Livelihoods and Food Security Programme
Agriculture Productivity and Nutrition

CLIMATE-SMART AGRICULTURAL SMALLHOLDER PRODUCTION IN ZIMBABWE

FIAT PANIS

UKaid
from the British people

This document has been produced with financial assistance from the United Kingdom, and with technical and implementation support from the Food and Agriculture Organization of the United Nations (FAO). The views expressed herein can in no way be taken to reflect the official opinion of the United Kingdom or of FAO.

Contents

ACKNOWLEDGEMENTS

This paper was prepared for FAO by Jan Venema, and edited by Jannie Armstrong.

1 Introduction

The real and potential risks posed by climate change and increased seasonal climatic variability in Zimbabwe requires farmers to be informed, flexible, and have good access to inputs (and markets) for a variety of production systems and farming practices. It requires production systems to be more buffered against exceptional weather conditions. For crop production, this means increased crop diversification, access to drought-resistant crops and crop varieties, training in water harvesting techniques and soil moisture conservation methods, and a revival of run-down irrigation schemes and other community assets. For livestock production, this means diversification and increased production of hay and silage, and an increased flexibility to profitably to sell animals and re-stock.

Agricultural Extension will need to be diverse, participatory and demand-driven. Information and Communication Technology (ICT) based extension can cheaply service increasing numbers of small-holder farmers engaged in commercial production. The improvement of traditional farming systems, management of wetlands and other valuable land resources may need more intensive forms of participatory learning, research and experimentation via Farmer Field Schools and other participatory extension approaches.

2 Strategic Challenges

Climatic variability and climatic trends in Southern Africa and Zimbabwe: Zimbabwe mostly lies in a semi-arid region and rainfall patterns exhibit considerable spatial and temporal variability. Climatic trends show shifts in the onset of rains, increases in the frequency and intensity of heavy rainfall events, increases in the proportion of low rainfall years, decreases in low intensity rainfall events, and increases in the frequency and intensity of mid-season dry-spells. Extreme weather events, namely tropical cyclones and drought have increased in frequency and intensity. Daily minimum temperatures have risen by approximately 2.6°C over the last century while daily maximum temperatures have risen by 2°C during the same period (all data from IIED, 2012).

Low and decreasing soil fertility and low use of fertilizer: Most of the soils in the smallholder farming sector are deficient in nutrients. They are mostly sandy and acidic, and low in organic matter content, water holding capacity and nutrient holding capacity. Continuous cultivation over many decades with little addition of external nutrients has caused further nutrient depletion. Average loss of nutrients in arable land is estimated at between 50-100 kg N, P_2O_5 and K_2O (FAO, 2011). The steady decline in soil fertility may partly explain the decrease in the yield of maize from around 2 t/ha in 1990 to less than 1 t/ha in 2010 (MAMID, ZIMSTAT) Marketing of fertilizer is inefficient and with very high unit costs, particularly for smallholder farmers in remote areas.

Poor crop diversification and rotation: Maize is the main food crop grown in Zimbabwe, even in the drier parts of the country which are only marginally suitable for this crop. Maize is often grown continuously in the same field, with or with minor intercropping (such as cowpea and watermelon). The dominance of maize not only risks crop failure and hunger in years with inadequate rainfall, but also decreases soil fertility through monocropping.

Poor options for small grains and legumes cultivation: Small grains (sorghum, millet) and legumes (round nut, groundnut, peas and beans) are better adapted to the climatic conditions in the drier parts of Zimbabwe than maize, but farmers are reluctant to grow them because of production constraints, food preferences, and lack of markets (IRIN, 2012).

Weak agricultural infrastructure: Zimbabwe has a large irrigation potential (Alterra, 2013), but on average only 22 percent of all wards in the country have irrigation schemes (ZIMVAC, 2013). Low yields and poor access to markets also diminish the viability of irrigation schemes. Many community assets (e.g. irrigation facilities, roads, processing, storage, bulking centres) are dysfunctional or operating below their optimal capacity due to wear and tear and lack of operational capacity by communities.

Post-harvest losses in the smallholder sector: Most households store their harvested crops in substandard structures. The lack of proper storage facilities compels farmers to sell soon after harvesting, when prices are generally low. In addition, poor storage of grain results in food spoilage, including aflatoxin contamination. Post-harvest losses in cereals measured from maturity to final consumption can range between 20 and 30 percent (ZIMVAC, 2013).

Low productivity of smallholder animal production: Approximately 40 percent of rural households in Zimbabwe own cattle and more than 60 percent own one or more sheep or goat ('shoat'). The productivity of cattle and shoats in the smallholder sector is low and losses are high, due to poor management and drought. Management factors include low use of improved technologies (vaccinating, dosing), poor diet of dairy cows leading to low milk production, poor barn/housing structures and contaminated water sources.

Spread of pests and diseases: Increasing temperatures and changing rainfall patterns will affect the geographical distribution and intensity of pests and diseases for both crops and livestock. Additionally, if farmers embark on new or modified production systems, they will be confronted with new pests and diseases.

Outdated Agro-ecological zoning of Zimbabwe: Extension messaging is often based on the five agro-ecological 'Natural Regions' generated by Vincent and Thomas in 1960. Although very popular and easy to use, the Natural Regions are based on old and limited data and do not capture variations in soil.

3 Strategic Opportunities

Whatever the present and future climatic changes, Zimbabwe as a whole is likely to remain highly suitable for various forms of crop and/or livestock production[1]. To remain resilient in the face of climate change, the trend should be towards production which is diverse, intensive and flexible, with a rapid response potential in the event of temporal and spatial variations in both weather patterns and markets.

Even if the impacts of climate change are less than anticipated, climate smart agriculture share significant overlap with good agricultural practice (i.e. integrated soil fertility management and micro dosing, minimum soil disturbance, crop rotations, integrated pest management, soil moisture conservation, water harvesting and irrigation), which should be promoted for sustainable agriculture in any case. Similarly, Conservation Agriculture, which has been widely practiced in Zimbabwe, equally relies on many of the techniques described below, as well as minimum soil disturbance, permanent soil cover, crop rotation and intercropping. This goes to underscore that CSA does not represent wholly new, untested approaches to agriculture, but is rather a confirmation of techniques already well understood in the Zimbabwean context.

Because each farm and farm family is different, farmers should be provided with a variety of techniques to choose from, in the understanding that a single technique will rarely be effective and should be applied in combination with others.

4 Support for Communal Management of Natural Resources

The management of natural resources such as surface water, wetlands, forests, rangeland and soil are often beyond the capacity and immediate interest of a smallholder farmer and need a sustained community effort. Communal NRM can be encouraged through support for farmer field schools and other broad-based interest groups.

[1] For example it is expected that areas suitable for maize will decrease by 2080, while cotton and sorghum suitable areas will increase by 2080. In the south western parts of the country, sorghum and maize will become increasingly vulnerable to climate change while cotton will become less vulnerable. In the north central and eastern parts of the country, maize, sorghum and cotton will become less vulnerable (IIED, 2012)

4.1 Crop production

Promotion of small grains: Small grains have important potential for national food and nutrition security and as an income source for rural households (FAO, 2012). Marketing interest should be encouraged by informing farmers of various processing options and the wider population of the nutritive value of small grains. From the production side, particular attention should be paid to seed availability and pest management (quelea birds, wildlife). Sweet sorghum (*Sorghum bicolour*) is a promising multi-purpose crop (food, fodder, energy) and could provide farmers with extra income (ICRISAT, 2008). A comprehensive national policy is needed with respect to the production and marketing of small grains (INRI, 2012).

Promotion of cassava: Cassava performs optimally in (semi-)humid areas, and improved varieties with a potential yield of more than 30 t/ha have been developed by International Institute of Tropical Agriculture (IITA) and promoted by the Southern Africa Root Crops Research Network (SARRNET) and the national agricultural research system. Cassava also survives in semi-arid areas and will contribute to food security in years of low and unreliable rainfall, is easily processed at the household level, and has potential as a biofuel cash crop.

Intensive cultivation of high-value crops; market gardening
Provided a source of water is available, high-value crops can be cultivated in an intensive and cost-effective manner, whereby moisture and nutrient supply and pests can easily be controlled. A good example is the popular "Potatoes in bags" technology.

Integrated soil fertility management and micro dosing: Integrated Soil Fertility Management (ISFM) aims to make required soil nutrients available by balancing different on-farm soil organic sources with nutrients from mineral fertilizers and reducing nutrient losses through soil and water conservation (FAO, 2013). ISFM can be achieved through CA, the cultivation of legumes and agro-forestry. Soil fertility can be improved by the use of legumes as green manures, planted in intercropping systems, as part of a scheme of crop rotation or in agro-forestry systems. Studies have shown that micro dosing in semi-arid regions increase yields by 30–100percent through timely and precise applications of relative small amounts of Nitrogen fertilizer.

Soil Moisture Conservation, Water harvesting and Irrigation: Investments in on-field moisture conservation techniques (e.g. minimum tillage, ripping, constant traffic, mulching, adapted crops and crop varieties) are more cost-effective than investments in formal (smallholder) irrigation schemes. Improved water harvesting and retention structures (such as pools, dams, pits and retaining ridges) can also compensate for the increasing irregularity of rainfall patterns (FAO, 2010). Presently there are many irrigations systems which are dysfunctional or perform below their potential. The revival of existing schemes with potential to be revitalized should take priority over the installation of new schemes.

Wetland cultivation and management: Dambos, the most common type of wetland in Zimbabwe occupy between 3 and 4 percent of the land area. Wetland cultivation has been discouraged or even prohibited since colonial times. Presently, a permit is needed to cultivate wetlands and stream banks. However, there are several advantages of wetland agriculture, including dry-season cropping, the possibility of early planting and double cropping. The presence of shallow groundwater provides an opportunity of supplementary irrigation of high value crops.

Integrated Pest Management: Integrated Pest Management (IPM) is a tool for farmers to deal with old and new pests and diseases. The principles and practicalities of IPM can be learned through Farmer Field Schools, as was the case in Zimbabwe in the late 1990s when IPM was applied in smallholder cotton production (Maumbe & Swinton, 2003).

Improved grain storage: Metal silos, super grains bags and other effective grain storage technologies have been promoted by CIMMYT and partners for many years. Brick granaries and metallic silos have also successfully been introduced by FAO and partners. The production of plastic has become relatively cheap in Zimbabwe and a variety of plastic containers and silos could provide additional storage method. An innovative scheme in Kenya enables small farmers to store their produce in certified warehouses and use it to obtain credit for agricultural inputs, and enabling them to sell or consume their produce when prices are high (Thomas Reuters Foundation, 2013b).

4.2 Animal production

Improved animal breeding and diversification for resilience and increased productivity: The greatest need in genetic improvement programmes is not only improvement within indigenous breeds, but also ensuring that the merits of these breeds are widely promoted. Herbivores have different niches in utilising available herbage. Goats for example are efficient users of browse as opposed to cattle which are primarily grazers. Combination of the two in a rangeland improves productivity per unit area. In addition, there is need for vigilance to ensure that genes of indigenous breeds are not lost due to overuse of exotic stock in breeding programmes directed at increasing meat and milk production. The conservation of indigenous cattle germplasm must an integral part of the national breeding programme (Nyathi, 1990).

Multinutrient blocks to improve digestibility of fibrous feeds: Fibrous feeds such as crop residues and low quality pasture are deficient in nitrogen, minerals and vitamins. Such feeds can be better used if the rumen diet is supplemented with nitrogen, carbohydrate, minerals and vitamins which are provided in the form of urea-molasses mineral blocks. These blocks increase productivity of meat and milk production and promote higher reproductive efficiency in ruminant animal species, such as cattle, sheep and goats (FAO, 2007).

Bagged silage[2]: Conserved forage in the form of bagged silage can maintain livestock productivity through the dry season. Researchers of the University of Zimbabwe and Matopos Research station have identified ways in which smallholder dairy farmers can grow enough feed on farm to ensure that their cows produce as much milk as possible. Intercropping forage sorghum or pennisetums with lablab or cow pea can produce an average of eight tons of dry matter per hectare.

4.3 Agro-forestry

Mutambara et al (2012) demonstrated that adoption of agroforestry practices leads to an improvement in livelihoods of farmers, with increases recorded in livestock ownership, farm assets, crop production and incomes between practitioners and non-practitioners. Agro-forestry trees and shrubs need to be drought tolerant and the technologies must be adaptable to dynamic user's demands. Four possible applicable agro-forestry technologies include: live fences, trees for nutrition, improved fallows and fodder banks. Levels of awareness to agro-forestry technologies are low among the rural Zimbabwean population.

4.4 Agro-ecological zoning for more precise agricultural research and extension

A Geographical Information System (GIS) can be used to define and map up-to-date Agro-ecological Zones (AEZ), based on an analysis of recent climatic data in combination with other land parameters such as soil and landform. These AEZ take into account climate change and variability and can be used to define more precise and relevant extension messages and research topics. (See also Mugandani, 2012).

5 Conclusion

In common with other countries in southern Africa, the potential of adverse impacts as a result of climate change reinforces the need for climate smart agriculture. These techniques support sustainable use of limited natural resources, and will serve to build resilience among populations with limited financial, agricultural and natural assets.

---

[2] http://www.researchintouse.com/nrk/RIUinfo/PF/LPP03.htm#L1.

However, external support will be required to ensure that these techniques are properly introduced, well implemented and adequately supported, so that practitioners gain for this process both in the near term as well as in the medium to long term. Many of these techniques are not unfamiliar in the Zimbabwean context, but nevertheless there is a need to reinforce the supporting extension systems, input markets and marketing possibilities for climate smart practices. Furthermore, there is a need for expanded information sharing and coordination among practitioners and stakeholders of CSA. The APN should serve as a platform for this exchange.

As appropriate strategies for CSA will depend on the precise agro-ecological locations in which the project will be implemented, these recommendations should be revisited as those locations are identified, and adjusted to fit the local conditions as applicable in each project location. To that end, a rapid rural appraisal and land resources inventory should be carried out in each of the target districts to assess local physical, social, economic and cultural constraints and potential.

6 Key recommendations

1. At the start of the project, a one-day meeting to discuss the proposed CSA interventions should be convened. Many of the proposed interventions have recently been tried out in Zimbabwe, and there is a wealth of experience in the country. Invitees should include representatives of MAMID (Agritex, DR&SS, Irrigation Division, DLVS), CGIAR (CIAT, ICRISAT, CIMMYT, ICRAF), UZ, FAO and DFID. The Agricultural Coordinating Working Group (ACWG) could be re-convened for this purpose.

2. Crop and livestock diversification is climate-smart. Most promising are crops which have a range of (potential) uses, such as sweet sorghum and cassava and small stock. Support to extension services should ensure that agricultural extension agents are well prepared to support and promote those agricultural approaches with strong resilience potential.

3. Agricultural extension should have three-pronged approach: (i) Mobile-phone based and cost-recovering AE targeting farmers (partly) engaged in commercial production, (ii) Targeted extension messages through traditional channels such as radio, input suppliers, agricultural shows, demonstrations and meetings, and (iii) Participatory AE (such as FFS) targeting farmers groups interested in improved and sustainable production, and encouraged by incentives.

4. Many interventions are inter-linked and single interventions may not have the desired results. At the same time interventions should not be prescriptive and farmers should be given choices. A (dynamic) matrix could be developed which shows the options (menu) for specific farming systems (livelihood systems), but also shows the linkages between one intervention and the other. Similarly, in the planning of the APN distinctions should be drawn between those technologies and approaches which can be introduced almost immediately (e.g. on-farm grain storage facilities), and other interventions which may need more research or dialogue with potential stakeholders and partners (e.g. agro-forestry for livestock).

5. Many of the proposed production interventions have a strong link with marketing (and local consumption patterns and nutrition) and their potential viability be evaluated in these respects. Some interventions could be self-defeating. For example, an area may be suitable for production of a particular high value crop, but increased production could result in a slump in prices, thus negating the positive gains associated with the crop.

6. Wetlands have the potential of playing a crucial role in climate-smart agriculture. The sustainable use of traditionally cultivated wetlands should be promoted. Expansion of wetland cultivation should be subject to an Environmental Impact Assessment in consultation with the Environmental Management Agency and other relevant authorities and institutions.

7. The present Agro-ecological zoning of Zimbabwe (Natural Regions) has to be updated. The study of Mugandani et al (2012) could be used as a starting point, but a final zoning has to be endorsed by the Meteorological Department, the Department of Agricultural Research (DR&SS) and other stakeholders. At the same time, some of the evidence of climate change is anecdotal or based on sub-recent data. Recent trends in relevant climatic parameters should be analyzed and made public.

Annex 1

References

Agritex/GTZ, 1998. ConTill Project. Annotated Bibliography 1988-1996. Institute of Agricultural Engineering. Harare. (hard-copy document available at FAOSFS).

Chikodzi D and Mutowo G, 2012. Agro-Ecological Zonation of Masvingo Province: Land Suitability Classification Factoring In Climate Change, Variability Swings and New Technology. In: Open Access Scientific Reports, Volume 1, Issue 6, 2012. http://www.jsd-africa.com/Jsda/Vol15No1-Spring2013A/PDF/Reclassification%20of%20Agro-ecological%20Zones%20of%20Zimbabwe.David%20Chikodzi.pdf

CIMMYT, 2012. Effective grain storage project

http://www.cimmyt.org/en/projects/effective-grain-storage-project-phase-ii

Dawson IK, Carsan S, Franzel S, Kindt R, van Breugel P, Graudal L, Lillesø J-PB, Orwa C, Jamnadass R. 2014. Agroforestry, livestock, fodder production and climate change adaptation and mitigation in East Africa: issues and options. ICRAF Working Paper No. 178. Nairobi. http://dx.doi.org/10.5716/WP14050.PDF

EU, 2013. Formulation of the Smallholder Irrigation Support Programme. Full Proposal. Landell Mills, Consultant's Draft Report.

(available at FAOSFS)

FAO, 1998. Wetland Characterization and Classification for Sustainable Agricultural Development. Zimbabwe Country Paper.

http://www.fao.org/docrep/003/x6611e/x6611e02g.htm

FAO, 2001. Soil Fertility Management in Support of Food Security in Sub-Saharan Africa. Rome.

ftp://ftp.fao.org/agl/agll/docs/foodsec.pdf

FAO, 2007. The State of Food and Agriculture 2007. Rome

http://www.fao.org/docrep/010/a1200e/a1200e00.htm

FAO, 2008. Farmer field schools on land and water management in Africa. Proceedings of an international workshop in Jinja, Uganda, 24-29 April 2006. (hard-copy document available at FAOSFS).

FAO, 2010. "Climate-Smart" Agriculture. Policies, Practices and Financing for Food Security, Adaptation and Mitigation. Rome.

http://www.fao.org/docrep/013/i1881e/i1881e00.pdf

FAO, 2011. Guidelines for the Management of Inland Wetlands in Southern Africa. Harare. (hard-copy document available at FAOSFS).

FAO, 2011. Promoting integrated cassava production, processing and utilization for increased food security and income generation. Terminal statement project TCP/ZIM/3203 (D)

(available from FAOZW)

FAO, 2012. Promoting the Production, Processing and Marketing of Small Grains in the Marginal Areas of Zimbabwe. Terminal statement project TCP/ZIM/3202.

(available from FAOZW)

FAO, 2013. Climate_Smart Agriculture Sourcebook. Rome.

http://www.fao.org/docrep/018/i3325e/i3325e.pdf

FAO/SADC, 2011. Climate-Smart Good Agricultural Practices in Southern Africa. Recommendations for out-scaling. Discussion Paper with amendments from Workshop participants (draft). Workshop Johannesburg 1-2 December 2011. (soft-copy document available from FAOSFS).

Financial Gazette, 2012. Zimbabwe: Delta Finances Cassava Farming. Financial Gazette, 27 April 2012.

http://allafrica.com/stories/201204290296.html

Gasana JK, Bell L, Kajume J, Mupindu, S and Smith-John M, 2011. Evaluation of FAO Cooperation in Zimbabwe (2006-2010). (Independent evaluation commissioned by FAO)

Hanyani-Mlambo BT, 2002. Strengthening the pluralistic agricultural extension system: a Zimbabwean case study. Agricultural Research Council. Zimbabwe.

ftp://ftp.fao.org/docrep/fao/005/AC913E/AC913E00.pdf

Hughes O. and Venema JH (eds), 2005. Integrated soil, water and nutrient management in semi-arid Zimbabwe. Farmer Field Schools Facilitators' Manual, vol. 1. FAO Regional Office, Harare.

ftp://ftp.fao.org/agl/agll/docs/ffsfm_zim.pdf

ICRISAT, 2008. Sweet sorghum for food, feed and fuel. The New Agriculturalist, January 2008.

http://www.new-ag.info/en/focus/focusItem.php?a=352

IIED, 2012. Climate change impacts, vulnerability and adaptation in Zimbabwe. Climate Change Working Paper No.3, December 2012.

http://www.pubs.iied.org/10034IIED.html

IRIN, 2012. ZIMBABWE: Small grains are tough sell (news report 21 May 2012)

http://www.irinnews.org/report/95489/zimbabwe-small-grains-are-tough-sell

Leonard DK, Ly C and Woods PSA, 2011. Community-based animal health workers and the veterinary profession in the context of African privatization. In: Primary Animal Health Care in the 21st Century: Shaping the Rules, Policies and Institutions. Theme 2: Sustainability and Privatisation.

http://sites.tufts.edu/capeipst/files/2011/03/Leonard-et-al-Mombasa.pdf

Maumbe BM and Swinton SM, 2003. Adoption of Cotton I.P.M. In Zimbabwe: The Role of Technology Awareness and Pesticide-Related Health Risks.

http://www.jsd-africa.com/Jsda/Fall2003/articlepdf/ARC-Adoption%20of%20cotton%20in%20Zimbabwe.pdf

Mugandani R., Wuta M, Makarau A and Chipindu B, 2012. Re-classification of agro-ecological regions of Zimbabwe in conformity with climate variability and change. In: African Crop Science Journal, Vol. 20, Issue Supplement S2, pp. 361 – 369.

http://www.ajol.info/index.php/acsj/article/download/81761/71908

Mutambara,J, Dube IV and Mvumi BM, 2012. Agroforestry technologies involving fodder production and implication on livelihood of smallholder livestock farmers in Zimbabwe. A case study of Goromonzi District. In: Livestock Research for Rural Development 24 (11) 2012.

http://www.lrrd.org/lrrd24/11/muta24210.htm

Nyathi, P, 1990. Strategies for the Sustainable Conservation, Improvement and Utilisation of Animal Genetic Resources in Zimbabwe. Harare.

http://ilri.org/InfoServ/Webpub/fulldocs/AnGenResCD/docs/SouthAfrican_AARNET/strzimba.htm#P159_9777

Parwada, C,. Gadzirayi CT, Muriritirwa WT and Mwenye D, 2010. Adoption of agro-forestry technologies among smallholder farmers: A case of Zimbabwe. In: Journal of Development and Agricultural Economics Vol. 2(10), pp. 351-358, October, 2010

http://www.academicjournals.org/JDAE

Rusike J, Masendeke D, Twomlow SJ and Heinrich GM, 2004. Impact of Farmer Field Schools on adoption of soil water and nutrient management technologies in dry areas of Zimbabwe. Global Theme on Agro- Ecosystems, Report no. 14. 24pp. ICRISAT, Bulawayo, Zimbabwe.

http://oar.icrisat.org/3776/1/674-2004.pdf

Shawn AC and Fernando AN, 2012. The Value of Advice: Evidence from Mobile Phone-Based Agricultural Extension.

http://www.povertyactionlab.org/publication/value-advice-evidence-mobile-phone-based-agricultural-extension

Tavirimirwa B, Mwembe R, Ngulube B, Banana NYD, Nyamushamba GB, Ncube S and Nkomboni D, 2013. Communal cattle production in Zimbabwe: A review. In: Livestock Research for Rural Development 25 (12) 2013.

http://www.lrrd.org/lrrd25/12/tavi25217.htm

Thomson Reuters Foundation, 2013a. SMS weather advice cushions Tanzanian farmers from drought. Thomas Reuters Foundation 4 November 2013.

http://www.trust.org/item/20131104120841-2fm9a/?source=spotlight

Thomson Reuters Foundation, 2013b. Kenya's smallholder farmers use grain stores to raise bank loans. Thomas Reuters Foundation 14 November 2013.

http://www.trust.org/item/20131114122939-k2ibc/

Twomlow S, Urolov JC, Jenrich M and Oldrieve B, 2008. Lessons from the field – Zimbabwe's Conservation Agriculture Task Force. Journal of SAT Agricultural Research 6.

http://oar.icrisat.org/2704/

Twomlow SJ, Rohrbach D, Dimes J, Rusike J, Mupangwa W, Ncube B, Hove L, Moyo M, Mashingaidze N and Mahposa P, 2010. Micro-dosing as a pathway to Africa's Green Revolution: evidence from broad-scale on-farm trials. Nutrient Cycling in Agroecosystems, 88 (1). pp. 3-15.

http://oar.icrisat.org/5376/

Whiteside, M, 2011. Evidence Base for Climate Resilient and Productive Agriculture in Southern Africa. http://conservationagriculture.org/uploads/pdf/EVIDENCE_BASE_FOR_CLIMTE_RESILIENT__PRODUCTIVE_AGRICULTURE_WHITESIDE_-_2011.pdf

Zimbabwe Conservation Agriculture Task Force, 2012. Farming for the Future. A Guide to Conservation Agriculture in Zimbabwe. 2nd edition. Harare. (hard-copy document available at FAOSFS).

ZIMVAC, 2013. Rural Livelihoods Assessment of 2013. Harare.

http://reliefweb.int/sites/reliefweb.int/files/resources/2013%20ZimVAC%20DRAFT%20REPORT.pdf