).

Eradicating extreme hunger and poverty depends on agriculture the most because it has been shown that there are strong, direct relationships between agricultural productivity, hunger, and poverty. Therefore policies that support improvements in agricultural productivity aimed at small-scale agricultural producers will benefit the rural poor first. Increased agricultural productivity enables the small-scale agricultural producers to grow more food, which translates into better diets and, under market conditions that offer a level playing field, into higher farm incomes. With more money, small-scale producers are more likely to diversify production and grow higher-value crops, benefiting not only themselves but the economy as a whole. According to FAO, addressing agriculture and population growth is vital to achieving food security. Other organizations too have come to this conclusion and advocate improvements in agriculture, and population control.

Way back in 1991, after considerable international debate, the World Bank acknowledged that investing in people provides the firmest foundation for lasting development (World Bank 1991). For the World Bank and for other international organizations such as USAID, this meant in principle better education, higher standards of health and nutrition, less poverty, a cleaner environment, more equality of opportunity, greater individual freedom, and a richer cultural life. However, reaching these ends requires economic growth, which, under current global economic conditions, depends heavily on productivity, technological progress, and human capital.

To increase productivity, countries must therefore compete effectively in the global market and make optimum use of new technologies. CIDA of Canada, in its report "*Sharing Our Future*" identified four principles of social development: poverty alleviation must be put first; people must be helped to help themselves; development priorities must prevail; and partnership must be the key (CIDA 1987). This interpretation was shared by the World Bank: it recognized that adjustment must be complemented by poverty alleviation. In terms of programs, CIDA's approach emphasized poverty alleviation and self-help through its focus on basic human needs. Similarly, OECD of Britain, put people up front, proposing a social-development concept in terms of capacity development at all levels: national, regional, local, and individual while the MDGs advocate among other interventions, providing soil nutrients to farmers in sub-Saharan Africa to reduce poverty.

Elsewhere, writers have expressed similar sentiments over the years when they stated that without doubt, the alleviation of extreme poverty is a priority (Chambers 1995). However, it must be recognized that in isolation, poverty alleviation is a short-term concern. The critical issue is how to address poverty in the broader framework of public policies and how, in so doing, to lay the base for sustainable development over the long term. A good example is education; not just basic education but education for the small-scale agricultural producers, who are central to poverty alleviation in most developing countries, Southern Africa included. The goal should be to strengthen rural livelihoods through education and appropriate technologies; those geared towards making these livelihoods sustainable and resilient to climatic stress and shocks.

As a continent, Africa recognizes that enhanced agricultural performance is the key to growth and poverty reduction through its direct impact on job creation and increasing opportunities, especially for women and for the youth; on food security; improved nutrition and building resilience. This is because most African economies and livelihoods largely depend on agriculture and the associated manufacturing and processing industries. In 2003, the AU adopted the Maputo Declaration on Comprehensive Africa Agriculture Development Program (CAADP) setting broad targets of 6 % annual growth in agricultural GDP, and allocation of at least 10 % of public expenditures to the agricultural sector. AU put forward its intentions to achieve these targets through collective actions across the continent focused on improving agricultural planning and policies, scaling up investment to implement these plans and policies, and harmonizing external support around African-owned plans (PAEPARD 2014).

Throughout the decade following the 2003 declaration, Africa as a continent has been guided by a well-formulated framework that has influenced policies, strategies and actions for agricultural development and transformation. Assessments carried out just before the beginning of 2014 have revealed that this framework and its objectives have been instrumental in raising the profile of agriculture at the centre of development agenda at national, regional and global levels which has facilitated mobilization and alignment of multi-stakeholders' partnerships and investments around national agriculture and food security investment plans. The CAADP process has encouraged and facilitated evidence based planning, and commitment to institutional and policy reforms with a sense of mutual accountability for actions and results. Mechanisms such as agricultural sector reviews at country level, and annual CAADP partnership platforms were put into action and used as review and dialogue avenues in fostering accountability for results on agriculture performance.

Recently, the African Union Assembly of Heads of State and Government declared the year 2014 to be the Year of Agriculture and Food Security in Africa, marking 10th Anniversary of the adoption of CAADP. Over the last decade, due to CAADP objectives, African agriculture and food security concerns remain high on the policy agenda at national, regional, continental and global levels. Thanks to such concerted actions, the performance of African agriculture has been encouraging; an annual average agricultural GDP growth of nearly 4 % since 2003 has been realized. This is well above the agricultural GDP growth rates for the previous several decades (PAEPARD 2014). AU's recent declaration is considered an important milestone and an opportunity that should be seized in the resolve to continue to uphold agriculture and food security as priority for policy and practical actions to generate concrete results and impacts.

The year for African Agriculture and Food Security is being commemorated across Africa, in Member States, Regional Economic Communities, Continental organizations, and the AU Headquarters in Addis Ababa, Ethiopia. The process is envisioned to give opportunities to communities, state and non-state actors in Africa to interact and express their voices on what works for them and chart the focus and targets for the next decade. The process is expected to contribute towards setting the agenda for sustaining the CAADP momentum which forms the basis for African leaders to recommit themselves towards realizing the vision set out in 2003. The agenda of agricultural transformation across Africa is strategically positioned to provide enormous opportunities for an inclusive and sustainable development.

It is gratifying to note that investments driven by strong political commitment and leadership and fostering effective partnerships has yielded very positive results so that by the beginning of 2014, 34 AU Member States had signed CAADP compacts; 30 among them having developed formal national agriculture and food security investment plans which were used as their medium term expenditure frameworks for agriculture, thus resulting in improved agricultural planning. At regional level, 50 % of the continent has entered into regional compacts with fully developed investment plans. On average public agricultural expenditures have risen by over 7 % per year across Africa since 2003, nearly doubling public agricultural

expenditures since the launch of CAADP. The important fact to note here is that the decade saw sustainable growth in agricultural sector which has generally supported sustainable rural livelihoods throughout the continent.

Sustainable rural livelihoods have been defined as the capabilities, assets (both material and social resources) and activities required for a means of living; livelihoods capable of coping with and recovering from stresses and shocks, able to maintain or enhance its capabilities and assets now and in the future while not undermining the natural resource base. Rural livelihoods are sustainable if they can maintain long-term productivity of natural resources and do not undermine the livelihoods of others or livelihood options open to others. The use of locally available resource materials ensures sustainability. Rural livelihoods are economically sustainable when a given level of expenditure can be maintained over time i.e. if a baseline level of economic welfare can be achieved and sustained. Rural livelihoods are socially sustainable when social equity can be maximized; if they can cope with and recover from stress and shocks and provide for future generations; they are institutionally sustainable when the prevailing structures and processes have the capacity to continue to perform their functions over a long period of time and they do not show dependence upon external support unless the support itself is economically and institutionally sustainable. And lastly rural livelihoods are environmentally sustainable when they maintain or enhance the local and global assets in which livelihoods depend, and have net beneficial effects on other livelihoods (Msangi 2008b).

Sustainability among rural livelihood systems must be supported by multidisciplinary research and analyses in order to appreciate and understand these systems (traditional and modern) particularly where the livelihood systems are hugely dependent on agriculture and the exploitation and management of natural resources. In most countries in Southern Africa where the majority of the population lives in rural areas, their livelihoods largely revolve around land ownership and natural resources exploitation and trade of basic agricultural goods. Land acts as security, as a means to gain access to other livelihood options; it acts as leverage for other forms of investment and linkages. It has been argued that the agricultural sector in most parts of rural Southern Africa lacks science, technology and financial investments and that productivity is low compared to other sectors. Rural development interventions must therefore focus on promoting sustainable livelihoods including improving productivity (both land and human) to enhance economic performance and opportunities.

In Southern Africa, rural livelihood systems are very vulnerable to land degradation, diseases and increased magnitudes of environmental hazards such as those attributed to climate change (e.g. unpredictable droughts and floods). Agriculture, a major sector of the economy in Southern Africa, is vulnerable to year-to-year weather fluctuations and variable climatic conditions. Rural development interventions must therefore focus attention on communication infrastructure, land management, land ownership, land tenure, research and extension as well as disease prevention and strengthening mitigation options as well as indigenous people's earlier coping strategies. Adjustment to climate change adversities heavily rely on improved management and adaptive techniques which incorporate traditional

knowledge that has evolved over time due to climate variability characterizing the region. It has emerged that recent increased magnitude of these vagaries is a challenge to many rural communities (Msangi 2008a).

In developing countries and in rural areas of Southern Africa in particular, these climate change challenges are exacerbated by multiple-stresses and limitations including low adaptive capacity, limited access to knowledge and technology support, extreme poverty, weak policy support, and lack of widespread integrated approaches for strategic planning and regional cooperation. The tragedy of climate change adverse impacts is the fact that whereas the industrially developed countries bear the largest responsibility for the causes of climate change, the less-industrial developing countries particularly those in Africa are the most vulnerable to the worst consequences of climate change. A summary of the 2007 IPCC report on the vulnerability of the African continent shows that by 2020, between 75 and 250 million people are projected to be exposed to increased water stress due to climate change and the yields from rain-fed agriculture could be reduced by up to 50 % in some countries. This would further adversely affect food security and exacerbate malnutrition. This prediction was further confirmed during the February 2009 meeting on climate change in Copenhagen, Denmark (Copenhagen Climate Change Conference 2009). For Southern Africa, it was depicted that the sea level would rise by between 90 and 130 cm by the end of this century thus worsening the plight of the region (Amweelo 2009).

On the other hand it must be recognized that traditional rural livelihood systems shaped by the natural environment are integral resources to communities and so form a basis for many of the society's beliefs, cultures and practices. Practices such as traditional farming techniques, changing hunting and gathering habits, crop and livelihood diversification, seasonal and climate forecasting as well as community-based disaster risk reduction. Therefore, respecting indigenous knowledge systems, community structures, institutional management agencies and site-specific resource management will contribute immensely towards strengthening the degree of success in devising sustainable adaptive alternatives. By enhancing the old-age traditional coping strategies through incorporation of indigenous knowledge into research and policy formulations, researchers and governments will go a long way in assisting the rural populations to adapt and adjust their livelihood systems to the changing climatic conditions (Msangi 2004).

Policies and investments (both by public and private sectors) geared towards supporting rural populations in adaptation and mitigation processes would enhance the rural population's resilience to climate change. Such undertakings would also help conserve biodiversity and improve ecosystem integrity as well as promote sustainability in natural resource management in the region. Research, education and specific management strategies (e.g. land use diversification, management and soil erosion control; flood and drought mitigation; food preservation, storage and marketing) should form part of the needed support. It would be prudent also to invest in education, awareness and capacity building to effectively empower rural populations using their own existing institutions which they can identify with; institutions such as chief's council, village committees and village councils; cooperatives and specific resource committees.

The issue of sound policies and management techniques that govern the sustainability of food security and poverty alleviation is addressed in Chap. 2 of this book. The chapter looks back at issues raised way back in 1992 when the UN commissioned the Earth Summit to review progress made in sustainability and those raised during the World Conference held in 2002 to review progress accomplished in protecting the global environment and reducing poverty world-wide. From the 2002 conference, several issues emerged among them the need to strengthen policies that guide decision makers and strengthen linkages to the global economy. Solutions were envisioned to lie with making markets work for sustainable development through adjusting prices which would incorporate the full cost of environmental degradation, instituting regulations which guard against pollution control and imposing market-based instruments such as taxes and tradable permit systems. The main goal of these policies was to guide management issues that would bring about agrarian reforms and enhance commercialization and marketing policies that would strengthen the position of the rural small-scale agricultural producers and adequately address poverty and food security issues (Msangi 2013).

In Southern Africa, it is access to markets and product perishability that constrain small-scale agriculture sector and the food security in the region. Throughout the region, agricultural produce from small-scale agricultural producers is often lost after production due to spoilage and inability to access the markets in good time. Poorly developed infrastructure and non-availability of reliable supportive organizations that represent and serve the small-scale agricultural producers compound an already bad situation. These factors reduce small-scale producers' opportunities and incentives to participate in formal markets, a situation which makes it difficult for them to shift into commercial farming and earning appreciable earnings from their efforts.

Equally important as access to markets and adequate policies that serve the small-scale agriculture sector is the paucity of relevant research on traditional crops. While cash crops such as grapes, sisal, cotton, grapes, green beans, sugar-cane, coffee, tea and cut flowers were accorded a great deal of attention in form of research, extension services and provision of agricultural inputs during the colonial era in Southern Africa, traditional subsistence crops such as millet, sorghum, pearl millet (*mahangu*) and cassava were neglected. Agricultural research, agricultural inputs availability as well as extension services are essential in increasing land productivity and securing food self sufficiency among small-scale producers. Substantial increase in agricultural production demands new innovations in agricultural practices, in farming methods and in the use of qualitative genetic materials of both plants and animals. The goal of pillar 4 of the New Economic Partnership for Africa's Development (NEPAD)'s Comprehensive African Agriculture Development Program (CAADP) is to enhance and improve the effectiveness of agricultural research and development which aim to improve agricultural production. This is in line with one of the objectives of the Millennium Development Goals (MDGs) of achieving 50 % reduction in poverty by 2015 and attaining 6 % growth in agriculture production per annum.

The persistent food and nutrition insecurity and low income among the rural farmers in developing countries and those in Southern Africa are among the factors which largely contribute towards prevalent poverty and poor health. It has been

demonstrated and acknowledged that the situation is even worse among the rural resource-poor households and particularly women who continue to use rudimentary arduous methods and equipment to produce and process food for their families. This is despite the fact that locally grown crops like cassava, pearl millet, sorghum and high protein crops such as cowpeas and soybeans with high potential in improving household food security have not been widely incorporated into traditional food processing methods. Cassava, Africa's second most important food staple, after maize, in terms of calories consumed requires fortification to improve its nutritional value. Cassava which is widely produced for food and income generation ranks high among food crops in many sub-Saharan African countries owing to, among other factors, its agronomical advantages as compared to other crops. Cassava has the ability to grow in poor soils and low rainfall while giving reasonable yields compared to other crops.

Understandably, many small-scale agricultural producers in Southern Africa remain skeptical on the value of agricultural research because it has not been sufficiently demonstrated that research can greatly improve agricultural land productivity which would improve poverty and food security to a great extent. Research input takes time to be seen especially where the consumer of the research findings and recommendations do not adopt these recommendations as detailed by the researchers. Often the small-scale agricultural producers being the main customers of research findings prefer to stick to their traditional methods of production because these are what they know and the one that have supported previous generations. Therefore it is prudent to revisit the research agenda, increase funding and investments in agricultural research activities that will lead to improved technology development and strengthening of extension services so as to convince and support the small-scale agricultural producers. These and other issues on the need and benefits of agricultural research are discussed in Chap. 6 of this book.

Chapter 6 also discusses research findings which demonstrate how pearl millet and cassava can be enriched through improved processing and fortification methods to assist in mitigating food and nutritional insecurity including severe protein malnutrition rampant in those areas dependent on the two crops. This is mainly due to the fact that proteins from animal sources are relatively in short supply and too expensive for the majority of the people in rural communities. Most diets thus derive their proteins from traditional vegetable sources, such as beans and leafy vegetables, which are inherently low in protein content thus leading to diets low in protein. High protein legumes such as cowpeas and soybeans are not widely incorporated into rural areas diets. This low protein intake coupled with a low caloric intake contributes to rampant malnutrition, especially in the form of Protein-Energy Malnutrition (PEM).

Chapter 3 of this book looks at the role that urban and peri-urban agriculture plays in enhancing food security in Southern Africa cities and towns. Globally, it is reported that since 2010 half of the world's population lives in cities and that the world's urban population will almost double from the current 3.5 billion (about 50 %) to more than six billion by 2050. An estimated 40 % of Africa's population

lived in urban areas by 2009 (UN-HABITAT 2009; UNDP 2012). In Southern Africa, urbanization is growing at an alarming rate due to increasing rural–urban migration triggered by dwindling employment opportunities in rural areas and due to the ever present attractions perceived to exist in the urban areas; attractions which lure the young and able bodied rural population to migrate to towns. Although cities will continue to largely depend on rural agriculture, urban and peri-urban agriculture is making an appreciable contribution to cities across the globe.

Chapter 4 of this book examines the role indigenous plant resources play in enhancing food security among small-scale agricultural producers in the dry lands of Southern Africa and Namibia in particular. The chapter demonstrates that the inhabitants of the dry lands had a rich heritage of ably managing and living harmoniously with their environment utilizing resources wisely stretching these from years of abundance into lean years. Many years of experience and folklore handed down over generations had equipped these people with viable adaptations to the unpredictable weather and harsh environment. Long traditional survival techniques included livestock rearing, keeping a few cattle and mostly small stock such as goats and sheep. They harvested wild fruits and vegetables to augment those they cultivated and harvested wildlife to supplement the meat they got from the animals they reared in their settlements.

Chapter 5 of this book discusses the role of small stock in enhancing food security and mitigating poverty among the small scale agricultural producers in Namibia. Namibia being a dry country, livestock farming constitutes an important agricultural activity that supports diets of the majority of the people. Small stock plays an important role in the livelihoods and food security for the small-scale agricultural producers in both southern and northern Namibia. Sheep and goats constitute the bulk of the small stock population kept to support food security and alleviate poverty. About 60 % of all Namibian goats belong to indigenous breeds which have valuable genetic properties that contribute to high fertility and resistance to aridity and disease (Werner and Odendaal 2010).

Chapter 7 discusses the advantages of climate smart agriculture particularly those based on research that employ a participatory approach that enables small-scale agricultural producers to understand and apply weather and climatic data into farming activities. The chapter demonstrates that since agricultural activities are vulnerable to variable weather and climatic conditions, agricultural decision-making should encompass weather and climatic information into decisions on land use and land management, selection of plant breeds and crop production practices like land preparation, weeding, pest and disease control as well as harvesting and crop storage. Citing a case study carried out in Limpopo, South Africa, the chapter demonstrates that consideration of weather risks such as short-term rainfall characteristics and short-term in-seasonal drought can be used effectively in determining the timing of land preparation, sowing, fertilizer application and pest and disease control. The case study demonstrates the practicability of participatory approach where the small scale agricultural producers work closely with the scientists and extension officials to produce good results.

References

Amweelo M (2009) Climate change: rising to the challenges in Africa. The Namibian (5 Feb 2009)
Chambers R (1995) Poverty and livelihoods: whose reality counts? Environ Urban 7(1):173–204
Christiansen L, Demery Kuhl J (2011) The (evolving) role of agriculture in poverty: an empirical perspective. J Econ Dev Elservier 96(2):239–254
CIDA (1987) Sharing our future. Canadian International Development Assistance, Ottawa
Copenhagen Climate Change Conference (2009) UN framework convention on climate change. Bella Centre, Denmark. UN COP 15 Copenhagen
FAO (1996) World food summit: Rome declaration and plan of action. Rome
FAO (2002) State of food insecurity in the world. www.fao.org/docrep/005/y7352e/y7352e00. Accessed 10 Dec 2013
FAO (2008) State of food insecurity in the world. ftp://ftp.fao.org/docrep/fao../011/i0291e/i0291e00.pdf. Accessed 10 Aug 2013
FAO (2009a) State of food insecurity in the world. ftp://ftp.fao.org/docrep/fao../012/i0876e/i0876e.pdf. Accessed 20 Aug 2013
FAO (2009b) State of food insecurity in the world: economic crises and lessons learned. ftp://ftp.fao.org/docrep/fao/012/i0876e/i0876e_flyer.pdf. Accessed Nov 2013
FAO (2012) State of food insecurity in the world: economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. http://www.fao.org/docrep/016/i3027e/i3027e.pdf. Accessed 10 Dec 2013
Gregory PJ, Ingram JS, Brklacichi I (2005) Climate change and food security. Philos Trans R Soc B 360:2139–2148
Kim JY (2013) The World Bank group strategy: a path to end poverty. World Bank group president's speech delivered at George Washington University-pre-annual meetings speech. Washington, DC
Lobell DB, Burke MB, Tebaldi C, Mastrandrea MD, Falcon WP, Naylor RL (2008) Prioritizing climate change adaptation needs for food security in 2030. http://www.sciencemag.org/content/319/5863/607. Accessed 25 Oct 2013
Mellaart EAR (2006) Simple manual for response farming, Handbook for extension officers. Ministry of Agriculture, Pretoria, 9 p
Moeletsi ME, Mpandeli NS, Mellaart EAR (2011) Crop water satisfaction analysis for maize trial sites in Makhado during the 2007/2008 season. In: Attri SD, Rathore LS, Sivakumar MVK, Dash SK (eds) Challenges and opportunities in agrometeorology. Springer, Berlin/Heidelberg
Msangi JP (2004) Drought hazard and desertification management in the drylands of southern Africa. (2004). Environ Monit Assess 99(1–3):75–87
Msangi JP (2008a) Alleviation of risks and vulnerability facing isolated communities through conservation and management of bio-diversity: the lower Kuiseb river basin, Namibia. In: Watkins MM (ed) World poverty issues. Nova Science Publishers, New York
Msangi JP (2008b) Sustainability in traditional rural livelihood systems: expert commentary. In: Watkins MM (ed) World poverty issues. Nova Science, New York
Msangi JP (ed) (2013) Combating water scarcity in Southern Africa: case studies from Namibia, SpringerBriefs in environmental science. Springer-Dordrecht, Heidelberg/New York/London
PAEPARD (2014) 10th CAADP partnership platform. http://paepard.blogspot.com/2014/03/10th-caadp-partnership-platform.html. Accessed 10 Apr 2014
Parry ML, Canziani OF, Palutikof PJ, van der Linden PJ, Hanson CE (eds) (2007) Climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, UK
Pauli G (2012) The next generation of Urban agriculture. http://theblueeconomy.org/blue/Case_97_files/Case%2097%20Next%20Generation%20Urban%20Agriculture.pdf. Accessed Oct 2013

Primavera JH (2000) Development and conservation of Philippine mangroves: institutional issues. Ecol Econ 35:91–106
Sukardjo S (1989) Tumpang Sari pond as a multiple use concept to save the mangrove forests in Java. Biotropica Spec Pub 37:73–109
UNDP (2012) Africa Human Development Report 2012: towards a secure food future. Empowered lives, resilient nations. http://undp.org/Africa and afhdr.org.. Accessed 12 Apr 2014
UN Department of Economic and Social Affairs/Population Division (2013) World population prospects: the 2012 revision. New York
UNHCR (2008) 2013 world hunger and poverty facts and statistics: world hunger education service. http://www.worldhunger.org/articles/Learn/world%20hunger%20facts%202002.htm. Accessed 22 Jan 2014
UN-HABITAT (2009) Planning sustainable cities: global report on human settlements 2009 United Nations human settlements programme. www.unhabitat.org. Accessed Nov 2013
Werner W, Odendaal W (2010) Livelihoods after land reform: Namibia country report. Rural poverty in Namibia, Legal Assistance Center, Land Environment and Development
Wikipedia. http://en.wikipedia.org/wiki/World_Population
World Bank (1991) World development report 1991: the challenge of development. World Bank/Oxford University Press, London, Great Britain
World Bank (2007) World development report 2008: agriculture for development. World Bank, Washington, DC

Chapter 2
Policies and Legislations Governing Marketing and Food Trade: Southern Africa

Abstract Trade policies and trade agreements support smooth trading among participating partners. The globalization of markets and the expansion of free-trade agreements have encouraged many areas of the world to consider regional integration as a means to better compete in the world economy. Thus regional integration has allowed several different countries to come together and form common markets. International institutions such as World Customs Organization (WCO), World Trade Organization (WTO) provide guidance on the formulation of policies and legislations governing marketing and trade among countries WTO requires regional trade agreements to reduce tariffs between countries, but does not allow these countries to increase tariffs on countries which are not part of the agreement. Many countries in Africa including those in SADC have embraced market-based food systems and market reforms to enhance farm profitability. Organs such as the Common Market for Eastern and Southern Africa (COMESA) and Southern African Customs Union (SACU) have been formed and are active in trade liberalization in Southern Africa region. Namibia, an emerging free market area has put in place several policies and enacted a variety of legislations to protect, guide and enhance trade in its agricultural sector. Namibia heavily depends on trade through which she imports food products to meet the shortfall in her locally produced foods. Meanwhile, Namibia is vigorously working towards self-sufficiency in food production through her Green Schemes and other undertakings discussed in chapters two, three, five and seven of this book. Despite the concerted efforts being made, there are many constraints that face the country which dictate that Namibia continue to depend on food imports.

Keywords Trade policies and legislations • Trade agreements and common markets • Regional integration • Trade liberalization • Food self sufficiency • Green schemes

Introduction

Policies are statements of intent formulated to guide the activities of any given organization or entity in order to achieve specific objectives which reflect the intent of the organization/entity that formulated them. Policies contain directives of what is to be done and what not to be done. Good policies are contextually formulated to

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address varying conditions and specific situations. Such policies should reflect the needs, interests and aspirations of the intended beneficiaries for effective implementation. It has been recognized that for policies to be relevant and well understood by all concerned, the policy making process has to be participatory and inclusive.

Some authors have argued that policy be considered as a long series of more or less related activities and their consequences for those concerned rather than as a discrete decision. That is a proposed course of action of a person, group or government within a given environment providing obstacles and opportunities which the policy was proposed to utilize and overcome in an effort to reach a goal and/or realize an objective or a purpose. This concept of policy focuses attention on what is actually done as against what is proposed and/or intended. It differentiates a policy from a decision which is a choice among competing alternatives. On the other hand, public policy has been defined as the course of action by government towards an aspect of the economy, including the goals a government seeks to achieve and choices of the methods to pursue those goals. Similarly, Fischer goes further and defines public policy "as political agreement on a course of action, mutually designed to resolve or mitigate problems on a political agenda". Arguably, whether public policies are arrived at through political deliberations or formal vote, they involve a specification of goals to be pursued as well as the means for achieving them (Anderson 2003; Ellis 1992; Fischer 2003).

Trade policy has been described as a collection of rules and regulations which pertain to trade. Trade, the exchange of goods i.e. the transfer of ownership of goods and products from one owner to another or from one entity to another takes place in a network known as a market. Every nation has some form of trade policy in place, with public officials formulating the policy which they think would be most appropriate for their country. The purpose of this policy is to guide smooth running of a country's trade by setting clear standards and goals which can be understood by potential trading partners.

In many regions such as Southern Africa, a number of countries come together to formulate policies on mutually beneficial trade laying down rules and regulations that take into consideration each other's interests, rules and regulations. Such policies include aspects such as import and export taxes, tariffs, inspection regulations, and quotas. A nation's trade policy attempts to protect their local products and industries with trade policies which restrict importation of goods similar to what they produce so as to allow domestic producers of goods and services to have access to local market without competition (protectionist policies). Two countries may enter into agreement to trade with each other and sign a bilateral trade agreement which is used to improve economic trade imbalances between the two nations. Taxes, tariffs and quotas are often lifted, reduced or restricted on specific goods or services to realign trade deficits and restore economic stability between the two parties. On the other hand, regional trade agreements contain terms and conditions on which the trade relationship among the countries will be based on.

Trade agreements support smooth trading among partners as they take into consideration the interests of participating trade partners who append their signatures to such agreements. Regular meetings may also be held to discuss changes in

the financial climate, and to make adjustments to trade policy accordingly. While multilateral trade agreements regulate trade between participating countries without discrimination, they are usually intended to lower trade barriers between participating countries and, as a consequence, increase the degree of economic integration between the participants. Such agreements include security issues as well as issues of product safety to ensure that product conform to standards spelt out by each participating partner. Meanwhile some governments might impose some protectionist policies that support local employment such as imposing tariffs to imports or offer subsidies to exports. Many governments may also restrict free trade to limit export of natural resources through the imposition of import quotas, high taxes and specific regulatory legislation.

Regional trade agreements have a number of advantages including that of lower prices through the reduction of tariffs between the countries which are part of the trade agreement. The World Trade Organization requires regional trade agreements to reduce tariffs between countries, but does not allow these countries to increase tariffs on countries which are not part of the agreement. Tariff reductions allow people to purchase goods from other countries at lower prices. Regional trade agreements also provide trade advantages for all countries in a region which improve their worldwide competitiveness, including in the markets of countries not included in the trade agreement. Furthermore, regional trade agreements can encourage other countries that are not part of the trade agreement to reduce their trade barriers.

In recent years, the globalization of markets and the expansion of free-trade agreements have encouraged many areas of the world to consider regional integration as a means to better compete in the world economy. Countries that alone may not have sufficiently large markets for production and consumption join together with regional neighbours in order to create favourable flow of areas where goods and services can flow relatively freely in response to market demand. This gives the region comparative leverage when trading as a unified block of economic activity. Every complex political and economic venture such as regional trade blocks has both advantages and disadvantages.

Regional integration usually allows several different countries to come together and form common markets. This is done by opening up borders and eliminating tariffs and taxes on imports and exports between member nations. Where before it might have been difficult for a manufacturer in country A to find enough demand, it is now able to easily market and sell its products in countries B, C and D, thus allowing it to expand its business. Manufacturers and other firms operating in countries B, C and D can do the same, thus increasing economic activity overall. That in turn raises GDP and if properly managed, this can lead to a better standard of living for all citizens within a regional block. A trading block has the advantage of increased global competitiveness as it enjoys a larger market which allows the internal economic output within the regional block to increase as well as putting the block at an advantage in relation to other countries around the world. Increased economic output and better efficiency through free trade across borders allows the regional block to offer many more goods and services on the international market than competitors.

The disadvantages include the loss of sovereignty as member nations give up some of their sovereignty to the newly created supranational body such as a regional parliament or council. This body will have to be entrusted to make binding decisions which affect every member country, effectively subordinating some national legislative and executive power to that body. This means that member countries may no longer be able to enact policies that meet their specific needs and interest, especially if such policies would come into conflict with regional initiatives. A transparent system governing the appointment of members to such regional bodies is a necessity to uphold democracy and accountability. Lack of transparency could create the perception unfair control.

Furthermore, regional integration can make it difficult for national governments to create and implement policies based on their own particular needs. This can be problematic when the specific economic conditions within a member country require actions such as adjusting the money supply or increasing public debt in order to finance infrastructure development or entitlements. These policies, while necessary for one member nation, could skew the economies of other member nations, especially if there is a unified currency. Additionally, poorer member countries may pull down the richer members as they may have to bail out the poorer members. Currency devaluation by the poorer member countries could jeopardise the whole regional economy as regional integration binds member countries together during times of prosperity and hard times.

Among the issues that emerged from the UN World summit held in Johannesburg, South Africa during 2002 included the need to strengthen decision-making and harnessing science and technology that would facilitate the management of linkages to the global economy and overcoming obstacles to reforms on the social dimension of sustainable development. Solutions were envisioned to lie with making markets work for sustainable development through adjusting prices and instituting regulations which allow imposing market-based instruments such as taxes and tradable permit systems (World Summit 2002).

International Institutions

Internationally there are several institutions which have been put into place to provide guidance on aspects to be taken into consideration during the formulation of policies and legislations governing marketing and trade among countries. These include the World Customs Organization (WCO) which is the intergovernmental organization exclusively focused on Customs matters. The WCO particularly works in the areas covering the development of global standards, the simplification and harmonization of Customs procedures, trade supply chain security, the facilitation of international trade, the enhancement of Customs enforcement and compliance activities, anti-counterfeiting and piracy initiatives, public-private partnerships, integrity promotion, and sustainable global Customs capacity building programs. The WCO also maintains the international Harmonized System Goods Nomenclature,

and administers the technical aspects of the World Trade Organization (WTO) Agreements on Customs Valuation and Rules of Origin. By promoting the emergence of an honest, transparent and predictable Customs environment, the WCO directly contributes to the economic and social well-being of its Members. The WCO's mission is to enhance the protection of society and the national territory, and to secure and facilitate international trade (WTO 2006).

Another institution put in place to provide guidance on trade policy and legislation formulation is the Harmonized System Goods Nomenclature (HS) The Harmonized Commodity Description and Coding System generally referred to as "Harmonized System" or simply "HS" which is a multipurpose international product nomenclature developed by WCO. It comprises about 5,000 commodity groups; each identified by a six digit code, arranged in a legal and logical structure that is supported by well-defined rules to achieve uniform classification. The system is used by more than 200 countries and economies as a basis for their Customs tariffs and for the collection of international trade statistics. Over 98 % of the merchandise in international trade is classified in terms of the HS. The HS contributes to the harmonization of Customs and trade procedures, and the non-documentary trade data interchange in connection with such procedures, thus reducing the costs related to international trade. It is also extensively used by governments, international organizations and the private sector for many other purposes such as internal taxes, trade policies, monitoring of controlled goods, rules of origin, freight tariffs, transport statistics, price monitoring, quota controls, compilation of national accounts, and economic research and analysis. The HS is thus a universal economic language and code for goods, and an indispensable tool for international trade (WCO 2012).

The HS is governed by "The International Convention on the Harmonized Commodity Description and Coding System". The official interpretation of the HS is given in the Explanatory Notes (five volumes in English and French) published by the WCO. The Explanatory Notes form part of a commodity database giving the HS classification of more than 200,000 commodities actually traded internationally. The maintenance of the HS is a WCO priority. This activity includes measures to secure uniform interpretation of the HS and its periodic updating in light of developments in technology and changes in trade patterns. The WCO manages this process through the Harmonized System Committee (representing the Contracting Parties to the HS Convention) which examines policy matters, takes decisions on classification questions, settles disputes and prepares amendments to the Explanatory Notes. The HS Committee also prepares amendments updating the HS regularly. Decisions concerning the interpretation and application of the Harmonized System, such as classification decisions and amendments to the Explanatory Notes or to the Compendium of Classification Opinions, become effective soon after the approval by the HS Committee.

WTO Agreement on Customs Valuation formally known as the Agreement on Implementation of Article VII of the General Agreement on Tariffs and Trade (GATT) 1994 established a customs valuation system that primarily bases the customs value on the transaction value of imported goods which is the price actually paid or payable for the goods when sold for export to the country of importation plus certain adjustments

of costs and charges. It constitutes the taxable basis for customs duties. It is also an essential element for compiling trade statistics, monitoring quantitative restrictions, applying tariff preferences, and collecting national taxes. Imported goods are valued in terms of the provisions of the WTO Agreement on Customs Valuation. The Agreement is intended to provide a single system that is fair, uniform and neutral for the valuation of imported goods for Customs purposes, conforming to commercial realities and outlawing the use of arbitrary or fictitious Customs values. The Agreement, by its positive concept of value, recognizes that Customs valuation should, as far as possible, be based on the actual price of the goods to be valued.

WTO Agreement on Rules of Origin provides transparency to regulations and practices regarding Rules of Origin, with the main purpose of preventing unnecessary obstacles to the flow of international trade. The Agreement establishes a platform for harmonizing Non-Preferential Rules of Origin. The main goal is to bring about further liberalization and expansion of world trade. The other motivation is to impose very precise disciplines on the application of Rules of Origin both now (transition period) and after the harmonization of Non-Preferential Rules of Origin. Under the Agreement, Members are obliged to adhere to the following disciplines:-

(i) Not to use Rules of Origin as instruments to pursue trade policy objectives.
(ii) Not to create restrictive, distorting or disruptive effects on international trade.
(iii) Not to discriminate against imports and exports or between Members.
(iv) To administer Rules of Origin in a consistent, uniform, impartial and reasonable manner.
(v) To base Rules of Origin on a positive standard.
(vi) To publish laws, regulations, judicial decisions and administrative rulings relating to Rules of Origin.
(vii) To provide origin assessments upon request.
(viii) Not to apply changes in Rules of Origin retroactively.
(ix) To treat confidential information confidentially.

Technically, regulatory laws are applied to a dynamic competitive market with the aim of achieving an objective which the market cannot reach alone either because there is a technical problem such as the lack of an essential infrastructure or where it is necessary to impose a structure for the common good of the national economy. The regulatory system of a particular market such as that involving trading of agricultural products facilitates the realization of specific objectives such as enabling access to products by the consumers and/or industries. In order to achieve this objective, the regulatory system must have specific rules and regulations due to the linkage that exist between laws and regulations which often leads to the setting up of specific institutions to serve as regulators. Technically, a regulatory system essentially takes into account the specificity of products which influences the rules and regulations surrounding those products.

While setting up regulatory mechanisms for certain products, it should be appreciated that inadequate understanding of supply and demand for agricultural products as well as inadequate handling and processing of these products could lead to dangerous outcomes and therefore food safety has to be accorded proper

consideration when setting up a regulatory system. The necessity for a regulatory system can arise because some products which are vital for people living in certain geographical and social conditions are not easily accessible to them. A regulatory system is therefore necessary to overcome breakdowns in the production chain of agricultural products to avoid universal risks. Furthermore, demand for agricultural products is closely linked to culture and consumers' eating habits. This should be taken into account when designing a regulatory system; likewise, the agricultural activity itself which is part of land development should be linked to regulatory systems for other sectors such as environment, tourism, mining, energy, transportation and telecommunications.

It is therefore prudent to set up regulatory policies that are not a set of exceptions but rather taking full cognizance of specific rules shaped by the technical specificity of a product and its market conditions; the main purpose being to understand the conditions of the suppler while targeting satisfaction of the consumer. For example, in terms of setting up a commercial system providing wider access to certain agricultural products, a long-term production policy with great transparency on the nominal nature of products in circulation is necessary. In the same way, the interactions between the agricultural sector, water regulatory systems, health policies and the protection of innovative medicines call for "inter-regulatory" systems, that take into consideration several aims and interactions in the decision-making in each sector. Consequently, a regulatory system must be set up with political and technical requirements in mind because the functioning of this system depends on the policies governing the production and distribution of given commodities. Harmonious policies and regulations would guarantee the success of a specific regulation governing agricultural marketable goods.

Various countries around the globe have devised regulatory systems to manage the entry and exit of agriculture related products in such a manner that the agriculture sectors of their countries are protected, sustained and developed to serve wide-ranging national interests. These are either in the form of food security, plant and animal health, industrial development, trade development or safeguarding national sovereignty.

USA and EU Examples

First example worth quoting here is United States of America (USA) where a web of laws and institutions are in place to create a legal context and mechanism of controlling border entry and exit of agricultural products, in line with the country's multitude of national interests. These include institutions that control and guard various sectors including:-

1. The United States Department of Agriculture (USDA) which works towards strengthening the American agricultural economy, building vibrant rural communities and securing a stronger future for the American middle class. It monitors the export of products from the U.S. through a standard set of regulations and policies.

2. The Marketing and Regulatory Programs (MRP) that facilitate domestic and international marketing of U.S. agricultural products and ensure the health and care of animals and plants, with agencies that are active participants in setting national and international standards.
3. The Agricultural Marketing System (AMS) that administers programs that facilitate the efficient and fair marketing of U.S. agricultural products, including food, fiber, and specialty crops.
4. The Animal and Plant Health Inspection Service (APHIS) with the basic charge of "Protecting American Agriculture" under the pretension of ensuring the health and care of animals and plants. The regulations guiding (APHIS) categorically state that while foreign regulatory systems need not be identical to the U.S. system, they must employ equivalent sanitary and health measures that provide the same level of protection achieved domestically for imported goods.
5. The Farm Service Agency (FSA) implements agricultural policy that administers credit and loan programs, and manages conservation, commodity, disaster and farm marketing programs through a national network of offices.
6. Center for Nutrition Policy and Promotion (CNPP) that works to improve the health and well-being of Americans by developing and promoting dietary guidance that links scientific research to the nutrition needs of consumers.
7. Food and Nutrition Service (FNS) which increases food security and reduces hunger in partnership with cooperating organizations by providing children and low-income people access to food, a healthy diet, and nutrition education in a manner that supports American agriculture and inspires public confidence.
8. Food Safety and Inspection Service (FSIS) which enhances public health and well-being by protecting the public from food borne illness and ensuring that the nation's meat, poultry and egg products are safe, wholesome, and correctly packaged.
9. Foreign Agricultural Service (FAS) which works to improve foreign market access for U.S. products. This USDA agency operates programs designed to build new markets and improve the competitive position of U.S. agriculture in the global marketplace.
10. Forest Service (FS) that sustains the health, diversity and productivity of the Nation's forests and grasslands to meet the needs of present and future generations.
11. The Grain Inspection, Packers and Stockyards Administration (GIPSA) which facilitates the marketing of livestock, poultry, meat, cereals, oilseeds, and related agricultural products, and promotes fair and competitive trading practices for the overall benefit of consumers and American agriculture.
12. The Grain Inspection, Packers and stockyards Administration (GIPSA) which facilitates the marketing of livestock, poultry, meat, cereals, oilseeds, and related agricultural products and promotes fair and competitive trading practices for the overall benefit of consumers and American agriculture. GIPSA ensures open and competitive markets for livestock, poultry, and meat by investigating and monitoring industry trade practices.

13. National Institute of Food and Agriculture (NIFA) whose unique mission is to advance knowledge for agriculture, the environment, human health and well-being, and communities by supporting research, education, and extension programs in the Land-Grant University System and other partner organizations. NIFA doesn't perform actual research, education, and extension but rather helps fund it at the state and local level and provides program leadership in these areas.
14. Natural Resources Conservation Service (NRCS) which provides leadership in a partnership effort to help people conserve, maintain and improve the national natural resources and environment.
15. Risk Management Agency (RMA) that helps to ensure that farmers have the financial tools necessary to manage their agricultural risks. RMA provides coverage through the Federal Crop Insurance Corporation which promotes national welfare by improving the economic stability of agriculture.

Another example worth noting is that binding the European Union countries. For most European countries, the common commercial policy is a pillar for the external relations of the European Union. It is based on a set of uniform rules under the Customs Union and the Common Customs Tariff and governs the commercial relations of the Member States with Non-EU Member Countries. The purpose of the instruments of trade defense and market access is mainly to protect European businesses from obstacles to trade. The EU has evolved during the process of globalization by aiming for the harmonious development of world trade and fostering fairness and sustainability. It actively encourages the opening of the markets and the development of trade in the multilateral framework of the World Trade Organization (WTO).

The objective of the European Union's food safety policy is to protect consumer health and interests. In order to achieve this objective, the EU ensures that control standards are established and adhered to as regards food and food product hygiene, animal health and welfare, plant health and preventing the risk of contamination from external substances. It also lays down rules on appropriate labeling for these foodstuffs and food products. The current food safety policy is based on a series of principles applied in line with the integrated approach 'From the Farm to the Fork' specifically include transparency, risk analysis and prevention, the protection of consumer interests and the free circulation of safe and high-quality products within the internal market and with third countries. A certain number of bodies, in particular, the European Food Safety Authority, are responsible for helping to guarantee food safety.

Africa and SADC

Many countries in Africa have since the 1990s been dismantling government controls and converting to market-based food systems, believing that market reforms would enhance farm profitability through their positive effects on prices, investment

levels, and commercialization. In fact, the need for such agrarian reforms, including commercialization of the smallholder production systems, received considerable attention from governments and development organizations, including SADC states. However, the results of the reform programs were mixed and frequently inconsistent with the expected increases in productivity. It was then realized that the sector-based reform prescriptions in many cases had been based upon superficial knowledge of the prevailing economic institutions and how they affect economic outcome in particular economies. It was then appreciated that it was prudent to go beyond generalizations so that property rights, market rules and exchange mechanisms were required to actually conduct pragmatic applied research on the specific kinds of property rights, rules, and exchange arrangements that would most contribute to the development of markets among states (Muchopa et al. 2004).

Globalization, a major influence on the development of institutions, should be considered when designing policies and legislations governing markets including markets for agricultural products. The globalization process, fuelled by such forces as the simultaneous opening of financial capital markets and the dismantling of closed trade in agricultural commodities, raises questions about the links between natural resources, government, household and private sector strategies and the economic welfare of a country or group of countries. If the globalization process and the creation of the correct institutions are to be the catalyst for economic growth and development in emerging and developed markets, then understanding these links is crucial. This calls for a fundamental review of the whole basis for policies that regulate agricultural investment and marketing in SADC (Muchopa et al. 2004).

The objectives of SADC include the achievement of development and economic growth, alleviation of poverty, enhancement of standard and quality life and support socially disadvantaged groups through regional integration. These objectives are to be achieved through the implementation of various protocols agreed upon to guide each cooperation area. The SADC Protocol on Trade calls for trade liberalization, the elimination of trade barriers and of import and export duties, harmonization with the trading practices of the WTO and SPS information management system (SPS IMS). The SPS IMS sets out basic rules on how governments can apply food safety and animal and plant health measures. The system allows users to track and obtain information on measures that member governments have notified the WTO (an obligation for WTO members), specific trade concerns, documents of the WTO's SPS Measures Committee, member governments' national enquiry points and their authorities handling notification. Through the liberalization schedules of each Member States, a free trade area has been established within SADC to allow freer movement of goods within the region (SADC 2006a).

The liberalization and promotion of agricultural trade is one of the main goals of SADC. There is a specific Directorate of Food, Agriculture and Natural Resources which promote trade in agriculture as one of its main functions. The SADC Protocol on Finance and Investment (FIP) signed in August 2006 and entered into force in April 2010 looks into legal and practical commitments to improve the investment climate in Member States and catalyze foreign and intra-regional investment as well as to enhance cooperation, coordination and harmonization of the financial sectors

in SADC (SADC 2006b). Regional financial integration is an economic and political process whereby capital and financial markets are increasingly integrated and capital is able to freely cross the intra-regional borders. These include the elimination of barriers and constraints to regional capital mobility, adoption of regionally integrated payment systems and harmonization of regulatory and supervisory frameworks. Other relevant protocols entered into include the SADC Protocol on Transport, Communication and Meteorology which aims to establish transport, communications and meteorology systems which provide efficient, cost-effective and fully integrated infrastructure and operations, which best meet the needs of customers and promote economic and social development while being environmentally and economically sustainable (SADC 1996).

Other organs including Common Market for Eastern and Southern Africa (COMESA) and Southern African Customs Union (SACU) are active in trade liberalization in Southern Africa region. COMESA, formerly known as PTA (a free trade area with 19 states stretching from Libya to Zimbabwe) existed since 1994 replacing the Preferential Trade Area (PTA) which existed since 1981. In 2000, nine of the members formed a free trade area (FTA – Djibouti, Egypt, Kenya, Madagascar, Malawi, Mauritius, Sudan, Zambia and Zimbabwe) with Rwanda and Burundi joining the FTA in 2004 and the Comoros and Libya in 2006 and Seychelles in 2009. COMESA is one of the pillars of the African Economic Community. In 2008, COMESA agreed to an expanded free-trade zone including members of two other African trade blocs, the East African Community (EAC) and SADC. Namibia participated in the process of establishing the FTA in the context of SACU, having made a single joint liberalization offer to the rest of the SADC countries (Wikipedia).

The aim of SACU (a customs union among five countries – Botswana, Lesotho, Namibia, South Africa and Swaziland), is to maintain the free interchange of goods between member countries. It provides for a common external tariff and a common customs area. Its specific aims are to facilitate the cross-border movement of goods between the territories of the Member States; to create effective, transparent and democratic institutions which ensures equitable trade benefits to Member States; to promote conditions of fair competition in the Common Customs Area; to substantially increase investment opportunities in the Common Customs Area; to enhance the economic development, diversification, industrialization and competitiveness of Member States; to promote the integration of Member States into the global economy through enhanced trade and investment; to facilitate the equitable sharing of revenue arising from customs, excise and additional duties levied by Member States and to facilitate the development of common policies and strategies (Wikipedia).

Trade liberalization among SACU Member States covers free movement of domestic products within the SACU region; goods imported from outside the Customs Union; customs duties on imported goods; specific excise and ad valorem excise duties and specific customs and ad valorem customs duties on imported goods of the same class or kind. The trade liberalization agreement also covers legislation relating to customs and excise duties; customs cooperation; freedom of transit; import and export prohibitions and restrictions as well as protection of infant industries. Covered also are rail road transport; technical barriers

to trade; arrangements for regulating the marketing of agricultural products and SPS measures (SACU 2004).

The SACU agreement states that no Member State shall enter into new preferential trade arrangement with third parties or amend existing arrangements without the consent of other Member States. Member States may maintain preferential trade and other related arrangements existing at the time of entry into force of the 2002 SACU Agreement in July 2004. SACU Member States, with the exception of South Africa may, as a temporary measure, levy additional duties on goods imported into its area to enable infant industries in its area to meet competition from other industries in other SACU countries. The SACU Agreement also calls upon Member States to cooperate in the application of regulations for agricultural products marketing and consult from time to time in matters affecting the production and consumption of agricultural commodities. It requires Member States to consult on matters affecting the improvements of such commodities. However, each Member State is at liberty to impose marketing regulations for agricultural products within its borders in favor of emergent agriculture and related agro-industries and for any other purpose as may be agreed upon between Member States (SACU 2004).

Namibia's National Legislations

Namibia, as an emerging free market area has put in place several policies and enacted a variety of legislations to protect, guide and enhance trade in its agricultural sector. The Plant and Quarantine Act of 2008 enables the law enforcement unit in the Directorate of Extension and Engineering Services to oversee the prevention, monitoring, controlling and eradication of plant pests. The unit is responsible for facilitating the movement of plants, plant products and other regulated articles within, into and out of Namibia. The unit provides certification of the phytosanitary standards of plants and plant products imported into Namibia following the WTO guidelines which have set rules and regulations that individual countries can use to ensure that each country's consumers are being supplied with food that is safe to eat. Safety is benched on the standards that the country considers to be appropriate while ensuring that strict health and safety regulations are not being used as an excuse to protect domestic producers. In terms of section 2 (1) of the Plant Quarantine Act, the line Ministry (or such other authority as the Minister by notice in the Gazette may designate) has the authority and responsibility to function as the official national plant protection organization of Namibia for purposes of the Convention (Parliament of Namibia 2008a).

In terms of the standing regulations under the Animal Health Act of 2011, the Directorate of Veterinary Services issued import and export permits for the importation and exportation of all animals and animal products from foreign countries into or out of Namibia. It also makes provision for the prevention, detection and control of animal diseases to provide for the maintenance and improvement of animal health incidental matters. In terms of section 4 (1) and (2) of this act, the Minister,

on the recommendation of the Chief Veterinary Officer, may in writing authorize a person to perform the function and exercise the power of a veterinary official that are specified in the authority. An authority under subsection (1) has effect for the period specified in the authority or, if no period is so specified, until the authority is revoked by the Minister. In terms of section 33 (1), (a) and (q), the Minister may make regulations relating to any matter which in terms of the Act is required or permitted to be prescribed as well as any other matter or action that the Minister considers necessary for the purpose of protecting human and animal health. In terms of section 33 (2) (d), regulations made under subsection (1) may confer powers or impose duties on any person (Parliament of Namibia 2011).

The Agronomic Industry Act of 1992 established the Namibian Agronomic Board as a statutory body in terms of the act. The mission of the Board is to develop and promote a sustainable and diverse Namibian agronomic industry through management, facilitation, advice and regulation. The aim is to facilitate production, processing, storage and marketing of controlled products (as listed in the Act). In terms of the Agronomic Industry Act section 10 (1) the Minister in the line Ministry may by notice in the Gazette make regulations with respect to the qualifications of persons who are authorized to examine and grade controlled products under this Act and the method of grading as well as any other matter which the Minister may deem necessary or expedient to regulate for the achievement of the objects of this Act (Parliament of Namibia 1992).

The Meat Industry Act of 1981 as amended established the Meat Board of Namibia whose main objective is the promotion of the interests of meat industry in Namibia. The Meat Board of Namibia facilitates the development of markets and matches consumer requirements with local supplier abilities. The mission of the Board is to manage, promote and represent the interests of the meat industry in Namibia effectively and efficiently. The functions of the Meat Board of Namibia include market development, livestock marketing, compilation and dissemination of strategic information and maintaining meat and food standards for the integrity of Namibia. The Board has jurisdiction over the marketing of cattle, sheep, goats, pig meat and other meat products. It carries out regulatory control of standards, quality assurance and import/export control of cattle, sheep, goat, pig meat and other meat products according to the directives of the portfolio Minister. The line Minister may by notice in the Gazette make regulations and appoint persons or organizations which the Minister may deem necessary or expedient to regulate for the achievement of the objects of this Act (National Assembly of South West Africa 1981; Parliament of Namibia 1992).

The State-owned Enterprises Governance Act of 2006 was enacted to harmonize all Acts including the ones governing the performance and regulation of the agricultural sector. The State-owned Enterprises Governance Act makes provision for the efficient governance of State-owned enterprises and the monitoring of their performances. It also makes provision for the restructuring of state-owned enterprises; state-owned enterprises Governance Council and defines its powers, duties and functions as well as provision for incidental matters. In terms of the State-owned Enterprises Governance Act under schedule 1 number (1) (2) and (9) the

Meat Board of Namibia and Namibian Agronomic Board are listed as State-owned Enterprises. By definition, in this Act, the portfolio Minister of the line ministry currently the Minister of Agriculture, Water and Forestry is responsible for the administration of the law governing the establishment and functions of the agricultural sector and is holding the shares and exercising the rights attached to the shares in the sector on behalf of State (Parliament of Namibia 2008b).

Namibia's Vision 2030 adopted in 2004, clearly spells out the country's development programs and strategies to achieve its national objectives. Vision 2030 is centered on the people of Namibia in as far as their social, economic and overall well-being is concerned. The Vision is seen as a road map guiding Namibia as she strives to achieve healthy and food-secure state for all including the promotion of diversified and open market economy with a resource-based industrial sector and commercial agriculture with a competitive export sector in terms of product quality and differentiation. The Vision as well as the ruling party manifesto commits the Namibian Government to devise programs and projects that contribute meaningfully to national economic growth (Office of the President 2004; Office of the Prime Minister 2012).

The third Five-year Strategic Plan of the Ministry of Agriculture, Water and Forestry identified key strategic issues while the National Agricultural Policy (NAP) set objectives of achieving increased agricultural production, trade and the sector contribution to GDP. The Agriculture Marketing and Trade Policy and Strategy are one of the catalysts aimed at achieving the agriculture sector's objectives as highlighted in Vision 2030, National Development Plans and the National Agriculture Policy (NAP). The aim of this policy is to further harmonize all policies and strategies across the agricultural sector and sub-sectors. It is categorically stated that the Agriculture Marketing and Trade Policy and Strategy make concerted efforts by hosting all role players within the Government, private sector and civil society to meet the envisioned policies and targets. Furthermore, it is stated that the policy function in full cognizance of relevant international cooperating partners as well as work closely with other various government departments, statutory bodies, regulatory bodies and any relevant organization as provided in various Acts. Therefore the policy should be utilized to protect the local market, uncover international trade irregularities, contact forensic investigation, carry out quality control, obtain data and information and advance economic analysis to ensure smooth marketing and trade environment for agricultural products in the local market and in the international markets.

Different public legislative organs are in place to oversee the functioning of the various Acts and legislations. The Ministry of Agriculture, Water and Forestry has the mandate to promote, develop, manage and utilize agriculture, water and forestry resources, with a mission to realize the potential of such sectors towards the promotion of an efficient and sustainable socio-economic development of Namibia. The Ministry's vision is to promote and manage the sustainable utilization and development of agricultural, water and forest resources for a prosperous Namibia through stakeholder partnerships. The Ministry of Trade and Industry is responsible for the development and management of Namibia's economic regulatory regime on the basis of

which the country's domestic and external economic relations are conducted. This includes putting in place appropriate policies to attract investment, increase trade and development of the country's industrial base in order to stimulate growth and development of the economy. Of relevance to the agriculture sector is putting in place border control mechanism and overseeing the activities of the Agriculture Trade Bureau. The functions of the Agriculture Trade Bureau include the management, regulation and facilitation of trade, commercial and business activities in the context of bilateral, regional and multilateral trade relations.

On the other hand other institutions whose functions affect the health of the agriculture sector include the Ministry of Works and Transport that is mandated with the responsibility of developing policy and regulation in the transport and construction sectors while ensuring infrastructure development and maintenance. The other institution is the Ministry of Finance that is mandated with the responsibility of protecting the society with respect to the international movement of goods and people; collecting, securing and managing revenue; facilitating trade whilst exercising appropriate control and advancing the country's interests regionally and internationally in these areas. The Directorate of Customs and Excise in the Ministry of Finance has a specific role that mainly encompasses the control of international movement of goods, people and conveyances.

Private Sector institutions which support trade and marketing of agricultural products include the Namibia Trade Forum which is a formal consultative and cooperative mechanism established to strengthen collaboration between the government and the private sector on matters related to international trade and investment. It was established in 2005 as an organization not for gain. Its role is to serve as the main consultative body representing the private sector views to the government. It is thus the highest public private partnership institution on international trade and investment matters. The rational for its establishment was that at the time, private sector input and government feedback into the process of international trade and investment was on a case by case basis lacking uniformity and therefore needed systematization and formality. The forum is seen as a necessity towards achieving a joint effort towards the realization of national aspiration and objectives and the positioning of the country competitively in international trade and investment arenas. In particular the private sector is encouraged to aggressively utilize the advantages or opportunities presented in the various trade and investment agreements effected by the government.

The other private sector institution that is instrumental in facilitating trade and marketing of agricultural products is the Agricultural Trade Forum (ATF) which was founded in 1999 as a loose association of interested stakeholders of the private agricultural sector with active concerns in trade issues. The forum, formalized in 2003, registered as an incorporated association not for gain. The forum serves as the mouthpiece for the whole value adding chain of agricultural products, with participation of producer and processor organizations, marketing boards, research institutions and representatives of the line ministries involved in trade issues. The objective of the forum is to advance and strengthen agricultural production and processing sectors in order to promote these sectors in national,

regional and international trade relations and negotiations in a transparent way. This is done, amongst others, by promoting private sector participation in making inputs to the national trade process, formulating and presenting the opinion and negotiation proposals of the private agricultural sector in trade and trade-related matters to the line Ministries involved in trade negotiations. The forum promotes close cooperation with relevant stakeholders and briefs them on relevant inputs necessary for the implementation of agricultural development aspects of existing or to be negotiated trade agreements in the framework of successive National Development Plans and the Agricultural Policy of Namibia.

Namibia Agricultural Union (NAU) is yet another private sector institution established to spearhead organized agriculture in Namibia acting as the mouthpiece and mediator for the commercial farmers. While NAU represents the farmers' thoughts and aspirations up front, it also endeavors to develop the total agricultural community. The mission of NAU is to promote/enhance a favorable environment for sustainable agriculture. In order to achieve its objectives, NAU works in close collaboration with other stakeholders, negotiates and makes recommendations to the government, promotes sustainable and diversified agricultural production and investigates and promotes farmers involvement in value addition chain (NAU 2013).

In 1992, Namibian National Farmers Union (NNFU) was established as a not for gain association to serve as a mouthpiece for the communal and emerging farmers. Twelve regional farmers unions are affiliated to NNFU. The aims of NNFU are to increase food production for household food security; enhance marketing of farming products to increase household income; increase participation and recognition of women in farming and to contribute to environmental protection and sustainable utilization of natural resources. NNFU promotes active participation of the small scale producers in the design and drafting of conducive and enabling policy environment related to agriculture, water, land, credit among other needs. NNFU facilitates the implementation of national policies, acts and legislations; implementation of projects and schemes and serves as a conveyer belt between farming communities country-wide and service delivery institutions. NNFU is involved in institutional strengthening in order to create vibrancy at grass-root level that allows for complimentary actions.

Food Trade Overview

Namibia has a sizable market for agricultural and agro-industrial products that was valued at more than N$5 billion (computation from the National Account, 2000–2008). Of this, local industries have a market share of around one-third. During this time, the main local visible products included agricultural products such as livestock-based (cattle, goats, sheep, pigs and poultry) and crops and horticulture-based (including maize, wheat, cabbage, watermelon, potatoes, tomatoes, onion, grapes, dates, mangoes). On the agro-industrial side, products included processed meat (chilled, dried, canned); dairies; leather products; flour; confectioneries; oil;

beer and beverage as well as spirit and wine. Animal products, live animals, and crop exports constituted roughly 10.7 % of total exports. The majority of inputs for primary production in the agriculture sector such as equipment and machineries, veterinary medicine and food supplements, are imported. Meanwhile, the government encourages retailers of fruits, vegetables, and other crop products to source 30 % of their stock from local farmers (Namibia Statistical Agency 2013; Annual Statistics Bulletin 2012).

During the period 2000–2008, out of top 25 export products, only 20 % had undergone some degree of processing, and even fewer that could be regarded as at a final phase of value addition. Conversely, of the agricultural and agriculture-related products imported, 80 % were in processed form, which demonstrates the domination of the local market by processed agricultural imports. This fact supports the fact that there is a high demand for agricultural products which, if taken advantage of could support the growth of the development of local agricultural processing industries. Thus the limited range of Namibia's agro-industrial products is testimony to the fact that there is room for increasing this range through value addition to a wide range of agricultural produce which would stabilize agricultural trade for the local farmers as it is common knowledge that value added agro-industrial products are less price volatile to international shocks than raw agricultural produce (Annual Statistics Bulletin 2012).

For example, it emerges that during 2008–2009 periods, Namibia had a negative balance of trade in agricultural products, averaging more than N$1 billion. In 2009, Namibia imported agricultural products valued at N$5.9 billion versus export value of N$4.6 billion. This translates into an agricultural trade deficit of N$1.3 billion. A glimpse at Namibia's exports and imports over a series of years illustrates a state of the agricultural industry with a high potential, but with marginal exploitation of such potential for the benefit of the country and its citizens Namibia (Namibia Statistical Agency 2013).

During 2008–2009 periods, Namibia exported various agricultural products which averaged more than 500 products lines at the six-digit HS code level. In 2009, the top export products included malted beer, live bovine animals, meat (fresh, chilled and frozen), fresh grapes, sheep/lamb carcasses (fresh and chilled), fermented beverages, live goats, no-alcoholic beverages, spirit and wine. The main export markets included countries within SADC region (South Africa and Angola); European Union (United Kingdom, Spain, Switzerland) and Norway as well as the United States of America (USA). Namibia, with the facilitation of her competent authorities, has been able to meet the technical sanitary and phytosanitary requirements for her exports to those countries. China is emerging as a major viable market; the challenge now is to attain certification and eligibility to retain old markets and accessing and taking advantage of new export markets. During the same periods, the range of imported agricultural and agro-industrial products was close to 600 lines at six-digit HS code level of which sugar and confectionery, cigarette, frozen chicken, non-roasted malt, malted beer and prepared food featured prominently. Over 80 % of agricultural products are imported from or via South Africa (Namibia Statistical Agency 2013).

It is reported in the media and various other documents that the agricultural regulation system in Namibia is operating with government intervention through the established statutory boards. The boards are supposed to advise and protect the interests of role players in the agriculture value chain through the enacted various legislations. However, it is reported that the current regulatory arrangements for some sub-sectors are made complicated and mostly favoring main role prayers, thus making the system non-transparent and difficult to achieve the set national objectives as highlighted in Vision 2030, National Development Plan and the National Agriculture Policy (NAP). Regulatory institutions such as the Namibian Standards Institution (NSI), Namibia Competition Commission (NCC) and Namibia Board of Trade (NBT) seem minimally involved in the operations of the agriculture sector despite the fact that they have been charged with the responsibilities to develop and enforce laws and standards as well as maintain a competitive domestic market and ensure fair competition against the international business communities.

It is reported that the import and export of controlled grain, grain products and fresh produce from and into Namibia are currently outsourced to Agri-Inspect appointed by the Namibian Agronomic Board in 2008 to monitor and inspect products as listed under the Agronomic Industry Act. This arrangement also applies to the meat industry. Agri-Inspect, a South African company is working closely with government structures in South Africa, United State, Zimbabwe, Zambia, Swaziland and Namibia. Together with different departments and bodies, its services include market protection, investigations of illegal imports, quality control, data collection and economic analysis to ensure that the dumping of commodities do not have a negative impact specific on the South African market.

It is thus safe to conclude that Namibia heavily depends on trade through which she imports food products to meet the shortfall in her locally produced foods. Currently, Namibia is meeting its grain requirements through annual local production and imports. About 50 % of her annual grain consumption is locally produced, the shortfall of local production made up of imports. Namibia imports about 50 % of her maize needs; 75 % of wheat and about 37 % her Pearl Millet (*Mahangu*) annual requirement. She imports 75 % of pork, 70 % of chicken, 50 % of milk, 75 % of cheeses and 90 % of her butter requirements. She also imports 65 % of all fruit and vegetables as well as 100 % of her sugar requirements. Most of the food imports are sourced from the major food producing countries in SADC including South Africa, Zambia and Zimbabwe and a few others from outside SADC including Brazil, EU member states, the USA and a few others. On the other hand Namibia exports Namibia exports about 80 % of all its beef, 90 % of all its lamb and sheep and about 95 % of all its goats. Further, Namibia exports about 95 % of all fish caught in Namibian waters (Hoffmann 2012).

Most of the maize is imported from the Republic of South Africa; some maize is imported from Zambia and sometimes from Zimbabwe. This imported maize is used as both staple food and as animal and chicken feed. It is beneficial to import maize from SACU member states because of the customs union which affords no internal trade barriers to its Member States. Wheat on the other hand is sourced from outside SACU trading block because all SACU member States are net importers of

wheat. The quality of the Namibian wheat harvest has to be blended with Hard red Winter wheat of the USA and A4 wheat of the EU to give it the required quality of wheat flour that meets Namibian market demand. A small quantity of pearl millet (*Mahangu*) is imported from India to augment the locally produced quantity to meet commercial *Mahangu* needs (Hoffmann 2012).

On the other hand, until 2013, the dairy sector was totally unprotected so that about 50 % of the UHT and fresh milk was imported from South Africa as well nearly all the butter and cheese requirements of the Namibian market. Currently most of butter and most of cheese products are imported from South Africa; small quantities are (about 10 % of total requirements) are imported from the EU. However, the Government has started tightening import regulations on dairy products such as milk to afford some protection to the local industry. Similarly, in the pork sector, most of the Namibian requirements are imported from South Africa just like sugar requirements. Research efforts made to reverse this situation revealed that the capacity of any sugar mill to be profitable must have a capacity of 150,000 t of sugar per year, and that would create a surplus and locally produced sugar will not be a cheaper alternative (Hoffmann 2012).

Prior to 2012, 70 % of all chicken was imported from South Africa in a frozen state. However, a Namibian based company is producing chicken locally which is hoped will satisfy the local demand. The Namibian Agronomic Board in collaboration with the Ministry of Agriculture Water and Forestry have embarked on a drive to increase the share of locally produced horticultural produce and it is hoped that this will be carried out until about 65 % of all Namibian requirements are satisfied out of own production. However, rainfall unreliability and water scarcity is a threatening this drive. It suffices to note here that the majority of small-scale producers are self sufficient in their food requirements due to the fact that their diet highly determined by the availability of the foods they produce and/or harvest from the indigenous plant resources (Iita 2012; Hoffmann 2012).

While Namibia will continue to rely heavily on trade to fortify her food security, the Government recently created national strategic food reserves (Silos) with a storage capacity of 11,000 t, representing 3.5 % of annual national consumption. Fresh produce outlets have also been put up to prolong the life of horticultural produce. Livestock production, an important agricultural sector as livestock and livestock products provide a major source of food and income for the majority of the population is also receiving concerted efforts to stabilize it. Moreover, Namibia is vigorously working towards self-sufficiency in food production through support to the Green schemes and other undertakings discussed in detail in Chaps. 5 and 7 of this book. Chapters 2 and 3 also contain relevant information on efforts being made by Namibia Government towards this endeavour.

Nevertheless, it must be appreciated that despite the concerted efforts being made, there are great constraints that face the country which dictate that Namibia continue to depend on food imports. These include the harsh climatic conditions characterized by unreliable and unpredictable rainfall, recurrent droughts and the fact that it will take a very long time (if ever) for Namibia to be self sufficient in all grains such as rice and wheat which are emerging as minor but important staples because these as

well as sugar-cane have high water requirements, a very scarce resource for Namibia. The other constraint is affecting fruit and vegetable production which can only be feasibly produced in Namibia to meet up to 65 % of total demand of the formal sector. Thus all these commodities have to be imported for the foreseeable future while promoting indigenous vegetables and fruit tree domestication.

References

Anderson JE (2003) Public policymaking: an introduction. Houghton Mifflin, Boston
Annual Statistics Bulletin (2012) Namibia Annual Trade Statistics 2012. http://www.nsa.org.na/files/downloads/9ae_Annual%20Trade%20Statistics%20Bulletin%202012.pdf
Ellis F (1992) Agricultural policies in developing countries. www.books.google.com.na/books/. Accessed 15 Feb 2013
Fischer F (2003) Reframing public policy: discursive politics and deliberative practices: discursive politics and deliberative practices. OUP, Oxford
Hoffmann J (2012) The role of cross-border trade in achieving food security in Namibia. www.reeei.org.na/…/Role%20of%20Cross-Border%20Trade%20in%20A…. Accessed 24 Feb 2014
Iita JS (2012) Food security situation in Namibia. http://www.reeei.org.na/admin/data/uploads/Food%20Security%20Situation%20in%20Namibia.pdf. Accessed 24 Feb 2014
Muchopa C, Manyong V, Sibanda L (2004) Agricultural policy priorities for improving rural livelihoods in Southern Africa: regional synthesis. FANRPAN, Harare, Zimbabwe
Namibia Statistical Agency (2013) Namibia Statistical Agency annual report. www.nsa.org.na. Accessed 20 Mar 2014
National Assembly of South West Africa (1981) Meat Industry Act, 1981 Act No 12, 1981. Amended in 1992 to read The Meat Industry Amendment Act, 1992. Government Gazette of the Republic of Namibia. Windhoek
NAU (2013) News and overview. www.agrinamibia.com.na/index. Accessed 20 Nov 2013
Office of the President (2004) Policy framework for long-term national development. Vision 2030 documents. Windhoek. http://209.88.21.36/opencms/export/sites/default/grnnet/AboutNamibia2/AboutNamsDocs/Vision2030/Chapter_3.pdf. Accessed 24 Feb 2014
Office of the Prime Minister (2012) Vision 2030. GrnNet.gov.na. Accessed 23 Feb 2014
Parliament of Namibia (1992) Agronomic Industry Act 20 of 1992 no. 465. Government Gazette of the Republic of Namibia 28 August 1992. Windhoek
Parliament of Namibia (2008a) Plant Quarantine Act 2008. Government Gazette of the Republic of Namibia no. 4149. Windhoek
Parliament of Namibia (2008b) State-owned Enterprises Governance Act of 2006. Government Gazette of the Republic of Namibia no. 4146 Act no. 5, 2008. Windhoek
Parliament of Namibia (2011) Animal Health Act of 2011. Government Gazette of the Republic of Namibia no. 4694. Windhoek
SACU (2004) Southern Africa Customs Union. www.dfa.gov.za/foreign/Multilateral/africa/sacu.htm. Accessed 26 Oct 2013
SADC (1996) SADC protocol on transport, communication and meteorology. SADC Secretariat, Gaborone
SADC (2006a) FANR: Directorate of the Southern African Development Community (SADC). www.sadc.int/fanr/. Accessed 15 Oct 2013
SADC (2006b) Protocol on finance and investment. www.sadc.int/index.php/documents-publications/protocols. Accessed 20 Oct 2013

WCO (2012) HS nomenclature 2012 edition: World Customs Union. www.wcoomd.org/en/…/nomenclature/…and…/hs_nomenclature_2012.a…. Accessed 15 Oct 2013
Wikipedia. Agriculture in Namibia. http://en.wikipedia.org/wiki/Agriculture_in_Namibia. Accessed 15 Oct 2013
World Customs Organization (WTO) (2012) Nomenclature and classification of goods. http://www.wcoomd.org/en.aspx. Accessed 12 Nov 2013
World Summit on Sustainable Development Plan of Implementation (2002). http://www.johannesburgsummit.org/html/documents/summit_docs/2309_planfinal.htm. Accessed 10 May 2012
World Trade Organization (WTO) (2006) World Trade Organization: documents and resources. http://www.wto.org/english/tratop_e/sps_e/spsims_e.htm. Documents and resources. Accessed 25 Oct 2013

Chapter 3
Urban, Peri-urban Agriculture and Food Security Among Small-Scale Agricultural Producers: Southern Africa

"Africa can and should feed Africa". *Mr. Carlos Lopes, Executive Secretary of the UN Economic Commission for Africa (UNECA) January 2014*

Abstract Agriculture is the backbone of most of the economies of the countries in Southern Africa and agricultural production and associated processing industries form a major economic sector of most countries in the region. Agriculture employs over 70 % of the population and agriculture supports the main livelihood systems of about 75 % of the rural population and like in the rest of the developing countries farmers constitute the largest group of natural resource managers. In Southern Africa, urbanization is growing at an alarming rate due to increasing rural–urban migration triggered by dwindling employment opportunities in rural areas and pull factors that lure the young and able bodied rural population to towns. While cities will continue to depend largely on rural agriculture, substantial contribution is increasingly coming from within the urban and the urban fringe environments to improve food security of the urban poor.

Keywords Urbanization rate • Urban/peri-urban agriculture • Food processing and marketing of urban food products • Constraints facing urban/peri-urban agriculture • Health risks associated with urban/peri-urban agriculture

Introduction

Agriculture is the backbone of most of the economies of countries in Southern Africa and agricultural production and associated processing industries form a major economic sector of most countries in the region. Agriculture employs over 70 % of the population and agriculture supports the main livelihood systems of about 75 % of the rural population and like in the rest of the developing countries farmers constitute the largest group of natural resource managers. Worldwide, agriculture is expected to feed the increased population that will number 9.1 billion in 2050, while providing income, employment and environmental services (FAO 2012).

Globally, it is reported that since 2010 half of the world's population lives in cities and that the world's urban population will almost double from the current 3.5 billion

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(about 50 %) to more than six billion by 2050 (Pauli 2012). There is an estimated 800 million people involved in urban agriculture worldwide producing at least 15 % of the world's food output. Urban and peri-urban agriculture as implemented today is not primarily a source of cash, but rather a tool to provide food security particularly for the urban poor. The percentage of poor living in cities is expected to increase from 30 % in 2000 to 50 % by 2035. As outlined in the Blue Economy report, food production in the cities must at least double in order to respond to the food and nutritional needs of the 250 million urban poor worldwide (Pauli 2012).

Urban and peri-urban agriculture comprises a variety of production systems, ranging from subsistence production and processing at household level to fully commercialized agriculture. It is generally characterized by close proximity to markets, high competition for land, space confined, the use of urban resources such as organic solid wastes and wastewater, a low degree of farmer organization, a focus on perishable products, and a high degree of specialization, to name a few. By supplying perishable products such as vegetables, fresh milk and poultry products, urban agriculture complements rural agriculture and increases the efficiency of national food systems. The most important distinguishing characteristic of urban and peri-urban agriculture is that it is an integral part of the urban economic, social and ecological system: urban agriculture uses urban resources (land, labor, urban organic wastes, water), produces for urban citizens, is strongly influenced by urban conditions (policies, competition for land, urban markets and prices) and impacts the food security, poverty, ecological and health aspects of the urban system (Fig. 3.1).

Fig. 3.1 Urban agriculture in close proximity to urban physical infrastructure

In order to facilitate the formulation of policies that guide the development and sustainability of urban and peri-urban agriculture, three perspectives on urban agriculture that are not mutually exclusive but in practice, are used conjunctively to give different emphasis depending on the location and the population in question include:

(i) The social perspective mainly (but not exclusively) associated with subsistence oriented types of urban agriculture that form part of the livelihood strategies of urban low income households with a focus on producing food and medicinal plants for home consumption. In addition, the family expenses on food and medicines are reduced and some cash is generated from sales of surpluses. These households seek out multiple additional income sources for their survival. Examples include home gardening, community gardening, institutional gardens at schools and hospitals, and open field farming at micro scale with low levels of investment. These systems show little direct profitability but have important social impacts such as enhanced food security, social inclusion, poverty alleviation, community development, HIV-AIDS mitigation etc.

(ii) The economic perspective related to market oriented types of urban agriculture which include small-scale family-based enterprises and sometimes larger scale entrepreneurial farms run by private investors or producer associations. The activities not only include food production (e.g. irrigated vegetable production, stall-fed dairy production) but also non-food products (e.g. medicinal and aromatic herbs, flowers, ornamental plants). These commercial farms are associated with small-scale and larger enterprises involved in delivery of inputs (such as seed, compost, fodder, agro-chemicals) and the processing and marketing of agricultural products. These types of urban agriculture have a more pronounced economic impact and higher profitability, but their externalities for the city and urban populations, especially those of the intensive larger scale enterprises, tend to be higher especially through risk of water and soil contamination due to intensive use of agro chemicals, health risks from use of contaminated water for irrigation and risks of animal-human disease transfers.

(iii) The ecological perspective that refers to types of urban agriculture that have a multifunctional character: besides provision of food and generating income they can play a role in environmental management for example, through nutrient recycling via decentralized composting and reuse of organic wastes and wastewater. They can also provide other services demanded by urban citizens: urban greening, improvement of the urban climate, keeping buffer zones and flood plains free from construction, provision of opportunities for leisure and recreational activities, storm water storage and flood prevention. In order to enable such a combination of functions, urban and peri-urban agriculture will have to adopt agro-ecological production methods, link up with eco-sanitation and decentralized sustainable waste management systems, as well as becoming part of the planning and management of parks, nature reserves and recreational services.

Due to the cross cutting and multi-dimensional nature of urban agriculture, policy development and action planning on urban agriculture should involve various sectors and disciplines: agriculture, health, waste management, community development, parks and nature management, among others. Moreover, urban farmers, and the

CBOs and NGOs supporting them, have to be involved in the planning process. An important aspect of strategic urban planning is related to the participation of the urban poor themselves in the analysis of the situation, in the definition of priorities and in action planning and implementation. Such consultative processes would make the outcomes of policy development and action planning not only robust and comprehensive, but also accepted and sustainable.

Urban and peri-urban agriculture (in as much as it produces food), increases food availability and contributes to the overall urban food supply. Urban and peri-urban agriculture contributes to poverty alleviation both through a reduction of expenditures and through an increase of income. The income earned is usually spent on non-food items (e.g. transport, housing, school fees, and health costs) and to a lesser extent, and especially by female producers, on food items. Either way, urban and peri-urban agriculture plays a significant role in household food security. Few paid jobs are created/exist in urban and peri-urban agriculture with the exception of commercial horticultural production in peri-urban zones because farming households generally sell the products themselves. While urban and peri-urban agriculture contributes to food availability and enhances food security and nutrition to city dwellers and in some cases also generates income for urban households involved in production, processing, marketing and distribution of these foods, it also has some negative health impacts linked to poor food quality.

Cities are often unable to provide sufficient employment opportunities for the growing populations which lead to a rapid increase in urban poverty rates and food insecurity. These urban poor often lack the money to purchase food or the land to grow it. It is estimated that these individuals spend up to 60–80 % of their incomes to buy food (World Urban Forum Nanjing 2008). For example, in recent past year's food crisis and increased food prices and the accompanying global economic downturn reduced employment opportunities and incomes especially within urban areas. Climate change and higher incidences of natural and human-induced disasters such as excessively high floods and landslides have also caused disruptions in food-supply chains into cities further undermining food security among urban population. Sound policies that encourage and support urban agriculture are known to have substantially improved the food security and nutrition of urban poor in many developing countries. Havana in Cuba is quoted as most successful city in using urban agriculture to strengthen food security and meet nutritional needs of the urban poor. There are 300,000 backyard patios covering 2,500 ha and the number is expected to increase to half a million small gardens by 2015. More than 40 % of the households are involved in urban agriculture, including the widespread use of hydroponics securing a healthy 2,600 cal daily per capita. After the collapse of the Soviet Union and the hunger that struck the nation, Cuba in general and Havana in particular succeeded within a decade in eliminating malnutrition. While over that same decade each adult Cuban lost on average 10 kg of body weight, 22 % of all new employment in the country has been created in urban and peri-urban agriculture (Pauli 2012).

In view of the need to double the output of urban farming which could reduce the cost of food for the urban poor by up to 90 % by eliminating the need for transportation, warehousing and cooling, more ambitious ideas and entrepreneurship are

needed. Among ambitious ideas and technologies put forward in recent years include those that convert gray water into clean water to support urban small-scale agricultural projects. It has been demonstrated that it is possible to obtain water for small gardens in urban areas by recycling sewage water to yield potable irrigation water through what is termed "clean technologies" which convert domestic wastewater into fertile irrigation water without chemicals or extra electricity through using advanced oxidation methods and technology such as solar photo-chemical oxidation. Solar photo-chemical oxidation being the niche from which the technologies are designed; all the systems perform without chemical additives and energy may be supplied entirely from the greatest untapped natural resource, the sun. Regions with abundant sun such as those in tropical Africa have great potential of using the sun technology for sustainable solutions during when domestic wastewater can be turned into safe irrigation water for subsistence gardens and vegetable patches. The sun technology offers both economic and environmental benefits and presents the first step towards keeping sewage from polluting surface and groundwater resources.

In many countries across the globe, the urban-fringe has been declared a green-belt which is used to delimit the spread of urban area which would otherwise replace the much needed agricultural activities that enhance food security for the urban dwellers. Peri-urban agriculture has been found to have a definite and irreplaceable role in enhancing food security for many cities and large urban centers all over the world particularly where rapid rural–urban migration leads into encroachment of the city into surrounding natural ecosystems and agricultural lands. It is a challenge for both urban as well as for rural areas because producing adequate food to feed such numbers and particularly for the vulnerable groups in an urbanizing world demands combined concerted efforts to increase food supply. It also requires improved land productivity employing viable and appropriate technology to double or triple yields per hectare. Thus agricultural policies that focus on rural–urban food production linkages are called for so as to attain food and nutrition security for all sectors of the urban population. These policies need to take into consideration the impacts of these expansions to both the urban and the surrounding ecosystems. All stakeholders from the public sector, the private sector and the civil society need to work together at global, national and local levels. Policies formulated should aim to remove barriers, establish incentives and promoting capacity building of urban and peri-urban farmers and other food producers because urban and peri-urban agriculture provides effective and viable solutions to addressing food and nutrition security for urban vulnerable populations such as those in many cities in Africa. An estimated 40 % of Africa's population lived in urban areas by 2009 (UN-HABITAT 2009; UNDP 2012; FAO 2012).

Peri-urban agriculture contributes to food security and food safety for many urban populations across Africa as it increases the amount of fresh vegetables, fruits, milk and meat products available to people living in towns/cities. Peri-urban agriculture is viewed as sustainable agriculture across African cities and towns because it promotes energy-saving local production, limits packaging and transportation costs thus making the products affordable to a large chunk of the urban population. Since the production takes place within the city/town boundaries, the use of preservatives is

reduced greatly thus increasing affordability, food safety and promotes good health for the people.

Thus, while many African cities and towns continue to largely depend on rural agriculture, peri-urban agriculture is providing significant quantities of food and improving food security of the urban poor. Vegetables, fruits, mushrooms, herbs, meat, eggs, milk and even fish are being produced in community gardens, private backyards, roof tops and vacant public lands (including at the side of roads and rail tracks). These undertakings do provide substantial family food requirements. This not only greatly improves nutrition it also allows families to spend more of their incomes on other expenses such as education and health. In addition, urban and peri-urban agriculture also generates micro-enterprises such as the production of compost, food processing and sizable incomes.

Peri-urban agriculture just like other rain fed agriculture is vulnerable to weather variability and climatic change in particular. Thus the provision of food products from the peri-urban agriculture is affected by the now inherent extreme climatic events which are becoming increasingly more frequent. These weather changes which are now increasingly being linked to climate change will most likely affect peri-urban agriculture and possibly in net positive or negative terms. The peri-urban zones are experiencing significant environmental transformations as well as increased demands to meet the ever growing urban population due to continued influx of rural people seeking better opportunities in towns and cities as the rural economies fail due to changed weather patterns and inherent climate change effects.

Earlier it was categorically stated that climate change impacts are a reality across the African continent and therefore Africa's vulnerability has been highlighted albeit differentially distributed across the continent with differing degrees of magnitude and severity (IPCC 2007). The analyses in these reports depicts that the future urbanization trajectory poses both challenges and opportunities because although climate change impacts have been felt and documented more explicitly in rural Africa, urban populations are also experiencing serious climate change-induced impacts. It has been documented severally that climate impacts on the population of African cities have accentuated poverty and have added a layer to their inherent development challenges. These impacts have left large chunks of the urban and peri-urban population in abject poverty effectively reducing their resilience to increased vulnerability to food insecurity.

The linkages between urban and peri-urban food systems, with the rural hinterland connected to urban systems, also play important roles in sustaining the balance of food supply, livelihoods and provision of ecosystem services along the urban–rural gradient. Where it is well managed, peri-urban agriculture has a potential for mediating climate change impacts and poverty on one hand and the provision of micro-level ecosystem services on the other, which can have a cumulative impact at the macro-scale. Recent research results highlight the role peri-urban agriculture play in enhancing food security in urban and peri-urban areas across the continent. In these studies and others on this subject, it is pointed out that integrated systems including crop-livestock systems, aquaculture-livestock-crop systems and integrated crop-forestry systems have the potential of paying off to some degree in terms of

livelihood benefits to urban dwellers. As evidence of scaling up, institutions such as FAO and UNEP are now promoting ecosystem-based adaptation in African cities focusing on food production and improvement of food systems in urban and peri-urban environments (FAO 2012).

As climate change risks continue to manifest, a new layer to the existing challenges in African cities has been added. Consequently, adaptation to climate change has now become high on the agenda in combination with development. Adaptation is necessary to build resilience of cities' response to climate change. Inland, coastal and mountainous cities face different climate risks ranging from storm surges, droughts, excessive rainfall, heat waves and cold waves. The impacts also range from flooding, storm surges, water scarcity, health impacts and landslides with social and economic implications in cities. Adaptation of cities to climate change will have to couple with development to bridge both the urban development deficit and adaptation gap. Building on early and scalable adaptation measures is paramount to enable communities, institutions, urban authorities and different actors to be prepared for probable climate change impacts able to address the inherent challenges. Rain water harvesting and small storage tanks can go a long way towards enhancing adaptation and mitigation measures (Figs. 3.2 and 3.3).

Urban and peri-urban agriculture is perceived as a locally designed but globally connected set of solutions to household food security. The extent to which urban and peri-urban agriculture is successful, particularly in enhancing food security and ecosystem services in the context of climate change mitigation and adaptation largely

Fig. 3.2 A back yard small water storage tank

Fig. 3.3 A healthy looking maize crop growing in a back yard garden with a small water tank—*upper left side* of crop

depends on how it is perceived by city officials and how well integrated it is into other urban polices related to ecosystem management, water and wastewater management, and landscape management policies. Much of the negative sentiments surrounding the practice of urban and peri-urban agriculture stems from concerns about health risks to humans as well as the environment. For example, peri-urban agriculture incorporates the use of easily accessible resources such as waste water and groundwater which could be easily affected by sewage water disposed from the industries in urban centers which have often been found to cause microbial and heavy metal contamination due to inadequate waste treatment before disposal. Livestock and poultry manures have also been reported as sources of pathogen contaminations mainly of fecal origin (WELER 2013).

Urban and Peri-urban Agriculture in Southern Africa

Urbanization is growing at an alarming rate in Southern Africa due to increasing rural–urban migration triggered by dwindling employment opportunities in rural areas and due to the ever present attractions perceived to exist in the urban areas, attractions which lure the young and able bodied population to towns. The outcome for the immigrants into the urban centers is not always what they expected; many are frustrated and fail to find a niche in the urban environment. Jobs are hard to come by particularly for those without necessary skills; most of them end up in shanty towns

and informal settlements without adequate sanitation and other social facilities. Many of the migrants find themselves in the out skirts of the cities (peri-urban) or in the poorer parts of the towns and cities from where they commute to industrial sections which offer cheap unskilled jobs or from where they engage in informal businesses. Yet a small section of this population join the myriad of unemployed people wondering the streets looking for jobs or begging for alms. Those who engage in small-scale farming activities mainly engage in horticulture, growing vegetables for home use and for sale to earn some income. Urban and peri-urban agriculture including keeping of small stock such as poultry, pigs and sometimes goats/sheep is practiced not just by the unemployed, but also by low and middle income earners employed in low paying jobs. A few high income earners practice urban agriculture as a hobby or as part of their traditional practices rather than as a means to supplement their food supply or their income. Urban and peri-urban agriculture is sometimes practiced as a coping mechanism during civil strife and during critical weather conditions. Water accessibility in towns supports irrigation of small plots and backyard gardens as well as watering small number of domestic animals that are a source of fresh produce during such critical times.

Urban and peri-urban agriculture in and around cities in Southern Africa, contributes to urban food security through increased food availability and to some extent, accessibility due to short distances to the consumer markets. This contribution varies widely across the countries in Southern Africa; it also varies within a country as there are great variations among the urban population in the cities. For example in some towns and cities in Malawi, Mozambique, Tanzania, Zambia and Zimbabwe, most families have fields where they produce staple crops such as maize, groundnuts, cassava, plantains, potatoes and beans. Horticultural crops are grown among the stable food crops or in individual small gardens alongside the fields or close to homes. In the cities of these countries, staple crops are grown in season while vegetables such as amaranth, kale, pumpkin and cow peas are grown all year round. In cities such as Harare, over a quarter of the poor practice this type of farming which contributes up to 60 % of the city's food consumption; 80 % of urban agriculture in Harare occurs on public land and by 2012, 25 % of the city's land was covered by small-scale farms (Pauli 2012).

The type of spaces used to practice urban and peri-urban agriculture in most cities and towns in Southern Africa include around buildings, community lands and parks, waste lands areas allocated to other uses such as road peripheries and areas not suitable for building, such as flood plains, wetlands and steep slopes where both men and women grow food crops. In Harare and townships of the Cape Town Metropolitan area for example, most of the urban small-scale agricultural practitioners are women. In Dar es Salaam, women grow food for their family's own consumption in home gardens while men and the youth grow food for the market in the open spaces. In Malawi, women do most of the work on the fields but the income is controlled by the men. Access to water, and in particular to clean water, is a major constraint for urban small-scale crop producers in most Southern African cities where there is either a lack of water or costly tap water must be used. Yet another major problem for urban food producers is theft of crops from the plots (Egal et al. 2003)

In many of the cities and towns in Southern Africa, local governments' reactions to urban food production (off-plot cultivation) have general been proscriptive, partly because it spoils the modern image that many administrators want for the city and partly because urban planning and management is not structured to incorporate such activities. Hostility and repression have been frequently experienced in many towns despite the realization that urban and peri-urban agriculture has a role to play in alleviating wide spread unemployment and in meeting food requirements of the urban less privileged population. The sector is increasingly receiving appreciation for its role in contributing to good health of the people through improved nutrition and hunger alleviation which promotes more days at school and more days at work per year.

Unlike many cities in Southern Africa, Zimbabwe formulated policies way back in 1992 which allowed the carrying out of urban agriculture in Harare. This policy document concentrated on planned and organized urban agriculture. It allowed those interested in carrying out agricultural activities in the urban area to apply for permission to use designated land for the cultivation of crops. One of the aims of the policy document was to manage peri-urban areas as zones of transition that maximize the benefits of both urban and rural lifestyles. The policies targeted the minimization of negative impacts of urban agriculture the main of which was that it caused soil erosion and subsequent siltation of water supply sources. Collection of water in gardens and water ponds were seen as increasing the incidences of malaria as mosquitoes inhabited these created habitats. Other negative impacts included pollution of water infrastructure with pesticides and fertilizers as well as increasing water treatment costs.

In Harare like elsewhere in Southern African cities, agriculture is not classified as an urban activity and hence by and large, city planners do not plan for urban agriculture. Agriculture is mainly permitted in the peri-urban areas, a zone which is normally dominated by titled properties which are way beyond the reach of the poor. However, the Harare Combination Master Plan of 1992 provided for intensive agricultural smallholdings within the city and the peri-urban areas surrounding it. Both central and local governments generally acknowledged the role of urban agriculture in their decision-making structures. During the Annual Conferences of the Urban Councils Association of Zimbabwe, a resolution was made that encouraged all local authorities to recognize the role of urban and peri-urban agriculture in poverty alleviation and enhancement of urban food-security, employment creation and economic development. Although the policy framework in Zimbabwe slowly became supportive of urban and peri-urban agriculture, not much has been achieved on the ground. As a follow up, the Nyanga Declaration on Urban and Peri-urban Agriculture in Zimbabwe which was passed in 2002 like the Harare Declaration by Ministers of Local Government in Eastern and Southern Africa acknowledged that urban agriculture contributes to urban food security, poverty reduction, local economic development and sustainable urban development. The Nyanga Declaration also urges the national Government of Zimbabwe to include urban and peri-urban agriculture in its programs to alleviate poverty, NGOs and international donors to provide financial and material support for urban and peri-urban projects, and the private sector to invest in urban and peri-urban agro-businesses.

On the other hand, the Harare Declaration of Urban and peri-urban Agriculture in Eastern and Southern Africa entered into in 2003 recognizes that although urban and peri-urban agriculture is practiced informally within the region, it already played a significant role in improving food security, health, and nutrition as well as income generation for urban dwellers. Given this fact, the declaration was passed to reinforce the urgency to develop policies and other appropriate instruments to regulate urban and peri-urban agriculture and create an enabling environment to integrate urban and peri-urban agriculture into urban economies. This declaration paved the way for the formulation of policy and legal frameworks for urban agriculture where it did not exists by then. In Tanzania, policies guiding the practicing of urban agriculture were put into operation way back during economic hardships of 1970s and 1980s (Appendix 1).

In most of the cities in Southern Africa, such policies encouraging urban and peri-urban agriculture were only passed in recent years. A good example is the Zimbabwe National Environmental Draft Policy that provides strategic directions include developing and publishing guidelines on urban agriculture, assisting local authorities to plan ways to integrate and co-ordinate support for urban agriculture and establishing extension programs to promote sustainable urban and peri-urban agriculture. During 2010, the Harare Metropolitan Governor and Resident Minister, implored Harare residents to take up peri-urban farming seriously as it enhances urban food security and reduces urban poverty (Appendix 2). However, despite the recognition and policy support, in Zimbabwe the sector is beleaguered by numerous constraints including shortage of land and agricultural resources, serious environmental health risks and policy gaps.

In other cities such as Windhoek, where explosive urbanization rates have been registered since independence in 1990 due to rapid rural–urban migration there is no clear policy guiding the practicing of urban and peri-urban agriculture (FAO 2002). In Windhoek, urban and peri-urban agriculture is practiced on very small scale due to environmental constraints as well as historical policy set up. Historically, intensive subsistence crop production with marketable surpluses in good rainy seasons existed around Windhoek long before the colonial era. Commercial crop production and marketing by smallholders in peri-urban areas such as Klein Windhoek (now a suburb of Windhoek) were practiced and maize, potatoes, asparagus, onions, radishes and a variety of fruit trees were grown. By 1931, local vegetable production constituted almost 42 % of Windhoek's fresh produce market's annual turnover. However, change and policy revisions 30 years later seriously suppressed vegetable production in peri-urban areas in Namibia as a whole. The development of homelands, up-market residential suburbs and the supply of water to mines and urban irrigation needs relegated vegetable production to the background. Consequently, since 1973 up to the present, Namibia is almost entirely dependent on South Africa for fresh vegetables and fruits save for some horticultural crops that are grown in several recently initiated green schemes scattered in the north-eastern, north-central and southern parts of the country along the Orange River. Urban and peri-urban agriculture in and around Windhoek is currently limited to minute gardens around homesteads and occasionally in dry river beds

as well as a few government and donor sponsored horticultural gardens and livestock farming including game ranching as one moves further away from the city centre.

Various horticultural projects initiated in Windhoek include the donor supported Integrated Initiative in support of Urban and Peri-Urban Horticulture in Namibia (UPH) initially funded by the Belgium Government during mid-2000. The mission of the project was to contribute to food security by improving access to high quality fresh horticultural produce at household level all throughout the year; to promote employment and income for the less endowed population in the urban and peri-urban environment. Those falling in the less endowed category include urban slum dwellers, landless and marginal land farmers, previously disadvantaged group members, resource poor families, unemployed and weak/old. The status of the project during 2013 was unclear due to management issues where neither the ministry of health nor that of agriculture or that of youth is willing to assume full responsibility. Initially the success of the project heavily depended on voluntary labor input from the youth and/or those inflicted by HIV/AIDS who were the main beneficiaries; this free labor is no longer readily available after the departure of the donor. Other projects which are were functional during 2013 included a welfare intervention project aimed at enhancing the quality of life of three feed centers at Greenwell Matongo, Otjomuise and Nathaniel Maxuilili community centers located in the city's informal settlements. The project, owned by the City of Windhoek was initiated in 2008 and revamped in 2013. It covers an area of 280 m located at Greenwell Matongo community center. In total the three community centers feed about 500 orphans and vulnerable children on a daily basis. It grows spinach, beetroots, onions, cabbages and carrots (Aloe 2013) (Figs. 3.4, 3.5, and 3.6).

The other recently initiated project is in the form of an elaborate horticultural and animal project owned by a Chinese enterprise located in the per-urban fringe of the city of Windhoek; it grows a variety of vegetables and raises pigs and chicken to supply an informal market frequented by Chinese nationals working in and around the city of Windhoek. This project utilizes semi-purified water from the city's waste

Fig. 3.4 City of Windhoek Garden Project, May, 2013

Fig. 3.5 City of Windhoek community development officer May 2013

Fig. 3.6 City of Windhoek garden care taker May 2013

water reservoir/dam. The enterprise further purifies the water to an acceptable standard before using it for irrigation and for the animals to guard against pollution risks.

Since policy revisions during late 1960s up to early 1970s which seriously suppressed vegetable production in urban and peri-urban areas in and around Windhoek, there has been no more policy formulated since then. Currently, there is no active policy on urban and peri-urban agriculture in Namibia as a whole. Although the sector is described as insignificant due to its small size, in Windhoek, it is viewed as a possible pollution threat to water and soil especially where the use of fertilizers, pesticides, herbicides fungicides and other chemicals is involved. Thus MAWF is planning to take steps towards determining the contribution of the sector to food security in the city. At the same time, the Ministry of Environment and Rural Development through Windhoek Greenbelt Landscape (WGBL) initiative is monitoring possible pollution threats to peri-urban agriculture activities (WELER 2013).

A number of constraints and issues have been identified as posing challenges to urban and peri-urban agriculture in Windhoek. These include the lack of access to water and other productive resources as well as competition for land and issues related to land tenure insecurity. While access to water, and in particular to clean water, is a major constraint for urban farmers in most Southern African cities, it is more pronounced in Windhoek partly due to limited access to potable water attributable to the aridity that inflicts the country as a whole and partly due to costly municipal tap water. The environmental impact of urban agriculture, the food safety concerns of using waste water and organic material and the risk of the spread of diseases and contamination by toxic pollutants are all perceived as a major concern. While the above mentioned vegetable gardens use tap water from the municipality water distribution system, others outside the reach of the municipality water distribution system depend on independent boreholes. Research carried out during 2008 pointed out the imminent pollution threat to the ground water aquifer from anthropogenic activities in Windhoek area (Mapani and Shreiber 2008). More recent research carried out during 2012/2013 on water quality in the Windhoek Green Belt area revealed that the agricultural practitioners in the peri-urban area depend on boreholes whose water quality is threatened by Windhoek's municipal waste water disposal system and small-scale industries within the peri-urban zone. In this study carried out at the end of 2012 and beginning of 2013 revealed that water had low dissolved oxygen, high mineral salts concentration and extremely high nutrient concentration. An analysis of soil and river sediments also showed high mineral concentrations as a result of effluent water overflow from the waste water disposal ponds and food processing firms located in the peri-urban zone. Direct effect of seepage water on the borehole mineral salts concentration was detected in the borehole of one of the agricultural entities in the study sample (WELER 2013). Yet another major problem facing Windhoek urban agricultural practitioners is theft. An informal survey conducted in 2012 in the informal settlements revealed that theft of crops and animals is one of rampant problems worsening over time due to increasing difficulties in accessing land, clean affordable water, and widespread poverty perpetuated by high rates of unemployment.

Other problems that constrain urban and peri-urban agriculture in Windhoek include pests and disease such as corn crickets, American bollworm and aphids. The health of a range of animals kept in back yards such as goats, sheep, rabbits, chickens, turkeys, parrots and other birds is threatened by the absence of veterinary extension services for this sector. Other constraints include lack of capital and lack of information on reliable markets for surpluses due to the fact that currently most of the major markets for vegetables and fruits are dominated by South African chains of supermarkets. Moreover there is an apparent psychological preference for imported products by Namibian business people and consumers probably due to more appealing appearance and better packaging of the produce. To reverse this prejudice requires training of the producers on how to handle and package their produce so that they are attractive to the consumers. There is also need to conduct campaigns to raise awareness to encourage people to consume locally produced fresh fruits, eggs, chicken, meat and vegetables. Deliberate campaigns and policies that offer protection to locally produced products have started to emerge starting with milk and chicken.

However, the absence of a strong and clear policy on urban and peri-urban agriculture in Windhoek and other towns in Namibia continues to curtail intensification and development of the sector. It implies that producers other than those involved in sponsored projects do not get the correct technical advice in carrying out the husbandry practices for the production of various vegetables and fruits. Knowledge of the chemicals and the quantities to be applied to various vegetables is limited and this may result in the use of the wrong chemicals as well as over dose. Once applied, information on the chemical process that might occur together with the resultant run-off is essential to assessing the impacts of the chemicals on water and soil as found out by the Windhoek Green Belt study. These findings will have an influence on the type and intensity of water treatment required. The absence of such a policy means that the quality of the produce from agricultural undertakings cannot be assured and therefore may not be fit for human consumption. The use of biodegradable chemicals to ensure that the pollution of water and soil is minimized is subject to the producers' ability and willingness to absorb the relevant costs which would be incorporated into the prices for their produce. Due to economies of scale, their produce might then be more expensive than for that benefiting from economies of scale such as those imported from South Africa. The importers of such products enjoy the trust of well established business men and chain supermarkets. Thus without a policy that protects the local producers, their produce will continue to face unfavorable competition.

The policy intervention required here is that which encourages and creates an environment that will enable the urban/peri-urban agricultural producers to grow high value vegetables, fruits, and raise healthy poultry and small stock using sustainable and environmentally friendly technologies. The private sector including agricultural banks should offer some micro loans with relaxed payment schedule to enable the producers to attain inputs including good quality water from the municipal supply system and affordable technology for application of husbandry practices. Water harvesting techniques should be part of the training as well as tailored financing regimes. Most urban agricultural producers are not aware of the existing environmental hazards and food contamination, and the accompanying human health risks, mostly because the effects of heavy metal contamination are mainly carcinogenic and normally felt in the long-term.

The greatest challenge facing urban agriculture is for it to become an environmental benefit rather than a liability. The role of urban agriculture in ensuring food security goes beyond supply and access arguments; the environmental context in which it is practiced is very important. Similarly, even though adequate and appropriate food supply is a necessary condition for eliminating hunger, increased food supply does not automatically mean increased food security. In order to assure sustainable urban food production, key environmental elements like fresh water, arable land and other resources should be available in sufficient quantity and quality in a renewable manner. If these issues are not addressed, it will be very difficult for urban agriculture to address the food utilization component of food security. The environmental and human health challenges associated with urban agriculture show that at the current level of practice, the sustainability of urban agriculture is highly compromised. Food security does not only involve the amount and type of food available but also the element of food quality and safety.

Urban and peri-urban agriculture should be supported in Windhoek as it is a positive and appropriate way of improving urban livelihoods. The success and expansion of urban agriculture will therefore depend on the ability of policy makers, administrators and urban farmers to use integrated social, economic and environmental strategies that effectively address food security and urban poverty. To ensure that the full potential of urban agriculture in reducing food poverty is realized, the Havana example in Cuba should inform Windhoek urban planners. Urban agricultural diversification which promotes production of high-valued specialty foods such as mushrooms that require little space for production but provide good monetary returns should be encouraged. Urban agricultural producers should be capacitated to produce protein rich pulses such as soya beans in their gardens to improve the dietary quality of their households. They will be able to appreciate environmental health benefits where good practices in urban agriculture are made readily available in simplified language and demonstration examples by urban planners and health practitioners. The benefits of multi-storey gardens (MSGs) which involve growing vegetables in empty cereal bags and empty cans rather than growing them directly in the ground should be encouraged because these gardens use minimum land space and are water efficient and ideal for areas with contaminated and/or poor quality soils.

Various South African cities have also been affected by high rate of rural–urban migration due to unequal distribution of high economic activities which show that urban areas contain 88 % of the total national economic activity, (22× times that in rural areas (Geyer et al. 2011). Among these, the city of Cape Town in the Western Cape is hosting large numbers of immigrants from rural areas in the Eastern Cape and the Northern Cape where subsistence farming is the primary economic activity and formal unemployment is high. Consequently, the city has been under great pressure to convert some of the fringe areas into agricultural islands to cater for the unemployed immigrants and at the same time meet increased food demand. The Western Cape Province which produces almost 30 % of the national agricultural output is the leading agricultural region in the country due its favorable climate. The region, particularly the city of Cape Town has been very active in promoting urban and peri-urban agriculture as a mechanism to ensure greater food security and employment among the urban poor.

Historically, urban agriculture was an essential land-use function of African settlements in South Africa where traditional settlements practiced horticulture on family plots in close proximity to the settlements while pastoral activities were practiced further afield up until the 1950s. Thus most urban settlements in South Africa were self-sustaining in food supply. During the 1950s the historic tradition of urban farming declined as commercial agriculture and rising urban incomes made urban agriculture redundant while apartheid policies and municipal by laws discouraged small-scale agriculture in and around cities. Thus contemporary urban agriculture programs are fairly recent having originated in the late 1970s and early 1980s as a result of anti-apartheid movements and interventions by Non-governmental Organizations (NGOs).

NGOs such as Abalimi Bezekhaya in Cape Town focused on recreating self-sustaining communities in the townships by forming grassroots organizations involved in urban agriculture aimed at providing subsistence and supplementary

incomes for individuals and families in deprived local communities. Different from the traditional urban agriculture, the contemporary agriculture is mainly informal in nature consisting of small-scale gardening or animal husbandry, supplementing the subsistence needs of private households. Vegetables are grown on tiny tracts of land within the boundaries of the residential property or illegally in larger vacant public plots and in nature conservation areas. Poultry and small stock (goats, sheep and sometimes pigs) are kept within the gardens and graze 'illegally' on open land in road reserves or on public land.

In and around the city of Cape Town, illegal farming is reported to be a risky endeavor because no property rights can be established and thus no fencing can be erected to prevent theft or scavenging. The majority of impoverished urban farmers are not able to access public land other than by squatting. Although economically insignificant due to the low unit value of agricultural produce, informal urban agriculture nonetheless provides substantial income savings to poor households. Because of declining economic conditions and high unemployment rate, urban agriculture is being promoted as a solution to social problems. Accordingly, in recent years, both the National Government and the City of Cape Town Municipality have prioritized urban agriculture as a core thrust in their urban planning interventions (Geyer et al. 2011).

Cape Town is home to approximately 3.7 million inhabitants and nearly 40 % of the residents exist on the economic margins, including those living in more than 230 informal settlements located largely on the Cape Flats (City of Cape Town 2011). Recognizing that urban and peri-urban agriculture is contributing immensely to food security for a large chunk of the city residents, the City passed the Urban Agriculture Policy of the City of Cape Town in 2007 which formally recognizes urban agriculture as an urban land use and creates a legal framework in which land-use rights can be protected and government assistance and intervention can be legitimated. The Cape Town Spatial Development Framework (CTSDF) also plays a crucial role in integrating and aligning the planning priorities and principles of the various spheres of government spatially, thus ensuring the protection of agricultural land uses in specific areas.

The Cape Town Urban Agriculture Policy of 2007 formalizes urban agriculture as a legitimate urban land-use function, and assigns rights to urban producers who prior to 2007 practiced urban agriculture illegally. It also prescribes the responsibilities of government in protecting, facilitating and assisting urban agriculture initiatives. The policy aims to promote household food security and economic development among the poorest communities in the city. The policy prohibits the raising of animals but it specifies the creation of agricultural commonages outside urban areas for grazing purposes, which would eventually be integrated into the land reform program. The Urban Agriculture Policy details the types of assistance available to urban farmers and the criteria for qualification of assistance, with collectives receiving the most assistance and subsistence farmers and small commercial farmers receiving decreasing amounts of aid, respectively.

Thus the city of Cape Town not only provides access to vacant land but also is assisting urban gardening groups in removing debris from that land, preparing it and delivery of compost. The city also provides assistance to reallocation of those urban producers that are poorly located and therefore may cause serious health and/or

environmental risks due to these locations. For example the city is planning to create new livestock kraals in the peri-urban area for the intra-urban herd owners. In its efforts to promote the provision of training and extension services to small-scale producers, the Cape Town policy on urban agriculture calls upon the services of research, training and support organizations in and around the city to provide the urban producers with training on business administration, technical skills and in marketing their produce. To enhance access to water, inputs and basic infrastructure, the municipality of Cape Town assists community garden groups with basic infrastructure (a fence, a tool shed, a water tank and hoses for irrigation) and allows them to use up to a certain amount of piped water daily free of charge.

In recent years, several projects have been undertaken in Cape Town's urban and peri-urban areas. Examples include the Powerline Project, otherwise known as SCAGA (Siyazama Community Allotment Garden Association) and Abalimi Bezekhaya project which fortifies the lives of the people in Cape Town's townships. In the Abalimi Bezekhaya project, the leading micro-urban agriculture model in Cape Town and almost certainly in South Africa, the very poor learn how to grow organic crops for sale and for eating at home, while conserving indigenous flora and promoting alternative technologies (Geyer et al. 2011). The project demonstrates how urban and peri-urban agriculture has emerged as a successful strategy for the immediate relief of hunger, malnutrition and poverty. The increased availability of fresh products also improves the quality of urban diets through diversification, by adding horticultural and animal products to the basis of staple food. This allows urban dwellers to consume a more balanced diet that is not only sufficient in energy, but also in protein and micronutrients required for body growth and maintenance. Furthermore, the income raised through vending agricultural products is used to buy other consumer items such as cooking-oil and soap which improves the producers' hygiene.

The Abalimi project involves about 1,500–3,000 residents of Gugulethu and Fezeka, where 40 % of the residents are unemployed, and poverty and hunger was rampant before the project was started during the late 1990s. The core purpose of Abalimi project is to combat poverty by growing food sustainably (and organically) both at home and in community gardens, and to further green the township areas by planting water wise indigenous trees in the schools and streets of the area. When the project was started the aim was to help people achieve subsistence from the crops grown in their gardens. Having surpassed that basic need, the project participants have gone commercial with the assistance of Harvest of Hope. Food grown at the Abalimi project goes to the families of the producers first, and to selected secondary schools in the area while residents of wealthy Cape Town suburbs form the main customer base for "Harvest of Hope," the center's social business branch.

The initiative has been successful save for the fact that it has registered very small profit margin. It is documented that among the approximately 3,000 urban agriculture small-scale producers supported by Cape Town NGOs such as Abalimi Bezekhaya and the 300 producers supported by the City of Cape Town's Urban Agricultural Assistance Program have not yet emerged as independent commercial farmers and only a few are able to subsist without external support. The Abalimi Bezekhaya project with their Harvest of Hope business branch, only acquired a net profit of approximately R90 per capita per month in 2008 (Geyer et al. 2011). However, this is not a

Fig. 3.7 (**a**–**c**) Applying organic compost manure at Fezeka Community Garden, 2013

mean achievement bearing in mind that the initial aim of urban and peri-urban agriculture was to provide food and alleviate hunger for the poor residents (Fig. 3.7).

The project is focused on equality for women in the program and tailoring the foods produced to fit the needs of the people in the area. At Fezeka Garden women run the project. As a whole there are very few men involved in growing community gardens on the Cape Flats. Abalimi project "subsidizes" the growers to the tune of R150 per grower per month by providing training, manure and set-up and maintenance of an irrigation system for each garden. Abalimi project also helps the growers gain access to council land and negotiates on their behalf to obtain access to water. Harvest of Hope collects the vegetables from the growers once a week and takes them back to the packaging shed to be washed and prepared for delivery (Appendix 3). The vegetables make up weekly organic vegetable boxes that are distributed via some of Cape Town's southern suburbs schools.

At the Abalimi project, farmers grow a variety of vegetables that suit the community's needs such as spinach, cabbage, and white onions, and maybe just a few spring onions (Stofile 2013). They also grow some that are in high demand by their main consumers such as leak and rhubarb. It is a story of hope for everyone who believes in

the power of small, community-owned agricultural plots. It took many years to get to the point where black people in South Africa accepted that organic crop growing was different and valuable. No one, except one or two really believed that reliable, adequate money could be made from micro-farming on tiny bits of wasteland, until money started pouring into people's accounts (Stofile 2013; Appendix 4).

Other initiatives are emerging; during June 2013, an NGO known as Avalon's initiated a new project on the expansion of organic urban farming in Cape Town with the aim of strengthening the concept initiated by the Abalimi project in addressing problems of food insecurity and unemployment growing exponentially in Cape Town and other urban areas in South Africa. Using a threefold approach, Avalon's objective is to firmly anchor urban agriculture in South African cities, starting with Cape Town. The objective of the project known as Family Strengthening Programs of SOS Children's Villages South Africa is similar to those of the Abalimi Bezekhaya project where the participating families get lessons in creating and maintaining organic vegetable gardens to feed their families and sell the surplus thus becoming semi-commercial producers. The project envisages the establishment of vocational training center for the successful semi-commercial producers who would be trained on how to manage larger plots of land and bring the marketing and sale of their products to a higher level converting them into fully qualified producers. The project, planned to run initially for 6 years, is funded by the COmON Foundation with contributions from the regional Western Cape Ministry of Agriculture, the organic compost company, Reliance, and the growers themselves. Avalon is working on this project together with SOS Children's Villages and the local urban agriculture organization Abalimi. It is hoped that the project will create more than 500 permanent jobs in the city's agricultural sector and result in more than six million improved meals a year (Avalon 2013).

Another recent initiative utilizes a previously abandoned piece of land used as a bowling green until 2012 when the piece of land was taken over by volunteers who plant, nurture, and grow a variety of horticultural crops and hosts a public market once a week. Known as the Oranjezicht City Farm, it is considered as the first in a project that will grow into 20 city farms throughout Cape Town. Through education, design and vegetable gardening, the project hopes that it will act as a catalyst for skills development, education about food and environmental issues, and a showcase for what can be done with unused or under-utilized public green spaces in the city. Crops grown in the farm include hedges of herbs such as thyme, lavender and rosemary which protect the vegetable beds from the wind (Appendix 5). The farm uses fresh water springs that run through the area to irrigate the plants. The cluster of springs is known to have provided perennial fresh water to local pastoralists (Khoekhoen) and used to irrigate vegetables and fruit trees that supplied fresh food supplies for passing ships during the seventeenth century up to the turn of the twentieth century.

The Oranjezicht City Farm, a neighborhood non-profit farm project celebrating local food, culture and community through urban agriculture is composed of community of adults and younger folk working together to engage in small-scale organic food production. The vision of the project is to improve under-utilized public green spaces by creating demonstration gardens for hands-on community-wide food gardening education, thereby increasing access to fresh vegetables. Oranjezicht farm aims to

re-connect the Oranjezicht neighborhood and the rest of Cape Town to build social cohesion across communities, to develop skills among the unemployed, to educate residents and their children and others about food, environmental and related issues, to beautify public spaces and to champion unused or under-utilized green spaces in the city. It is envisaged that the farm will serve the purpose of increasing access to nutritious fresh vegetables for the community, to increase the number of organic gardeners and hence lead to more outdoor activities and healthier lifestyles and build capacity and skills of youth and adults seeking work in urban food production. The farm also strives to promote connections and foster relationships between and among individuals, garden communities, and NGO's throughout South Africa. A well laid out farm in an affluent part of Cape Town, it produces a range of horticultural crops (Appendix 5).

Conclusion

On the whole, it should be born in mind that urban and peri-urban agriculture has many benefits as well as negative effects emanating from being located within or so close to the city. The benefits include increased food supply particularly for the poor and vulnerable section of the urban population, hunger and poverty alleviation, solving widespread unemployment and increased food security for the underprivileged sector of the population. The negative effects emanate from the fact that the poor sections of urban centers lack affordable adequate clean water and that those who cannot afford paying for water resort to using waste water to support their agricultural activities. Cities' waste products including waste-water and industrial and sold waste gets disposed off in the urban fringe and thus pose imminent pollution threats to products from the agricultural activities located within the urban-fringe zone. Many backyard gardens within the city boundaries may also make use of domestic waste water posing possible pollution threats to crop products as well as meat products such as that from poultry pens and fish ponds utilizing such water. This is the case in particular for infectious diseases transmitted through contact of human beings with animals during production processes, or ingestion of contaminated water or animal products.

In Southern Africa, some poor parts of the cities and their periphery zones such as those in Windhoek and northern Mozambique, poor hygiene abounds; latrines are not customarily utilized so that human waste get washed into seasonal rivers and permanent streams by rain surface flow. The vegetable and other agricultural undertakings which depend on contaminated stream water for irrigation and watering livestock, pollution and food contamination is a high threat to food quality and food safety. Similarly, despite the fact that urban agriculture in Tanzania is practiced in a generally favorable political and legal context, in Dar es Salaam environmental contamination of crops was reported around latrines, pathways and industrial wastewater outlets (Egal et al. 2003). This calls for policy makers to take cognizance of such threats and work in close collaboration with environmental health specialists who would look into the conditions pertaining to food production and processing in

the urban and peri-urban zones. Multidisciplinary teams that include physical land planners and environmental health specialists should determine appropriate locations of urban and peri-urban fields and plots. Municipalities and local government authorities ought to carry out health and hygiene campaigns and awareness building among urban and peri-urban agricultural producers and residents.

Furthermore, policy makers ought to take full cognizance of advantages of urban and peri-urban agriculture and should encourage collaboration and research as a supportive measure towards the urban and peri-urban agriculturalists so that they produce safe and nutrient-rich products for both home consumption and city markets. Policy makers should incorporate the needs and benefits of urban and peri-urban agriculture into physical urban planning including land tenure, water availability and drainage characteristics. Among other roles, urban researchers should look into viability of food production in the urban environment and advise the city planners accordingly. The growers should also be involved during the planning phase. By and large, all concerned stakeholders should participate in policy formulation to ensure that food produced in urban and peri-urban areas is safe to eat and that which gets processed is distributed efficiently while observing health standards to ensure its safety.

By formally accepting urban and peri-urban agriculture as a viable urban land use activity urban policy makers throughout the region would effectively contribute to the development of safe and sustainable urban agriculture. By passing legislation including policies and by-laws that control and guarantee and safeguard land tenure and security of agricultural land use, they will strengthen and increase the productivity and economic viability of urban agriculture. Policies should take into account the need to facilitate access of urban agricultural practitioners to training, technical advice, and credit that would support growth of undertakings including small business enterprises. Required training should include the prevention and/or reduction of health and environmental risks associated with urban and peri-urban agriculture as well as wise use of waste water, pesticides, fertilizers and organic waste.

Quality control along the entire food chain from production to consumption is essential so that urban consumers can have access to safe and healthy foods. Ensuring good quality of urban agriculture products would also help producers obtain good prices for their products. Information from surveyed literature reveal that many countries in Southern Africa do not have urban agricultural services with the exception of two towns in Tanzania (Dar es Salaam and Dodoma) and one in Mozambique (Maputo) and Cape Town (South Africa) where non-governmental organizations (NGOs) have emerged as the effective supporters of urban and peri-urban agricultural practitioners.

Equally as essential is advise to the poor and less educated on foods that are rich in nutrients and can adequately supplement the common diet, such as fast-growing crops and, where appropriate, small livestock, which should be culturally acceptable and easy to market. Concerned institutions should ensure that there is no contamination of foods during and after production and that there is consumer protection through the establishment of food control systems. Links of nutrition needs of urban consumers with the urban and peri-urban producers would ensure sustainability and security of livelihoods of poor households. Required also is coordination among the various sectors involved, from the urban, local level up to municipalities and national level.

Appendix 1: Legal and Policy Aspects of Urban Agriculture in Tanzania

Urban agriculture (UA) in Tanzania is practiced in a generally favorable political and legal context. At the national level, during the 1970s and 1980s, the government, faced with a poor economy, issued policies encouraging people to undertake urban agriculture. This was for urban dwellers to attain food self-sufficiency, to grow food in order to offset sky-rocketing inflation. Government and political leaders time and again told urban dwellers to raise livestock and produce their food in their backyards and other open space. Policies behind this included *Siasa in Kilimo* (Politics is Agriculture) of 1972 and *Kilimo cha Umwagiliaji* (Irrigated Agriculture) of 1974, *Kilimo cha Kufa na Kupona* (Agriculture for Life and Death) of 1974/75 and *Mvua za Kwanza ni Zakupandia* (First Rains are for Planting) of 1974/75. Others included the National Economic Survival Programme (NESP) of 1981/82, the National Food Strategy of 1982, the National Livestock Policy (NLP) of 1983, the National Agricultural Policy (NAP) of 1983, and the National Economic Recovery Programme (ERP) of 1986–1990.

At the ministerial level, urban agriculture has been partly encouraged by agricultural extension officers who offer non-formal education to urban dwellers. In a bid to encourage urban dwellers to produce own food, the government set up an urban agriculture extension service in the 1970s under the Ministry of Agriculture and Food Security (MAFS). Currently, MAFS uses its urban-based Agriculture/Livestock Extension Agents (ALEAs) who work in towns to promote the raising of livestock and growing of crops. ALEAs visit urban dwellers and impart modern skills and knowledge (non-formal education) about agriculture so that the farmers' production will increase. It was in the early 1980s when government policies of encouraging urban agriculture, especially livestock keeping, started to have negative effects on the operations of most urban councils and the physical urban environment. So it was time to review the existing municipal bylaws regarding farming in town.

The first urban bylaws regulating the growing of crops and raising of livestock in urban centers were enacted by the British colonial authorities in 1928 under Rule 16 CAP. 101 titled bylaws for regulation of cultivation and keeping of animals in urban areas. These bylaws had three main objectives: (1) to prohibit people of African descent to grow crops and raise livestock in urban areas; (2) to prevent urban agricultural activities in urban areas, because it was thought to increase the presence of malaria-causing mosquitoes, especially crops taller than one meter; and (3) to maintain a cleaner urban environment and sustain urban aesthetics by preventing people of African descent from growing crops in most of the towns' open spaces.

After independence in 1961, most of these bylaws became moribund. Later, however, most towns and municipal councils found it necessary to revive the bylaws so as to regulate urban agriculture for the smooth running of towns. The essence of these bylaws is that growing crops or raising animals is allowed, be it under certain conditions. In Tanzanian towns, bylaws on crop cultivation make a distinction between areas where growing crops is completely prohibited and where it is permitted. Growing crops is also not permitted within a distance of fourteen meters from road banks. As

for the river valley, however, crop cultivation is not allowed within a distance of fifteen meters from the river banks. The cultivation of annual crops is unrestrictedly allowed in these areas. For permanent crops, however, a written permission from the Municipal Director is needed. Other bylaws regulate the proper ways in which crops have to be cultivated, including for instance use of machinery, planting time, use of inputs, weeding, use of certified seeds, planting on slopes, as well as how to act in case of plant pests or diseases. Other bylaws stipulate the penalties on not adhering to these regulations, including fines, imprisonment and destruction of crops.

However, although these bylaws exist and clearly stipulate the penalties for defaulters, they are rarely implemented. For instance, it is common to see crops of all varieties planted in all municipal administrative wards, road reserves, riverbanks, public open spaces including children playgrounds, and surveyed plots, rendering the bylaws 'toothless.' In towns, bylaws on livestock keeping define "animals" as cattle, donkeys, goats, horses, mules, pigs and sheep. In other words, small livestock like improved chicken, local chicken, ducks, rabbits and turkeys, most of which are now raised in urban areas, are left out. Most town Councils' bylaws stipulates that they "shall earmark certain areas to be known as "specified areas" within the urban area for the purpose of keeping animals [and] along which to move an animal or animals and permits shall be issued by the Councils in respect of animals authorized in the Urban Areas". Yet, the bylaws do not specify the numbers and types of animals that urban dwellers are allowed to raise in different density areas.

Bylaws forbid keeping animals outside "a building, structure or enclosure"; hence, keeping animals in free range is prohibited. Moreover, according to bylaws do not allow animals to be kept "in a building or part of such building that is used for human habitation". Yet, people do keep improved chicken, goats, sheep and local chicken in their houses. On the other hand, chicken (local and improved) are not defined as "animals" in these bylaws. Animals can only be moved with special permission from the Council. Most urban dwellers keep animals without having a permit. Bylaws which require urban dwellers to remove manure, liquid filth, and other animal waste are never enforced. The fact that there are many senior government and ruling party officials among the livestock keepers who break the bylaws with impunity, is probably the best assurance for most other livestock keepers that they will not be punished whenever they break the law. The National Human Settlements Development Policy of 2000 of the Ministry of Lands and Human Settlement Development says the following regarding Urban Agriculture:

Urban agriculture exists in most urban areas both in the developed and developing countries. As an economic activity, it provides income and employment opportunities to the urban populations, and a reliable supplementary source of food supply to urban dwellers at affordable prices. As a land use, well-planned urban agriculture creates a pleasant greenery scene.

Issue. Although urban agriculture is considered an important component in sustainable development, improperly practiced urban agriculture conflicts with other urban land uses and leads to land degradation, water pollution, and is a threat to health and safety.

Policy statement. The government shall: (i) designate special areas within planning areas whereby people will be granted legal rights to engage themselves in agricultural activities; (ii) continue to regulate and research on the conduct of urban agriculture and will ensure that it does not disrupt planned urban development; (iii) review existing laws to facilitate planned urban agriculture; and (iv) facilitate the construction of appropriate infrastructure to mitigate/prevent land degradation, water pollution, and health and safety hazards in areas whereby urban agriculture is permitted.

Thus, the legal context is somewhat confusing for the urban farmers. The national government pursued a generally favorable policy and even tried to encourage people during periods of severe economic recession. Even, though farming in town is generally accepted, the bylaws at the local level pose many restrictions to the practice. Many urban farmers appear not to know what is allowed and what is not. On the other hand, despite these regulations, enforcement is sparingly done and discriminatory in nature (the elite are less affected), councils lack funds and personnel to reach sprawling and sometimes unplanned urban areas.

Source: Malongo RS and Mlozi MRS (2003). Legal and Policy Aspects of Urban Agriculture in Tanzania. www.ruaf.org/sites/default/files/econf4_submittedpapers_mlozi.pdf

Appendix 2: Harare Metropolitan Governor and Resident Minister Address 2010

He acknowledged that for years, farming has not been regarded as an urban land-use and local authorities have been quick to cut down crops grown by residents on open spaces within cities and towns. He said although local authorities' by-laws on urban farming have not changed, most municipal authorities have realized the importance of farming for urban residents. They are now allocating land at the periphery of urban areas to town and city residents intending to grow different food crops. He gave the example of Mr and Mrs Edgar Makowe of Tynwald in Harare who have been practicing peri- urban farming for some years and it had significantly contributed to the upkeep of their family. He told them last season the Makowes planted maize on four hectares of land and they managed to harvest a yield that is as good as any if not better than that harvested by communal farmers. On the back of the good harvest, the Makowes invited agricultural experts to come and share their expertise to encourage neighbors and friends to take this type of farming seriously. Speaking at the occasion, Governor David Karimanzira urged other urban dwellers to emulate what the Makowes have done and help eradicate poverty in the country. Mr and Mrs Makowe said they are now looking to farming as a viable option of sustaining their family and supplementing the family income. Speaking at the same event, Ivan Craig an agricultural expert with a local seed manufacturing concern also noted that peri-urban agriculture is one of the several

tools for making productive use of urban open spaces, treating and recovering urban waste and managing fresh water resources more effectively. He also stressed the importance of knowing the soil type and using the appropriate seed. Agricultural experts also encouraged people practicing peri-urban agriculture to plant trees in open spaces they are utilizing for peri urban purposes so as to conserve the environment. Last year, government allocated 60.000 ha of land for urban agriculture in Harare in a bid to eradicate poverty in urban areas.

Source: Urban Agriculture (2010) Residents urged to take peri-urban farming seriously. Harare, Zimbabwe.

Appendix 3: Packing Some of the Abalimi Project Vegetables at Harvest of Hope Shed

Appendix 4: Cape Town's Women Take the Lead in Farm-Focused Social Enterprise

Tuesday mornings are always busy for the staff of Abalimi Bezekhaya, an urban agriculture project operating in the sprawling townships of Cape Town, South Africa. Each Tuesday, peppers, eggplants, cabbages, beets, and the like are collected from dozens of community gardens to be sorted, boxed and driven to 25 pickup points around the city. On a particular Tuesday in February though, there is a problem. The list of recipes distributed with each box includes one that calls for leeks, but leeks are nowhere to be found. "What's the crisis today?" asks Rob Small, the co-director and founder of Abalimi Bezekhaya ("farmers of the home" in the native Xhosa language). "I think it might be this," he says, pointing to the leek-less boxes. Despite daily hurdles, Small and his staff are successfully running a hybrid social enterprise that provides training, financial support, and food security to small farmers. The roughly 15,000 people Abalimi reaches—3,000 farmers, with an average of five family members—all live in the historically disenfranchised Cape Flats townships, where residents have faced high crime rates, a lack of opportunity, and a 30 % to 40 % unemployment rate since the days of apartheid.

Abalimi's profitable social business, Harvest of Hope, relies on a community-supported agriculture model that provides customers (who pay in advance) a box of fresh, organically grown produce harvested from community gardens each week. Abalimi's main objective is securing access to "local fresh food and nutrition security" through a combination of subsistence plots and community gardens. The organization is addressing three of South Africa's most chronic problems—unemployment, racial disempowerment, and nutritional inequality—with a blend of entrepreneurship, philanthropy, and organic compost. "These days, to be charitable means you're making people weak," Small says, referring to the negative stigma

attached to nonprofits. “Social businesses are conducted with the interest of the whole at heart, while the individual is honored and recognized within that.”

Liziwe Stofile, who lives in the township of Khayelitsha, trains Abalimi’s new farmers. She explains that in her home province of the Eastern Cape, where many Cape Flats’ residents are from, few Africans grow or eat vegetables like peppers, chard, or green beans. Instead, they grow traditional subsistence crops like potatoes, squash and mealies (corn), which offer less nutritional diversity than what she eats today. “What is happening now,” says Vatiswa Dunjana, another trainer and field worker living in the township of Nyanga, “is we are learning something about the healthy food: what to cook, how not to overcook, what veggies you can eat raw while picking in the garden—it is boosting our bodies.”

While the food grown by Abalimi’s farmers goes to their own families first, the main customer base for Harvest of Hope’s commercial produce is not the residents of nearby townships. Instead, the main customers are the white residents of wealthy Cape Town suburbs. It is, however, common for township residents to buy one or two bunches of vegetables from nearby community gardens. Stofile says these small-scale transactions are subtly changing the tastes of residents. “Farmers are growing a variety of vegetables that suit the community’s needs. The community doesn’t want to buy leeks, green onions, baby marrows. They want to buy spinach, cabbage, and white onions, and maybe just a few spring onions when they are making their *imifino*,” Stofile says, referring to a green vegetable stew commonly prepared in South Africa.

Small encourages this trade in the townships and hopes it will expand in the future into local farmers markets. But he says Abalimi plans to stick with the CSA model, even if township residents can’t afford it yet. “The CSA model is the most conscious, viable and fair form of social business on the planet,” Small says. “It is 1,000 % more equitable and fair to the farmers.” When Small talks about the challenges of running Abalimi, rarely does he mention things like poor soil quality, early frosts, or controlling insects without the use of pesticides. He says his biggest challenges have little to do with cultivating organic fruits and vegetables, and everything to do with the mindsets of the people he works with. “Go back [in time] and maybe you’ll find yourself in a clan, in a tribal grouping maybe under a king or queen. Here in Africa, that group consciousness is very recent. You can encounter it still,” Small says. “Relationship in Africa is far more important than results.”

Small recounts a recent incident in which vegetables that required refrigeration prior to delivery were repeatedly left just outside the refrigerator door, causing them to wilt. Despite being instructed numerous times, the staff repeated the same mistake for several weeks. Small believes the staff did this to show their collective dissatisfaction with some aspect of management but, he said, upsetting the client only served to “damag[e] the ground they walk on.” “The biggest challenge is people’s ability to conceive of potential and future possibilities,” he says. Recently, Small stepped down as the day-to-day director of Abalimi and handed the responsibility over to a formidable Xhosa woman referred to as ‘Mama Kaba,’ a longtime staff member with considerable experience and clout. Small was eager to step down and said that the decision was in part an attempt to reverse the perception of Abalimi as a “black empowerment project led by white people.”

In the townships where Abalimi operates, it's not uncommon for women to be leaders in the community and in charge of social projects. This is reflected in the core staff of Abalimi, which is mostly female. "From the beginning, we took [Mama Kaba] as the one who is in charge because she's an older woman and she's got more experience," Stofile says. "The reason that women take over most of the community gardens is because they want to take vegetables home to feed their children. The men only want to make money." While he wants more young men to get involved to reap the benefits of small farming, Small doesn't see the women-led movement as a problem. "The mothers and grandmothers tend to be more honest and values driven, thus development really happens, rather than smoke and mirrors," Small says.

Abalimi trains individuals in their target group—the disadvantaged, poor, and unemployed who "don't fit to the western European model for getting jobs"—to what Small calls the livelihood stage—more than subsistence farming, but not large scale enough to be fully commercial. "[The livelihood stage] is the stage which governments and development agencies worldwide generally don't understand," Small says. "They try to leapfrog people from subsistence to commercial." Small recalls a time when he struggled to convince farmers that they could sell the excess produce from their subsistence plots for money. He describes jumping over fences into small plots to scavenge the surplus harvest that would otherwise be left to spoil. "It took many years to get to the point where black people in South Africa accepted that organic was different and valuable," Small said. "No one, except one or two of us [at Abalimi], really believed that reliable, adequate money could be made from micro-farming on tiny bits of wasteland, until they saw it pouring into people's accounts."

Source: Learn in Agriculture, Business and Farm (2012) Cape Town's Women Take the Lead in Farm-Focused Social Enterprise

Appendix 5: Oranjezicht Farm Layout and Some of Its Horticultural Products

Source: www.ozcf.co.za/

References

Aloe (2013) City of Windhoek newsletter no. 9, June 2013

Avalon (2013) Avalon starts project for organic urban farming in South Africa. http://www.avalon.nl/nieuws/avalon-starts-project-for-organic-urban-farming-in-south-africa. Accessed 4 Feb 2014

City of Cape Town (2011) http://www.capetown.gov.za/en/stats/Pages/CityStatistic.aspx

Egal F, Valstar A, Meershoek S (2003) Urban agriculture, household food security and nutrition in Southern Africa. Food and Nutrition Division of the Food and Agriculture Organization (FAO)

FAO (2002) State of food insecurity in the world. www.fao.org/docrep/005/y7352e/y7352e00. Accessed 10 Dec 2013

FAO (2012) State of food insecurity in the world: economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. http://www.fao.org/docrep/016/i3027e/i3027e.pdf. Accessed 10 Dec 2013

Geyer H, Schloms B, du Plessis D, van Eeden A (2011) Land quality, urban development and urban agriculture within the Cape Town urban edge. African Journals On Line (59). http://www.ajol.info/index.php/trp/article/viewFile/77220/67674

IPCC (2007) Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) Climate change 2007, fourth assessment report, intergovernmental panel on climate change. Cambridge University Press, Cambridge, UK/New York. http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html. Accessed 15 Jan 2014

Mapani BS, Shreiber U (2008) Management of city aquifers from anthropogenic activities: example of the Windhoek aquifer, Namibia. J Phys Chem Earth 33:674–686

OHCHR (Office of the UN High Commissioner for Human Rights) (2006) Principles and guidelines for a human rights based approach to poverty reduction strategies. HR/PUB/06/12, Rome, Italy

Pauli G (2012) The blue economy: case 97. The next generation of urban agriculture. 100 innovations, 10 years, 100 million jobs. Report to the club of Rome, 2012. www.TheBlueEconomy.com. Accessed 2 Dec 2013

Stofile L (2013) Cape Town's women take the lead in farm-focused social enterprise. Learn in agriculture, business and farm (2012). Cape Town South Africa

UN-HABITAT (2009) Planning sustainable cities: global report on human settlements 2009 United Nations human settlements programme. www.unhabitat.org

UNDP (2012) Africa human development report: towards a food secure future, New York

Weler (2013) Water quality assessment dry season results. NAMPLACE Namibia landscape conservation. http://www.landscapesnamibia.org/windhoek-green-belt/threats-to-the-environment

World Urban Forum in Nanjing (2008) Urban agriculture for resilient cities (green, productive and social inclusive

Chapter 4
Indigenous Plant Resources and Food Security Among Small-Scale Agricultural Producers: Southern Africa

Abstract Products from land holdings of small-scale producers in Southern Africa's dry lands are many and varied. The dry lands are known for their richness of tree species with edible fruits which contribute to food security and income generation which is sometimes higher than that from animal husbandry or arable agriculture. The inhabitants of the dry lands in Southern Africa have a rich heritage of ably managing and living harmoniously with their environment utilizing resources wisely stretching these from years of abundance into lean years. Introduced 'development' undertakings have greatly undermined these earlier coping mechanisms such that livelihoods and environmental health of some parts have been undermined. Loss of biodiversity occasioned by small-scale producers' practices including bush and forest clearing to increase production required to meet developmental goals and targets is widespread. Meanwhile, small-scale producers struggle to meet their subsistence needs as well as produce for the world market economy (e.g. tobacco, fruits and cut flowers). Climate change being experienced by the rest of Africa is also affecting Southern Africa where it has caused an increase in the frequency and intensity of extreme events as well as gradual changes in the rainfall and temperature patterns. Recent interventions that borrow from the traditional coping strategies include indigenous tree domestication to increase sustainability of fruit and other tree based products.

Keywords Traditional coping strategies • Living harmoniously with environment • Frequency and intensity of climatic extreme events • Environmental health deterioration • Indigenous tree domestication • Information capturing and documentation • Indigenous technical knowledge • Indigenous plant resources

Introduction

Many products from agricultural small-scale producers' land holdings in Southern Africa include products such as medicinal products extracted from leaves, tree barks and roots; beehives crafted from tree barks, a range of vegetables, a range of pulses including cowpeas and beans as well as a range of grains and wild fruits. Dry lands are known for their richness of tree species with edible fruits. The tree species with edible fruits increase with mean annual rainfall. Where there is adequate rain,

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fruit production spans the whole year but most abundant production occurs during the rainy season whenever heavy rainfall is received. The fruits provide a significant source of nutrition particularly during the dry season. Poorer households also harvest and sell these wild fruits to derive much needed income. Some studies have revealed that for such households the income from the selling of such fruits is higher than that from animal husbandry or arable agriculture (Van Wyk and Gericke 2000).

The inhabitants of the dry lands in Southern Africa have a rich heritage of ably managing and living harmoniously with their environment utilizing resources wisely stretching these from years of abundance into lean years. Many years of experience and folklore handed down over generations had equipped these people with viable adaptations to the harsh environment. Long traditional survival techniques included livestock rearing, keeping a few cattle and mostly small stock such as goats and sheep. They harvested wildlife, wild fruits and vegetables to augment those they kept and/or cultivated. In many instances, perennial indigenous tree crops perform better than exotic species. Many indigenous fruit species available in the dry lands of Southern Africa are reported to contain higher levels of vitamins and minerals than domesticated species (Shackleton and Clarke 2007). Currently, small stock still predominates while cattle are kept for milk and for sale as well as meeting cultural and traditional ceremonial needs.

However, across Southern Africa, the agricultural small-scale producers' survival techniques have been weakened by introduced medicine, veterinary services and other western lifestyles. While these are viewed as 'development' by many, their impacts on the livelihoods of the dry lands inhabitants is a far cry from 'development'. Increasing populations of people and animals due to introduced health services and veterinary medicine have led to increasing demand for all natural resources including water which far exceeds readily available supply. Numerous projects which tout 'wise use, sustainable management and conservation' have been introduced and implemented in some of the areas. Many water resource development projects have been built to provide more dependable water supplies for man and his livestock, wild animals as well as limited agricultural projects. Additionally, expansive cultivated areas and large ranches owned by commercial farmers depending on groundwater and small earth dams which produce for export particularly in South Africa, Swaziland and to a lesser extent Namibia and Zimbabwe have also been implemented. Yet, the sustainability of some of these undertakings remains questionable as boreholes have dried, earth dams have silted up and residents have been left in limbo when donor funding ended. In many instances, projects which could be termed 'white' elephants are a common feature across Southern Africa.

There has been great deterioration of environmental health of some parts where agricultural activities which symbolize 'development of the rural areas' due to the creation of habitats which have increased hazards and risks facing these small-scale producers. Experience has shown that inappropriate harnessing of water resource has resulted in the emergence of insect borne diseases such as malaria, bilharzias, trypanosomiasis and river blindness. The abundant vegetation that characterises the surrounding areas of dams and other water impoundments provide ideal habitats for the vectors that cause these debilitating diseases. Limiting or even forbidding the

use of bush fires which were used by the herders to control ticks and other unwanted parasites for livestock have created new threats to the pastoralist's livestock. The recent introductions of pesticides (herbicides, insecticides, fungicides) in rural areas have generated a number of threats to the environment just like heavy metals (e.g. arsenic, selenium) resulting from the development of wastes containing these products in rural areas pose contamination threats to crops and livestock. Some soil alterations caused by recycled city wastes, wastes from agro-industries, and local rock phosphates have been noted in some areas used by the small-scale producers.

Other threats to the environment emanate from increased production of staple foods such as cassava which generate cyanide from cassava cyanogens (linamarin, cyanohydrins and hydrogen cyanide). Accumulation of these wastes in the environment leads to pollution of rivers and accumulation in aquatic species such as fish. Linked to cassava processing are the cassava peels which are sometimes used as animal feed but sometimes the peels accumulate to such an extent that they are a menace to the surrounding environment. The peels become more hazardous when they start decomposing as hydrogen cyanide and other gases are released to the atmosphere leading to choking and obnoxious smell. Similarly some locally small-scale processing of agricultural products such as Gossypol from cotton oil set ups and fermentation vinasses from the sugarcane factories is documented to have generated hazards to the environment. Thus there is need to pay greater attention to the impacts of activities grouped together as 'development' in the areas inhabited by small-scale producers.

A worrying realization is that even programs that entail expansion of production of basic agricultural commodities might be accompanied by unsystematic expansion of acreage under cultivation or by the arbitrary application of modern production practices, including fertilizers and other modern amenities without due consideration to recognized standards for health and environmental safety. Much of these were observed and/or recorded in the sugar and citrus industry where local small-scale producers who are somehow linked to international markets are often unaware of safety standards and therefore are forced to compromise on quality with adverse consequences. While generally agriculture reduces the biodiversity of a given land as it alters the habitat of fauna and flora, mono cropping system such as sugar cane growing is particularly bad in this regard. Thus mitigations for introduced activities such as outlay sugar cane growing as part of commercial farms should look into probable threats to the environment including the hazards associated with inputs such as agro-chemicals used to obtain higher yields. Linked to this is the danger of increased severity of biodiversity decline and the ravages of pests and diseases as a result of changing weather patterns and subsequent climate change.

Loss of biodiversity emanates from uniformed agricultural small-scale producers' practices including bush and forest clearing to increase production required to meet developmental goals and targets. These demands for increased outputs are often not linked with necessary education, training and awareness building among the small-scale producers which would give them an understanding of the needs as well as the importance of balancing between the tonnage increase and the ecosystem. The training should include aspects such as raising

environmental awareness; imparting environmental knowledge; (i.e. a basic understanding of how the environment functions, the role people play in the environment and how issues and problems with the environment arise). Changing attitude geared towards helping the agricultural small-scale producers to enhance their sense of responsibility and concern with regards to the environment and to motivate them to act more responsibly to conserve environmental quality is often absent in these expectations. Absent also are skills packaging to enable the small-scale producers appreciate and identify the issues that may impact the environment both positively and negatively.

For example, agricultural small-scale producers should be made aware of agroforestry advantages where legume trees are planted in the fields to improve soil fertility and reduce use of large quantities of inorganic fertilizers that might be leached into the underground water and contaminate the drinking water in the wells. The small-scale growers who would otherwise abandon their old food crop farms to open new fields in the existing forests would be encouraged to maintain their old fields because the soils would be rejuvenated through agroforestry and would remain productive particularly when combined with the use of inorganic fertilizers. As a spin off, the agroforestry trees also would provide fuel wood that would help reduce harvesting trees from natural forests thus curbing land degradation and promoting sustainability in small-scale agriculture (Leakey et al. 2005).

Meanwhile, throughout Southern Africa dry lands, agricultural small-scale producers struggle to meet their subsistence needs as well as produce for the world market economy including materials needed by a wide range of industries located in the developed countries (e.g. tobacco, fruits and cut flowers). For these agricultural small-scale producers, irrigation is not often an option; rather rain fed agriculture is the norm. To ensure success where limited irrigation is practiced, it is desirable that social attitudes be reoriented through education, campaigns and awareness building so that communities are able to appreciate the implications of over utilization of natural resources against ever escalating demands.

Climate change being experienced by the rest of Africa is also affecting Southern Africa where it has caused an increase in the frequency and intensity of extreme events as well as gradual changes in the rainfall and temperature patterns. Southern Africa is faced by a number of weather and climate-related anomalies including cyclones, floods and droughts. The impacts and losses caused by such events are catastrophic due to poor infrastructure and low technology inherent in large parts of the region particularly the dry parts. Many communities among the agricultural small-scale producers are very vulnerable to these climatic vagaries as they possess little capacity to prepare for and recover from such natural calamities. It is also important to relate how climate change related stress interacts with other existing stressing factors to worsen vulnerability. For example how climate change related factors are combining with impacts of existing aridity on agricultural livelihoods and food security.

This scenario requires intervention in building capacity to respond to and plan for these emerging threats in the region. In Mozambique for example, the focus is still largely on disaster management, having suffered immensely from cyclone

events and flooding in recent years. In Malawi the impacts of flooding and droughts on agricultural livelihoods are compounded by widespread deforestation and HIV prevalence, limiting the implementation of existing coping strategies during times of crop failure and food insecurity, such as collecting wild foods and charcoal production. In some of the other countries, communities plagued interchangeably by periodic flooding and droughts have acknowledged a shift in weather patterns over recent decades (for example changes in the timing of the rainy season) that have negatively impacted water availability and agricultural production. For example in Namibia, a largely dry country, recent years have seen floods with increased magnitude to the extent that large numbers of people are displaced and have to be accommodated and fed in relief camps, a new phenomenon in the country; droughts have also become more intense to necessitate countrywide relief food.

Engaging in old traditional survival techniques is among the activities that serve as fall back for agricultural small-scale producers during the harsh times. Activities such as wild fruit collection, rudimentary processing and marketing as well as bush meat and vegetables harvesting support some of these communities during lean times (Campbell and Brigham 1993). Recent interventions that borrow from the traditional coping strategies include indigenous tree domestication to increase sustainability of fruit supply. Exotic fruit trees have also been introduced in some areas to strengthen the food base for these producers who largely depend directly on their natural environment (Akinnifesi et al. 2006). It is common to find both exotic as well as indigenous fruit trees in the areas inhabited by small-scale producers growing naturally or grown in farms and around homesteads. Exotic fruit trees include pawpaw, apple and pear trees, dates, orange, lime and lemon trees as well as kiwi, mango and avocado trees. Indigenous fruit tree species include *Adansonia digitata; Azanza garckeana; Diospyros; Ficus; Uapaca and Ximenia; Vitellaria Paradoxa; Parkia biglobosa; Tamarindus indica, Ziziphus mauritiana and Sclerocarya birrea* (*Amarula tree*).

Amarula fruit from the *amarula* tree (*Sclerocarya birrea*) is widely distributed in the semi-arid areas in Southern Africa including in South Africa, Botswana, Zimbabwe, Namibia, Angola and Mozambique. The tree is also found in other areas outside Southern Africa including Eastern Africa and Sahel countries. Others such as *Uapaca kirkiana* and *Azanza garckeana* are widely distributed in the miombo woodlands and semi-arid areas in Southern Africa. *Amarula* flesh is very rich in Vitamin C as well while the kernel is rich in oil similar to olive oil (+50 % oil); it is used as food during drought periods, sundried fruit, processed into jams, juices and jelly. *Amarula* is also used to produce alcoholic beverages (liqueur and cider) among which the *amarula* cream from South Africa is the most famous. Baobab fruit (*Adansonia digitata*) has many uses including making juices which are rich in Vitamin C and B-complex plus other minerals. Communities living along the Zambezi valley depend on indigenous fruits to supplement their diets even during times outside droughts and famine periods (about 42 % of natural food basket) and in South Africa indigenous fruits are consumed and processed into juices, jams, drinks and liqueur (e.g. *amarula* cream which trades internationally).

Traditionally, agricultural small-scale producers across Southern Africa often retained and protected indigenous fruit trees in their fields; abundant evidence exists

in most Southern Africa countries including Zimbabwe, Malawi, Zambia, Mozambique, South Africa and Namibia. Historically, rural folks relied on wild vegetables and wild fruit collection for food particularly for local beer brewing. Therefore up to the present time, apart from serving as a fall back source of food during hard times, some of these fruits and nuts remain important cash crops. Fruits and nuts contribute towards improving social and economic benefits to the livelihoods of small-scale producers in the rural areas as food, health care and income generation. In some places these trees are used to determine where to site a homestead while many households plant these trees within their homesteads or within the arable fields or along field boundaries. Fruit trees within homesteads or in the arable fields often record higher yields than those growing wild in the woodlands probably due to less competition or due to fertilizers and manure applied to the crop fields or due to manure and watering taking place within the homesteads.

It is common knowledge that trees have very positive impact on water conservation as they increase infiltration and ground water recharge. Clustered trees that form forests and woodlands are also carbon dioxide sinks which lowers the rate of global warming and thus climate change whose impacts are negatively affecting the Southern Africa region. The future and sustainability of fruit trees as a source of food security and environmental conservation lies in research looking into conservation and/or domestication of the indigenous fruit trees. Concerted efforts towards indigenous tree domestication started way back in 1986 when the International Center for Research on Agroforestry (ICRAF) now the World Agroforestry Center embarked on efforts to domesticate some of the indigenous fruit tree species. The indigenous tree domestication started as a participatory venture involving the local communities as a farmer-driven and market-led process. Fruit tree domestication has now become a very popular internationally supported initiative geared towards commercialization of indigenous fruit tree products throughout Southern Africa. The species included in the domestication process include *Uapaca Kirkiana, Stryschnos Cocculoides, Parinari Curatellifolia, Sclerrocarya Birrea, Vangueria infausta, zizfus mauritiana, Adansonia digitata, Syzigium cordatum and Vitex* species.

Domestication of indigenous fruit trees embraces a participatory approach which supplements the more traditional aspects of tree improvements. It is seen as an important strategy towards achieving the millennium development goals (MDGs) of eradicating poverty and hunger, promoting social equity and environmental sustainability. Tree domestication is aimed at promoting the cultivation of indigenous trees with economic potential as new cash crops. Improved productivity and quality of the products through value addition to indigenous fruits ensures markets and higher incomes which go a long way towards reinforcing food security and reducing poverty among small-scale producer communities.

Results indicate that the species with long maturity periods can be domesticated through various vegetative propagation methods and thus increase productivity to improve diets, nutrition and raise the living standards of the small-scale producers. Domestication of indigenous trees uses two approaches: forestry and horticulture-based approaches. The forestry approach is disadvantaged by the fact that it takes a substantially long period to come up with the most viable cultivar in long-lived

perennial species. The horticulture approach on the other hand captures superior genetic variants through vegetative (asexual) propagation. It is documented as being faster than the forestry approach.

Several challenges face this initiative the main one being that large chunks of land fall under the communal land tenure system. Indigenous trees growing in these lands are treated as open access goods available to anyone. Everybody has access and has the right to harvest yet no one is accountable to the management of the trees. Other challenges that threaten the sustainability of indigenous fruit trees products is low demand and lack of reliable markets for indigenous fruits either due to historical factors where such fruits were not accorded high values like exotic fruits or because locally the fruits were a common good and their availability and significance were taken for granted. The nutritional value was not known and the colonial masters undervalued and looked down on the fruits as inferior more out of ignorance than scientific data. Under such conditions, the local people did not see the necessity of caring for the trees and sometimes the need to plant new trees until ICRAF and other research organizations embarked on initiatives of awareness building and value addition as well as scoping for markets for the products.

More challenges arise from the bulkiness and perishableness of the ripe fruits made worse by lack of suitable skills on packaging and preservation methods and the short period within which these fruits are available as well as the low demand by local markets. Lack of reliable transportation system to distant markets predominantly in urban centers further disadvantages the distribution of these products. While products such as locally produced alcoholic and non-alcoholic drinks; liqueurs, traditional beer and wines, jams, juices, concentrates, confectionaries are slowly but increasingly entering the local and international commercial markets, they are facing stiff competition from more preferred imported exotic products.

Individual Country Undertakings

Besides fruit tree domestication by the World Agroforestry Center, individual countries in Southern Africa are also making efforts directed towards conservation of indigenous tree and other plant resources as well as in promoting the use and value addition to these indigenous resources.

Namibia

Namibia, a large country (823,680 km^2) with a coastline 1,440 km long, is located on the west coast of the Southern Africa sub-continent (Fig. 3.1). Namibia is a dry country with very limited water resources; its climate is second in aridity to that of the Sahara. The rainfall is variable, unpredictable and unreliable; it varies between 20 mm along the west coast to more than 850 mm in the extreme northeast.

The rainfall occurs mainly during summer months for most parts of the country, the south-western part receiving winter rainfall. Summer rain is subject to very high evaporation rates; the average evaporation rate for the country being 2,500 mm in the northwest and 3,700 mm in the southeast (Msangi 2008).

Namibia's climate is highly variable and difficult to understand. It is a direct interplay of various factors including its relative location on the south-western part of the Africa continent, spanning a zone between 17° and 29° south of the equator. Thus Namibia is exposed to air movements driven by three major climatic systems. The Inter-tropical Convergence Zone (ITCZ) feeds in moisture laden air from the north while the Sub-tropical High Pressure System positioned across the country pushes the moist air back with dry cold air. The effect of this system is more pronounced than that of the ITCZ so that Namibia is characterized by dry hot weather for most of the year. The Temperate System to the south of the country with predominantly moisture laden westerly winds which carry a succession of low pressure systems and cold fronts from west to east feeding bursts of cold air from the Antarctic sweep across Southern Africa during southern hemisphere winter. It brings some moisture to the south-western part of Namibia. These three systems move south and northwards in response to the overhead sun (Fig. 4.1).

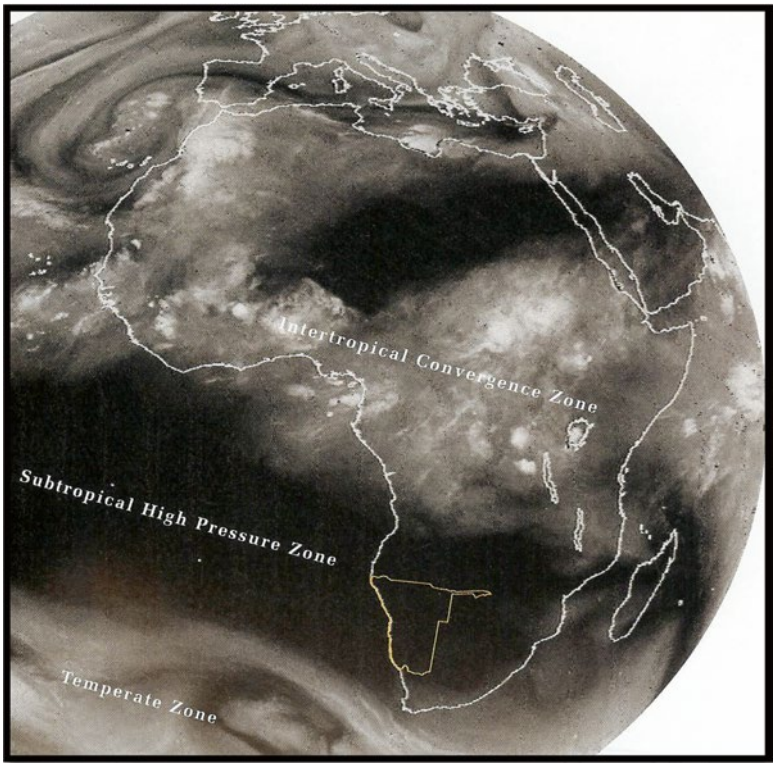

Fig. 4.1 Major climatic systems affecting Namibia

Other factors influencing the climate in Namibia include the cold Benguela current flowing from South Atlantic Ocean and the Drakensberg range mountains that span the south-eastern coast of the continent. The cold Benguela current cools the easterly flowing air stream from below occasioning fog formation along the coast extending to about 100 km inland. No clouds form and therefore most years pass without rain in this part of the country. The mountain range along the south-eastern coast of Southern Africa force moist airstreams to rise, condense and drop most of the moisture on its eastern side descending as dry air on the mountains' western side reaching Namibia as dry airstreams; thus the presence of the Kalahari desert on the eastern part of Namibia.

Although known to be hot and dry for most of the year, Namibia's climate is highly variable. Temperatures and rainfall vary greatly over space and time, variability being compounded by the shifts in the relative position of the three major climatic systems. Temperatures are usually very high for most part of the year (in the mid and upper 30 °C reaching 40–44 °C in the northern and southern part of the country as well as over the Namib desert only cooling off during the short winter period. Winds blow strongly for most part of the year being strongest along the coast where dry hot sand-laden winds fill up hand dug wells and compounding difficulties and risks facing agricultural small-scale producer communities dependent on natural resources exploitation for their livelihood.

Only 2 % of Namibia's land receives sufficient rainfall to grow crops. As all inland rivers are seasonal, irrigation is only possible in the valleys of the Border Rivers (Orange, Kunene and Okavango) as well as at man-made dams (Hardap and Naute dams). Forty-one percent of the land is under communal tenure while 44 % is under commercial farms. The rest is pure desert which does not support any form of agriculture. Although Namibian agriculture, (excluding fishing) contributed between 5 % and 6 % of Namibia's GDP from 2004 to 2009, a large percentage of the Namibian population depends on agricultural activities for their livelihood, mostly small-scale subsistence farming (Lwasa et al. 2013). Subsistence farming is mainly confined to Namibia's "communal lands". In the communal lands of the north, roaming cattle herds and small stock are prevalent pearl millet, sorghum, corn, pulses and peanuts are grown to supplement diets and incomes. The southern communal lands are predominantly used for subsistence rearing of small stock such as goats and sheep. For the agricultural small-scale producers, small stock rearing forms the back bone of their day to day survival and hence their food security greatly depends on this as well as on their indigenous technical knowledge on the utilization of indigenous plant resources (Bennett 2005).

In Namibia research and case studies have been initiated by the Research and Training Directorate of the Ministry of Agriculture, Water and Forestry in attempting to realize the goal of conserving indigenous trees and other plant resources as well as in promoting the use and value addition to these indigenous resources. Namibia's initial step comprised capturing and documenting information from the communities on the type and use made of indigenous plant resources to be followed by research on viable methods in value addition, storage and marketing of the products other than those identified by the communities. The purpose of the initial case

study was to identify and gauge the role that indigenous plant resources play in enhancing food security of the agricultural small-scale producers in Namibia. This case study titled "The role of indigenous plant resources in fortifying food security and rural livelihoods in Namibia" by Ipinge SNA, Shiningavamwe KL & Shindume FN as edited and updated by Msangi, JP is presented here below.

Introductory Observations

Namibia is endowed with a variety of indigenous plant resources (IPRs) which play significant roles in alleviating poverty and form reliable supplementary food source especially during lean times such as during droughts. Equally, these IPRs also serve as a source of small income for many agricultural small-scale producers. Fruits and other IPRs derived products are traded at both informal and formal markets. Since time immemorial, rural communities in Namibia have been using these IPRs as sources of nutritious food and medicine for people and their animals. These IPRs are also a source of income and inputs into their cultural practices and ceremonies. Over the years, communities have accumulated a considerable sound indigenous technical knowledge and understanding on the utilization of these IPRs. With the move to process and manufacture natural products based commodities such as perfume and liqueur, opportunities have been created for agricultural small-scale producers to take advantage of and improve their livelihoods from these resources.

In quest to diversify livelihoods of the rural population, the government of Namibia resolved to explore the inherent potential of indigenous plant resources in poverty alleviation and income generation. Consequently the Directorate of Agricultural Research and Training in the Ministry of Agriculture, Water and Forestry was tasked with the responsibility of conducting the initial field survey to document indigenous technical knowledge and usage of indigenous plant resources as well as the role they play in day to day life of the agricultural small-scale producers in the country. A task team (Indigenous Plant Task Team-IPTT) was constituted to survey and document the roles of IPRs in stabilizing food security and suggest ways of optimizing their utilization through appropriate value addition and marketing. The team developed and administered a questionnaire survey in 11 of the 13 political regions during 2010/2011 season seeking to look into ways of promoting sustainable use of indigenous plants for a greater household food security, agricultural diversification, income generation, employment and diversification of livelihood opportunities as well as agro-industry development. The questionnaire survey was designed to capture and document all the information still available among the rural people and subsequently fill in any identified gaps and suggest recommendations on the way forward. Prior to administering the questionnaire, the task team consulted relevant literature on the subject particularly that pertaining to biological resources utilization and their conservation.

Furthermore, recognizing that one cannot talk about value of indigenous plant resources in human terms without falling back to what people know and how they utilize these resources and that indigenous technical knowledge in Namibia is

largely derived through oral traditions passed on down generations, it became imperative that there is a possibility of losing some information during the relay process. Thus, on this basis, the government established broad based Stakeholders Working Groups and Task Teams including Indigenous Plant Task Team (IPTT); Hoodia Working Group (HWG) and Devil's Claw Working Group (DCWG and tasked them develop a coordinated approach and strategy for the implementation of an economically sustainable utilization and promotion of indigenous plant based products in Namibia.

The Indigenous Plants Task Team (IPTT), a multi-stakeholder team, was tasked with developing a coordinated approach that would promote strategies for the documentation of indigenous plant resources. The task team was also tasked with coming up with implementation strategies that would contribute towards economically sustainable promotion and utilization of indigenous plant resources for greater household food security, agricultural diversification, income generation, employment and livelihood opportunities creation as well as agro-industrial development. The task team came up with priorities and activities that would promote the commercial use of indigenous plant resources while respecting indigenous technical knowledge. IPRs are considered as an important aspect in the lives of the small-scale producers in rural Namibia. A considerable number of Namibian women and youth groups and co-operatives derive their livelihoods from indigenous plants and plant products. Examples of these groups include Eudafano Women Co-operative (EWC); King Nehale Community Resource Trust (KNCRT); Tulongeni Twa Hangana (TTH); Topnaar Foundation; Omaheke San Trust and many others.

Literature Review

The United Nations Convention on Biological Diversity (CBD) recognizes the "close and traditional dependence of many indigenous and local communities embodying traditional lifestyles on biological resources". Further, the convention requires that national governments, subject to their national legislations, "respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biodiversity". The CBD further recommends that national governments recognize and involve the holders of such knowledge, innovations and practices while formulating use and conservation of biological resources; it encourages equitable sharing of benefits arising from the utilization of such knowledge, innovations and practices" (CBD 1992).

Since time immemorial, people on all continents have utilized indigenous plants for a variety of reasons (Bosze 2000). Balick and Cox (1996) argue that many plant derived drugs used in modern medicine today were originally discovered through indigenous technical knowledge systems. Good examples include the quinine tablets used in the treatment of malaria; a celebrated medical breakthrough sourced from the bark of the indigenous Cinchona tree (*Cinchona pubescens*) which the

Peruvian Indians have used to treat fevers for many centuries and the Malagasy rosy periwinkle used for the treatment of childhood leukemia. There is enough documented evidence from all continents to indicate that the use of plants for varieties of reasons including medicinal purposes has been practiced since the days when man settled on planet earth. (http://jrscience.wcp.muohio.edu/FiledCourse00/PapersCostaRicaArticles/MedicinalPlant).

Like in many other countries in the world, indigenous plant resources play a crucial role in the social fabric of both rural and urban small-scale economies in Namibia. The importance of indigenous plant resources' availability for gift giving and social interaction is surmountable as IPRs are intricately intertwined in the agricultural small-scale producers' everyday lives. This is consistent with some authors who argue that the knowledge base acquired by the indigenous and local people over many hundreds of years was through direct contact with their environment. Such knowledge includes an intimate and detailed knowledge of plants, animals and natural phenomena, the development and use of appropriate technologies for hunting, fishing, trapping, agriculture and forestry coupled with a holistic knowledge or a world view which parallels the scientific discipline of ecology (Inglis 1993, p. VI).

Sustainable development depends on successfully addressing the twin challenges of poverty and environmental degradation. It is an approach to productive reorganization that encompasses the combined experiences of all relevant stakeholders and all sectors in any given country (http://www.ifad.org/events/wssd/e/). The opportunities rural small-scale producers can derive from IPRs are many and varied. With the world trend of moving towards the use of natural products from IPRs, there are wide opportunities these producers can take advantages of to generate additional income. In this connection, the IPRs serve as a source of employment or basis for business opportunities that take advantage of local and international markets. Increasingly, fruit species are traded at both informal and formal markets (Lusepani-Kamwi 2003, p. 22).

Different stakeholders and institutions are playing an important role in developing and encouraging sustainable use of the indigenous plants and their products. This is done through the back-up of the concept of sustainable development and optimization of the use of IPRs as well as promoting their access to market and business opportunities. Similar to some wild animal species, rural people possess hereditary cognitive tendencies towards the medicinal value of wild plant species. It has been documented that wildlife has a tendency to seek out bitter plant parts in response to illness (Van Wyk et al (1997).

Undoubtedly, IPRs play an important role in the social fabric of the Namibia's economy. While the importance of indigenous plant resources availability for cultural ceremonies such as wedding gifts and other social interactions cannot be assigned a monetary value and therefore could be said to be intangible, it is far from being insignificant. Some researchers have argued that the knowledge base acquired by the indigenous and local people over many hundreds of years was through direct contact with the environment. Such knowledge includes an intimate and detailed knowledge of plants, animals and natural phenomena, the development and use of

appropriate technologies for hunting, fishing, trapping, agriculture, forestry and holistic knowledge which parallels the scientific discipline of ecology. It is also argued that a number of harvesters and collectors continue to rely on indigenous plant resources for their livelihoods, either as source of food, income and/or employment opportunities. There is also documented evidence of indigenous technical knowledge on the use of those resources, although many a time it is not widely circulated (Christian 1999; Inglis 1993).

Data Collection and Analysis

In May 2010, the Directorate of Agricultural Research and Training was tasked with the responsibility of designing and carrying out an investigation into the utilization of indigenous plant resources by the local inhabitants throughout Namibia. Subsequently, the directorate designed and distributed a standard questionnaire to 11 of the country's 13 political regions. The designed questionnaire was used to gauge, determine and document the utilization of different types of indigenous plant resources. During August 2011, the questionnaires were distributed and administered by Extension and Agricultural Research officials as follows: 30 in Caprivi; 10 in Erongo; 20 in Hardap; 40 in Kavango; 20 in Kunene; 20 in Ohangwena; 20 in Omaheke; 30 in Omusati; 20 in Oshana; 20 in Oshikoto; and 20 in Otjozondjupa regions.

The questionnaires were administered by both agricultural research and extension technicians to a total of 250 key informants. For ease of administration, some of the questionnaires were translated into local languages. Upon completion, questionnaires were sent back to MAWF headquarters for coding and analysis. Collected data were coded and analyzed using Excel 2010 version. Additionally, group discussions and field observations were conducted to augment information collected using the questionnaires. Such information has a significant impact not only on resource exploitation by local communities but also on future policy interventions such as plant and tree domestication. The information was incorporated into the final survey report.

Findings from the Field Survey

The questionnaire survey covered more than thirty eight (38) indigenous plant resources. This survey documented the practices and usage of indigenous plant resources by different communities in Namibia. The survey revealed that the plant resources were used for medicinal purposes, for food to meet daily sustenance and for income generation. Bearing in mind that indigenous technical knowledge is derived largely from oral traditions passed down generations; the team understands the fact that indeed some useful information may have been lost along the way

particularly due to changing practices influenced by the adoption of modern practices and foreign products by the younger generations. The outcome from this case study presents and discusses some of the Namibian indigenous plant resources that have been used traditionally by Namibian rural inhabitants over centuries. Some of these indigenous plant resources are still being used by some members of the communities surveyed. The report documents and discusses the species in the context of their economic importance and usage.

The field survey revealed that nineteen (19) species are used for food and ten (10) for medicinal purposes for both human and livestock while eleven (11) are used as fodder and five (5) as hair food. Out of the 38 plant resources, only six (6) were used for making household utensils, dyes, fiber, clothes and ornaments and/or for the construction of storage utilities. A very significant find among these include the fact that *marula* oil which is traditionally extracted forms a stable lipid currently receiving extensive interest from researchers and development practitioners as well as cosmetic sectors. The study found out that constant use of some of the products from indigenous plant resources has led to the cultivation and eventually domestication of some of the plant species including a variety of palm trees, bird plum trees, wild medlar, jackel berries, *kigelia* and *strychnos* species found scattered in cultivated land tracts.

For ease of reference, the indigenous plant resources captured by this field survey are presented here below in alphabetical order of their scientific names.

Acacia karoo

Common Name: *Omutjuula*
Family: *Fabaceae*

Traditionally, women use the thorns of this tree to pierce their ears. The tree produces edible gums that are used as food. The bark and leaves are a remedy for diarrhea and dysentery. Although this plant resource is not on IPTT's priority pipeline list, it has cultural significance for many communities.

Acanthosycios horridus

Common Name: !*Nara*
Family: *Cucurbitaceae*

!Nara is a leafless, thorny melon-bearing bush that grows in the Namib Desert. It is an endemic cucurbit to the Namib and the plant forms an important component of the dune ecosystem, providing shelter and food to many different animals and bringing moisture to the surface via its deep roots. The *!Nara* is regarded as a valuable resource to the Topnaar Community which live in the lower Khuiseb valley in the Namib Desert (Henschel et al. 2004). This community collects and uses

the flesh of the fruit for food while the fruit's seeds are extracted and sold to commercial companies. The *!Nara* fruit has high nutritional value and the sale of its seeds generates much needed cash which contributes significantly to the livelihood of the Topnaar. The seeds contain oil with high-unsaturated fatty acids and protein while the roots are known to have medicinal properties; they are used to treat diarrhea, high blood pressure and diabetes.

Adansonia digitata

Common Name: Baobab tree (*Omikwa*)
Family: *Bombacaceae*

In Namibia, baobab trees are found mostly in Omusati Region especially near Outapi and Onesi towns. During wars *Omikwa* were used as hiding bases for warring factions; these trees are perceived to have spiritual value especially to Oshimbalantu speakers of the Oshiwambo dialect. The fruits on these trees contain white edible pulp known as *omakwa*. The residents of the Outapi and the Onesi constituencies, traditionally process baobab pulp into high quality powder which is fed to children as a milk substitute while the seed is processed into high quality oil. The fruit pulp has been used to treat fevers, diarrhea, while the bark is also used in the treatment of urinary disorders and diarrhea in humans.

Albizia adianthifora

Common Name: Omutundungu
Family: *Fabaceae*

This resource is mainly used for carving grain mortars "iini" (singular: oshini) where pearl millet, sorghum and other grains are pounded into flour. The leaves and barks of this resource are also used for medicinal purposes including de-worming both animals and human beings.

Albizia anthementica

Common Name: *Omupopo*
Family: *Fabaceae*

This resource is mainly used for carving house hold utensils such as *iitenga* (singular: *oshitenga*) used for drinking *omalovu* and *omatenga* (singular: *etenga*) and serves as a milking bowl. Its leaves and barks are also used for the treatment of internal parasites for both human and animals. It is also used as a remedy for pollen allergic reactions.

Aloe Species

Common Names: *Aloe* spp., *Omandombo*
Family: *Asphodelaceae*

The leaves and roots of most of these species are boiled in water and sieved to produce concoctions used as laxatives for humans, cough medicine chickens, dressing for wounds, constipation remedies and for the removal of retained placenta. Concoctions from the leaves are used for treating eye ailments as well as for the treatment of bruises, burns and wounds. The flowers of some species are used as a vegetable (*ekundu*).

Berchemia discolor

Common Name: Bird plum tree, *Omiye*
Family: *Rhamnaceaea*

Bird plum tree produce delicious fruits called *oombe*, which are eaten fresh or dry. These fruits are known for making excellent quality local gin known as *ombike,* an alcoholic drink produced by distilling dried fermented fruits. Usually processed for sale, this drink can be produced from a mixture of different fruits or from one type depending on the quality of the fruits at the farmers' disposal. Important *ombike* or *olambika* sale points are Onhimbu near Outapi in Omusati Region, *Omatala* (open market) in Oshakati and Ondangwa in Oshana, Eenhana in Ohangwena Region and Onathinge South sometimes referred to as *"Onathinge yoombike" or "Onathinge yayandje ontoye"*. Dry fruits are also pounded to produce delicious cakes called *oshindangulila*. Root barks are traditionally used as dyes for clothing and basket making fronds harvested from *makalani* palm trees. Other products that are obtained from this fruit tree include building poles, knob *kerries*, black shoe polish and jam.

Boscia albitrunca

Common Names: Shepherd tree, *omunkuzi*
Family: *Capparaceae*

Widely distributed, the shepherd tree is a protected species in Namibia. Most of the tree parts are used for varying purposes; examples include: leaves which are very nutritious and are used as animal fodder while the roots are used to preserve milk. Unripe fruits are used to treat epilepsy, while ripe fruits are eaten as a snack. In times of food deficits, ripe fruits are used by lactating mothers to stimulate continuous milk production; in sickness they are used to revitalize peoples' poor health.

Citrullus lanatus

Common Names: Kalahari melon seeds; *Manketti* fruits, *Oontanga*
Family: *Cucurbitaceae*

Manketti fruits have long been part of the staple diet of many Southern Africa communities inhabiting the dry lands. In Namibia, *Citrullus lanatus* is a wild melon that is perceived to be the progenitor of all improved water melons. It grows as an agricultural weed in Oshikoto, Oshana, Omusati, Omaheke, Kunene and Ohangwena regions. In the first four regions, seeds of *Citrullus lanatus* are traditionally used as oil rich drought resistance food crop from which traditional moisturizing oil is processed. Kalahari melon seeds contain rich clear yellow oil which is used as food and as body lotion. The oil is believed to have regenerating properties. Traditionally, women extract the seeds, dry them and then pound them into flour. The flour is subsequently put into a pot to which water is added and then boiled. After filtering the oil, the remains are molded into cakes which are eaten by people and also used as animal feed (mostly pigs and dogs). Generally, the seeds are roasted and eaten as food particularly during food shortages. It is said that this source of food has saved a large number of people during famines.

Commercial productions of the oil were first started by two Ondangwa business women in 1992 and are now operating as a registered company under the name Oontanga Oil Producers CC. The women began by producing the oil using a traditional method that constituted boiling the seeds as explained above. However after some years of experimenting, they are now using large extraction machines that have made it possible to increase production and expand their distribution centers which include overseas markets. Currently, there are many players in the processing of this IPR. Locally, the oil is used for massaging especially in relieving leg problems.

Colophospermum mopane

Common Names: *Mopane tree, Omusati*
Family: *Fabaceae*

Mopane trees are an important indigenous plant resource whose versatility is matched by a few other plant resources. *Mopane* tree has special cultural and religious significance among the Otjiherero and Oshiwambo speaking population. It is a tree of choice; its firewood has few equals. Among the Otjiherero speakers, only *mopane* tree wood is used for making a sacred fire as well as for teeth removing ceremonies. Among the Oshiwambo speakers *mopane* tree is used to make pestles for both threshing and pounding pearl millet, their staple food. The leaves are nutritious, they have high protein content and are used as livestock feed, especially goats.

There is now some interest for their aromatic properties. The *mopane* tree is host of the *mopane worm*, an important local source of protein and a delicious delicacy known as *uutushi*.

Combretum Species

Common Names: Leadwood, *Omumborombonga, omukuku*
Family: *Combretaceae*

Trees in this group are protected species in Namibia and therefore one can be prosecuted if caught cutting it without a permit. Three species were identified; important among them is known as *Omumborombonga* (Otjiherero) or *Omukuku* (Oshiwambo). The *Omumborombonga/Omukuku* has special cultural and religious significance for the two main language groups in Namibia. Historical folklore has it that it is at this tree that the Otjiherero and their Oshiwambo cousins parted ways at *Omumborombonga/omukuku*. Reasons for parting ways are sketchy and not clear. One of the species, Leadwood is exceptionally hard, heavy, strong and durable. It is an important source of firewood and for grain mortars. Poles from these species are used for fencing.

Croton gratissimus

Common Names: Lavender croton
Family: *Euphorbiaceae*

Lavender croton is a very good source of essential oils. A USA based Pharmaceutical Company called Shaman produced croton-based remedy for diarrhea in 1999 and there is some scientific evidence to suggest that croton species have some potential for more products. The survey results indicate that croton tree is used to treat animals suffering from black quarter, pneumonia and/or coughing.

Cucumis metuliferus

Common Names: African horned cucumber, *Omanyoshwa*
Family: *Cucurbitaceae*

A traditional food plant in many parts of Africa, this fruit has potential to improve nutrition, boost food security and foster rural development. It is an essential source of water during the dry season in the Kalahari Desert. It grows naturally in the fields and also in the bush. Sometimes it is left to rot in the fields for the next rainy season's seeds/plants. It is primarily used as a fruit-snack, salad. It is eaten at any

stage of its growth either young or fully matured. The skin is very rich in vitamin C and fiber. A small amount of salt or sugar can increase the flavor especially when eaten raw.

Dalium engleranum

Common Names: Kalahari pod berry, *nonsimba, thimba*

Kalahari pod berry is a popular snack in the Kavango region; rural people derive their livelihood from the sale of the fruits during the fruiting season.

Diospyros lyciodes

Common Names: *Oshimumu, oshiyugulu*
Family: *Ebenaceae*

This resource is traditionally used as toothpaste; there are also some potential for industrial applications in the manufacturing of dyes, ointments and cosmetics.

Diospyros mespiliformis

Common Names: Jackal berry tree*, Oomwandi*
Family*: Ebenaceae*

Jackal berry trees produce fruits called *oonyandi*. These fruits are eaten fresh or dried and serve as supplementary food during the fruiting season and beyond. Several carved products can also be made from knife handles to different traditional utensils such as traditional drinking cups (*iitenga*). Fruits are made into alcoholic drink called *ombike* while the bark is used for the treatment of several sexually transmitted diseases.

Grewia Species

Common Names: Grewias, *oshishegele* (plural: *iishegele*), *omishe*
Family: *Tiliaceae*

Grewia spp. produce very tasty fruits called *ooshe* that can be eaten fresh or dried. Fruits can also be used for liquor making especially *ombike*. Branches are used for making walking sticks and knob *keries*. The survey results revealed that this IPR is also used to treat high blood pressure.

Guibourtia coleosperma

Common Names: False *mopane* copal wood, *nonsivi*
Family: *Fabaceae*

False *mopane* copal woods are common in the Kavango West and Kavango East and the Zambezi Regions. They produce edible seeds, traditional *nonsivi* are cooked with cabbage.

Harpagophytum procumbens and Harpagophytum zeyheri

Common Names: Devil's claw, *Omakakata, makakata*
Family: *Pedaliaceeae*

Devil's claw is a perennial plant that is found in the semi-arid areas of Southern Africa mainly in Namibia, Botswana and South Africa. A fully-grown plant has a taproot which can grow up to two meters underground with several tubers growing laterally from it. The tubers contain active ingredient with anti-inflammatory and analgesic effects that have been used by the inhabitants of Southern Africa for centuries in treating a wide range of ailments for both human beings as well as animals. The field survey revealed that Devil's claw is used to treat an array of diseases such malaria, weakness in animals, coughing in both humans and animals, lung sickness, wounds in animals, *anaplasmosis* in livestock, gall-bladder infections and high blood pressure in humans. It is also used for treating other illnesses such as Arthritis, fibrosis and Rheumatism. A mixture of roots and barks treats infertility. Roots alleviate and relieve heavy and painful menstrual periods. The plant is proving to be useful for treating various other ailments. Scientific medical evidence obtained through clinical research and testing has confirmed the indigenous knowledge on the potency of this plant. This has resulted in an increased demand for devil's claw as a medical plant in many parts of the world.

Devil's claw is a protected plant in Namibia where the harvesting policy states that Devil's claw may only be harvested in March and October of each year and that a permit issued by the Ministry of Environment and Tourism is needed for harvesting and trading in Devil's claw.

Currently Namibia is the world's largest producer of Devil's claw. It is recognized that Devil's claw is a valuable resource for Namibia with high potential of generating significant income for both harvesters and traders. To ensure that harvesting of and trade in Devil's claw is conducted in a sustainable manner for the benefit of future generations, it is imperative that local communities are empowered to take control over the resources. The Devil's Claw Working Group (DCWG) set up by the Ministry of Environment and Tourism is mandated with the responsibility of coordinating research, harvesting and exporting of Devil's claw in Namibia and to facilitate information flow. A regional Devil's Claw Working Group was established at the beginning of 2002 with the aim of strengthening regional cooperation with regards to Devil's claw resource management, marketing, research and

legislation. In Namibia, IPTT is supporting a sustainable harvesting method as well as a propagation and cultivation programme.

Hoodia Species

Common Name: Hoodia
Family: *Apocynaceae*

The *Hoodia* plants are part of the succulent flora of Southern Africa which is a minor source of food and moisture to a range of wild species in arid eco-systems. Namibia is considered to be a centre of diversity for the eleven *taxa* that are found here. The plants are very attractive and are used for horticultural purposes. *Hoodia* species are perennial, slow growing and form multiple above ground stem clusters which provide shelter or breeding sites for small animals. The genus is recognized as having appetite suppressant properties that indigenous people (including the San of Namibia) have been using for centuries during hunting.

Hoodia species include *Hoodia currori,* which is eaten as fresh food as well for appetite suppression. The traditional usage include among others: the treatment of indigestion, hypertension, diabetes, and stomach ache. Survey results revealed that some of the *Hoodia* species are used for the treatment of stomach pain. *Hoodia gordonii,* a leafless spiny succulent plant grows naturally in South Africa and Namibia. *It is* eaten as fresh food, as an appetite suppressant by animal herders and hunters. It is also used ironically as appetite stimulant. It treats abdominal pain, as well as peptic ulcer. *Hoodia officinalis* has been used for the treatment of pulmonary tuberculosis, and *Hoodia flava* is eaten as food as well. It is used for both appetite and thirst suppressant (Hargreaves and Turner 2002).

In recent years there has been a noticeable increased demand for Hoodia plant material as a result of public awareness campaign on its potential. A Hoodia Working Group was established to oversee the promotion and conservation of *hoodia*. The working group comprises members from the Ministry of Environment and Tourism which serves as the chairman, the Ministry of Agriculture, Water and Forestry, Ministry of Education, CRIAA SADC, the Working Group of Indigenous Minorities in Southern Africa (WIMSA) and the University of Namibia (UNAM). In addition, IPPT is supporting *hoodia* cultivation programme in partnership with stakeholders. Furthermore, a grower association called Hoodia Growers Association of Namibia (HOGRAN) has been established to represent and articulate the interest of the growers.

Hyphaene petersiana

Common Names: *Makalani* palm, *Omilunga*
Family: *Arecacea*

Makalani palm is one of the valuable, versatile natural plant resources in the rural areas of Namibia. *Makalani* palm produce leaves that are used for basketry, hats and mats making and the fruits *oondunga* are edible and used for making liquor

called *ombike*. Palm oil wine is also tapped from the male trees although this practice is not taken kindly to by the traditional authorities in different communities rightly so because of the negative impact this practice has on the affected trees. Other products that can be made from this resource include jam and jewelry from the kernels, which are sold to tourists. This resource plays an important role in ritual ceremonies, fencing, thatching and for rope making. The survey results revealed that the stem peels and roots are used to treat infertility as well as for bringing good luck especially for those who want promotion at work.

Indigenous Leafy Vegetables

The leaves of many different plants are widely used with *Cleome gynandra* and *Amaranthus* species being the most harvested and nurtured. These indigenous vegetables are known to contain essential minerals and vitamins A and C, iron and protein higher than known commercial vegetables. These resources can be made into dry cakes called *omakaka* and are sold in markets of major towns (Kolberg 2003).

Kigelia african

Common Name: Sausage tree
Family: *Bignoniaceae*

The sausage tree, found mostly in the Kavango West, Kavango East and Zambezi Regions is valued for its sausage-like fruits which are highly valued for their tasty flavors. It has a long traditional history as a treatment for skin disorders. The results from this survey revealed that the bark (stem peels) is used for the treatment of women who have difficulties to give birth; snake bites; dysentery and for bringing good luck (steam bath). The dried fruits are powdered and used as a dressing for sores, ulcers and curing syphilis. The dry fruit is also used as bath sponge; it is known to have anti-bacterial properties.

Loeschea leubnitzae

Common Names: Bitter bush, ***Peschuel***, *Oshizimba* (plural *iizimba*).
Family: *Asteraceae*

This plant is used for making granaries for storing *Omahangu*, some locals believe that grain weevils do not attack the *Omahangu* stored in the granaries made from the bitter bush. The plant is used as a cough remedy and also to treat poultry for a variety of poultry ailments. Although several pharmaceuticals have expressed intention to extract essential oils from the plant, so far no major work has been carried out.

Ochna pulchra

Common names: *Parinari Curatellifolia plum; Makopa*
Family: *Chrysobalanaceae* (mobola family/coco **plum** family)

Parinari Curatellifolia plum belongs to the *p. curatellifolia* species. It is a traditional food plant whose fruit has potential to improve nutrition, boost food security, foster rural development and support sustainable land care (National Research Council 2008). The wood is said to be very hard and difficult to work but it makes good charcoal which is sold for cash. The main value of the tree is the delicious fruit, which can be harvested over 3 or more months. It is rich in Vitamin C, it is used as a snack and the kernel has high oil content. The crushed pulp of the fruit is an ingredient in alcoholic drinks because it ferments well. The seed oil has protective qualities for the hair and skin. *Ochna pulchra* are very common in Kavango, Omaheke and Caprivi regions and they yield very good oil, in Kavango the oil is produced using traditional extraction methods.

Ricinus communis

Common Names: Castor Oil Plants, *Oomono*
Family: *Euphorbiaceae*

By definition castor oil plant is a naturalized exotic crop which is treated as one of the underutilized orphan crops. Castor oil is distinguished from other vegetable oils by its high acetyl/hydroxyl value and its high specific gravity, high viscosity and high solubility. Castor oil is a well-known purgative medicine, disliked by children due its taste. In some communities seeds are used to counter food poisoning, however taken in larger quantities, castor beans are extremely toxic; however, the toxicant is not present in the oil. A mixture of crushed leaves and root portions are widely applied to wounds, sores and boils. Castor oil is used in pharmaceutical industry, in the manufacturing of paints, plastics and special lubricants.

Schinziophyton rautanenii

Common Names: *Manketti nut, Mongongo nut, omunkete*.
Family: *Euphorbiaceae*

Mongongo belongs to the monotypic genus *Schinziophyton. Mongongo* is an important indigenous resource especially in the Oshikoto, Kavango West and Kavango East regions. The results from this survey revealed that the resource is used to treat infertility in humans. The egg-shaped, velvety fruits contain a thin layer of edible flesh around a thick, hard, pitted shell. Inside this shell is a highly nutritious nut. *Mongongo* nuts are a staple diet in some areas, most notably amongst the San of northern Namibia. They are very popular because of the flavor and also

because they can be kept for a long time. Traditionally, dry fruits are first steamed to soften the skins and after peeling, the fruits are then cooked in water until the flesh separates from the hard inner nuts. The pulp is eaten, and the nuts are saved to be roasted later. Sometimes, the nuts are collected from elephant dung as the hard nut survives the digestive process. During roasting of the nuts, direct contact with the fire is avoided, using sand to distribute the heat evenly. Once dry, the outer shell is cracked revealing the nut, encased within a soft, inner shell. The nuts are either eaten straight, or pounded as ingredients in other dishes.

The oil from the nuts is also traditionally used as a body rub in the dry winter months, to clean and moisten the skin. The oil is used for cooking in the Kavango Region. The oil is a potential candidate for both food and cosmetics products. This resource has also attracted some international pharmaceutical interest. However its market is still not yet confirmed, a cosmetic formulator is yet to be identified. The wood, being both strong and light, makes excellent fishing floats, toys, insulating material and drawing boards. More recently, it has been used to make dart-boards and packing cases.

Sclerocarya birrea

Common Names: *Marula tree, omigongo*
Family: *Anacardiaceae*

The *marula* tree is regarded as one of the most important and multi-purpose indigenous plant resource in Namibia. Its leaves and fruit provide fodder for animals, while the fruits known as *oongongo* are a source of Vitamin C and pectin; it is used to make oil and oil cake, jam and favourite juice drink called *oshinwa* and a much loved alcoholic drink called *omagongo*. The nuts are good source of protein; they yield stable and nutritious oil. The fruit shells are excellent animal feed, while the trees are also a good source of edible worms that are again source of protein. The leaves bark and roots of the *marula* tree are used for various medicinal products which treat among others infertility in humans, cough, ear aches and eye infections. The *marula* oil is an additive to many cosmetics products. Additionally, the products that are derived from *marula* tree have cultural values among the people who live in Oshana, Omusati, Oshikoto and Ohangwena regions.

Strychnos spinosa

Common Names: *strychnos trees, Omiguni, maguni*

Spiny Monkey-orange/Green Monkey Orange tree (English), Doringklapper (Afrikaans)
Family: *Loganiaceae*

Strychnos spinosa is an indigenous tree known as *maguni* found in the Ohangwena, Kavango West, Kavango East and Zambezi Regions. It produces juicy,

sweet–sour, yellow fruits, containing numerous hard brown seeds. The fruits are very popular with humans as well as wild animals including monkeys, pigs and a number of browsers. The fruit from these trees has potential to improve nutrition, boost food security, foster rural development and support sustainable land care. The fruits are eaten fresh, cooked or used for the production of alcoholic drinks. An entrepreneur has started a business venture, which produces a *maguni* liqueur. The wood can be used for general carpentry. Timber from this tree is also used to produce implement handles, fighting sticks and hut poles. It is also used ornament carving. Local people in these regions derive some livelihood during the fruiting season by gathering and selling the fruits along the road side to passing motorists.

Terminalia sericea

Common Names: Silver cluster-leaf, *silver terminalia*, *Vaalboom*, *Omigolo, Muwolo*
Family: *Combretaceae*

The silver cluster-leaf grows in open mixed woodland on sandy soils. It is often found growing with other trees species such as *mopane, acacia* and bush willows. The timber of the silver cluster-leaf is hard-grained and is resistant to attack by wood-boring insects and termites. As such it is used in building construction particularly granaries and to make tool handles, furniture and fencing posts. It is used for firewood and the making hoe handles and for making charcoal. The bark is been used to make ropes and is also pounded to produce a substance for waterproofing boats. In traditional medicine, both leaves and roots are used as a remedy for stomach ailments and a concoction of the roots for treating bilharzias, diarrhea and pneumonia. The bark is used to treat diabetes and to dress wounds. This survey result also revealed that a concoction of the leaves and roots are used to treat coughs.

Tylosema esculenta

Common Names: *marama bean, ombanui, gemsbok* bean
Family: *Fabaceae*

The *marama* bean is an underutilized leguminous oilseed plant native to the Kalahari Desert and neighboring sandy regions of Botswana, Namibia, South Africa and Angola. It also grows well in Mozambique and Zambia. In Namibia, *Marama* bean is reported to have great potential as a cash crop in the communities where it grows. Unfortunately harvesting practice of this legume in the wild is very extensive and random harvesting by local people is threatening some genotypes with extinction in where it grows well. Some wild animals feed on the foliage as well the seeds. The potential of this resource is more pronounced among the KhoiSan, Setswana and Otjiherero speaking populations of Ohangwena region where indigenous technical knowledge system on its utilization exists. The *marama* bean forms part of the

diet of the indigenous population. The plant has a large edible tuber and has pods containing oil and protein rich seeds with a nutritional value similar to soybean. In the regions where the survey was carried out, m*arama* beans are roasted and eaten as a snack while young roots are used as vegetable.

Despite the importance of this indigenous plant resource, *marama* bean remains one of Namibia's "orphaned crops" that is crying out for research that will promote and popularize it's domestication. Its cultivation has successfully been experimented in Australia, Israel, Kenya, South Africa and the United States especially in the State of Texas. Recently research towards its domestication has been carried out in Namibia (Takundwa et al. 2012). Research carried out elsewhere has shown that *marama* beans have protein content of up to 29–39 % and the oil content is 24–48 %. The protein content is comparable to that of soybeans while the oil content is twice that of soybeans; its oil is rich in mono- and/or di-unsaturated fatty acids and contains no cholesterol. *Marama* bean is reputed to be a good source of micronutrients such as calcium, iron, zinc, phosphate, magnesium, and B vitamins including foliate. It is also reported to be a potential source of phytonutrients including phenolic compounds which have been shown in other foods to contribute towards the prevention of non-communicable diseases such as cardiovascular diseases, diabetes, and some cancers. The *marama* bean plant has been shown recently to portray anti-bacterial and anti-retroviral properties and since Retroviruses (RV's) are a major source of diarrhea in infants, the plant is traditionally used as a treatment against diarrhea (Chingwaru et al. 2011).

Vangueria infausta

Common Names: Wild medlar trees, *Iimbu* (*plural: oombu*)
Family: *Rubiaceae*

This shrub or small tree occurs in abundance in woodlands, scrub, valleys, stony hills or sandy dunes throughout much of Southern including Namibia. It is a traditional food plant producing fruits known locally as *oombu* which have the potential to improve nutrition, boost food security, foster rural development and support sustainable land care. The fruit are consumed raw or the pulp may be dried and stored for later use, while the seeds may be roasted. *Ombike*, an alcoholic drink is produced using ripe fruits. Goats and game browse on the leaves and other wild animals eat the fruit in the tree or after they are shed on the ground. Branches are used to make arrows. Information gathered from this survey revealed that this resource is used to treat pains in human as well as for traditional rituals.

Ximenia caffra

Common Names: Sour plum trees, *grootsuurpruim, Iipeke*
Family: *Olacaceae*

Reviewed literature show that the tree is found in woodlands and grasslands and on rocky outcrops and sometimes on termites mounds. Ripe fruits are eaten by birds while the leaves are eaten by wild animals. Ripe fruit has a vitamin C content of 27 %, is high in potassium and contains protein. The seed has 65 % oil content. Fruits have a refreshing sour taste, best eaten when slightly overripe, but can also be used for making jams, jelly and syrups. They can be added to porridge. Oil from the seed is used to soften human skin and for softening animal hides due to its anti-inflammatory and emollient properties when applied to the skin. It is also used for lighting lamps. An extracted concentrate from the leaves is used to soothe inflamed eyes. Infusions of the roots are used as a remedy for dysentery and diarrhea and together with the leaves are taken for abdominal pain and bilharzias. Powdered roots are used to dress wounds; and added to soups and beer as an aphrodisiac. Powdered dried leaves are taken orally for fever and infertility, and extracts of the leaves are used as a gargle for tonsillitis. Porridge made using a decoction of the roots is eaten for nausea in pregnancy; the root decoction is also taken for infertility and to treat toothache and constipation.

In Namibia, the oil from the fruit of the sour plum tree is highly valued and used locally by women for hair treatment. Local companies involved in producing and selling the oil include Omalindi African Life Style CC and Pewa Cosmetics while other entrepreneurs such as Tulongeni Twa Hangana Co-operative with a membership of over 800, is actively involved in the collection and harvesting of this resource. Furthermore, the results from this survey revealed that the root barks are used for the treatment of eye sickness in goats and in treating sexually transmitted diseases in both humans and livestock. Some scientific evidence suggests that ximenynic acid has some anti-aging effects.

Ziziphus mucronata

Common Names: Buffalo thorn trees, *Omukekete* (*plural: eenghekete*)*, oosheshete*
Family: *Rhamnaceae*

The Buffalo Thorn is a small to medium sized tree that occurs in many habitats mostly open woodlands, often on soils deposited by rivers, and grows frequently on termite mounds. The tree produces fruits which ripen into a deep red color. In Namibia, the fruits are locally called *oosheshete* which are used for the production of an alcoholic drink called *ombike*. The root, bark and leaves are used widely to treat dysentery, coughs and as a painkiller; a solution of the bark and leaves in water is used for chest pains. The leaves are edible, and can be cooked into a tasty vegetable while the fruits are also very nutritional, though not very tasty. The leaves can be used as an aphrodisiac, either by being chewed or used in dishes. The nuts surrounded by the pulp can be roasted and ground as a substitute for coffee.

Discussion, Conclusions and Recommendations

With the world trend of moving towards the use of natural products from indigenous plant resources, there is a wide range of opportunities that small-scale producers in rural areas can take advantages of to improve their diets and to generate additional income. While not all the plant resources documented by this survey are wholly indigenous to Namibia, the rural communities in the country have worked out means and techniques of utilizing these resources beneficially to enrich their livelihoods. The findings from the field survey confirm the many opportunities available to rural communities in Namibia in enhancing food security through putting to use various plant resources in their disposal.

The survey laid bare the fact that indigenous plant resources are used by many communities in the small-scale producers sector to meet their health care needs and/or other religious and cultural practices. The survey revealed that out of 38 plant resources recorded, nineteen (19) species are used for food; ten (10) species are used mainly for medicinal purposes for both humans and livestock, eleven (11) species are used for fodder while five (5) are used as hair food and six (6) are used for construction purposes. This study has created a bench mark towards the documentation of the indigenous technical knowledge existing in Namibia which if well preserved will be available to future generations. The study has also reveled that the full potential of many indigenous plant resources has not yet been fully explored and some of the resources remain as "orphan crops". Initial findings of research carried out in Namibia and elsewhere indicate that there is very high potential for some plant resources such as *marula* tree, *marama* bean and the devil's claw.

Namibia is credited for being the first country in Southern African region to establish an indigenous plants dedicated task team. It is worth noting that the research and development initiatives of the Ministry of Agriculture, Water and Forestry and her development partners in championing the cause of the indigenous plant resources, are beginning to pay dividends. Awareness on the importance of indigenous plant resources created as a result of these initiatives has attracted interest from a variety of stakeholders both locally and from international community. While it is true that significant public and private funds have been invested in the development and promotion of the indigenous plants sector over the years, there has been a positive spillover effect to rural livelihoods countrywide. To ensure sustainability in the management of these valuable resources for the benefit of current and future generations, it is essential that prudent management continue to be accorded top priority by all stakeholders.

Namibia has unique bio-diversity, particularly in the plant kingdom. Some of this diversity is already utilized through traditional use of plants for an array of purposes including food medicine, decoration, clothes and cosmetic industries. Indigenous plant resources continue to play a central role in the livelihoods of small-producers communities living in the rural areas of the country. Efforts to promote commercial use of such plant resources should yield much more success if they are to take full cognizance of indigenous technical knowledge systems. Improvements and strengthening of

this knowledge through research, appropriate scientific technologies and continued injection of funds to the sector should lead to the development of business opportunities that would stimulate growth in the localities, increase sales and promote relevant markets for end products. It is encouraging to note that more development agents are now paying attention to indigenous technical knowledge which is recognised as a catalyst for sustainable development.

The past few years have seen an increased amount of effort to upgrade and promote the use of Namibia's abundant bio-diversity which has culminated into a number of projects supporting the commercial exploitation of indigenous plants. This study has documented and confirmed the wider value of these commodities as contributors to households needs and to the rural economy in general. In the long run, the national and local economies can greatly benefit from indigenous technical knowledge systems through their contribution to tourism through sales of natural products to visitors to the country. It is hoped that the results from this survey will add to the body of knowledge on indigenous plant resources in Namibia but will assist in highlighting the value of the resources to peoples' livelihoods and sustenance.

The utilization of indigenous plant resources can only be successfully exploited for the benefit of its inhabitants if the existing indigenous technical knowledge is strengthened by scientific research and continuous documentation. More research is required on the full commercial value of some of these resources. Regrettably, many of the indigenous plants are harvested and/or collected from the wild which pose high threat to sustainability that could end in extinction of some species. It is therefore recommended that a domestication program be formulated and implemented for targeted species that have high economic, medicinal and cultural significance such as the *marama* bean, Devil's Claw, and the *marula* trees. The harvesting of all indigenous plant resources with economic and traditional significance such as *ximenia, strychnos*, palm trees, bird plum trees and *manketti* nut trees should be strictly controlled and their conservation enforced to curb over-harvesting and eventual extinction.

References

Akinnifesi FK et al (2006) Towards the development of Miombo fruit trees as commercial tree crops in Southern Africa. Forests Trees Livelihoods 16: 103–121. AB Academic Publishers, Great Britain. http://www.icuc.iwmi.or/files/news/akinnifesi.pdf

Balick MJ, Cox PA (1996) Plants, people and culture: the science of ethnobotany. Scientific America, New York

Bennett B (2005) The economic importance of indigenous plants in Namibia: a rapid assessment. Issues in agricultural marketing, discussion paper no. 22

Bosze S (2000) Medicinal plants in rainforest: effects on biodiversity and indigenous peoples. Tropical Ecosystems of Costa Rica

Campbell B, Brigham T (1993) Paper prepared for the FAO expert consultation on non-wood forest products (Anglophone Africa)

Chingwaru W, Majinda RT, Yeboah SO, Jackson JC, Kapewangolo PT, Kandawa-Schulz M, Cencic A (2011) *Tylosema esculentum* (Marama) tuber and bean extracts. Evid Based Complement Altern Med, 11pp, Article ID 284795. http://dx.doi.org/10.1155/2011/284795

Christian I (1999) Exploratory case studies on socio- economic benefits derived from trees in North Central Namibia farming systems. PhD dissertation. University of Joensuu, Finland

Hargreaves BJ, Turner Q (2002) Uses and misuses of Hoodia. Asklepios 86:11–16

Henschel J, Dausab R, Moser P, Pallet J (eds) (2004) !Nara fruits for development of the !Khuiseb Topnaar, Namibia. Scientific Society Windhoek, Windhoek

http://www.ifad.org/events/wssd/e/

Inglis JT (ed) (1993) Traditional ecological knowledge: concepts and cases. International Programme on Traditional Ecological knowledge and International Research Centre, Ottawa

Kolberg HH (2003). Conservation and evaluation of genetic resources of indigenous leafy vegetables. In: Proceedings of the 2nd national indigenous fruit workshop, 8–9 May 2003, Tsumeb

Leakey RRB et al (2005) Agroforestry tree products (AFTPs): targeting poverty reduction and enhanced livelihoods. Int J Agric Sust 3(1):1–23

Lusepani-Kamwi E (2003) Domestication and genetic improvement of some selected indigenous fruit frees. In: Proceedings of the 2nd national indigenous fruit workshop, 8–9 May 2003, Tsumeb

Lwasa S, Wahab B, Mugagga F, Simon D, Fragkias M (2013) The role of urban and peri-urban agriculture in enhancing food security and climate change resilience in East and West African cities. Final project report for 2013 START grants for global change in Africa. START 2013

Msangi JP (2008) Alleviation of risks and vulnerability facing isolated communities through conservation and management of bio-diversity: the lower Kuiseb river basin, Namibia. In: Watkins MM (ed) World poverty issues. Nova Science Publishers, New York

National Research Council (2008) Gingerbread plums. In: Lost crops of Africa: volume III: fruits. National Academies Press, Washington, DC

Shackleton CM, Clarke JM (2007) Research management of Miombo Woodlands. Paper prepared for the World Bank. Melrose Arch, Johannesburg, South Africa

Takundwa M, Chimwamurombe PM, Cullis CA (2012) A chromosome count in marama bean (*Tylosema esculentum*) by Feulgen Staining using garden pea (*Pisum sativum* L.) as a standard. Res J Biol 2(6):168–196

UN (1992) Convention on biological diversity, Rio-de Janeiro

Van Wyk BE, Gericke N (2000) People's plants. A guide to useful plants of Southern Africa. Briza Publications, Pretoria

Van Wyk B-E, Van Oudtshoorn B, Gericke N (1997) Medicinal plants of South Africa. Briza Publications, Pretoria

Chapter 5
Role of Small-Stock in Safeguarding Food Security in Dry Lands: Case in Namibia

Abstract Agricultural small-scale producers in communal areas found mainly in the northern and southern parts of Namibia keep small stock as a means to attain food security and wade off widespread poverty as many residents perceive poverty as having no livestock, land and water. Dependence on small-stock dates back over 1,000 years during when nomadic pastoralists shifted their settlements seasonally in search of water and grazing. Currently, small-stock farming is one of the four major farming systems dominantly practiced in the rugged lowlands of western parts of the country ideal for goat farming and in the rolling plains of southern Namibia ideal for extensive sheep grazing. The eastern part of the country is dominated by cattle ranching while an integrated farming system is practiced in northern communal lands where roaming cattle herds, goats and to a lesser extent sheep are prevalent. Indigenous breeds with valuable genetic properties that contribute to high fertility and resistance to disease survive well in all communal lands. Goats and sheep contribute substantially to household food security because they provide food and are easy to convert into quick cash required in meeting immediate household needs; they can also be bartered for household commodities. Small stock, mainly goats form part of government's resettlement schemes initiated to mitigate poverty and secure food security among previously landless now settled as agricultural small-scale producers.

Keywords Communal lands • Farming systems • Integrated farming system • Small stock and food security • Poverty and poverty mitigation • Small stock indigenous breeds • Resettlement schemes • Skills training and extension services • Indigenous vulnerable groups • Back to school and stay at school campaign

Introduction

There are three broad categories of land tenure in Namibia. Approximately 44 % of the country is allocated to the so-called "commercial" farmland with freehold tenure, 41 % is allocated to communal areas, and the remaining 15 % is state land including conservation areas. The communal areas are situated mainly in the north and south of the country, while the commercial (freehold) areas occupy most of the centre and part of the south parts of the country (Mendelsohn and el Obeid 2002;

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Schneiderat 2011). Apart from the small north-eastern strip, the country's climate is described as dry. However, micro-climatic conditions exist and are highly variable. Generally, large seasonal variations are experienced where summers are very hot and wet and winters are cold and dry. High temperatures are experienced for most part of the year particularly during summer during when most of the annual rainfall is received. A small part of the country in the very south-west of the country receives winter rainfall associated with frontal systems. The annual potential evapotranspiration exceeds annual precipitation by ratios of up to 30:1 (not counting the desert areas); hence aridity is a common feature throughout most of the country. These conditions greatly narrow the choices of viable economic activities that can be undertaken to mitigate poverty and back up food security of the agricultural small-scale producers inhabiting 41 % of the country i.e. communal areas. An activity that has shown great potential is rearing small stock such as goats and sheep.

Namibia Poverty Defined

Namibia is reputed to have the most unequal income distribution in the world. Its Gini Coefficient of 0.63 in 2003/2004 placed it right at the top of a selection of 30 countries (Werner and Odendaal 2010). This scenario is partly an outcome of the apartheid regime policies before Namibia's independence in 1990 which restricted access to land and economic resources to the majority of citizens and partly due to Namibia's traditional reliance on resources that are difficult to extract such as marine fish and minerals/precious stones including diamonds, gold and uranium which means that production is highly technical and/or capital intensive rather than labor intensive.

Prior to independence in 1990 and soon after, people who were landless or who were not in formal employment or engaged in non-agricultural activities were categorized as poor (The National Land Policy, Republic of Namibia, National Planning Commission 2006a, b). The National Planning Commission (NPC) put forward a narrower definition of poverty which put an upper limit of poverty at N$262.45 per month per capita (i.e. N$3,149 per person or N$15,747 per household of 5 people). Thus using this definition, technically the average Namibian household of slightly more than 5 people earning less than N$15,747 per annum is defined as poor. According to this definition of poverty, the review categorized 27.6 % of all Namibians to be poor and 13.8 % as severely poor. Most poor households were found in rural rather than urban areas. Just over 38 % of rural households were poor and 19 % of those were severely poor. The corresponding figures for urban areas were 12 % and 6 %.

To assess the peoples' perception on poverty, the government initiated a program of participatory poverty assessment in all regions of the country from 2004 to 2006. Responses from the assessment revealed that people in the rural areas see poverty as lack of well-being which they defined by the ownership of assets such as livestock and formal employment as well as having access to sufficient land and water for

both humans and livestock. The survey among farm workers revealed that they considered their lives as being similar to that of flies: constantly hungry and moving from one place to another in search of food until they fall down and die in the milk. This comparison describes the vulnerability emanating from the high mobility of farm workers who are always on the lookout for work seeking better living conditions. Not having a house or place of their own to which they can retreat when they lose their employment exacerbates their vulnerability to poverty. Lack of resources or having limited access to resources for subsistence farming with livestock or gardening was seen as central to poverty. Thus for many people, access to land, water and livestock is a fundamental ingredient of well-being (Werner and Odendaal 2010).

The peoples' perception on poverty is also reflected in national policies and political rhetoric where land reform features very strongly as a fundamental ingredient in tackling poverty issues. The National Land Policy requires the government to ensure that the poor are settled on productive land where they can productively participate in economic activities. The Namibian Cabinet was reported to have stated that without achieving a breakthrough in the land reform program, the fight against poverty would not succeed. NDP2 (2001–2005) which was intended to concretize the Poverty Reduction Strategy did not feature very strongly the land reform strategy. However, although improved access to land through land reform did not feature in detail in NDP2, it was mentioned that land would be provided to poor landless families. The issue did not feature either in the third 5-year development plan (NDP3) which was released in 2008. The overarching strategies of NDP3 to eradicate extreme hunger and poverty included strengthening and diversifying the agricultural base of poor rural communities by encouraging diversification and improving agricultural production to make sure that beneficiaries of land redistribution contribute to developing the country's economy. Therefore there was a deliberate shift from just land provision to landless people; emphasis was placed on making land available to those who have the means and skills to manage the land productively.

Although the emphasis had shifted to the ability of the beneficiaries to farm productively, provision was made for resettlement programs of a social welfare type which offered appropriate support services to accommodate people who lack assets and/or farming skills. In this respect, the government initiated two settlement schemes to provide land to the landless which were aimed at reducing poverty among the landless and assist them contribute towards the development of the country's economy and towards alleviating poverty and food insecurity, the government acquired previously large scale farms and allocated them to the landless people. The basic concept underlying the approach was that beneficiaries were to engage in small-scale small stock rearing and small-scale dry-land crop farming for own consumption. There was a clear distinction between economic land redistribution and land-based "welfare" programs. Initially when the government settled needy people it accorded them support to enable them establish themselves in their new resettled farms. However during the late 1990s and early 2000s the emphasis was placed on allocating land to self supporting beneficiaries probably

due to inability of the government to meet spiraling costs of resettling and supporting all the beneficiaries on monthly basis which was instituted during the initial resettlements in the early 1990s.

Small-Stock Farming in Namibia

Historically, small-stock has been farmed in southern and north-western Namibia for at least 1,000 years during when nomadic pastoralists shifted their settlements seasonally in search of water and grazing. Currently, small-stock farming is one of the four major farming systems practiced in Namibia (RAISON 2006). Small-stock farming is dominantly practiced in southern and western Namibia in a semi-arid area lying between true desert to the west (Namib Desert) and savanna woodlands to the east and north. This farming system covers about 33 % of Namibia, and extends over most of Hardap, Karas, much of Erongo, south-western Kunene, and small parts of southern Khomas and Omaheke). Small-stock farmed in Namibia includes Damara sheep, various indigenous breeds of goats, Boer goats and Blackhead Persian sheep (Mendelsohn 2006). About 60 % of all Namibian goats belong to indigenous breeds, variously called North-western, North-central, Caprivi or Kavango breeds. Many of these goats have valuable genetic properties that contribute to high fertility and resistance to disease. In Namibia, goats are kept and survive well in all communal lands.

Poverty stricken indigenous small stock farmers inhabiting communal land in southern Namibia own small herds of goats, sheep and few cattle (Lowrens 2004). Goats predominate in the communal farming districts while Dorper sheep make up the highest percentages of livestock on freehold farms. Some wealthier part-time farmers also farm the communal lands of southern Namibia but unlike the indigenous poor farmers, they own hundreds of animals creating a great deal of competition for grazing around established water points after good rains. These wealthier farmers move their animals to distant grazing areas where they use vehicles to cart water for their animals. Thus the herds of the poor farmers suffer and losses are common due to lack of grazing, water and diseases. Also involved in small-stock farming are well off freehold farmers who employ indigenous people as farm workers on temporary terms or as casual laborers who perform manual work in what are normally large farms (Werner and Odendaal 2010).

Southern Namibia, dominated by rolling plains intercepted by long sand dunes and linear inter-dune valleys is ideal for extensive sheep grazing. Bursts of palatable grasses become available shortly after sporadic rainfall storms but lasts for short periods before wilting and dying under the scorching sun characteristic of these semi-arid areas. Success in farming in these areas heavily depends on water availability in boreholes and water pools and wells dug in the dry sandy river beds.

Several breeds of mutton sheep and cross-breeds or hybrids currently farmed in Namibia include Dorper, Damara, Van Rooy and Blackhead Persian. Dorper breed which was specifically developed for farming in arid areas forms the backbone of

the country's mutton industry. While Dorpers produce valuable meat, they require more water and high quality food and are more vulnerable to parasites than other breeds. Dorpers do not flock well and are therefore not suitable for unfenced communal farmlands. On the other hand, Damara sheep which are indigenous to Namibia are hardy and well adapted to conditions of limited water and food supply. Damara sheep has tasty meat, good resistance to parasites, and are known for their varied diet with up to 64 % of its food consisting of browse (similar to goats and higher than other sheep that eat more grass). Damara ewes also take exceptional care of their lambs. The breed is well suited to communal areas because it requires relatively little care. Like the Damara sheep, Van Rooy sheep which originated from South Africa are hardy, resistant to diseases and have unlimited mating season as well as good maternal care. They are thus suited to the dry conditions prevalent in the communal lands in the southern part of the country (ARD 2008).

Two other breeds of sheep which survive well in the dry lands of Namibia include the Karakul and the Blackhead Persian sheep which probably originated from Somaliland and Arabia. The Blackhead Persian sheep are small, have lower needs for food and water, and have greater heat tolerance and higher fertility than most other breeds. They may breed in any season, and have high resistance against disease and parasites. However, this breed is not very popular with formal market consumers due to its fatty meat. The Karakul found on scattered freehold farms in Hardap and Karas Regions perform well under arid conditions, provide wool suited for carpets and good mutton which unfortunately is also too fatty for the formal market. Compared to other breeds, Karakul production is usually less risky because they require less maintenance and have high levels of resistance to parasites. During very dry periods, the ewes survive because their lambs are slaughtered for pelts. These sheep are easy to manage because they gather in flocks.

The rugged lowlands of western parts of the country are ideal for goat farming due to the presence of ephemeral river valleys lined with perennial riverside forests along ephemeral rivers and open woodlands and shrubs. Here browse and fallen pods support large herds of goats and to a lesser extent sheep. North-western part of the country, goats are kept alongside cattle by indigenous tribes inhabiting the dry lands along Kunene River and associated highlands bordering Angola. These people in this part of the country in Kunene district have an advantage over those in the southern parts of the country because they own more goats and cattle which they take to the better watered mountainous parts bordering Angola during prolonged dry spells and during droughts. In the Angolan highlands and valleys, they find ample grazing and browse for their livestock (Fig. 5.1).

Goats are known to be largely browsers although sometimes they may consume grass because goats more than any other domestic animals are very opportunistic. Studies carried out in different parts of the world including in Namibia have demonstrated that goats prefer browse and do survive on forage produced by woody plants rather than on herbaceous plants. When they consume herbaceous plants they prefer herbs, bulbs, weeds and other ephemeral plants including woody plants known to invade overgrazed savanna rangelands (Rothauge et al. 2003, 2004). During dry

Fig. 5.1 Goats at Ruakana communal area, April 2007

seasons, goats survive by consuming tree pods that fall onto the ground and those on low branches (Figs. 5.2 and 5.3).

Therefore goats do not present serious competition to sheep and cattle who are grazers; they can actually survive on degraded rangeland where few other domesticated livestock can survive. Goats are thus suited to the sparsely vegetated arid lands of southern and northwestern Namibia and to some extent the semi-arid rangelands in the eastern part of the country. It is documented that in Namibia, there are very high incidences of range deterioration through bush encroachment which has rendered rangelands more suitable for browsing animals such as goats. It is also documented that people living in communal areas in southern Namibia (Karas Region) prefer that any development projects that would be initiated in their areas include goat production including training on good practices that would lead to increasing heard size (Lowrens 2004).

The majority of goats in Namibia are of indigenous breeds which form part of small-scale integrated farming systems where they are kept alongside cattle and sheep. They are used for myriad of purposes including milk production, meat and a host of cultural practices. Smaller percentages of Boer goats, Angora and dairy goats are also found in the country. Boer goats, indigenous to Africa are hardy, highly productive (they have high percentages of twins), have high resistance to external parasites and have lean tender meat that has low cholesterol content (Rothauge et al. 2003). Their only disadvantage is that Boer goat kids are vulnerable

Fig. 5.2 Pods popular food for goats during dry season Elim, Northern Namibia

Fig. 5.3 Low tree branches laden with nutritious pods Ogongo, Northern Namibia

to lice and ticks and have low resistance to several diseases. They thus require constant care with good veterinary services and highly hygienic housing conditions. They do not fare very well in communal areas where different breed of animals (such as donkeys, sheep, goats and cattle) are kept together in one kraal. While there is low demand for goat meat in Namibia, South Africa offers a lucrative market for live goats mostly in KwaZulu-Natal and the Eastern Cape (Werner and Odendaal 2010).

The eastern part of the country bordering Botswana popularly known as "cattle country" or officially as Omaheke Region is predominantly a savannah environment in which *Terminalia combretum* and *Acacia* savannahs are the dominant types of vegetation. Forest and woodland savannahs of the northern Kalahari, camel thorn savannahs of the central Kalahari and mixed shrub vegetation of the southern Kalahari are the region's dominant vegetation zones. Omaheke Region as a whole has low suitability for crop cultivation and extensive cattle ranching predominates; it has some of the best grazing areas in the country. In some parts of the region sheep and goats are farmed on a small-scale mostly for own consumption; small surpluses are sold privately. Small herds of goats and to smaller scale sheep are kept alongside cattle which are the main livestock in the region.

In the northern communal lands an integrated farming system is practiced where roaming cattle herds, goats and to a lesser extent sheep are prevalent. The main crops that form part of this integrated farming include pearl millet, sorghum, corn, and a variety of pulses such as beans and cowpeas. In these communal lands grazing land is shared and unlike in the south and eastern parts of the country where commercial land is fenced off, unfenced communal land tenure is the norm. No fencing is allowed legally except around the home and crop fields. Sheep and goats are herded during the cropping season in cropping areas, and where there are predator or theft risks in other areas, but herding tends to be relaxed during the dry season during when animals have access to crop residues. Pigs and poultry kept by few inhabitants of these communal lands are free-ranging and scavenging, although some owners practice housing and feeding (Isaacson 1995).

The northern communal areas of Namibia are home to more than 60 % of the Namibia's population, majority of who depend on both livestock and crop farming for their daily sustenance. In 2006, 1 % of all sheep and 38 % of all goats were found in the northern communal areas compared to 9 % of all sheep and 27 % of all goats which were found in the southern communal areas. During this time, cattle formed the majority of all livestock found in the northern communal areas which totaled 44 % compared to just 17 % in the southern communal areas (Werner and Odendaal 2010).

In the northern communal areas, there is no room for spatial expansion of livestock numbers because livestock densities are already very high and the resource base on which livestock depends is poor and declining. Currently the livestock largely depend on grazing annual grasses as there is no supplemental feeding making livestock production highly risky. Below-average rainfall years are fraught with high probability of a crash in livestock numbers as was experienced in the 1980s and early 1990s (Kruger and Werner 2007). The scenario was repeated

during 2012/2013 rainfall year because like the early 1980s and 1990s Namibia experienced severe drought conditions and livestock owners suffered colossal losses particularly cattle in the northern communal areas.

Between mid-1990s and the whole of 2000s livestock numbers increased substantially in the northern communal areas so that in 2006, more than 45 % of the total cattle herd in the country was held in the six regions of the northern communal areas. This overstocking and associated range degradation foretells large scale livestock losses and associated social impacts. Even though cattle are kept in different cattle-posts to minimize risks associated with drought and disease, the cattle numbers far exceeds land carrying capacity. There is therefore great need to make efforts to change the perceptions and attitudes of the inhabitants of these communal lands so that the inhabitants can realize the commercial value of livestock and to pro-actively market excess livestock when animal condition is still good and prices are high. The majority of cattle are kept in the cattle-post areas but some milk cows are brought back to the homesteads at the start of the rainy season and as grazing become available. With an increase in population density and the subsequent increased demand for crop fields, less grazing area is now available around homesteads so that animals stay for shorter periods of time. In most cases only limited management of livestock takes place, animals roam freely seeking the best grazing possible. They wonder back home to kraals on their free will. Sometimes the owners go out to guide the animals to watering points and to later round them up and guide them home at the end of the day. In these parts of the country, livestock are seen as an effective "savings bank." Goats rather than cattle are largely sold when the need for disposable cash arises.

Small-Stock and Food Security

On a broader scale, goats farming is reported to be the best choice for attaining food security for agricultural small-scale producers in developing countries due to the fact that goats have low investment, they are easy to manage, they have wide adaptability, high fertility and high fecundity as well as high feed conversion efficiency, quick pay-off and low risk (Mutenje et al. 2008). Small stock (mainly goats and sheep) play an important role in the livelihoods and food security for the agricultural small-scale producers in both southern and northern Namibia. In Namibia, goats and sheep contribute substantially to household food security by providing income, quality meat and milk as well as manure. Goats and sheep are valuable assets for a majority of rural households because they are easy to convert into quick cash required in meeting immediate household needs; they can also be bartered for household commodities. They are often referred to as "walking bank" or "bank on the hoof" to be called upon in times of need, stress or hardship because they are central to people's livelihoods, food security and nutrition. The high survival rates common to goats make them a means of risk mitigation during crop failures; goats

are used as property security, monetary saving and investment in addition to many other socio-economic, religious and cultural functions (Peacock 2005).

Both goats and sheep have short gestation interval and high frequency of multiple births which allow rapid increases in animal numbers which build financial capital. Goats and sheep contribute directly and indirectly to food security as they contribute directly to the sustainability of crop farming by providing manure for the integrated farming system practiced by some small-scale producers in the communal areas thus increasing soil fertility. Goats and sheep are an important means of empowering vulnerable households including those affected by HIV/AIDS, those which are female-headed and those which are perceived as poor because they play a significant role in the nutrition and in smoothening income fluctuations for these vulnerable groups (Mutenje et al. 2008).

Despite the central role that goats play in strengthening food security in the communal areas of southern and northern Namibia, several constraints face goat farming including diseases outbreaks as a result of congestion and poor hygienic housing conditions consisting of poorly constructed open kraals where all animals are housed together throughout the year. In the northern communal areas, these kraals are cleaned at long intervals of up to over 4 years. This results in outbreak of diseases during wet seasons leading to large losses of goat kids (Isaacson 1995). High mortality rates have been recorded among the exotic Boer goats due to poor management and small-scale producers' inability to fulfill the conditions required for such breeds. Furthermore, overstocking and severe overgrazing especially during winter when natural pasture is reduced to zero results in insufficient feeding because many small-scale producers cannot afford supplementary feeds due to costs involved, thus starvation and high losses. High transport costs and long distances to veterinary service centers compel the small-scale producers to resort to treating their goats and other animals using indigenous herbs and traditional medicines which do not seem to be effective on the Boer goats. Inadequate water sources and long distances to lakes, dams or boreholes have forced some of these producers to water their animals with polluted water from wells which cause diseases and complications to the Boer goats (Molefe 1985). Therefore indigenous breeds should be given higher preference over the more productive introduced breed.

Further, there are several other constraints that affect the small-scale small stock producers in the southern and northern communal areas centered on access to markets, abattoirs and prices offered for their small stock. The small-scale producers often claim that prices they get for selling their goats in auctions and at abattoirs are very low compared to what they get from private agents who pay a fixed price without looking at the grade of the animal. However, this informal channel is neither reliable nor dependable. Many sellers opt to walk the animals to markets which results in weak and lean animals by the time they reach the market outlets. Most of the goats sold are placed on B_1 and B_2 grades; the prices for both grades are very low. Other than long distances walked to abattoirs and formal

markets, insufficient feeding and poor quality pastures exacerbate the poor condition of the goats that reach abattoirs. To improve on the quality of their goats, small-scale producers must be encouraged to invest in housing, supplemental feeds and veterinary services.

Food Security of Vulnerable Indigenous Groups

In Namibia, the San are among vulnerable indigenous people who are categorized together with agricultural small-scale producers. The San, originally hunters and gatherers depended wholly on the natural resources of the land they roamed freely; they lived in harmony with their environment. However with invasion of their lands by agricultural and other economic ventures, they were compelled to give up their survival mode and participate in agricultural and other economic activities. The 1991 census indicated that there were 12,921 San on commercial farms (47.5 %), 14,024 in communal areas (51.5 %) and 284 in urban areas (1 %). Living conditions for this group of agricultural small-scale producers differ significantly in commercial and communal areas. While the majority of San who obtain employment on commercial lands have no right to the land and have to make a living as farm laborers/domestic workers or as urban squatters, those who got settled in resettlement schemes located in communal areas are better off because they have access to land and are free to either farm or establish conservancies and community forests on communal land. Also those living in or close to conservancies are fortunate in that because they have access to land and can manage the natural resources of the land and practice, to varying degrees, their traditional lifestyles. Despite this breather, the settlement farms do not offer complete solution to all the San people in Namibia. At present there are some San people who were not officially resettled and who are still at the mercy of better off farmers in both the communal and commercial areas as well as other sorts of employers where they are marginalized and subjected to unfair labor practices (Suzman 1995, 2001a, b).

An outcome of the government's initiative to give land access to the vulnerable indigenous people who were displaced by commercial agricultural activities saw six commercial farms allocated to the resettlement of the Haillom San on the southern border of the Etosha National Park (the ancestral land of the Haillom) and one farm in the Otjozondjupa Region for other San groups who were encouraged to farm with goats and grow their own food. Many Haillom from the surrounding commercial land area and the towns in the vicinity moved to these farms. However, as on other resettlement farms in Namibia, establishing sustainable livelihoods independent of government food aid and massive external support has proven difficult because these people who were hunters and gatherers have to learn new production techniques different from their traditional modes of survival. Success is minimal because crop growing and livestock farming is new to these people just like permanent

settlements. It is gratifying to see that some of San youths and young children have been exposed to formal education which is hoped will help them influence the older generations on alternative land management and livelihood system.

During 2010, as part of the San Development Program, the Office of the Prime Minister established the "Back to School and Stay at School Campaign". Its main objective is to encourage learners from marginalized communities such as the San to attend school and remain in school, and receive a good education like other citizens in Namibia (ODPM 2008, 2011). Also the Working Group of Indigenous Minorities in Southern Africa (WIMSA) continued its special education program for the San, which specifically supports Early Childhood Development but also helps with bursaries for San students in different fields. During the year, three San students from Namibia took part in a 9-month training course at the San cultural and education centre, !Khwa ttu, located 70 km northwest of Cape Town in South Africa, in which they developed their skills in community-based tourism and hospitality. Additionally, they learned about life skills, San issues, rock art, botany and environmental issues. Local news papers and news broadcasts from time to time report more and more successes on formal training of San children several of who have graduated from tertiary institutions in recent years.

Other efforts to assist the San are being made on a regional level. The San are represented by the Working Group of Indigenous Minorities in Southern Africa (WIMSA), which comprises the national San Councils of Botswana, Namibia and South Africa. Many non-governmental organizations (NGOs) are assisting indigenous peoples in Namibia in various aspects (e.g. education, human rights, and livelihoods). Most of these NGOs are part of the San Support Organizations' Forum (SSOF), which was established in 2009 as a platform of stakeholders working with San in Namibia. This platform encourages win-win situations, it offers the opportunity to present ongoing activities in the various regions, to discuss and negotiate matters with government agencies, to share ideas, lessons learnt and best practices and to improve the coordination of the various San support initiatives. The platform further gives the opportunity to align the work of the different stakeholders with international standards, such as the UNDRIP.

In Namibia, tourism comprises one of most important sources of income. Indigenous communities throughout the country, some of which include and involve the San people, have established several tourism-related projects. As of 2010, it was reported that at least ten indigenous communities in conservancies are involved in joint venture tourism agreements with lodges and other tourism companies (NACSO 2010). There are other projects that are geared towards supplementing the San's livelihoods in the conservancies and on San resettlement farms including village gardens, the harvesting and marketing of indigenous plants (e.g. Devil's Claw) and craft production. For example in 2010, it was reported that on the three San resettlement farms in Omaheke Region supported by Desert Research Foundation of Namibia and HABITAFRICA Foundation, 104 producers were active in craft production and the total annual income was N$149,178 with an average annual income per producer of N$ 1,750. While the amount per person may look small, for the San living in the rural areas is quite substantial because food

comes from the land. Most of the money would go to purchase clothes, consumer goods such as sugar, soap and salt (Werner and Odendaal 2010). In 2011, various craft production training projects took place in different regions throughout the year in order to enable San women and men produce high quality products for the national and international market.

Central Government Interventions

Immense efforts have been put forward by the government of Namibia to strengthen and improve food security for the less endowed of the population as well as subsistence producers. Efforts geared towards alleviating poverty and improving food security include those already referred to above and those geared towards resettling landless people who applied for resettlement or those that the government considered as vulnerable or previously disadvantaged by the apartheid regime policies including those who were dispossessed of their ancestral lands. These people were resettled in Group Resettlement Schemes (GRS) with the expectations that they would engaged in small-scale agricultural activities to meet their food needs and where they generated some surplus, to sell and obtain cash which would be used to purchase other consumer goods. Three of these group farms, Drimiopsis, Skoonheid and Donkerbos/Sonneblom, are located in the eastern part of the country (Omaheke Region) while two, Westfalen and Bernafey, are located in the south (Hardap Region) (Desert Research Foundation of Namibia and Fundación CEAR 2006a, b, c).

Compared to other farms where large groups of people have been settled, GRS of the Ministry of Lands and Resettlement (MLR) are defined in terms of specific official membership and by the fact that some have project co-coordinators. A marked difference between the GRS in Omaheke and Hardap regions is that beneficiaries on the Drimiopsis and Skoonheid schemes are almost exclusively of San origin while the ethnic origins of those on Westfalen and Bernafey are diverse (Nama, Damara, Owambo, Kavango and Zambezan-previously Kaprivian). This difference may be explained by the fact that at the time when resettlement program was initiated up to the present, large numbers of the landless San people were found in Omaheke Region.

Another category of those who benefited from land reallocation are those who applied to be allocated land for resettlement but were expected to take up agricultural activities as small-scale commercial producers using their own resources under the Farm Unit Resettlement Scheme (FURS). Also allocated land alongside these two categories of producers is the category comprising those who qualified for bank loans to enable them to undertake agricultural production as large-scale commercial farmers under the Affirmative Action Loan Scheme (AALS). These large-scale commercial farms and the small-scale commercial producer farms offer an alternative source of income to the poor agricultural small-scale producers who get employed as farm laborers on part-time basis and a few on permanent bases leaving their allocated interests in resettlement lands in the care of their spouses or family

members. In southern Namibia, where various large-scale livestock farms which also practice limited irrigated crop production, is one of the areas where this symbiotic relationship is well entrenched. In the western parts of Hardap region, small-stock predominates while the eastern part which receives a bit higher rainfall, both cattle and small stock farming is practiced. Risky crop production takes place on farms to meet own food needs but where water is available, extensive crop production takes place such as below the Hardap Dam where about 2,000 ha are being irrigated using water from the dam. Further east, just over 600 ha are being irrigated in the Auob-Stampriet area using groundwater from rich artesian reserves. These are the undertakings which offer alternative source of income in the form of labor wages to the poor small-scale producers.

In southern Namibia, unfavorable international market conditions have compelled many large-scale livestock farmers (mostly Karakul sheep farmers) to diversify out of agriculture and enter into commercial hunting and tourism. Some farmers replaced Karakul farming with mutton production by raising Dorper sheep and Boer goats instead of Karakul sheep. The change from Karakul pelt to mutton production had serious environmental and socio-economic ramifications for the farming sector in the south because grazing practices and needs of sheep bred for meat differ markedly from those of Karakul. The intake of pasturage of sheep bred for meat is generally greater than that of Karakul. Many existing farms became too small to accommodate enough "mutton sheep" to compensate for the loss of revenue following the collapse of the pelt market during early 1990s.

The socio-economic impact of this transformation is that many farmers could no longer run their farms and opted to sell. What this meant was that the small-scale agricultural producers lost part-time jobs and their ability to augment meager outputs from their small parcels of land. Evidence suggests that agricultural employment opportunities decreased rapidly; between 2002 and 2004 opportunities declined by 39 % overall while the highest decline of 80 % was in the category of temporary employment (Werner and Odendaal 2010). As well as losing jobs the poor small-scale agricultural producers also lost other opportunities such as keeping a limited number of livestock on commercial farms allowed by their employers (on average they were allowed to keep 23 small stock, 5 large stock and 3 horses or mules or donkeys). In other farms, workers were allowed to keep a maximum of 25 goats at cattle posts. With the loss of these privileges, the poor small-scale agricultural producers were compelled to move all their accumulated livestock back into communal areas which have resulted into overstocking and over grazing and subsequently environmental degradation.

Following this state of affairs, the government then initiated the two settlement schemes (GRS and FURS) to provide land to the landless which were aimed at reducing poverty and assist them contribute towards the development of the country's economy and towards alleviating food insecurity. The government acquired previously large scale farms and allocated them to the two categories of landless people. The basic concept underlying the approach was that beneficiaries were to engage in small stock farming and practice limited dryland crop farming for own consumption. These families were allocated land under the FURS model where they were to use the land for small-scale commercial

farming. These schemes were "mainly social welfare projects providing free accommodation, food and other transfers, which displayed few signs of being resettlement projects as commonly understood".

The National Resettlement Policy provides for two models of group resettlement: group holdings and co-operative holdings and other legal entities. The groups holdings category caters for a formal or non-formal group composed of people who cannot form a co-operative but are interested in engaging in agricultural or other production as a group. The second category caters for duly registered co-operatives or other legal entities such as companies and close corporations. Officially the Ministry of Lands and Resettlement runs 14 group resettlement projects across the country. Half of these are located in communal areas and the other half in the commercial or freehold sector. GRS projects were launched in haste after independence to accommodate large numbers of the San and returnees from exile (ex-combatants) who had no shelter, employment or other source of income. The San who were used as trackers for the colonial government during the liberation struggle were left helpless in former military camps after Namibia gained independence.

As a result of the haste with which group resettlement projects were established, little planning went into the process. The basic concept underlying the approach was that beneficiaries were to engage in dry-land crop farming for own consumption, combined with small stock rearing and any other small-scale income-generating activities. Thus they fall into the small-scale agricultural producers' category. At the outset, some group schemes were assisted with the procurement of farm implements and provision of drinking water in keeping with the government policy of offering support to the poorest section of beneficiaries for the first 5 year period after which they were expected to be self sustaining. However, the beneficiaries developed a dependency syndrome so that until 2008 they still expected the government to continue assisting them with land preparation costs, irrigation infrastructure, drilling boreholes, purchasing fencing materials and constructing houses. Some of the settlement schemes in this category attracted many outsiders (squatters) so that the government felt the financial strain of continuing to support growing numbers. Consequently this mode of settlement has been abandoned by MLR.

The GRS beneficiaries augment the outputs from agricultural activities through harvesting wild foods (*veldkos*) in the allocated farms as well as in other lands around the resettlement schemes. However due to prevalent arid conditions in and around the resettlement schemes harvesting of wild food is practiced on very small scale largely during and soon after the short rain period. The foods harvested include wild cucumber (*boesman komkommer* or "bushman cucumber"), *marimba* nuts, wild potatoes and berries. A few of these wild foods are sold or exchanged for other goods; m*arimba* nuts in particular are very much sought after. Traditionally, the sale of wild potatoes and *boesman komkommer* was prohibited, whereas *marimba* nuts and berries could be sold. The old people crush the nuts, boil the mulch and scoop off the fat, the taste of which is said to be as good as beef fat. This fat is very popular with the Herero people. Devil's Claw (k*amagu*) is also harvested at Drimiopsis mostly for own medicinal use. Some beneficiaries risk hunting rabbits and small antelope such as steenbok and warthogs which is prohibited by law. A few beneficiaries hunt snakes and tortoises for food (Werner and Odendaal 2010).

Hand craft production and needlework provide modest but important complementary income streams for some households at these schemes. San dances appeal to many tourists and there is a market for cultural tourism, potentially also at these group schemes. Wages earned at the neighboring farms and pension money remained the most important source of additional source of income other than what is produced at the scheme farms.

By the end of 2000s, small-scale commercial farming or the Farm Unit Resettlement Scheme (FURS) was the most prominent component of redistributive land reform. This model entails acquiring and subdividing large-scale commercial farms, and allocating portions or units to individual beneficiaries according to allocation plans developed by land use planners in the line ministry. To qualify for resettlement, beneficiaries may not have more than 150 large-stock units (LSU) or the small-stock equivalent thereof. In 2004 the average sizes of the units allocated to FURS farmers were 2,138 ha in the southern half of the country and 1,200 ha in the more fertile northern regions. In many instances it has emerged that the size of the unit allocated to beneficiaries did not match with their productive assets such as livestock numbers. Consequently, beneficiaries were not able to utilize all of their land, and large tracts remain underutilized.

Therefore it becomes evident that the small-scale commercial resettlement model is not likely to yield expected results unless the beneficiaries are assisted with soft loans which would enable them acquire more livestock and trained in livestock management as commercial enterprises. The land redistribution program does not give small-scale commercial farmers an option to buy portions of commercial farms with financial support from government. Instead, potential land reform beneficiaries have to apply to the MLR for resettlement in response to advertisements of farms available for resettlement to the disadvantage of people with no or little education.

The majority of FURS beneficiaries applied to be resettled in order to farm with livestock. Some of these beneficiaries regarded resettlement as a means to build up their livestock farming operations, on a small-scale commercial basis while for others, resettlement meant obtaining a piece of land on which to retire in peace away from the hassles of communal area farming which is dodged with rampant stock thefts and quick spread of diseases which resulted into large stock losses. Many former farm workers regarded this as a more attractive option for retirement than a communal area as most of them had previously suffered losses due to the inability to control the movement of their livestock in communal areas. They hoped that by obtaining their own piece of land, they would be able to control their livestock, build up their herds and improve their livelihoods. A few FURS beneficiaries applied for resettlement because they were no longer able to keep their livestock on the commercial farms where they worked, but they did not want to farm on communal land.

The FURS beneficiaries have been facing several setbacks including poor social relations partly due to the way that beneficiaries were selected. The beneficiaries were not given a chance to choose their neighbors. As social issues were not considered in the land allocation process, fate alone determined who settled next to whom.

Thus there was no real sense of community on most resettlement farms and when they had to co-operate on crucial farming issues requiring co-operation such as water sharing and infrastructure maintenance and repair. Water sharing is a thorny issue due to the fact that the resettlement farms were subdivided into small-scale commercial farms from a large-scale farm with single water source. As such not all allocated portions of land had their own borehole. Beneficiaries with smaller animal herds expect those with larger herds to meet larger portions of the costs. Ethnic differences sometimes also impacted negatively on social relations on these farms.

FURS beneficiaries in Hardap primarily practiced extensive small-stock farming, while extensive cattle farming predominated in Omaheke, but all of them kept small or large stock in addition to their primary livestock herds. Small stock losses were rampant due to diseases and vermin (jackals) particularly of goat kids and sheep lambs which are highly susceptible to diseases and require good husbandry practices. The high losses of adult females are attributed to adverse weather conditions (extreme dry as well as extreme cold conditions). Dilapidated and/or non-existent farm infrastructure also impacted negatively on agricultural production. Adult small stock (goats and sheep) is also slaughtered on a regular basis for household consumption. It is common for farmers to slaughter one or two goats or sheep per month for consumption by themselves and their workers. Some of the adult small stock sold consisted of goat nannies and sheep ewes.

Marketing of small stock is usually not a major problem for FURS farmers because there are several outlets including periodic auctions and small traders who go to farms in their small pick-up trucks to purchase livestock at what they call farm gate prices which are far lower than formal market prices. This offers a solution for beneficiaries with smaller herds and hence smaller numbers for marketing who find it difficult to take their livestock to auctions on their own steam. For these sharing consignments poses challenges as not all beneficiaries necessarily want to market at the same time. Another option available to and often used by beneficiaries is selling directly to individual buyers and neighboring farmers, which gives beneficiaries the freedom to sell livestock whenever they needed to; this also is a solution to the transport huddle. Those beneficiaries located closer to auction venues tend to walk their livestock to auction centers. However, goats are sold on an informal basis when money is needed.

Another constraint facing FURS producers is lack of basic skills in general farm maintenance, animal husbandry and business management; many lack knowledge of appropriate farming practices/methods. Apart from some support provided recently by the Emerging Farmers Support Program (ECFSP) initiated in 2007, FURS beneficiaries did not receive any pre- or post-settlement support from government or any other agency. Many do not even know where to obtain specific agricultural information whenever they need it. However the issue of post-settlement support has been addressed in the MLR's Strategic Plan 2006–2010 which treats provision of basic infrastructure and empowerment of communities as a separate strategic theme.

The strategic plan states that it is the responsibility of MLR to provide tailor-made pre- and post-settlement support packages which include technical advice,

training and support in appropriate farming methods and agricultural practices. Implementation of the plan is ongoing albeit at a slow pace. Severally, resettlement farmers as well as those in communal lands have expressed a need for practical training on technical issues, and some feel that they have inadequate management knowledge and skills (Lowrens 2004; Mendelsohn 2006; Werner and Odendaal 2010). Recently established farmers have responded to this need by offering training in breeding, selection, animal husbandry, and infrastructure maintenance, supplementary feeding, rangeland management and overcoming cash-flow problems. This training is being offered under ECFSP.

While the MLR policy stipulates that extensive livestock farming was the single most important land-based livelihood strategy prescribed for FURS beneficiaries, it is only possible where adequate rainfall is received. Here livestock farming is combined with small-scale crop cultivation for own use as well as limited sale such as in Omaheke Region, where rain-fed cultivation of maize and beans for own consumption takes place. On the other hand, in Hardap Region only very few with enough water produce crops to meet their own consumption using irrigation. Due to irrigation and marketing infrastructure constraints, the main source of income for beneficiaries remains the sale of small stock. A factor that impacts negatively on the marketing of crops is the absence of timely and organized transport arrangements. Quite often when crops are ready for marketing, transport is hard to access to get crops to markets on time. A few beneficiaries use much of the maize harvest to feed livestock while some surplus is sold at nearby markets such as in the communal areas. A few beneficiaries under the GRS have gardens in which they grow vegetables such as cabbage and carrots for household use but goat farming forms the backbone of their livelihood as it brings in more money than the garden produce.

In several cases beneficiaries combine land-based strategies with other livelihood strategies such as monthly old-age pensions which are the most important source of additional cash for FURS beneficiaries. Part-time FURS beneficiaries supplement their farming income with income from their off-farm employment and other cash generation activities such as carpentry and crafts. Many FURS beneficiaries as well as large-scale commercial farms offer employment opportunities to those settled in the neighboring GRS beneficiaries largely inhabited by the San people. Both FURS beneficiaries and the large-scale commercial farms recruit farm laborers as temporary/casual workers and in rare cases as long term employees who live in their compounds and receive a wage and other benefits like food rations.

Thus it emerges from the foregoing analysis that small stock has a very pivotal role in the food security of the small-scale agricultural producers in Namibia largely because of the climatic conditions which determine the availability and condition of the range. Namibia is largely a dry country suited to the farming of small stock such as goats and sheep. While scientific experimenting and breed genetic enquiries have identified those breeds which perform well in the rangelands of Namibia, more need to be done to improve on the productivity and specific needs and requirements of those breeds of goats and sheep that are able to withstand the prevailing climatic conditions and do well under the prevailing rangeland resources. Efforts and support to the poorer small-scale producers should be centered on the rearing and

improvement of such breeds. Alternative productive activities should be sought and identified while appropriate skills should be imparted to all small-scale producers to strengthen and enhance their survival techniques.

Actual and Perceived Advantages of Resettlement

The group resettlement scheme offered both access to land and to a small brick house and basic services such as water. Access to land on a group scheme provided a sense of security which replaced the sense of vulnerability that most farm workers experience. In Omaheke region particularly, the schemes have served as secure places from which beneficiaries can go out to look for work and withdraw back to at the end of employment. Group resettlement schemes have also provided access to residential land for people who are not official beneficiaries by taking advantage of family ties with official beneficiaries. Those who were not allocated land initially have settled with relatives either as a temporary measure while looking for work and in a few cases permanently. Due to the ethnic homogeneity of Drimiopsis and Skoonheid, family ties among beneficiaries there are strong and have played an important role in facilitating access to resettlement without the need to apply formally (Desert Research Foundation of Namibia and Fundación CEAR 2006b, c).

An issue that begs to be answered is whether access to land through group resettlement has improved the livelihoods of the scheme beneficiaries. According to Werner and Odendaal 2010, the answer is not straightforward, particularly considering the fact that for many beneficiaries, access to land means much more than simple economic factors. For the vast majority of beneficiaries of group schemes, a major benefit of resettlement is that they have rights to a piece of land on which they have a secure home of their own. Resettlement means not only access to a piece of land, but also the provision of a small brick house with basic amenities and access to potable water. Moreover, as official beneficiaries, initially they qualified for state support, in particular food aid. However, in terms of socio-economic improvements of livelihoods in general, the group resettlement schemes have not proved successful. The vast majority of the beneficiaries have not managed to generate surpluses in the communal gardens which might have enabled them to start accumulating productive assets such as livestock. Conversely, the beneficiaries have had to sell assets including livestock in order to buy food and other basic necessities while others sold off assets and sank deeper into poverty due to excessive use of alcohol.

Group resettlements scheme villages particularly those in Omaheke accommodating mainly San beneficiaries, undoubtedly provide some protection against external shocks. While their own produce contributes towards enhancing their food security and contributes towards hunger protection, it was primarily government's food aid programs that prevented them from starving in the beginning and in recent years donor and government donations of goats and other aid that has fortified their livelihoods. In a very profound way, Skoonheid and Drimiopsis have proven to be welfare projects more than anything else. It is prudent to point out that all of the

livelihood improvements attained by land reform beneficiaries have been attained at the expense of hundreds of former farm laborers who lost their employment, their place of residence and their access to land after the state bought the applicable commercial farms. To this day, there still does not appear to be an explicit policy statement on how these previous farm workers should be compensated or incorporated into the resettlement programs.

In conclusion, it clearly emerges that there is need for the government and policy makers to revisit the issue of resettlement models for small-scale commercial farmers. Although opportunities may be limited, options other than extensive livestock farming need to be identified and pursued to enable previously disadvantaged Namibians with the requisite skills to produce more food. For example, the potential of small-scale irrigation to increase food production for own consumption and urban markets remains largely unexplored with the exception of limited effort made in recent years by MAWF to boost food security for the small-scale agricultural producers through irrigated agriculture. The Green Scheme projects which were aimed at encouraging the development of irrigation crop production in order to increase food production and create jobs have increased capacities for a few of these producers (MAWF 2013).

Sadly, output from the Green Schemes is still negligible. Recent media reports have it that out of a total of seven Green Schemes only one, Hardap irrigation scheme has proven economically worthwhile; the other schemes are said to be causing losses to the government which acts as guarantor with Agricultural Bank of Namibia (Agribank) for the loans taken out by small-scale farmers affiliated to a Green Scheme. Some small-scale agricultural producers are said to simply default on their loans and then the government has to come through as guarantor (Namibian Sun, November 2013). Furthermore the media report criticizes all Green Scheme projects currently falling under the State with the exception of the Hardap project for failing to pay the required lease fees in accordance with their leasehold agreements, leading to even more losses for the State. The schemes in question include the Etunda, Shadikongoro and Uvhungu-Vhungu irrigation schemes. This, the reports say has led to the government losing out on its 40 % profit share following investments in land, farm infrastructure, implements, machinery and equipment.

Further, it has been suggested that for land reform to effectively reduce poverty levels and enhance food security among the small-scale agricultural producers, the needs of people categorized as “poor” must be identified much more accurately in order to develop models that properly address them. This assumes that a clear definition of poverty exists. One question that must receive careful consideration though is whether a person who is resettled with some animals falls into the same category of poverty as a person with no assets at all? What has emerged very clearly is that those who have no farming assets, or with only a few, can be resettled only with generous government support in the form of grants (Werner and Odendaal 2010).

Furthermore, it has emerged that the welfare intervention mode is proving very costly to the government and has generated a dependency syndrome which has proven to be a hinderance of inculcating a sense of accountability and need to be self sufficient; it has undermined the quest by an individual to seek and become

innovative to support oneself. Often one hears calls from the "poor" calling on the government to provide this or that instead of them coming together to look into how they can meet their own needs. This dependency syndrome must be addressed through education and campaign drives that will inculcate a sense of accountability and responsibility for own welfare.

It should be made mandatory that before land is allocated, appropriate skills training should be a prerequisite for every prospective land beneficiary. Finally, any land reform planning and post-settlement training should incorporate aspects of water resource management due to the inherent aridity characterizing the country. In line with Namibia's various National Development Plans and the provisions of the new Water Resource Management Act of 2004 and Water and Sanitation Policy of 2008, the land reform planning and capacity-building strategies should address the need for integrated land and water management. Since land and water linkages are an important issue in all activities relating to rural development and the management of natural resources, this issue deserves a stronger and more explicit emphasis in future land reform planning and capacity-building strategies.

Over and above the foregoing, it has been recommended that better co-ordination of land reform planning is essential to avoid conflicts arising from the fact that the central government controls land allocation at regional levels which often leads to a breakdown in communication or in the flow of information required for proper planning. Partnerships between government, the private sector and civil society at regional level could effectively ensure their co-responsibility and accountability for their regional resettlement programs, and directly empower the resettlement beneficiaries to participate in planning and to manage their resources effectively. The National Resettlement Policy provides that a number of government ministries should carry a responsibility for co-coordinating action plans in a particular area to ensure that sector partners in government and NGOs are involved with these plans. For example, the MLR's main responsibility is to finance the resettlement program while the Ministry of Agriculture, Water and Forestry is responsible for, among other things, training resettlement beneficiaries through its Directorate of Extension Services. However, it has often emerged that a lack of co-ordination and communication between these two ministries has often hindered the implementation of agricultural training programs for resettlement beneficiaries.

Training and extension service provision by Ministry of Agriculture, Water and Forestry should be accorded equal importance for both communal and resettlement farmers. The practice has been that priority is given to communal farmers training and service provision while ministry contracts out to private contractors the provision of technical services to resettlement projects. This clearly shows that despite the government's pledge to empower resettlement beneficiaries to become self-sufficient, the beneficiaries have to rely on external services to resolve even a minor problem. For example beneficiaries at the group schemes of Bernafey, Westfalen, Skoonheid and Drimiopsis are not allowed to repair broken equipment themselves; they have to wait for a technical team appointed by the Ministry of Land Resettlement to undertake repairs, which usually involves hiring private contractors. To avoid this cumbersome operational procedures, land reform support service systems need to

be strengthened or established where they don't exist. Of particular importance is the linking of the various information sources and the actual exchange of information within the key government institutions and their regional structures.

Similarly, financial co-operation between the government, donor organizations, the NGOs and the private sector should be directed towards supporting the development of infrastructure relating to land reform. Of particular importance are the poverty-reducing effects of infrastructure investments, and broadening and diversifying the production activities. Due to the fact that many resettlement projects are located far from big towns or trade centers, efforts should be made to ensure that these beneficiaries do not feel cut off from the rest of the country; the media and broadcasting services outlets should be made available at the schemes. Transport should also be improved because isolation obviously negatively influences the economic activities of most resettlement project communities and makes marketing of products very difficult. Supervision and assistance provision is also expensive and ineffective due to limited follow up schedules. Whatever measures are taken to improve infrastructure on the resettlement projects it has been recommended that they must include measures to improve communication and transportation infrastructure.

References

ARD (2008) Millennium Challenge Corporation: Millennium Challenge Account Namibia Compact: volume 3: Thematic Analysis Report-Livestock. Namibia Strategic Environmental Assessment, Windhoek

Desert Research Foundation of Namibia and Fundación CEAR (2006a) Participatory poverty assessment/situational analysis: site report for Skoonheid resettlement farm, Omaheke Region. DRFN/CEAR, Windhoek

Desert Research Foundation of Namibia and Fundación CEAR (2006b) Summary report: consolidated findings of key informant interviews and PRA studies at Drimiopsis, Skoonheid, Donkerbos/Sonneblom and Arovley. DRFN/CEAR, Windhoek

Desert Research Foundation of Namibia and Fundación CEAR (2006c) Drimiopsis San resettlement project, Omaheke Region: site report. DRFN/CEAR, Windhoek

Isaacson B (ed) (1995) Namibia food security and nutrition assessment report. National Food Security and Nutrition Technical Committee, Windhoek

Kruger B, Werner W (2007) Redistributive land reform and poverty reduction in Namibia. Livelihoods after land reform. Institute for Poverty and Agrarian Studies (PLAAS)/Institute of Development Studies, South Africa, 37 pp

Lowrens A (2004) The socio-economic agricultural baseline survey in the communal areas of the Karas region. Agricola 2004 ministry of agriculture, water and rural development. Directorate of Research and Training, Windhoek, Namibia. 14:43–51

MAWF (2013) Audit report on the Green Scheme Program for the Years 2009 to 2011. A Cabinet Submission, Nov 2013

Mendelsohn J (2006) (with contributions from el Obeid S, de Klerk N, Vigne P) Farming systems in Namibia. Research and Information Services of Namibia for the Namibia National Farmers Union, Windhoek

Mendelsohn J, el Obeid S (2002) The communal lands in Eastern Namibia. Namibia Nature Foundation, Windhoek

Molefe DS (1985) Review of the present sheep and goat production programs and future prospects. In: Morapedi NT (ed) Food comes first. Seminar proceedings on livestock production, marketing, training and development. University of Botswana, Gaborone

Mutenje MJ, Mapiye C, Mavunganidze Z, Mwale M, Muringai V, Katsinde CS, Gavumende I (2008) Livestock as a Buffer against HIV and AIDS Income Shocks in the Rural Households of Zimbabwe. Development Southern Africa. http://www.informaworld.com/smpp/content~db=all~content=a790526994. Accessed 26 Aug 2013

NACSO (2010) Namibia's communal conservancies: a review of progress and challenges in 2009, Windhoek

National Planning Commission (2006a) Omaheke regional poverty profile based on village-level participatory poverty assessments in the Omaheke Region in Oct/Nov 2004. Office of the President, Windhoek

NPC (2006b) Draft poverty profile: Hardap Region. Office of the President, Windhoek

ODPM (2008) The San development program report 2007/2008. Office of the Deputy Prime Minister, Windhoek

ODPM (2011) Draft annual report for the year 2009/2010. Draft report. http://www.sandevelopment.gov.na/index.htm. Accessed 15 Aug 2013

Peacock CP (2005) Goats – a pathway out of poverty. Small Ruminant Res 60(1):179–186

RAISON (2006) Farming systems in Namibia. A Publication for the Namibia National Farmers Union (NNFU), Windhoek

Rothauge A, Kavendji G, Nghikembua Ml (2003) Forage preference of Boer goats in the highland savanna during the rainy season I and II. Agricola 2003 ministry of agriculture, water and rural development. Directorate of Research and Training. Windhoek, Namibia, 35–48

Rothauge A, Abate AL, Smit GN (2004) Stocking rate of free-ranging beef cattle affects their diet selection. Agricola 2004 ministry of agriculture and rural development. Directorate of Research and Training, Windhoek, Namibia. 14:37–39

Schneiderat U (2011) Communal rangelands in Northern and Central Namibia: the grazing and browsing resources and their users. Inaugural Dissertation zu Erlangung des Doktorgrades (Dr. agr.) beim Fachbereich Agrarwissenschaften Okotrophologie und Umweltmanagement der Justus-Liebig-Universitat Giesen. http://geb.uni-giessen.de/geb/volltexte/2012/8595/pdf/SchneideratUte_2011_12_09.pdf. Accessed 20 May 2013

Suzman J (1995) In the margins: a qualitative examination of the status of farm workers in the commercial and communal farming areas of the Omaheke region. Farm workers project research report series, no. 1. Legal Assistance Centre, Windhoek

Suzman J (2001a) An assessment of the status of the San in Namibia. Report series, no. 6. Legal Assistance Centre, Windhoek. Jan 2001

Suzman J (2001b) An introduction to the regional assessment of the status of the San in Southern Africa. Report series. Legal Assistance Centre, Windhoek. Apr 2001

Werner W, Odendaal W (2010) Livelihoods after land reform: Namibia country report. Rural poverty in Namibia Legal Assistance Center Land, Environment and Development. Windhoek, Namibia

Chapter 6
Improving Productivity, Food Safety and Nutritional Levels of Dependable Food Crops: Southern Africa

Abstract Climate change and research outputs greatly affect land productivity and performance of dependable food crops such as cassava, millet and sorghum. Interventions that enrich these crops particularly pearl millet and cassava are discussed showing that the use of fertilizers can greatly enhance crop yields. Cassava, a cheap source of carbohydrates but nutritionally poor protein source can be fortified through improved processing and fortification methods. Pearl millet too, can be fortified to add essential minerals that are absent in this dependable crop growing in poor mineral deficient soils. Mitigation of food and nutritional insecurity including severe protein malnutrition rampant in many cassava and pearl millet growing areas are highlighted showing that protein malnutrition is occasioned by inadequate access to animal based proteins by the majority of the people in the small-scale agricultural production sector dependent on cassava as their staple food crop. Most diets of these small-scale producers in these areas derive their proteins largely from traditional vegetable sources, such as beans and leafy vegetables which are inherently low in protein content. High protein legumes such as cowpeas and soybeans not widely incorporated into these people's diets are recommended to be intercropped and incorporated into pearl millet and cassava flour milling.

Keywords Climate change and agricultural productivity • Enhancing agricultural productivity • Food and nutritional insecurity • Protein rich legumes • Protein deficiency and protein malnutrition • Traditional and dependable food crops • Food crops processing and fortification

Factors Influencing Productivity of Small-Scale Agricultural Producers

Climate Change

Globally, it has been acknowledged that there is a large risk that will be caused by continued release of greenhouse gases into the atmosphere. The risk is in the form of a range of adverse impacts including global warming, sea level rise, increase of storms, changes in historical patterns of rainfall (and drought), threats to

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endangered habitats and the possible spread of contagious diseases. Even if the countries of the world agree to take aggressive steps to stabilize or reduce CO_2 emissions over the next 20–50 years, it is still feared that there is a strong possibility that the cumulative effects of past greenhouse gas emissions will cause sea level to rise and storms to intensify for at least the next several decades, and probably longer (Susskind 2009). Temperatures in Southern Africa have been increasing while lower rainfall with greater variability is expected. Higher temperatures rises will boost evaporation rates, leading to severe water shortages which will negatively affect agricultural productivity. An increase in the frequency and intensity of extreme events such as droughts are also predicted to increase substantially (Reid et al. 2007).

There is sufficient evidence suggesting significant changes in global climate over the past century, and that this phenomenon will continue throughout the twenty-first century due to anthropogenic activities as well as natural cycles (UNDP 2009; NCCF 2007). Agriculture in Southern Africa is extremely vulnerable to predicted changes in climatic elements such as rainfall variability and unreliability. Persistently high temperatures keep evaporation rates at astronomical levels consequently limiting moisture availability to crops reducing yields of dependable crops such as cassava and pearl millet. The overall impacts of these weather attributes will no doubt affect the hydrology of the region limiting the potential for supplemental irrigation thus breeding uncertainty surrounding agricultural productivity that will be a threat to regional food security (Dirkx et al. 2008).

The prolonged droughts of the 1970s, 1980s and 1990s saw very low food yields which precipitated an already bad situation that sent food self sufficiency into disarray culminating into food shortages, hunger and even famines. It is documented that the devastating 1991–1992 drought resulted into 45 % fall of agricultural production across Southern Africa to the extent that a food gap was felt throughout the region, more so in arid areas such as those in Namibia where food deficits resulted into acute hunger and malnutrition in many parts of the country particularly in the northern areas where majority of the small-scale agricultural producers live. The food deficit and relief food demands emerged as a major social issue of concern to policy makers across all countries in Southern Africa. Most national governments were forced to divert funds from investment in order to import relief food. During this period food crop harvests fell by a large margin; for example cereal harvests in Namibia fell by 70 % (Hirji et al 2002).

Research

Previous to independence of most countries in Southern Africa, paucity in research on traditional crops produced by small-scale producers was widespread. During the colonial rule in Southern Africa, cash crops such as grapes, sisal, cotton, grapes, green beans, sugar-cane, coffee, tea and cut flowers were accorded a great deal of attention in form of research, extension services and provision of agricultural inputs

at the expense of traditional subsistence crops such as millet, sorghum, pearl millet (*mahangu*) and cassava. At the time, such malady did not attract much attention because population numbers were low and increased demand that called for increased production was attained through farm area expansion. However as the population numbers increased and demand for land grew exponentially particularly after many countries attained independence, the negative impact of paucity in research and inherent neglect on traditional subsistence crops became apparent. Land output remained constant or at worst declined due to falling soil fertility resulting from continuous use of the same parcel of land for a long time. Meanwhile demand for food production escalated due to rapidly growing population numbers as the result of improved health and lowered mortality rates. As population numbers increased the pressure on the land and its resources also increased causing rapid decline in soil fertility and crop yields across the region. It is a known fact that low soil fertility and land degradation characterizes many parts of the region particularly those areas which have been in use for generations. Thus research addressing these issues is of paramount importance.

Across Southern Africa, agricultural research, availability of agricultural inputs as well as extension services are essential in increasing land productivity and securing food self sufficiency among small-scale agricultural producers. It is widely recognized that substantial increase in agricultural production demands new innovations in agricultural practices, in farming methods and in the use of qualitative genetic materials of both plants and animals. Equally recognized is the fact that demand-driven agricultural research that is strongly geared towards the development and applications of best practices is the key factor to success. The Indian Green Revolution Policy provides a classic example of what impact good research policy can bring to bear on agricultural performance.

Some small-scale agricultural producers as well as other stakeholders in Southern Africa are still skeptical on the value of agricultural research because of held perceptions that this research has not produced significant impact on agricultural productivity, poverty reduction and food security. However, it should be remembered that research input takes time to be seen especially where the consumers of research findings and recommendations fail to adopt these recommendations as specified by the researchers. Often the customers of research findings prefer to stick to their traditional methods of production because these are what they know and the ones that have supported previous generations. Therefore the research agenda should be revisited prudently while increasing funding and investments in agricultural research activities that will lead to improved technology development and strengthen extension services so as to convince and support the research findings consumers.

At the continental level, Pillar 4 of the New Economic Partnership for Africa's Development (NEPAD)'s Comprehensive African Agriculture Development Program (CAADP) also focuses on enhancing and improving the effectiveness of agricultural research and development with aim of improving agricultural production in keeping in line with one of the objectives of the Millennium Development Goals (MDGs) of achieving 50 % reduction in poverty by 2015 and attaining 6 %

growth in agriculture production per annum. This goal can best be attained by continuously realigning research agenda to fit the need and the aspirations of the agricultural sector particularly that which supports the small-scale agricultural sector. Thus policy research that informs decision-making process in areas that encourage efficient use of inputs as well as promoting sustainable cropping systems is required. Required research policy must also include a thorough understanding of decisions taken at household levels. The required research must also address integrated management of natural resources as well as marketing, product processing, value addition and nutritional requirements.

Meanwhile throughout Southern Africa, relevant government ministries have embarked on measures to increase land productivity and promote crop diversifications as part of strategies to improve food security and reduce poverty among small-scale agricultural producers. Promoting soil erosion control and cubing land degradation and value addition to agricultural produce are among strategies identified as viable means of meeting these goals. Additional strategies include strengthening extension service to the small-scale agricultural sector through information dissemination and advisory services aimed at changing small-scale producers' perceptions and attitudes towards adopting improved technologies and good agricultural practices. Strategies adopted by government research departments include practical research programs which are demand-driven oriented towards addressing specific issues such as that targeting land conservation, the promotion of optimal livestock carrying capacities as well as access to local, regional and international markets particularly for those areas characterized by aridity in Botswana and Namibia. In these lands, research emphasis has been put on animal health and land carrying capacity as well as quick maturing cereals and hardy vegetables. Attention has been placed on animal products processing and marketing as well as effective and efficient livestock disease control, meat hygiene and coping strategies during critical times.

While developing viable and appropriate research generated options to the land productivity challenge, researchers have placed specific emphasis on staple food crops including grains and root crops which constitute the main survival foods for the majority of small-scale agricultural producers. Many research scholars are of the opinion that the key to success lies in finding ways to adopt systems to natural environmental variability rather than attempting to homogenize the environment with massive inputs that are exceedingly expensive, economically unsustainable and environmentally unsound (Heinrich 2004). They also believe that developing scientific interventions that are appropriate, affordable, user-friendly and well packaged, efficient and effective in addressing specific needs will ensure success in coming up with useful interventions for the small-scale agricultural producers.

Essential to envisaged success is the availability of informed scientists who are able to skillfully analyze, synthesize and integrate agricultural research findings into indigenous knowledge and indigenous practices in order to foster smart stakeholders' participation and partnerships. Participatory approaches would strengthen the relevancy of research findings and make technology appropriate to local conditions. Therefore for agricultural research to be relevant and useful to the consumers

of new knowledge it is necessary to holistically look at agriculture research and relating it to the broader environment in which small-scale agricultural producers in the region operate.

Dependable Crops

(a) Pearl Millet and Sorghum
Pearl millet is one of climate-smarts crops. Pearl millet is a hardy dry land cereal grain crop largely grown in the drought-prone regions of Africa and Asia where it performs better than other cereals. Pearl millet which has its origin in the Sahel zone of Western Africa was introduced into Southern and Eastern Africa about 2,000 years ago. Its tolerance to drought, heat and soil salinity and its high water use efficiency qualifies it a climate-smart crop. While pearl millet can grow on a wide variety of soils ranging from clay loams to deep sands, yields and grain quality are best on deep, well-drained sandy soils because areas with soils prone to "water logging" in wet seasons cause shallow rooting, low seed protein and poor yields (Dewey et al. 2009).

(b) To a certain extent, sorghum is also a climate-smart crop. Sorghum, grown in many localities within Southern Africa's arid and semi-arid areas is among the most photo-synthetically efficient and fast maturing food plants which thrive on marginal sites where other crops fail. The crop faces limited productivity due to lack of improved production technologies and unavailability of improved cultivars. In cultivar development, emphasis should be placed on incorporating enormous genetic variability that has higher yields and higher moisture deficit tolerance than the indigenous varieties. Researchers should strive to raise their understanding of the varieties farmers have access to, their properties, characteristics and uses.

Pearl Millet and Sorghum in Namibia

Pearl millet (*pennisetum glaucum)* and sorghum (*sorghum bicolour)* are both dependable cereal crops supporting the livelihoods of small-scale agricultural producers in Namibia. In Namibia, pearl millet and sorghum are popularly planted in one field with pearl millet occupying the larger portion of a field. Both pearl millet and sorghum flourish in dry sandy soils with low fertility and low pH (high salinity); both crops have extreme genetic diversity and high tolerance to heat and meager soil moisture conditions. It is documented that a great percentage of Namibia has the lowest soil fertility in Southern Africa. This is more so in the northern parts of the country where the situation among small-scale agricultural producers has been described as precarious due to poor soil fertility. Although in large parts of Namibia mixed crop cultivation and livestock rearing are practiced, the soil does not benefit

Fig. 6.1 Pearl millet ready for harvesting, Northern Namibia (Source: Lydia Horn, MAWF)

much from animal manure because livestock ownership is not uniformly distributed across the entire population of small-scale agricultural producers. Also, insufficient moisture availability in the very dry parts does not support fast digestion and beak up of manure so that it can be integrated into the soil. In some parts, the dried manure is collected and used as cooking fuel. Thus soil fertility largely remains low adversely affecting crop yields (Matanyaire 1998) (Fig. 6.1).

Poor soil fertility and low crop yield is a recognized concern across the small-scale agriculture sector in Namibia which has compelled researchers to continuously search for crop options that are beneficial to all small-scale agricultural producer households including those with little or no access to manure and other fertilizers. While some households use manure to improve crop yields, maintaining soil fertility at all times has not been attained and is particularly difficult for resource poor households which have limited access to manure as well as to financial resources to procure fertilizers. Thus research that focuses on developing good practices such as intercropping, crop rotation and agro-forestry zeroing on legumes and biological nitrogen fixing species is particularly demanded in order to increase crop yields and secure food security for such households (Fig. 6.2).

Fig. 6.2 Sorghum field Northern Namibia (Source: Lydia Horn, MAWF)

However, one of the issues that require attention of researchers and extension officers alike is that of opportune planting time. Given the endemic rainfall unpredictability in Namibia, early planting is usually recommended to enable the crop to fully utilize the entire growing season to achieve physiological maturity before the onset of the dry and cold weather during May-June. It has been documented that due to uncertainty surrounding the onset of rainfall, researchers must come up with a variety of pearl millet that would mature before the onset of the dry season for late planted crop. Field research results demonstrated that the gap between genetic yield potential and the realized yield in pearl millet is primarily related to planting time and environmental stress factors which include moisture deficit during the growing period (Ipinge 1998a, b, 2000).

Pearl millet (locally known as *mahangu),* Namibia's most important and dependable food crop, survives the harsh climatic conditions pertaining in the country's dry lands stretching between Oshikoto, Ohangwena, Omusati, Oshana, Kavango and Zambezi (previously Caprivi) regions. This variety of pearl millet survives in areas that experience prolonged periods of dry weather during either the vegetative or reproductive phases. In Namibia, *mahangu* has proven to be more tolerant to sandy

and acidic soils than other millet crops such as sorghum. It has been reported that *mahangu* is deep-rooted and can use residual nitrogen, phosphorus and potassium and, therefore, may not need the levels of fertility required by other millet grains (Dirkx et al. 2008).

To ensure a good harvest, weed control is vital; it is particularly important to control early emerging weeds. Stink bugs and other insects also require control on developing grain heads as these bugs feeding causes small and shriveled seeds. Corn earworms, webworms, chinch bug and fall armyworms can also destroy and damage *mahangu* seeds. Chinch bugs can damage *mahangu* grain any time from the seedling stage to the soft dough stage. It is reported that damaged plants can have a drought-stressed appearance, and generalized death of lower leaves. Early infestations can cause severe stand loss and can also wither and kill plants from before flowering through grain filling (Bunting et al. 2007). Research carried out during 2009 revealed that losses also occurred from flooding experienced during 2008 when the six regions were affected by floods that negatively affected crop yields. The flooding damaged flowering crops and swept away crop stands growing close to river bank. Greatly reduced harvests were recorded, some areas registering as much as 63 % and 67 % drop in yield (Dewey et al. 2009).

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and national research organizations have developed open-pollinated varieties of pearl millet in eight countries in Southern Africa region. Among these, *Okashana 1 and Okashana 2* varieties were introduced to Namibia from Zimbabwe in 1990. Both have been widely adopted so that in 2008, they covered more than 50 % of the total pearl millet area in Namibia. Recently more productive varieties of pearl millet have been introduced, enabling farmers to increase production considerably (Manning et al. 2010). Recent research conducted by ICRISAT in collaboration with national research organs in eight countries across the region found out that cultivars originating from the collaborative research have proven to be highly transferable across different environments. Yields increased substantially particularly where fertilizers were used to overcome low soil fertility. In Namibia, research on crop rotation to improve soil fertility was conducted using leguminous plants (lablab, Jack bean and cowpeas). Pearl millet recorded marked increase in yield particularly where pearl millet was rotated with lablab followed by Jack bean and lastly cow pea (Shiningayamwe 2012; Fleissner 2005). Improved cultivars proved to be very popular mainly due to their early maturity and drought tolerance giving high yield of between 10 % and 38 % higher than local varieties (Manning et al. 2010).

Elsewhere, a recent study published in August 2013 Journal of Nutrition revealed that improved pearl millet cultivars which contain more iron can provide young children with their full daily iron needs. In India and Pakistan, these new varieties of pearl millet are being conventionally bred to provide more dietary iron to rural farming communities in arid drought-prone regions where few other crops thrive. In the study, iron-deficient Indian children under the age of three who ate traditionally-prepared porridges (*sheera, uppama*) and flat bread (*roti*) made from iron-rich pearl millet flour absorbed substantially more iron than from ordinary pearl millet flour,

enough to meet their physiological requirements. As an added bonus, this iron-rich pearl millet also contained more zinc, which was similarly absorbed in sufficient amounts to meet the children's full daily zinc needs. Lack of zinc in children is linked with stunting and impaired immune response against common infections.

Iron-rich pearl millet being developed using conventional breeding by ICRISAT showed that iron-rich pearl millet variety (ICTP-8203Fe) commercialized in 2012 also provides more zinc, is high yielding and is disease and drought tolerant. The bioavailability studies done in women and children show that high-iron pearl millet provides many health benefits. Thus in areas where pearl millet is the main food staple like in many parts of Namibia, results from these studies offer important strategy that can overcome rampant malnutrition and stunting inherent in the areas that rely on pearl millet. These results should encourage the production and consumption of bio-fortified pearl millet in Namibia.

Other crops that form part of bio-fortification research include cassava, maize and orange sweet potato as well as beans, wheat and rice, all crops grown in Namibia. These efforts are being undertaken by HarvestPlus which is part of CGIAR research program on agriculture for nutrition and health spread over 40 countries across the globe. CGIAR is a globe agriculture research partnership for food secure future. HarvestPlus works with public and private partners and is coordinated by International Centre for Tropical Agriculture (CIAT) and International Food Policy Institute (IFPRI). Thus Namibian researchers stand to gain if they seek partnership with these organizations.

Pearl Millet Processing in Namibia

Food science is uncovering new ways to improve the diets of the small-scale producers. Research on bio-fortification and breeding nutrients into crops holds great promise because it focuses on the unprocessed food staples that small-scale agricultural producers eat in large quantities every day. Bio-fortification implicitly targets its nutrient enrichment to small-scale producer households that cannot afford to purchase commercially fortified processed foods. While the technology has limits, it could give traditional African diets a major nutrition boost (UNDP 2012). Agricultural produce is the principal input into food processing industries in Namibia mainly livestock derived products such as meat products, biltong, canned beef, leather products, milk and other dairy products. From the crop products, significant processing activities include maize and wheat flour milling, packaging and baking. Many other food products such as *mahangu* are processed on a small scale for domestic consumption and domestic sales while only a few such as table grapes are exported (Fig. 6.3).

After thrashing and winnowing, *mahangu* grain is stored in a granary consisting of a number of large spherical woven baskets or bins made of *Mopane* (*Colophospermun mopane*) branches and interlaced with strips of *Mopane* bark. *Mahangu* grain is processed into flour in two major stages: first stage is pounding to

Fig. 6.3 (**a**, **b**) Harvested *Mahangu* Ears Ready for Thrashing (Source: Lydia Horn, MAWF)

remove husk during when the bran is separated from the starch, and then winnowing may follow to remove the bran. The second stage is the pounding of the starch component into flour (pulverizing or size reduction). The processing of flour involves a fermenting process which yields tasty white flour. Most commonly, pounding into flour and sieving the product is done twice. After the second pounding the flour is dried in the sun before it is considered ready for use in the kitchen or stored for a few days. In recent years, some industrial grain processing facilities have been introduced to hasten the processing procedure. Efforts are also being made to develop smaller scale processing using food extrusion and other methods which allow the grain to be milled, forced through a die so as to make a variety of products including breakfast cereals, puffed grains and pasta shapes.

Nutritionally, *mahangu* is known to be a very healthy grain and the products made from its flour provide healthy snacks compared to most other snacks whose main ingredient is plain white flour, sugar and fat. *Mahangu* is said to not just be nutritious but also gluten free and does not form acid. It is thus soothing and easy to digest. It is rich in vitamins such as Thiamine, Riboflavin, Niacin, Vitamin B and minerals such as iron, magnesium, phosphorus, copper and manganese. It also contains Phytic acid believed to lower cholesterol and Phytates, which is associated with reducing cancer risk (Namibian Economist 2011).

Traditionally, *mahangu* flour is made into porridge (*oshithima/oshifima*) or fermented to make a drink called *ontaku or oshikundu.* Recently more products have been introduced into the market through research efforts to promote processing and value-addition to indigenous products by the line ministry in collaboration with the Namibian Agronomic Board and two private entrepreneurs. *Mahangu* cookies have been introduced boasting of various brands such as *mahangu* crackers, *mahangu* cookies, *mahangu* biscuits, *mahangu* cookies with hazelnut, and *mahangu* oatmeal cookies, *mahangu* tarts, *mahangu* bread and *mahangu* cakes. The cookies, made from pure *mahangu* flour, come in four flavours, Oatmeal, Biscuits (short bread), plain cookies and cookies with nuts. They were reported to

have high nutritional values (protein and carbohydrates 77.3 g); fat (19.9 g); crude fiber (1.5 g); calcium (5.8 g), sodium (32 mg) and zinc (1.3 mg) per 100 g (Namibian, 05 December 2013).

When *mahangu* cookies were first introduced during 2012, the line Minister explained that the project is part of the ministry's efforts to promote processing of and value addition to indigenous produce. The ministry made available an industrial biscuit-making machine to one of the entrepreneurs and the nutritional value and dietary information were determined at the ministry's product development laboratory. To assure the safety and quality to consumers, the cookies were tested at an accredited laboratory in South Africa where they met all health and quality standards. Thus this can be commended as an involvement of the government in ensuring that nutritious locally developed and manufactured food and which is safe is accessible to her citizens. Processed products made from *mahangu* flour are stocked in supermarkets and are very popular among a large population in Namibia (The Namibian Economist 2011; Namibian Sun 2012). However, it is not known whether these products are accessible and affordable to the small-scale agricultural producers who do not have direct access to supermarkets. Nevertheless, this undertaking benefits the small-scale producers in that there is a ready and accessible market for their primary produce, *mahangu* grain.

Cassava and Livelihoods in Tanzania, Malawi and Mozambique

Recent years have seen growing interest in increasing land productivity and improving nutritive value and ensuring food safety of cassava in various countries including those in Southern Africa (Tanzania, Malawi Mozambique). Since the introduction of cassava (*Manihot esculenta* Crantz) into Africa by Portuguese trade-merchants in the fourteenth century the crop has become increasingly popular in Southern Africa among other regions in the continent. By 2008, cassava was grown by over 31 African countries with Democratic Republic of Congo being the largest producer followed by Tanzania as the second largest cassava producer (SADC 2009a). It is widely documented that cassava is Africa's second most important food staple, after maize, in terms of calories consumed.

In Southern Africa countries like Tanzania, Mozambique and Malawi, cassava is widely produced for food and income generation. In Tanzania cassava is grown in Eastern, Southern, Central and Lake agro-ecological zones whereas in Mozambique the crop is mainly grown in Nampula, Zambezia, Cabo Delgado and Inhambane provinces while in Malawi cassava, the second important root crop is grown in most parts of the country. It is a staple food crop for about 30 % of the 10 million people in Malawi, especially those in the five districts along the shores of lake Malawi where the soils are generally poor (Karonga, Rumphi, Nkhata Bay, Nkhotakota, and Salima). The crop ranks high among food crops in these countries owing to, among other factors, its agronomical advantages as compared to other crops. Cassava has

the ability to grow in poor soils and low rainfall while giving reasonable yields compared to other crops.

In developing countries such as Tanzania, Mozambique and Malawi, persistent food and nutrition insecurity and low income are among the factors which contribute towards the prevalent poverty and poor health among small-scale agricultural producers who depend on cassava for their livelihood. It is well acknowledged that the situation is even worse among the rural resource-poor households particularly women who continue to use rudimentary arduous methods and equipment to produce and process food for their families. This is despite the fact that locally grown root crops like cassava and protein-rich legumes such as cowpeas and soybeans have high potential in improving household food security. Nutritionally, cassava is a cheap source of carbohydrates but poor protein source. Despite this situation, the improvement of cassava nutritive value and food safety through food fortification and improved processing methods had not been given serious consideration until the early part of 2000s. Cassava consumption was largely limited to its raw state, boiled, roasted or fried, with fried cassava being popular in urban areas. Despite the huge potential lying in cassava fortification, food and nutritional insecurity including severe protein malnutrition was and still is rampant in many cassava growing areas (SADC 2009a).

Researchers in other parts of the world, particularly in Nigeria (the biggest producer of cassava in the world) had for some time embarked on enhancing the nutritional quality of cassava products through processing, especially fermentation. Prior to early 2000s, Tanzania, Malawi and Mozambique cassava small-scale producers did not benefit much from cassava be it nutritionally or financially. This is attributed to poor traditional processing technologies and preservation and marketing methods (SADC 2009a). To rectify this anomaly, during the later part of 2000s, researchers working in collaboration with the International Institute of Tropical Agriculture (IITA) and with SADC's Food, Agriculture and Natural Resources directorate (FANR) initiated investigations into ways to address the two constraints facing food insecurity among the small-scale agricultural producers dependent on cassava. The investigations confirmed that in Tanzania and Mozambique, cassava was mostly grown on small-scale farms intercropped with leguminous crops and vegetables while in Malawi the majority of the fields were planted to a mix of cassava cultivars with no or little intercropping since the soils are much poorer and other crops perform dismally (Schöning and Mkumbira 2007). In all three countries cassava was gown as a smallholder low input crop where no fertilizers were used to add to nutrient deficits inherent in the soils.

The aim of one of the research projects conducted during 2007–2009 was to develop and promote soil fertility management technologies for increasing production in smallholder cassava-based farming systems through integrated use of nutrient resources. At the time, cassava based farming systems were faced by three major constraints i.e. low soil fertility, pests and diseases and inadequate availability of high yielding disease-free planting material. Other constraints facing the small-scale producers at the time included inadequate post harvest processing technology, low per capita production and unstable and unreliable markets.

The objective of the second project was to improve the status of rural cassava small-scale growers by protecting them from cyanide exposure that emanated from traditional methods of cassava processing and subsequently improving their health through consumption and marketing of safe and high quality cassava products. Traditional cassava processing methods in the locality where the research was carried out were deemed to be inefficient and ineffective in removing cyanogens from cassava. The methods used at the time of the research involved soaking the tubers for 5–10 days before directly sun-drying of peeled whole or peeled and split cassava roots depending on the sunshine intensity. The dried cassava tubers would then be pounded in mortars to obtain fine flour for making stiff porridge (*ugali/nsima*). The method leaves the root intact with little tissue disintegration that exposes large surface area to allow release of the indigenous enzyme *linamarase* that hydrolyses the *cyanogenic glucosides* in cassava particularly the bitter varieties (SADC 2009a).

The research conducted at the time reported that during prolonged drought *cyanogenic glucosides* get concentrated in cassava varieties increasing the concentration of the toxic *glucosides* in dried cassava. During food shortages experienced during prolonged droughts, a shortened traditional cassava processing method was used that involved alternate pounding of freshly peeled bitter cassava roots followed by sun-drying and repeated pounding several times until sufficient flour is obtained the same day. During these times, cyanogens levels in cassava become highly concentrated. Therefore alternative and more efficient cassava processing methods were explored to reduce dietary cyanide exposure amongst small-scale cassava dependent communities (SADC 2009a). The research recommended soaking the tubers after peeling to improve the efficiency in cyanide reduction and that milling machines replace hand pounding. Furthermore the research recommended that waste materials be pre-treated before disposal into the environment to reduce pollution rates which were very high due to cyanogens and organic wastes being released directly into rivers and water wells.

The research revealed that lack of reliable transportation system curtailed efficient marketing of any crop surplus. Although some small-scale producers realized surpluses very few of them were involved in cassava large scale marketing mostly because transportation modes were limited to bicycles or head carting. Commonly used modes of transport were either owned or hired bicycles. Motor vehicles were only accessible to traders who transported dried cassava tubers to milling machines located in urban centers. Improved cassava processing methods were not resorted to because of poverty and lack of knowledge and cultural beliefs such as the belief that cassava processing was women's occupation and that machine processed flour becomes light and therefore difficult to handle during cooking. Even then, many of the villagers expressed interest in attending training on available diversified usage of cassava and on how to access credit facilities and market information (SADC 2009a).

The aim of the third research project conducted in Tanzania, Malawi and Mozambique was to address issues of soil fertility, food and nutritional insecurity through improvement of processing techniques, nutritional qualities of cassava products, and diversification of products. The main goal was to explore ways of

enhancing nutritional quality, safety and diversity of cassava based food products. Specifically, the project targeted two things; (i) developing novel cassava fermentation techniques that would improve the nutritional quality and safety of cassava products through protein enhancement and reduction of cyanogens levels by fine-tuning the traditional fermentation process used to detoxify the cassava and (ii) developing improved cassava based formulations and fortification techniques using soybeans and cowpeas for nutritional enhancement and diversification of products. Improvement of nutritional and safety status of cassava products was envisaged to offer significant advantages to the small-scale agricultural producers diets because animal-based proteins were too expensive for the majority of the small-scale producers in the three countries. Most diets derived their proteins from traditional vegetable sources such as beans and leafy vegetables, which are inherently low in protein content. High protein legumes such as cowpeas and soybeans were not widely consumed which partly explained the high rate of malnutrition observed during the research period.

In carrying out the projects the researchers closely involved the small-scale producers in identifying shortfalls and possible interventions which incorporated the producers' indigenous knowledge and processing methodologies. It emerged that the producers in predominantly cassava-based farming systems were poor and faced frequent food and nutritional insecurity due to among other things poor production and processing methods. Thus focus was placed on poverty alleviation through soil fertility improvement and value addition to cassava products. To address the soil low fertility, Zinc fertilizer was added to Nitrogen (N), Phosphorus (P), and Potassium (K) fertilizer to ensure that it does not limit plant growth. Cropping systems tested were cassava-maize-cowpea multiple cropping system; cassava-cowpea intercropping system; cassava-maize-*bambara* groundnut multiple intercropping and cassava-*bambara* groundnut intercropping systems (SADC 2009b).

Phosphorus, potassium and zinc fertilizers were applied by broadcasting at planting. Nitrogen was applied in two splits using banding method. Half at 4 weeks after planting, and the remaining half at 4 months after planting. Second dose was applied at 2 months after planting. In the cassava + cowpea + maize cropping system, crop spacing was 1 × 1.2 m, which is 1 m between cassava plants (*kiroba* variety) within the cassava line and 1.2 m between cassava lines. Maize was planted between cassava lines at a spacing of 60 cm between maize plants (TMV I variety). Cowpeas (*vuli* variety) were planted in the cassava line between the cassava plants. In the cassava-cowpea intercropping system, crop spacing was 1 × 1 m (that is 1 m between cassava plants within the line and 1 m between cassava lines). Cowpeas were planted between cassava lines at a spacing of 30 cm between cowpea plants (*vuli* II variety) (SADC 2009b).

Exchange visits were organized where individual grower groups visited individual experimental plots and assessed the different treatment performances. There were also exchange visits between groups in each other's country. During these visits superior as well as poor treatments were noted. Discussions between the different groups were held on the impact of the treatments to the environment. The growers for example appreciated the impact of the canopy of the fully grown cassava

and healthy plants which suppressed weeds and therefore saved them from weeding for the third time. In addition they noted that soil erosion and runoff were minimized as a result of the canopy.

Fertilizers application increased cassava yields significantly ($P<0.05$) as compared to non fertilized cassava yields. Average yields for two growing seasons showed that all tested fertilizers except N treatments gave highest yields in all plots treated with combinations of N, P, K and Zn at a rate of 40, 30, 40 and 10 respectively (SADC 2009b). High response of cassava yields to these combinations indicates that all these nutrients should be applied to get optimal crop yields from the production systems (all things being equal). It has been reported elsewhere that water stress during 1–5 months after planting cassava may reduce root tubers up to 32–60 % (SADC 2009b). Yields from non fertilized plots (Figs. 6.4 and 6.5) were much higher than those from non-fertilized fields (Figs. 6.6 and 6.7). Timely farm operations, use of improved variety (*kiroba*) and appropriate plant population contributed to higher yields from the trials. Generally the response of the crops to the tested fertilizers in the cropping systems was associated with soil fertility conditions, crop characteristics, adequate and distribution of rainfall during the growing seasons.

The research project introduced value addition to the cassava products. The project introduced the philosophy of processing cassava into a range of value-added products

Fig. 6.4 Cassava tubers treated with N, P, K and Zn at a rate of 40, 30, 40, and 10 kg/ha (Tanzania)

Fig. 6.5 Cassava tubers treated with N, P, K and Zn at a rate of 40, 30, 40, and 10 kg/ha (Malawi)

Fig. 6.6 Tubers from non-fertilized field (Tanzania)

Fig. 6.7 Tubers from non-fertilized field (Malawi)

like high quality and fortified cassava flour, baked products like breads, deep fried products such as chips (*kibabu)* and fried products such as flat bread (*chappati)*. This move was achieved with full participation of the farmers who were the key stakeholders. The issue of poverty which was identified as the trunk of the tree of problems was addressed primarily by encouraging the farmers to add value to their produce during processing in order to earn more money from the cassava they produce. Appropriate agro-processing machines (i.e. the cassava chipper for producing cassava chips and the cassava grater for grating cassava into a paste) were introduced and the farmers were trained on how to use them.

In Tanzania, the problem of lack of improved planting materials was addressed by linking the farmers with the Root and Tuber section of the Kibaha Sugarcane Research Institute (KSRI) which has a national mandate to produce improved root and tuber planting materials. One prolific cassava variety (locally known as *"kiroba"*) was obtained from KSRI and introduced to the small-scale producers in the research area. This variety is known to be high yielding and resistant to common cassava diseases in the country. The main product that had huge market potential was the High Quality Cassava Flour (HQCF). The problem of limited market for raw cassava was addressed by encouraging the farmers to focus on sale of value-added cassava products rather than raw cassava (SADC 2009c).

In Tanzania, cassava fortification by using soybeans was chosen because (i) soybean is nutritionally superior over other legume crops, and (ii) soybean is readily

available in the country although it was not grown in the study area at the time of the research. In Mozambique, fortification employed cowpeas because they were grown locally while soybean was scarce even in large markets in Mozambique. As for cassava fermentation, in Tanzania both wet and dry fermentation were experimented with as practiced in different parts of the country, although dry fermentation was used almost exclusively in the study area. Stakeholders agreed to try both methods of fermentation because the results obtained could be used in other areas thereby making it easy to scale-out the project. In Mozambique on the other hand, cassava fermentation was of lesser significance because cassava was largely consumed in the form of *rale* prepared directly from fresh cassava tubers.

Conclusions and Recommendations

Southern Africa is characterized by similar climatic conditions and more or less similar natural resources such as soil and land productivity. While small variations exist, the great similarities are manifested in that agriculture is the dominant sector of economic activity and employment in most countries of the region. Agriculture is the backbone of the region's economy which employs between 70 % and 90 % of the population. Agriculture contributes more than 35 % of GDP and accounts for almost 85 % of the export earnings. Many rural communities are small-scale crop producers and animal herders depending upon agriculture for their livelihoods. Much of the small-scale agricultural production is characterized by low inputs, rudimentary agricultural implements and machinery and depends largely on rainfall. Irrigation is rarely practiced to support the small-scale farming systems.

Research investigations cited in this chapter endorse the fact that agriculture is the most important economic activity supporting the livelihoods of the majority of the small-scale producers who are largely resource-poor and that the most important crops grown are pearl millet, sorghum and cassava sometimes intercropped with legumes such as cowpeas, ground beans and maize. The research projects revealed that the major constraints limiting farmers from achieving the potential crop yields are low soil fertility, scarce rainfall, limited production resources and inadequate knowledge on soil fertility improvement options. Some social economic and cultural factors such as producers' perception on fertilizer requirements for their most dependable crops, low household income, inaccessible markets, poor processing techniques and post-harvest crop losses influence non-employment of soil fertility improvement technologies that would increase nutritional levels and ensure food security and food safety.

Success in the small-scale agricultural sector is largely constrained by climatic and land physical characteristics as well as low labor skills. Despite the high agricultural potential of the region, often, food deficits are experienced particularly during extended dry spells that are from time to time prolonged culminating into droughts. Thus efforts are being made to address the chronic food deficits which have dogged the region for quite a while. At these times of food deficits, many

small-scale producers resort to food relief and extended family support wherever feasible. Out of the many crops grown by the sector, millet and cassava have proven to be the most dependable crops that support the small-sector producers during critical periods. Thus efforts to stabilize and increase yields have been stepped up by government agriculture departments and researchers in tertiary institutions in collaboration with foreign research agencies who provide research funds and in some cases technical advice. The research findings presented in this chapter are examples of the outcome of such collaborative endeavors.

Recent research on fortification of pearl millet offers an important strategy that can overcome rampant malnutrition and stunting inherent in those areas that rely on pearl millet like northern parts of Namibia. More productive varieties of pearl millet have been introduced into the small-scale agricultural sector enabling farmers to increase production considerably. Iron-rich pearl millet is being developed using conventional breeding by the ICRISAT and it has been demonstrated that iron-rich pearl millet variety (ICTP-8203Fe) commercialized in 2012 provides more zinc, is high yielding and is disease and drought tolerant. The bioavailability studies done in women and children show that high-iron pearl millet provides many health benefits. Thus these results should encourage the production and consumption of biofortified grains in Southern Africa as a whole.

The three research projects carried out in collaboration with FANR at the SADC Secretariat and funded by FIRCOP of France recommended the need to fortify soil fertility by applying fertilizers. From these studies the best fertilizer use combination giving the highest benefit for investment is Phosphate Rock (MPR) at a rate of 30 kg P/ha + Potassium Chloride 40 kg K/ha + Zinc 10 kg/ha for the cassava and cowpea intercrop. For sustainability it was recommended that fertilizer application should be for at least one out of two seasons. It was also recommended that small-scale producers need to be linked to input dealers and farm equipment owners. Long term plans to address the problem of poor farming equipment access and lack of inputs should include putting in place tractor hire centers within the reach of the small-scale producers as well as input stocks within or close to their settlements.

Further recommendations made include that improved processing techniques centered on food safety and value addition as well as better post harvest product management including marketing should be part of the efforts geared towards improving production in order to encourage farmers to invest on good land management, fertilizer use and environmental protection. A rectification is called for to dispel the farmers' belief that cassava cannot be grown with fertilizer because cassava is low nutrient demander hence can be grown without application of inorganic fertilizer, and that the taste of cassava would change if fertilizer is applied. Therefore, departments of agricultural extension services need to continuously campaign to raise and strengthen awareness on the need to use fertilizer in cassava production systems.

More recommendations made by these research studies include those on efficient and safe methods of cassava processing and preservation and raising awareness among the households on health risks posed by cassava cyanide and toxicity. Training on safe and hygienic methods of cassava processing to minimize

contamination by microorganisms is called for just like ways of establishing linkages to markets which would afford small-scale producers chances to negotiate and respond to price fluctuations affecting their products. Such ways could include the establishment of farmer information centers where market information and demand of cassava products and their prices would be shared.

Further interventions recommended involve setting up more demonstration plots for improved cassava varieties in order to have seed multiplication of improved cassava varieties that are resistant to drought, pests and diseases. The value addition projects already started in the case of pearl millet and those recommended in the case of cassava require further support and strengthening. The small-scale producers should be afforded easy-terms credit facilities and assisted in acquiring business skills so as to be able to start and run their business ventures successfully and thus repay loans promptly.

References

Bunting DG, H WA, Wilson JP, Ni Xinzhi (2007) Efficacy of insecticides for control of insect pests of pearl millet for grain production. Management plant network. www.ddr.nal.usda.gov. Accessed 28 Mar 2010

Dewey L, Wayne H, Bunting GD, William D, Timper P, Wilson JP (2009) Pearl millet for grain. University of Georgia and USDA-ARS cooperating. www.pubs.caes.uga.edu. Accessed 28 Mar 2010

Dirkx E, Hager C, Tadross M, Bethune S, Curtis B (2008) Climate change, vulnerability and adaptation assessment Namibia. UNDP, Windhoek

Fleissner KWE (2005) The effects of crop rotation between cowpea and pearl millet on pearl millet yield. AGRICOLA/MAWF, Windhoek

Heinrich G (2004). A foundation for the future: the Sorghum and Millet Improvement Programme (SMIP) in Southern Africa. In: Proceedings of the SMIP final review and reporting workshop, ICRISAT, Bulawayo, 25–26 Nov 2003

Hirji RJ, Maro P, Chiuta M (eds) (2002) Defining and mainstreaming environmental sustainability in water resources management in Southern Africa. SADC/IUCN/WB/SIDA, Maseru

ICRISAT/IITA/SARRNET (2012) Iron-rich pearl millet variety (ICTP-8203Fe) commercialized. http://www.icrisat.org/newsroom/latest-news/happenings/happenings1578.htm#2. Accessed 26 Nov 2013

Ipinge SN (1998a) Breeding to increase productivity and grain yield in pearl millet. www.nbri.org.na/old/agricola/. Accessed 13 Nov 2013

Ipinge SN (1998b) A proposal for release of pearl millet varieties SDMV 93032 (Okashana 2) and SDMV 92040 (Kangara). MAWF, Directorate of Research and Training, Windhoek

Ipinge S (2000) Improving sorghum and pearl millet for specific end-users: a challenge. MAWF, Directorate of Research and Training, Windhoek

Journal of Nutrition (2013) Bio-fortification of pearl millet with iron and zinc in randomized controlled trial. J Nutr. doi:10.3945/jn.113.176677; Total iron absorption by young women from iron-biofortified pearl millet composite meals. doi:10.3945/jn.113.176826

Manning K, Pelling R, Higham T, Schwenniger J-L, Fuller DQ (2010) 4500-year old domesticated pearl millet (*pennisetum glaucum*) from the Tilemsi Valley, Mali: new insights into an alternative cereal domestication pathway. J Archaeol Sci 38(2):312–322

Matanyaire CM (1998) Sustainability of pearl millet (*Pennisetum glaucum*) productivity in northern Namibia: current situation and challenges. S Afr J Sci 94:157–165

Namibian Sun (2012) *Mahangu* cookies hit the market. Namibian Sun Reporter 2, 7 Sept 2012
NCCF (2007) Climate change: impacts, vulnerabilities and adaptation in developing countries. United Nations Convention on Climate Change Framework, Bonn
Reid H, Sahlén L, Stage J, MacGregor J (2007) The economic impact of climate change in Namibia: how climate change will affect the contribution of Namibia's natural resources to its economy. Environmental Economics Programme Discussion Paper 07–02. International Institute for Environment and Development, London
SADC (2009a) Improving rural family health through proper processing and consumption of safe and high quality cassava products in Mtwara. Final FIRCOP project report, Project 4
SADC (2009b) Participatory technology development for improving soil productivity in cassava based farming systems in Tanzania and Malawi. Final FIRCOP project report, Project 7
SADC (2009c) Diversification of processing and utilization of cassava products through the development of fortified soya/cowpea based products for enhancement of nutrition and safe qualities. Final FIRCOP project report, Project 5
Schöning A, Mkumbira J (2007) Cassava Transformation in Southern Africa (CATISA) project Malawi report, 2007. Research report submitted to Lund University, Sweden as part of Southern Africa Root Crops Research Network (IITA/SARRNET)
Shiningayamwe EN (2012) Crop rotation as a soil fertility improvement strategy using different legumes on pearl millet yield. AGRICOLA, MAWF, Research and Training Division, Windhoek
Susskind L (2009) Adaptation vs mitigation. http://the consensusbuildingapproach.blogspot.com/2009/4/climate-change-adaptation-vs-mitigation.html. Accessed 10 Apr 2013
The Namibian Economist (2011) Gluten free *Mahangu* cookies. http://www.economist.com.na/2011-12-07-11-05-31/environment/1814gluten-free-mahangu-cookies
UNDP (2009) Reporting and documentation guidelines for assessment of investment and financial flows to address climate change. Windhoek
UNDP (2012) Towards a food secure future: human development report 2012. Regional Bureau for Africa (RBA), New York

Chapter 7
Climate-Smart Agriculture: Incorporating Weather Information into Small-Scale Agricultural Producers' System: South Africa

Abstract Climate-smart agriculture is a site-specific and knowledge intensive concept that urges the world to pay attention to impacts of climate change on agriculture and food security by promoting sustainable practices that will increase agricultural productivity and build resilience to environmental pressures including adaptation to climate change. The need to meet food demands that support poor small-scale agricultural producers and enhance national food security and development goals is emphasized. Small-scale agricultural producers being the foundation of food security in many countries are able to respond innovatively to rapid changes and challenges provided they receive required policy and technological support. In Southern Africa it has been demonstrated that the small-scale agriculture as practiced in many parts is dynamic; the small-scale producers often come up with innovations that are the result of very complex long-term processes and networks without external interventions. However limited resources hamper meaningful advancement. Thus demand for appropriate policy and collaborative research to assist the small-scale agricultural producers attain success. Required is research that incorporates ideas and innovations evolving from the small-scale agricultural producers' practices i.e. getting out of the traditional linear model where researchers provide the technologies that are supposed to be taken up by extension services that in turn wait for adoption by the producers. The Response Farming Project initiated to fortify the small-scale producers' food security by helping them make optimal crop planning decisions through adapting their day-to-day management by responding to anticipated immediate on-hand crop-plant-weather situation and to the medium term forecasts for the coming weeks attest to the ability of small-scale producers to respond and adapt to weather and climate variability. Incorporating weather and climate forecasts as one of the factors to consider in the day to day management of the fields was largely embraced by most of the small-scale producers and extension officers. The participatory and collaborative project involving University researchers, the weather service, provincial departments of agriculture, extension officers, the producers and donor funding agency resulted in successful production of a maize crop under low and unpredictable rain conditions amidst high temperatures and resultant high evaporation rates.

Keywords Climate-smart agriculture • Participatory and collaborative research • Response farming • Weather forecasting • Weather variability • Sustainable agriculture • Appropriate policy • Dynamic agriculture, innovative response to weather and climate change

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Introduction

Climate-Smart Agriculture

Climate-smart agriculture is a terminology coined by FAO in 2009 and refined during subsequent three global conferences first during the Global Conference on Agriculture, Food Security and Climate Change held in The Hague (October/November 2010); during a second conference held September 2012 in Viet Nam and a third conference held in Johannesburg, South Africa during December 2013. The first conference brought together the agendas of agriculture, food security and climate change while the second conference ministers of agriculture called for utilization of climate-smart agricultural practices to sustainably increase agricultural productivity and build resilience to environmental pressures while simultaneously assisting farmers to adapt to climate change while reducing greenhouse gas (GHG) emissions.

The purposes of the third conference were:

1. To promote a climate-smart agriculture alliance and share knowledge, information and good practices among public, private and civil society stakeholders as well as to promote the mainstreaming and up-scaling of climate-smart agriculture within the broader development goals.
2. To facilitate the implementation of concrete actions linking agriculture-related investments, policies, and measures with the transition to climate-smart agriculture.
3. To build global partnerships for resilience of agriculture, forestry and fisheries to climate change.
4. To promote the application of scientific solutions, information and policies conducive to increased and sustainable agricultural production yields, productivity and sustainable development.
5. To explore and share knowledge and responses of agriculture to climate change with emphasis on climate-smart agriculture, low carbon farming practices and conservation.
6. To search for new technological approaches conducive to productivity, adaptation and mitigation.

During the third conference, the World Resources Institute (WRI), United Nations Development program (UNDP), United Nations Environmental Program (UNEP) and the World Bank (WB) issued a report on achieving a sustainable food future. The report emphasizes the importance of reducing waste and demand for animal products, as well as following other climate-smart guidelines discussed during 2010 conference. The publication supports the call made earlier that "the world must meet food demands in a way that creates opportunities for the rural poor, limits clearing of forests, and reduces greenhouse gas emissions from agriculture". The report reiterates that by reducing excessive demand for animal products, hundreds of millions of hectares of forests that would otherwise be cleared for

grazing will be spared and land fertility levels restored. The report recommends that concerted efforts to improve soil and water management, improve pastureland productivity and restore degraded lands be formulated and where they exist, should be strengthened. The report further calls upon all actors to make extra efforts to raise awareness on better land management practices focusing on bringing the most inefficient farmers up to standard farming efficiency levels.

Climate-smart agriculture as coined by FAO in 2009 is defined as agriculture that sustainably increases productivity, resilience, reduces or removes Greenhouse Gases (GHGs), and enhances achievement of national food security and development goals. The approach is a further strengthening of ways to achieve the goals of sustainable development which focuses on economic, social and environmental dimensions. It is an approach geared towards developing technical, policy and investment conditions to achieve sustainable agricultural development for food security amidst climate change effects (FAO 2010). It was recognized then that meeting the multiple objectives of climate-smart agriculture requires an integrated approach that is responsive to specific local conditions. As a new approach, climate-smart agriculture also targets strengthening livelihoods and food security, particularly those of small-scale producers by improving the management and use of natural resources and enabling them to adopt appropriate methods and technologies for the production, processing and marketing of agricultural goods. To maximize the benefits and minimize the tradeoffs, climate-smart agriculture takes into consideration the social, economic, and environmental context of the localities where it will be applied as well as repercussions on local resources.

Therefore, climate-smart agriculture is an approach that requires site-specific assessments to identify suitable agricultural production technologies and practices. The approach aims to prioritize and strengthen livelihoods of the small-scale producers through improving among others, access to services, knowledge, production resources, financial support and access to markets. Climate-smart agriculture interventions are highly location-specific and knowledge-intensive. Considerable efforts are required to develop the knowledge and capacities to make climate-smart agriculture a reality. In large part, these are the same efforts required for achieving sustainable agricultural development which have been pursued over several past decades. Climate-smart agriculture offers an opportunity to revitalize these efforts, overcome adoption barriers, while also adjusting them to the new realities of climate change.

In 2010, FAO estimated that agricultural production will have to increase by 60 % by 2050 to meet expected global food demands. That is why it was deemed necessary that agricultural production be revolutionized in order to meet this demand and reduce poverty particularly in the developing countries including those in Africa. By 2010, Africa's population had just passed one billion and was expected to double by 2050. Consequently, it was estimated that Africa will need to provide adequate food supplies to feed an additional over 20 million people each year and improve the nutritional status of more than 239 million people (Pye-Smith 2011). At that time, it was recognized that developing countries as a whole and small-scale producers in particular were already grappling with the consequences of climate

change and degraded natural resource base. Hence to ensure a food-secure future, farming must become climate resilient. Examples drawn from around the world and published in 2013 indicated that governments and communities have demonstrated willingness and ability to adopt innovations that would result in an improvement of lives of millions while reducing agriculture's climate footprint. These incidences show the many ways climate-smart agriculture can take shape, and should serve as inspiration for future policies and investments (Neate 2013).

Although from the outset climate-smart agriculture appeared to be the answer to the predicament facing the global population particularly those in developing countries where most of the food is produced by resource poor small-scale agricultural producers, some reservations have been expressed by those who see difficulties in its implementation particularly the weight it gives to mitigation potentials. Serious doubts and concerns over the technical mitigation potentials revolve around whether funding will be forthcoming to enable the small-scale agricultural producers mitigate the challenges posed by climate change and rehabilitate their degraded fields so as to realize substantial increased land productivity. Another key reservation expressed entail challenges that must be tackled in order to register success in the long run including the fact that climate-smart agriculture practices require not only funding but also strong political leadership, supportive and coherent government policies and strategies, land tenure arrangements that make investments worthwhile, and, importantly, access to inputs and markets (FAC 2011a).

Those who expressed their reservations appreciates that these are not new challenges. On the contrary, they fully recognize that these challenges have been at the heart of debates on agricultural development for many decades but it has emerged very clearly that there are no quick fixes for any of them. Thus the main question is whether climate-smart agriculture will remain a distant dream, whether it will become another empty slogan, or whether it will lead to lasting improvements for the small-scale agricultural producers across Africa. While climate-smart agriculture presents an optimistic message of the future of agriculture in Africa, it however hinges on a belief that climate change can help facilitate changes that will lead not only to short term gains but also tackling the structural reasons for why small-scale agricultural producers in Africa have remained vulnerable over decades during when sustainable agriculture has been dominating the agenda of world organs (FAC 2011b).

Small-scale agricultural producers are the foundation of food security in many countries and an important part of the socio-economic and ecological landscape in many countries particularly in the developing world. Small-scale agricultural producers depend on family labour and mostly family resources to derive a large but variable share of their income and livelihoods. The land holdings are run by family members, a large proportion of which are headed by women and women play important roles in production, processing and marketing activities. Small-scale agricultural producers operate with scarce resources, especially land, which they use to generate a level of income that helps fulfil basic needs and achieve sustainable livelihoods (HLPE 2013).

Small-scale agricultural producers often resort to off-farm activities to augment their incomes and diversify risks, thus improving their resilience to the shocks that impact on agriculture; shocks such as droughts and pests invasion. During these times many small-scale agricultural producers rely on reciprocal family ties, kinship and social proximity. More often than not, small-scale agricultural producers produce for their subsistence and their food security is largely determined by their ability to meet food consumption needs and selling meager surpluses for cash generation. At the collective level, small-scale agricultural producers' families are part of social networks within which mutual assistance and reciprocity translate into collective investments (mainly through work exchanges) and into solidarity systems. They also participate (when social factors and political freedom allows it) in rural producers' organizations and local development associations in order to improve service provisions, including market access and market power, access to productive assets and to have a voice in public policy debates.

Small-scale agricultural producers contribute to food security and nutrition as well as to solving unemployment issues as they absorb family members who would otherwise be wondering the streets of urban centers looking for jobs which are hard to come by and in most cases non-existent. Small-scale agricultural producers effectively contribute towards a country's food security by feeding the rural masses and in some cases where there is policy and public investments support can contribute effectively to food sovereignty and self sufficiency and significantly to economic growth. Small-scale agricultural producers also contribute towards poverty reduction, the emancipation of neglected and marginalized groups and the reduction of spatial and socio-economic inequalities. Where there is political and technological support, small-scale agricultural producers can contribute towards sustainable management of biodiversity and other natural resources while preserving their social and cultural heritage. Thus, small-scale agricultural producers directly and indirectly contribute towards world food security and nutrition as well as poverty reduction because they produce and sustain consumption of many rural households and in many instances serve as a source of food products for urban markets.

Meanwhile, it has been erroneously stated that small-scale agricultural producers often lack knowledge about potential options for adapting their production systems to climate change effects and have limited assets and risk-taking capacity to access and use appropriate technologies proposed by scientists and donors alike. It has also been hastily recommended that in order to enhance food security in the face of climate change, mitigation measures that would preserve the natural resource base and strengthen agricultural production systems should be considered so as to increase land productivity of small-scale agricultural producers. These statements need to be tested by examining specific locations and practices going on therein because in many instances these are blanket unsubstantiated conclusions. It is crucial that factors that affect the small-scale agricultural producers' food security and their contribution towards a country's food security be accorded the attention of researchers and technologists, policy planners and policy implementers who specialize in food production issues such as weather vagaries and risks including rainfall variability, unreliability and unpredictability.

Climate-Smart Agriculture in Southern Africa

It cannot be denied that agriculture in Southern Africa like in other developing countries ought to embrace predicted climate and weather changes and adopt new technologies in order to overcome food security impediments such as constant weather variability characterizing the region including predicted long term climate change. Responding to the predicted changes and adopting recommended interventions is what was referred to as "climate-smart agriculture" (FAO 2010). Meanwhile it is safe to say that effective climate-smart practices are already being implemented in some parts of Southern Africa, what remains is injecting necessary changes that will strengthen these practices through scientific research and sourcing the required funding. These changes ought to be site specific addressing specific issues because of numerous micro variations that characterize the region. Changing small-scale agriculture is not only important for food security but also for reducing unemployment and mitigating poverty as well as for effective economic growth for the region.

Weather variability and subsequent climate change threatens the stability of food production and land productivity in large parts of Southern Africa. Long term changes in the patterns of temperature and precipitation, that are part of climate change, are expected to shift production seasons, pest and disease patterns, and modify the set of feasible crops affecting production, prices, incomes and ultimately, livelihoods and lives. In order to stabilize output and income, production systems must become more resilient, i.e. more capable of performing well in the face of disruptive events such as droughts and floods. More productive and resilient agriculture requires transformations in the management of natural resources (e.g. land, water, soil nutrients, and genetic resources) and higher efficiency in the use of these resources and inputs for production. In Southern Africa intensive research and scientific interventions are absolutely necessary.

The type of agricultural research required is research that incorporates ideas and innovations evolving from the small-scale agricultural producers' practices i.e. getting out of the traditional linear model where researchers provide the technologies that are supposed to be taken up by extension services that in turn wait for adoption by the producers. Various attempts that are now emerging include those that seek to incorporate indigenous knowledge and recognize the small-scale agricultural producers' capacity to identify and contribute to mitigations that would reduce rural poverty and improve food security. The small-scale agriculture as practiced in many parts of Southern Africa is said to be dynamic because the small-scale producers often come up with innovations that are the result of very complex long-term processes and networks. Many times these innovations occur without external interventions, they are often the outcome of the producers' response to challenges such as the depletion of vital natural resources or when they seek to benefit from market opportunities. Researchers and policy makers and implementers should recognize this and put in place policies that encourage and support these innovations. Thus it is not only a question of involving small-scale agricultural producers in experiments; they must also be allowed to play their full part at every stage of agricultural

research process from research priorities identification to interpretation and sharing the results and finally to implementation activities. The goal should be to encourage knowledge sharing and establish a strategy of dialogue between all interested parties, researchers, developers, donors and the small-scale producers themselves.

Generally, African small-scale agriculture has been described as dynamic because with little or no support from public research and development institutions, many small-scale agricultural producers are actively innovating individually and collectively to solve problems, improve their farming and income, and grasp opportunities. It is documented that small-scale agricultural producers respond in many innovative ways to the rapid changes and global challenges they face, including market competition, increasing and conflicting demands on use and management of land and water, and increasing unpredictability of weather. It is also documented that there are numerous ongoing innovative processes which show the capacity of small-scale agricultural producers to grasp opportunities, to create or access markets, to increase their resilience to risks and shocks, to manage natural resources in a responsible and sustainable way and to reshape urban–rural linkages. Yet many such initiatives take place "under the radar" or are ignored by state, non-state, private-sector and even organizations that unilaterally concentrate in developing and spreading agricultural technologies. Thus local innovations fitting the wide variety of contexts of African agriculture need to be recognized valued and encouraged (Letty et al. 2013).

While formal research and development actors provide important elements, such as new knowledge and technologies, external inputs and other stimuli for innovation, the small-scale agricultural producers and other local stakeholders such as private business in the "real world" are better placed to identify key constraints and opportunities. They are also the ones who decide if and how to use and adapt the inputs from researchers and developers to their own context, so that innovation takes root and succeed. External interventions can play an important role in initiating and supporting innovation, but should avoid creating artificial enabling conditions and incentives (including market outlets) that are far removed from local realities and are short-lived and unsustainable. Such interventions may easily undermine the existing innovation dynamics and can seldom drive innovation over the longer term. Under such conditions, interventions should start with a thorough joint assessment with local actors of ongoing innovation processes in the area, looking for initiatives that should be supported, rather than ignoring or trying to bypass them.

In Southern Africa setting, research and innovation depends on social and organizational dimensions that are closely intertwined and therefore should be addressed jointly if innovation is to be successful. Taking a holistic view of innovation by supporting its multiple dimensions gives a better chance of achieving outcomes more relevant for small-scale agricultural producers and other local actors. Beside generating and transferring technology, support should hence go to enabling and accompanying organizational and institutional changes that make innovation possible in order that it may drive large-scale spread and adaptation of technology. For example, when market opportunities emerge or new value chains are possible, small-scale

growers and processors respond eagerly if they have access to the resources and services to do so. Evolving consumer demand in terms of quantity and quality of products may also drive growers and other actors to develop new practices and relationships that promote access to food sources and income generation opportunities that stabilize their food security situation.

In Southern Africa several attempts have been made by development agencies including non-governmental agencies to come up with feasible interventions that address issues affecting productivity and food security of the small-scale agricultural producers. In certain circumstances where the suggested interventions (practices and techniques) were put forward without the input of the producers, ecological damage such as degradation of soils have resulted in lower and lower yields and have been a driver of small-scale agriculture encroachment into important natural ecological areas such as forests and land reserves. The small-scale agricultural producers' quest to increase yields through expansion of land under cultivation without incorporating appropriate informed land management techniques often resulted in crop failures and increased vulnerability to climatic shocks such as droughts, floods and changing climate patterns. Research conducted in South Africa as part of French FIRCOP supported project involving small-scale food crop producers, participatory approaches demonstrated just how much success can be achieved if a holistic approach is employed. In this case, a participatory and collaborative project involving University researchers, the weather service provider, provincial departments of agriculture, extension officers, the small-scale agricultural producers and donor funding agency resulted in successful production of a maize crop under low and unpredictable rain conditions amidst high temperatures and resultant high evaporation rates (SADC 2009).

Aim of the Project

The aim of the Response Farming Project was to fortify the small-scale agricultural producers' food security by helping them make optimal crop planning decisions through adapting their day-to-day management by responding to anticipated immediate on-hand crop-plant-weather situation and to the medium term forecasts for the coming weeks. The main purpose of the project was to enhance and sustain agricultural productivity and efficiency in the subsistence farming sector in South Africa. The main goals were to improve food security in poor rural communities; to help the small-scale producers to better manage agro-climatic risk and to alleviate poverty. It was envisaged that the project would contribute to achieving these goals by mitigating risks and improving efficiency of inputs which would result in cost savings in bad years (through applying less inputs), and achieving higher than normal production in good years (through applying greater inputs). This response made it possible to make important savings on inputs by applying inputs only when a good chance of success was envisaged. When drought risk was predicted, inputs such as fertilizer were reduced or their application postponed.

The Response Farming Project was based on responding to the immediate weather and climate conditions where the activities at farm level were altered or shifted in response to daily predicted weather conditions. Relevant farm management activities were recommended to the small-scale agricultural producers which gave them a chance to instantly change an activity (e.g. suspending weeding upon prediction of dry conditions or hurriedly harvesting a ripe crop upon prediction of excessive heavy rainfall). In this method, relevant input data like weather forecasts, amount of rainfall and physical status of the plants were deemed important in establishing the Response Farming System. In this project the weather forecasts were obtained from the South African Weather Service (SAWS) on a daily basis, whilst rainfall data and information on the physical condition of the fields were obtained directly from the small-scale agricultural producers. After data analysis and conversion of the weather forecast probabilities for different localities, recommendations were made and sent to the producers via SMS to their cell phones to advise them of the viable activities to be undertaken.

Project Methodology

Data Collection

Selected sites for the project on response farming were located in the provinces of Mpumalanga and Limpopo, South Africa where dry land farming is threatened by various risks associated with particular weather conditions such as drought occurring in the middle of the growing period and thus affecting the output from the small-scale producers' fields. The small-scale producers that were involved in the project were mostly women either working individually or together in community gardens. These producers had little capital and mainly manual tools. They worked on lands where potential for irrigation is limited or non-existent and their major preoccupation was to support their extended families. As such the project was designed to help resource-poor small-scale agricultural producers in coping with agro-climatological risks associated with dry land farming.

In order to achieve the goal of this project, the necessary information (water balance of the individual producers' fields, climate and weather forecasts and resulting recommendations) were given to the extension officers and the participating small-scale agricultural producers who were trained to understand and appreciate the recommendations and therefore were able to implement them. All the involved producers were able to understand the weather forecasts and how to interpret the recommendations. Both the small-scale agricultural producers and extension officers fully appreciated the environmental impacts of the agricultural activities as they had been trained on good practices to lessen natural resources' degradation.

The participatory approach afforded opportunities for resource poor small-scale agricultural producers to work together with crop specialists so that the producers learned by experience whilst the specialists became more aware of indigenous knowledge and other sociological aspects and beliefs which influence the producers

decisions. Customarily, participatory research requires that all activities and recommendations are discussed between the producers and extension officers. As such during the planning of the research, the producers and the extension officers as well as the research scientists discussed relevant issues touching on crop varieties, planting density, planting conditions, and mixed cropping. The fieldwork was done by the producers while the research institutes covered the costs of inputs. Costs of additional labor were also covered by the research institutes depending on the individual situation. Two times a week, the producers received coded forecast by SMS, including recommendations (i.e. not orders).

The subproject supervisors made sure that they visited the small-scale agricultural producers at least twice a month at the start and during the growing season. These visits were used to discuss the given recommendations and to evaluate the actual crop status as well as to gauge the producer's perceptions. The producers were visited by extension officers as frequently as possible in order to keep track of the developments and to collect appropriate data and information necessary for better project management. There were also interactive training sessions for the producers and the extension officers to enable better understanding of used methodologies. The producers' concerns as well as challenges emanating from the project were discussed with the extension officers during these gatherings. Through a series of meetings with representatives from the departments of agriculture, a total of 12 sets of small-scale producers were selected from service centers which have different micro-climates, 4 in Limpopo and 8 in Mpumalanga. In total 108 producers were selected to participate in the project. A simple rain gauge (Fig. 7.1) was installed in all selected sites.

Fig. 7.1 An extension officer beside a simple rain gauge at Mamvuka

Fig. 7.2 Planting maize at Phula, Mpumalanga

Soil samples were taken at each and every field to determine the fertility and mineral deficiency in the soil. Samples were taken at more than five sites per field for the 0–15 cm upper soil depth and then mixed to find an average. The parameters measured were Phosphorus (P) content in mg/kg; Potassium (K) content in mg/kg and me/100 g; Calcium (Ca) content in mg/kg and me/100 g; Magnesium (Mg) content in mg/kg and me/100 g; Sodium (K) content in mg/kg and me/100 g; pH Resistance (ohms).

The main crop of interest to the project was maize as it was the staple food for most people in Limpopo and Mpumalanga. Cowpeas were added as a second crop to help the small-scale producers balance their diet and to introduce intercropping which was not commonly practiced in these rural areas. Yield from the cowpeas was not determined in the project because the producers constantly harvested the leaves which they used as a vegetable and thus undermined the ultimate grain yield (Fig. 7.2).

The maize crop was planted first using a line spacing of 90 cm and row spacing of 40 cm and the second crop (cowpeas) was planted later. During the first year (2007/2008) the majority of the small-scale agricultural producers ended up only with maize crop because of the unavailability of cowpea seeds at the time of planting and subsequent dry spells during the season. During the second agricultural season (2008/2009), most of the small-scale agricultural producers from both provinces planted both maize and cowpeas. Planting of the fields started in mid-November 2007 and ended in mid-January 2008 for the Limpopo trials. In Mpumalanga, most producers planted during late November and December 2007. Due to germination problems some of the producers had to re-plant in January 2008.

Medium-term forecasts were obtained on a daily basis from the South Africa Weather Service (SAWS). The forecasts were presented in map format showing

probability of light rainfall (>1 mm), medium rainfall (>5 mm) and heavy rainfall (over 20 mm). The images were then converted to percentage codes for each of the regions in order for the information to be shortened for SMS transmission. The coded SMSs contained four main parts, dates; weather types; rainfall probabilities and recommendations. Information was abbreviated so that the dates started with the abbreviation of the day of the week and the date of the first day of the weather forecast followed by the abbreviations of the day of the week until the end of the week according to Mellaart's format. For example **W=9 TFSSMT** indicates that the forecast is effective from Wednesday (W) the 9th followed by Thursday (T) up until the following Tuesday (T). Weather types were in the following code: f=fine, t=thunderstorm, r=rain, d=drizzle, p=partially cloudy, s=showers, c=cloudy and they appeared in the second row of the coded SMS, e.g. W=**9 TFSSMT tcpffpt.** The first "t" and last "t" imply that there are thunderstorms expected on Wednesday the 9th and Tuesday the 15th.

In the above example, rainfall probabilities were represented in deciles with 1 representing 10 % and 8 representing 80 % chance of rainfall. The probabilities were divided into three categories: the chances of rainfall exceeding 1 mm appeared in the second and third rows, the chances of rainfall exceeding 5 mm appeared in the fourth and fifth rows, and lastly, the chances of rainfall exceeding 20 mm in the sixth and seventh rows. The values in the second row showed probability of rain for 7 days starting on Wednesday, while the third row showed the chances of rainfall in the second week preceded by "2w" which is a symbol for second week. The seasonal forecast was obtained during the beginning of the season from the SAWS as well as the monthly updates. This information was helpful in providing the expected cumulative 3-monthly rainfall for the season. The small-scale agricultural producers and extension officers were advised in advance of the expected rainfall in the next 3–6 months of the agricultural season.

To make recommendations on the farming actions, the data considered included the plant development stage because the stage of the plant growth was key in determining the recommendations to be made as normally the plant responds differently to a weather phenomenon depending on its growth stage as well as the pertaining state of the field due to the fact that usually the state of the field is also crucial in tailored recommendations. The extent of the weeds coverage, level of pest infestation and moisture content are some of the physical environmental properties of the field which had to be considered before making any recommendations. During the pre-season, seasonal forecasts were viewed which gave an indication of how the season might be for the entire region. These earlier forecasts also helped to determine the seed varieties to be used. During the season, the 2-week forecasts formed the integral part of the Response Farming decision-making system.

Harvesting for each plot, yield data was obtained from a random sample of size 10 m×10 m but in some places the whole field was harvested. Figure 7.3 shows accumulated harvest data from one of the fields during the 2007/2008 agricultural season. All the cobs were harvested and counted. Three to six samples of 20 cobs

Fig. 7.3 Maize cobs harvested at one of the fields in Limpopo

Fig. 7.4 Weighing of cobs, Limpopo

were then weighed to obtain the average weight of one cob (Fig. 7.4). Three to six cobs were also selected randomly; the grains were then removed and counted to obtain the average number of grains per cob (Fig. 7.5). A further 3–6 samples of 200 grains were weighed to obtain the average weight of one grain (Fig. 7.6). Moisture content of the three samples was determined using a grain moisture meter (Figs. 7.7 and 7.8).

Fig. 7.5 Counting of grains

Fig. 7.6 Weighing of grains

Fig. 7.7 Measuring grain moisture content

Fig. 7.8 Grain moisture meter reading

Data Analysis Results and Discussion

Rainfall Data Analysis

Long-term cumulative seasonal rainfall records show that the western parts had low cumulative rainfall of less than 400 mm (October to April). These sites in the western parts were more prone to extended dry spells while the other trial sites situated in the eastern and central parts recorded long-term mean seasonal rainfall between 500 mm and 600 mm. There were few sites which fell on a higher rainfall zone of 600–700 mm. Cumulative rainfall for Mpumalanga trial sites showed the majority of the sites as being in the 600–700 mm rainfall zone while a few others had seasonal rainfall normally above 700 mm. The interpolated mean surfaces shown in Figs. 7.9 and 7.10 show the average seasonal rainfall for the sites and thus in other years (El Nino years) the seasonal rainfall would be lower than normal while in favorable years (neutral & La Nina years) the seasonal rainfall would be normal to above-normal.

Soil Sample Results

Soil fertility results for the Limpopo trial sites showed that most of the fields had deficiency of phosphorus (P). The potassium (K) content in most of the fields was moderate to high. A few exceptions were noted where P and K deviated slightly from those recorded in most of the fields. The content of micro-elements like calcium (Ca), magnesium (Mg) and sodium (Na) were moderate to high in all the fields. The pH of the soil was neutral with a slight bias to acidic. Fertilizer recommendations were made taking these findings into consideration. The soil mineral

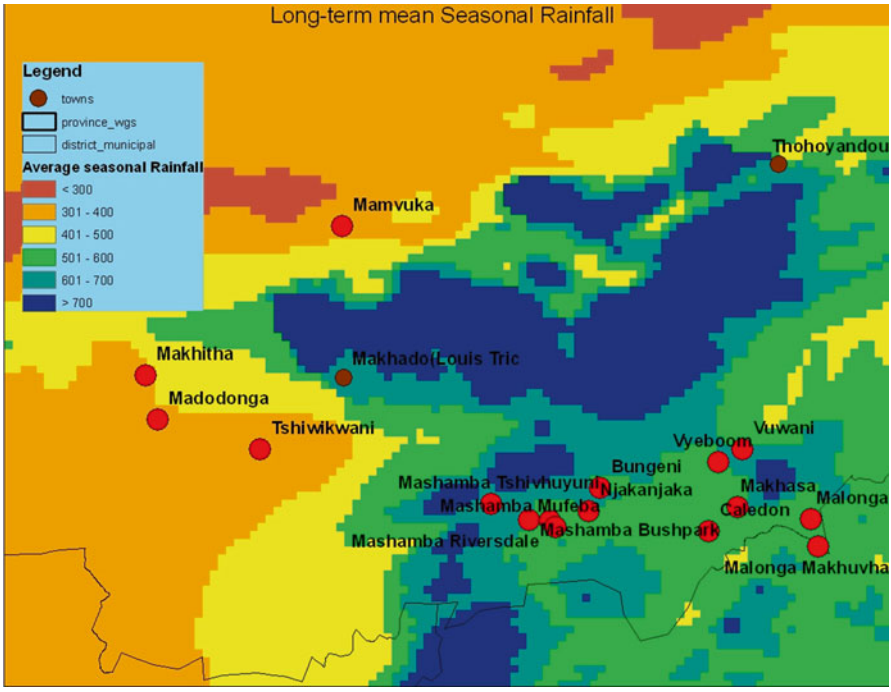

Fig. 7.9 Long-term seasonal rainfall for Limpopo sites

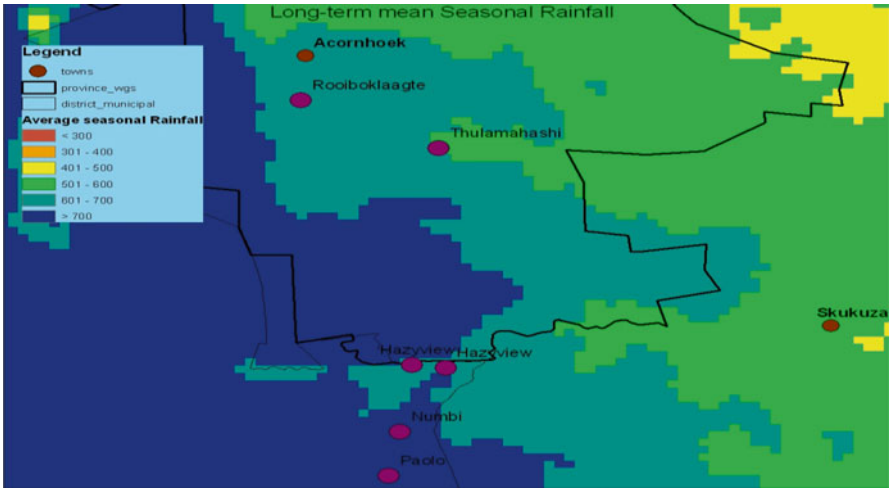

Fig. 7.10 Long-term seasonal rainfall for Mpumalanga sites

content in Mpumalanga trial sites also showed deficiency in P in most fields with the exception of one field which had moderate P content. Potassium content was mostly moderate with values below 60 mg/kg. The levels of micro-elements were low to moderate at all the Mpumalanga sites with neutral pH.

Crop Water Requirement

During the first agricultural season most planting was done late with the earliest planting in the second dekad of November (21–30 Nov). The latest planting dates were between 1 January and 10 January. The water requirement satisfaction index (WRSI), which is a measure of how the water requirement of maize were met, show unsatisfactory results for all the trial sites in Limpopo with the exceptions of two sites where the water requirement was marginally met (70–80 %). At the few sites where cumulative seasonal rainfall exceeded the cumulative crop water requirement, the index value was not at maximum value (100 %) because the rainfall was not distributed according to crop water requirement. However in the second agricultural season the crop water requirement was achieved as in all the fields the seasonal rainfall exceeded the seasonal crop water requirement. The number of dekads with water deficit was comparatively lower than that experienced in the first (2007–2008) agricultural season.

Grain Yield

All the grain yield values were calculated at a moisture content of 12.5 %. During the 2007/2008 season, at some places the yield was very low, around 0.3 t/ha. This low yield was mainly attributed to the very late weeding at the critical phenological stage i.e. vegetative stage (Fig. 7.11). Where better field management was practiced and the recommendations were followed closely, much higher yields (>3 t/ha) were recorded (Fig. 7.12).

The 2008/2009 agricultural season resulted in an overall increase in maize yield in most places due to better understanding of methodologies even though the seasonal rainfall was low and its distribution was also uneven. During this season, some of the fields recorded less maize yields than the yields obtained in the previous season mainly due to the infestation of birds at emergence and monkeys at silking stage. At this site planting occurred way before the surrounding producers not participating in the project and thus all the birds and monkeys seriously affected the resulting harvest. Some of the affected fields had to be re-planted as a result of birds eating emerging plants/seeds. However, on the whole there was a great deal of improvement in maize yield (1.1–2.3 t/ha). In a few cases, the producers harvested the fields without informing the project leader and in others animals destroyed all the harvest because of inadequate fencing; so that no yields were recorded.

Fig. 7.11 Poor crop due to late weeding at Malonga, Limpopo, in 2007

Fig. 7.12 Health crop due to early weeding at Mashamba, Limpopo, in 2007

The yield of cowpeas was not calculated because the producers progressively harvested the leaves as well as the green peas for their home consumption.

The final harvests indicated the extent to which the recommendations resulted in reducing risk and minimizing unnecessary inputs. Measurements of production made to ascertain food security showed that in most fields the harvest exceeded the normal harvest obtained during previous years during when only traditional knowledge and traditional methods were used to manage crop growing.

Challenges, Conclusions and Recommendations

Project Challenges

Several challenges were faced in this project. Some of the participating small-scale agricultural producers found it difficult to treat response farming plots differently from the rest of their fields and lacked consistence, hence making it difficult to distinctly differentiate between the producer-managed plots and the response farming plots. In some cases crop losses were experienced due to invasions by both wild and domestic animals; in a few cases the producers lost all their produce. Furthermore at a few of the producers' fields, rainfall recording was not properly done making it difficult to analyze rainfall data. Similarly, measurements of the growth rate and weed infestation were inconsistent in a few fields.

More challenges arose where communication problems arose in some of the fields and the producers unilaterally took major decisions like harvesting without informing project managers. It would have been ideal for all the fields to have planted the two crops recommended for the project i.e. maize and cowpeas, but unavailability of seeds and persistent dry spells delayed and even prevented the planting of the second crop at some places. Tractor availability was a common constraint in most places as there were few tractors in the project areas where demand was high especially during the early parts of the rainfall season. In addition, excessive rainfall made it difficult for tractors to work in some areas. Disagreements within some of the community gardens restricted full participation by all members; as a result some of the important tasks like weeding were not done satisfactorily.

Further challenges arose from the fact that some of the recommendations included in the messages that were sent to the producers were not adhered to without any valid reasons. Varying literacy levels as well as understanding of simple scientific approaches among the small-scale agricultural producers was a challenge to the project administrators as the producers had to be reminded regularly on the objectives of the project. The Limpopo trial sites were over 400 km away from the agriculture research offices and this resulted to a lag on the response to problems and delivery of inputs. Another constraint was the inability by the scientists to speak local languages in both Limpopo and Mpumalanga.

The project thus recommended that the assistance of NGOs like EcoLink which focus on small-scale agricultural producers should be exploited fully to help the producers have access to recommended crop varieties. Further, it was recommended that the legislation governing farming activities take cognizance of the interaction between socio-economic factors and climatic variations when implementing the response farming methodology in different regions and countries to establish the potential and advantages of the method. Research on reducing risk is important in order to combat the inherent problems linked with then persistent increase in HIV/AIDS and decline in farming labor force as well as meeting the requirement to have improved diet. Additionally, the then large reductions in government drought relief in South Africa placed the responsibility of producing enough food to meet diet requirements of the resource poor population squarely on the shoulders of the

small-scale agricultural producers; hence the need that they learn how to handle the climatic risks facing them. Furthermore, it was recommended that mixed cropping using leguminous crops such as groundnuts or cowpeas which fortify food supply and improve soil fertility whilst reducing production risks be incorporated into extension services packages.

At the time of the research, unemployment was rife in the selected areas where most small-scale producers were women who had slim prospects of securing formal employment. Hence the project could improve conditions for these vulnerable members of the population by potentially enabling them to produce more of their own food and eventually generate an income from selling any accruing surplus.

Project Conclusions

Generally, small-scale agricultural producers have restricted resources and they therefore tend to lower inputs to avoid cost increase but end up lowering yields from their pieces of land. The yield is also affected by variable weather conditions inherent in the area. Therefore to lower the risks and ensure better yields it was made sure that the producers received appropriate information and had access to those crop varieties which are most suited to that area. Response Farming research carried out during 2000–2006 by Mellaart had shown that small-scale producers are usually willing to use improved new crop varieties. Non-use is attributed to lack of access to improved seed varieties which forces them to grow crop varieties which are available locally (SADC 2009).

Although it was highly challenging to work with this sector of the farming community in South Africa, it emerged that the method helped a large group of resource-poor agricultural producers and improved output from their small plots of land. The incorporation of weather and climate forecasts as one of the factors to consider in the day to day management of the fields was largely embraced by most of the small-scale agricultural producers and extension officers. The producers and extension officers showed great interest and ability in grasping the principles of response farming after the training workshops that took place during mid-season.

Use of indigenous languages made it easy for the small-scale agricultural producers and the extension officers to understand the methodology. Those producers who were more dedicated in implementing the response farming methodology received better yields than those who were not so committed. However most of the producers displayed great interest in knowing the soil fertility of their fields as well as how they could improve their soils following the information sessions. Frequently the producers including large-scale agricultural producers not involved in the project requested for the information provided to those in the project which was a good indication that the response farming approach had yielded visible benefits to the participating small-scale agricultural producers. Meanwhile the scientists grasped the benefits of indigenous knowledge and beliefs which still play an important role in agricultural production in the rural areas. Better understanding of these aspects by the scientist definitely closed the gap between indigenous knowledge and science.

Project Recommendations

It was recommended that in future communications between the researchers and the small-scale agricultural producers should be conducted in local languages to enhance interpretation of the forecast recommendations. The participation of the small-scale agricultural producers is essential in improving the Response Farming system. It was further recommended that the growers be assisted with basic funding to meet basic needs such as mending gates and fences to their field to minimize losses from animal invasion and thefts which were rampant at some of the fields. Furthermore, it was recommended that in the future, socio-economic analysis should be included in the evaluation of the project to assess the real benefits of the project. The amount of money spent on manpower hours, in the purchase of fertilizer and other inputs, payment of casual labor for weeding and harvesting should be compared to the monetary value of the harvest to determine the actual benefit of using the methodology in managing crop production. It would be more profitable to include dissemination of weather and climate forecasts to cooperatives and unions in order to feed more producers with climate information to help them improve their productivity. All members of the cooperative or union should be given tailored information with a low level of complexity.

It was further recommended to urgently upgrade and finance national research and extension systems targeted specifically to the needs of small-scale producers, with supporting financial mechanisms. The main objective would be to increase productivity and resilience through diversification of the production system with a high concern for the self-provision of diverse foods with a high nutritional value. Combining increased productivity and resilience will require a high level of investment in research to develop productive land-use systems with minimal ecological risk such that biodiversity may be used productively. Agricultural research and extension should support the in-situ and ex-situ conservation of agricultural biodiversity in the context of climate change. Small-scale producers need appropriate seeds as well as machinery for field operation, food processing and other value-adding transformations. International collaboration and the sharing of experiences in technology development for small-scale producers in different regions of the world should be promoted with a strong engagement, if not leadership, of small-scale producers' organizations.

General Conclusions and Recommendations

While small-scale agricultural producers are the main investors in their own agriculture system, they face many investment constraints that are specific to their situation. First, self-provision of food remains a key component of the food security strategies of their production system; it is both an asset and a constraint to generation of income and capacity to invest. Second, their risk-prone environment is a double threat to investments, first by reducing the expected output generated from agriculture, and thus limiting their own capacity to invest, and second by the need to sell some of their existing assets to cover urgent needs when there is a shock.

On the productive side, technical risks owing to plant pests, animal diseases, climate variability, rainfall irregularity and floods combine with market price volatility to reduce the expected output from their land holdings.

Meanwhile, all small-scale agricultural producers have to make investments in seeds, fertilizers and labor for current production yet limited income and assets constrain both direct investments and access to credit. Natural and production hazards may lead to increased indebtedness. Family labor is often diverted towards more remunerative off-farm activities such as paid employment. In the small-scale agricultural producers' holdings the family side and the productive and economic sides are closely intertwined: domestic or family risks such as illness, or life-related events such as marriage, may lead to a reduction in productive assets in order to cope with such needs.

In most cases small-scale producers are keen to invest in agriculture to improve their performance if minimum conditions are met. First of these conditions is the capacity to access diversified assets without reducing family consumption below a critical level. Second is a secure environment that provides expectations of improvement in the technical and economic performances of the land holding at their disposal. Third is to enjoy improved standard of living conditions regarding access to public or private services and to consider that living in the rural areas depending on agriculture is a viable option. This minimum set of conditions implies that continues investments by small-scale agricultural producers require injected investments by both private and public institutions. Private institutions should have an interest in investing in rural areas, while public investment is needed to guarantee access to basic services and convince the small-scale agricultural producers to remain in the rural areas when they see prospects of more decent living in rural areas. Migration to towns will cease if the third condition is fulfilled (Chamberlin and Jayne 2012).

Agricultural advisors and research scientists are in a key position to be brokers of innovation processes and to provide a host of other support services to innovation initiatives of small-scale agricultural producers and local enterprises. However, they need to have an explicit mandate for playing such roles, while their capacities to do so need to be strengthened by adequate funding, relevant policies and regulations governing the small-scale agriculture sector (Waters-Bayer 2011). Renewed investment in rural advisory services is needed, and institutional support for advisors to be able to play a brokerage role in innovation processes has to be firmly integrated at all levels in the advisory services. Universities, colleges and vocational schools play a major role in preparing future and current researchers, rural advisors, small-scale agricultural producers' leaders and local government staff through initial and continuing education. To build capacities, educational and training institutions need to interact closely on the ground with small-scale agricultural producers, rural communities, entrepreneurs, advisors, researchers and government staff. Students, teachers and all stakeholders should be exposed to innovation dynamics in small-scale agriculture and should learn how to see and analyze the processes, contribute to documenting and understanding how agricultural innovation happens, and acquire the skills needed to support it.

References

Chamberlin J, Jayne TS (2012) Unpacking the, meaning of "Market Access". World development, vol 41, Jan 2013. www.afre.msu.edu/people/chamberlin_jordan. Accessed 19 Sep 2013

FAC (2011a) Agriculture and climate change in the UN climate negotiations. FAC policy brief. www.future-agricultures.org/component/content/article/38-blog/. Accessed 2 Dec 2013

FAC (2011b) Climate smart agriculture: The new holy grail of agricultural development. Future agriculture consortium. http://www.future-agricultures.org/component/content/article/38-blog/7643-climate-smart-agriculture-the-new-holy-grail-of-agricultural-development#.Up3vcMLxs5s. Accessed 5 Dec 2013

FAO (2010) Climate-smart agriculture: policies practices and financing for food security, adaptation and mitigation. The Hague conference on agriculture, food security and climate change. www.fao.org/fileadmin/user_upload/newsroom/docs/the-hague. Accessed 30 Nov 2013

HLPE (2013) Investing in smallholder agriculture for food security: a report by the high level panel of experts on food security and nutrition. http://paepard.blogspot.fr/2013/12/investing-in-smallholder-agriculture.html. Accessed 12 June 2013

Letty B, Stevens J, Rootman G, Buthelezi N, Jagiello W, Triomphe B (2013) Experiences from JOLISAA: three cases of multi-stakeholder innovation processes in South Africa. http://www.sasae.co.za/pdf/JOLISAA%20policy%20brief%20DINA4%20low%20density.pdf. Accessed 22 Jan 2014

Neate P (2013) Climate-smart agriculture success stories from farming communities Around the world. CGIAR and CTA, Wageningen. http://www.farmingfirst.org/tag/climate-smart-agriculture/. Accessed 4 Dec 2013

Pye-Smith C (2011) Farming's climate-smart future: placing agriculture at the heart of climate-change policy. CGIAR and CTA. Wageningen. http://ccafs.cgiar.org/publications/farmings-climate-smart-future-placing-agriculture-heart-climate-change-policy#.Uybor2KKAfQ. Accessed 4 Dec 2013

SADC (2009) Adapting day to day management of subsistence and small-scale farming to weather and climate forecast to optimize inputs and reduce drought risks. Final FIRCOP project report, Project 8

Waters-Bayer A (2011) Farmer-managed innovation funds drive multi-stakeholder learning processes. In: CTA/GFRAS international conference "Innovations in Extension and Advisory Services", Nairobi. extensionconference2011.cta.int/programme/session3/networks/1