Breeding better groundnut for Sub-Saharan Africa

RIU

Validated RNRRS Output.

A variety of new technologies are now available to boost groundnut production in Sub-Saharan Africa. Advances include a new method to detect rosette disease using reverse transcription-polymerase chain reaction (RT-PCR) and the development of high-yielding, fast-maturing varieties that will allow farmers to grow two crops of groundnut per year. This work is complemented by a groundnut production manual that targets agricultural extension agents and NGO staff. To combat disease, researchers have also identified molecular markers that can be used to pinpoint resistance genes. They also developed a basic genetic linkage map for groundnut. Hybrid groundnut breeding lines have also been developed for use in crop improvement programmes.

Project Ref: **CPP38:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Protection Programme**

Document Contents:

Description

CPP38

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

Sudan, Uganda,

Target Audiences for this content:

Crop farmers,

A. Description of the research output(s)

1. Working title of output or cluster of outputs.

Improved technologies for groundnut production in sub-Saharan Africa.

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

The research was supported by the Crop Protection Programme of the Department for International Development (DFID). Additional funding to support groundnut breeding activities was provided by the Serere Agricultural and Animal Research Institute and the International Crops Research Institute for the Semi-Arid Tropics. Complementary funding for specific activities on disease transmission was provided by the Peanut Collaborative Research Support Programme of the United States Agency for International Development. Related research on the control of groundnut leaf miner was supported by the DFID-funded Client-Oriented Agricultural Research and Dissemination (COARD) project.

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities.

Programme	***Project no.***	***Project title***
CPP	R6811	Groundnut rosette disease epidemiology
CPP	R7445	Groundnut rosette disease management

Lead institute: **Natural Resources Institute**, University of Greenwich, Chatham Maritime, Kent ME4 4TB, United Kingdom. (Dr Tim Chancellor; ct06@gre.ac.uk).

Main partner organisations:

Serere Agricultural and Animal Research Institute (SAARI), P.O. Soroti, Uganda. (Dr Charles Busolo-Bulafu; cbusolo@hotmail.com)

AT Uganda Ltd, Plot 1, Muwafa Road, Ntinda, P.O. Box 8830 Kampala, Uganda. (Dr Rita Laker-Okok; rojok@spacenet.co.ug)

ICRISAT-Lilongwe, Chitedze Agricultural Research Station, PO Box 1096, Lilongwe, Malawi (Dr Emmanuel Monyo; e.monyo@cgiar.org)

Soroti Catholic Diocese Integrated Development Organisation, PO Box 641, Soroti, Uganda.

Dr Naidu Rayapati, University of Georgia, USA. (naidu@mail.prosser.wsu.edu)

4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? ***(max. 400 words)****. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

Research conducted under project R6811 between 1996 and 1999 resulted in the development of a new method to detect the three causal agents of the destructive and economically-damaging rosette disease complex in groundnut and aphids by ***Reverse Transcription-Polymerase Chain Reaction*** (RT-PCR). The research also led to an improved understanding of the ***transmission characteristics*** of the disease complex and the identification of ***vector resistance*** in an early-maturing, high yielding groundnut line (ICG-12991).

Using the outputs developed under R6811, project R7445 was designed to address the problem of low and declining yields and reduced profitability in groundnuts in eastern Uganda by developing improved management practices for the key production constraint, groundnut rosette disease. The research outputs comprised:

An ***electronic database*** containing social and economic data related to groundnut production in the TESO district of Uganda, with particular reference to groundnut rosette disease was produced in 2001.

Three high-yielding, short-duration, rosette-resistant groundnut varieties which meet the specific requirements of different local markets. 'Serenut 2' (ICGV-SM 90704), an ICRISAT variety, was released in 1999 and rapidly established itself as one of the most popular groundnut varieties. Serenut 3R (ICGV-SM 93530), a red type, and the tan-coloured Serenut 4T (ICG 12991) were released by the Uganda Seed Board in 2002. The short duration of the varieties have enabled farmers to grow two crops of groundnut a year and thus to significantly enhance their income potential.

The identification of ***mechanisms of resistance*** against the aphid vector of groundnut rosette disease, *Aphis craccivora*. Experiments using Serenut 4T (ICG 12991) established that resistance was due to both *non-preference* and *antibiosis*. Detailed feeding studies revealed that virus transmission might be inhibited through the collapse and death of plant cells at the feeding site.

Hybrid groundnut breeding lines were developed for use in crop improvement programmes and ***molecular markers*** were identified linked to the resistance gene in ICG 12991. A basic ***genetic linkage map*** for groundnut was also developed.

A ***groundnut production manual*** was compiled in 2002 and a total of one thousand copies were distributed to agricultural extension agents and NGO staff. The manual describes recommended groundnut production practices and provides information on post-harvest activities such as drying, curing and storage.

After the completion of R7445, one of the project partners AT Uganda took forward the research by addressing the key constraints of limited availability of seed, sub-optimal post harvest practices and poorly organised marketing (projects R8105 and R8442).

5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	Technology	Service	Process or Methodology	Policy	Other Please specify
X	X		X		

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

The main commodity on which the research focussed was groundnut, *Arachis hypogaea*, but the outputs might also be applied in the broader context of legume-based cropping systems. The methodologies used in the breeding and work and in the identification of resistance mechanisms could be applied to other annual crops.

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	High potential	Hillsides	Forest-Agriculture	Peri-urban	Land water	Tropical moist forest	Cross-cutting
X	X	X		X			

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	Irrigated	Wetland rice based	Smallholder rainfed highland	Smallholder rainfed dry/cold	Dualistic	Coastal artisanal fishing
X			X	X		

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**).*

The development of pest and disease-resistant groundnut varieties with a range of other desirable characteristics that meet the needs of both farmers and consumers has generated lessons that can be shared with stakeholders in other crop pathosystems. Similarly, research conducted in other client-oriented breeding programmes (for example, R7565, R8302, R8269) and in projects where pest and disease resistance is incorporated into improved varieties (for example, R6519, R8425, R8445 and R8456) can add value to outputs generated through the groundnut projects.

The development of improved groundnut production technologies, and of methodologies for adding value to groundnut breeding programmes, has greatly enhanced the potential for smallholders to generate additional income from the crop. However, there are still important institutional and market-related constraints to the development of profitable and sustainable groundnut value chains in sub-Saharan Africa. Complementary research led by AT Uganda in Uganda (R8105 and R8442) has demonstrated the value of farmer-led approaches to seed multiplication and distribution. The success of this model in Uganda, and findings from a needs

assessment in eastern Africa (R8428), suggests that there is scope for the approach to be transferred to other countries.

The research led by AT Uganda has shown the importance of appropriate post-harvest handling procedures and of collective marketing approaches by farmers. Work led by the University of Zimbabwe on peanut butter processing (R7419) has demonstrated the potential of low cost technologies for added value. In addition, research conducted by ICRISAT (R8483, R7809 and R8298) has resulted in a serological technique for detecting aflotoxins in agricultural commodities and in reducing levels of aflotoxin in groundnuts. These innovations show that there is scope to successfully address market-related constraints. When combined with the improved production technologies developed through R6811 and R7445, there is good potential for successful interventions along the whole groundnut value chain.

Validation

B. Validation of the research output(s)

*10**. How** were the output(s) validated and **who** validated them?*

*Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation **(max. 500 words)**.*

The advanced short-duration lines were evaluated for rosette resistance, adaptability, yield and other attributes at SAARI and 5 other locations in 1999, 2000 and 2001. The lines, including susceptible and resistant controls, were tested in a completely randomised block design, with four replications. The performance of the most promising lines was then evaluated in on-farm trials, involving three groups of eight farmers (72 in total) in each of three districts. These farmers, who cultivated between three and eight acres of groundnuts, were representative of groundnut producers in their respective localities. Based on the data generated in these trials, two lines (ICGV-SM 93530 and ICG 12991) were submitted to the Ugandan Seed Board for release and this was approved in 2002.

Subsequent field-scale validation of the improved varieties was conducted between 2001 and 2005 through projects R8105 and R8442 in the process of multiplying seed for farmer to farmer distribution. During this process validation was conducted by the coordinating organisation, AT Uganda, which worked with farmer groups to evaluate the recommended production practices and to train farmers in appropriate post-harvest methods. Validation was also carried out by the National Agricultural Advisory Services (NAADS) whilst they were promoting the use of the rosette-resistant varieties in the initial sixteen districts where operated. NAADS documented substantial increases in productivity in some of the districts where data were collected. For example, in Arua district in northwest Uganda, yield increases of between 300 and 500 percent in varieties Serenut 2 and Serenut 3 were recorded by farmers (see Final Technical Reports of projects R8429 and R8281).

Validation of the marker-assisted selection techniques utilised for the identification of resistance genes to rosette viruses and the aphid vector was done by the Agricultural Research Council in South Africa.

The research findings have been validated by scientists in a formal peer review process and published in international journals and newsletters. Details are provided in Annex A.

11. ***Where and when*** *have the output(s) been validated?*

Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above ***(max 300 words)****.*

The on-farm trials described in section 10 were conducted across the 3 main districts of the Teso farming system (Soroti, Katakwi and Kumi) in eastern Uganda between 1999 and 2001. Subsequent promotion of the varieties by AT Uganda was carried out in these districts and in the Bagisu farming systems from 2001 to 2005. Most of these areas are semi-arid lowlands but production also extends to the lower slopes of Mount Elgon.

Validation of the rosette-resistant varieties by NAADS was done in several of the initial six pilot districts in Uganda in which NAADS activities were launched in 2001; namely, Arua, Kabale, Kibaale, Mukono, Soroti and Tororo. In 2002, the NAADS programme was extended to include ten additional districts; Bushenyi, Busia, Iganga, Kabarole, Kapchorwa, Kitgum, Lira, Luwero, Mbarara and Wakiso. There was no formal process involved in the NAADS validation but in Soroti, Tororo and Arua, in particular, adoption levels were monitored. In Tororo, groundnut production has been classified as a strategic enterprise by NAADS and so particular attention has been focussed on this district.

In southern Sudan, the Consortium for Agricultural Research and Rehabilitation has carried out formal testing and dissemination of ICG 12991 (Serenut 4T) as part of a wider evaluation of promising new groundnut lines.

Current Situation

C. Current situation

12. ***How and by whom*** *are the outputs currently being used? Please give a brief description* ***(max. 250 words****).*

The technology is being used by small scale farmers who grow groundnuts for both subsistence and cash in most of the major groundnut producing areas in Uganda. Socio-economic characteristics of farmers utilising the new technology in the Teso district of eastern Uganda are available in a detailed survey conducted under project R7445. Farmers vary with regard to size of land holding and access to other resources but most have less than 8 acres of land and count farming as their main economic activity.

Farmer groups linked to AT Uganda and coordinated by Parish Development Committees have been instrumental in the rapid multiplication and dissemination of seed of the rosette-resistant varieties. A total of 5,217 farmers (3,650 women and 1,567 men) received seed that was multiplied and distributed in this way during the three-year period of project (R8105). During the second phase of this work, covered by project R8442, over 2,880 farmers received seed of the improved varieties and a total of 80 farmer groups were trained. See the pro forma completed by AT Uganda on projects R8105 and R8442 for further details.

Other users of the project outputs are:

- Government and non-government extension agencies using information generated during the research; for example, in the groundnut production manual.
- Private companies such as Tral Ltd which roasts and packages the groundnut seed and sells to supermarkets in Uganda.
- Peanut butter processors (see AT Uganda pro forma). These include women's groups such as one in Bukedea.

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

The improved rosette resistant groundnut varieties are now widely grown in the Teso farming system (Soroti, Kumi, Bukedea, Katakwi, Amuria, Kaberamaido, Pallisa, Tororo) and in the Lango farming system (Lira, Apac, Amolator, Dokolo). They are also grown in Mbale, Sironko, Busia, Bugiri, Iganga and Kumi, as well as the northern districts of Gulu, Kitgum, Arua, Nebbi and Pader. Farmers are now beginning to adopt the varieties in Western Uganda and Central region.

The adoption of the new groundnut varieties and associated technology in the northern districts is particularly encouraging because the region is emerging from a long period of civil strife. The instability resulting from this conflict has led to the displacement of large numbers of people into refugee camps. Groundnut cultivation is increasing in the area and more than one third of the production is sold as a cash crop. The importance of groundnut production was underlined in study conducted in 2005 by the Catholic Relief Services. This revealed that the crop was grown by 83% of households in Gulu, Kitgum and Pader Districts and that the varieties Serenut 2 and Serenut 4 have been adopted by many farmers.

Serenut 2 has recently been introduced into southern Sudan and is rapidly gaining acceptance by farmers and consumers (Richard Jones, personal communication). ICRISAT has released several rosette-resistant lines in Nigeria and these are currently being evaluated in other countries in the region. Similarly, rosette-resistant lines developed by ICRISAT have been released in Malawi.

*14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading **(max 250 words).***

The improved rosette-resistant varieties released in Uganda have been adopted rapidly since Serenut 2 was released in 1999. Because of the advantages of these varieties and the strong demand for groundnut in the country, this rapid rate of adoption is continuing particularly in areas where NAADS is operating. The International Food Policy Research Institute conducted a study in 2005 in which it found that 13 percent of

groundnut farmers in the initial six NAADS pilot districts had adopted the improved groundnut varieties. This compares with a 9 percent adoption rate in the ten districts NAADS have operated in since 2002-03 and 7 percent in districts in which NAADS does not have a presence. This suggests that active promotion of the varieties by NAADS has led to higher adoption rates.

In southern Sudan and Kenya the scale of current use is low because promotional efforts have been limited to date. However, the adoption rates in southern Sudan in areas where the Catholic Relief Service is active have been high. No data are available from Kenya but there is strong demand for rosette-resistant seed, as evidenced by the interest of seed companies in exporting the improved varieties to the country (see para 16 below).

Whilst the spread of Serenut 2 and Serenut 4 is continuing to proceed rapidly, Serenut 3 is being adopted less quickly. This may be due to its slightly bitter taste and its tendency to rot and turn rancid when harvest is delayed. This leads to poor germination and hence a low multiplication rate (R. Laker-Ojok, personal communication).

15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? ***(max 350 words).***

The promotion and adoption of improved technologies for groundnut production has been successful in Uganda for a variety of reasons. NAADS has taken a leading role in promoting the technology, particularly the rosette-resistant groundnut varieties, in response to clear demand identified at the sub-county level. The role played by NAADS has been supported by the involvement of several NGOs who have close links with farmer groups in specific locations. AT Uganda and SOCADIDO were actively involved in the initial phase of the applied research and were therefore well placed to continue with promotional activities.

Other NGOs such as Vision Terudo and Catholic Relief Services then identified the potential of the improved groundnut varieties to improve livelihoods of farmers in the areas they were working. In the case of Catholic Relief Services, this organisation was responsible for introducing the seed into new areas and popularising it through innovative mechanisms such as seed fairs. Other organisations subsequently saw the potential and began to disseminate it once the demand for the seed was apparent. The financial support allocated to seed aid has certainly facilitated this process.

In the past, the low multiplication rate of groundnut acted as a disincentive for private seed companies to enter the market. The surge in demand for groundnut in recent years has changed this situation and led to strong interest from the private sector. Part of this demand has been stimulated by the need for seed in the aid and relief markets. However, there has also been an increase in demand for groundnuts for use in confectionery and oil extraction. More attractive incentives provided by the government for investors willing to start up agro-processing industries have contributed to the strengthening of these markets. Market reform and liberalisation policies have also created a more favourable climate for farmers to diversify into crops such as groundnut.

Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

The main direct environmental benefit related to the use of the improved rosette-resistant groundnut varieties is the reduction of insecticide applications directed at the aphid vector of the disease, *A. craccivora*. In many locations in sub-Saharan Africa where groundnuts are cultivated, farmers are not able to purchase insecticides. However, in some areas where rosette-resistant varieties are not available, there has been heavy reliance on the use of synthetic insecticides with consequent risks to human health. The availability of rosette-resistant varieties, coupled with the use of appropriate cultural practices, provides farmers with more environmentally sustainable options for rosette disease management.

Groundnuts play an important role in maintaining soil fertility in cereal-based cropping systems in sub-Saharan Africa because of their ability to fix nitrogen. The crop is particularly important in the maize-based production system which covers large areas of eastern and southern Africa. The degradation of soils that has occurred in intensive maize systems has been well documented and the introduction of a legume such as groundnut helps to mitigate this problem.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

No adverse environmental impacts from the adoption of the outputs have been identified. In the medium- to long term the intensification of production associated with the cultivation of two groundnut crops a year may lead to the depletion of certain nutrients if appropriate crop management practices are not followed. However, the risk has been reduced by the promotion of the new short-duration varieties as part of a package of improved production practices. Moreover, the cultivation of two groundnut crops adds significantly to the pool of available soil nitrogen in the soil.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

The outputs are primarily targeted at cropping systems in semi-arid areas in sub-Saharan Africa which are particularly at risk from the effects of climate variability and climate change. Current climate models predict that temperatures in sub-Saharan Africa will increase by 1-2^{0}C by 2020 and by up to 5.5^{0}C by 2080. Projections for future rainfall vary widely but most forecasts indicate a decrease in rainfall for southern Africa of approximately 5% by 2020 and 10% by 2050. Similar decreases are also anticipated in parts of the Horn of Africa. Groundnuts have the advantage that they can tolerate high temperatures and so the projected increases in areas where they are currently grown in sub-Saharan Africa are not expected to have a significant impact on production levels. The crop needs adequate moisture, particularly at critical growth stages such as pegging. An important characteristic of the rosette-resistant varieties is that they are more tolerant to drought than many other varieties available to farmers. Their short duration means that they are less prone to late-season water shortages. Consequently, the cultivation of rosette-resistant varieties should help farmers to cope better with the effects of climate change.

Annex

Publications

GRACE, T. (2004) Farmer led multiplication of rosette resistant groundnut varieties. Uganda Journal for Agricultural Sciences, **9** (1): 578-582. ISSN 1026-0919.

Herselman L., Thwaites R., Kimmins F.M., Courtois B., van der Merwe P.J.A., Seal S.E. (2004) Identification and mapping of aflp markers linked to peanut (*Arachis hypogaea* L.) Resistance to the aphid vector of groundnut rosette disease. *Theoretical and Applied Genetics* **109**, 1426-1433.

HERSELMAN L. (2003) Genetic variation among Southern African cultivated peanut (*Arachis hypogaea* L.) genotypes as revealed by AFLP analysis. *Euphytica* **133**, 319-327.

Page, W.W., Busolo-Bulafu, C.M., vander Merwe, P.J.A. and Chancellor, T.C.B. (2002) Groundnut Manual for Uganda: Recommended Groundnut Production Practices for Smallholder Farmers in Uganda. Chatham, UK: Natural Resources Institute. 17pp.

Merwe, van de, P.J.A., Subrahmanyam, P., Kimmins, F.M. and Willekens, J. (2001). Mechanisms of risistance to groundnut rosette. *International Arachis Newsletter* **21**: 43-45.

Subrahmanyan, P., van der Merwe, P.J.A., Reddy, L.J., Chiyembekeza, A.J., Kimmins, F.M. and Naidu, R.A. (2000). Identification of elite short-duration rosette resistant lines in world germplasm collections. *International Arachis Newsletter* **20**: 46-50.

Page, W.W., Epieru, G., Kimmins, F.M.,Busolo-Bulafu, C. and Nalyongo P.W. (2000). The groundnut leaf miner *Aproerema modicella*: a new pest in eastern districts of Uganda. *International Arachis Newsletter* **20**: 64-66.

Naidu, R.A., Kimmins, F.M., Holt, J., Robinson, D.J., Deom, C.M. and Subrahmanyam P.(1999b). Spatio-temporal separation of groundnut rosette disease agents. *Phytopathology* **89**:934-939.

Naidu, R.A., Kimmins, F.M., Deom, C.M., Subrahmanyam P., Chiyembekeza, A.J. and van der Merwe, P.J.A. (1999a)· Groundnut Rosette: A Virus Disease Affecting the Sustainability of Groundnut Production in Sub-Saharan Africa. *Plant Disease* **83**: 700-709.

Table. Production, consumption and export of groundnut in DFID-PSA countries in 2004 (FAOSTAT 2006)

	Quantity produced (1000 tonnes)	Yield per hectar (tonnes /Ha)	Area harvested (1000/ Ha)	Food quantity (1000 tonnes)	Food quantity /day/ capita (g)	Calories /day/ capita (kcal)	Protein /day/ capita (g)	Fats /day/ capita (g)	Export quantity (1000 tonnes)	Import quantity (1000 tonnes)	Net trade (X-M) (1000 tonnes)
West Africa											
Congo, Dem Republic	363.85	0.78	467.91	275.12	13.85	59	2.7	5.1	0	0.46	-0.46
Ghana	389.65	0.9	432.27	339.73	43.54	162	7.3	14	19.72	1.49	18.23
Nigeria	2,937.00	1.02	2,882.38	2,021.20	43.56	175	7.9	15.2	8.57	11.07	-2.5
Sierra Leone	16	0.76	21.01	14.49	7.68	32	1.4	2.8	0	0.63	-0.63
Southern Africa											
Lesotho	0	0	0	0.07	0.11	0	0	0	0	0.07	-0.07
Malawi	161.16	0.74	218.07	121.23	26.92	100	4.5	8.7	14.5	3.41	11.09
Mozambique	127.5	0.43	297.9	75.01	10.71	44	2	3.8	0.29	3.24	-2.95
South Africa	127.97	1.79	71.32	98.55	5.97	25	1.1	2.1	23.54	24.71	-1.17
Zambia	42	0.34	124.7	24.42	6.12	25	1.1	2.2	1.45	1.01	0.44
Zimbabwe	150	0.58	260.02	135.02	28.6	126	5.7	10.9	0.8	4.14	-3.34
Eastern Africa											
Ethiopia	20.72	1.03	20.04	15.97	0.6	3	0.1	0.2	0.16	0.06	0.1
Kenya	30	1.77	16.99	28.65	2.42	10	0.5	0.9	0.24	1.53	-1.29
Rwanda	10.79	0.57	18.84	9.22	2.98	12	0.6	1.1	0.01	1.32	-1.31
Sudan	1,200.00	0.63	1,900.01	586.92	46.84	182	8.2	15.8	11.09	6.82	4.27
Tanzania, United Rep	83	0.7	118.95	48.74	3.54	15	0.7	1.3	6.55	0.17	6.38
Uganda	155	0.7	221.12	110.99	11.39	47	2.1	4.1	1.4	0.68	0.72
Asia											
Bangladesh	34	1.3	26.14	24.18	0.44	2	0.1	0.2	0.03	1.58	-1.55
Cambodia	21.54	1.19	18.1	19.23	3.64	15	0.7	1.3	0.11	0.04	0.07
China	14,410.30	3.02	4,772.49	8,454.53	17.54	72	3.3	6.3	1,056.99	120.9	936.09
India	7,000.00	1.04	6,702.11	5,731.70	14.52	60	2.7	5.2	406.3	0.26	406.04
Indonesia	1,469.00	2.03	723.53	1,370.19	16.86	69	3.1	6	24.18	155.1	-130.92
Nepal	0	0	0	0.97	0.1	0	0	0	0.08	1.13	-1.05
Pakistan	76.5	0.7	109.92	53.08	0.92	4	0.2	0.3	2.01	2.65	-0.64
Viet Nam	451.1	1.74	258.69	269.52	8.95	37	1.7	3.2	64.47	2.29	62.18

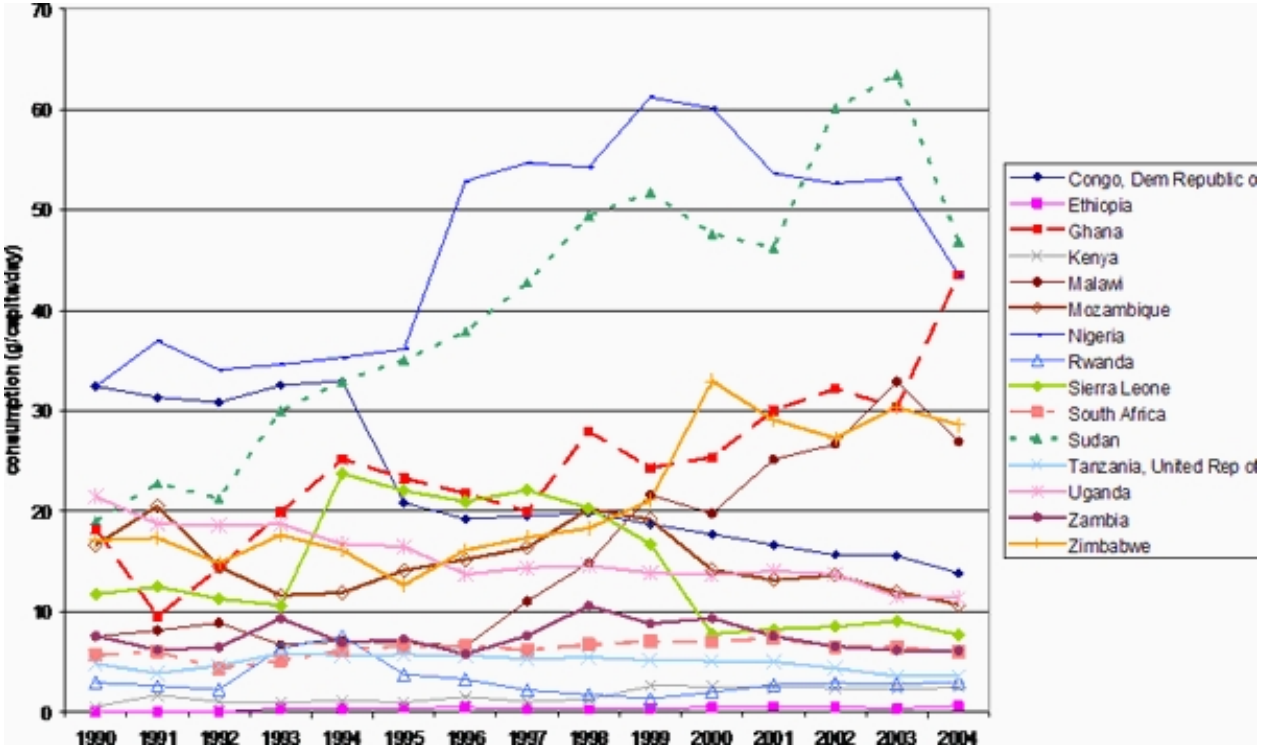

Figure. Changes in consumption of groundnuts in DFID-PSA sub-Saharan Africa countries 1990-2004