New groundnut production techniques promote health and wealth

RIU

Validated RNRRS Output.

Feed manufacturers, national agricultural research systems (NARS), NGOs, farmers, traders and consumers in India, Malawi, Mozambique, Mali, Niger, Nigeria and Senegal are benefiting from new technologies that enable them to defend themselves against deadly aflatoxins. Previously, these natural carcinogenic agents produced by fungi in the soil were reducing the ability of the poorest farmers to sell their groundnut crops and were also threatening the health of consumers. The new control measures include a simple, low-cost aflatoxin diagnostic test kit, detection laboratories with staff trained in the use of the diagnostic kits, awareness-raising activities, farmer participatory testing of new varieties, and a range of pre- and post-harvest aflatoxin prevention techniques suitable for various agro-ecological and socio-economic conditions.

Project Ref: **CPP16:**
Topic: **5. Rural Development Boosters: Improved Marketing, Processing & Storage**
Lead Organisation: **ICRISAT**
Source: **Crop Protection Programme**

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Geographical regions included:

India, Malawi, Mali, Mozambique, Western Africa,

Target Audiences for this content:

Crop farmers,

Document Contents:

Description

CPP16

A. Description of the research output(s)

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Simple Food Safety Technologies for Health and Wealth: Technologies for Reducing Aflatoxin Levels in Groundnut in Asia and Sub-Saharan Africa

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

Crop Protection Programme

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. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.

'R' Numbers: R8483, R8279 and R7809

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*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.*

Problem

Aflatoxin is the natural **carcinogenic** substance produced by ***Aspergillus flavus*** and ***A. parasiticus*** in several crops, including **groundnut** and **maize**, grown and stored in warm and humid climatic conditions. Groundnut pods are highly susceptible to aflatoxin contamination due to the soil-borne nature of the fungi. Groundnut cultivated under rainfed conditions is frequently exposed to terminal drought, which exacerbates contamination. Nearly 80% of groundnut is produced in **South and Southeast Asia**, and **Sub-Saharan Africa (SSA**), mainly by the moderately and extremely vulnerable poor. Studies have shown that about 20 to 25% of the groundnut produced in Asia and SSA contains aflatoxin beyond statutory limits, thereby exposing people to uncontrolled amounts of aflatoxin. This situation has contributed to 70% reduction in groundnut exports from Asia and SSA, with significant impacts on livelihoods. Aflatoxin may enter the food chain directly, by consuming groundnuts, or indirectly, for example in milk from animals that consume groundnut haulms. Studies in West Africa and elsewhere have shown strong links between aflatoxin levels and health in humans, especially children. Lack of **awareness of aflatoxin**, lack of **tolerant varieties**, non-availability of cheap **diagnostic kits** and inadequate monitoring skills all exacerbate the problem.

Outputs

1) New **aflatoxin diagnostic test kit** for cost-effective monitoring: A simple and low-cost aflatoxin-**ELISA** detection test was developed. The estimated sample cost using this test is US $1.00, the cheapest known. This has triggered widespread adoption of this test for assessing food quality, efficacy of host resistance and aflatoxin-mitigating strategies.

2) Capacity building in aflatoxin testing**:** Aflatoxin detection laboratories have been set up with support from ICRISAT in 13 laboratories of ICAR in India; one each in Malawi, Kenya, Mozambique and Mali in Africa; and in several commercial companies in India. Hundreds of people have been trained to use the diagnostic kits.

3) Institutional awareness of aflatoxin: A Panel comprising state government, civil service, state federations, research, oil millers and exporters organisations, veterinary, consumer organisations and the medical profession has successfully raised awareness in government and state level institutions, with positive outcomes.

4) Farmer participatory testing of tolerant varieties**:** Aflatoxin tolerant, agronomically good lines have been successfully tested with farmers in two districts of AP using participatory methods (**participatory varietal selection, PVS**). Varieties are more productive (seed and fodder), have less contamination and are being adopted by farmers.

5) Pre- and post-harvest Integrated management practices: A range of pre- and post-harvest aflatoxin prevention technologies suitable for various agro-ecological and socio-economic conditions were developed and tested with farmers. Among these, *Trichoderma* and/ or application of gypsum to reduce pre-harvest contamination, and mechanical threshing for timely processing to reduce post-harvest contamination, have proved effective and popular with farmers.

Outputs were generated between 2000 and 2006.

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	X	X	Training

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 outputs have primarily focussed on groundnut. However, certain pre- and post-harvest technologies for mitigating aflatoxin contamination, and the diagnostic aflatoxin test, are applicable to other stored crops, such as maize, sorghum, chillies, soyabean and many edible tree nuts such as pistachio, and spices. The principles and practices of reducing aflatoxin contamination apply also to other mycotoxins on stored products, such as ochratoxin on coffee and cocoa. The participatory methods employed are applicable elsewhere.

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			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	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**).*

Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

Aflatoxins and other mycotoxins are found in a wide range of commodities and foods in many countries and environments. As such, the diagnostic test kits have applicability and use in all aspects related to food production, processing and safety. Some examples are given below. New aflatoxin tolerant varieties, and integrated management technologies, can be promoted and their adoption scaled up by participatory methods. Many projects in Plant Sciences Research Programme are relevant here. Among poor farmers, maize in SSA; and groundnuts in SSA and S. Asia are both very important to livelihood and the health of humans and animals, and projects that contribute to improved pre-harvest ‘ plant health’ and post-harvest storage are also relevant.

- ***ICPM for smallholder coffee in Malawi (R8423, R8203):*** For assessing coffee beans for ochratoxin A.

Food safety – street foods (R7493, R8270, R8433, R8272): For monitoring food substances for mycotoxins – most common food-borne contamination source in developing and under developed nations in Asia and SSA.

Sorghum in poultry feed (R8267): For monitoring feed for aflatoxins, the major hazard for poultry birds, particularly chicks.

Aflatoxin control (R5898, R6091, R6125, R6127): Development of bioassays and sampling strategies for mycotoxins

- ***Promotion of crop residues for fodder (R7346, R8296 and R8339):*** For monitoring fodder for aflatoxins and enhance fodder quality.

- Increasing food security and increasing livelihoods through the promotion of integrated pest and soil management in lowland maize systems Phase III (R8452, R8215): For assessing aflatoxins in maize – the major health hazard in SSA, and also to promote use of integrated methods to reduce pre- and post-harvest aflatoxin contamination thus value addition for quality.

- Plant Sciences Programme Generic themes PVS & CBSPD

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)****.*

1. Aflatoxin detection test & 2. Capacity building:

Aflatoxin test kit was validated by NARS in several countries, who now are routinely using this test in their research (intermediary use) and monitoring work (end use). Utility of technology was demonstrated through training courses conducted in India, Mali, Malawi and Mozambique. At present over 50 laboratories in India, Vietnam, China, Philippines, Malawi, Mozambique and Mali are routinely using our aflatoxin test. Two private feed/ pet food companies, Janaki Feeds Pvt. Ltd. and Effem India Pvt. Ltd in Hyderabad are routinely using the test. ICRISAT have been contacted by 5 companies to commercialise the technology at large scale

3. Institutional awareness

A panel representing key stakeholders in the groundnut food, feed and oil chain, both government and private sector, was formed in 2000, to create awareness on aflatoxins among various institutions concerning agriculture, trade and health. This has contributed to the setting up aflatoxin testing laboratories and provided subsidy for threshers in Andhra Pradesh (AP) State, India. TV programmes were created on aflatoxin being aired in AP. An aflatoxin web site set up by ICRISAT (www. aflatoxin.info) receives 1200 hits per month.

4. Farmer participatory testing

Aflatoxin tolerant and agronomically superior groundnut varieties have been tested by >225 farmers to date in Andhra Pradesh, India using participatory approaches (PVS). The PVS was carried out in collaboration with two local NGOs, RDT in Anantapur and SAHJEVAN in Chittoor. Farmer selected varieties are being grown by 34 farmers who participated in the project in 0.1 ha area during 2005. These varieties have produced 15-60% higher pod yield over local variety TMV 2 (control yield 368-590 kg/ha). Aflatoxin levels in the new varieties were between 16 to 35 µg/kg, against 59 µg/kg in TMV 2 in Anantapur region. Whereas, it was 107-257 µg/kg aflatoxin compared to 402 µg/kg in TMV 2. At present the farmers who participated in the project are growing these varieties.

5. Pre- and post-harvest integrated management practices

The pre and post harvest management technologies, which were developed as three modules, (i) no-cost, (ii) low-cost, and (iii) high-input oriented, have been widely validated in rainfed groundnut production systems in Chittoor and Anantapur districts of AP. Community-based mechanical threshers established at three villages are being managed by 'Women Self-Help Groups'. This is gaining popularity among farmers as it enables them to overcome labour shortage for pod threshing and generates income and most importantly helps rapid drying of pods and prevents aflatoxin contamination. Use of these technologies in Mali during the last three led to 50% reduction of aflatoxin in groundnut.

The outputs were promoted through institutional partnerships, farmers' participation, training and information bulletins. Government and non-governmental (NGOs and farmers cooperatives), scientists and farmers, were involved in uptake of technologies, for regional adaptation and usage, which led to the validation of the outputs. The technologies were neutral to gender and income-base. However, during promotion, specific emphasis was made on smallholder farmers and low-income groups in marginal areas.

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)****.*

1. Aflatoxin detection test & 2. Capacity building:

An aflatoxin-testing laboratory was established in **2001** at ICRISAT **Bamako** in West Africa; at Chitedze Agricultural Research Station, Lilongwe, **Malawi** in **2004** and supported by National Small Farmers Association of Malawi (NASFAM) for their members; In **Mozambique** a laboratory was established in **2005** at Nampula; the Andhra Pradesh Government has funded the establishment of Food Safety Laboratory at ICRISAT, **India** in **2005**; An aflatoxin-testing laboratory was established at IER (Mali National Program), **Mali** in **2006**; Govt. of AP has commissioned to establish aflatoxin laboratory in Anantapur, **India** in **2007**.

In India, 13 national agricultural research / university laboratories in **India**, are using aflatoxin test.

A quality control laboratory was established at M/s, Janaki Feeds, Basheerbagh, Hyderabad, **India**, to assess the raw material and manufactured feed for aflatoxins.

3. Institutional awareness

Panel meetings were held throughout the duration of project and beyond at ICRISAT Centre, AP and in Anantapur and Chittoor districts, India.

4: Groundnut varieties

Fourteen aflatoxin resistant varieties have been tested in Anantapur, Chittoor and Mahaboobnagar districts from 2003-05 by farmers with NGO facilitation. A total number of 138 on-farm PVS trials were conducted during the 2003-05. Varieties were tested with moderately and extremely vulnerable poor groups, including women headed households.

5. Integrated aflatoxin management approaches

Pre-harvest management practices have been tested with farmers in 2 villages and 10 farmers in Anantapur district. This was further extended to Chittoor district in 2005 with the same number of farmers and treatments. Post-harvest practices (mechanical threshers) have been tested in 2 villages (West Narsapurum and Charlopalli) in Anantapur District, and one village in (Ontillu) Chittoor District. Threshers were supplied to women's self help groups and the users thus represent exclusively moderate and extreme vulnerable poor groups, often women headed.

Current Situation

C. Current situation

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

1. Aflatoxin detection test & 2. Capacity building:

The outputs of the project are currently being used by NARS, feed manufacturers, NGOs, farmers and traders in India, Malawi, Mozambique, Mali, Niger, Nigeria and Senegal. The level of utilisation of technologies depends on the need of the user. Several universities in India are using the antibodies developed for aflatoxin detection. Training program was conducted to assure that aflatoxin detection technology can adequately be used and we are assuring supply of antibodies.

3. Institutional awareness

TV, Radio and press communications continued after the end of the project. Several TV programs on aflatoxin and health, and integrated management technologies have been broadcast in local languages. In addition the Earth program of BBC broadcasted a program on aflatoxin estimation and management practices developed through DFID projects.

4: Groundnut varieties

ICRISAT continued to supply seed to farmers and NARS partners. We have also used the opportunity of other special projects such as IFAD supported legumes project in India and CFC funded project in Mali to assure continuity of varietal testing and promotion.

5. Integrated aflatoxin management approaches

In collaboration with NARS and NGOs we continue to carry out on-farm research on IPM in Anantapur in India and also in Kolokani in Mali. The outputs of this project have also been applied to other crops. We had some limited assessment of aflatoxin contamination in maize in India to develop a model for its management using knowledge and experience gained on peanut.

*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 outputs are in use in several countries:

India: The ICAR stations including National Research Center for Groundnut (NRCG) at Junagadh. We trained >75 scientists/technicians in aflatoxin detection and management methodologies. ICAR has several research stations and most of them were equipped to carry the test not only in groundnut but many other crops. We are continuing to supply the necessary antibodies and support as and when required. In addition the NGOs continued to supply seed to farmers in two districts and follow the pre and post harvest technology testing. PVS continued in collaboration with RDT and ANGRAU. Seed was made available to farmers in these districts. The integrated management trials are being continued by the farmers who participated in the project.

Malawi: The NASFAM in collaboration with ICRISAT continue to support the activities and recently the human capacity was increased to handle high demand.

Mali: The National program (IER) was fully equipped and trained for testing and certification. On farm demonstrations are being conducted in association with farmer’s seed producers in Kolokani.

Mozambique: ICRISAT and the National program in Mozambique are jointly using the laboratory facilities to assess aflatoxin contamination in groundnut and other crops. We have trained 2 national scientists and technician on detection of aflatoxin. Further training courses have been planned for the coming season to train a number of staff on good agricultural practices to reduce aflatoxin in crops

Through media, TV and flyers awareness activities were carried out in India, Malawi, Mali and Niger.

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

1. Aflatoxin detection test & 2. Capacity building:
Although, specific impact assessment studies were not commissioned, the available data on utilization of aflatoxin estimation tests suggests that at least 50 different organizations are currently using this technology and this growth is continuing (see Appendix)

3. Institutional awareness
In India, Agriculture and Processed Food Products Export Development Authority (APEDA) of Ministry of Commerce, has shown interest to establish regional testing centres based on aflatoxin test developed from the project. Two meetings were held in Delhi in 2006 and a project proposal submitted to IOPEA by APEDA and project partners.

4: Groundnut varieties
Over 2000 farmers in 100 ha directly benefited from access to aflatoxin tolerant agronomically superior varieties. Certainly the number is far greater than this as due to the secondary spread from farmers and local seed multiplication units.

5. Integrated aflatoxin management approaches
Andhra Pradesh state is promoting production of Trichoderma formulations and subsidies are provided to promote use of Trichoderma and also to purchase mechanical threshers.

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).***

1. Aflatoxin detection test & 2. Capacity building
Institutional interest to invest on food safety issues and groundnut crop improvement as it is a major commodity crop, in Asia and Africa.

3. Awareness
Worldwide, awareness about 'aflatoxins' has increased leading to implementation of stringent food safety regulations (e.g. WHO and *CODEX Standards*). This has drastically affected groundnut exports, forcing most of the governments in developing and developed countries to monitor production very carefully. For instance, Ministry of Commerce in India has promulgated an order for aflatoxin certification for groundnut meant for exports in July 2005 (*GO# QMC/GEN/055/2005*). This has triggered action by State Governments and Trading Bodies for aflatoxin testing in groundnut. Due to the proven low-cost, most of the agencies have began to adopt diagnostic

test developed in DFID projects. Similarly in SSA, NASFAM has used aflatoxin technology to promote groundnut with good success.

The emergence of clear evidence demonstrating the role of aflatoxin in causing liver cancer and other health hazards, and also visibility of the 'aflatoxin threat' in print, television and the internet – has attracted attention of health and social sector in countries in Asia and SSA to pay greater attention to the aflatoxin issue.

An expert Panel established during the project period has provided impetus for specific organizations to take relevant actions. Establishment of aflatoxin testing centres; subsidy to mechanical threshers and Trichoderma production units, production of TV programmes on aflatoxin issues are some of the major outcomes enabling promotion and adoption of the outputs.

4. Groundnut varieties & 5. Integrated aflatoxin management approaches

Clear demand from farmers and oil millers for new groundnut varieties with improved yield and oil contents, as well as lower aflatoxin. PVS and on-farm participatory approaches adopted in this project have excited interest and created demand. Decentralised variety release system favouring the states to release new and regionally adapted varieties. The government support to groundnut farmers and farming due to the precarious nature of groundnut-based livelihoods in this highly drought-prone area. Suicide amongst farmers is a highly visible sign of the problems facing farmers.

Current Promotion

D. Current promotion/uptake pathways

*16**. Where** is promotion currently taking place? Please indicate for each country specified detail what promotion is taking place, by whom and indicate the scale of current promotion **(max 200 words).***

All the five outputs are being promoted by ICRISAT and partners in Asia and SSA.

1. Aflatoxin test is widely promoted by ICRISAT to various NARS and private sector. It is currently being used by NARS in India, Philippines, China, Iran, Mali, Mozambique, Malawi and Kenya. Demand for adoption of this test is very high.

2. Capacity building & 3. Awareness: Awareness campaigns and training programmes in aflatoxin detection and integrated aflatoxin management technologies is being provided through ICRISAT and CFC funded projects to the NARS and farmers from India, Philippines, China in Asia; and Malawi, Mali, Niger and Mozambique in SSA. Awareness promotion is also being done through print and TV media, internet and information brochures, and farmer field days.

4. Groundnut varieties & 5. Integrated aflatoxin management approaches

Farmers in Anantapur and Chittoor districts of Andhra Pradesh, India are cultivating the new varieties and implementing the integrated technologies. ICRISAT, local NGOs (Rural Development Trust, Anantapur and Sahajeevan, Pileru) and Agriculture University (ANGRAU) are involved in seed production and providing technology backstopping. The adoption of improved varieties is potentially high, but limited by the availability of seed. The adoption of integrated aflatoxin management technologies is low at present.

17. What are the current barriers preventing or slowing the adoption of the output(s)? Cover here institutional issues, those relating to policy, marketing, infrastructure, social exclusion etc. ***(max 200 words)****.*

Financial and human resources are the limitation in many under developing and developed countries.

1. Aflatoxin detection test & 2. Capacity building
International and national standards require policies and the enforcement of the policies. However, lack of adequate infrastructure and human capacity is the bane. ICRISAT currently supplies antibodies free using its own resources, but scaling this up would require additional funding or greater use of the private sector.

3. Institutional awareness
In general institutions and consumers are ignorant about the risks of aflatoxin and also about legislation, the availability of cheap diagnostic kits and technologies to reduce aflatoxin.

4: Groundnut varieties
Groundnut has low seed multiplication ratios and is expensive, and the spread and uptake of new varieties is limited by the availability of seed.

5. Integrated aflatoxin management approaches
Consumers, including farmers and traders, are unaware of the risks associated with consuming aflatoxin. Therefore, there is no market-led incentive for farmers to produce aflatoxin-free groundnut, and hence no incentive to adopt technologies that increase production costs or incur labour costs. Aflatoxin is invisible and infection with *Aspergillus* does not contribute to a significant yield reduction. Motivating farmers to uptake technology is therefore a tough task.

18. What changes are needed to remove/reduce these barriers to adoption? This section could be used to identify perceived capacity related issues ***(max 200 words).***

Greater investment in capacity building and training so that farmers and traders get their produce analysed for quality, and aflatoxin-free produce does reach the market. State agencies need to provide infrastructure for storage and establish marketing information and forward linkages to trade.

Create awareness about food safety regulations among various stakeholders. Interest in governments to enforce food safety polices.

Promotion of new varieties among moderate poor and extremely vulnerable poor groups using participatory methods. Seed multiplication schemes need to be set up to maintain seed production at villages. These schemes also need to be maintained at some level as most poor farmers sell seed before the next season, and can only obtain seed, if available, on credit. State subsidised seed is often the only source available to farmers at planting, especially following a drought in the previous season.

A quality-based price is necessary to create interest and incentive for farmers to adopt aflatoxin-mitigating technologies. Although, technologies that increase yield, and reduce aflatoxin excites farmers interest, price incentive will attract farmers to adopt the technologies at rapid pace.

Participatory and socially inclusive approaches are needed as most farmers are moderately and vulnerable poor, including many women farmers.

19. What lessons have you learnt about the best ways to get the outputs used by the largest number of poor people? ***(max 300 words).***

1. Aflatoxin detection test & 2. Capacity building:

The diagnostic aflatoxin test kit is simple and does not require a sophisticated laboratory nor a highly trained scientist to operate (cf. thin-layer chromatography), and this greatly helps adoption. *In situ* training and continued support to ex-trainees and their laboratories has also been important. These trainees than act as ‘ambassadors’ for the outputs and institutions involved, creating demand.

3. Institutional awareness

Food and feed chains are multi-stakeholder and multi-dimensional and it is essential to bring all the stakeholders together, especially to facilitate links between policy makers/institutions, and farmer/extension institutions. Institutional innovation is necessary.

Good communication of project outputs through news media, informal publications, information brochures in local languages, short television programmes in local language, village-level field days, websites and workshops are necessary to attract attention of the end-users, other than researchers. Good publications in journals and conferences contribute to the peer review of the outputs.

4: Groundnut varieties & 5. Integrated aflatoxin management approaches

Farmer-participatory approaches are the key to deliver technologies to farmers and instigate a number of farmers to adopt new technologies/products. This also increases the visibility at farm level. Participatory methods can also ensure that technologies are adapted and adopted to suit local stakeholder needs. Participatory research involving regional scientists and NGOs will help building the local capacity, and also create interest due to ownership of the work to sustain the activities. These centres then form the local nodes for region-specific research and dissemination points.

Seed-based interventions are the most cost-effective and convenient for farmers’ adoption.

Impacts On Poverty

E. Impacts on poverty to date

20. Where have impact studies on poverty in relation to this output or cluster of outputs taken place? This should include any formal poverty impact studies (and it is appreciated that these will not be commonplace) and any less *formal studies including any poverty mapping-type or monitoring work which allow for some analysis on impact on poverty to be made. Details of any cost-benefit analyses may also be detailed at this point. Please list studies here.*

Formal impact studies were not conducted under the projects (**R8483, R8279 and R7809**) or by other agencies. However, PRAs were conducted at the start of the project to categorise villages and farmers into groups based on wealth, gender and caste.

The PRA studies conducted by this project indicate that a large proportion of farming community in the rural areas of Anantapur and Chittoor Districts of Andhra Pradesh fall under three poverty groups: moderate poor, extreme vulnerable poor and/or under women headed household categories.

In Anantapur area, the PRAs at the village level show that in six of the villages studied, across three different Mandals (local government area), the percentage of farm households that came under extreme vulnerable poor ranged from 38 - 75% of the total households surveyed. The majority of women headed households fall into this group. In addition to this, another 25 - 40% of the farm households fall under moderate poor category. The overall percentage of the households that could be broadly categorized as poor therefore ranged from 60 - 90%. Therefore groundnut farmers in Anantapur are very vulnerable and poverty is extensive.

In Chittoor District the situation was worse than in Anantapur. Village level PRAs indicated that the range of extreme vulnerable poor was between 75 and 100% of the households across different villages, while the remainder were all moderate poor.

A larger picture of the magnitude of likely impacts could be discerned by comparing the village level figures of the PRAs discussed above with district level figures of poverty noted from occupational classification of population census of 2001 and an analysis of the gender-wise control of operational holdings of the different size categories from Agricultural census of 2001 (regrouped from the original data to identify with RIU classification).

The population census of 2001 for Anantapur District shows that out of 529,202 of total number of farmers, 347,442 were men while 181,760 were women farmers (around 34% to the total). In addition to this, 288,280 male agricultural labourers and 382,680 female agricultural labourers (around 57% of the total of 670,960) constitute the agricultural labour force of Anantapur District. Furthermore, as a majority of the agricultural labourers either do not own any land or own only a very small amount of land or other assets, they can be classed as extreme vulnerable poor. Therefore, the impacts of the interventions would be of considerable magnitude, affecting over a million people in this District alone.

A further analysis of the land holdings controlled by men and women (agricultural census 2001) as per land holding size in Anantapur District showed that, men belonging to extreme vulnerable poor group control 64% of the operational holdings (307,533 men) of the total holdings controlled by men, while 70% of the holdings controlled by women belong to this category of the poor. In addition to this, another 25% and 22% of the total operational holdings controlled by men and women respectively, fall under moderate poor category.

This clearly shows that the village level picture of the poverty observed by this project team through PRAs largely corresponds with the larger picture of the poverty at the district level and clarifies that any interventions made regarding technology transfer will have a direct impact on about one million poor men and women in Anantapur district. As a majority of the women headed households fall under the poorer categories and the population census figures indicate that about 10% of the rural households (not quoted here from the source) constitute women headed households, we can consider this as a close proxy to the extremely vulnerable poor that would benefit from specific project interventions to improve their livelihoods.

In Chittoor district, Population census 2001, show an account of 332,233 male cultivators and 196,192 women cultivators (37%) out of a total farmers of 528,425. Among the agricultural labourers, men were 310,411 while women were 319,116 (51 %) out of a total of 629,527 agricultural labourers in the district. Once again, the data

shows that 1,157,952 people related to farming would directly or indirectly are likely to receive the benefits of improved livelihoods due to technology transfer.
A further analysis of agricultural census (2001) of Chittoor district as per the land holding size shows that around 87% (412,353) of the operated land holdings (total : 476,291) belonged to male farmers of the extreme vulnerable poor category while 92% (121,282) of land holdings of the women (total: 131,415) belong to this category of the poor. In addition to this, around 11% (50, 364) of male land holdings and 6% (8381) of female land holdings belong to moderate poor category of farmers. This clearly shows that a vast majority of the farmers in the district belong to either extreme vulnerable poor or the moderate poor categories, which emphasizes the need for focusing interventions for the use of these vulnerable sections. Overall the gender analysis of women cultivators as well as women labourers particularly highlights the fact that women are the most vulnerable group among these poorer groups and hence require particular focus of attention.

21. Based on the evidence in the studies listed above, for each country detail how the poor have benefited from the application and/or adoption of the output(s) ***(max. 500 words):***

- *What positive impacts on livelihoods have been recorded and over what time period have these impacts been observed? These impacts should be recorded against the capital assets (human, social, natural, physical and, financial) of the livelihoods framework;*
- *For whom i.e. which type of person (gender, poverty group (see glossary for definitions) has there been a positive impact;*
- *Indicate the number of people who have realised a positive impact on their livelihood;*
- *Using whatever appropriate indicator was used detail what was the average percentage increase recorded*

Changes in approaches, attitudes and livelihood status of the farmers had been gradual and qualitative during the DFID projects period (2000 to 2006). The impacts conforming to the outputs emerge from the three major characteristic-technological issues:

Estimation of aflatoxins: Our aflatoxin test has enabled several laboratories to undertake routine aflatoxin testing, which otherwise could not be done due to constraints in funding and importation problems. This has enabled farmers to test the groundnut produced for aflatoxins and lead to separation of contaminated lots. For instance, adoption of aflatoxin test by NASFAM resulted in increase in groundnut exports from Malawi, benefiting farmers in gaining higher income. Although systemic studies were not yet conducted to estimate benefits of its adoption, we envisaged that use of this kit would result in cost savings of at least US$ 14 to a maximum of US$29 per sample analysis. This translates to a savings of US$1400 to $ 2900 per every 100 samples analyzed. The benefits out of testing certification could be several times higher.

Impact of new varieties: Poor farmers in Anantapur district, India has benefited from extra income from the yield gains attained by the new varieties. A 42kg bag of groundnut pods of a local variety fetched a price ranging from US$ 15 to 16 after rainy season of 2005, i.e. about US$ 0.37 per kg on average. An yield gain on average of 20%, at the lower end of observed gains (see section 10) would give an extra US$ 3.78per ha. With 872,320 ha in Anantapur and 218,760 ha in Chittoor, mostly farmed by moderately poor and vulnerable poor farmers, the potential impact is huge. This figure does not include the value of fodder production, which is also greater in new varieties, nor the premium that exists on new varieties while seed is in short supply. Higher yielding and better quality groundnut crops may also benefit the rural economy through greater demand for labour.

Impact of threshers: Threshers were purchased by SHGs in three villages in Anantapur district. In one village the thresher was operated for 31 days during the harvesting season in 2005. A total income of $290 was derived from its' use and the expenditure was $91. The profit per person was about $ 346. In effect, the farmers had already realized over 62% of their capital investment in the thresher with just 31 days of operations. If $8 of extra income per person for one month of operation of thresher is multiplied by 564, 440 (number of women cultivators and laborers), an amount of $4,339,916 of extra income to the women could be generated in Anantapur District alone. Since a majority of women fall under extreme vulnerable poor category, out of this even around 60% the extra income generated ($2,603,949) is likely to reach the extreme vulnerable poor group of women. So even allowing for modest expansion, the impact could be substantial.

Health benefits: Production of aflatoxin-free groundnut contributes to reduce dietary exposure to aflatoxins through contaminated groundnut and prevents aflatoxin related illness particularly among children, thereby reducing the burden of diseases on household income in rural areas.

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)***

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

The project promotes groundnut, a legume, whose cultivation enriches soil by fixing atmospheric nitrogen.

The adoption of new varieties will have a positive impact on genetic diversity, which is very limited at present in Anantapur district.

The projects contribute to mitigation of aflatoxin B1, recognized as Class I environmental Carcinogen by the International Agency for Research on Cancer (IARC).

Further extension of these outputs can lead to new initiatives that can study the level of aflatoxin contamination in food and feed in various regions, and also to determine the human exposure to aflatoxins to determine the risk of cancer, which can lead to identification of most vulnerable groups of populations / regions and appropriate policies can be developed to avoid the risk of aflatoxin contamination. Not environmental impact – delete or move to section above this is a supply point

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

The outputs/outcomes have no negative impact on the environment.

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)***

Climate variability (drought; unseasonal rains at the time of harvest etc.) is exacerbating the fungal infection and aflatoxin contamination in several crops, including groundnut. New varieties are better adapted (shorter duration) to prevailing climate. Aflatoxin-mitigating technologies can empower farmers to cope with fungal contamination due to vagaries of climate. Survey data and experimental data can be modelled as a decision support system for aflatoxin, with benefits to planners and some farmers. Further this project can be linked with a few existing projects on climate changes and GIS and modelling for prediction of aflatoxin

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Annex

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