CROP PROTECTION PROGRAMME

Promotion of farmers' participatory management of groundnut diseases for higher yield and nutritive value of crop residues (haulm) used for peri-urban dairy production on the Deccan Plateau in India

R 8450 (ZA 0675)

FINAL TECHNICAL REPORT

1 April 2005 – 31 January 2006

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Submission requirements:

The Final Technical Report must be submitted to CPP on the contractual date the project ends. A letter of reminder specifying number of copies, and any other relevant details, will be sent to project leaders close to the project's end date.

FINAL TECHNICAL REPORT

Cover page (Please see page 3)

Note to project leaders: For FTRs, which continue previous research funded through the CPP phase, bear in mind that reviewers with a knowledge of previous phases will be used (they will also be provided with a copy of the previous PCSS). Therefore, do not feel obliged to concentrate on previous findings**.**

Executive Summary

A very brief summary of the purpose of the project, the research activities, the outputs of the project, and the contribution of the project towards DFID's development goals. (Up to 500 words).

The main purpose of project R 8450 was the dissemination and promotion of improved dual-purpose groundnut cultivar in the Deccan Plateau of India. The goal was to improve food security and increase incomes of peri-urban dairy producers from sale of crop residues and livestock products. Groundnut is grown extensively in the Deccan Plateau of India (75% of cropped area) by resource poor farmers; and groundnut haulms are the major source of home grown fodder for their animals. Based on past research farmers identified new groundnut cultivar ICGV 91114 resistant to foliar diseases to meet their multiple requirements. Secondly, resistance to foliar disease is found to be positively correlated with mycotoxin resistance, which is a serious threat to animal health and through milk to human health.

Under the current project the up scaling and out scaling of the improved technology was carried out through training and capacity building of NGOs, local organizations and farmer SHGs in disease management, seed production / distribution and crop management technology. The extension wing of the State Agricultural University based in Ananthapur, DATTAC, a partner in the project, is playing an important role in disseminating the new technology to local NGOs based in Ananthapur, Kurnool, and Chittoor districts in Andhra Pradesh. Another NGO partner RORES in Karnataka is taking the lead role in spreading the technology in Kolar and Tumkur districts of Karnataka. Concurrently, community based village level seed multiplication and distribution system are being strengthened under the supervision of local NGOs for their long-run sustainability.

The project also explored new techniques for disease control and opportunities for further augmenting the production of own fodder resources through introduction of borderline crops / intercropping with cereals, such as sorghum, etc.

Another important activity was tracking the spread of improved groundnut cultivar through reconnaissance surveys in the major growing areas of Andhra Pradesh and Karnataka. Findings indicate that the improved cultivar is being grown in more than 120 villages covering 4 districts in Andhra Pradesh state and 3 districts in the neighbouring Karnataka state. A large majority of these villages fall in the low to medium rainfall regions indicating its importance for

small farmers in marginal areas. The information on its widespread adoption will help in sensitising the government officials about its popularity and the need for integration with the formal seed multiplication and distribution system. The short-term impacts of the adoption of the technology at the household level measured in terms of higher crop, haulm and milk yields are already visible. The medium and long term impacts on the overall quality of life of the farming community measured in terms of asset acquisition, health, education, investment in agriculture, etc., can be documented only after the technology has gone through its full course.

The project directly contributes to the CPP purpose of developing pro-poor strategies to reduce the impact of key pests, improve yield and quality of crops, and reduce pesticide hazard in peri-urban systems. The ongoing livestock revolution will provide opportunities for increased production and marketing of milk and meat thus augmenting the income of marginal and small-scale farmers who derive a large share of their income from livestock activities.

Background

Project leaders should feel free to simply cut and paste this information from the background section of their project memorandum (RD1)

Key Findings

- In the target area, groundnut accounts for 60 to 75% of cropped area; paddy, sorghum and orchids account for the rest
- Groundnut haulms provide for > 70% of the dry fodder in Ananthapur district. More than 25% of groundnut haulms fed to animals are traded within the village
- Plant disease decreases crop residue yield and quality and consequently income from crop residues – either from feeding or selling
- Farmers observed greater yield losses due to disease of haulms than of pods. Yield losses of 10-20% were observed on pods as compared to 20-30% on haulms.
- Farmers observed disease incidence every year while pest incidence was observed once in two years
- Disease resistant / tolerant cultivars were identified and farmers preferred these cultivars on grounds of superior pod yields, and haulm quantity and quality.
- On-farm feeding trials indicated an increase in milk yields of dairy animals fed on haulm of improved disease resistant groundnut cultivar
- Seed cost is the single most expensive input, accounting for 35% of total input cost
- Although the seed rate was higher for new cultivars, farmers received higher gross income by growing improved varieties
- Farmers on an average sell 78% of the milk produced through formal and informal sources and it is an important source of income for landless, marginal and small-scale farmers.
- Economic analysis indicated higher gross returns from adoption of ICGV 91114 due to higher pod yields, higher haulm yields, and higher milk yield from animals fed with haulms.

Farmers have clearly shown a demand for residues from dual-purpose crops that are free of plant diseases and provide better quality fodder. Better-feed resources will substantially contribute to improved livelihoods of livestock keepers by enabling them to participate more fully in the forecasted livestock revolution. Demand for quality crop residues will, therefore, persist and most likely increase. In a similar context, the concept of improvement of crop residues by genetic enhancement is part of the longer-term research strategy of ICRISAT and ILRI, which will assure continuing work on, and the supply of, dual-purpose varieties. Various delivery mechanisms for seed of improved dual-purpose varieties exist such as the

private seed industry, NGOs and farmers' seed exchange mechanisms. Traditionally, private seed companies multiply and trade hybrids of sorghum but not groundnut. However, farmers' help groups are emerging as an alternative for groundnut seed multiplication and distribution. These help groups operate in a cooperative mode at village level.

Project Purpose

The purpose of the project and how it addressed the identified development opportunity or identified constraint to development.

Project R. 8450 is a logical sequel to Project R. 8339 and contributes to the CPP purpose of *"developing pro-poor strategies to reduce the impact of key pests, improve yield and quality of crops, and reduce pesticide hazards in peri-urban systems".*

India has the largest population of ruminants in South Asia, and livestock production is an integral part of mixed farming systems. The so-called 'livestock revolution' will provide opportunities for increased production of milk to meet the requirements of the ever increasing human population and lead to improved livelihoods, provided constraints can be overcome. One of the most important technical constraints to animal production is the inadequate supply of high quality feed resources throughout the year. As the area of common property resources for grazing continues to decline with increased cultivation, so the dependence on crop residues (mainly cereals and legumes) and agro-industrial by-products will increase in importance.

On the Deccan Plateau in the state of Andhra Pradesh, traditional dual-purpose groundnut haulms account for the bulk of crop residues fed to animals. In Ananthapur district, groundnut accounts for 61-77% of the cropped area under irrigation and rain-fed conditions. However, groundnut crop is susceptible to a number of foliar diseases that reduce production and affect the quality of both pod and haulms. Another concern is the production of mycotoxins on crop residues that present a serious threat to animal health and, through milk, to human health.

If ruminant productivity is to be raised to meet new demands for more milk and safe milk, then the availability of crop residues of good quality must be increased. Improving the yield and nutritive value of crop residues will increase the availability of nutrients to ruminants, help alleviate animal feed deficits and protect human health. The major beneficiaries would be the landless, and marginal and small farmers who derive a large share of their income from livestock related activities and sale of livestock products.

From our previous research farmers identified new groundnut cultivar ICGV 91114 to meet their multiple requirements. This cultivar is resistant to drought, early maturing thus escaping end of season drought, resistant to foliar diseases, needs far fewer sprays reducing pesticide hazards, having higher pod and haulm yield, more pods per plant, fewer empty pods, heavier pods and superior nutritive value of haulm, thereby contributing to higher milk production. Secondly, resistance to foliar disease is found to be positively correlated to mycotoxin resistance, which is a serious threat to animal health and through milk to human health. All these positive traits of the improved groundnut cultivar ICGV 91114 have been corroborated by the researchers (based on laboratory analysis of samples, on-farm feeding trials, etc.), by farmers (based on their observations and usage on farm). Economic analysis indicated higher gross returns from adoption of ICGV 91114 due to higher pod yields, higher haulm yields, and higher milk yield from animals fed with haulms. However, its widespread adoption is constrained by non-availability of seed and lack of extension activity related to IDM technology. Farmers feel storage is a serious problem due to pod borer infestation. Hence many small farmers feel it is safe to dispose all pods and purchase seed prior to sowing. Farmers also have debt servicing which leads to

distress disposal of the entire produce without any saving for seed. Low profit margins, bulky seeds, storage space problems, and unstable seed demand are major constraints to the entry of private sector in seed distribution. The public sector seed multiplication and distribution system suffers from a number of inefficiencies and due to bulk procurement, it may not be possible to collect seed on a varietal basis, instead the seed supplied could be a mix of different varieties. In any case they are only multiplying and distributing seed of existing released varieties. In this situation the role of community-based village seed systems becomes very critical for spread of improved varieties.

Under the current project the up scaling and out scaling of the improved technology was carried out by strengthening the role of NGOs and local organizations in disease management, seed production and crop management technology. The extension wing of the State Agricultural University based in Ananthapur is playing an important role in disseminating the new technology to local NGOs based in Ananthapur, Kurnool, and Kolar district of neighbouring Karnataka. Concurrently, community-based village level seed multiplication and distribution system are being strengthened under the oversight of local NGOs for their long-run sustainability. Another important activity was sensitising government officials on the superiority of the new cultivar, its widespread adoption, and the need for its seed multiplication on a formal basis. In this connection the spread of the cultivar was tracked through reconnaissance surveys in the major growing *mandals* of the district.

Research Activities & Outputs

The activities conducted should be listed. Lessons learnt from them should be provided and the outputs that they have achieved. Were any intended outputs not achieved, were any additional outputs achieved? Please keep this as succinct as possible.

1. Village level seed systems for multiplication of improved groundnut cultivars established and upscaled

The role of Farmers' Self Help Groups (SHGs) and NGOs participating in the project for seed multiplication and distribution was strengthened through training and demonstrations. Seed multiplication was carried out in a farmers' participatory mode with the backstop support of NGOs. At the field level participating farmers were trained in seed multiplication and its safe storage.

Under the project a village-level seed multiplication system was established in four villages in Ananthapur district in collaboration with the District Agricultural Advisory and Transfer of Technology Center (DAATTC), ANGRAU, Ananthapur, and the Rural Development Trust (RDT) an NGO, during 2004-05 post-rainy season for sowing in 2005 rainy season. Twenty-five farmers from 4 villages in Ananthapur district participated in the seed multiplication of the cultivar ICGV 91114 on 30 acres (1 acre = 0.42 ha). Seeds from the 2005 rainy season crop were further distributed for seed multiplication in the project and adjoining villages, increasing seed multiplication area 10 fold, to about 335 acres with more than 150 farmers participating in seed production for the 2006 rainy season sowings (Table 1).

This activity is contributing immensely to out scaling of the seed multiplication system. For example, RORES, an NGO partner from Kolar district of Karnataka has taken up the seed multiplication of the ICGV 91114 on 4 acres on their farm in addition to more than 6 acres on farmers' field for distribution in 2006 rainy season.

2. Improved crop and foliar disease management practices up scaled, and new practices of growing groundnut in combination with sorghum demonstrated and implemented.

Two hundred and seventy farmers from 6 villages in Ananthapur district, 6 villages in Kolar district and 2 villages in Tumkur district, Karnataka, participated in promotion and up scale of the IDM technology. Besides DAATTC and RDT long-standing partner on the project, RORES, Sujala Watershed Committee in Kolar and Tumkur districts of Karnataka also participated in up scaling the integrated disease management technology for groundnut.

The rainfall pattern in the entire Deccan Plateau was unique in 2005. Rains came on time and rainy season sowings were carried out in a timely fashion, i.e., between 15 to 25 July, but this was followed by a long dry spell of 25-30 days. Following the drought period there was continuous and heavy rainfall from the last week of August to October that helped the crop to recover from the initial dry spell. However, due to excess and untimely rain prior to harvest the haulm quality was affected. Mean pod and fodder yields across locations were significantly high (1.54 and 2.21 t ha^{-1}) for ICGV 91114 compared to local cultivar (0.92 and 1.38 t ha^{-1}). Also, lower severity of foliar diseases (rating of 6 on a 1-9 scale) were recorded in IDM plots as compared to non-IDM plots (rating of 9) across locations in all the districts.

Besides conducting on farm participatory trials of selected dual purpose cultivars farmer orientation schools were organized twice during the crop season in which >300 farmers were given training on improved groundnut production practices. Information bulletins / handouts that provide first hand information on diagnosis and management options of the production constraints were published in the local language and distributed to farmers.

3. Improved fodder resources through higher yields of better quality groundnut haulms and intercropped and / or borderline-cropped sorghum

Along with improved groundnut cultivar 20-25% of the farmers participating in the project were provided seed of dual-purpose sorghum ICSV 700 to be grown as border crop around the groundnut crop for disease management (PSND). The option to grow sorghum as an intercrop was left to the farmers. A majority of the farmers preferred to grow sorghum as border crop since they considered disease control as an important strategy. However, due to long dry spell (25-30 days) after planting in July 2005, the sorghum crop did not achieve its expected growth to act as a barrier crop for managing PSND.

On station evaluation of early and medium-maturing groundnut cultivars for higher quality and quantity of haulms and pods:
Cultivars having moderate resistance to foliar diseases when combined with moderate level of disease management (economical use of fungicide) produce higher quantities of pods and healthy fodder. Healthy fodder has high digestibility contributing to higher milk yields when fed to dairy cattle.

In addition to existing cultivars meeting the above criteria, efforts are on to identify more high yielding dual-purpose groundnut cultivars that are resistant to foliar diseases. With this objective, a replicated trial with nine selected groundnut cultivars and 6 disease management levels was conducted at ICRISAT, Patancheru, during 2005 rainy season. Four early maturing cultivars (ICGV 89104, ICGV 91114, ICGV 99201, ICGV 99206), 4 medium maturing cultivars (ICGV 92020, ICGV 92093, ICGV 99032, ICGV 99054) and one susceptible cultivar (TMV 2) were included in this trial. Disease management levels using fungicide chlorothalonil (Kavach @ 2 g L^{-1} water) included the following: (a) no spray; (b) one fungicide spray at 60 days after sowing (DAS); (c) two fungicide sprays at 60 and 75 DAS; (d) three fungicide sprays at 60, 75 and 90 DAS (for medium-maturing cultivars only); (e) weather based advisory system using leaf wetness counter; and (f) continuous fungicide spray from 30 DAS till maturity with 10-day interval. Plot size was 4 rows of 9 m length with 60 x 10 cm inter- and intra-row spacing. Design of the experiment was split-plot with spray schedules as main plots and genotypes as sub-plots. Severity of foliar diseases was

recorded on a 1-9 rating scale at regular intervals of crop growth. At harvest, dry weights of fodder and pods were recorded and yield per hectare was calculated.

One fungicide spray at 60 DAS for early maturing and two fungicide sprays at 60 and 75 DAS for medium-maturing genotypes gave higher yields and healthy fodder with low foliar disease severities. Among early-maturing cultivars, lowest foliar disease severities (3-4 for LLS and 4-5 for rust), highest fodder yields (2.35 to 2.73 t ha^{-1}) and pod yields (1.36 to 1.54 t ha^{-1}) were recorded in the cultivar ICGV 99201 followed by ICGVs 99206, 91114 and 89104.

Among medium-maturing cultivars, lowest foliar diseases severity (up to 3.0 for both LLS and rust), highest fodder (3.31 to 4.8 t ha^{-1}) and pod yields (2.15 to 2.95 t ha^{-1}) were obtained in the genotypes ICGV 92093, followed by ICGVs 92020, 99032, 99054. Significantly higher foliar disease severity (9 rating), lowest pod (0.95 t ha^{-1}) and fodder (1.45 t ha^{-1}) yields were recorded in susceptible TMV 2. Fodder from all the cultivars was found healthy when compared to TMV 2.

The concept of improvement of crop residues by genetic enhancement is part of the longer-term research strategy of ICRISAT and ILRI, which will assure continuation of work on, and supply of, dual-purpose varieties.

4. Opportunities and constraints for introducing new approaches of disease management and improving fodder resources evaluated

i. Farmers perceptions for introducing new approaches disease management and improving own fodder resources

Ananthapur district faces fodder shortage of around 10 to 15% of the total requirement varying from 240 000 t in a drought year to 75 000 t in a normal year (Animal Husbandry Department, (AHD), Ananthapur) (Figure 1). Within the district, in about one-fourth of the mandals out of 63 the fodder shortage is more acute. These mandals fall in the low to medium rainfall category and are located mainly in the western and central part of the district. The AHD is trying to mitigate the fodder shortage through various programs that include community fodder cultivation on tank beds, supply of straw on subsidy, cattle camps, demonstrating use of *azolla* (an alternate and less expensive livestock feed with unique combination of proteins, minerals, vitamins and essential amino acids), supply of fodder seed for cultivation on private lands, etc. However, these programs are not able to mitigate the shortage and a majority of farmers are buying crop residues, mainly paddy straw. The preference for paddy straw is twofold: as a cereal supplement to groundnut haulm, and as a cover to protect the staked groundnut haulm from rains. Besides paddy straw, to augment their feed resources farmers are purchasing small quantities of maize fodder, sorghum straw, etc. Sale and purchase of groundnut haulm is mainly restricted to within village transactions, or at best within a radius of 20 kms. A majority of the farmers purchasing paddy straw are marginal and small farmers.

The main source of supply is from the command area of Tungabhadra river high-level canal irrigation (HLCI) that passes through the central and northwestern part of the district. Here paddy accounts for more than 10-15% of cropped area. Villages within a radius of 50-60 kms of these command areas buy their supplies of paddy straw immediately after harvest. During drought years villages at a distance of 150-200 kms also get their supplies from the canal irrigation areas. Additionally, during summer months and acute drought years the AHD procures paddy straw from the coastal districts that are 400-500 kms away (the study area and the flow of paddy straw in Ananthapur district are shown in Figures 2 and 3).

Participatory rural appraisals indicated the following: firstly, farmers are willing to augment their fodder resources through improved groundnut varieties with superior pod and haulm yield but prefer to buy other feed resources including concentrates; second, farmers are willing to try new disease control techniques since diseases and pests were considered to be significant yield reducers. Hence a majority of the farmers grew the improved sorghum cultivar ICSV 700- as a border crop to prevent PSND disease rather than as an intercrop to augment their fodder resources. Farmers are not very keen to grow sorghum or minor millets as intercrops although they are good sources of fodder since their grain is not fetching a good price in the market due to availability of subsidized rice and wheat through government shops**.** Instead many farmers are growing pigeonpea as an intercrop, which fetches a good price in the market.

ii. Economic impact assessment

Based on reconnaissance surveys it was found that improved groundnut cultivar ICGV 91114 is grown in more than 120 villages covering 4 districts in Andhra Pradesh and 3 districts in Karnataka state. Two-thirds of the villages are located in Ananthapur district. The location of these villages was recorded using GPS instrument and is shown in the enclosed map (Figure 4). The number of farmers involved in production of the improved variety was estimated to be more than 5000. A majority of the villages are located in the low to medium rainfall *mandals* indicating the importance of this cultivar for resource poor farmers in marginal environments. Tracking these villages at some future point would give insights into factors leading to faster spread in some locations as compared to others. The spread of the improved cultivar as documented is however, an underestimate since information on adoption was not recovered from several villages located in the hinterlands i.e., far away from state or national highways.

At the macro level assuming 10% of the groundnut area under improved cultivar by 2011 (based on current rates of adoption) the cumulative incremental benefits to the economy by 2011 will be INR 1151.8 million (US $25.5 million), that includes incremental returns from higher pod yield, haulm yield and higher milk yield from dairy animals fed the haulm of improved cultivar (based on on-farm feeding trials). At the household level the short-term impacts of the adoption of the improved groundnut technology measured in terms of higher yields and returns are already visible and documented. The medium and longer term impacts on the overall quality of life of the farming community measured in terms of asset acquisition, health, education, investment in agriculture etc., can be documented only after the technology has gone through its full course. It is observed that a majority of the farmers are risk averse and hence are adopting the new technology only on 10-20% of their cropped area. This would increase in due course unleashing bigger impacts at the household level.

The potential impacts on marginal and small farmers would depend on the linkages between small farmers, the public sector actors and other stakeholders in the groundnut and milk economy. The linkage between adoption of the improved technology, higher incomes, asset acquisition reinvestment in agriculture and improvement in overall quality of life will have to wait until the technology is adopted on a larger scale at the household level.

Since the variety ICGV 91114 is not yet officially released the government agencies are not involved in its seed multiplication. Their focus is mainly on multiplication of existing varieties. Thus the spread of ICGV 91114 is mainly based on seed available from village based farmer participatory seed multiplication efforts. Presently, efforts are on to release the variety through official channels. Up scaling and out scaling are interlinked and the adoption will be faster when both take place simultaneously.

Contribution of Outputs to developmental impact

How the knowledge is promoted benefiting the poor? What coverage has been achieved (numbers of farmers, institutions and production areas adopting the technology)? What is the potential for wider scale impact? What follow up action/research is necessary to promote the findings of the work to achieve their development benefit?

In the Deccan Plateau of India groundnut accounts for more than 70% of the cropped area. Groundnut haulms are an important source of animal feed. Income from livestock and sale of livestock products constitutes an important source of earnings for the landless, and small and marginal farmers. A major output from the earlier project was the identification of disease-resistant, dual-purpose cultivars capable of producing high yields of grain and nutritious stover / haulm, as part of an integrated disease management strategy. More than 1000 marginal and small farmers have been trained in the use of IDM technology and many more have been sensitised through demonstrations, leaflets, media, etc. Farmers adopting the technology are increasing their gross returns from groundnut crop due to higher pod and haulm yield and higher milk yield from dairy animals fed with straw of the improved disease resistant cultivars.

Under this project the transfer of integrated disease-management technology to farmers based on superior cultivars in the major groundnut-growing region of the Deccan Plateau was up scaled and out scaled. To this effect local NGOs (who are key stakeholders) in Ananthapur, Kurnool and Kolar district of Karnataka have been trained on IDM technology and multiplication and distribution of seed through village based seed systems. To sustain this activity beyond the life of the project, the extension wing of the Andhra Pradesh Agricultural University, DATTC centre based in Ananthapur will liaise with farmers and the NGOs for further out scaling of the technology. Based on reconnaissance surveys it was estimated that the technology has now spread to more than 120 villages in the Deccan Plateau covering an area of more than 3000 ha involving about 5000 farmers. The spread of the improved technology was mainly in the low-medium rainfall regions / *mandals* where more than 70% of the area is under groundnut crop.

The potential for further adoption is very high and the whole process would be speeded up once the improved disease resistant cultivar is released through official channels. Both scale-up and scale out are inter-related because as change spreads further geographically, there are greater chances of influencing those at higher levels, and likewise, as one goes to higher institutional levels then the chances for horizontal spread increase. While there are factors that are controlled by the activities and actions planned and implemented, there are also factors that are outside the control of the arena of any research /development initiative. These could be climatic, market related aspects or policy changes. They would influence the speed with which the planned initiatives progress, in this case of adoption of new technology. Presently the technology is spreading through seed multiplication and distribution through village based seed multiplication systems. A few large farmers with irrigation facilities have taken up seed production on a commercial basis. Private traders are entering the business with buy-back arrangements for seed. Despite all this the demand for seed far exceeds its supply.

The short-term impacts of the adoption of this technology in terms of higher yields and returns are already visible. The potential impacts on marginal and small farmers would depend on the linkages between small farmers, the public sector actors and other stakeholders in the groundnut and milk economy. The linkage between adoption of the improved technology, higher incomes, asset acquisition reinvestment in agriculture and improvement in overall quality of life would take some time to unfold.

Sensitising the public sector extension and seed multiplication institutions, on the role and importance of the new improved groundnut technology and putting in place pro-poor

livestock policies will enable a larger number of poor to adopt the technology and garner a larger share of the potential benefits from the improved groundnut technology.

Biometricians Signature

The Project's named biometrician must sign off the Final Technical Report before it is submitted to CPP. This can either be done by the project's named biometrician signing in the space provided below, or by a letter or email from the named biometrician accompanying the Final Technical Report submitted to CPP. (Please note that NR International reserves the right to retain the final quarter's payment pending NR International's receipt and approval of the Final Technical Report, duly signed by the project's biometrician)

I confirm that the biometric issues have been adequately addressed in the Final Technical Report.

Signature: Sd /(signature will appear in the hard copy)
Name (typed): D. Ravi
Position: Scientific Officer (Statistics)
Date: 30-01-06

Table 1. Seed multiplication of ICGV 91114 in Ananthapur district during 2005-06 post-rainy season

Village	Mandal	Farmers (No.)	Area (acres)
Ananthapur			
Lingareddypalli	Battalapalli	23	33.5
Jalalapuram	---do----	6	12
Gummallakunta	---do----	5	25
Bondaladinne	---do----	25	35
Shivapuram	Kanaganapalli	30	60
Cherlopalli	Ramagiri	20	50
Potlamarri	---do----	6	10.5
Narsimpalli	---do----	4	8
Talupuru	Atmakuru	26	50.5
Akuledu	Singanamala	5	8.5
Pulakunta	Ananthapur (R)	3	12
Chittoor			
Nakkalapalli	Palamaneru	1	20
Srikalahasti	Srikalahasti	1	10
Total		**155**	**335**

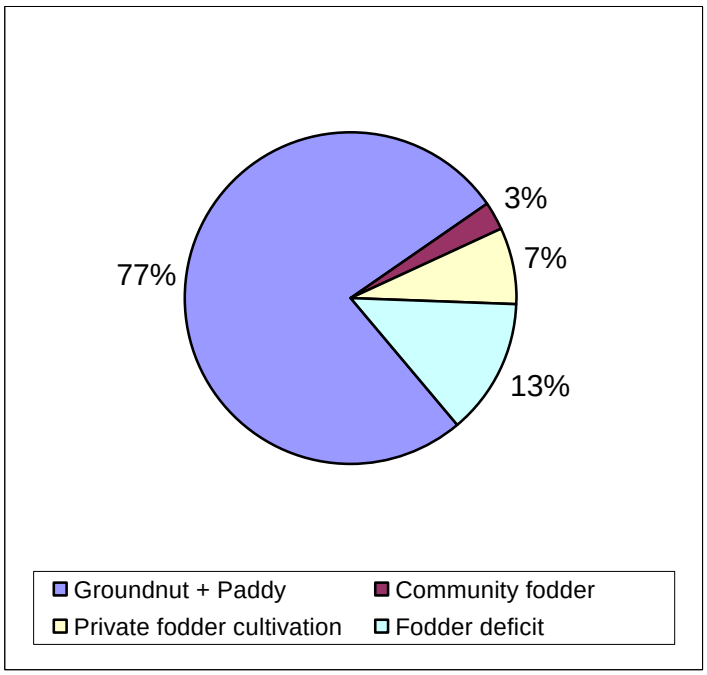


Figure 1. Share of fodder resources to requirement in Ananthapur district during 2003-04.

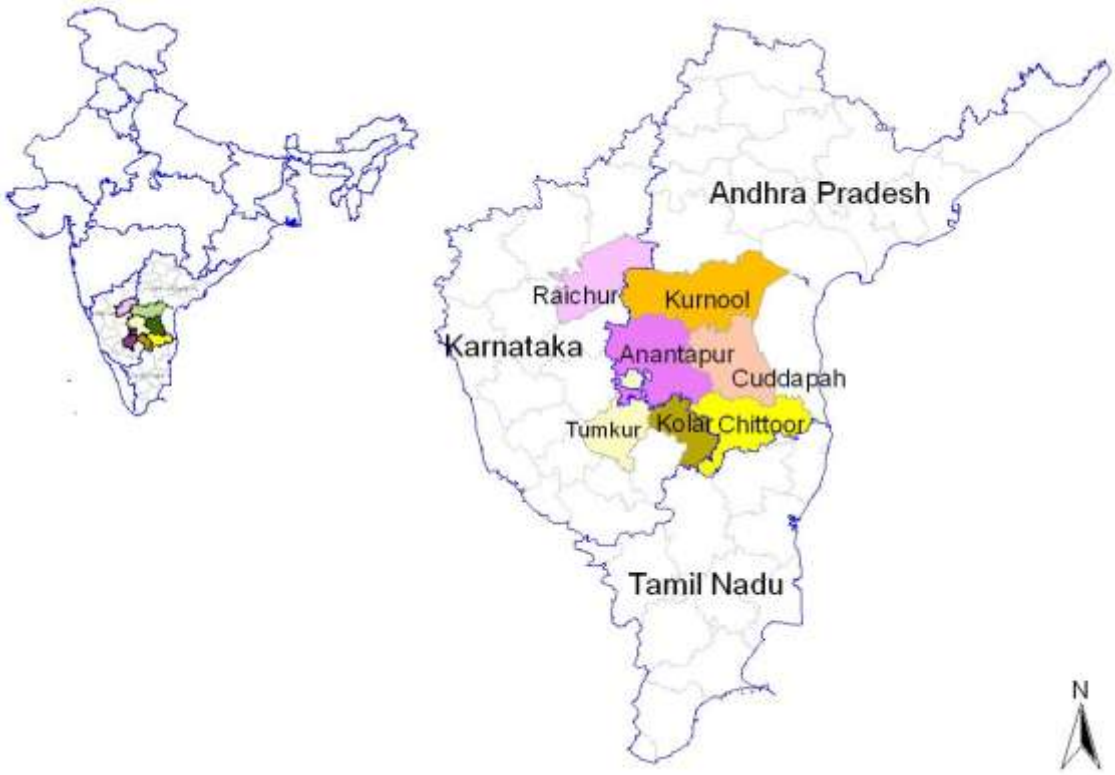


Figure 2. The study region: The Deccan Plateau of India.

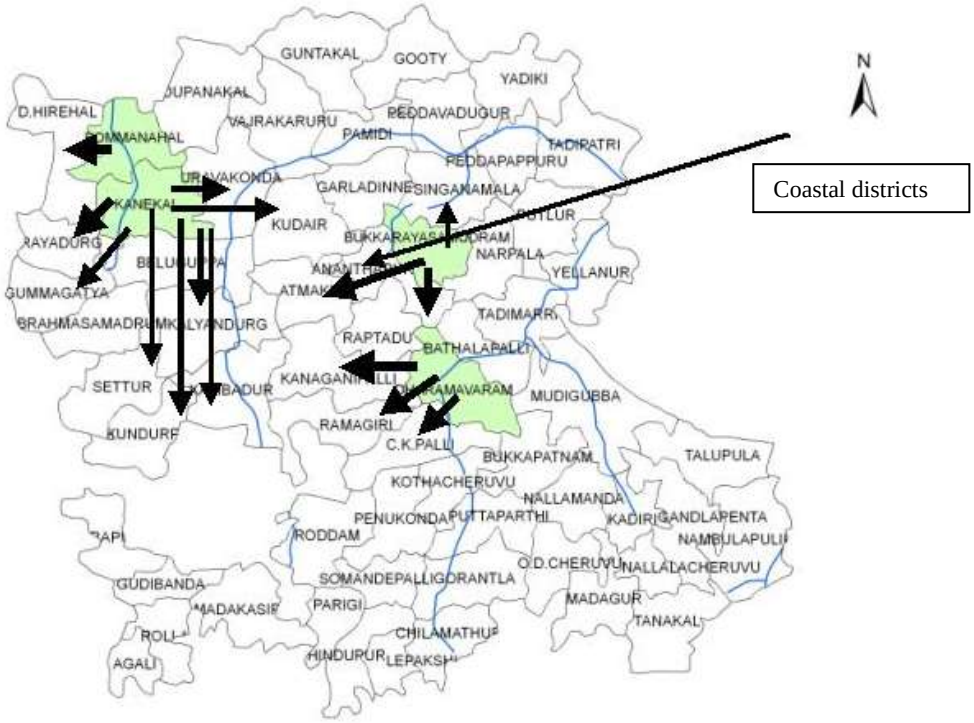
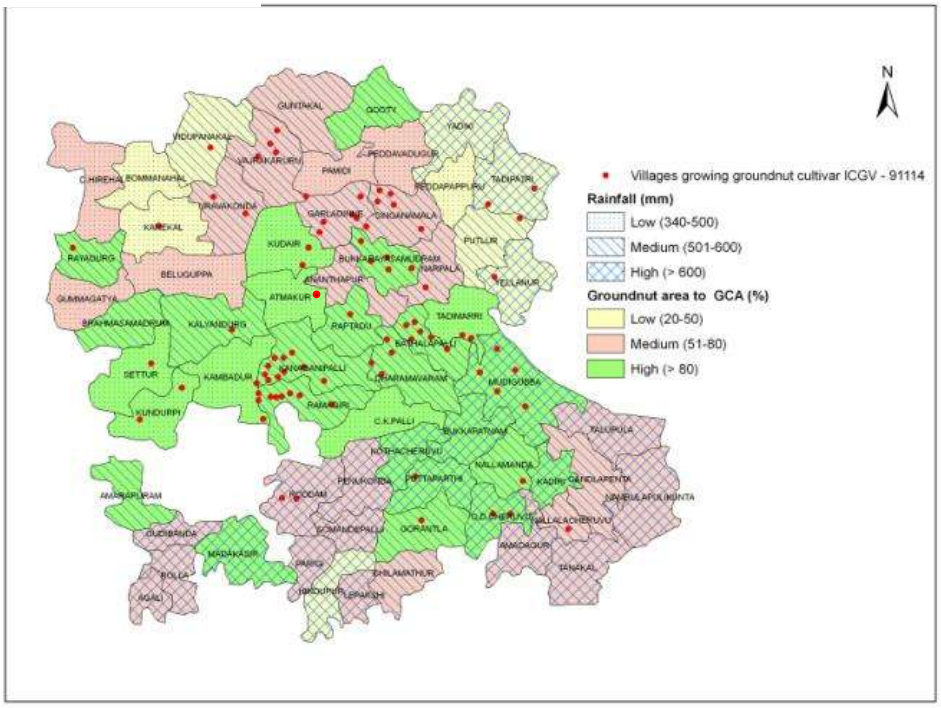


Figure 3. Flow of paddy straw, Ananthapur district.

Ananthapur



Chittoor

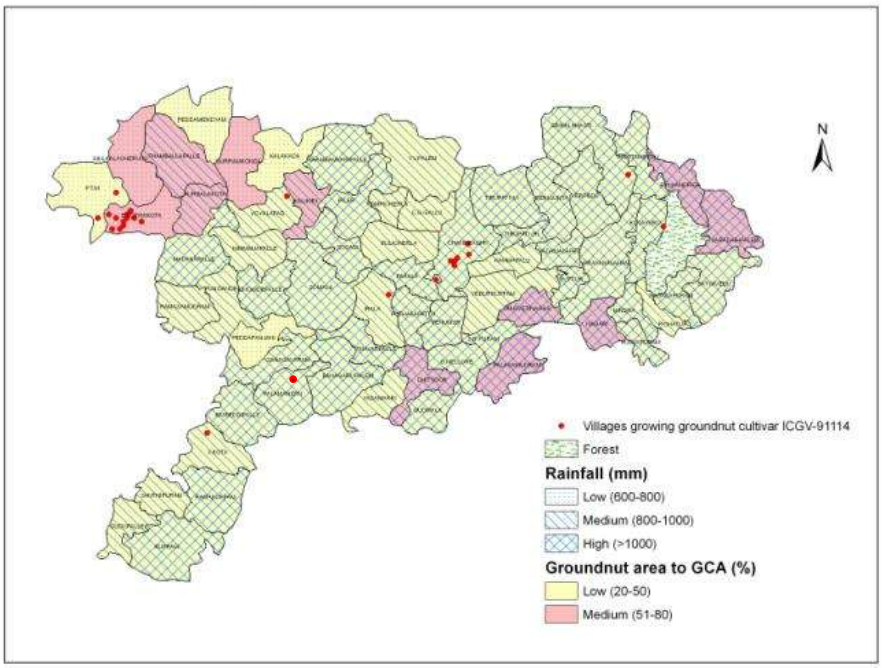


Figure 4. Spread of dual-purpose groundnut cultivar ICGV 91114 and its IDM technology in villages of Ananthapur and Chittoor district.