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Improving the Contribution of Agricultural Research to Economic Growth: Policy Implications of a Scoping Study in Tanzania

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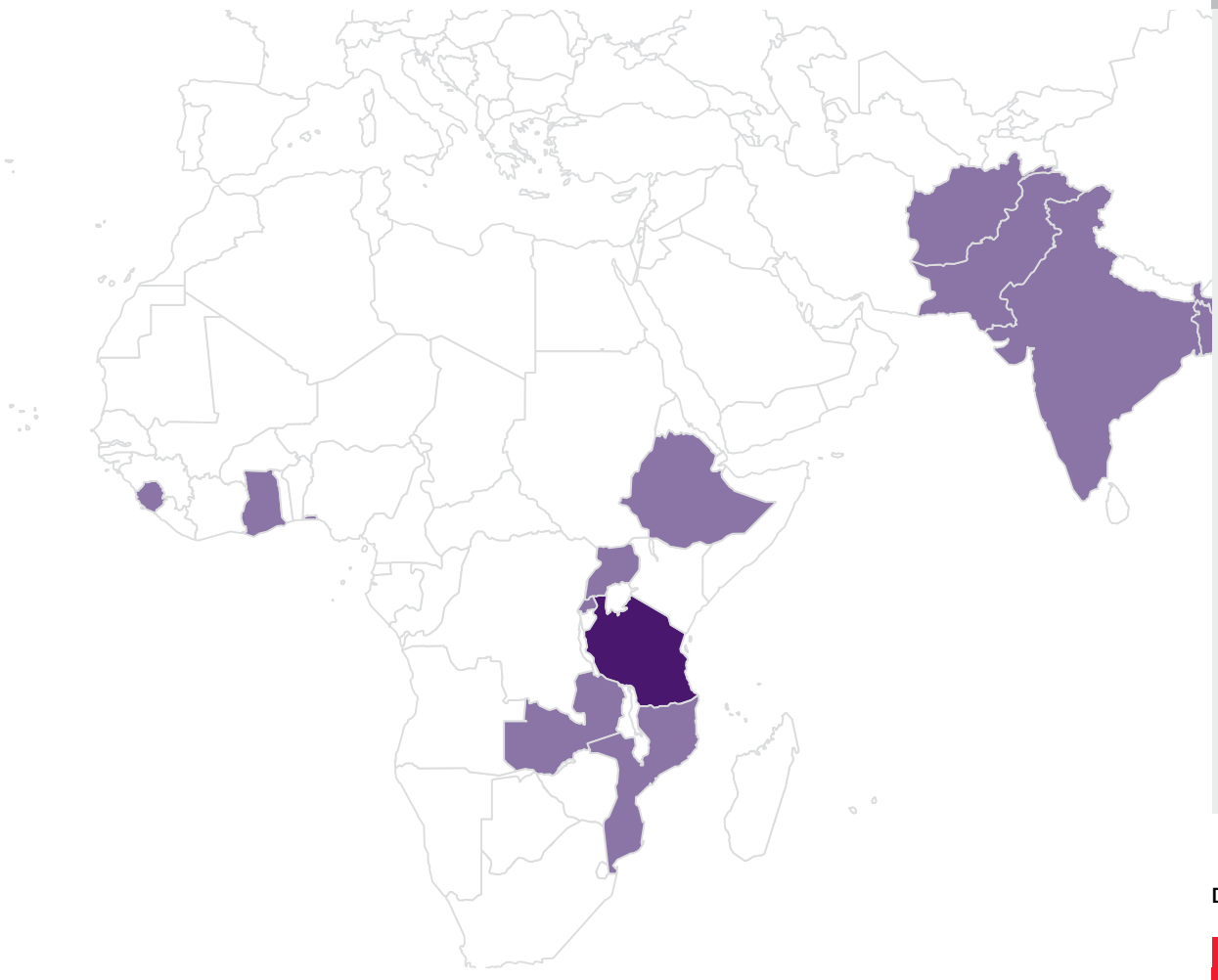

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Policy Implications of a Scoping Study in Tanzania

Andrew Coulson[1] and **Bitrina Diyamett**[2]

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This report makes recommendations on how more use can be made of research to increase agricultural production and growth in Tanzania. It was commissioned by the International Growth Centre, through its office in the Bank of Tanzania, supported by the UK Department for International Development. It shows that, while good work is being done, there is the potential to make much more use of it, but this will require coordination with the extension service, with other parts of value chains, with other researchers, and with those who are promoting large scale farming.

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Summary[3]

This report was commissioned by the International Growth Centre to make recommendations on how more use can be made of research to increase agricultural production and growth in Tanzania.

Agricultural research in Tanzania has a long history. But since the difficult years of the 1980s and 1990s, the research infrastructure, and in particular the research institutes under the Ministry of Agriculture, Food Security and Cooperatives, have suffered. Despite this, relevant work has been undertaken and continues. Resources appear to be less problematic at the privately run research stations, and at Sokoine University of Agriculture.

Tanzania is able to draw on the knowledge and expertise of the international agricultural research organisations, including those associated with so-called "green revolutions" in Asia and elsewhere. Many of the challenges for research, including plant breeding and combatting of diseases and pests, cross political boundaries and can benefit from international cooperation.

In this report, the issues facing agricultural research are looked at through case studies of the research undertaken on six of Tanzania's most important food crops (Rice, Maize, Cassava, Beans, Pigeon peas and Irish potatoes).

These studies identify a series of challenges facing the agricultural research community in Tanzania. One is the relative isolation of many of the researchers, and their need for regular meetings with others working on the same crops and similar issues. Another is the need to publish more regular reports, so that other research users and policy-makers inside and outside the country know what is going on – especially annual reports from research stations and reports giving updates on particular crops. There are serious shortages of basic resources at the Zonal Research Institutes, and many of the most experienced researchers have retired and are continuing to work on short term contracts.

Meanwhile, there is a concentration of agricultural researchers at SUA (Sokoine University of Agriculture), but this is under another Ministry, and most of the researchers have many other commitments, and their

[3] **The authors would like to thank those named at the end of this report, without whose support it could not have been written. However, they remain responsible for any errors or omissions, and the judgements are theirs, and may not be shared by the International Growth Centre**.

research may not always be coordinated with that of the Zonal Research Institutes.

The district councils, responsible for the extension service, need to take agriculture in general more seriously, and to draw on agricultural research when preparing district plans, recognising that good extension needs constant updating in the light of new research and changes in markets.

Work on agricultural economics is one of the strengths of the Zonal institutes, and of SUA. But more work is needed on whole value chains, which will identify bottlenecks in storage, marketing and processing, i.e. not just on-farm production, and suggest policy improvements. The presentations at the recent Cassava Week in Dar es Salaam illustrate what is needed.

The system of seed licensing and multiplication is currently under review. This is partly because of pressure to have a common system of seed registration for all of East Africa (much of the hybrid seed currently used for maize, for example, derives from Kenya). But it is also because it is recognised that, while a licensing system can work well for hybrids, where it is important for those buying the seed each year to know that they are getting the genuine article, it often works very poorly for open or self-pollinated seeds, or plant materials such as cassava or potatoes spread by vegitative means, i.e. planting tubers or cuttings. Here experience has shown that the farmers will do the propagation themselves, and it is pointless to stop them. Hence the value of the system of Quality Declared Seeds, which needs to be developed and promoted.

In short, there is need to look at the agricultural sector problems holistically – looking at how issues on productivity, value addition, markets and prices impinge on each other. From that can follow agreed, and feasible, plans for all Tanzania's main crops, which involve the whole value chains, from production through to processing and sales, and include specific commitments by all the stakeholders which can be monitored and to which they can be held. Only then can the specific contributions most needed from agricultural research be firmed up, and the service funded and planned reliably, on a medium to long-term basis.

These conclusions are expressed in 10 recommendations, which follow from the arguments on pages 27-37 of this report.

Recommendations

Recommendation 1: Core Funding

The Zonal Research Institutes and other stations run by the Ministry of Agriculture, Food Security and Cooperatives need reliable long-term core funding. The best way to achieve this, and also to ensure co-ordination with other research agencies, may be to place the research institutes in an arms-length parastatal body.

Recommendation 2: Human Resources

Tanzania needs to give urgent thought as to how it can replace the generation of agricultural research scientists who were trained in the 1970s.

Recommendation 3: Relationships with University researchers

Specific efforts are needed to make it easier for SUA to work more closely with the Zonal Research Institutes, and for more external resources to be channelled to them. The most direct way to achieve this would be through a National Plan for Agricultural Research, signed up to by all the relevant Ministries, and the Planning Commission, in which SUA would undertake specific responsibilities. Donors and international organisations, and NGOs, would take note of this when deciding which projects to support.

Recommendation 4: The International Organisations

Tanzania needs to make as much use as possible of the skills and knowledge of the international organisations coordinated by AGRA, ASARECA and CGIAR – IIAT, IRRI, AfricaRice, CIAT, CIMMYT, IFPRI , etc. In particular these organisations- should be invited to assist Tanzania in its aim of developing the research skills of a new generation of agricultural researchers.

Recommendation 5*:* The need for regular meetings of those working on key crops

The Ministry of Agriculture, Food Security and Co-operatives should, without delay, revive the National Coordinating Committees for key crops and regular meetings for all the researchers undertaking work on these crops. These meetings should be tasked: to review achievements, identify bottlenecks, and make recommendations for further work. A few key individuals from the academic and private sectors should be invited to attend as observers.

Recommendation 6: Research and Extension

It is essential that research works hand in hand with extension. Agricultural problems and projects – whether research or otherwise - should be made to feature highly in the district development plans. These plans should include specific locations and targets for areas to be planted, inputs to be used, and quantities of produce to be harvested. They should also include lists of issues or challenges facing farmers, and where possible research programmes to address these. The plans should be signed off at a national level, and any district unable to produce a convincing plan should expect levels of funding for agriculture to be cut in the future.

Recommendation 7: Whole Value Chain Research

Cross-sectoral workshops should take place for each of Tanzania's main crops, with the aim of producing, for each of these crops, a plan for development of the whole value chain, including marketing, storage, processing, and export, with specified targets and milestones.

Recommendation 8: Seed Certification and Distribution

The processes of registering new varieties need to be streamlined. For self-pollenating, open pollenating or vegitatively propagated crops the system of Quality Declared Seeds should be developed as far and as fast as possible, and more faith placed in markets and in the ability of farmers to distribute seeds and planting materials.

Recommendation 9: The Research Needs of Large-scale Farms

There should therefore be formal understandings of how large scale farms can draw on research expertise, and more general understandings with organisations that represent large scale farmers, such as the Agricultural Council of Tanzania. Where international companies are involved, steps should be taken to ensure that their research knowledge is shared with the rest of the research community in Tanzania. The Ministry of Water and Irrigation and the other ministries with interests in agriculture and the rural economy need also to be involved.

Recommendation 10: The Need for a Holistic Approach

Further work is needed to bring about the changes in institutions, and in culture, that are needed if agricultural research is to bring maximum benefits to Tanzania. This will need to be on the basis that a whole large number of institutions need to coordinate their activities and work together. This should be institutionalised through the creation of the new national plan for agriculture, which should include the specific programmes for agricultural research agreed by the National Coordinating Committees, and for the multiplication and dissemination of improved seeds and planting materials, based on dialogue with farmers and the dissemination studies of agricultural economists. These plans would be developed, for each crop and district, with the universities, relevant international organisations and NGOs, and be revised every year to take account of new information and markets.

Improving the Contribution of Agricultural Research to Economic Growth: Policy Implications of a Scoping Study in Tanzania

1. Terms of Reference and Methodology

The terms of reference for this project, agreed by the International Growth Centre, required us to:

> *provide a scoping study and a bibliography of published research on crop agriculture which has been carried out in Tanzania in recent years, and a summary of the research that is on-going now, and discuss the issues it raises in terms of dissemination, relevance to different kinds of farming activity in the country, collaboration within the country and with international agencies, and the case for a more formal strategy to guide agricultural research.*

Fieldwork took place between 12 and 30 September 2011 and 9-20 January 2012.

In discussion at an initial meeting in Dar es Salaam, it was agreed to refine these terms of reference down to a consideration of the research being undertaken on Tanzania's main food crops; to focus on the Zonal Research Institutes of the Ministry of Agriculture, Food Security and Cooperatives; on research which had resulted in positive messages, and on the constraints on these being heard and actions taken that would improve agricultural production and economic growth. This would inevitably raise some issues about dissemination and extension, but these could and would not be dealt with systematically in this short scoping report.

The two researchers visited the Research and Development Department of the Ministry of Agriculture, Food Security and Cooperatives from where introductory letters were sent to the Directors of four Zonal Research Institutes. We also visited Sokoine University of Agriculture in Morogoro (SUA) where we were received by the Deputy Vice Chancellor (Academic) and other senior staff at the University. Finally we interviewed representatives from seven external organisations providing assistance to agricultural research, from Tanzania Official Seed Certification Institute (TOSCI), and from the Agricultural Seed Agency.

The interviews concerned with specific crops were conducted using a semi-structured questionnaire, and where possible supported by publications. A list of papers referenced or consulted follows this report.

The authors would like to acknowledge the support provided by the Directors and all those that we met, and their enthusiasm. We came away with a strong impression that we were raising important issues, and that this was a good time to discuss them, ahead of any possible restructuring of the service.

We start by making some general observations about the nature of agricultural research, especially in Africa. That is followed by brief studies of the issues raised by the research that is being undertaken at present on six of Tanzania's main food crops. From those studies, some of the key issues are then drawn out, leading to conclusions and recommendations.

2. Agricultural Research in Tropical Africa

Agriculture is a long term commitment, in Africa as everywhere else. It takes years to develop a farm, to make best use of its soils and water, to learn how best to protect crops from pests and diseases. Agricultural research is even more long term, especially the "holy grail" of crop research which is breeding new varieties which are high yielding, resistant to the most dangerous plant diseases or pests, and incorporate other desired traits. It is seldom possible to develop, test and release a new variety in less than 4-5 years and often it will take longer.[4]

Farmers, on small farms but also on large ones, make trade-offs – such as whether, and if so at what level, to use inputs such as fertilizers, insecticides, weedkillers, and fungicides. Which crops to plant, and when? How often to weed? How much labour to use, or employ? What tools or machinery to use? Where to sell, etc? Agriculture depends on markets, which are volatile and difficult to predict, and (especially in recent years) subject to speculation. It is clear that farming, whether a small family farm or a huge mechanised estate, is a business – always hard work and often very cruel.

Much of the skill lies in minimising risk. Risks are greater if the farm depends on a single crop, or on expensive chemical inputs. Small farmers have developed a whole series of means of lessening risk – from planting

[4] It is often stated that tropical Africa has more insect pests, viruses, fungi and predators – ranging from elephants, quelea birds and monkeys to armyworm and locusts – than any other part of the globe. For a comprehensive overview of the challenges facing researchers in Tanzania, and an assessment of the progress made see Brigitte Nyambo *Agricultural Sector Development Programme: Integrated Pest Management Programme*, Revised version 2009

more than one crop in a field, separating the fields (so that pests are less likely to spread), planting at different times, and different varieties, planting in ridges, using shade and fallow periods for the soils to recover their fertility. The use of hand tools also minimises risk, because they are much less likely to damage soils than heavy machinery.

Irrigation is a means of minimising risk. But most areas of Tanzania do not have plentiful supplies of water even for drinking. And some of the areas that traditionally were irrigated, such as the slopes of Kilimanjaro, are suffering because many sources of water have dried up.[5] Large scale irrigation projects also have risks, e.g. of the soil becoming salty, or waterlogged, or subject to disputes about the distribution of water. Irrigation should be developed where it is feasible, not overly costly, and then the water should be used with care and skill to get maximum benefit from high yielding crops, and several crops per season.

Around the world, markets for agricultural products are increasingly dominated by a few international companies, linked with processing factories, supermarket chains, or wholesalers, who demand large quantities from reliable and predictable sources of production and require very high quality standards. Small and medium African farmers have demonstrated over and over again that they can meet high quality standards (e.g. in the production of tea or tobacco), but often the marketing has required an intermediary to enforce those standards, such as a marketing board or a processing factory. "Outgrowers" can supply processing factories, either completely or by supplementing production on large scale farms. This, it has been argued, can get the best from small scale production (maximum use of local labour, avoidance of the overhead costs of a permanent workforce, less investment and risk for processors). But they are not without possible problems, e.g. if relationships between the producers and the purchasers break down, and the producers have no other outlets for their produce.

3. The Infrastructure for Agricultural Research in Tanzania

Scientific agricultural research in Tanzania has a long history. The Germans created a research station at Amani near Tanga which experimented with most of the crops now commonplace in Tanzania, and with agriculture-related aspects of human health. The British, with some stops and starts, continued the tradition, until, by the time of Independence in 1961 there was a network of agricultural research

[5] For a socio-legal study which brings out many of the difficulties which may arise when villages adopt irrigation, see Fred S Lerise *Politics in Land and Water Management: Study in Kilimanjaro, Tanzania*, Mkuku na Nyota Publishers, 2005

stations and sub-stations which covered the country. USAID was the main external donor for the construction of an agricultural college just outside Morogoro, which grew to become Sokoine Agricultural University (SUA). In the early 1970s, a project jointly funded by the four Nordic countries constructed a major new agricultural research station at Uyole, not far from Mbeya, to be the centre of research on the crops of the Southern Highlands.

Between 1980 and 1989, research on crops was undertaken by a body at arms-length from the Ministry, the Tanzania Agricultural Research Organisation (TARO). In 1989, the Ministry took research back under its direct control, and consolidated the research stations and sub-stations dealing with crop agriculture into seven zones which covered the country, with a Zonal Research Institute in each zone. Research centres which specialised in tea, coffee (where much of the production is on large farms) and tobacco subsequently moved into the private sector. There are specialist facilities at Mikocheni in Dar es Salaam, and at the Tropical Products Research Institute near Arusha which is semi-autonomous, with its own Governing Council.

Thie infrastructure suffered, as did all other parts of the Tanzanian public sector, from the structural adjustment policies of the 1980s and 1990s, only emerging from this with assistance from donors and (nationally) write-offs of debts owed to overseas governments. Agriculture was a recipient of donor assistance, but not on a large scale. As far as agricultural research was concerned, a National Agricultural Research Masterplan was agreed, to include rehabilitation of the research stations and support for research on priority crops, but it was only implemented in parts. Between 1995 and 2005 there was a freeze on recruitment. The outcome, at the time of our visits to four of the seven Zonal Research Institutes, was a severe shortfall in the resources needed to keep basic facilities running[6], and a gradual loss of the experienced staff trained in the 1970s. Despite this, as our case studies below show, research has continued, and some valuable results have been achieved, especially in plant breeding.

Agricultural researchers know that they need to be client-related.[7] Starting in the 1960s the Ministry of Agriculture it appointed agricultural

[6] The practical difficulties are clear in the 2009#2010 Annual Report from Uyole Agricultural Research Institute.

[7] This is enshrined in the philosophy of "Farmer First", promoted among others by Robert Chambers, which argues that research should come from a dialogue with farmers, not just from demonstrations of the highest possible yields on research stations. See his Forward to Ian Scoones and John Thompson (eds*) Farmer First Innovation for Agricultural Research and Development*, Practical Action publishers, 2009. See also Ninatubu Lema and Barnabas Kapange "Farmers' organizations and Agricultural Innovation in Tanzania. The Sector Policy for Real Farmer Empowerment". In: Winnink, B.and W. Heemskerk (eds.) *Farmers' Organizations and Agricultural Innovation, Case*

economists to its research stations, and to this day the agricultural research service is organised around four specialisms: crop research, special programmes (these include research on soils and soil protection, mechanisation, irrigation, agro-forestry, etc), farming systems (including agricultural economics, "adoption studies" of how and whether farmers have taken up innovations, and crop marketing), and "information and linkages" which manages information and disseminates information though the extension service and other stakeholders. It has long been understood that it is not sufficient to conduct trials just on the artificial conditions of research farms, but that they must also take place on farmers' fields, with feedback from the farmers.

This has not stopped some big mistakes being made. Thus coconut breeding is one of the slowest kinds of research, since each generation takes 2-3 years to produce seed. Our informant at Mikocheni told us that after more than 20 years of breeding, in the 1970s, an improved variety was released, but it had to be withdrawn two years later because it needed a high water table or high rainfall and was not sufficiently resistant to drought in most Tanzanian conditions.

The researchers at SUA, especially the Departments of Agricultural Education and Extension, and of Agricultural Economics and Agribusiness, regularly work with farmers in a range of practical situations (such as PASS, the Private Agricultural Support Sector trust promoted by Dr Andrew Temu and others which was established by the Danish and Tanzanian governments in 2000 with finance from the Danish Agricultural Support Programme[8]). Other projects have been supported by USAID[9] and Norway[10] and the Netherlands, to take but just three donors.

Agricultural researchers in Tanzania benefit from working with the international research organisations through AGRA (the Alliance for a Green Revolution in Africa), ASARECA (the Association for Agricultural Research in East and Central Africa, main office in Uganda) and CGIAR (the Consultative Group on International Agricultural Research), the FAO, UNDP, the International Fund for Agricultural Development, the World Bank and others. The principal members of CGIAR are listed in Appendix

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Studies from Benin, Rwanda and Tanzania. Bulletin 374. Development Policy and Practice. Royal Tropical Institute, Amsterdam, 2008. Also Ninatubu Lema, Chira Schouten and Ted Schrader (eds.) *Managing Research for Agricultural Development*, Proceedings of the National Workshop on Client Oriented Research, Moshi, 2003

[8] Temu, Andrew "Private Agricultural Support Sector (PASS) - Tanzania" Global Partnership Program – Linking Farmers to Markets (GPP-LFM)**,** accessed at www.egfar.org/.../DRAFT_FOR_PASS_Case_%201_NEW.doc on 20 October 2011

[9] E.g. a programme linking SUA and Ohio State University, see Ohio State University, "Ohio State Receives $24M USAID Grant to Boost Agriculture, Food Security in Tanzania", Press Release, 7 March 2011

[10] The Norwegian government has been supporting the link between SUA and two universities in Norway for more than 40 years, most recently in the PANTEL programme, now completed, and EPINAV which started this year.

1, including the International Rice Research Institute (IRRI) and the International Maize and Wheat Improvement Centre, CIMMYT which created the varieties that made possible the first "green revolutions" in India and other Asian countries, IITA (the International Institute for Tropical Agriculture, with headquarters in Ibadan and a regional office in Dar es Salaam, working not least on cassava), CIAT (the International Centre for Tropical Agriculture, based in Columbia, but with offices in Uganda and Kenya, specialising in research on a small number of crops including cassava, rice and beans), and AfricaRice which shares a regional office in Dar es Salaam with IRRI. These all raise funds internationally, including from foundations such as the Bill and Melinda Gates Foundation, and support research projects undertaken by individual researchers, research institutions, universities and NGOs. Of particular value is the sponsorship they are often able to give for post-graduate training of researchers.

Despite all this understanding, and much good practice, agricultural productivity remains obstinately low. That is one of the reasons why there is renewed interest in large scale farming. Some of the main promoters of *Kilimo Kwanza*, the national strategy for agriculture adopted in 2009, including the Agricultural Council of Tanzania, represent large scale farming interests. The Southern Agricultural Growth Corridor of Tanzania (SAGCOT) is promoting the concept of mechanised irrigated farming in the Kilombero valley, broadly along the line of the TAZARA railway, on the basis of central farms with outgrowers, similar to schemes along the Zambesi river in Zambia. It is sponsored by ten major international companies, including Yara International, Uniliver, Monsanto, Syngenta, Du Pont, General Mills and SAB Miller. There are a number of other projects or proposals for very large scale agricultural production, based on biofuels, sugarcane, or rice, but little is known about the details and how much progress they have made.

As of now, it is our understanding that these have very limited links with the Ministry of Agriculture. The same is true of other policies often associated with *Kilimo Kwanza*, such as the provision of powered tillers to every district, and the target for a million hectares of new land under irrigation.

Thus the main target market for the agricultural research undertaken by the Ministry are the small and somewhat larger farmers who farm on the basis of family labour, and who are seen as the main source of increased agricultural production in the Agricultural Sector Development Strategy. However, the results of this research are not being used as much as they could be. To shed light on what has been achieved, and the issues it raises, the next section of this report consists of case studies of the research that has recently been undertaken on six of Tanzania's most important food crops:

Rice
Maize
Cassava
Beans
Pigeon peas
Irish potatoes

This is followed by a general discussion of the issues raised in these studies, and the areas of work which need further research, and then our preliminary conclusions and recommendations as to the steps that are needed if the very considerable amount of research being undertaken is to make a greater contribution to increased agricultural productivity and growth, and the welfare of all Tanzanians, who, one way or another, depend on agriculture.

4. Crop Studies

4.1 *Rice*

Rice production in Tanzania stagnated in the early 1980s and then rose sharply, exceeding 800,000 tonnes in 2007 and 900,000 tonnes in 2010.[11] It is grown by about a third of all Tanzania farmers, and in towns and cities consumed especially by higher income earners.

Tanzania is the largest producer of rice in East Africa, with much of the best land for rice growing. As of now, it both imports rice (cheap rice, mostly imported through Zanzibar and Dar es Salaam) and exports it, to countries to the North and West. From 2005 imports have been supposedly subject to a 75% tariff agreed by the East African Community to encourage domestic rice production. However, imports through Zanzibar either pay no tariff or 25%, and there are dispensations in times of food shortage.[12]

The tariff was imposed before international rice prices shot up at the end of 2007. Its impact, in so far as it is enforced, is to raise prices for consumers and for local producers. In 2010 Tanzania received conflicting advice from two of its main donors relating to this. Hans Binswanger, a leading agricultural economist working for the World Bank, in a report that was presented to the Prime Minister and to the Cabinet, argued that world prices for rice were likely to remain high for about 20 years. This is because of increasing demand for rice from the middle classes of the main Asian producing countries, combined with yields that are declining in those countries, partly as a consequence of poor management of irrigation. If the prices stay high, Binswanger argued that Tanzania can produce rice competitively and should deliberately develop export markets for its rice. [13] His report says little about the tariff, but in discussion in 2010 he argued that it was not needed: Tanzanian farmers

[11] This is not the place for a detailed analysis of the challenges raised by Tanzania's statistics of small-scale and non-traded production. For a discussion of the disparities between statistics on poverty derived from the Household Budget Surveys and the national accounts, see A B Atkinson and M Lugo *Growth, Poverty and Distribution in Tanzania*, Working Paper 10/0831, International Growth Centre, 2010. For discussions of the agricultural production statistics see Stephano Ponte *Farmers and Markets in Tanzania*, James Curry 2002, pp.64-71. Also Rune Skarstein "Smallholder agriculture in Tanzania: Can economic liberalism keep its promises?" in Kjell Havenevik and Aida Isinika (eds) *Tanzania in Transition – from Nyerere to Mkapa*, Muki na Nyota, 2010, pp.99-101 and 108-112

[12] See Ole Therkildsen "Policy making and implementation in agriculture:Tanzania's push for irrigated rice." Working Paper 2011:26, Danish Institute for International Studies, 2011

[13] Binswanger-Mkhize, Hans and Madhur Gautam *Towards an Internationally Competitive Tanzanian Agriculture*, World Bank, Dar es Salaam, March 2010.

could compete in international markets without it. A different study, in which a team employed by USAID studied the value chain for rice in the Kilombero valley, argued that if production continued to expand, there would be surpluses which would force the price down, with bad consequences for farmers.[14] The 2009 National Rice Development Strategy sets a target of 2m tonnes by 2018, more than doubling present production, without fully considering these issues. [15]

Most Tanzanians prefer the local varieties for their aromas and cooking qualities. But they are slower growing and yield much less than high yielding quick growing varieties introduced over the last 30 years or through the International Rice Research Organisation and other international bodies – broadly the varieties that made the "green revolution" in Asian countries. Some Tanzanian farmers grow two different varieties of rice: a low yielding aromatic variety to eat and a high yielding but much less aromatic variety to sell.

According to the National Rice Development Strategy, in 2008 rice was grown on 464,000 hectares of "rainfed lowlands", i.e. valley bottoms that flood after heavy rains, and on 200,000 hectares of land that was irrigated, out of a total of 681,000 hectares used for growing rice. The Southern Highlands, which includes areas with the most reliable rainfall, produces about a third of Tanzania's rice (from about a quarter of the land used for rice).

The experiences of irrigation in Tanzania are mixed. But from 2005 Tanzania had a policy to increase the area under irrigation by a million hectares within five years; this target could not be met, but substantial resources were invested in new or rehabilitated irrigation schemes, and the irrigated area was estimated at 330,000 ha in 2010, compared with 264,000 in 2006. The majority of this is used for rice (though a strong case can be made that more of it should be used for sugar production, or higher value crops such as vegetables.)

Agreements for a number of very large scale mechanised rice projects have been signed or are being considered. Several of these would export rice directly back to their donor countries, in South Korea, India, Bangladesh, etc. [16]

Research on rice in Tanzania started in the 1930s and was re-launched after Independence in 1961. Rice breeding was supported by the

[14] USAID, *MicroCLIR/CIBER assessment: The legal, policy, regulatory, and institutional constraints to the growth of maize and rice in Tanzania - Agenda for Action*, 2010
[15] Ministry of Agriculture Food Security and Cooperatives, *National Rice Development Strategy*, 2009, Table 2, p.21
[16] Cecilie Friis and Anette Reenberg *Land grab in Africa: Emerging land system drivers in a teleconnected world.* Global Land Project Report No. 1. GLP-IPO, Copenhagen, pp.29, 31, 34

Netherlands Government from the late 1980s up to 2003, and continues to be supported by the Japanese government, based at Kilimanjaro Agricultural Training Centre in Moshi. New high-yielding varieties were released in the 1980s, using germplasm from outside the country, but these were not accepted by most farmers. As a result, attention turned to trying to breed improved yield into the local varieties, while keeping their aroma and taste, the most recent variety being *Saro 5* or *TXD 306* which under irrigation can yield up to six tonnes per hectare, more than four times the present average. But, as was pointed out to us at SUA, there are really two crops – and some farmers grow both (a plot of local rice for their own consumption and some sale, and another plot of high yielding rice for sale). The breeding work takes place at KATRIN, Ifakara, and also at Uyole, but with assistance from Mikocheni for bio-technological support, and from the IRRI/Africa Rice office, also in Mikocheni. The World Bank through the East African Agricultural Productivity Programme is supporting a rice research development programme, coordinated from KATRIN, which seeks to upgrade the institute to a rice research excellency centre.. Trials to evaluate these varieties are conducted at Uyole (for upland areas – but also specialising in studies of different methods of weed control and mechanisation), Ukiriguru (for middle altitude areas, but also fertilizer and soil fertility management including organic as well as inorganic inputs), and KATRIN (for the lowland areas). Work on plant diseases takes place at Dakawa, North of Morogoro, in particuloar to combat rice yellow mottle virus, which is becoming virulent and spreading rapidly. Meanwhile AfricaRice is promoting the Nerica varieties which have been highly successful in West Africa and in Uganda to upland areas of Tanzania.

Yields could be much higher, even without fertilizer – for example we were told by the agricultural economist from the IRRI/AfricaRice office in Dar es Salaam that yields in the rainfed areas could be doubled with better agronomic practices, (e.g. planting in lines instead of broadcasting, transplanting instead of direct seeding and water control through bunding) and varieties. Yields in Uganda are at present rising faster than in Tanzania[17], though farmers supported by PASS are apparently getting yields well over twice the national average.[18] The USAID study of the value chain suggested that the main problems were in marketing (the problems of assembling small quantities from large numbers of farmers, and giving them a stronger position in the market, for which it advocated more storage at village or town level, so that rice could be sold when prices were higher). It also highlighted the position of four large grain

[17] For a thorough discussion of the potential in Uganda and how it is being achieved, see Kijima, Yoko; Yukinori Ito, and Keijiro Otsuka, *On the Possibility of a Lowland Rice Green Revolution in Sub-Saharan Africa:Evidence from the Sustainable Irrigated Agricultural Development (SIAD) Project in Eastern Uganda,* Japan International Cooperation Agency Research Institute Working Paper No.25, 2010

[18] Temu, op cit, p.8

importing and purchasing merchants who dominate the Dar es Salaam market.

This is a crop where we have two detailed analyses of the value chain.[19] The USAID study shows how "collectors" and "traders" take much of the value, and points to the near-monopoly position of a few large grain buyers and importers based in Dar es Salaam. Prices fluctuate considerable around the year. It concludes from this that more storage is needed locally, so that the collectors and traders can hold back some or all of the rice when prices are low. It gives very little consideration to how Tanzania can make the adjustment from being an importer of rice to being, increasingly, an exporter, or how the rice markets will deal with very substantially increased quantities which will arrive if any of the very large scale project proposals take off.

For a long time it was not easy to persuade farmers to grow the high yielding varieties, or to persuade the seed companies to multiply them. However, this has changed and the Agricultural Seed Agency is currently selling up to 700 tonnes of seed per year. We have not found agricultural economic studies comparing the economics of growing the traditional varieties (with great taste and aroma, but low yield) and/or of improved high yielding varieties, nor studies of the issues that need to be confronted if mechanisation is to be successful (thus planting in rows, needed for mechanised weeding and harvesting, is substantially more labour intensive than planting randomly, but that too can be mechanised, using either oxen or small scale powered machines). Such studies are needed for each of the areas where rice is grown, and for irrigated and rainfed production, and they need to feed their conclusions back to the extension service, which may need to accept that there are really two crops, a high value rice for local consumption, and a low value but high yielding rice for sale as a cash crop.

In summary, here is a crop where production is on a rising path, but where it could rise much farther. If this happens, yields will rise but prices for farmers will almost for certain fall. However, if the figures are correct, Tanzania has the potential to become an exporter. The challenge is to manage this process, which means looking at the whole value chain, including the agronomy, the key messages for farmers, and the impact of new large scale production, as well as marketing, storage, processing and

[19] USAID, *op. cit.* for the Kilimbero; and Rural Livelihood Development Company, *Rice Sector Strategy: Improving Rice Profitability through increased productivity and better marketing focusing on Tanzania's Central Corridor*, November 2009, for the corridor from Morogoro to Shinyanga. An earlier USAID-sponsored report looked at the value chains for rice in Mbeya, Iringa and Morogoro regions, and concluded among other things that "milling is more profitable than farming" *Rice sub-sector study*, Private Enterprise Support Activities Project Tanzania, 2003 (prepared by Ebony Consulting International Pty), p.30

provisions for exporting. The technical knowledge is in the country, both to develop new varieties of rice and to test and disseminate them. But our impression is that to make the best use of the new varieties requires more co-ordination and more understanding both of the costs and benefits of different kinds of rice production, and of the markets.

4.2 *Maize*

Maize was introduced in Tanzania before the First World War notably in the Arusha area – but only became popular in Mbeya and Ruvuma in the 1950s and Rukwa in the 1970s. It is now, by many measures, Tanzania's most important food crop, with the Southern Highlands producing the greatest surpluses for sale. The highest yields are for areas above 1,500 metres with reliable rainfall. They come from hybrid seeds, including many created in Kenya, Zimbabwe or South Africa, but also at Uyole[20], distributed and sold by private seed companies, and using fertilizers (by 1995 a majority of farmers in the Southern Highlands were using fertilizer to grow maize, in what has been described as a green revolution for the Southern Highlands[21]). Hybrids require farmers to buy new seeds each year, and so provide a steady income for companies selling seeds.

Maize has always been a controversial crop, because while it is easy to cook, can be roasted or turned into flour, and easily transported, it is also a risky crop, depending on rainfall at specific points in the growing period. Maize is therefore central to Tanzania's food security policies, and this has led, at many times, to bans on transporting maize across national boundaries and sometimes also across regional or district boundaries – with the result that, in some years, some of the maize, especially in remote areas like Rukwa, is either not purchased or sold informally across borders.

There have been many endeavours to increase yields through the use of fertilizer – culminating in the present subsidies – but whether in low rainfall areas this is the best use of Tanzania's resources is debatable (the farmers growing hybrids in the upland areas know that they must use fertilizers, and if possible pesticide sprays also).

Most of the hybrids do less well in medium or low rainfall area. Hence the value of "composites" or improved open-pollenating varieties, such as those released from the 1960s onwards for medium rainfall areas from Ukiriguru, and for low rainfall areas from Ilonga. With these varieties farmers can safely keep back some of the biggest cobs, and plant the

[20] Lyimo, Nick G *Improving farmers' access to and management of disease resistant cultivars in the Southern Highlands of Tanzania – Phase 2 R 8406 (ZA 0634) Final Technical Report*, DFID, 2006
[21] Scarstein op.cit. p.119

seeds, so there is no need to buy new seeds each year. This makes these seeds much less attractive to seed companies. This is the point made by one of the researchers at Selian: "really with maize improved varieties one does need to put a lot of energy and money in the dissemination because maize is a very popular crop and all one needs is to get the research right, and make the improved seeds available to farmers – there is nothing like popularization of improved seeds for maize, but efforts need to be geared to making seeds available."

More researchers in Tanzania work on maize than on any other crop – 47 out of the 294 researchers employed by the Ministry of Agriculture in 2008 according to ASTI figures.[22] The achievements of research on maize in each of the main zones of Tanzania were documented in a series of studies published in 1988 and 1989.[23]

A very comprehensive report, a model of its kind, was published from Uyole in 2006.[24] Maize breeding started there in 1985, with the first hybrid released in 2001 – bred for high yield, high altitude and disease resistance, but incorporating consumer preferences – extremely good milling qualities and a hard kernel that makes good ugali. Four varieties from Uyole are on the market. A plant disease, grey leaf spot disease, spread rapidly around 1994, and for a time the research and extension services worked together to combat it, until resistant varieties were introduced.

Maize breeding at Ukiriguru was moved to Selian in the 1980s, but restarted about 5 years ago. Since then five improved varieties have been released. The maize breeder is at present away studying, but agronomic work is continuing, especially to check for resistance to stork-borers and striga. Experiments are also ongoing on the feasibility and the economics of a form of biological control, suitable for high altitude areas such as Tarime, in which farmers plant a legume, desmodium, between the rows of maize, which repel the insects, and napier grass round the edge of the plot which traps the fleeing insects. This system leads to increased maize yields of 25% or more when stork-borers are the only problem and up to

[22] Flaherty, Kathleen and Deogratias Lwezaura, *Tanzania: Recent Developments in Public Agricultural Research*, ASTI (Agricultural Science and Technology Indicators), Country Note, October 2010. The figures are "Full Time Equivalent" numbers of staff.
[23] E.g. Bisanda, S., W Mirangi, H Verkuijl, A J Mushi, and P Andanajayasekeram, *Adoption of Maize Production Technologies in the Southern Highlands of Tanzania*. International Maize and Wheat Improvement Centre (CIMMYT), United Republic of Tanzania, and the Southern Africa Centre for Cooperation in Agricultural Research, 1998; and January Mafuru; Robert Kileo, Hugo Verkuijl, Wilfred Mwangi, Ponniah Anandajaysekeram, and Alfred Moshi, *Adoption of Maize Production Technologies in the Lake Zone of Tanzania*, 1999
[24] Lyimo, *op.cit.*

50% more if striga is also a problem – but at the cost of considerable extra labour at the start of the season.[25]

Maize breeding at Ilonga has also stalled, after the sad death of the breeder a few months ago. Before that a number of varieties were released, two of which, Star and TMV-1, are now widely found in the drier areas of Tabora, Dodoma and Iringa. TMV-1 is very popular, because it is sweet, so good for green maize, and also heavy, so good for business.

Selian has one maize breeder assisted by two other junior researchers. At the time of our visit the main breeding activities were the evaluation of new varieties from CIMMTY that resist stalk borer and other pests; crossing some of these with local breeds; adding protein to open pollinated maize to produce Quality Protein Maize, and screening this for rust. Selian is also running maize trials in four villages, designed to quantify the impact of fertilizers, including the natural *Minjingu* phosphate fertilizer, mined not far from Arusha.

However, some of the improved hybrids, such as Selian Mh -07 and Selian H-308 and 208, have not spread widely. This, according to the researchers, is because of problems in the production and dissemination of the seeds. With the hybrid seeds, part of the problem is to persuade commercial seed companies to take the small quantities of breeder seeds supplied by the research station, and to multiply these in order to produce the quantities of "foundation seed" needed for commercial seed companies to plant and produce large quantities of seed for commercial sale.

With self-pollinated seeds, such as the Quality Protein Maize, the incentives for the seed companies to multiply the seeds are much weaker, because once farmers have purchased a small quantity of the improved seeds, they can multiply these themselves. A seed company will therefore expect to sell only small quantities of the improved seed, and has little incentive to take this on. But if farmers are not aware that an improved seed exists, they will not seek it out. The problems of seed multiplication are a feature of all these case studies here, and are further discussed later in this report.

In 2010 a detailed study of the value chain for maize was published by USAID, based on fieldwork in the Manyara and Kiteto areas of Arusha Region.[26] This shows how maize is purchased from small farmers by "consolidators", who sell to "traders" in the larger towns, some of whom are agents for the large millers. Much of the discussion is about the price

[25] *The quiet revolution: Push-pull technology and the African farmer*, Gatsby Foundation Occassional Paper, 2005

[26] USAID, *MicroCLIR/CIBER assessment: The legal, policy, regulatory, and institutional constraints to the growth of maize and rice in Tanzania - Agenda for Action*, 2010

paid to farmers, and the consequence of the ban on exports of maize. Main conclusions are that there is need for more investment in transport, and that more attention should be given to storage – on farms (where the larger grain borer, *Prostephanus truncates*, unofficially called the scania borer, after the lorries which in 1978 or 79 carried the food aid within which the first beetles came, is a real risk to any stores constructed of wood[27]), and by the consolidators (who if they had storage could sell maize at times other than immediately after harvest).

The 2006 dissemination study from Uyole presents detailed results from the breeding programmes, but also of the work with farmers and the problems they face, and the contribution that NGOs were making to extension and dissemination.[28] Work in progress in 2010 in Mara region, showed that for a number of extension recommendations, e.g. about fertilizer, many of the farmers who accepted the recommendations in one year, and therefore understood them, did not follow them the subsequent year.[29]

In summary, maize is seen as a key agricultural product by the Government of Tanzania, which has invested heavily in subsidies for fertilizer, and in research overall, including the largest breeding programmes in the country. However, it is the most controversial of crops, with ongoing debates about whether it should be promoted in drier areas, and whether it should be sold abroad in times of food shortage. If Tanzania is to get the most out of its heavy investment in the crop, it needs to be more selective, listen more to farmers, and probably also to be more trusting of market forces, both as a means of disseminating improved self-pollenating seeds but also as a means of moving maize around the country and outside.

4.3 *Cassava*

Cassava is one of the most versatile natural products on the planet. It can be eaten (both the leaves and the roots). The roots can be ground up to make flour, which can be used for animal feeds, converted to starch which is used in food, in the textile industry, as an adhesive and in cosmetics, and then converted into a sweetener for biscuits and soft drinks. It can also be fermented into alcohol for use in cooking and

[27] Cross, Michael "Boring into Africa's Grain: A new insect from Central America is suddenly devastating maize stores in Tanzania", *New Scientist*, 16 May 1985
[28] Lyimo, *op.cit.*
[29] Salatiel, Simon; M S Theofora and X Nyoni "Improved technologies disseminated by research institutions, the adoption rate and the extent of abandonment", REPOA Research Workshop, Dar es Salaam, 2010. Also Urasa, Justin K "Maize Farming and Household Wellbeing: A Case Study of Rukwa, Tanzania", REPOA Research Workshop, Dar es Salaam, 2011

lighting, and this can be distilled to produce ethanol for use as a biofuel or alcoholic drink.[30]

It is a crop that can give farmers acceptable yields even with minimum inputs such as use of fertilizers (use of nitrogen fertilizers often leads to too much leave growth), and is resistant to drought.

Tanzania is currently the World's eighth largest producer of cassava, and Africa's fifth largest, after Nigeria, Democratic Republic of the Congo, Ghana and Angola. By dry weight it is Tanzania's second most important food crop, after bananas. But production, in terms both of weight (around 7 million metric tonnes) and area (600,000 hectares) has been roughly static for the last 20 years.

Yields in Nigeria are roughly double those in Tanzania. The Nigerian production grew on the basis of improved hybrid seeds, resistant to Cassava Mosaic Disease which were developed in Tanganyika in the 1940s, and passed to research stations in West Africa in 1957 when the colonial government stopped the programme. The breeders in West Africa subsequently kept the resistance, while improving the yield.

The breeders have also dealt with two pests, the cassava mealybug, which was a big problem in Tanzania in the 1980s, and the green mite, by introducing natural predators. A study at CGIAR has shown that this was a hugely cost-effective piece of research, since effectively all producers of cassava benefited from it.[31]

In Tanzania, two viral diseases are currently the greatest challenges threatening the crop – CMD developed a virulent off-shoot, the Uganda variant, and Cassava Brown Streak Disease, which destroys the tubers as well as the leaves. As of now, resistant varieties are not yet available, and farmers are advised to combat it by growing tolerant varieties (which show symptoms in the leaves but the roots are intact) and to control the spread by quickly uprooting and burning any infected plants they see.

Breeding of varieties of cassava was restarted in the 1970s, at Ukiriguru (for the Lake and upland areas). Breeding for the coastal and semi-arid areas is based at Kibaha and Naliendele. In 2009 8 new improved varieties were released for the Western and Lake Zones, resistant to the Uganda strains of CMD. Five improved varieties have been released for

[30] Adetunji, Oluwatoyin "Nigerian Presidential Initiative on Cassava: Its Successes, Challenges and Future plans", Cassava Week, Dar es Salaam, September 2011.
[31] Maredia, Mywish K. and D.A. Raitzer. "CGIAR and NARS Partner Research in sub-Saharan Africa: Evidence of Impact to Date". CGIAR, 2006

the coastal and semi-arid areas. Varieties resistant to CBSD are, it is hoped, 3-4 years away from release. [32]

Work to identify the relevant viruses, using advanced molecular technology, is conducted at Mikocheni Agricultural Research Institute (MARI). At least three international organisations working are also involved: IITA, CIAT and ASARECA.
In September 2011, the Ministry of Agriculture, Food Security and Cooperatives sponsored Cassava Week in Dar es Salaam. All elements of the value chain were present: representatives of processors (a large scale plant designed to process 250 tonnes of cassava per day, will shortly open in Rufiji District), NGOs involved in small-scale processing and nutrition projects, and the food security, the Tanzania Food and Nutition Centre, research and extension, and crop promotion departments of the Ministry of Agriculture, Food Security and Co-operatives.[33]

If cassava is to become a cash crop in Tanzania on a scale substantially larger than at present, then all these will have parts to play. There is no point in encouraging farmers to plant large areas of cassava if, when they harvest the crop, the market will be flooded, especially as unprocessed cassava starts to spoil after three days (in Shinyanga, in response to a campaign, the price of a truck of cassava fell by 90% in just a few months – not giving farmers long term faith in the crop). Nigeria, with its oil money, used subsidies to establish large processing plants and passed a law that required millers of wheat and maize flour to include 10% cassava flour. Distilleries need regulation and inspection.

The two main cassava diseases have spread widely, so there is an urgent need to promote the new disease tolerant varieties – these are still in short supply. However, to get maximum yields farmers also need to learn and adopt improved farming practices for when to plant, spacing, how to take and plant the cuttings, and how to deal with any diseased plants.

Cassava Week demonstrated that there is the potential for substantially greater cassava production in Tanzania, by developing the whole value chain. The higher yields should lead to lower prices, while still giving

[32] Hartmann and Victor M. Manyong' "Tanzania's Economic Transformation: the Role of Agriculture", Keynote address, Cassava Week, Dar es Salaam, September 2011.
Myaka, Fidelis "Tackling Production and Productivity Challenges of Cassava (*Manihot Esculenta*)-in Tanzania: The role of research", presentation, Casssava Week, Dar es Saalam, September 2011

[33] Mr Alex Nalitolela, a specialist on extension, said the National Cassava Week will help the public to have more knowledge on farming and consumption of the crop. He said through the growth of cassava, jobs opportunities will be created and unemployment eased. "The project of building cassava processing industries in Rufiji District is underway. There are hopes of creating more jobs". Mr Nalitolela said for the food manufacturing industry alone, Tanzania can save an estimated US$20 million per year. (DAILY NEWS-online edition, 18th, October, 2011)

increased incomes to the farmers. So here is a checklist of what is needed:

1. Continuing plant breeding, in the first instance to be able to release the new high yielding varieties resistant to both Cassava Brown Streak Disease and the Uganda variant of the Cassava Mosaic Disease. For the new starch plant, and outgrowers supplying it, clean planting materials will be needed, of varieties with high starch content.
2. Extension work to help farmers to increase the yield. Tanzania's average yield at present is about half of that in Nigeria, and the potential is much higher, through more intensive planting and better rootstock, but without expensive purchased inputs.
3. Farmers will also need the best available information about how to control diseases and pests, how best to cut and plant cuttings, crops that can be intercropped with cassava, and when to plant and harvest.
4. Processing plants and further downstream processing will need to be planned and constructed by private sector companies, in locations that minimise transport costs. These will need to identify specific market outlets – e.g. for animal feeds (probably the easiest), pharmaceuticals, soft drinks, low grade distillation for local use as a cooking or lighting fuel, or high grade distillation for use as bio-fuel.
5. Extension work to alert farmers to the new markets that will be opened up by these mills, and the actions they need to take to benefit from them.
6. Work with NGOs to develop recipes and foods based on cassava, but also using beans, cowpeas, chickpeas etc to provide proteins.
7. It would also be very useful, if this has not already been done, to have agro-economic studies of the value chain, which compare cassava with other crops, especially maize, but also cotton in the Lake regions, coffee in the Western regions and cashewnuts in the coastal regions, on the basis of a range of plausible assumptions about the farmers' prices for these crops. These studies should seek to understand what happens to all these crops in years of poor rainfall.

4.4 *Beans*

Beans are one of Tanzania's most important crops, not least because they provide protein for people who may not have access to much protein from animals or fish.

Breeding of improved varieties of beans has been undertaken in Tanzania for more than 30 years.[34] Varieties for altitudes up to 1,000m are bred at Sokoine, for intermediate altitudes at Seliani, and for altitudes above 2,500m at Uyole. Research at SUA was for much of that period supported with assistance from USAID and through collaboration with international research organisations, especially CIAT and ICRISAT. More recently it has been supported by the Kirkhouse Trust, based in Scotland, and the PANTIL programme based on collaboration with the University of Life Sciences in Norway.[35] Across the world, the creation of improved varieties of beans has been supported by CIAT, "bean research networks" in Southern Africa and in Eastern Africa, and a number of foundations including and the McKnight Foundation and the Bill and Melinda Gates Foundation. SUA's collection of germplasm is maintained in cold storage in Morogoro, with some also in the national germplasm collection in Arusha. At Uyole alone more than 300 varieties of bean are currently being maintained, by planting every 2-3 years. The use of molecular techniques has allowed the introduction of new traits or properties to be focussed and speeded up.

These programmes have bred for disease resistance and higher yields, in many cases incorporating germplasm imported from CIAT in Colombia. Around 1990, the breeders realised that the new varieties were "not what the farmers really want" – which were above all shorter cooking times and durability after cooking (so that the food could be used on subsequent days), and ability to grow in poor soils. So plant material from Zambia was incorporated into the two new varieties produced at SUA. Uyole has released 20 varieties in all, but its most recent varieties are still seeking approval from TOSCI. Seliani has released 12 varieties, and is in touch with large scale commercial farmers who grow beans, mainly in the Arusha area.

There remain a series of issues around dissemination.

In November 2008, SUA gained Plant Breeders Rights from the Registrar of Plant Breeders for the two new varieties of beans created by Professor Nchimbi-Msolla, named *mshindi* and *pesa*. That means that their ownership of the intellectual property are recognised, and they can negotiate commercial agreements to multiply the seeds with commercial seed companies. But the difficulty for a commercial seed company is that, unlike say hybrid maize where farmers have to purchase new seeds every year, for self-polinating varieties such as these a seed company can only expect to sell to a farmer once – after that the farmer will keep back

[34] Corliss, Julie "Better beans from Tanzania - Joint U.S.-Tanzanian research to improve bean yields" *Agricultural Research*, USAID, 1991

[35] See the Sokoine University of Agriculture, *Institutional Overview* 2008-9, especially the report of the Technology Transfer Office, pp.98-101

some of the best beans for planting the next year, and beans is not a high-value crop, other than for the commercial farmers around Arusha who have their own sources of seeds. Indeed the CEA of ASA (the Agricultural Seed Agency) told us that he has in stock 100 tonnes of beans suitable for small-scale farmers, but there is little demand for them.

SUA, and also Uyole, are therefore exploring various methods of Community Based Seed Production. That means getting farmers to multiply the new seeds on small farms. This, however, is unlikely to generate a commercial income for the breeders. Nor does it depend on a licensing arrangement, since the farmers cannot be prevented from keeping some of the seeds for the following year, to be planted by themselves or their friends. Hence the argument for what the summary of the National Bean Strategy, produced at Selian, calls the
"'informal seed system" which " involves production of Quality Declared Seed [QDS] by trained individuals or farmer groups, at district level. Production of QDS grade has less stringent rules and regulations than certified seed. It is meant to be much more readily available at affordable price to small scale farmers in remote areas."[36]

4.5 *Pigeon peas*

Pigeon peas are an important food crop in certain parts of Tanzania – in the coastal areas, especially Mtwara and Lindi, in Shinyanga - and an export crop in Arusha, Manyara and Kilimanjaro. About a third of the annual crop of under 50,000 metric tonnes comes from an area of Arusha region where the crop is grown both on large mechanised farms and on very small family plots, and from where about 30,000 tonnes a year are exported.

A report based on field studies in 2004, in Babati, the centre of the commercial and export production, published in 2007, showed that in many areas of Tanzania production was declining. The main reason was a plant fungus, fusarium wilt.[37] To respond to this in the early 1990s the research stations and ICRISAT in Nairobi (with funding from Denmark, the Rockefeller Foundation, the Kellogg Foundation, and the Bill and Melinda Gates Foundation) started breeding varieties that would resist this disease, and also mature more quickly (another loss arises when the

[36] Selian Agricultural Research Institute, National Bean Research Programme, Challenges, Strategies and Outputs 1985-2011, p.3. See also Britt Granqvist, *Is Quality Declared Seed Production an effective and sustainable way to address Seed and Food Security in Africa?* CTA, Wageningen, Netherlands

[37] Shiferaw, Bekele; Said Silim, Geoffrey Muricho, Patrick Audi, Joseph Mligo, Stephen Lyimo, Liangzhi You and Jørgen L Christiansen, "Assessment of the Adoption and Impact of Improved Pigeonpea Varieties in Tanzania", *ICRISAT eJournal* ejournal.icrisat.org Vol. 5, Issue 1, 2007

plants dry up at the end of the season before they have become mature). These varieties possessed good aromas and colour, and were quick to cook. Improved varieties were released in 1999, 2002 and 2003. More varieties are in the pipeline for release.

The adoption study showed fusarium was widespread, and that with traditional varieties losses were heavy – up to 60% of the crop – but less than 5% with the new varieties. However, in 2002-3 only about 25% of the farmers used the improved seeds. The figure rose to 34% the following year. This, according to the researchers, is how it happened in one village:

> A substantial increase in the adoption rate of some of the villages could be attributed to the seed intervention in the village by Dodoma Transport Company, a private grain trading enterprise based in Arusha, Tanzania. ICRISAT provided seeds of improved varieties to this company which distributed seeds to farmers in some of the surveyed villages. The company also bought back the grains from the farmers. In an effort to encourage the company pay better prices to farmers, TechnoServe provided valuable market information to Dodoma Transport on attractive market opportunities for exporting pigeon peas. This strategic alliance was very instrumental in enhancing the delivery of improved seeds to farmers and in providing reliable market outlets to their produce.[38]

The study showed that the farmers who adopted the new varieties were substantially better off, and concluded that the biggest constraint was the availability of the new seeds.

Following this, efforts to multiply the seeds and to promote the new varieties were intensified at Selian and Ilonga research stations. By 2010 researchers from Selian reported that the adoption rate had risen to 80%, that yields had approximately trebled, and that the main constraint was the availability of seed. They also commented that prices were often uncertain, and the private sector had "a lack of interest". As a result, much of the seed has been multiplied on the research stations or on farmers' farms under the supervision of the research stations, although in more recent years, when the international export price rose substantially, the Agricultural Seeds Agency and commercial seed companies have started producing and selling seed in substantial quantities.[39] A three year project, which started in 2010, funded by AGRA, has already shown that moderate doses of phosphate fertilizer can further enhance the yields of

[38] Shiferaw et al, op cit, p.13

[39] Lyimo, S.D; Mligo, J; Mmbando,F; Ubwe, R.M; Mushi, P.P; and Sulumo,P.F "Overview of Pigeon Peas Research and Development in Tanzania", Northern Zone Agricultural Research and Training Institute, 2010; Lyimo, S.D; Rose Ubwe; P.P. Mushi; Marietha Owenya; Sulumo, P.F; and Frank Mmbando "TL II Pigeon Peas Activities in Tanzania", presentation, Northern Zone Agricultural Research and Training Institute, April 2011

both pigeon peas and the maize which is customarily planted at the same time.[40]

4.6 *Irish Potatoes*

Irish potatoes are a success story, in the Southern Highlands and the Arusha and Lushoto areas. But how much of that success comes from research and extension, and how much is a result of farmers' initiatives and opportunities?

A careful anthropological study published in 1996 comments that

> From the time a Tanzanian potato research programme was initiated in 1974, efforts have been made to select high yielding and disease resistant potato varieties. In an attempt to adjust research efforts to meet farmers' needs, so called adaptive research trials were set up, testing new varieties in the area itself. Yet, none of the approximately six varieties selected over the past fifteen years is still used by Uporoto potato producers. For various reasons, peasants withdrew from the production of these high yielding and disease resistant varieties soon after the introduction. This ... rejection of propagated varieties is not a matter of potato producers' individual preferences, but ... it relates to the (different) social contexts within which these cultivars were introduced.[41]

This appears to refer to the varieties *baraka* and *sasamua*, introduced in 1979, and *bulongwa*, *tana*, *sabira* and *kikondo* introduced in 1987. No varieties from the research stations have been released since. In 2010 an adoption study, reporting on surveys of (only) 30 households in two villages, found that 58% of the farmers were using one of the released varieties – a substantial increase, at least in these two villages, from the situation 15 years earlier. 80% were using fungicides, and 52% insecticides, and 90% were using the recommended density of planting, and 100% were planting at the recommended time. Only 30% (18 farmers) appeared to be using fertilizers. So by this time, the work of the research station was having an impact, though not as great an impact as the researchers would have liked.[42]

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[40] Lyimo, S.D. and others "Improving Soil Fertility, Productivity and Livelihoods of Smallholder Farmers in Tanzania through Intensification and Diversification of Pigeon pea Cropping Systems", Progress report for AGRA funded Project, Selian Agricultural Research Institute (SARI), Arusha, 2011

[41] Andersson, Jens A "Potato Cultivation in the Uporoto Mountains, Tanzania: An analysis of the social nature of agro-technological change", *African Affairs* Vol. 95 (1996), footnote 10, p.87

[42] Namwata B.M.L, Lwelamira, J and Mzirai, O.B "Adoption of Improved agricultural technologies for Irish potatoes (Solanum tuberosum) among farmers in Mbeya Rural district, Tanzania: A case of Ilungu ward", *Journal of Animal & Plant Sciences*. Vol. 8, Issue 1: 927- 935, 2010

The 1996 report told in detail the stories of three farmers who had been migrant labourers in the Arusha and West Kilimanjaro areas where they had grown irish potatoes, and had brought some of them back to the Southern Highlands and planted them, in one case as early as 1961, with considerable success. These were varieties with resistance to blight originally bred in Kenya. Several of these varieties are still being grown, completely unofficially, including the red-skinned *irika* variety in the highest areas, and the high-yielding *kagiri* variety, which is suitable for boiling or mashing, in lower areas. It is likely that many of the 42% of the sample in the 2010 study not growing the official varieties were growing these unofficially imported varieties. Even a new variety, *tigoni*, developed at Uyole, which has been trialled on farmers' farms, is already spreading unofficially; the farmers like it and they are growing it.

The 1996 study related the growing of irish potatoes to a number of factors. From the early 1960s, pyrethrum was a profitable cash crop in the highland areas, more profitable than potatoes. But its market collapsed in the 1970s, around the time that the road from Mbeya to Dar es Salaam was tarmacked. There were many lorries returning from Malawi or Zambia with spare capacity, so it became cheap to transport potatoes to Dar es Salaam. Then in the 1980s, the production of cassava (nationally) reduced due to infestation by mealy bugs, and in Dar es Salaam chips made from irish potatoes partly replaced roasted cassava.

So here is another green revolution: research has done its work, and the majority of farmers understand how to grow the crop. But they select varieties on the basis of a range of factors, and many of the preferred varieties have been introduced by farmers, without assistance from the extension service. These farmers adopt some recommendations (e.g. to use fungicides) much more enthusiastically than they adopt others (e.g. to use fertilizers).

5. The Challenges facing Agricultural Research

The case studies above demonstrate the richness of what is being undertaken in Tanzania, for just six crops. The total resources devoted to research on these and other crops is great: a recent study identified 674 full time equivalent agricultural researchers working in Tanzania in 2008, spending over T.Shs.30bn at 2005 prices (see Appendix 2 for a key table from this report). Of these a little under half were working for the Ministry of Agriculture, Food Security and Cooperatives and 130 were in the higher education sector, most at Sokoine (this does not include all the staff at Sokoine, given as 436 academic staff and 818 technical and administrative staff in June 2009 in the University's 2008-9 Institutional Overview, including livestock and forestry).

According to the study quoted above, 16% of the staff were working on maize, 8% on rice and 8% on cassava (42% were working on "other crops" including beans and potatoes). We were therefore able to consider an important proportion of the research on the most important food crops, and there is no doubt that much of this is highly relevant, as the case studies demonstrate. Much of it focuses on plant breeding, and this has created improved varieties, higher yielding than traditional varieties, but also resistant to important plant diseases. The researchers have tested their varieties with farmers, and incorporated many traits that appeal to them – taste, smell, ease of cooking, speed of growing, nutritional properties, etc.

Our interviews revealed, however, a series of problems and issues: lack of basic resources at the Zonal Research Institutes, human resources issues and in particular the retirement or immanent retirement of a generation of agricultural researchers, the need for more coordination with SUA, and to maximise the benefits from the international organisations working in Tanzania, the benefits which could arise if there were more organised contacts between the researchers working on particular crops, the need for more regular publication especially annual reports, the need for more consideration of whole value chains for key crops, for closer involvement with the extension service now under the control of the District Councils, and the need to speed up the processes for licensing new crop varieties but also to develop the less formal systems of Quality Improved Seeds. Above all there is a need to bring together all those involved with particular crops, so that problems of marketing, storage, exporting, as well as supplies of inputs, are dealt with holistically. These matters are further discussed below, and followed up our recommendations.

5.1 *Budget Issues at the Zonal Research Institutes*

There are serious problems of resources and budgets at the research institutes, made worse by the lessening of funds from donors, by withdrawal of some support from what were formerly state farms and from some public sector funding, especially the Zonal Agricultural Research and Development Fund, with contributions from large scale public sector farms. Ukiriguru has not had tap water for nearly 10 years (this situation, we were told, will shortly be remedied), nor until recently a single operational tractor. Most of its vehicles are more than 10 years old. Uyole was harvesting wheat with a 1970s combine harvester, kept running with spare parts from South Africa. The maintenance of the internal road network is another problem. There are shortages of money for chemicals, for maintaining equipment, and for transport (needed to visit farms and off-institute field trials). None of the Zonal centres have operational refrigerated storage. That means that they must maintain collections of germplasm by carefully planting the seeds every year or two, and harvesting the crops. But in that way over time the quality of the germplasm will decline, since some seeds will fail to germinate and will be lost, while others will be struck down by plant diseases or pests. This also requires accurate recording and systematic procedures. It is much preferable to keep seeds refrigerated – as is possible at SUA. Breeding can be speeded up using molecular methods, and this is being done at Mikocheni. The researchers would like this technology elsewhere in the country. Funding is needed on a long-term basis – one, two or three year project-based funding will not support many of the most fundamentally needed projects.

Recommendation 1: Core Funding

The Zonal Research Institutes and other stations run by the Ministry of Agriculture, Food Security and Cooperatives need reliable long-term core funding. The best way to achieve this, and also to ensure co-ordination with other research agencies, may be to place the research institutes in an arms-length parastatal body.

5.2 *Human Resources*

Agricultural research needs highly specialised staff: who are meticulous, honest, able to take initiative, scientifically well trained, and able to keep up with the latest thinking, and to defend their work in international gatherings.

There is an approaching crisis in human resources especially in the Zonal Research Institutes. The situation is most extreme at Ilonga where for most of the posts for senior research officers are vacant. A generation of researchers was recruited and trained in the 1970s. Many of these have now retired – and several are still working on contract and keeping the service alive.

Recommendation 2: Human Resources

Tanzania needs to give urgent thought as to how it can replace the generation of agricultural research scientists who were trained in the 1970s.

5.3 *Sokoine University of Agriculture*

There has been a concentration, over many years, of resources for agricultural research at SUA, which has been able to attract direct support from donors such as NORAD and USAID, but its staff are also involved in other external work, e.g. providing counterpart staff for evaluation studies. SUA staff also have opportunities to be entrepreneurial and to develop outreach work with banks and financial institutions, of which PASS is an excellent example. Yet they are also held back by very large teaching loads, and university administration, and there is no obvious mechanism for their work to be co-ordinated with other agricultural research.[43]

Sokoine collaborates with the Zonal Research institutes from time to time (e.g. in the bean breeding programmes), but there is no formal mechanism for this, not least because they are under the Ministry of Education, with no direct involvement with any of the ministries responsible for agriculture. There is therefore a danger of research being driven more by academic demands, e.g. for publication in peer-reviewed journals, than by what is most needed.

Recommendation 3: Relationships with University researchers

Specific efforts are needed to make it easier for SUA to work more closely with the Zonal Research Institutes, and for more external resources to be channelled to them. The most direct way to achieve this would be through a National Plan for Agricultural Research, signed up to by all the relevant Ministries, and the

[43] This issue is by no means unique to Tanzania. A recent ASARECA conference proposed the establishment of a new set us universities, directly responsible to ministries of agriculture (*Daily News*, 13 Janaury 2012, p.13). This, however, could make the situation worse, if it encouraged more researchers to move away from the single-minded persuit of research, and had to take on teaching loads.

Planning Commission, in which SUA would undertake specific responsibilities. Donors and international organisations, and NGOs, would take note of this when deciding which projects to support.

5.4 *The International Research Agencies*

Agricultural research in Tanzania has benefited from the involvement of a number of external donors, and from the staff employed by the international organisations broadly coordinated by CGIAR (see Appendix 1) which opens up to Tanzania the breeding work, and research on plant pests and diseases, carried out in other parts of the world. This support is, however, very dispersed, to the Zonal Research institutes, to what are nominally substations such as Mikocheni, Kibaha, KATRIN, Dakawa and Maruku, to NGOs, and to the Universities (mainly SUA and the University of Dar es Salaam).

Research projects funded by these organisations often include bursaries or other forms of financial support for researchers to undertake doctoral or masters studies, and senior external scientists then work with the chosen university to provide supervision. This is one of the main ways in which a new generation of Tanzanian agricultural researchers can be trained.

From the local perspective, the number of international research organisations can be overwhelming – their proliferation, and consequent overhead costs, and the salaries they pay (well above local salaries) have long been issues of contention, though this cannot be resolved by a single country. The external organisations can also find it hard to work with Tanzania, even when there is a single named point of contact, especially where research on a single crop is undertaken at more than one Zonal Research Institute. From their point of view, a parastatal body responsible for agricultural research would make it easier for them to undertake more projects in Tanzania.

It is clearly easiest when there is a local presence or office in the country, as with IIRI/AfricaRice and with IITA, and Tanzania should seek to attract or create regional offices for the international organisations where possible.

Recommendation 4: The International Organisations

Tanzania needs to make as much use as possible of the skills and knowledge of the international organisations coordinated by AGRA, ASARECA and CGIAR – IIAT, IRRI, AfricaRice, CIAT, CIMMYT, IFPRI , etc. In particular these organisations- should be

invited to assist Tanzania in its aim of developing the research skills of a new generation of agricultural researchers.

5.5 *Need for Regular Meetings of Research Workers*

Partly for these reasons, the research is not always well co-ordinated, and the researchers specialising on particular crops need more contact with each other. Until about 20 years ago, there were National Coordinating Committees for each of the main crops, each with a coordinator, who convened annual meetings where all the researchers working on a particular crop came together for a day. These meetings were highly productive – they allowed ideas to be exchanged, gaps or needs for new research to be identified, they encouraged a climate of competition between researchers, and, since individuals from the private sector and sometimes from processing companies were also invited, they allowed the needs of each crop to be considered right down the value chain, in so far as this was in Tanzania. This is how scientific research works – with dialogue and discussion between researchers, very seldom with individuals working on their own.

Recommendation 5*:* The need for regular meetings of those working on key crops

The Ministry of Agriculture, Food Security and Co-operatives should, without delay, revive the National Coordinating Committees for key crops and regular meetings for all the researchers undertaking work on these crops. These meetings should be tasked: to review achievements, identify bottlenecks, and make recommendations for further work. A few key individuals from the academic and private sectors should be invited to attend as observers.

5.6 *Research and Extension*

Agricultural improvement, along with livestock development, water, health services, education, and a great deal more, is decentralised to districts. We were told, as far as crop agriculture is concerned, that it works well in a few places, where there are capable District Agricultural Officers and Regional Commissioners who understand the importance of agriculture and the difference it can make to the lives of those in the areas. But it can also lead to neglect, over-simplified and often out of date advice, and there is little to stop resources allocated to agriculture

being used for other things. As matters stand, for most district areas, the researchers are increasingly isolated from the extension service.

For extension to be effective, it needs constant updating – so that extension workers give good advice in the light of the latest price trends, research on insects and pests, new varieties, and other matters which are constantly changing. It also needs to be a two-way process, in which, when farmers have problems, they consult extension workers, who if they need technical advice or support can get this from the research stations.

Extension also needs socio-economic and agro-economic research to be built in – so that, where recommendations are not accepted, the reasons for this are understood, and the effect of innovation on whole families and communities is researched and understood.

A main strength of the ASDP is that it is based on a bottom up approach. This needs to be maintained in the design of research projects, which where possible should be in response to problems identified by farmers (this will not always be the case, as there are some research possibilities which farmers are unlikely to think of without assistance).

A common strategy, which we heard about more than once, is to hold farmers' field days where farmers are invited to see trial farms and compare this with their own traditional ones, to give out fliers summarising good practice, to use "Nane Nane" day events, radio programs, tv, and to provide training by use of video. If for any reason, e.g. shortages of funds for transport, this kind of dissemination is not possible, then researchers will create their own extension work. Thus one researcher spoke to us about working with 100 farmers. Others use their trials on farmers' farms as a form of extension. But this will never be sufficient in scale to cover more than a small proportion of the farmers.

We understand that a new agricultural strategy for Tanzania is being prepared, to update ASDP, and that this will include specific commitments for research. We presume that this will be integrated with agricultural plans for the districts. But without waiting for this, every district council should be required to produce a plan for agriculture. This should indicate which crops should be promoted, at which locations in the district, with targets for areas to be planted, inputs to be used, produce to be harvested. This plan should be widely publicised, and available to any visitor to the district. These plans should be signed off at a high level, in the Prime Minister's Office or the Ministry of Agriculture. Any district unable to produce a convincing plan to develop its agriculture, should expect the level of its funding for agriculture to be cut.

Recommendation 6: Research and Extension

It is essential that research works hand in hand with extension. Agricultural problems and projects – whether research or otherwise - should be made to feature highly in the district development plans. These plans should include specific locations and targets for areas to be planted, inputs to be used, and quantities of produce to be harvested. They should also include lists of issues or challenges facing farmers, and where possible research programmes to address these. The plans should be signed off at a national level, and any district unable to produce a convincing plan should expect levels of funding for agriculture to be cut in the future.

5.7 *The Need for Whole Value Chain Research*

Work on agricultural economics is one of the strengths of the Zonal institutes, and of SUA. It is mainly focussed on single crops. But more work is needed on whole value chains, which will identify problems in storage, marketing and processing and suggest policy improvements. These should look at more than one crop, or systems of cropping. There is little point in suggesting that farmers grow a certain crop if another crop is more profitable in that area, or can be grown using less farm labour at peak periods. (Thus the work on cassava discussed in the case study looks at the whole value chain, but it is not clear that it considers other crops, e.g. how farmers should balance growing cassava with growing maize, or cashewnuts).

The Ministry of Agriculture, Food Security and Cooperatives has a strong Research and Development Department at its Head Office in Dar es Salaam. The Ministry is committed to implementing the Agricultural Sector Development Programme, agreed in 2005 as a means of implementing the Agricultural Sector Development Strategy, with a strong emphasis on small-scale family farming, and donor support through a "basket" approach – a set of donors coordinated by the World Bank. But the Ministry is not directly responsible for storage and processing, extension, the distribution of agricultural machinery such as powered tillers, or the large private investors who are interested in the Southern Agricultural Growth Corridor. Nor for livestock or forestry. It has recently taken responsibility for the agricultural aspects of irrigation. All of these need research, to support them and ensure that best use is made of the investments.[44]

[44] In theory, the research needs, including research for large farms, are coordinated through the Client Oriented Research Management Approach (CORDEMA) of the Ministry, which includes research priorities for each zone. But in practice it has proved hard to relate this to funding through the Zonal Agricultural Development Fund and the ASDP.

The presentations at the recent Cassava Week in Dar es Salaam demonstrate the value of and need for plans which look at the whole value chains for the main crops, and are signed up to by all the stakeholders who will have to be committed if these plans are to be a success. Otherwise there is a risk of encouraging farmers to grow crops for which there is little market, for insufficient attention to be given to problems of storage and transport, and for new processing plants to be delayed because of uncertainty about the availability of raw materials.

Recommendation 7: Whole Value Chain Research

Cross-sectoral workshops should take place for each of Tanzania's main crops, with the aim of producing, for each of these crops, a plan for development of the whole value chain, including marketing, storage, processing, and export, with specified targets and milestones.

5.8 *Seed Multiplication and Distribution*

The system of seed licensing and multiplication is seldom easy in a big country. Tanzania has been trying to get this right for at least 40 years. Lyimo described the situation in 2005 in the following terms:

> Poor access to quality seed by farmers has been a major constraint for a long time, both during the 20+ years monopoly of the national seed company, TANSEED and since. During this period, inefficiency and poor management limited its ability to operate a seed system capable of sustaining farmers' requirements for good quality seed. Most of the certified seed, which was marketed through a limited distribution network, had been of questionable purity and in many cases exhibited unacceptably low rates of germination. In response, farmers rejected this enterprise by gradually disadopting virtually all types of certified seed marketed by TANSEED, consequently leading to its collapse by 2002. This situation severely disrupted the certified seed system, encouraging unscrupulous traders to resort to marketing fake or un-adapted seed, consequently plunging poor farmers into deeper trouble and making them lose faith further in the so-called improved seed.
>
> Subsequently, private seed companies, both international and [increasingly] local, have entered the Tanzanian seed market. With respect to seed of improved maize varieties, there has been a significant increase in price and a subsequent decline in returns to the crop. Farmers appear to have adapted their livelihood strategies in response by e.g. growing a larger area of maize to compensate for a decline in fertilizer use, switching to other crops, reducing the amount of improved certified seed purchased and making greater use of re-cycled seed. The outcome has varied, but for many still dependent on maize, the returns from the crop have declined, with implications for people's financial situation (e.g., less money to purchase inputs, possibly unable to support children going to school). The current situation is still associated with a lack of trust or confidence held by farmers in improved crop varieties from seed companies and other institutions dealing with seed distribution.

The formal system, under the Seed Act 2003, allows a breeder with a new variety to apply to TOSCI (the Tanzania Official Seed Certification Institute) for a license, sending samples of the new seeds, $600 per variety, and data on trials conducted both on research stations and on farmers' farms for two seasons. TOSCI uses the samples to carry out its own "national performance trials", taking a further year. It then presents the data to the National Performance Trials committee, and if these are satisfied to the National Variety Release Committee, and finally to the National Seed Committee, chaired by the Permanent Secretary. Only when all these are satisfied, is the variety licensed and its name registered, and the owner can sell the seeds and charge royalties for any farms that carry out the seed multiplication.

This system is currently under review, partly because of pressure for a common system of seed registration for all of the East African Community (much of the seed currently used for maize, for example, derives from Kenya). It can be cumbersome and slow – for example AfricaRice has three new varieties lodged with TOSCI, but meanwhile two of these have already been released in Burundi. In the last 20 years, according to IRRI, only seven varieties of rice have been released in Tanzania. But it is also because it is recognised that, while a licensing system can work well for hybrids, where it is important for those buying the seed each year to know that they are getting the genuine article, it often works poorly for open or self-pollinated seeds, or plant materials such as cassava or potatoes spread by vegetative means, i.e. planting tubers or cuttings. Here experience has shown that, if the planting materials are good and the economics is right the farmers will do the propagation themselves. That also means that it is difficult for a seed company or a breeder to make a profit from selling the seeds – the only feasible method may be to multiply them on the farms of the research stations, and give them out in different places, or through NGOs, relying on the farmers to decide if they like them, and that if they do they will multiply and spread them.

This is the basis of the system of Quality Declared Seeds, which permits seeds to be multiplied on small farms. It is intended to operate for relatively short periods of time, until a market for improved seeds has developed, on the basis of certification from the research stations. A method such as this is probably the only way in which many of the new varieties so carefully created in the research stations will be disseminated, given the lack of interest of the commercial companies.[45] With this system, there is a risk of poor quality seed being sold as good; however, even with full certification it is sometimes hard to stop seed companies diluting improved seed with unimproved. In both cases, the key is to gain the trust of the farmers.

[45], Britt Granqvist *Is Quality Declared Seed Production an effective and sustainable way to address seed and food security in Africa?* CTA, Wageningen, Netherlands

Markets can be a blessing or a curse, as far as agriculture is concerned. In certain circumstances, such as the discussion of potatoes above, they will ensure that a new technology spreads, without much need for extension. At other times they are a problem – e.g. the market incentives for seed companies to distribute self-pollinated or vegetatively propagated seeds or planting material are weak, or when they lead to speculation in times of food shortage. But, as a general principle, in a big country such as Tanzania, markets should be used wherever this is feasible, and steps taken to remove non-market disincentives and incentives.

Our case studies bring out the wide range of improved varieties which have been developed in Tanzania, many drawing on germplasm from international sources to improve yields. Some of these are officially released, others in the process of being released, and others unofficially circulating, originating in Tanzania or neighbouring countries. One conclusion from this is that the modern farming initiatives, e.g. SAGCOT, should not need to import yet more varieties from abroad – they should look first to what is already here.

Recommendation 8: Seed Certification and Distribution

The processes of registering new varieties need to be streamlined. For self-pollenating, open pollenating or vegitatively propagated crops the system of Quality Declared Seeds should be developed as far and as fast as possible, and more faith placed in markets and in the ability of farmers to distribute seeds and planting materials.

5.9 *The Research Needs of Large Farms*

Tanzania has always had large farms, growing coffee, tea, sisal, sugar, wattle, wheat, and many other crops, and now flowers, milk, and horticultural products. There are many new developments, and even more proposals, for the large scale production of biofuels (such as jatropha or oil palm), rice, cassava, wheat, sorghum, sugarcane, seeds, and animal feeds. Investors from a very wide range of countries are investing in these, or have publicised their intention to do so.

Where foreign investors are involved, they are permitted to import their own seeds, provided these pass phyto-sanitory checks (to prevent diseases entering the country) and provided the seeds are not sold to others. However, many of the seeds and planting materials used in other countries are not resistant to drought, which is why many of the incoming

investors are seeking control of water, or at least the possibility of supplementary irrigation in years when the rains fail.

For some traditional crops, the research needs of large farms are already well provided – tea, coffee, sugarcane, sisal. But for the food crops covered in this report, it appears that there are only limited contacts between the large scale farms and the research community in Tanzania.

Yet these farms will face most of the problems that confront smaller farms – plant diseases, pests, the need to produce varieties that are acceptable in Tanzanian markets, the problems of unreliable rainfall, and fragile soils subject to erosion. Moreover, it is not in Tanzania's interests to import technology from overseas if it already exists, or can easily be developed, within the country.

There will be great benefits if some of the techniques adopted by large scale farms can be used on, or adapted to, the small scale sector.

There is therefore a need for more formal means by which large farms can draw on the expertise of the agricultural researchers in the country (paying them if appropriate) both on an individual farm basis, and more generally through organisations such as the Agricultural Council for Tanzania and other organisations where large farmers or farming companies are represented.

Recommendation 9: The Research Needs of Large-scale Farms

There should be formal understandings of how large scale farms can draw on research expertise, and more general understandings with organisations that represent large scale farmers, such as the Agricultural Council of Tanzania. Where international companies are involved, steps should be taken to ensure that their research knowledge is shared with the rest of the research community in Tanzania. The Ministry of Water and Irrigation and the other ministries with interests in agriculture and the rural economy need also to be involved.

5.10 *The Need for a Holistic Approach*

In short, there is a need to look at the agricultural sector problems holistically – looking at how issues on productivity, value addition, markets and prices impinge on each other.

The Maputo Declaration commits the country to spending at least 10% of its budget on agriculture and rural development. In that context, the new

agricultural strategy should include a plan for research, built up on the basis of plans for each crop, at programme level, and the agricultural development strategies for each district as in Para.5.6 above, which should involve dissemination strategies and associated research for a variety of seeds and innovations.

From that can follow agreed, and feasible, plans for all Tanzania's main crops. These would incorporate the priorities programmes for research on these crops include discussion of the bottlenecks in the value chains for each crop, from production through to processing and sales, and proposals to remove them. They would include specific commitments by all the stakeholders, including universities and international research agencies and donors as well as the DRD, which can be monitored and to which they can be held. They should be reviewed annually, to take account of changing market opportunities, the availability of new varieties, and threats from predators or diseases. They need to involve agricultural economic and socio-economic studies to ensure that recommendations are robust and will be accepted by farmers. (As things stand now, the root cause of the lack of adoption of improved technologies is often not very clear). These plans should be public and shared with donors. In this way the specific contributions most needed from agricultural research can be firmed up, and the service funded and planned reliably, on a medium to long-term basis.

Recommendation 10: The Need for a Holistic Approach

Further work is needed to bring about the changes in institutions, and in culture that are needed if agricultural research is to bring maximum benefits to Tanzania. This will need to be on the basis that a whole large number of institutions need to coordinate their activities and work together. This should be institutionalised through the creation of the new national plan for agriculture, which should include the specific programmes for agricultural research agreed by the National Coordinating Committees, and for the multiplication and dissemination of improved seeds and planting materials, based on dialogue with farmers and the dissemination studies of agricultural economists. These plans would be developed, for each crop and district, with the universities, relevant international organisations and NGOs, and be revised every year to take account of new information and markets.

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Professor Kallunde Sibuga, Agronomist
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Appendix 1

CGIAR: The Consortium of International Agricultural Research Centers

Active CGIAR Centers	Headquarters location	East Africa location
Africa Rice Center	Bouaké, Côte d'Ivoire / Cotonou, Benin	Mikocheni, Dar es Salaam
Association of Agricultural Research in East and Central Africa (ASARECA)	Kampala, Uganda	Kampala
Bioversity International	Maccarese, Rome, Italy	
Center for International Forestry Research (CIFOR)	Bogor, Indonesia	
International Center for Tropical Agriculture (CIAT)	Cali, Colombia	Kampala
International Center for Agricultural Research in the Dry Areas (ICARDA)	Aleppo, Syria	
International Centre of Insect Physiology and Ecology	Nairobi	Nairobi
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	Hyderabad (Patancheru), India	Nairobi
International Food Policy Research Institute (IFPRI)	Washington, D.C., United States	Kampala
International Institute of Tropical Agriculture (IITA)	Ibadan, Nigeria	Kampala Dar es Salaam
International Livestock Research Institute (ILRI)	Nairobi, Kenya	Nairobi
International Maize and Wheat Improvement Center (CIMMYT)	El Batán, Mexico State, Mexico	Nairobi
International Potato Center (CIP)	Lima, Peru	
International Rice Research Institute (IRRI)	Los Baños, Laguna, Philippines	Mikocheni, Dar es Salaam
International Water Management Institute (IWMI)	Battaramulla, Sri Lanka	
World Agroforestry Centre (International Centre for Research in Agroforestry, ICRAF)	Nairobi	Nairobi
WorldFish Center (International Center for Living Aquatic Resources Management, ICLARM)	Penang, Malaysia	

Appendix 2

Public Spending on Agricultural Research and Staff Numbers, 2008

	Total spending			Total staffing	
Type of agency	**Tz shillings**	**PPP dollars**	**Shares**	**Number**	**Shares**
	(million 2005 prices)		(%)	(FTEs)	(%)
Ministry of Agriculture Food Security & Coops	12,191.6	30.8	39.4	294.0	43.6
Ministry of Livestock Development and Fisheries	4,536.7	11.5	14.7	96.1	14.3
Other government Departments	5,994.2	15.2	19.4	138.0	20.5
Non-profit Research Organisations	2,951.5	7.5	9.5	23.6	3.5
Higher education	5,245.5	13.3	17.0	121.9	18.1
Total	**30,919.7**	**78.2**	**100%**	**673.5**	**100%**

Sources: Kathleen Flaherty and Deogratias Lwezaura *Tanzania: Recent Development in Public Agricultural Research*, Country Note, Agricultural Science and Technology Indicators, Oct. 2010, Table 3