Farmers’ participatory management of diseases for higher yield and nutritive value of crop residues of groundnut, Deccan Plateau, India

International Crops Research Institute for the Semi-Arid Tropics
Farmers' participatory management of diseases for higher yield and nutritive value of crop residues of groundnut, Deccan Plateau, India

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Foreword

Groundnut (Arachis hypogaea L.) is one of the most important oilseed crops in the rainfed areas of the Deccan Plateau in India, providing nutritious fodder for ruminants. For several decades, farmers in this region have been cultivating the traditional cultivar TMV 2. However, they have been plagued by economically significant foliar diseases like late leaf spot (Phaeoisariopsis personata) and rust (Puccinia arachidis), leading to low and poor pod and fodder yields.

For the past decade, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), in collaboration with partner organizations, has been striving to develop and promote sustainable management technology options to manage these diseases in groundnut and achieve higher pod and fodder yields at the farm level. Following several on-station and on-farm studies, a dual purpose, early-maturing groundnut cultivar ICGV 91114 and its Integrated Disease Management (IDM) technology were developed at ICRISAT as a substitute for TMV 2. The package includes the economical use of fungicide as seed treatment and foliar application.

The objectives of this workshop, Farmers' participatory management of diseases for higher yield and nutritive value of crop residues of groundnut, Deccan Plateau, India, are to critically review the results of the studies conducted over the last two years and ascertain how to make best use of the findings. Held at the Agricultural Research Station (ARS), Acharya NG Ranga Agricultural University (ANGRAU), Anantapur, Andhra Pradesh, the workshop was sponsored by ICRISAT, the International Livestock Research Institute (ILRI), ANGRAU, and funded by the Department for International Development (DFID), UK.

ICRISAT is a firm believer that farmers are partners in progress. Participating in these discussions were farmers/farmer representatives, fodder traders, village-level veterinarians, extension specialists, NGOs, and natural and social scientists. The specific objectives of the final workshop of stakeholders were to synthesize results, finalize recommendations and discuss the need and form of further research.

This proceedings elucidates on farmers' participatory IDM and its components, such as the management-responsive early-maturing groundnut cultivar (ICGV 91114) and need-based minimal use of fungicides. It also traces the genesis, evaluation and eventual promotion of IDM in farmers' participatory approach. Its potential economic benefits and impact in groundnut-growing areas of the Deccan Plateau are also outlined, making it clear that the dual-purpose ICGV 91114 can successfully replace local cultivar TMV 2.

I am sure that the IDM technology will enhance crop yields and the nutritive value of crop residues, thus improving the livelihood of farmers engaged in the mixed crop-livestock system. The efforts in promoting the technology for more pods, haulms and milk to benefit groundnut farmers in the Deccan Plateau are indeed laudable.

William D Dar  
Director General, ICRISAT
Acknowledgments

The authors are grateful to the United Kingdom's Department for International Development (DFID), and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). We gratefully acknowledge the support of Dr M Blummel, Animal Nutritionist, International Livestock Research Institute (ILRI) based at ICRISAT, and Dr Farid Waliyar, Advisor to the DG and Principal Scientist (Pathology), ICRISAT for providing active support and participation in the project. We acknowledge Drs CLL Gowda, Global Theme Leader - Crop Improvement, HC Sharma, Special Project Scientist (Entomology) and Belum VS Reddy, Special Project Scientist (Breeding) for their cooperation and contribution provided to the project activities.

Our grateful thanks to the scientists and field staff of the Agricultural Research Station (ARS) of the Acharya NG Ranga Agricultural University (ANGRAU), Rural Development Trust (RDT), Legumes Pathology unit of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Agricultural Man Ecology (AME) and its network of NGOs for their cooperation and committed work.

We remain thankful to farmers who participated in this on-farm research.

We thank Ms Sheetal Vyas, for editing these proceedings and finally, Mr TR Kapoor and Ms Lydia Flynn, for coordinating the production process.
Inaugural session
On behalf of the International Crops Research Institute for Semi-Arid Tropics and the International Livestock Research Institute, I would like to welcome you to this Stakeholders' Workshop, *Farmers' participatory management of diseases for higher yield and nutritive value of crop residues of groundnut, Deccan Plateau, India*, funded by the United Kingdom's Department for International Development (DFID). The workshop has been jointly organized by ICRISAT, Acharya NG Ranga Agricultural University (ANGRAU) and ILRI-Asia Unit based at ICRISAT, Patancheru.

Collaboration between ICRISAT and ANGRAU dates back to the 1970s when ICRISAT came to Andhra Pradesh, India. Our association with ANGRAU added several dimensions to our portfolio of research and developmental activities across our Global Themes, especially to the Global Themes on 'Crop improvement, management and utilization for food security and health', and 'Land, water and agro-diversity management - agroecosystem development'.

India has the largest population of ruminants in South Asia and livestock production forms an integral part of an age-old system of mixed farming. However, in recent times specialized peri-urban dairy farming has been developed by the landless in many areas. Feed resources are brought daily into peri-urban areas from the surrounding rural areas. Projected increase in human population in South Asia, particularly in India, and higher per capita income over the next 25 years is expected to stimulate significant consumption of bovine products such as milk. The 'livestock revolution' will provide opportunities for increased production and improved livelihood, provided the constraints are overruled. One of the most important technical constraints in animal production is inadequate supply of high quality feed throughout the year. As progressive shrinkage of natural pastures continues with increased cultivation, the dependence on crop residues and agro-industrial by-products as feed resources will continue to increase.

The major crop residues that are used as fodder come from cereals and pulses. On the Deccan Plateau, in India, sorghum and groundnuts are major sources of such fodder. Sale of cereal crop residues to peri-urban producers accounts for more than 50% of income derived from cropping. Large areas of dual-purpose cultivars of sorghum are grown on the plateau. These cultivars

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1 Global Theme Leader, Crop Improvement, ICRISAT, Patancheru, Andhra Pradesh, India.
that provide both grain and straw for animal feed are important for farmers who care about fodder yields as much as they do about grain yields. The increasing importance of sorghum straw is reflected in its market price, which in parts of India has been increasing relative to the price of grain. Groundnut is also an important oilseed crop in the Deccan Plateau. In this region alone, it accounts for more than 21% of the total production in India. Although groundnut crop residues are a major roughage source for dairy animals here, their nutritive value is low.

If ruminant productivity is to be increased to meet new demands for milk, then the availability of higher quality crop residues will be a critical factor. Improving yield and feeding value of crop residues will increase the availability of nutrients to ruminants, help alleviate animal feed deficits and enhance the benefits resulting from the complementarities between crop and livestock systems.

It is against this background that the current project has been conceived. Traditional dual-purpose sorghum cultivars are susceptible to foliar and stalk diseases, while commonly grown groundnut cultivars are susceptible to foliar diseases. The quantity and nutritive value of their residues are also likely to be affected by these diseases. In many ways, the project is unique. Two DFID research programs fund the project and one program (Crop Protection Program) does not have a history of involvement in livestock-related work. Plant, animal and social scientists have participated in various studies in a truly multi-disciplinary manner. The research is novel. The effects of pathogenic microorganisms on grain yields are well documented, but effects on biomass yield and nutritive value are rarely recorded. Activities have involved not only \textit{in vitro} studies of nutritive value in the laboratory, but also \textit{in vivo} assessment in both buffalo and cattle. In addition to two international agricultural research centers, the work has involved farmers (both men and women), village level farmer organizations, national agricultural research institutes (NARS) and non-government organizations (NGOs), and provided training opportunities for postgraduate students.

During phase 1 of the project (1999-2002), the component studies generated a wealth of important data. Information has been collected from on-farm surveys of disease incidence in three states of India, even as perceptions of farmers and fodder traders regarding the effects of diseases have been solicited. On-station trials have been conducted to quantify disease effects and their mitigation through management practices. Finally, indoor animal feeding trials have been undertaken to measure the effects of diseases on digestibility and voluntary intake in buffalo and cattle.

Impressed by achievements and successes of the first phase of the project, DFID decided to further fund this project for another two years (2003-2005) with the main goal of further validating and expanding the improved
technologies to grow healthy sorghum and groundnut crops and their residues. Another important goal of the project is to establish village level seed systems for the multiplication and distribution of dual-purpose and management responsive high yielding (both pod and haulm) groundnut varieties in the mixed crop-livestock systems.

Accordingly, the purpose of this stakeholders' workshop is to critically review the results of studies conducted over the last two years; and to consider the opportunities for an extension of the project to examine the effects of diseases on milk production, quality, human health and sustainable livelihoods. I welcome participatory farmers, natural and social scientists, representatives of ANGRAU, the two international centers, NGOs, farmers and fodder merchants to this two-day workshop.
Welcome address

A Satyanarayana¹

On behalf of the Acharya NG Ranga Agriculture University (ANGRAU), I extend a warm welcome to all scientists from ICRISAT, Central Research Institute for Dryland Agriculture (CRIDA), the Department of Agriculture, and to all the farmers and journalists who have graced our research center today.

Farmers who raise rainfed crops in dryland agriculture give as much importance to livestock as they do to agriculture. Home dairying, sheep and goat rearing are alternate livelihoods during the summer if they are to have a stable supplementary income. Therefore, dual-purpose crops that produce food grains as well as fodder have acquired importance, and are grown widely in the Deccan area. Of late, however, dual-purpose crops are being replaced by commercial crops and as a result, there is an acute shortage of fodder. This in turn leads to distress sale of cattle by farmers. This shortage of fodder is felt more acutely during drought years.

In the current scenario, traditional types of cultivation with bullocks are gradually being forgotten, cattle rearing is becoming rarer and agriculture is being mechanized to an even greater degree. As you all know, there is a remarkable difference in sustaining soil fertility with and without cattle manure. An example to demonstrate how handicapped we are without bullocks: when there is continuous rain on black soils, the field does not dry quickly. This usually results in vigorous growth of weeds. Unless the soil is worked out, it won't dry and the crop does not get aerated and turns green. A farmer with bullocks would be able to take rapid action, but without them, he would have to rely on someone else's cattle to be available on hire. I do not suggest that we not mechanize agriculture; I only recommend that we conjunctively use bullocks also. Cattle and crops go together, indeed they are complementary to each other. I always especially tell small farmers that they should own cattle so they can have farmyard manure available to their fields. The soil becomes fertile and its physical structure improves; it can retain more moisture and salinity decreases. Farmers often express their inability to maintain cattle in the absence of fodder. We come to a full circle: with an increase in dual-purpose crops, livestock populations would also increase and stabilize, thus leading to greater sustainability in agriculture. Women and children can work with dairy animals and supplement their agricultural income.

¹ Director of Extension, ANGRAU, Hyderabad, Andhra Pradesh, India.
During this workshop, we discuss several important issues: Groundnut which gives pods as well as nutritious haulms; the possibilities of Jowar, another dual purpose crop; excessive use of pesticides, their effect on crop residues and the health of cattle; the effects of chemical residues through the food chain to humans and ensuing health problems. This project, initiated by ICRISAT in collaboration with other allied organizations and farmers, aims at improving the quality of the haulms by choosing disease resistant varieties of crops, especially groundnut, and following Integrated Disease Management (IDM) practices. During this workshop, ICRISAT and partners (including farmers) will take stock of the work done on IDM technologies in groundnut, and suggest areas for future research and development in groundnut and other dual-purpose crops that can be grown profitably in the Deccan Plateau.
I welcome all participants from ANGRAU, CRIDA, SK University and farmers. I believe this workshop has great relevance in the present scenario of dryland agriculture in Anantapur. Groundnut is the major crop here, useful to human beings as well as cattle; and as such, it is quite appropriate to discuss it in detail. I will give a brief account of the work Rural Development Trust (RDT) is doing, by touching on three or four issues we have taken up.

Soil conservation is one of our main programs. So far, this has been undertaken in roughly 10% of the district, ie, 0.1 m hectares. We adopt a participatory mode, working in conjunction with farmers. Participation was sought in two areas: contour bunding and financial contributions. Our experiences in the first type were revealing. At first, we created the contour bunds scientifically without involving farmers at all. As they did not understand the concept, over time, they started to plough away the bunds. Then the benefits that accrue from contour bunding were clearly explained, and farmers' opinions sought. This led to a very effective interaction. In the second type of participation, farmers paid 10 to 30% of expenditure incurred for works undertaken in their area. This demonstrates their understanding of the importance of the work being carried out.

Our second program is rainwater harvesting. Contour bunds perform the first task of stopping rainwater. Beyond this, lies necessary maintenance of traditional water harvesting structures such as tanks, ponds, check dams. We are happy to report that about 1500 such repairs have been completed by us; even here, farmers contributed 5-10% of estimated costs, which is an unmistakable indication of their active participation.

Our third program is horticulture under rainfed conditions. Orchards are usually grown where irrigation facilities are available. In this drought prone area, we are trying to establish mango, tamarind and sapota orchards with protective irrigation for the first two years by hand watering. Supportive irrigation to these saplings was done either through tankers or through pot watering from ponds and tanks. RDT also gives financial assistance initially for three years for the maintenance of these crops. Like the government of Andhra Pradesh, we also supplied seedlings free of cost or at subsidized rates.

Dairy and orchards are very essential in Anantapur if sustainable incomes in agriculture are to be achieved. Once they are established, trees like mango or

1 Executive Director, AF/RDT, Anantapur, Andhra Pradesh, India.
Sapota can withstand drought conditions, and can survive continuous dry spells for 50 to 60 days. Farmers have shown much enthusiasm for horticulture in the district.

Extension education on-site is another of our programs. Agricultural research stations, i.e., scientists, bring out certain effective research findings such as the correct rate of seed and fertilizer to be used, methods of intercropping and laying dead furrows. RDT organizes campaigns to spread these messages in the farming community through brochures, pamphlets etc. We have been receiving good feedback on this - farmers have benefited from this and have been able to obtain 10 to 20% better yields from their crops even in drought years.

We also take part in on-farm research activities. For example, RDT is a partner in ICRISAT's IDM research project and 'on-farm' research activities. We have encouraged farmers to sow new varieties of groundnut in their fields, and also help with crop monitoring, recording yield and other important economic parameters of each variety. Likewise, we also work with scientists of the Agricultural Research Station, Anantapur; on the water innovation project which helps study new ways to counter scarcity of fodder.

I hope that such effective collaborations between research institutions, NGOs and the farming community continue and reach greater benefits to the poor.
Background and objectives of the project

S Pande

The project Evaluation of plant diseases on crop residues in India funded by DFID has two phases. In Phase I from 1999 to 2002, we quantified the effect of diseases on yield and nutritive value of crop residues in groundnut and sorghum. During this phase, we developed improved integrated foliar disease management (IDM) technology to manage foliar diseases in groundnut. During Phase II, from 2003 to 2005, IDM technology, along with dual-purpose groundnut varieties, was evaluated, validated and promoted through farmers' participatory mode in villages in the Deccan Plateau, India.

The principal crop residues used as fodder are those from cereals followed by pulses. It is estimated that the potential availability of residues in India includes 75 million tons from coarse grains (sorghum, etc.) and 39 million tons from legumes (mainly from groundnut). On the Deccan Plateau, in the state of Andhra Pradesh alone, groundnut is the second major source of residues (after sorghum) comprising 14 million tons as feed for livestock.

Groundnut crop residue (fodder) from farmers' local cultivars in the Deccan Plateau is low in protein and digestibility. If the quality of crop residues is improved, as well as its nutritive value, it will meet the new demands of milk. Improving nutritive value increases nutrient availability, alleviates feed deficits and enhances benefits from crop-livestock complementarities.

In this project, the main focus is management of diseases to improve quality of crop residues. In Phase I, we noticed that diseases affect quality and quantity of crop residues. Diseased residues command lower prices. High quality and quantity of residues increase farm incomes of resource-poor farmers in this region.

Farmers also perceive that diseases reduce the quality. Hence, fodder quality is important for the poor in rural populations, as it constitutes the main source of feed for their cattle. They also depend on the sale of fodder as a source of additional income. Poor and middle class farmers are dependent on milk and a loss with fodder combined with inferior quality costs them dearly. Therefore, there is a need to improve the quantity and quality of the groundnut crop and its residues for the sustainability of the mixed crop-livestock system.

1 Principal Scientist (Pathology), ICRISAT, Patancheru, Andhra Pradesh, India.
In Phase II of the project, it has been decided to work in partnership with farmers through our active collaborators. The specific objectives of this phase are to:

- Refine, validate and scale-up IDM practices in groundnut
- Multiply and distribute dual purpose groundnut varieties that are responsive to management
- Use crop residues of improved varieties in milk production trials with dairy animals
- Quantify losses and gains at farm level in varietal adoption and milk production
- Establish village level seed systems

We have achieved most of these objectives. What we seek to do now is review critically farmers' responses in this stakeholders' meet. We will identify areas that need correction and explore opportunities for further extension.
Genesis of participatory IDM technology in ICGV 91114, a dual purpose, short duration, high yielding groundnut cultivar in Anantapur, India

B Sreenivas\(^1\), S Pande\(^2\) and J Narayana Rao\(^3\)

Anantapur district in western Andhra Pradesh lies between 13° - 41' and 15° - 14' North latitude and 76° - 47' and 78° - 26' East longitude. It is bounded on the north by Bellary and Kurnool districts, on the east by Kadapa and Chittoor and on the south and west by Karnataka state. It forms part of the northern extremity of the Deccan Plateau and slopes from south to north. Its elevation towards the south is 2200' mean sea level (MSL) while it gradually comes down to 1000' in the north and 900' in the northeast. The area towards the eastern side is hilly with rolling topography.

The total geographical area is 1917000 ha with a total population of 3639000 with a density rate of 190 per square kilometer. Nearly 68% of its people are dependent on agriculture. In Andhra Pradesh, the district ranks third in area and eleventh in population. Geographically, Anantapur can be grouped into three natural divisions: (i) Gooty, Tadipatri and Urava Konda in the North with large areas of black cotton soils (vertisols); (ii) Anantapur, Kalyandurga, Rayadurg, Dharmavaram, Kadiri and Penukonda in the center with their arid, treeless expanses and poor soils, and (iii) Hindupur and Madakasira in the south, with their comparatively less hospitable soils. The terrain of Anantapur is undulating and the soils for the most part are red sandy loams; low in ion exchange capacity, water holding capacity and poor in fertility status.

The major cropping systems under rainfed agriculture are groundnut/pigeonpea or groundnut/castor. Occasionally other crops like bajra, jowar and sunflower are intercropped with groundnut. The total area under groundnut is about 0.8 m ha, with a total production of 363000 tons - the highest in the state. But unfortunately productivity is low: merely 0.5 t/ha. The general problems facing crop production in these areas are:

- Non-availability of improved varieties of groundnut seed
- Poor crop stands due to crusting, rapid drying of surface soil and high soil temperatures

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\(^2\) Principal Scientist (Pathology), ICRISAT, Patancheru, Andhra Pradesh, India.

\(^3\) Senior Scientific Officer (Pathology), ICRISAT, Patancheru, Andhra Pradesh, India.
Poor crop growth due to unreliable soil moisture, low soil fertility, difficult soil tillage and compact subsoil layer (argillic horizons)

Poor yields due to biotic constraints, mainly foliar diseases

Late leaf spot, rust, collar rot, stem rot, bud necrosis are among the biotic constraints for groundnut production, economically. Late leaf spot \((\text{Phaeoisariopsis personata})\) and rust \((\text{Puccinia arachidis})\), together called 'tikka' disease are the most destructive and cause pod and fodder losses upto 70\% every year when farmers' local cultivar \((\text{TMV 2})\) is used in this district. Farmers also suffer severe losses by indiscriminate use of hazardous chemicals while trying to control these foliar diseases.

Despite good intentions, the distance between phytopathologists and farmers remains wide and is even greater in backward areas such as Anantapur. To narrow the gap between technology generation, technology transfer and technology adoption subsystems, there is an urgent need to initiate on-farm evaluation of groundnut foliar disease management technologies to boost groundnut productivity both in pod and haulms. Haulms are of considerable economic importance as nutritious fodder for cattle in the case of both draught and milch animals.

Complete reliance on host plant resistance has not been a successful approach as such groundnut varieties were not available to farmers. Since 1995, efforts have been made to manage foliar diseases by adopting Integrated Disease Management \((\text{IDM})\). Experiments on IDM carried out at ICRISAT showed promise in obtaining higher productivity both in pods and fodder with appreciable good quality. This resulted in collaborative studies between ANGRAU, various NGOs and ICRISAT. ANGRAU and its research stations in the Deccan Plateau have been major partners in the evaluation and validation of IDM technology through the on-farm participatory approach in this area.

Collaborating institutes involved in on-farm research are:

1995 to 1996  
Agricultural Research Station \((\text{ARS})\) of Acharya NG Ranga Agricultural University \((\text{ANGRAU})\), Anantapur; Rural Development Trust \((\text{RDT})\), Anantapur; Krishi Vignan Kendra, Kurnool and Nalgonda

1997 to 1998  
On-farm trials were devolved by ICRISAT; evaluation of IDM technology was carried out by ARS and RDT, Anantapur. Varieties tested were IGGV 89104 and 91114.

1999 to 2000  
Agriculture Man Ecology \((\text{AME})\), and its NGO network in Andhra Pradesh and Karnataka.

2001 to 2004  
District Agricultural Advisory and Transfer of Technology Centre \((\text{DAATT Centre})\) of ANGRAU (Eruvaka); ARS and RDT, Anantapur.
The IDM technology package

ICRISAT and collaborating institutions together initiated the evaluation and validation of IDM technology in Anantapur, Kurnool and Nalgonda districts of Andhra Pradesh in 1995 and 1996. The technology consisted of an improved high-yielding cultivar with moderate host plant resistance, seed treatment with fungicide and one or two sprays with fungicide 'Kavach' (one spray at 65-70 days after sowing (DAS) for the early variety and two sprays: the first at 65-70 DAS and the second, 15 days later for medium maturing cultivars). Groundnut cultivars included ICGVs 89104, 91114, 91123 and 94361 (early maturing) and ICGVs 86590, 86699 and ICGS 76 (medium maturing lines) during 1995 and 1996. In both trials, susceptible TMV 2 and local cultivars were included as checks in all locations. During these two years, ICGVs 89104 and 91114 emerged as potential candidates for on-farm IDM studies as they out-yielded other cultivars in both pod and fodder.

During 1997 and 1998, ARS and RDT evaluated IDM technology through farmers' participatory research in Anantapur district. After the devolutionary period at ICRISAT, on-farm IDM research was conducted from 1999 to 2004. These included two promising early maturing cultivars, ICGVs 89104 and 91114, which were most preferred by farmers, along with a new set of three medium maturing lines, ICGVs 92020, 92093 and 94080 in Andhra Pradesh and Karnataka. Year wise details of locations and trials are given in Table 1.

The year wise highlights of IDM trials are as follows.

1995

All medium-maturing cultivars had lower severities of LLS and rust than TMV 2. Pod yield was higher in all medium-maturing cultivars compared to the local cultivar.

Among the early maturing cultivars ICGVs 89104 and 91114 had moderate level of foliar diseases and yielded better than rest of the cultivars.

1996

With encouraging results and favorable farmers reactions, IDM trials were continued in the 1996 rainy season.

- LLS and rust severities were low in early maturing cultivars in sprayed plots compared to unsprayed plots in all locations (Table 2).
- ICGV 91114 followed by 89104 recorded the highest pod and haulm yields over local cultivars (Table 2).
- These two cultivars were much preferred by most farmers.
Table 1. Details of participatory on-farm trials conducted.

<table>
<thead>
<tr>
<th>Year</th>
<th>District (no. of villages)</th>
<th>Number of trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>Anantapur (2)</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Kurnool (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nalgonda (1)</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>Anantapur (5)</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Kurnool (3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nalgonda (4)</td>
<td></td>
</tr>
<tr>
<td>1997-98</td>
<td>Devolutionary period; however, took up evaluation of IDM technology using ICGVs 89104 and 91114</td>
<td>-</td>
</tr>
<tr>
<td>1999</td>
<td>Chittoor (2)</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Kolar (8)</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>Chittoor (3)</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Kolar (6)</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>Anantapur (1)</td>
<td>21</td>
</tr>
<tr>
<td>2002</td>
<td>Anantapur (2)</td>
<td>45</td>
</tr>
<tr>
<td>2003</td>
<td>Anantapur (2)</td>
<td>70</td>
</tr>
<tr>
<td>2004</td>
<td>Anantapur (5)</td>
<td>150</td>
</tr>
</tbody>
</table>

Table 2. Effect of IDM on foliar disease incidence and mean yield in selected short duration groundnut cultivars in on-farm trials, 1996.

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Foliar disease score*</th>
<th>Yield (t/ha)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Haulm</td>
<td>Pod</td>
<td>IDM</td>
<td>Non-IDM</td>
<td>IDM</td>
</tr>
<tr>
<td>ICGV 89104</td>
<td>5.5</td>
<td>8.3</td>
<td>2.58</td>
<td>2.25</td>
<td>1.87</td>
<td>1.40</td>
</tr>
<tr>
<td>ICGV 91114</td>
<td>4.7</td>
<td>8.0</td>
<td>2.83</td>
<td>2.40</td>
<td>2.20</td>
<td>1.75</td>
</tr>
<tr>
<td>Local variety</td>
<td>6.0</td>
<td>9.0</td>
<td>2.25</td>
<td>1.75</td>
<td>1.06</td>
<td>0.85</td>
</tr>
</tbody>
</table>

* on a 1-9 rating scale.

1997 and 1998

Trends in 1997 and 1998 were similar to those observed in 1995 and 1996 regarding severity of foliar diseases, and pod and fodder yields in the two cultivars ICGV 91114 and 89104. During this period, these two cultivars spread to several farms in the villages.
Soon after restoration of on-farm research at ICRISAT, IDM trials were conducted in 10 villages in Andhra Pradesh and Karnataka using ICGV 89104 and 91114. Again, these cultivars proved to be superior to local cultivars in pod and haulm yields in all the trials.

2000

During this year, the adoption of IDM technology, with cultivar ICGV 91114 spread not only across farms but also to several villages. The low severity of foliar diseases and high quality fodder from the cultivar ICGV 91114 attracted many farmers.

Table 3. Mean severity of foliar diseases, and haulm and pod yield as influenced by IDM and non-IDM practices in on-farm trials, 1997-2000.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Disease score on a 1-9 scale</th>
<th>Haulm yield (t/ha)</th>
<th>Pod yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IDM</td>
<td>Non-IDM</td>
<td>IDM</td>
</tr>
<tr>
<td>ICGV 89104</td>
<td>7.3</td>
<td>7.7</td>
<td>1.51</td>
</tr>
<tr>
<td>ICGV 91114</td>
<td>7.0</td>
<td>7.3</td>
<td>1.70</td>
</tr>
<tr>
<td>TMV 2</td>
<td>8.3</td>
<td>9.0</td>
<td>1.12</td>
</tr>
</tbody>
</table>

2001 to 2004

The dual purposes of the cultivar ICGV 91114 was appreciated by farmers in several villages and therefore spread rapidly to villages and neighboring districts in Andhra Pradesh and Karnataka (Fig. 1). During this period, ICGV 91114 demonstrated low severities of foliar diseases and high pod and fodder (haulm) yield compared to the local cultivar. Moreover, the fodder was found nutritious and milk yield increased when fed to milch animals.

Conclusion

Groundnut is entwined with the economic prosperity of the district, where more than two thirds of the population depends on agriculture. The quality and quantity of pod and fodder are affected mainly by foliar diseases and further aggravated collaterally by diseases like stem rot. Diseased fodder has low digestibility and low market value. IDM technology tested in on-farm trials confirmed beyond doubt that management of foliar diseases resulted in concomitant increase in quality of fodder and pod yields. Groundnut variety
ICGV 91114 pleased farmers both in favorable and unfavorable seasons by tiding over drought with superior yields. This is reflected in the fact that farmers rapidly adopted and spread this cultivar.

A tailpiece in the farming system, household dairy is nevertheless an important component that supplements incomes in this ecologically hard-pressed tract of Anantapur. Groundnut haulm has been found to be the main nutritive proteinaceous crop residue for dairy animals. Healthy fodder is more digestible and results in increased milk yields, which supplements farmers' economic status.

Our suggestion is to upscale IDM technology as an innovative program in all area development programs. This must be carried out by agencies such as the District Water Management Agency (DWMA). The multiplication of ICGV 91114 must be promoted as part of work on village level seed system in a participatory mode in watershed areas, as this is the only variety that fits well into the available crop growth period of less than 100 days under rainfed conditions. This cultivar has the potential to replace the traditional local variety TMV 2/JL 24.
Crop-livestock linkages: A case study of improved groundnut cultivars in the Deccan Plateau

P Parthasarathy Rao\textsuperscript{1} and V Shravan Kumar\textsuperscript{2}

\section*{Introduction}

The integrated nature of crop-livestock production is a unique characteristic of agricultural production in most semi-arid tropical countries in Africa and Asia. The inseparability of the two, in fact, sustains the production of each. Livestock provide draught power and manure, while crops provide feed and fodder for animals. The scale of production of both crops and livestock is small, yet the complementarities between the two have considerable social, economic and environmental impact. Livestock are an important source of income and employment for the rural poor and can be considered a living savings bank with offspring as interest. Being liquid compared with land, livestock act as a cushion against risk and uncertainty in crop production.

During the last decade, the demand for milk and meat has grown rapidly due to sustained rise in per capita income and urbanization. Recent estimates show very low to negative elasticity for cereals and pulses, and high elasticity for milk (0.60), meat, fish and eggs (0.89). High expenditure elasticities coupled with high growth in income and population have lead to considerable rise in demand for livestock products in recent years. This trend will continue to strengthen in the near future, as the underlying forces will further fuel growth in demand. In India, for example, by 2020 demand for milk and meat is expected to double from 75 million t and 4.4 million t respectively.

India has the largest population of ruminants in South Asia, and livestock production is an integral part of mixed farming systems. To meet the growing demand for livestock products in recent times, specialized peri-urban/urban dairy production has been developed by the landless in many areas. The so-called "livestock revolution" will provide opportunities for increased production of milk to meet the requirements of the increasing human population and lead to improved livelihoods, of those dependent on crop and livestock income.

\section*{Constraints to production}

The past performance of the livestock sector however indicates that to a large extent growth in production was number-driven. Livestock productivity both

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for milk and meat continues to be abysmally low compared to the world average or domestic potential. 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 fine and coarse cereals and leguminous crops) and agro-industrial by-products (bran, oilcakes etc) are the main sources of feed. In the semi-arid districts of India, crop residues account for almost 55-70% of the total dry matter intake by large ruminants. The residues are stored and used throughout the year, particularly in the dry months when other sources of feed are scarce.

Although crop residues are a major roughage source for ruminants, their nutritive value is often low. Furthermore, crops like sorghum and groundnut are susceptible to a number of foliar and stalk diseases that may reduce production and quality of both crop and residues. In recent years, considerable attention has been paid to alleviate feed scarcity through technological intervention. Chemical and biological treatment of cereal straws is an example. However, much of the work has been on the shelves of research stations. Attempts at transfer of the technology have not succeeded due to technological and socioeconomic constraints at the farm level. Disease resistant improved varieties of crops are an option with potential payoffs.

**Crop-Livestock interaction on the Deccan Plateau**

Crop-livestock interaction is an important feature of agriculture on the Deccan Plateau. In Anantapur district, traditional dual-purpose sorghum and groundnut crops provide most of the residues. Groundnut is an important crop in Andhra Pradesh, accounting for 18-21% of total production in India. Anantapur accounts for 46% of groundnut area in Andhra Pradesh where groundnut accounts for 61-77% of the cropped area under irrigated and rainfed conditions.

Groundnut residues are a nutritious source of livestock feed and are used locally either by farmers themselves or exchanged for food and other crop residues. Sales of cereal crop residues to peri-urban/urban milk producers' account for a large share of the income derived from cropping in rural areas. Depending on stover quality, farmers are getting more income from the sale of crop residues.

**Household surveys**

Farmer surveys conducted during 2003-04 in two project villages, Gummallakunta and Jalalapuram of Bathalapalli mandal, indicate that groundnut accounts for 61-75% of the cropped area under rainfed conditions. The balance is made up
by sorghum (1-10%), paddy rice (1-6%), permanent crops (13-22%) and other crops. Only a small proportion of groundnut is irrigated in the postrainy season. About 10% of the area cultivated by farmers in the sample was planted with the improved groundnut cultivars promoted by the project. The household surveys were carried out primarily to assess the performance of improved cultivars against traditional ones.

On average, farmers were found to own 2-3 milk animals, and buffalo outnumbered cows. About 50% of the households maintained a pair of bullocks for traction. The main sources of feed were groundnut residue, paddy rice and sorghum, green grass from bunds (especially in the wet season), and forage from grazing common property resources and fallows. Groundnut haulms were found to provide >50% of dry fodder, and >25% of the haulm fed to animals was traded (exchanged) within the village. Farmers purchased 75% of paddy rice straw and about 50% of sorghum stover from outside the village. In many cases, paddy straw was purchased from distances 100-150 km away. Rice bran and concentrate mixtures were bought in the nearest town, and reserved for lactating animals and bullocks used for land preparation in the planting season.

Pest and disease incidence in groundnut is an important constraint that reduces yields of both pod and haulm. Farmers generally felt that yield loss was higher due to foliar diseases (Table 1).

Table 1. Percentage of yield loss due to diseases.

<table>
<thead>
<tr>
<th>Yield loss (%)</th>
<th>Gummallakunta*</th>
<th>Jalalapuram**</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>15</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>30</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>35</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Sample farmers = 20
** Sample farmers = 12
The effect of diseased stover on selected indicators is shown in Table 2. Generally, farmers perceived a decline in milk yield due to feeding of diseased haulm.

### Table 2. Effect of diseased haulm on select indicators.

<table>
<thead>
<tr>
<th>Effects</th>
<th>No change</th>
<th>Decreased by 25%</th>
<th>No change</th>
<th>Decreased by 25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market price of stover</td>
<td>17</td>
<td>3</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>Animal growth</td>
<td>13</td>
<td>7</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Milk yield</td>
<td>3</td>
<td>16</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Milk quality</td>
<td>19</td>
<td>1</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>Milk price</td>
<td>19</td>
<td>-</td>
<td>12</td>
<td>-</td>
</tr>
</tbody>
</table>

*Sample farmers = 20  
**Sample farmers = 12  

**Farmer perceptions and profitability of improved cultivars**

The 2004-2005 season received good rainfall, and data was available from farmers for economic analysis. Nine farmers grew the local variety JL 24 and 37 farmers cropped the most popular variety TMV 2 and they were asked for their perceptions of the new improved cultivar ICGV 91114. The results are presented in Table 3.

The majority of farmers growing both local varieties think that ICGV 91114 is superior by 25-50% in terms of grain/fodder yield, grain/fodder quality, palatability, resistance to diseases and drought tolerance. A majority of farmers think that there are no differences between cultivars with respect to inputs of labor/materials required.

The involved costs and returns from improved cultivar ICGV 91114 or local varieties JL 24 and TMV 2 in three villages under rainfed or irrigated conditions are shown in Table 4. Pod and haulm yields were highest for ICGV 91114. Gross returns were much higher for the new improved cultivar. Although the costs of cultivation were marginally higher for ICGV 91114, the overall costs of production were 9% lower for the new cultivar under irrigation and 8% lower in rainfed conditions. Net returns from growing ICGV 91114 were about 29% higher under irrigation and 25% higher under rainfed conditions.
Table 3. Farmers assessment ICGV 91114 in comparison with traditional varieties.

<table>
<thead>
<tr>
<th></th>
<th>ICGV 91114 versus JL 24*</th>
<th>ICGV 91114 versus TMV 2**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No difference</td>
<td>Slightly higher/better (25%)</td>
</tr>
<tr>
<td>Grain yield</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Fodder yield</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Grain quality</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Fodder quality</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Disease resistant</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Pest resistant</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Drought resistant</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Labor inputs</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Material inputs</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: Survey data.

*Number of farmers = 9

**Number of farmers = 37.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Irrigated</th>
<th>Rainfed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TMV 2</td>
<td>JL 24</td>
</tr>
<tr>
<td>Pod yield (kg/ha)</td>
<td>1322</td>
<td>1216</td>
</tr>
<tr>
<td>Haulm yield (kg/ha)</td>
<td>1730</td>
<td>1730</td>
</tr>
<tr>
<td>Gross returns (Rs/ha)</td>
<td>24291</td>
<td>24637</td>
</tr>
<tr>
<td>Cost of cultivation (Rs/ha)</td>
<td>9558</td>
<td>10008</td>
</tr>
<tr>
<td>Net returns (Rs/ha)</td>
<td>14733</td>
<td>14629</td>
</tr>
<tr>
<td>Cost of production (Rs/kg)</td>
<td>7.2</td>
<td>8.2</td>
</tr>
</tbody>
</table>

Data collected from sample farmers from three project villages.
Source: Survey data.

Impact on milk yield

Laboratory analyses of groundnut haulms from farms confirm that the feeding value of improved cultivars is high. The range of values for crude protein content, \textit{in vitro} digestibility and metabolizable energy were 13.9-15.8\%, 63.2-65.3\% and 8.8-9.2 MJ/kg, respectively. Laboratory measurements were similar across cultivars and farms.

Milk yields in animals (mostly buffaloes but also dairy cows) fed haulms from improved cultivar 91114 was about 10\% higher (4.36 kg/day) than when animals were fed the local cultivars TMV 2 and JL 24 (3.92 kg/day).

Conclusion

The advantages of growing improved cultivars are threefold:
1) higher pod yields,
2) higher haulm yields and
3) higher milk yields from dairy animals that are fed the haulms.

Currently, farmers are receiving about Rs 24-28/kg for seed of improved cultivar ICGV 91114 compared to Rs 18-22/kg for seed of traditional varieties. Milk yields per animal on farm are 0.44 kg/day higher with haulm ICGV 91114 than with the local varieties. Some 70-80\% of milk is sold through both formal and informal sources.

At current rates of adoption, it is anticipated that some 80,000 hectares of groundnut (10\% of the total crop) in Anantapur district will be under improved cultivars by 2010, and that there will be dissemination of seed into the adjoining states of Karnataka and Tamil Nadu. Demand for high quality crop residues will
increase in the future. The new disease-resistant, dual-purpose cultivars will thus contribute to increased groundnut and milk production and consequently raise incomes at the farm level leading to improved livelihoods for small-scale farmers.
Session I: Integrated crop and pest management in groundnut
Improved crop husbandry practices in groundnut in dryland agriculture: Need and scope

T Yellamanda Reddy

Among oilseed crops, groundnut holds first place in India. In Andhra Pradesh, it is grown in an area of 2.2 million ha with a production of 1.5 million tonnes and productivity of 842 kg/ha. Groundnut seed contains about 45 percent oil and 26 percent protein. It is a good source of B vitamin except for B\textsubscript{12} and thiamine, riboflavin, nicotinic acid and vitamin E.

In the Deccan Plateau, the ideal time for sowing rainfed groundnut is from the second week of July to the first week of August. Delay in sowing beyond the first week of August leads to lower yields (Table 1) as the crop faces drought at the pod filling stage.

<table>
<thead>
<tr>
<th>Date of sowing</th>
<th>No. of pods/m</th>
<th>Pod yield (kg/ha)</th>
<th>Haulm yield (kg/ha)</th>
<th>Shelling %</th>
<th>100-seed weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 July</td>
<td>350</td>
<td>1582</td>
<td>2130</td>
<td>69.9</td>
<td>25.94</td>
</tr>
<tr>
<td>1 August</td>
<td>147</td>
<td>1236</td>
<td>1815</td>
<td>70.12</td>
<td>25.15</td>
</tr>
<tr>
<td>30 August</td>
<td>105</td>
<td>547</td>
<td>333</td>
<td>65.33</td>
<td>21.73</td>
</tr>
</tbody>
</table>

Tillage

Light textured soils with low organic matter and routine soil manipulation in the form of tillage operations are more prone to either wind or water erosion. Soils of Anantapur are shallow in depth, low in organic matter content and almost without structure. Minimum tillage in general may help improve the soil structure, organic matter content, interception of rainwater and may reduce soil erosion. Experiments conducted at ARS, Anantapur, revealed that there was no significant difference in yields between conventional tillage and minimum tillage (Table 2). Minimum tillage therefore is recommended in order to raise a successful crop.

\footnote{Principal Scientist (Dryland Agriculture), ARS, Anantapur, Andhra Pradesh, India.}
Table 2. Mean effect of tillage practices on groundnut yields, ARS, Anantapur*.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Pod yield (kg/ha)</th>
<th>Haulm yield (kg/ha)</th>
<th>Shelling %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional tillage</td>
<td>1020</td>
<td>1748</td>
<td>67.3</td>
</tr>
<tr>
<td>Low tillage</td>
<td>951</td>
<td>1725</td>
<td>66.2</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>Non-significant</td>
<td>Non-significant</td>
<td>Non-significant</td>
</tr>
</tbody>
</table>

* Mean of five years (2000 to 2004).

In groundnut, seed cost constitutes 30% of the total cost of cultivation. Farmers generally grade the seed, and bold seed is used for sowing and shriveled seed is discarded. On-farm trials conducted during 2003 and 2004 rainy seasons in 50 farmers’ fields revealed that crop sown with partially shriveled seed gave yields on par with crops sown with bold seed (Table 3).

Table 3. Effect of partially shriveled groundnut seed on pod yields in on-farm trials.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pod yield (kg/ha)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal seed</td>
<td>405</td>
</tr>
<tr>
<td>Partially shriveled seed</td>
<td>472</td>
</tr>
</tbody>
</table>

* Average from 50 trials.

Seed treatment

Seed treatment with fungicide is very important as it protects the crop from seed and soil-borne diseases. Seed treatment with Mancozeb @ 3 g/kg seed or carbandizim @ 2 g/kg seed helps reduce soil borne diseases like collar rot, stem rot etc. Peanut stem necrosis disease (PSND) can be controlled by treating the seed with Imidacloprid @ 1 ml/kg seed and chloropyriphos @ 6 ml/kg seed to avoid root grub incidence.

Sowing

CRIDA-ANGRAU have developed a 9-row planter that can be used for groundnut sowing along with intercrop sowing at a ratio of 8:1. This planter maintains the recommended seed rate of 90-100 kg kernels/ha and covers an
area of 6 to 7 ha/day of 8 hours. The cost of sowing with this machine works out to Rs 350/ha compared to Rs 500/ha with an animal drawn seed drill (Table 4).

<table>
<thead>
<tr>
<th>Planter</th>
<th>Seed rate (kg/ha)</th>
<th>Population (m²)</th>
<th>Average intra row spacing (cm)</th>
<th>Field capacity (ha/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRIDA-ANGRAU planter</td>
<td>90</td>
<td>33</td>
<td>10.23</td>
<td>0.50</td>
</tr>
<tr>
<td>Local seed drill</td>
<td>124</td>
<td>42</td>
<td>8.86</td>
<td>0.46</td>
</tr>
</tbody>
</table>

**Nutrient management**

**Permanent manure trial:** The results of 19 years' research in this district revealed that inorganic fertilizer input can be reduced by 50% by adding either groundnut shells or FYM @ 4 t/ha (Table 5). Further, there was improvement in the physical structure of soil, infiltration rate and moisture holding capacity and decrease in runoff losses due to the use of organics. There was a significant build up of available phosphorus due to continuous use of inorganic fertilizers (Table 6). Soil biological activity in terms of dehydrogenase enzyme activity increased with the application of FYM.

**Fertilizer application based on soil analysis:** Experiments conducted at Anantapur indicated that fertilizer application based on soil analysis was the best method to obtain higher pod yields with reduced cost of cultivation by avoiding application of excess fertilizers (Table 7). In this method, soil is analyzed for availability of NPK elements.

- The steps suggested for groundnut are:
  - If soil analyses reveal low levels of nitrogen, phosphorus and potash, the full-recommended dose of chemical fertilizer viz, 8-16-16 kg of N, P₂O₅ and K₂O/acre must be applied.
  - If results reveal medium levels of N, P₂O₅ and K₂O, then half the recommended dose must be applied.
  - If the status is high, no fertilizer need be applied, and the investment on the fertilizer component can be rationalized.

**Soil Amendments:** An experiment was conducted in Anantapur from 1997 to 2000 to study the effect of application of sand, gypsum and farmyard manure as amendments to create a favorable environment in the soil for groundnut crop growth and yield (Table 8) on hard surface crusting soils (alfisols).
Table 5. Effects of long term Integrated Nutrient Management on pod yield of groundnut over years.

<table>
<thead>
<tr>
<th>Year</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
<th>T7</th>
<th>T8</th>
<th>T9</th>
<th>CD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>1186</td>
<td>1367</td>
<td>1288</td>
<td>1187</td>
<td>1058</td>
<td>1077</td>
<td>1197</td>
<td>1309</td>
<td>991</td>
<td>84</td>
</tr>
<tr>
<td>1986</td>
<td>902</td>
<td>1055</td>
<td>943</td>
<td>1300</td>
<td>1168</td>
<td>1233</td>
<td>960</td>
<td>1072</td>
<td>945</td>
<td>204</td>
</tr>
<tr>
<td>1987</td>
<td>1364</td>
<td>1467</td>
<td>1428</td>
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<td>1478</td>
<td>1447</td>
<td>1473</td>
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<td>1988</td>
<td>1480</td>
<td>1786</td>
<td>1920</td>
<td>1605</td>
<td>1915</td>
<td>1741</td>
<td>1912</td>
<td>2040</td>
<td>1977</td>
<td>280</td>
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<tr>
<td>1989</td>
<td>1156</td>
<td>1446</td>
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<td>1152</td>
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<td>1453</td>
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<tr>
<td>1990</td>
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<td>1264</td>
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<td>1348</td>
<td>1290</td>
<td>1218</td>
<td>1315</td>
<td>1238</td>
<td>1302</td>
<td>NS</td>
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<tr>
<td>1991</td>
<td>381</td>
<td>608</td>
<td>547</td>
<td>507</td>
<td>569</td>
<td>524</td>
<td>491</td>
<td>432</td>
<td>424</td>
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<tr>
<td>1992</td>
<td>1016</td>
<td>1250</td>
<td>1143</td>
<td>1207</td>
<td>1130</td>
<td>1250</td>
<td>1352</td>
<td>1280</td>
<td>1141</td>
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<tr>
<td>1993</td>
<td>493</td>
<td>745</td>
<td>724</td>
<td>634</td>
<td>662</td>
<td>642</td>
<td>716</td>
<td>733</td>
<td>626</td>
<td>NS</td>
</tr>
<tr>
<td>1994</td>
<td>469</td>
<td>658</td>
<td>568</td>
<td>633</td>
<td>625</td>
<td>757</td>
<td>708</td>
<td>642</td>
<td>601</td>
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<td>1995</td>
<td>760</td>
<td>1111</td>
<td>984</td>
<td>799</td>
<td>926</td>
<td>1004</td>
<td>994</td>
<td>1131</td>
<td>946</td>
<td>84</td>
</tr>
<tr>
<td>1996</td>
<td>563</td>
<td>632</td>
<td>625</td>
<td>688</td>
<td>660</td>
<td>701</td>
<td>701</td>
<td>694</td>
<td>653</td>
<td>NS</td>
</tr>
<tr>
<td>1997</td>
<td>241</td>
<td>410</td>
<td>347</td>
<td>333</td>
<td>320</td>
<td>338</td>
<td>336</td>
<td>297</td>
<td>329</td>
<td>66</td>
</tr>
<tr>
<td>1998</td>
<td>966</td>
<td>1250</td>
<td>1112</td>
<td>1013</td>
<td>1088</td>
<td>1256</td>
<td>1182</td>
<td>1329</td>
<td>1087</td>
<td>NS</td>
</tr>
<tr>
<td>1999</td>
<td>823</td>
<td>1265</td>
<td>1080</td>
<td>957</td>
<td>1018</td>
<td>1152</td>
<td>1337</td>
<td>1348</td>
<td>988</td>
<td>123</td>
</tr>
<tr>
<td>2000</td>
<td>613</td>
<td>658</td>
<td>740</td>
<td>575</td>
<td>740</td>
<td>636</td>
<td>792</td>
<td>694</td>
<td>679</td>
<td>NS</td>
</tr>
<tr>
<td>2001</td>
<td>1034</td>
<td>1085</td>
<td>1188</td>
<td>888</td>
<td>1148</td>
<td>942</td>
<td>1302</td>
<td>930</td>
<td>1151</td>
<td>201</td>
</tr>
<tr>
<td>2002</td>
<td>451</td>
<td>363</td>
<td>391</td>
<td>498</td>
<td>410</td>
<td>522</td>
<td>456</td>
<td>415</td>
<td>460</td>
<td>NS</td>
</tr>
<tr>
<td>2003</td>
<td>441</td>
<td>385</td>
<td>366</td>
<td>577</td>
<td>414</td>
<td>588</td>
<td>328</td>
<td>401</td>
<td>267</td>
<td>89</td>
</tr>
<tr>
<td>2004</td>
<td>955</td>
<td>1546</td>
<td>1342</td>
<td>1196</td>
<td>1433</td>
<td>1419</td>
<td>1295</td>
<td>1370</td>
<td>1380</td>
<td>204</td>
</tr>
<tr>
<td>Mean</td>
<td>819.7</td>
<td>1017.6</td>
<td>971.9</td>
<td>929.6</td>
<td>966.5</td>
<td>981.5</td>
<td>1018.1</td>
<td>1014.1</td>
<td>930.8</td>
<td>-</td>
</tr>
</tbody>
</table>

Treatments: T1: Control; T2: Recommended fertilizer dose (RFD); T3: Half RFD; T4: Groundnut shells (GNS) 4 t/ha; T5: Farmyard manure (FYM) 4 t/ha; T6: T3 + T4; T7: T3 + T5; T8: RFD + zinc sulphate; T9: FYM 5 t/ha; T10: T2 + T4
CD = Critical difference; NS = Not sown.

Bio-fertilizers: Experiments conducted for three years at Anantapur revealed that addition of bio-fertilizers did not influence the yield of groundnut (Table 9). It was concluded that application of bio-fertilizers under rainfed conditions may not be useful for groundnut production in this district.

Intercultivation

Normally, intercultivation or ploughing between crop rows to kill weeds is needed to keep the crop weed free. This is done twice, at 25 and 35 days after sowing (DAS). Most farmers use an animal drawn four-typed blade harrow, locally known as 'metla guntaka', which is a labor intensive and time consuming
Table 6. Effects of long term Integrated Nutrient Management on the physio-chemical properties and available nutrients of soil.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>pH</th>
<th>EC (dS/m)</th>
<th>OC (%)</th>
<th>Available nutrients (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P</td>
</tr>
<tr>
<td>T1 Control</td>
<td>6.2</td>
<td>0.024</td>
<td>0.32</td>
<td>9.7</td>
</tr>
<tr>
<td>T2 Recommended fertilizer dose</td>
<td>5.7</td>
<td>0.069</td>
<td>0.20</td>
<td>55.3</td>
</tr>
<tr>
<td>(RFD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3 Half RFD</td>
<td>5.8</td>
<td>0.038</td>
<td>0.21</td>
<td>42.5</td>
</tr>
<tr>
<td>T4 Groundnut shells (GNS) @ 4 t/ha</td>
<td>5.9</td>
<td>0.031</td>
<td>0.29</td>
<td>18.9</td>
</tr>
<tr>
<td>T5 Farmyard manure (FYM) @ 4 t/ha</td>
<td>7.3</td>
<td>0.082</td>
<td>0.60</td>
<td>38.8</td>
</tr>
<tr>
<td>T6 T3 + T4</td>
<td>5.6</td>
<td>0.042</td>
<td>0.34</td>
<td>44.0</td>
</tr>
<tr>
<td>T7 T3 + T5</td>
<td>7.0</td>
<td>0.084</td>
<td>0.43</td>
<td>54.5</td>
</tr>
<tr>
<td>CD (0.05)</td>
<td>0.3</td>
<td>0.03</td>
<td>0.06</td>
<td>12.5</td>
</tr>
<tr>
<td>T8 T2 + ZnSO₄ 50 kg/ha (once in 3 years)</td>
<td>5.5</td>
<td>0.051</td>
<td>0.26</td>
<td>59.7</td>
</tr>
<tr>
<td>T9 FYM @ 5 t/ha</td>
<td>7.4</td>
<td>0.096</td>
<td>0.52</td>
<td>43.2</td>
</tr>
<tr>
<td>CV%</td>
<td>2.8</td>
<td>17.6</td>
<td>10.0</td>
<td>18.5</td>
</tr>
<tr>
<td>Initial values (1985)</td>
<td>6.6</td>
<td>0.15</td>
<td>0.25</td>
<td>19.2</td>
</tr>
</tbody>
</table>

EC (dS/m) = Electrical Conductivity (Desi Siemens/meter)
OC = Organic Carbon
P = Phosphorus
K = Potash

Table 7. Effects of soil test based fertilizer application on groundnut yield at Rekulakunta village during kharif, 2004*.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pod yield (kg/ha)</th>
<th>Haulm yield (kg/ha)</th>
<th>No. of matured pods/plant</th>
<th>Shelling (%)</th>
<th>Test weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer based on soil test value</td>
<td>1699</td>
<td>2963</td>
<td>10.9</td>
<td>76.4</td>
<td>34.7</td>
</tr>
<tr>
<td>Local practice (1 bag of Di-ammonium phosphate of 50 kg)</td>
<td>1723</td>
<td>3010</td>
<td>11.3</td>
<td>76.8</td>
<td>36.0</td>
</tr>
</tbody>
</table>

* All statistics are mean of 14 trials.
Table 8. Effects of soil amendments on the soil's physical properties and yield of groundnut*.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Soil crust strength (kg/cm²)</th>
<th>Infiltration rate (mm/minute)</th>
<th>Water holding capacity (%)</th>
<th>Pod yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1: Control</td>
<td>1.36</td>
<td>12.5</td>
<td>29.9</td>
<td>761</td>
</tr>
<tr>
<td>T2: Sand @ 40 t/ha once in two years</td>
<td>1.27</td>
<td>14.0</td>
<td>30.5</td>
<td>870</td>
</tr>
<tr>
<td>T3: Gypsum @ 2 t/ha + FYM @ 5 t/ha every year</td>
<td>1.16</td>
<td>15.0</td>
<td>31.4</td>
<td>969</td>
</tr>
</tbody>
</table>

*All statistics are mean of 3 years.

Table 9. Effects of bio-fertilizers on groundnut yield.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Pod yield (kg/ha)</th>
<th>Haulm yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1: Control</td>
<td>370</td>
<td>1979</td>
</tr>
<tr>
<td>T2: NPK</td>
<td>537</td>
<td>2309</td>
</tr>
<tr>
<td>T3: Rhizobium @ 500 g/ha + PSB @ 500 g/ha</td>
<td>539</td>
<td>1822</td>
</tr>
<tr>
<td>T4: Rhizobium + Phosphate solubilizing bacteria (PSB) + NPK</td>
<td>537</td>
<td>2563</td>
</tr>
<tr>
<td>C D (5%)</td>
<td>104</td>
<td>343.7</td>
</tr>
</tbody>
</table>

device. Instead, the tractor drawn mechanical sweep developed by ANGRAU can be used to complete the task faster where labor and bullock power are constraints (4 to 5 ha in a day).

Alternately, weeds can also be controlled by herbicides effectively. Pendimethalin (Stomp) 2 to 2.5 l/ha as pre-emergence application or butachlor (Matchet) 2.5 to 3 l/ha as a pre-emergence application also effectively controls most broad leaved weeds.
Water management

**Polythene film mulching:** Field experiments were conducted in the late kharif seasons of 1998 and 1999, with polythene film as mulch on raised and flat beds. It was found that there was an increase of 22.8% in raised beds with mulch and 75.9% in flat beds with mulch over control. This was mostly due to conservation of soil moisture with mulch in the root zone area (Table 10).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>1998</th>
<th>1999</th>
<th>Mean</th>
<th>1998</th>
<th>1999</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raised bed with mulch</td>
<td>2496</td>
<td>1980</td>
<td>2238</td>
<td>2542</td>
<td>1619</td>
<td>2081</td>
</tr>
<tr>
<td>Raised bed without mulch</td>
<td>2421</td>
<td>1225</td>
<td>1823</td>
<td>2457</td>
<td>1497</td>
<td>1977</td>
</tr>
<tr>
<td>Flat bed with mulch</td>
<td>4050</td>
<td>2580</td>
<td>3315</td>
<td>4700</td>
<td>2059</td>
<td>3380</td>
</tr>
<tr>
<td>Flat bed without mulch</td>
<td>2067</td>
<td>1703</td>
<td>1885</td>
<td>4020</td>
<td>2383</td>
<td>3177</td>
</tr>
<tr>
<td>SE m ±</td>
<td>220</td>
<td></td>
<td></td>
<td>266</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD 5%</td>
<td>678</td>
<td></td>
<td></td>
<td>NS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Water harvesting and irrigation in rainfed crop:** Water harvesting and supplementary irrigation was found feasible and increased pod yield by 20-40% (Table 11). The optimum size of a farm pond is 10 mx 10 m x 2.5m and can store about 2 lakh liters of runoff water. Supplementary irrigation with stored runoff water through sprinkler systems with a quantity of 10 mm for duration of one hour is sufficient to restore crop vigor particularly during pod maturity stages. This is usually necessary if the dry spell lasts longer than 10 days.

To avoid seepage and losses from storage ponds, different lining materials like Kadapa slabs, sodic soil, cement + bricks, cement + cement bricks and cement + soil (1:8) were tested at ARS, Anantapur. Of these, lining with cement + soil (1:8) proved to be more effective and economical (Table 12).

**Irrigated rabi crop:** Groundnut needs 400-450 mm of water every season. In light textured soils, 8-9 irrigations are necessary. The pod filling stage is the most critical stage for moisture. Weekly irrigation from 60-80 days helps obtain higher pod yields.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Rainfed</th>
<th>With supplementary irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filled pods/m²</td>
<td>50</td>
<td>153</td>
</tr>
<tr>
<td>100-pod weight (g)</td>
<td>43</td>
<td>45</td>
</tr>
<tr>
<td>Shelling (%)</td>
<td>68</td>
<td>69</td>
</tr>
<tr>
<td>Pod yield (kg/ha)</td>
<td>315</td>
<td>698</td>
</tr>
<tr>
<td>Haulm yield (kg/ha)</td>
<td>1250</td>
<td>1843</td>
</tr>
</tbody>
</table>

Table 12. Cost of farm ponds with different lining materials.

<table>
<thead>
<tr>
<th>Lining material</th>
<th>Cost (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kadapa slabs</td>
<td>25000</td>
</tr>
<tr>
<td>Sodic soil</td>
<td>8000</td>
</tr>
<tr>
<td>Cement + bricks</td>
<td>25000</td>
</tr>
<tr>
<td>Cement + cement bricks</td>
<td>25000</td>
</tr>
<tr>
<td>Cement + soil (1:8)</td>
<td>10000</td>
</tr>
</tbody>
</table>

Recommended pest management practices

**Red hairy caterpillar**

- Deep ploughing to expose and kill pupae during the hot summer months (March to June).
- Adults can be trapped by using light traps or setting up of bonfires in the fields two days after rain from 8.00 to 10.00 pm. As a supportive measure, a pan filled with either soap water/kerosene may be set up below the light source to kill the adults.
- Dusting of folidol around the light traps on the ground and on field bunds to destroy the early instar larvae.
- Vegetative trapping of larvae by sowing trap crops like cowpea, greengram and castor, and dusting with folidol after observing initial scrapings on leaves of trap crops.
- Poison baiting to control grown up larvae by using 10 kg of rice bran mixed with one kg of jaggery and one litre of quinalphos.
**Leaf webber**

- Application of quinalphos @ 2 ml/l at the first and second instar.
- After web formation, application of monocrotophos @ 1.6 ml/l or chlorpyriphos @ 2 ml/l of water is recommended after larvae have been exposed by drawing a thorny bush across the crop.

**Late leaf spot**

- Late leaf spot can be reasonably predicted three days in advance based on leaf moisture. Fungicidal spraying can be taken up after this.
- One spray at 70 DAS with 1 g of carbendazim + 2 g of mancozeb/l of water effectively controls late leaf spot for Anantapur and Kurnool districts where medium duration types are grown.
- Other chemicals like chlorothalonil @ 2 g/l or hexaconazole @ 2 ml/l at 70 DAS are effective.

**Peanut Stem Necrosis Disease (PSND)**

- Removal of weed hosts like Parthenium before flowering.
- Seed treatment with Imidacloprid @ 1.0 ml/kg of seed.
- Border cropping with maize, sorghum or pearl millet reduce incidence of the disease.

**Harvesting**

With draught power dwindling, the tractor-drawn ANGRAU blade 'guntaka' (SWEEP) can be used to harvest groundnut. The *guntaka* can cover four rows at a time and harvests 4-5 ha a day. The cost of the unit is Rs 6000/- and the cost of operation is Rs 500/ha. Harvesting operation done at the right time helps avoid loss of pods in the field.

**Threshing and decorticating**

A groundnut thresher can be used for stripping groundnut pods mechanically. The thresher has high stripping capacity of 200 to 300 kg per day. The cost of operation is about Rs 33/q of pods. It was found advantageous to thresh the crop immediately after harvest ie, within five days after harvest as the threshing and cleaning efficiency is high (Table 13). The thresher can be used also as decorticator by changing the cylinder and sieve. It can decorticate upto 3 to 4 tons of groundnut pods a day.
### Table 13. Performance of the peg type groundnut thresher.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Moisture content (% w.b)</th>
<th>Threshing efficiency (%)</th>
<th>Cleaning efficiency (%)</th>
<th>Broken (%)</th>
<th>Capacity (ha/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>38.36</td>
<td>96.65</td>
<td>98.08</td>
<td>10.07</td>
<td>0.25</td>
</tr>
<tr>
<td>T2</td>
<td>30.57</td>
<td>95.92</td>
<td>99.00</td>
<td>16.18</td>
<td>0.23</td>
</tr>
<tr>
<td>T3</td>
<td>19.16</td>
<td>96.44</td>
<td>98.43</td>
<td>15.77</td>
<td>0.25</td>
</tr>
<tr>
<td>T4</td>
<td>15.45</td>
<td>89.89</td>
<td>97.50</td>
<td>12.16</td>
<td>0.33</td>
</tr>
<tr>
<td>T5</td>
<td>11.86</td>
<td>92.34</td>
<td>93.33</td>
<td>12.08</td>
<td>0.20</td>
</tr>
<tr>
<td>T6</td>
<td>10.62</td>
<td>96.90</td>
<td>92.00</td>
<td>10.70</td>
<td>0.20</td>
</tr>
<tr>
<td>T7</td>
<td>10.12</td>
<td>96.11</td>
<td>96.67</td>
<td>18.78</td>
<td>0.23</td>
</tr>
</tbody>
</table>

T1: 1st day after harvest; T2: 3rd day after harvest; T3: 5th day after harvest; T4: 10th day after harvest; T5: 15th day after harvest; T6: 13th day after harvest; T7: 14th day after harvest.

**Storage:** Groundnut pods with 8% moisture can be stored in gunny bags @ 40 kg/bag. Cleaning and removal of ill filled and immature pods aids safe storage. The bags must be laid on the wooden dunnages for free aeration. Bags should be laid in a crisscross manner, a little distance from side walls and the heap height must allow a clearance of three feet to the roof. Periodical cleaning of the walls and bag surfaces at weekly intervals reduces the damage from storage pests. Aflatoxin contamination can be avoided by removal of damaged and ill filled pods. If storage pests like bruchids are noticed, it is recommended to spray the bags with Malathion @ 2 ml/1 of water or place celphos tablets with the bags.
**Integrated management of groundnut fungal diseases**

S Pande¹, G Krishna Kishore² and J Narayana Rao³

**Introduction**

Groundnut (*Arachis hypogaea* L.) is grown in 8.2 million ha in India, with a production of 6.2 million tons annually. It contributes 29% of the total oilseed production. Average pod yield of groundnut in India is less than 1000 kg/ha compared to 2650 kg/ha or more in developed countries. Groundnut diseases are caused by more than 100 fungal, viral and nematode pathogens, and these are the biotic constraints that limit pod and haulm yield in this crop (Pande et al. 1996). Economically important fungal diseases of groundnut in the Deccan Plateau are early leaf spot (ELS), late leaf spot (LLS), rust, collar rot, stem rot, aflatoxin contamination and bud necrosis (Table 1). These diseases are reported from all groundnut-growing areas of the country, and distribution of these diseases along with bud necrosis/stem necrosis is presented in Figures 1 and 2.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Causal organism</th>
<th>Yield losses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fungal diseases</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early leaf spot</td>
<td>Cercospora arachidicola</td>
<td>10-50%</td>
</tr>
<tr>
<td>Late leaf spot</td>
<td>Phaeoisariopsis personata</td>
<td>10-50%</td>
</tr>
<tr>
<td>Rust</td>
<td>Puccinia arachidis</td>
<td>10-50%</td>
</tr>
<tr>
<td>Collar rot</td>
<td>Aspergillus niger</td>
<td>5-10%</td>
</tr>
<tr>
<td>Stem and pod rot</td>
<td>Sclerotium rolfsii</td>
<td>10-20%</td>
</tr>
<tr>
<td>Aflatoxin contamination</td>
<td>Aspergillus flavus</td>
<td>*</td>
</tr>
<tr>
<td><strong>Viral diseases</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peanut bud necrosis</td>
<td>Tomato spotted wilt virus</td>
<td>10-20%</td>
</tr>
<tr>
<td><strong>Nematode disease</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root-knot</td>
<td>Meloidogyne arenaria, M. incognita</td>
<td>5-10%</td>
</tr>
</tbody>
</table>

* Aflatoxin contamination mainly causes qualitative losses of yield and quantitative losses in market and trade, in addition to human health hazards. Yield losses due to preharvest aflatoxin contamination are reported to 10-30% and can be greater depending on the climate.

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Fig. 1. Distribution of economically important diseases of groundnut in India.

Fig. 2. Distribution of potentially important diseases of groundnut in India.
Disease management practices and IDM

Definition and concept

Integrated Disease management (IDM) as a part of Integrated Pest Management (IPM) is defined by the Office of Technology Assessment, USA, as "the optimization of disease control measures in an economically and ecologically sound manner, accomplished by the coordinated use of multiple tactics to assure stable crop production and to maintain pathogen damage below the economic injury level whilst minimizing hazards to humans, animals, plants and the environment" (Jeger 2000). The major characteristics of IDM technology are: (a) cost-effectiveness, (b) reduced fungicide usage, (c) environment friendliness and (d) long term sociological benefits in terms of employment and public health.

Disease management practices of groundnut mostly vary from no-input to moderate use of fungicides. The exploitation of host plant resistance (HPR) is not significant. IDM technology includes a judicious use of fungicides, host plant resistance, biocontrol agents and recommended cultural practices. Reducing costs associated with disease management in groundnut production systems in India will become increasingly important due to changes in federal legislation that reduced support prices and removed the escalator provision. The number of groundnut growing farmers adopting IDM technology is not very large, and there is an urgent need to educate more farmers about the adoption, benefits and economic returns of IDM technology. In this paper, we emphasize the available options for management of economically important fungal diseases of groundnut in order to design an effective IDM package. Further, on-farm attempts for effective and economical disease control using a rational combination of different available management strategies are presented.

Integrated management of groundnut foliar fungal diseases

The occurrence and severity of foliar diseases, ELS, LLS and rust, largely depends on the genotype, available inoculum, geographical region and mainly on epidemiological factors during the crop season. When weather conditions are conducive, foliar diseases cannot be managed by any one of the available options; hence, location specific IDM is essential to protect the crop and obtain economic yield. Also, the non-availability of desired levels of host plant resistance in cultivated genotypes necessitates an integrated approach for foliar diseases control. Various components identified for foliar diseases management are:

Host plant resistance (HPR). Groundnut cultivars currently in use by farmers are susceptible to foliar diseases and varieties that combine desirable levels
of disease resistance and agronomic traits are scarce. A world collection of
groundnut germplasm from 92 countries (>14,000 accessions) and advanced
breeding material (>400 accessions) wild species were screened for foliar disease
resistance at ICRISAT. The large-scale screening resulted in identification of
wild accessions with high and moderate levels of resistance (Subrahmanyam
et al. 1995). Attempts have been made to transfer disease resistance traits
into the most popular genotypes through breeding programs and more than 20
genotypes have been released in India. High levels of resistance to LLS and rust
were identified in wild Arachis spp. (Pande and Rao 2001) and continued efforts
are being made to transfer genes from wild Arachis to cultigens. Among the
breeding lines, ICGV 91114, a short duration dual-purpose, IDM-responsive
genotype was found suitable and acceptable to most farmers in the Deccan
Plateau (Pande et al. 2001).

**Chemical control.** Fungicides such as carbendazim, chlorothalonil, tridemorph
and mancozeb, either alone or in combination had a high potential to control
foliar diseases of groundnut (Reddy 1982; Sawant 2000; Culbreath et al.
2002). These fungicides should be applied @ 500 l of spray fluid/ha at a regular
interval of 15 days starting from 45 days after sowing (DAS) until harvest.
Nutritional management was also observed to have an effect on the chemical
control of leaf spot diseases. Application of mancozeb along with nitrogen-
phosphorus-potassium (NPK) and farmyard manure was found more effective
than mancozeb alone and NPK + mancozeb (Bag et al. 2000).

**Cultural control.** Cultural practices include crop rotation for 2-3 years, phyto
sanitation, adjustment of sowing date to avoid weather conditions favorable
for disease development (Hazarika et al. 2000), row spacing, plant population
densities (Pande and Narayana Rao 2002) and intercropping that retards
the development of foliar diseases. However, these practices have long been
neglected in groundnut cultivation in the Deccan Plateau.

Fungicide trials at ICRISAT indicated that carbendazim @ 1g/l of water
or chlorothalonil @ 2 g/l water at 60-70 DAS (one spray) for early maturing
cultivars and one spray at 60-70 DAS and a repeat 15 days later effectively
controls foliar diseases in groundnut.

**Biological control.** Several mycoparasites affect groundnut. These include
Acremonium obclavatum, Dicyma pulvinata, Fusarium spp., Pencillium spp. and
Verticillium lecanii, parasitizes C. arachidicola, P. personata and P. arachidis
(Podile and Kishore 2002). However, field application of these mycoparasites
is limited by their poor survival in the phylloplane.

A chlorothalonil-tolerant *Pseudomonas aeruginosa* GSE 18, when applied
in combination with chlorothalonil reduced the effective dose of fungicide
required for LLS control by three times (Kishore et al. 2005a) (Fig. 3).
Plant extracts. Aqueous leaf extracts and oil from *Azadirachta indica* significantly reduced the severity of LLS and rust in field, and these are often comparable to chemical fungicides. Leaf extracts of *Lawsonia inermis*, *Nerium odorum* and *Calotropis* sp. reduced the severity of foliar diseases (reviewed by Podile and Kishore 2002). Limnoids isolated from *A. indica* (Suresh et al. 1997) and a tetranotriterpenoid compound, cedrelone from *Toona ciliata* had potent antifungal activity against *P. arachidis* (Govindachari et al. 2000) and reduced rust pustule emergence effectively.

Aqueous leaf extract of *Datura metel* (DME) and *Lawsonia inermis* completely inhibited the spore germination of *P. personata* and *P. arachidis*. DME was tolerant to high temperatures and retained its antifungal activity up to 180 days at room temperature. DME and *L. inermis* extract significantly reduced the incidence of LLS up to harvest and increased pod yields up to 48.0% (Kishore et al. 2002). The extracts applied in combination with chlorothalonil further improved the disease control and reduced fungicide requirement (Fig. 4).
Integrated management of soil-borne fungal diseases in groundnut

Host Plant Resistance. Host plant resistance against soil-borne fungal diseases, stem rot, collar rot and aflatoxin contaminations has not yet been identified in cultivated genotypes of groundnut. Although several genotypes are reported to possess resistance to seed colonization by A. flavus, seed invasion and/or aflatoxin production, a high level of stable resistance to aflatoxin contamination has not been identified in cultivated groundnut.

Chemical control. Chemical control of stem rot is expensive and makes the crop uneconomical. Seed treatment with Thiram or Captan @ 2 g/kg is effective in control of both collar rot and reducing A. flavus invasion and subsequent aflatoxin contamination to a certain extent.

Cultural control. Terminal drought during 30-40 days before harvest drastically enhances seed invasion and production of aflatoxins by A. flavus. Avoidance of terminal drought is recommended to reduce its incidence. Also, storage of groundnuts after proper drying with shell moisture content of 10-11% reduces postharvest aflatoxin contamination. Other cultural practices including crop rotation for 2-3 years with non-host crops, use of apparently healthy seed
for planting, proper weed control, removal of crop debris from the field after harvest reduces the inoculum build up and subsequent infection by *A. flavus*, *A. niger* and *S. rolfsii*.

Biological control. *Trichoderma* spp. has been identified as a potent biocontrol agent of collar rot and stem rot in controlled environments and to a limited extent in the field (Podile and Kishore 2002). Fungicide tolerant *P. aeruginosa* GSE 18 was identified for its suitable application along with Thiram for improved control of collar rot (Kishore et al. 2005b).

**Conclusion**

Integrated management of foliar diseases is essential for cost-effective production of groundnut. More economical components of IDM such as biological control and use of plant extracts need to be encouraged in addition to host plant resistance and chemical control. Further details on the epidemiology, plant age, fertilizer application and cultural practices on foliar diseases severity will be helpful in designing disease prediction models. Also, pathogen variation in aggressiveness and virulence exists and should be considered in developing disease management strategies and simulation models. A combination of disease further enhances the scope of IDM technology. Estimation and popularization of the economic impacts of IDM technology is also of equal importance for large-scale adoption of IDM technology by resource-poor farmers. Free international exchange of genetic resources facilitates the access of genetic material to researchers across the world and to use the resistance sources to develop disease resistant breeding lines. Application of transgenic plant technology has enormous potential to increase disease resistance and also to improve other quality traits of groundnut. For the present time, IDM of groundnut diseases using a combination of available host plant resistance and rational use of fungicides is desirable.

**References**


Groundnut diseases and their management

K Subrahmanyam

Groundnut cultivation in Andhra Pradesh, particularly in the district of Anantapur, plays a major economic role in the lives of resource-poor farmers. Nearly 800000 ha is under groundnut cultivation in the district. It provides not only high quality cooking oil and also nutritious fodder for cattle. It is well known that this crop is attacked by several pathogens. The economic damage occurs not only through losses in pod and fodder yields but also due to low quality of crop residue, which is caused by these diseases and which drastically reduces the digestibility of fodder. So, it is essential to understand the economic importance of these diseases and their control measures in order to obtain higher quality and quantity of residues.

Crown rot (*Aspergillus niger*)

Moisture deficit stress favors this disease and it shows up 30 days after sowing. The fungus causes both seed and seedling rot, resulting in low plant stand. Rotting seeds are usually covered with black masses of spores. Infected seedlings rapidly wilt and die with black spores at the collar region and at cotyledons.

**Control measures**

Collecting and burning diseased plants is the best way to reduce the incidence of crown rot in the soil. Seed treatment with Thiram or Captan @ 2.5 g/kg seed reduces disease incidence.

Stem and pod rot (*Selerotium rolfsii*)

This disease occurs from the seedling to maturity stages of the crop. Undecomposed organic matter create favorable conditions for the disease. The fungus attacks the plants at the collar region and kills the plant or a few lateral branches. The fungus also attacks stems and pods. A whitish mycelial growth is seen around affected stems. Infected pods show brown colored lesions and get left in the soil when the crop is lifted at maturity.

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**Control measures**

Deep ploughing in the summer to eradicate viability of sclerotia. The removal and destruction of the affected plants helps in reducing the inoculum of the fungus. Seed treatment with Captan @ 2.5 g/kg seed reduces disease incidence.

**Late leaf spot** (*Phaeoisariopsis personata*)

Generally, late leaf spot appears as black circular spots on leaves, around 60 days after sowing. Low temperature around 25°C and intermittent leaf wetness create favorable conditions for the disease. Under favorable conditions, the leaves defoliate leaving the bare stems. Under severe conditions, elongated lesions are also observed on stems.

**Control measures**

Removal and burning of diseased plants greatly helps control this disease. Use of disease resistant/tolerant cultivars along with an IDM package that includes one sprays at 60-75 days and followed by another after 15 days, Kavach @ 2 g/l of water or Bavistin @ 1 g/l of water and 200 l of spray fluid/acre. For early maturing cultivars like ICGV 91114, a spray at 65-70 days after sowing (DAS) controls the disease.

**Rust** (*Puccinia arachidis*)

Generally, the disease appears at 60-75 DAS along with LLS. The fungus produces orange or brown color pustules on the underside of the leaf. These pustules coalesce and the leaves become dry and remain attached to the stem. The chlorophyll content of leaf is lost and photosynthesis is affected resulting in early maturity of the crop.

**Control measures**

Since the pathogen survives on groundnut plants, removal and burning of volunteer plants is necessary. Wherever possible, it is advisable to use resistant varieties like ICGV 89104, ICGV 91114, ICGV 92020 and ICGV 92093. Apply Kavach @ 2 g/l of water, or claxin @ 0.5 ml/l of water and spray 200 l of the chemical solution per acre.

**Bud Necrosis (Peanut bud necrosis virus)**

This is a virus disease that spreads through thrips. Affected plants remain bushy and stunted in growth. Initial symptoms appear in the young tender leaves below the terminal bud; later the terminal bud becomes necrotic and rots. If
the disease occurs within one month after sowing, the whole plant dies. Leaflets produced on auxiliary shoots are reduced in size, mosaic with chlorosis.

Control measures
Control of this disease is helped by maintaining optimum plant stand in the field. Intercropping with fast growing cereal crops like sorghum to avoid free movement of thrips is also conducive. The use of resistant cultivars such as ICGVs 86029, 86030, 86031 reduce losses caused by this disease.

Stem Necrosis (Tobacco streak virus)
Stem necrosis is also a virus disease and is transmitted through thrips. The disease appears as black necrotic spots on young leaves. These later extend to petioles, stems and to the growing bud resulting in the death of the vegetative buds. If the disease occurs within 30 days of sowing, the stem becomes necrotic and the plant dies. In adult plants, the proliferation of branches appear at leaf axils and the leaves on these branches are reduced in size and appear chlorotic.

Control measures
The virus survives on several weeds and sunflower plants. Parthenium is a major host for this virus. Removal of parthenium on bunds and in the field helps reduce disease incidence. Optimum plant stand in the field is also recommended and intercropping with fast growing cereal crops like sorghum to avoid free movement of thrips is beneficial.
Groundnut aflatoxin and its management

Farid Waliyar\textsuperscript{1} and S Veera Reddy\textsuperscript{2}

Many agricultural commodities including cereals, oilseeds, spices and fruit nuts are vulnerable to infestation by fungi that produce secondary toxic metabolites called aflatoxins. \textit{Aspergillus flavus} and \textit{A. parasiticus} produce aflatoxin B\textsubscript{1}, B\textsubscript{2}, G\textsubscript{1} and G\textsubscript{2} in groundnut. Aflatoxin contamination in groundnut is a serious problem in groundnut growing areas of the world. Toxicologically, aflatoxins particularly aflatoxin B\textsubscript{1} (AFB\textsubscript{1}) is regarded as a quadruple threat, ie, as a potent toxin, a carcinogen, a mutagen and as an immuno-suppressive chemical entity. Aflatoxin contamination in groundnut has gained global significance due to its deleterious effects on human and animal health and its importance to international trade. According to Charmley et al. (1994), 25\% of the world’s food crops are affected by mycotoxins each year and groundnut suffered a loss of $26 million in the USA alone. In groundnut, \textit{A. flavus} infection and aflatoxin contamination occur at preharvest and postharvest stages and during storage.

\section*{Effects of aflatoxin}

\textbf{Plant health.} The quality of groundnut kernels deteriorates due to \textit{A. flavus} infection. Severely mold-affected kernels become unfit for consumption. The fungus can cause pre-emergence of seed rot in the soil and aflatoxin causes afla-root disease in young seed and lyso appear stunted with small pointed leaves.

\textbf{Human health.} AFB\textsubscript{1} induces liver cancer in several animal species, and has also been linked to liver cancer in human beings (Wang et al. 1996). Statistical correlations between contaminated food supplies and high frequencies of human hepatocellular carcinomas in Africa and Asia have implicated aflatoxins as risk factors in human liver cancer. All epidemiological studies of aflatoxins and liver cancer conducted in Africa and Asia involving populations subjected to hepatitis B virus (HBV) infection indicates possible synergistic effect of aflatoxins and HBV infection in the etiology of liver cancer (Montesano et al. 1997; Groopman and Kensler 1996). Aflatoxin causes impaired growth in children, notably in Africa and childhood cirrhosis in India. One of the most important accounts of aflatoxicosis in humans occurred in 150 villages in northwest India in the fall of 1974. About 397 persons were affected and 108 persons were reported to

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have died in the outbreak, due to contaminated corn, where aflatoxin levels of 0.25 to 15 mg/kg were found. Recently, about 120 people died in Kenya due to intake of aflatoxin-contaminated maize.

**Livestock health.** All animal species are susceptible to aflatoxicosis, although sensitivity varies considerably from species to species. For example, birds, fish, dogs, and swine appear to be more susceptible than mature cattle. In poultry, besides fatty liver and kidney disorders, leg and bone problems can develop as well as outbreaks of coccidiosis. Aflatoxins may cause vaccines to fail, increase birds' susceptibility to disease resulting in suppression of the natural immunity to infection. Animals become susceptible to infection by bacteria such as *Salmonella* and to various viruses and other infectious agents commonly found around the farmyard, feedlot or poultry house that normal healthy animals ward off. Decreased blood clotting results in a greater downgrading and condemnation of birds because of massive bleeding and bruises. Less carcass pigmentation is exhibited and egg yolks become pale. The hatchability of eggs can drop, and reduced production may be noted as well as smaller eggs with shell problems. Growth is restricted and mortality increases, especially during the growing period.

Several outbreaks of aflatoxicosis in cattle have been reported. The lesions were confined mainly to the liver, showing degenerative changes with biliary proliferation and finally leading to diffuse cirrhosis. Regular or occasional consumption of feed containing aflatoxin in the range of less than 100 parts per billion (ppb) to a few hundred parts per million (ppm) by farm animals result in decreased feed consumption, poor feed conversion, stunting and decreased flesh growth. Decreased productivity may be accompanied by damage to the liver, hemorrhaging into the muscles or body cavities, and suppression of natural immunity. Once the damage has been done the animal cannot fully recover, even if returned to a toxin-free ration.

**Aflatoxin in milk.** Aflatoxin M1 (AFM1) is major metabolite of aflatoxin B1 found in milk of animals that have consumed feeds contaminated with aflatoxin B1. Toxic and carcinogenic effects of AFM1 have been convincingly demonstrated in laboratory animals and therefore AFM1 is classified as class 2B human carcinogen. AFM1 is relatively stable during pasteurization, storage and preparation of various dairy products; and therefore AFM1 contamination poses a significant threat to human health especially to children, who are major consumers of milk. Analysis of milk samples from different regions of Andhra Pradesh indicated that AFM1 contamination was greater in peri-urban samples than rural samples. The major feed ingredients for cattle in peri-urban areas of Hyderabad city are cotton cake, groundnut cake, rice bran and straw. A majority of cotton and groundnut cake samples contained aflatoxin levels exceeding 500 µg/kg. In rural areas of Anantapur, the majority of farmers feed their animals with green grass, straw, groundnut and haulms. Groundnut haulms with small pods were found to contain high levels of aflatoxins.
International trade
Since aflatoxins affect human as well as animal health, countries importing relevant commodities have imposed regulations on permissible limits, ie, 4 to 50 µg/kg of aflatoxin in food and feeds. The economic implications of aflatoxin and its potential health threat to human as well as livestock clearly created a need to eliminate or reduce aflatoxins contamination in food and feed.

Management
Aflatoxin management options include:
• Resistant cultivars
• Cultural practices
• Biological control
• Integrated management

Resistant cultivars. The best way to control or reduce aflatoxins contamination is by growing resistant cultivars. Unfortunately cultivars with good agronomic background, resistant to aflatoxin contamination are not available. Fourteen aflatoxin resistant/tolerant groundnut lines were tested through the farmer participatory approach in Anantapur and Chittoor districts, Andhra Pradesh. Two varieties, ICGVs 94379 and 94434, produced 25-40% higher pod yield in farmer fields with comparatively lesser aflatoxin contamination than local cultivars.

Cultural practices. Cultural practices such as summer ploughing, sowing at the right time, seed treatment with Mancozeb and chloropyriphos, gypsum application, removal of premature dead plants, managing pest and diseases, harvesting at the right time, quick pod drying, controlling storage pests and storing the pod/seed with <10% moisture help reduce aflatoxin contamination.

Biological control. Various bio-control agents such as non-toxigenic Aspergillus flavus, Trichoderma viride, Trichoderma harzeanum were reported to be effective in reducing the seed infection by A. flavus and aflatoxin contamination. Application of Trichoderma viride, a bio-control agent along with the cultural practices is effective in reducing A. flavus population in soil upto 65%, seed infection up to 75% and aflatoxin contamination upto 80% in on-farm trials.

Integrated management. Integration of host plant resistance with cultural practices and bio-control agents helps minimize A. flavus seed infection and reduce aflatoxin contamination in groundnut. Currently, trials on integrated management are in progress.
References


Insect pests are one of the main constraints that affect groundnut productivity. Among the several insects attacking groundnut, only a few are economically important. Depending upon how they feed on groundnut foliage, they are grouped as: (i) leaf eating insects, (ii) sucking insects and (iii) those attacking roots and pods. Red hairy caterpillar, semi-looper and leaf miner belong to the first category. Thrips, jassids, aphids and mites are important sucking pests, while white grubs and termites cause severe damage to roots and pods. However, they are very sporadic in nature.

**Red hairy caterpillar (Amsacta albistriga)**

This is a highly sporadic pest and can be devastating. The moth has brown striped wings on a white body. These insects diapause in their pupal stage in the soil and they emerge soon after the first showers in June/July. They also lay eggs on weeds and ber (Ziziphus spp.) plants on the field bunds and boundaries. Each female lays about 500 to 1500 eggs on the underside of the leaflets.

**Control measures**

- Deep tillage in summer exposes diapausing pupae, which are killed due to solarization. The exposed insects also become prey to birds.
- In case deep ploughing is not done, the adults come out roughly 48 hours after the first rain. To counter this, bonfires must be lit in the evening between 7 pm and 10 pm: this causes the adult moths (which are attracted to the fire) to perish in large numbers. Farmers ideally must come together and light bonfires in pre-arranged places for maximum efficiency. Insects that may not have perished must be handpicked and destroyed. On the following morning, it is recommended to keenly observe the leaves of plants in the surrounding areas and destroy egg clusters that may have been missed. These measures succeed in limiting damage by the red hairy caterpillar by upto 90%.
- Neem oil can also be sprayed within three days of egg laying because the eggs hatch in 3-4 days. Farmers must take care to destroy eggs not only on groundnut leaves but also on weeds and bushes. Infestation tends to appear like a patch of starch on a white cloth, and eggs and small insects can be

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seen under the leaf. If this is observed on groundnut leaves, it indicates that infestation of the crop has begun. Even so, in early stages, infected leaves can be handpicked and destroyed.

- As a last alternative, common pesticides like quinalphos or monocrotophos can be sprayed (2ml/l and 200 1 spray fluid/acre) when the insect is very small (1-2 instar). Beyond this stage, it is difficult to control the insect as the larvae develop a lot of hair preventing the insecticide coming into contact with their skin. Once the 3rd instar stage is crossed, handpicking of caterpillars is the only way to save the crop. Also, a plough furrow around the field filled with insecticidal dust (Folidol 2%) will prevent migration of the insect from field to field.

**Semilooper (Plusia spp.)**

This insect also lays its eggs in masses. The integrated crop protection methods to combat this insect are well known and greatly contribute to its control in the early stages. Once the larvae grow bigger, however, the pest is difficult to control.

**Leaf miner (Aproaerema modicella)**

This species is the biggest pest of groundnut in many parts of southern India. The adult is a brownish grey moth. Shiny white eggs are laid singly, usually on the under surface of leaflets. Each female moth can lay upto 200 eggs. The young larvae mine into the leaves as soon as they hatch. When the mine is opened, the minute caterpillar inside become visible. When the larvae become too large to occupy the mine, they emerge and web adjacent leaflets together and continue to feed on leaf tissue from inside. A severely attacked field looks 'burnt' from a distance. Epidemics can result in total crop loss.

**Control measures**

Insecticides, preferably dimethoate @ 200-250 ml active ingredient/ha or monocrotophos @ 150-200 ml active ingredient/ha -should be applied if clouds of groundnut leaf miner moths are seen flying in the cropped area when disturbed, or as soon as the first mines are noticed. Chemical control is recommended if five or more active larvae/plant are found about 30 days after seedling emergence (DAE), 10 larvae/plant at 50 DAE, or 15 larvae/plant at 75 DAE or later.

The role of natural enemies must be considered before chemical spraying. For instance, if more than 50% of the larvae are parasitized (parasites can seem to appear like minute white specks, no more than 1 mm long, attached to the outside of the larvae), it is advisable to postpone the spray, and closely monitor the development of the pest population.
Mites (Tetranichus spp.)

Mites attack when atmospheric temperature is low. These spear shaped small creatures are seen on leaves, buds and tender stems. When they are tiny, they are light green in color and have a crawling movement. As they grow, they become darker. When the attack is intense, the plant may be invaded by many fungi. As a result, much of the chlorophyll content is reduced, photosynthesis is affected and the growth of the plant is arrested.

Farmers are also advised to look out for ladybird beetles, which are natural predators to mites. The larvae of this beetle looks like a caterpillar and eats the mites. If these beetles are seen in abundance, it might be unnecessary to spray. If they are not in adequate numbers to check mites, however, 2 ml of rogor in 1 l water or 1.6 ml of monochrotophos in 1 l of water can be sprayed.
Session II: Farmers' participatory on-farm Integrated Disease Management in groundnut
Influence of IDM on groundnut yields in the Deccan Plateau, Andhra Pradesh

S Pande, J Narayana Rao, P Lakshmi Reddy and G Krishna Kishore

Introduction

Groundnut (*Arachis hypogaea* L.) is a valuable source of protein and provides high quality cooking oil. Its crop residue (haulm) is widely used as fodder for dairy cattle and buffalo in Andhra Pradesh in the Deccan Plateau. Several diseases influence the quantity (yield) and quality (nutritive value) of groundnut residue.

Among fungal diseases, late leaf spot (LLS) (*Phaeoisariopsis personata*) and rust (*Puccinia arachidis*) - together called foliar diseases - are the major constraints for groundnut production (Pande et al. 2001). Early leaf spot (*Cercospora archidicola*) also attacks the crop and causes severe losses in haulm and pod yield. Important soil-borne fungal diseases that affect the quality and quantity of groundnut haulms and pods include stem and pod rots (*Sclerotium rolfsii*), collar rot (*Aspergillus niger*) and aflatoxin contamination (*Aspergillus flavus*). The incidence of stem and pod rots is increasing alarmingly in groundnut growing areas of this region.

Generally foliar diseases occur together and cause > 70% losses in the quality and quantity of haulms and pods in the region. Increased milk production in peri-urban areas of the Plateau will require greater quantities of higher quality crop residue.

In Andhra Pradesh, groundnut is the second major source (14 million tons) after sorghum of feed for livestock. Approximately 0.8 million ha fall under groundnut production every year in the district of Anantapur. The local variety commonly grown in this district produces very poor quality haulms due to foliar diseases every year. It is believed that disease-affected fodder has low digestibility and fetches lower prices in the fodder markets resulting in substantial reduction in the incomes of the resource-poor farmers (Ramadevi et al. 2000).

Foliar disease management in groundnut often involves indiscriminate use of chemicals or total reliance on host plant resistance. We attempted to develop and validate an effective Integrated Disease Management (IDM) technology.
consisting of a combination of available moderate levels of host plant resistance with high yield background and judicious application of chemical fungicides. Results obtained from on-station IDM trials at ICRISAT-Patancheru indicated that significantly high quantity and quality of haulm and pod yields were obtained from control plots when compared to non-IDM plots (Pande et al. 2003). Healthy or less-diseased haulms were found to be better digested than diseased haulms (Sivaiah et al. 2003).

The objectives of the present study were:
1. To develop economically feasible IDM technology for the management of late leaf spot and rust diseases of groundnut, and
2. To evaluate and promote IDM technology and its components through participatory on-farm research in Anantapur.

Materials and methods

Development of IDM technology

On-station experiments to develop an economically feasible IDM technology package in groundnut was conducted in an Alfisol field at an experimental farm at ICRISAT, Patancheru during 1999-2000. Seven cultivars, ICGVs 89104, 91114, 92267 (early-maturing), 92020, 92093, 94080 (medium-maturing) and TMV 2 (similar to local cultivar) were included in this experiment. The two treatments comprised Integrated Disease Management (IDM) and no management (non-IDM). The design of the experiment was split-plot with treatments as main plots and cultivars as sub-plots with three replications.

The components of IDM studied in these experiments were: improved cultivar with partial resistance to foliar diseases, fungicide seed treatment with a mixture of Bavistin and Thiram (1:1) @ 2 g/kg seed and economical use of one or two foliar applications of fungicide, Kavach, at 60 DAS for early-maturing cultivars (one spray) and one spray each at 60 and 75 DAS for medium-maturing cultivars. None of the inputs of IDM were given to the non-IDM plots. The experiment was repeated twice. At harvest, the dried (50°C) sample haulms from all the cultivars were analyzed for in vitro digestibility by an animal nutritionist.

Severity of foliar diseases (both LLS and rust) was scored at 10-day intervals from 45 DAS till maturity on a 1-9 rating scale where 1 = no disease and 9 = maximum disease, with all leaves defoliated (Subrahmanyam et al. 1995).

Farmers' participatory on-farm evaluation of IDM technology

IDM technology was evaluated through farmers' participatory on-farm research in farmers' fields in Anantapur. The on-farm research was conducted
in collaboration with the District Agricultural Advisory and Transfer of Technology Centre (DAATTC), Agricultural Research Station (ARS), Acharya NG Ranga Agricultural University (ANGRAU), and Rural Development Trust (RDT), Anantapur. During 2001, IDM technology was evaluated in the fields of 21 farmers in the village Jambuladinne, and in 2002, with 80 participating farmers in two villages, Danduvaripalli and Rekulakunta. The year 2003 had 70 farmers from two villages, Gummallakunta and Jalalapuram, and 2004 had 150 participating farmers from five villages, Lingareddypalli, Jalalapuram, Jonnalakothapalli, Talupuru and Antaraganga. The selection of villages and participating farmers followed the guidelines suggested by Pande et al. (2001).

Farmer orientation field schools were conducted in each village to educate selected farmers on major production constraints and their timely management. Brochures were prepared in Telugu, the local language, and distributed to all participating farmers during orientation. These schools were organized three times during the season, one before planting and the others at 30 to 40 days and at 60 to 70 days after sowing. During the first class, farmers were encouraged to share their experiences and perceptions about groundnut production constraints. Then they were told about the concept driving IDM. In the second and third classes, more detail was given on symptoms and losses caused by foliar diseases, favorable weather conditions for the development of these diseases, the time of their appearance and management options.

Two trials - participatory varietal selection (PVS) trials with seven cultivars during the rainy seasons of 2001 and 2002 and IDM trials with ICGV 91114 during the rainy seasons of 2001 to 2004 - were conducted in these selected villages. The PVS trial was conducted to verify the cultivar's superior adoptability in the region.

**PVS trial.** Six groundnut cultivars that were moderately resistant to foliar diseases and one local cultivar were evaluated in these trials. The six cultivars were: ICGVs 89104, 91114, 92267 (early-maturing); ICGVs 92020, 92093, 94080 (medium-maturing), and the local cultivar used was TMV 2. The evaluations took place in the fields of five farmers in Jambuladinne during 2001, and in 10 farmers' fields in Danduvaripally and Rekulakunta in 2002. Each cultivar was sown in about 500 m$^2$ in a strip plot design in each trial. After sowing, each cultivar was divided into two halves in each trial with IDM in one half and non-IDM in the other.

**IDM trial.** Dual-purpose groundnut cultivar ICGV 91114 was included in this IDM trial for all the years. About 16 trials in 2001, 70 trials each in 2002 and 2003, and 150 trials in 2004 were conducted in selected villages. Each trial was planted in about 2000 sq m (half an acre) with IDM technology and compared with the non-IDM treated local cultivar for quantity and quality of haulms and pods.
Results

Development of IDM technology

The severity of LLS received a 4 to 5 rating on a 1-9 rating scale in IDM and around 5-9 in the non-IDM section in all cultivars. Significantly, lower severity of LLS was recorded in all improved cultivars in IDM plots when compared to TMV 2 of non-IDM plots. Similarly, severities of rust were significantly lower in IDM plots in all cultivars (Table 1). Significantly, higher haulm (residue) and pod yields were obtained in all cultivars in IDM plots than in non-IDM plots. Haulm yields were significantly higher in all improved cultivars with IDM treatment than in the case of TMV 2 with non-IDM treatment (Table 2). In vitro analysis of haulms indicated that percent digestibility was significantly high in all improved cultivars in IDM plots compared to non-IDM plots.

Among the improved cultivars, ICGVs 89104, 91114, 92020 and 92093 were selected as they had superior digestibility under in vitro analysis (Table 3) and hence were included in farmers' participatory on-farm trials.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>LLS IDM</th>
<th>LLS Non-IDM</th>
<th>Rust IDM</th>
<th>Rust Non-IDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICGV 89104</td>
<td>5.0</td>
<td>9.0</td>
<td>5.3</td>
<td>7.7</td>
</tr>
<tr>
<td>ICGV 91114</td>
<td>4.7</td>
<td>9.0</td>
<td>5.0</td>
<td>7.7</td>
</tr>
<tr>
<td>ICGV 92267</td>
<td>5.0</td>
<td>7.3</td>
<td>4.7</td>
<td>7.0</td>
</tr>
<tr>
<td>ICGV 92020</td>
<td>4.3</td>
<td>6.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>ICGV 92093</td>
<td>4.3</td>
<td>4.3</td>
<td>2.0</td>
<td>2.3</td>
</tr>
<tr>
<td>ICGV 94080</td>
<td>4.0</td>
<td>5.7</td>
<td>3.3</td>
<td>5.3</td>
</tr>
<tr>
<td>TMV 2</td>
<td>5.0</td>
<td>9.0</td>
<td>5.3</td>
<td>7.7</td>
</tr>
<tr>
<td>LSD 5%</td>
<td>0.56</td>
<td>0.471</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*On a 1-9 rating scale.

IDM = Integrated disease management with improved cultivar, fungicide seed treatment and economical application of one or two sprays of fungicide Kavach (chlorothalonil).

Non-IDM = No IDM inputs; traditional treatment.
Table 2. Effect of Integrated Disease Management on haulm and pod yields of selected groundnut cultivars, ICRISAT, Patancheru, 1999-2000.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Yield t/ha</th>
<th>Haulm</th>
<th>Pod</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IDM</td>
<td>Non-IDM</td>
<td>IDM</td>
</tr>
<tr>
<td>ICGV 89104</td>
<td>2.05</td>
<td>1.35</td>
<td>1.37</td>
</tr>
<tr>
<td>ICGV 91114</td>
<td>2.15</td>
<td>1.40</td>
<td>1.50</td>
</tr>
<tr>
<td>ICGV 92267</td>
<td>1.99</td>
<td>1.35</td>
<td>1.44</td>
</tr>
<tr>
<td>ICGV 92020</td>
<td>3.10</td>
<td>2.34</td>
<td>2.17</td>
</tr>
<tr>
<td>ICGV 92093</td>
<td>3.35</td>
<td>2.75</td>
<td>2.11</td>
</tr>
<tr>
<td>ICGV 94080</td>
<td>3.10</td>
<td>2.25</td>
<td>1.97</td>
</tr>
<tr>
<td>TMV 2</td>
<td>1.76</td>
<td>0.98</td>
<td>1.10</td>
</tr>
<tr>
<td>LSD 5%</td>
<td>0.136</td>
<td></td>
<td>0.108</td>
</tr>
</tbody>
</table>

Table 3. Effect of Integrated Disease Management on the *in vitro* digestibility of haulms of selected groundnut cultivars, 1999-2000.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Digestibility %</th>
<th>IDM</th>
<th>Non-IDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICGV 89104</td>
<td>65.6</td>
<td>60.3</td>
<td></td>
</tr>
<tr>
<td>ICGV 91114</td>
<td>68.7</td>
<td>61.0</td>
<td></td>
</tr>
<tr>
<td>ICGV 92267</td>
<td>64.8</td>
<td>59.1</td>
<td></td>
</tr>
<tr>
<td>ICGV 92020</td>
<td>70.2</td>
<td>66.8</td>
<td></td>
</tr>
<tr>
<td>ICGV 92093</td>
<td>73.3</td>
<td>68.8</td>
<td></td>
</tr>
<tr>
<td>ICGV 94080</td>
<td>71.4</td>
<td>67.9</td>
<td></td>
</tr>
<tr>
<td>TMV 2</td>
<td>67.3</td>
<td>56.9</td>
<td></td>
</tr>
<tr>
<td>LSD 5%</td>
<td></td>
<td>2.34</td>
<td></td>
</tr>
</tbody>
</table>

Farmer's participatory on-farm evaluation of IDM technology

Drought was severe during 2001, 2002 and moderate in the 2003 rainy seasons in all targeted villages in the district. Supplementary irrigation was given to approximately 50% of the trials in each village and data was collected from these trials during the drought years.

PVS trial. Severity of foliar diseases was significantly lower (3.0 - 5 rating on 1-9 rating scale in both 2001 and 2002) in IDM plots compared to non-IDM plots (4-7.5 rating) for all improved cultivars as against TMV 2 and the
local cultivar. All the improved cultivars had significantly low severity of foliar diseases than TMV 2 and the local cultivar in non-IDM plots (7.5-8.5 rating) as well. Severity of foliar diseases was significantly lower in medium-maturing cultivars than in early-maturing cultivars in both years. Haulm and pod yields were very poor during 2001 compared to 2002, across all the trials in both treatments, because of drought. Haulm and pod yields were significantly higher in all improved cultivars with IDM treatment than in the local cultivar with non-IDM treatment (Tables 4 and 5). Among the cultivars of the PVS trial, ICGV 91114 was most preferred by farmers as it had traits (pod shape, size and seed color, oil content and percent shelling) acceptable to them. Moreover, this variety matures in 95 DAS with high yield potential, tolerance to drought and has good market value.

**Table 4. Severity of foliar diseases LLS and rust in farmers' participatory varietal selection trials, Anantapur, 2001-2002.**

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>2001 IDM</th>
<th>2001 Non-IDM</th>
<th>2002 IDM</th>
<th>2002 Non-IDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICGV 89104</td>
<td>5.0</td>
<td>7.5</td>
<td>5.3</td>
<td>7.7</td>
</tr>
<tr>
<td>ICGV 91114</td>
<td>5.0</td>
<td>7.0</td>
<td>5.0</td>
<td>7.7</td>
</tr>
<tr>
<td>ICGV 92020</td>
<td>3.0</td>
<td>4.0</td>
<td>3.3</td>
<td>4.5</td>
</tr>
<tr>
<td>ICGV 92093</td>
<td>3.0</td>
<td>4.0</td>
<td>3.0</td>
<td>3.5</td>
</tr>
<tr>
<td>TMV 2</td>
<td>6.0</td>
<td>7.0</td>
<td>6.3</td>
<td>7.7</td>
</tr>
<tr>
<td>Local cultivar</td>
<td>7.0</td>
<td>8.5</td>
<td>7.5</td>
<td>8.5</td>
</tr>
</tbody>
</table>

LSD 5% 0.42 0.58

*On a 1-9 rating scale.

**IDM trial.** Since the early-maturing ICGV 91114 gained farmers' favor, it was included in IDM trials in several villages in Anantapur. In the initial trials, few farmers understood the advantages of this variety, particularly its nutritive haulms and tolerance to foliar diseases. They noted an increase in milk yield by feeding cattle with haulms of this cultivar. Severity of foliar diseases in ICGV 91114 ranged from 3 - 5 in IDM plots compared to 5 - 6.5 rating in local cultivar of non-IDM plots. Haulm and pod yields were higher in IDM plots than non-IDM plots. Though the haulm and pod yields were low in 2001 and 2002, compared to the average production during the previous years, ICGV 91114 recorded significantly higher yields than the local cultivar with non-IDM treatment (Table 6).
Table 5. Effect of Integrated Disease Management on haulm and pod yields in farmers' participatory varietal selection trials, Anantapur, 2001-2002.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>2001 Haulm</th>
<th>2002 Haulm</th>
<th>2001 Pod</th>
<th>2002 Pod</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IDM</td>
<td>Non-IDM</td>
<td>IDM</td>
<td>Non-IDM</td>
</tr>
<tr>
<td>ICGV 89104</td>
<td>1.29</td>
<td>0.97</td>
<td>1.93</td>
<td>1.54</td>
</tr>
<tr>
<td>ICGV 91114</td>
<td>1.38</td>
<td>1.04</td>
<td>2.12</td>
<td>1.85</td>
</tr>
<tr>
<td>ICGV 92020</td>
<td>1.67</td>
<td>1.33</td>
<td>3.45</td>
<td>2.50</td>
</tr>
<tr>
<td>ICGV 92093</td>
<td>1.66</td>
<td>1.31</td>
<td>3.15</td>
<td>2.35</td>
</tr>
<tr>
<td>TMV 2</td>
<td>1.36</td>
<td>0.82</td>
<td>1.75</td>
<td>1.20</td>
</tr>
<tr>
<td>Local cultivar</td>
<td>1.14</td>
<td>0.74</td>
<td>1.60</td>
<td>1.02</td>
</tr>
<tr>
<td>LSD 5%</td>
<td></td>
<td>1.29</td>
<td>0.97</td>
<td>1.38</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Year</th>
<th>Village</th>
<th>Foliar disease score*</th>
<th>Yield t/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Haulm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IDM</td>
<td>Non-IDM</td>
</tr>
<tr>
<td>2001</td>
<td>Jambuladinne</td>
<td>5.0</td>
<td>6.3</td>
</tr>
<tr>
<td>2002</td>
<td>Danduvaripalli</td>
<td>4.0</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>Rekulakunta</td>
<td>3.7</td>
<td>6.0</td>
</tr>
<tr>
<td>2003</td>
<td>Gummallakunta</td>
<td>5.0</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>Jalalapuram</td>
<td>4.7</td>
<td>6.5</td>
</tr>
<tr>
<td>2004</td>
<td>Jalalapuram</td>
<td>5.0</td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>Lingareddypalli</td>
<td>4.3</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>Jonnalakothapalli</td>
<td>4.7</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>Talupuru</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>Antaraganga</td>
<td>4.3</td>
<td>5.7</td>
</tr>
</tbody>
</table>

* On a rating scale of 1-9.
Establishment of the village level seed system

Seed is an important component of farming in rural households in the Deccan Plateau. In districts like Anantapur where approximately 0.8 million ha of groundnut are grown every year with a narrow multiplication ratio (1:5) and heavy seed rate, i.e., the recommended seed quantity for sowing, no single agency can meet the demand for seed. Some of the seed needs are met from government and non-government agencies in the district and the rest from neighboring districts but with poor quality of seed. If new cultivars are to be adopted successfully by farmers, availability of quality seed within accessible distance is essential. Therefore, a village level farmer participatory seed multiplication system was established successfully to provide quality seed of the new dual-purpose cultivars in the district. Cultivar ICGV 91114 was most preferred by farmers, and its demand exceeds supply. To meet this requirement, 25 enthusiastic farmers/self-help groups in five villages were identified to multiply the seed during the 2004/05 postrainy season (Table 7).

<table>
<thead>
<tr>
<th>Village</th>
<th>No. of farmers</th>
<th>Area</th>
<th>Yield (q/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jalalapuram</td>
<td>6</td>
<td>8</td>
<td>64</td>
</tr>
<tr>
<td>Lingareddypalli</td>
<td>10</td>
<td>12</td>
<td>100</td>
</tr>
<tr>
<td>Talupuru</td>
<td>5</td>
<td>10</td>
<td>76</td>
</tr>
<tr>
<td>Gummallakunta</td>
<td>3</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>Jonnalakothapalli</td>
<td>2</td>
<td>3.5</td>
<td>28</td>
</tr>
</tbody>
</table>

Discussion

In the Deccan Plateau, crop residues are very important sources of fodder for cattle and buffalo. Adequate nutrition is essential for livestock production, which is an integral part of mixed crop-livestock system in this region. Groundnut haulms are the second major source of fodder after sorghum in Andhra Pradesh. Pande et al. (2001) reported that foliar diseases (LLS and rust) were the major constraints for groundnut production. Both these diseases occur together and reduce the quantity and quality of residue drastically in this region. The adverse effects of these foliar diseases on the quantity and quality of residue and pods were confirmed through the present study. In the present study, severity of foliar diseases was significantly lower in IDM plots. These results are in agreement with results obtained by Pande et al. (1998, 2001). Pande et al. (1998) reported that lower severities of foliar diseases of improved cultivars in IDM plots yielded higher quantities of haulms and pods than the
local cultivar from non-IDM plots in farmers' participatory on-farm studies. Similar results of higher haulm and pod yields were obtained from improved cultivars in IDM plots than from local cultivars of non-IDM plots in all trials. The low haulm and pod yields of cultivar ICVG 91114 during 2001 and 2002 was due to severe drought in the selected villages but still its performance is relatively better than all the others under testing.

Management of foliar diseases in groundnut by adopting IDM technology in both on-station and on-farm farmers' participatory IDM trials yielded higher quantities as well as high quality nutritive fodder (Pande et al. 2003). Higher quantities and quality residue were also obtained in the present study. Thus IDM technology developed at ICRISAT-Patancheru helps resource-poor farmer obtain higher quantities of haulm and pod and also high quality nutritive feed for cattle and buffalo. This in turn leads to increased milk yield and helps augment their income in a sustainable way.

References


Late leaf spot (LLS) (*Phaeoisariopsis personata*) and rust (*Puccinia arachidis*) are two of the most critical and destructive diseases in groundnut. Economic losses to farmers are heavy as well. According to estimates, these diseases cause up to 70% losses in pods and up to 90% in haulms. These then are the major biotic constraints in the production of groundnut in Anantapur district, where the crop is cultivated in more than 0.8 million ha annually. These foliar diseases can be effectively managed by using Integrated Disease Management (IDM), a package developed at ICRISAT.

Integrated Disease Management

Integrated Disease Management (IDM) is defined as "The optimization of disease control measures in an economically and ecologically sound manner accomplished by the coordinated and conjunctive use of multiple tactics to assure stable crop production and to maintain pathogen damage below the economic injury level to humans, animals, plants and environments" (Jesen 2000). On-station IDM trials at ICRISAT, Patancheru, have clearly demonstrated that when moderate levels of resistance are combined with affordable levels of chemical control, expected yields and economic returns are higher than with susceptible genotypes. Accordingly, IDM technology consisted of an improved cultivar with partial resistance to foliar diseases, seed treatment with a mixture of fungicides ie, Thiram and Bavistin 1:1 @ 2 g/kg seed and economical use of one or two foliar applications of fungicide Kavach (Chlorothalonil) at 60 days (one spray) for early maturing cultivars and at 60 and 75 days after sowing for medium maturing cultivars.

The IDM technology was evaluated, validated and promoted through on-farm research in collaboration with Agricultural Research Station (ARS), Rural Development Trust (RDT) and District Agricultural Advisory and Transfer of Technology Centre (DAATT Centre) during 2001-2004 (Table 1). In these participatory trials, IDM technology with four genotypes ICGV 89104, ICGV 91114 (short duration 95 days), ICGV 92020, ICGV 92093 (medium duration 125 days) was evaluated and compared with local cultivars in nine...
Table 1. Locations of groundnut on-farm IDM trials in Anantapur district, 2001-2004.

<table>
<thead>
<tr>
<th>Year</th>
<th>Village</th>
<th>Mandal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Jambuladinne</td>
<td>Garladinne</td>
</tr>
<tr>
<td>2002</td>
<td>Rekulakunta</td>
<td>BK Samudram</td>
</tr>
<tr>
<td>2002</td>
<td>Danduvaripalle</td>
<td>BK Samudram</td>
</tr>
<tr>
<td>2003</td>
<td>Gummallakunta</td>
<td>Bathalapalli</td>
</tr>
<tr>
<td>2003</td>
<td>Jalalapuram</td>
<td>Bathalapalli</td>
</tr>
<tr>
<td>2004</td>
<td>Jalalapuram</td>
<td>Bathalapalli</td>
</tr>
<tr>
<td>2004</td>
<td>Lingareddypalli</td>
<td>Bathalapalli</td>
</tr>
<tr>
<td>2004</td>
<td>Jonnalakothapalli</td>
<td>Mudigubba</td>
</tr>
<tr>
<td>2004</td>
<td>Talupuru</td>
<td>Atmakur</td>
</tr>
<tr>
<td>2004</td>
<td>Antaraganga</td>
<td>Kuderu</td>
</tr>
</tbody>
</table>

Villages in Anantapur district (Table 2). Foliar diseases (LLS and rust) severities remained low (5 rating on 1-9 scale in IDM plots) while it was 7 rating in non-IDM plots in all the cultivars in all locations. Pod and haulm yields were higher in IDM plots of all improved cultivars than in non-IDM plots with local cultivars. Of the four improved cultivars, ICGV 91114 being an early maturing cultivar was liked and preferred by most farmers.

Table 2. Characteristics of groundnut cultivars included in IDM trials in 90-95 days after sowing (DAS); Anantapur district, 2001-2004.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICGV 91114</td>
<td>Moderately resistant to LLS and rust; matures in 90-95 days after sowing (DAS); shelling 70%; pod yield 2.5 t/ha</td>
</tr>
<tr>
<td>ICGV 89104</td>
<td>Moderately resistant to LLS and rust, and resistant to aflatoxin contamination; matures in 90-95 DAS; shelling 68%; pod yield 2.5 t/ha</td>
</tr>
<tr>
<td>ICGV 92020</td>
<td>Moderately resistant to LLS and rust; tolerant to drought; matures in 125-130 DAS; shelling 68%; pod yield upto 3.5 t/ha</td>
</tr>
<tr>
<td>ICGV 92093</td>
<td>Moderately resistant to LLS and rust; matures in 125-130 DAS; shelling 70%; yield upto 3 t/ha</td>
</tr>
<tr>
<td>Local cultivar (TMV 2)</td>
<td>Locally adopted material of mixed identity; susceptible to LLS and rust; matures in 110-115 DAS, shelling 60%; pod yield around 0.5 to 0.8 t/ha</td>
</tr>
</tbody>
</table>
Farmers' perceptions

Farmers by and large seem to favor ICGV 91114 because of its responsiveness to IDM, earliness, drought tolerance, partial resistance to LLS and high pod and haulm yields. Further the fodder is exceptionally good in terms of quality and quantity and higher milk yield was recorded when fed to animals. There is also appreciable reduction in cost of cultivation and a better benefit: cost ratio. These are some farmer reactions to ICGV 91114 and its IDM components:

1. Challa Bhaskar, Lingareddypalli, Bathalapalli mandal
ICGV 91114 is excellent, and produces 10 bags (40 kg each) from 1 bag seed as against 6 bags of produce with JL 24. Moreover, it yields higher quantities of fodder than the local cultivar.

2. P Dastagiri Reddy, Lingareddypalli, Bathalapalli mandal
Cattle seemed to relish fodder from ICGV 91114 more than the local cultivar JL 24. Milk yield also increased when cattle were fed fodder from this variety. Pod yields were also greater than with JL 24.

ICGV 91114 is an early maturing variety and the crop emerged with minimal LLS. The cattle also seem to relish the fodder, and milk yield has increased.

4. V Ramalinga Reddy, Gummallakunta, Bathalapalli mandal
ICGV 91114 is a high yielder with a good shelling percentage. The kernels are bold as with JL 24. Farmers have managed to get premium prices for this variety when it was sold as seed.

5. P Indiramma, Jalalapuram, Bathalapalli mandal
The variety ICGV 91114 yielded good quality haulms and also enhanced the milk productivity of milch animals. After practicing IDM, disease incidence also was substantially low compared to the local variety.
On-farm Integrated Disease Management in groundnut and upscaling of dual purpose, short duration groundnut genotype ICGV 91114

KA Karim\textsuperscript{1} and B Raghu Rami Reddy\textsuperscript{1}

The groundnut variety most used in Anantapur district is TMV 2, which was released in 1942. Area under this variety is around 80%. Also popular is cultivar JL 24 which is widespread in the Kadiri area. Although many varieties have been introduced as an alternative to TMV 2, replacement has not taken place in spite of partial success.

Generally, farmers tend to like a variety if it stands up to prolonged drought and has the capacity to rejuvenate when the rains do come, withstands foliar disease and gives high haulm and pod yields.

Cultivar ICGV 91114, which was introduced by Suresh Pande and his team of scientists from ICRISAT during 1995/1996, has traits similar to TMV 2 and JL 24. It also yields bold pods and bold uniform kernels, which are not found in TMV 2. The oil content is higher than TMV 2 and JL 24. Its fodder has good nutritive value for dairy animals.

During 1997-1998, when ICRISAT on-farm research was devolved, Rural Development Trust (RDT) further evaluated IDM technology using ICGV 91114 in five villages in Atmakuru and Kalyandurga mandals. Although the performance of this cultivar was superior to the local TMV 2, seed of this cultivar could not be saved due to drought.

Later during the kharif season of 2002, ICRISAT again collaborated with Accion Fraterna (AF/RDT) and conducted on-farm PVS trials in Danduvaripalli and Rekulakunta villages with small quantities of cultivars ICGV 91114, ICGV 92020, 89104, 94080, 92093, 92267, 86590 and K 134, TMV 2 (local cultivar) as checks. Sowings were taken up during the first week of August 2002. There was a dry spell of 45 days after sowing.

Because of drought, pod yields were low in both villages in all the cultivars. However, ICGV 91114 yielded 0.66 t/ha and ICGV 89104 yielded 0.55 t/ha. Both these cultivars were found acceptable by most farmers as they were early-maturing and high-yielding compared to local cultivars.

\textsuperscript{1} RDT, Anantapur, Andhra Pradesh, India.
The following year, i.e., in the 2003 kharif season, AF/RDT took up ICGVs 91114 and 89104 each in five holdings (half an acre each) in West Narsapuram village, Singanamala mandal. Farmers here were impressed with the performance of ICGV 91114 when it came to pod yield, fodder and tolerance to drought of 42 days when compared to ICGV 89104 and the local variety.

Having observed the performance of ICGV 91114, farmer Shyamala of West Narsapuram cultivated $1^{1/2}$ acres under irrigated conditions during rabi 2003-2004 and produced 30 bags of 40 kg each and sold some of it to farmers in her village as seed. This was also the beginning of participatory seed production at the village level.

During kharif 2004, ICRISAT supplied 83 bags of 30 kg each of ICGV 91114 variety for distribution and multiplication to RDT, which then distributed these among 75 farmers in six villages @ Rs 10 per kg with the understanding that they must return the same quantity of seed at the same price at the time of harvest.

Farmers who received seed

- Twenty six farmers received 30 kg each; apart from these, 17 farmers purchased seed from Shyamala.
- Twenty five farmers of Sivapuram of Kanaganipalli mandal received 30 kg each.
- Seven farmers of Battuvaniapalli of Kalyandurga mandal received 60 kg each.
- One farmer of Mallapuram in Kalyandurga mandal received 60 kg.
- Ten farmers of Veligonda village of Vajrakarur mandal received 30 kg. A total of 86 farmers took up cultivation of ICGV 91114 during kharif 2004.

Although the mean annual rainfall in the area is less than the average, fortunately the 2004 kharif season had a favorable distribution of rainfall, which was good for groundnut except for one drought spell during August.

The performance of ICGV 91114 was good in all six villages and all farmers were convinced that this variety was superior to TMV 2 and was suitable to local climatic conditions. Anand Kumar of Bhattuvanipalli said that ICGV 91114 was found to be the best yielder of pods and haulms among TMV 2, JL 24 and TAG 24. In all villages, the yield increase of ICGV 91114 over local varieties ranged from 80 to 200 kg/acre (its value being Rs 1400/- to Rs 3500/acre).

From the kharif 2004 produce, RDT arranged to distribute seed of this variety to farmers of other villages for cultivating under irrigation @ Rs 10/kg on a no-loss-no-profit basis. About 59 farmers were supplied a total quantity of 1980 kg (66 bags of 30 kgs each) for kharif sowing for further multiplication under the participatory seed village concept (Table 1).
Table 1. Details of ICGV 91114 sown under irrigated conditions during rabi, 2004-2005.

<table>
<thead>
<tr>
<th>Village</th>
<th>Mandal</th>
<th>Quantity of seed disbursed (kg)</th>
<th>Area sown (ac)</th>
<th>No. of farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kundurpi</td>
<td>Kundurpi</td>
<td>60</td>
<td>0.60</td>
<td>2</td>
</tr>
<tr>
<td>Nizavalli</td>
<td>Kundurpi</td>
<td>60</td>
<td>0.60</td>
<td>2</td>
</tr>
<tr>
<td>Bandameedapalli</td>
<td>Kundurpi</td>
<td>150</td>
<td>1.60</td>
<td>5</td>
</tr>
<tr>
<td>Yerraborepalli</td>
<td>Settur</td>
<td>150</td>
<td>1.60</td>
<td>5</td>
</tr>
<tr>
<td>Mallapuram</td>
<td>Kalyandurga</td>
<td>380</td>
<td>42.00</td>
<td>3</td>
</tr>
<tr>
<td>Battuvanipalli</td>
<td>Kalyandurga</td>
<td>360</td>
<td>4.00</td>
<td>5</td>
</tr>
<tr>
<td>Sivapuram</td>
<td>Kanaganipalli</td>
<td>7000</td>
<td>71.75</td>
<td>26</td>
</tr>
<tr>
<td>Vepakunta</td>
<td>Kanaganipalli</td>
<td>240</td>
<td>2.60</td>
<td>6</td>
</tr>
<tr>
<td>Chelopalli</td>
<td>Ramagiri</td>
<td>210</td>
<td>2.30</td>
<td>7</td>
</tr>
<tr>
<td>Narsimpalli</td>
<td>Bathalapalli</td>
<td>300</td>
<td>3.30</td>
<td>8</td>
</tr>
<tr>
<td>Tumpera</td>
<td>Narpala</td>
<td>270</td>
<td>3.00</td>
<td>4</td>
</tr>
<tr>
<td>West Narsapuram</td>
<td>Singanamala</td>
<td>6600</td>
<td>73.00</td>
<td>26</td>
</tr>
<tr>
<td>Koppalakonda</td>
<td>Garladinne</td>
<td>90</td>
<td>1.10</td>
<td>3</td>
</tr>
<tr>
<td>Ragulapadu</td>
<td>Vajrakur</td>
<td>300</td>
<td>3.30</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>16170</strong></td>
<td><strong>172.95</strong></td>
<td><strong>105</strong></td>
</tr>
</tbody>
</table>

Due to the lack of irrigation, many farmers of West Narsapuram supplied 152 bags of 40 kg each to relatives in neighboring villages with an understanding that all produce was to be sold back to the farmers in West Narsapuram after harvest. This variety has now been introduced in 105 holdings in 25 villages in Anantapur district for cultivation during rabi 2004-05.

The farmers of Sivapuram and West Narsapuram have expressed their intention to completely replace the local variety with ICGV 91114 for two seasons. RDT also plans to take up two more villages under the seed village program with ICGV 91114 during 2005/06 season.
On-farm Integrated Disease Management for groundnut in Kadiri: Constraints and opportunities

Y Ramesh

The Mysore Relief and Development Agency (MYRADA) is a voluntary organization. For 25 years, we have been working with farmers and women’s self help groups (SHGs) in the Kadiri area to improve farmer incomes. We have collaborated with research institutions such as ICRISAT, ANGRAU and ARS to work on groundnut. In our work with watershed development, we are trying to improve groundwater levels for groundnut to withstand drought conditions, enabling the farmer to gain at least 2 or 3 bags per acre.

Compared to Anantapur, the area of Kadiri is rocky with rolling topography with erosive top soils of not very great depth. In 2000, ICRISAT introduced dual purpose cultivars ICGV 89104, 91114 and IDM technology suited to climate in the tract. Earlier, when farmers noticed defoliation at 60-90 days, it was assumed that the crop had matured and the crop was pulled out prematurely and haulm yield was very poor as well. Thanks to training by ICRISAT, it is now known that the leaf drop was due to foliar diseases and farmers are capable of diagnosing and spraying the crop. With IDM, farmers can gain about 2 bags per acre with good quality of fodder; gains can go upto Rs 1500/-. In Kadiri, we met all the farmers in the area, and listed out their problems in a participatory interactive session and drew up a budget. Ten varieties of groundnut were obtained from ICRISAT and ARS, Kadiri, and evaluated in farmers' fields by following IDM technology. Farmers collectively discussed the merits of each variety and its suitability for our area in all respects. It was decided that ICGV 91114, TAG 24 and K 4 were suitable in that order of priority. We set up a village seed bank, multiplied the seed and distributed them to all farmers. Seed was multiplied in two or three villages in Nallacheruvu mandal, Anantapur. Women farmers were trained to diagnose diseases.

Soil depth in Anantapur is comparatively less - about 12 to 18 cm. We found that if red gram were sown along with groundnut as an intercrop, it takes moisture from deeper profiles and supplies additional income. Our farmers also experimented to find alternative biopesticides. The leaves of eucalyptus, neem and tobacco were boiled together and kept overnight. The liquid was sprayed the next morning and it was found to work as a fungicide in controlling leaf spot disease.

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Other such experiments are still being carried out so that farmer can reduce cultivation costs. We have arranged exposure visits to ICRISAT and ARS, so that farmers may benefit even more. We have tried to support farmers through the entire process - from seed to yield. Among other measures, we encourage farmers to use organic manures and tank silt; this not only gives 25% more yield in pods and haulms but also maintains long-term carrying capacity of the soil. Farmers have also been told about the importance of optimum plant population; about 33 plants in one square meter gives an excellent crop stand and greater yield.
Farmers' participatory crop and disease management in the Deccan Plateau: NATP experiences

Suseelendra Desai

Introduction

Known as the poor man's almond, groundnut contributes about 38% to the oilseed pool of India. About 81% of the Indian groundnut crop is rainfed where productivity hovers around 500 and 1500 kg/ha with a national average of 1000 kg/ha. Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamil Nadu account for about 89% of the total groundnut area and constitute nearly 88% of the total groundnut production of our country. The rest are scattered in the states of Orissa, Rajasthan, Punjab, Uttar Pradesh, and Madhya Pradesh.

With an increasing limitation on resources, there is hardly any scope for horizontal growth in production and so vertical growth by increasing crop productivity and intensity is the only alternative. To do this, biotic and abiotic constraints need to be tackled in a cost effective manner.

The major foliar diseases of groundnut are early leaf spot, late leaf spot and rust. Collar rot or crown rot, stem and pod rots and dry root rot are the major diseases caused by soil-borne pathogens. Limb rot and botrytis blight are problems in some pockets. Bacterial blight fortunately is not a problem in India whereas it is one of the major constraints in South and southeast Asia. There are many minor diseases caused by fungi and actinomycetes. Among virus diseases, bud necrosis is a major constraint. Since 2000, stem necrosis disease has been a concern in Andhra Pradesh and adjoining districts of Karnataka. Aflatoxin contamination is a major pre- and postharvest problem affecting produce and trade.

Participatory research has emerged as a powerful tool to identify agro-ecosystem indicators in developing countries. Indigenous knowledge has generated complementary scientific information to the benefit of all stakeholders (Goma et al. 2001). Under the National Agricultural Technology Project (NATP), a few programs were developed to facilitate technology transfer in a participatory mode. One of the prime objectives apart from technology transfer was refinement through on-farm trials. Various governmental and non-governmental agencies were involved in these programs. Howell (1998) suggested that the participation process was greatly facilitated by the previously

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existing relationship between the international NGOs and the communities, and also by the high level of staff input into the project. Major diseases of groundnut in the project area and experiences gathered while implementing the programs are presented in this paper.

**Diagnostic key for major diseases**

**Early leaf spot** (*Cercospora arachidicola*)

Symptoms of early leaf spot first appear as pale areas on the upper surface of lower leaves about 10 to 28 days after emergence. The spots later turn yellow, necrose the center of the lesion, and later the entire spot becomes necrotic. The large, circular to irregular spots measure to 1 to 10 mm in diameter and spots are characterized by a yellow halo of variable width. At maturity, the spots turn reddish brown to black. The lower surface of the spot is orange in color.

**Late leaf spot** (*Phaeoisariopsis personata*)

Dark brown to black, circular to sub-circular lesions measuring 1 - 6 mm diameter appear on the lower surface of the quadrifoliate leaves where most sporulation occurs. Lesions are black and fruiting structures occur in concentric rings on lower surface leaflet giving lesions a slightly rough appearance on the other parts. In severe cases, oblong brown to dark brown lesions develop on the stem and branches. The late leaf spot tends to remain distinctly round, 1.5 to 5 mm in diameter and yellow halos around the spot are found only with mature spots. Spots are almost black on both the surfaces, but lower surface of the spot is distinctly black in color.

**Rust** (*Puccinia arachidis*)

Orange red to chestnut brown elliptical raised pustules appears on the abaxial surface of the leaves. The pustules are 0.3 to 2.0 mm in diameter. The corresponding adaxial surface area of the leaf gives a grey appearance due to formation of fleck. The rust pustules are either isolated or in groups. When the pustules burst, a reddish brown mass of spores becomes visible on the surface of leaves. As the infection advances, the pustules turn dark brown and frequently coalesce to cover large areas. Normally rust infected leaves do not get detached. However, often rust and leaf spots appear together and defoliation due to leaf spots is very common. The seeds of infected plants remain small.
Stem and pod roots (*Sclerotium rolfsii*)

*S. rolfsii* is a facultative parasite and is found in a wide range of soils. The fungus survives in soil mainly as sclerotia, which represent the main source of inoculum and remain viable for several months. *S. rolfsii* attacks all parts of the plant but stem infection is the most common and serious. The first symptom is sudden wilting of a branch, which is completely or partially in contact with the soil. The junction of the branch with the stem near the soil level is the most favored point of attack and a white coating of mycelium appears at infection site. Sclerotia of mustard seed size appear on the infected areas at later stages. Under congenial conditions, the pods also get infected showing sclerosis of the pod surface. Seeds when infected show pale discoloration.

Crown rot (*Aspergillus niger*)

The disease appears both as pre-emergence and post-emergence rot. In the pre-emergence phase, the seed may rot and become covered with sooty black masses of spores. On germination, the hypocotyl is rapidly killed by the lesions at the collar region, resulting in rotting of the seedling before their emergence from the soil. In the post-emergence phase, initially a circular light brown lesion appears on the cotyledons and as the time advances the hypocotyl tissue or stem region becomes water-soaked and shows light brown coloration.

Bud necrosis (Peanut bud necrosis virus, PBNV)

This is a virus disease and produces a variety of symptoms in groundnut. Initial symptoms appear on young quadrifoliates as mild chlorotic mottle or spots, which develop into necrotic and chlorotic rings. Necrosis of the terminal bud is a characteristic symptom, which brings the disease the name 'bud necrosis'. The secondary symptoms are stunting, auxiliary shoot proliferation and malformation of leaflets. If plants are infected early, they are stunted and bushy. Late infected plants may produce seed of normal size, but testa on such seeds are often mottled and cracked.

Peanut stem necrosis (Tobacco streak virus, TSV)

Necrotic lesions and veinal necrosis symptoms first appear on young quadrifoliates. Necrosis later spreads to petiole and stem, finally killing the bud. If infection occurs at early stages, plants are killed. In some cultivars, axillary proliferation of the shoots is noticed with small leaflets in bunches with general necrosis. Growing buds show necrosis but it may also occur due to bud necrosis or any other factor. Necrosis of pegs or necrotic lesions on pods was recorded under severely infected conditions. This symptom could also be due to infection by bud necrosis virus.
A participatory rural appraisal (PRA) was conducted during the initial stages of the project to understand production systems currently in place in project areas. The PRA also helped obtain information on auxiliary data on socioeconomic aspects of the farmers.

Farmers face several constraints in groundnut production. These constraints fall into various categories from seed through crop production, crop protection and marketing facilities. Through a detailed questionnaire, information was gathered on various crop production, marketing and socioeconomic constraints. A database has been prepared and the salient findings are presented here.

In Gujarat, about 205 farmers out of 1179 possessed landholdings of more than 5 ha which accounts for 17% of the farmers surveyed. About 65% of the farmers fell into the category of medium farmers and 16% belonged to the small farmers category.

Genotype plays a very significant role in achieving higher productivity. In general, across the country it was felt that there has not been a good seed replacement mechanism for penetration of improved cultivars of groundnut. Gujarat has been an exception to this rule: many improved cultivars been introduced and accepted here (Fig. 1). The genotypes included: GG 20 (548), GG 2 (120), GAUG 10 (232), Sandhadi (127), Tata sumo (51), GAUG 11 (37), Shedubhar (21), J 11 (16), Punjab 1 (6), Samudri (6), GG 13 (5), GG 5 (2), local (2), GG 12 (1) and Somnath (2). Farmers have been using six genotypes of which three were released cultivars and three farmer varieties such as Tata sumo, Sandhadi and Shedubhar. The ruling cultivar GG 20 occupied nearly 47% of the fields surveyed followed by GAUG 10 (20%). GG 20 is a Virginia bunch cultivar with good yield potential and also confectionery quality. The distribution pattern of major genotypes viz, GG 20, GAUG 10, GG 2 and Sandhadi across Gujarat was analyzed (Fig. 1).

About 70% of the farmers said they used their own seed, which signifies that they consider groundnut their main crop. Among cultivars, farmers' own seed contributed these percentages: GG 20 (32%), GAUG 10 (13%), Sandhadi (8%) and GG 2 (6%). The market as source of seed contributed about 23% of the total seed requirement. A few farmers depended on their neighbors and kits offered for trial purposes.

As against this, Andhra Pradesh and Karnataka reported a disintegrated and highly localized scenario. Most farmers used a very old variety TMV 2, demonstrating the poor rate of seed replacement in this part of the country. Although new varieties have been released for these regions also, either non-availability of seed to farmers or lack of entrepreneurship has resulted in their non-adoption. The risk taking ability and openness of Gujarat's farmers to new technologies made a big difference their achieving high productivities, an approach that was relatively lacking in Andhra Pradesh and Karnataka.
In Gujarat, about 85% farmers followed monocropping of groundnut, about 12% adopted intercropping and 3% farmers followed both monocropping and intercropping depending on the area and season. In Andhra Pradesh, farmers felt sole cropping reduced levels of organic matter in soil due to the use of chemical fertilizers were unfavorable for quality produce of groundnut.

In both Gujarat and Andhra Pradesh, only about 1% of the farmers suggested that aflatoxins were economically significant in groundnut crop and 99% were not aware of aflatoxin contamination, the reason for this being that they have never seen it, except in Kutch and Bhuj districts of Gujarat. In Kutch and Bhuj, about 48% farmers knew about aflatoxins and considered it an important constraint. Interestingly, of the farmers who knew about aflatoxins, 78% hailed from Nakhatrana taluk where a training program had been organized. Aflatoxin has not widely been perceived as a major problem for various reasons: its effects on quantity or quality of produce cannot be felt or measured directly; most produce at local markets is used for oil extraction; and there is no premium for aflatoxin-free groundnuts. There is a need for raising awareness among farmers and consumers and a need for providing incentives to farmers for aflatoxin-free groundnuts.

In Andhra Pradesh, farmers felt that end-of-season soil-moisture-deficit stress was the major limiting factor in the production of groundnut in the
Table 1. Farmers’ awareness of biotic and abiotic constraints of groundnut in four districts of Andhra Pradesh.

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Percentage of farmers aware</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf spots</td>
<td>75</td>
</tr>
<tr>
<td>Thrips</td>
<td>57</td>
</tr>
<tr>
<td>End-of-season soil moisture deficit stress</td>
<td>52</td>
</tr>
<tr>
<td>Helicoverpa</td>
<td>52</td>
</tr>
<tr>
<td>Bud necrosis</td>
<td>35</td>
</tr>
<tr>
<td>Aflatoxins</td>
<td>33</td>
</tr>
<tr>
<td>Stem rot</td>
<td>32</td>
</tr>
<tr>
<td>Collar rot</td>
<td>32</td>
</tr>
<tr>
<td>Jassids</td>
<td>23</td>
</tr>
<tr>
<td>Rust</td>
<td>18</td>
</tr>
<tr>
<td>Aphids</td>
<td>18</td>
</tr>
<tr>
<td>Termites</td>
<td>18</td>
</tr>
<tr>
<td>Leaf miner</td>
<td>16</td>
</tr>
<tr>
<td>Nematodes</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

region. About 75% of the farmers were aware of losses due to foliar diseases and 63% were aware of root grubs as a constraint (Table 1).

Among diseases, there was more awareness of damage caused by bud necrosis followed leaf spots, stem rot and collar rot, in that order. Among insect-pests, damage due to thrips and *Helicoverpa* were considered important. However, 33% of farmers were aware of the bitter taste of kernels, which is not due to aflatoxins but the production of fatty acids.

They attributed decline in yield of groundnut to poor soil moisture retention, erratic rainfall patterns, and non-availability of high yielding varieties. The majority of farmers continue to grow groundnut as a family tradition and also due to the lack of other economically viable alternatives. Postharvest processing, such as drying and shelling are done by traditional methods, which are time-consuming and often not cost-effective. Studies conducted on the socioeconomic aspects of groundnut cultivation in Kurabalakota mandal, Chittoor district in Andhra Pradesh also revealed similar constraints (Khatana et al. 2001).

Another important constraint was the proper diagnosis of biotic stresses and their management options. In our surveys, we found that farmers are often guided by marketing agencies that offer credit facilities and that sometimes, vested interests override the interests of farmers. Private sector advisors have greater influence on individual farmers because regular contact than was customary with the public sector (Rogers 1996). Studies on sources of
information rated agricultural press, agrochemical representatives and private consultants higher than government advisory services. Biradar et al. (2003) have reported differences in farmers' perceptions in different regions with regard to quality of crop byproducts and their feeding pattern. For example, farmers of the traditional belt considered wheat straw an important fodder source, which is not utilized at all by farmers in dry areas although they grow wheat.

**Successes and limitations of technology transfer**

Many innovative methods of technology transfer have been adopted to effectively communicate the advantages of the improved technology over conventional technology. For any technology to be effective, the basic requirement is its validation at the farmers' level and further refinement to ensure that it suits local needs. The experiences of ICRISAT and other organizations have been quite positive. A participatory evaluation conducted in 2001 helped identify suitable cultivars (Srivastava 2002). Piraux et al. (1996) combined farmers' interests and research results to define suitable interventions for each surveyed farm, with the aim of increasing farm income and restoring soil fertility. The research also yielded elements for formulating an appropriate and realistic agricultural policy for the region. Even though there were differences among farmers of different regions, often farmers responded positively to participatory research programs. In an on-farm participatory mode, Pande et al. (2001) observed that farmers preferred new IDM-responsive genotypes viz, ICGV 89104 and ICGV 91114 over the local variety as farmers realized >50% yield benefit while the new varieties were phenotypically similar to the local variety. The acceptance of new cultivars was primarily because of high yield coupled with disease management and early maturity. These regions are drought-prone and so the crop faces quite often end-of-season drought leading immature pods and pod looses due to crust formation. As farmers also use groundnut haulm as fodder for livestock, fodder quality is also important. These genotypes maintained not only higher pod- and haulm-yields but with IDM also increased digestibility of the fodder (Pande et al. 2002). Pramanick and Malliek (1996) demonstrated through participatory testing that farmers preferred water use-efficient crops and were convinced that the technology increases productivity.

Groundnut is primarily a self-pollinated crop and as such does not offer greatly reward private companies with regard to seed production. The governmental agencies produce most of the seed and farmers also store their own seed. This practice ensures that basic seed is not replaced and old varieties continue to rule. Despite several efforts by governmental agencies to replace old varieties with new ones, the results have been unsatisfactory. In Andhra Pradesh and Tamil Nadu, the popular variety TMV 2 has been mixed over the years and it is now difficult to find pure seed of the variety.
Capacity building of farmers in cluster modes has proved to be a useful mechanism in technology transfer. A common platform for private-public partnership can improve the sustainability of production systems. Regular visits, informal discussions also help with confidence building. Horizontal spread of technology transfer must be given priority.

Various media have been used in this cause: group meetings of farmers at the research stations and villages, distribution of pamphlets in local languages, newspaper reports, radio talks, television programs and audio-visual presentations.

Peanut stem necrosis disease devastated groundnut crops in 2000 in Anantapur. In Andhra Pradesh, awareness and promotional activities to spread information about the causal organism, alternate hosts and management practices for the containment of PSND were taken on in a campaign that involved the district administration, government officials, school children and college students. Before the campaign, the Department of Agriculture officials from Anantapur, Kurnool, Mahboobnagar, Chittoor and Kadapa were made familiar with PSND and PBND symptoms through intensive training programs. The press and electronic media played a pivotal role in spreading the message. As a result, the message reached all 1010 villages in the district.

As *Parthenium hysterophorus* is a major source of the virus inoculum, the district administration launched a mass campaign in 2001 for its removal from wastelands, vacant fields, roadides and field bunds. However, the program lost momentum when farmers failed to get together to remove *Parthenium* from common lands and wastelands. In a similar campaign in Raichur in Karnataka, *Parthenium* was eradicated by spraying glyphosate on bunds.

References


I have planted two varieties of groundnut, ICGV 91114 and ICGV 92093. I received these from ICRISAT along with local cultivars and implemented IDM technology as suggested by ICRISAT scientists. During the current season, the rains were well distributed and pod yields were good. Surprisingly, foliar diseases - which are major yield and quality reducers - were low in both ICGV 91114 and ICGV 92093 cultivars compared to our local cultivar. The quality of fodder in these two cultivars was very high ie, there was low foliar disease and the animals relished them and gave more milk than earlier.

Many farmers in my village have similar observations. I also noticed that the cultivar ICGV 92093 matured in 100 days along with ICGV 91114 instead of 130 days as in the case of TMV 2, which we normally grow. It also produced very high quality of fodder and pods.

S Linga Reddy (Jalalapuram, Bathalapalli Mandal, Anantapur District)

I have a lot of experience growing TMV 2. In the last three years, I have been growing JL 24 from my own seed and ICGV 91114 from ICRISAT. I have also been following the IDM package recommended by ICRISAT scientists.

With this system, we have been able to manage foliar diseases and to some extent stem and pod rots. Nothing can be done if stem necrosis disease attack the crop; preventive measures and cultural practices are the only way to manage it.

The dual purpose ICGV 91114 gave higher pod and fodder yields than JL 24. I gave some seed to other farmers and sold the rest in the market at a premium price. All farmers in the village are very happy with the variety ICGV 91114, because it gave higher pod and haulm yields than the local cultivar even under drought conditions. The fodder is also very healthy and milk yield has increased after it was fed to milch animals.
I am a farmer from Talupuru village, Anantapur. I have been in agriculture for the past 30 years. Today's discussions have been very interesting and issues regarding groundnut cultivation are of interest to all farmers in this district.

Timely rains are most essential to farmers. In spite of timely rains, if the farmer is unable to adopt necessary improved practices, he could lose the crop. Today scientists have many useful tips for farmers. In truth, our ancestral fathers were very knowledgeable about cropping habits. Reluctant to listen to ancient wisdom, modern farmers have used pesticides indiscriminately and uneconomically, resulting in atmospheric pollution and health hazards to humans and cattle.

If we are to obtain higher returns we must act collectively with regard to integrated pest management etc. Awareness, capacity building and resource literacy must be improved among the farming community. Workshops of this kind are useful in imparting knowledge and provide a common platform for exchange of ideas between farmers and scientists.
Session III: Diseased haulm, yield, nutrition and digestibility
Effect of diseased groundnut and sorghum crop residues on nutrient utilization in cattle

Y Ramana Reddy\textsuperscript{1}, K Sivaiah\textsuperscript{1}, T Janardhana Reddy\textsuperscript{1}, S Pande\textsuperscript{2} and M Blummel\textsuperscript{3}

Introduction

Livestock farming is an important occupation for small and marginal farmers and landless laborers in India. To the vast arid zone and drought prone areas of the country, animal farming constitutes a type of drought proof mechanism that generates an alternate source of income. According to FAO (2002), the cattle and buffalo population of India was 219.6 and 80.6 million respectively, producing 87 million tons of milk. While milk production is increasing, feed and fodder resources are declining due to increased population, urbanization and pressure on land for cereal and cash crops. This has led to deficiency of greens, concentrates and dry fodder to an extent of 38, 44 and 45 percent (NIANP 2002) respectively and has caused livestock owners to depend more on crop residues for feeding ruminant livestock.

The major crop residues used for feeding ruminants are from cereals followed by pulses. In the Deccan Plateau in India, sorghum (\textit{Sorghum bicolor}) straw and groundnut (\textit{Arachis hypogaea}) haulms form a major source of dry fodder for dairy animals. In the Plateau alone, the availability of sorghum and groundnut crop residues was 14 million tons, indicating the importance of these crop residues as livestock feed. However, the quality of these crop residues is adversely affected by diseases and storage pests. These reduce nutritive value of crop residues of jowar and groundnut. During the cropping season, plant diseases such as anthracnose and leaf blight attack the sorghum crop and foliar diseases (leaf spot and rust) and stem rot affect groundnut crops, which in turn lower the quantity and quality of residues. This effects the performance of ruminants in terms of growth and milk production. In addition, fodder traders confirm that diseased crop residues command much reduced prices and eat into the profit margins compared to healthier residues (Rama Devi et al. 2000).

Since no systematic studies are available on the devastating effects of plant diseases on the fodder value of crop residues, an attempt was made at Acharya

\textsuperscript{1} Department of Animal Nutrition, College of Veterinary Science, ANGRAU, Hyderabad, Andhra Pradesh, \textsuperscript{2} Principal Scientist (Pathology), ICRISAT, Patancheru, Andhra Pradesh, India. \textsuperscript{3} Ruminant Nutritionist, ILRI South Asia Project, ICRISAT, Patancheru, Andhra Pradesh, India.
Effect on chemical composition of feed

The proximate principles (AOAC 1997) other than crude protein (CP), crude fiber (CF) and nitrogen free extract (NFE) content were not affected by the diseases (Table 1). The CP and NFE content were lower and CF was higher in diseased sorghum straw and groundnut haulms. Among cell wall constituents (Van Soest et al. 1991), the neutral detergent fiber (NDF), acid detergent fiber (ADF) and cellulose content of diseased sorghum and groundnut crop residues were higher and hemicellulose content was lower compared to healthy crop residues (Table 1). Increase in NDF, ADF and cellulose content was observed with an increase in intensity of foliar disease in sorghum straw (Gandhi et al. 1980). Decrease in CP content, soluble carbohydrates and increase in fiber fractions in diseased residues could be due to higher content of stem portion and reduced level of leaf portion. Leaf spot and rust causes general weakening of foliage by excessive spotting on the leaves, which results in defoliation. The damage caused to the leaves in addition to their loss is also responsible for low CP, soluble carbohydrate content and high fiber content.

Table 1. Effect of disease on chemical composition (% dry matter basis) of sorghum straw and groundnut haulms.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Sorghum straw</th>
<th>Groundnut haulms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Healthy</td>
<td>Diseased</td>
</tr>
<tr>
<td><strong>Proximate principle</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry matter</td>
<td>90.75</td>
<td>87.56</td>
</tr>
<tr>
<td>Organic matter</td>
<td>93.78</td>
<td>93.93</td>
</tr>
<tr>
<td>Crude protein</td>
<td>05.40</td>
<td>03.91</td>
</tr>
<tr>
<td>Ether extract</td>
<td>00.90</td>
<td>01.00</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>33.05</td>
<td>38.20</td>
</tr>
<tr>
<td>Nitrogen free extract</td>
<td>54.34</td>
<td>50.82</td>
</tr>
<tr>
<td>Total Ash</td>
<td>06.22</td>
<td>06.07</td>
</tr>
<tr>
<td><strong>Cell wall constituents</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral detergent fiber</td>
<td>66.96</td>
<td>69.57</td>
</tr>
<tr>
<td>Acid detergent fiber</td>
<td>47.59</td>
<td>48.86</td>
</tr>
<tr>
<td>Hemicellulose</td>
<td>19.37</td>
<td>20.71</td>
</tr>
<tr>
<td>Cellulose</td>
<td>35.03</td>
<td>38.41</td>
</tr>
<tr>
<td>Lignin</td>
<td>10.17</td>
<td>09.03</td>
</tr>
</tbody>
</table>
Effect on \textit{in vitro} and \textit{in situ} disappearance of dry matter

\textit{In vitro} dry matter digestibility (IVDMD) of crop residues was adversely affected by plant diseases. IVDMD was lower by 16.48 to 20.22 percent in diseased jowar (sorghum) and 16.11 to 28.85 percent in diseased groundnut haulms when evaluated (Table 2) by the Tilley and Terry method (1963) with rumen liquor of both cattle and buffaloes. Similarly the effectively degradable dry matter (EDDM) calculated by the McDonald model (1981) through \textit{in sacco} studies (Kempton 1980) using fistulated Deoni steers and Murrah male buffaloes, was decreased by 16.91 to 22.99 percent and 16.15 to 34.87 percent respectively when diseases affected the sorghum and groundnut crops (Table 2). Lower IVDMD and EDDM of diseased crop residues may be due to high fiber and low CP content. A significant negative correlation exists between fiber content and \textit{in sacco} DM digestibility of fodders (Rajput et al. 1991). Further, anthracnose in sorghum, leaf spot and rust in groundnut have the effect of hastening maturity which might account for higher DM disappearance of healthy sorghum and groundnut crop residues compared to diseased residues.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sorghum straw</th>
<th>Groundnut haulms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cattle</td>
<td>Buffaloes</td>
</tr>
<tr>
<td>IVDMD</td>
<td>37.24</td>
<td>29.71</td>
</tr>
<tr>
<td>Rumen kinetics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>14.60</td>
<td>14.20</td>
</tr>
<tr>
<td>B</td>
<td>42.28</td>
<td>34.60</td>
</tr>
<tr>
<td>C</td>
<td>0.047</td>
<td>0.044</td>
</tr>
<tr>
<td>EDDM</td>
<td>36.43</td>
<td>30.27</td>
</tr>
</tbody>
</table>

Effect on voluntary intake and nutrient digestibility

The dry matter intake or DMI (% of body weight) was significantly (P<0.01) low in cattle and buffaloes fed with diseased groundnut haulms (Table 3). Feeding of diseased sorghum straw also reduced the DM intake significantly (P<0.01) in cattle and non-significantly (P>0.05) in buffaloes. Lower dry matter intake (DMI) in cattle and buffaloes fed with diseased sorghum and groundnut crop residues resulted from high fiber and low leaf content. Feeds that are of equal digestibility but differing in cell wall constituents will promote different intakes. Cell walls in leaves are easily broken down so animals given
leaves eat about 40% more DM per day than those offered stems (McDonald 1999). Further, the palatability of diseased crop residues was affected due to defoliation.

Nutrient digestibility of diseased crop residues in comparison to healthy ones is estimated by different techniques. Digestibility coefficients of DM, OM, CP and NFE was significantly (P<0.01 or P<0.05) higher in cattle and buffaloes, fed healthy sorghum and groundnut crop residues than those fed diseased ones (Table 3). The ether extract (EE) digestibility was significantly

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI (kg/d)</td>
<td>1.95&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.83&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.32</td>
<td>4.09</td>
<td>2.71&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.14&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.61</td>
<td>4.21</td>
</tr>
<tr>
<td>DMI (% bwt)</td>
<td>1.87&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.68&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.85</td>
<td>1.70</td>
<td>2.75&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.87&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.73&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Digestibility of nutrients (%)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td>47.54&lt;sup&gt;a&lt;/sup&gt;</td>
<td>43.49&lt;sup&gt;b&lt;/sup&gt;</td>
<td>48.32&lt;sup&gt;c&lt;/sup&gt;</td>
<td>44.19&lt;sup&gt;d&lt;/sup&gt;</td>
<td>55.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>48.13&lt;sup&gt;b&lt;/sup&gt;</td>
<td>58.57&lt;sup&gt;c&lt;/sup&gt;</td>
<td>50.17&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>OM</td>
<td>51.72&lt;sup&gt;a&lt;/sup&gt;</td>
<td>48.51&lt;sup&gt;b&lt;/sup&gt;</td>
<td>52.40&lt;sup&gt;c&lt;/sup&gt;</td>
<td>47.08&lt;sup&gt;d&lt;/sup&gt;</td>
<td>57.51&lt;sup&gt;a&lt;/sup&gt;</td>
<td>51.56&lt;sup&gt;b&lt;/sup&gt;</td>
<td>61.73&lt;sup&gt;c&lt;/sup&gt;</td>
<td>55.42&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>CP</td>
<td>50.16&lt;sup&gt;c&lt;/sup&gt;</td>
<td>35.27&lt;sup&gt;d&lt;/sup&gt;</td>
<td>42.47&lt;sup&gt;c&lt;/sup&gt;</td>
<td>26.35&lt;sup&gt;d&lt;/sup&gt;</td>
<td>60.27&lt;sup&gt;c&lt;/sup&gt;</td>
<td>34.64&lt;sup&gt;d&lt;/sup&gt;</td>
<td>47.91&lt;sup&gt;c&lt;/sup&gt;</td>
<td>32.29&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>EE</td>
<td>50.21&lt;sup&gt;c&lt;/sup&gt;</td>
<td>32.76&lt;sup&gt;d&lt;/sup&gt;</td>
<td>50.69&lt;sup&gt;c&lt;/sup&gt;</td>
<td>58.92&lt;sup&gt;d&lt;/sup&gt;</td>
<td>34.41</td>
<td>32.65</td>
<td>32.81</td>
<td>36.29</td>
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<tr>
<td>CF</td>
<td>40.94</td>
<td>42.25</td>
<td>47.16</td>
<td>48.65</td>
<td>50.46</td>
<td>48.23</td>
<td>58.83</td>
<td>59.21</td>
</tr>
<tr>
<td>NFE</td>
<td>58.46&lt;sup&gt;a&lt;/sup&gt;</td>
<td>54.55&lt;sup&gt;b&lt;/sup&gt;</td>
<td>55.74&lt;sup&gt;c&lt;/sup&gt;</td>
<td>48.03&lt;sup&gt;d&lt;/sup&gt;</td>
<td>61.76&lt;sup&gt;c&lt;/sup&gt;</td>
<td>58.67&lt;sup&gt;d&lt;/sup&gt;</td>
<td>65.55&lt;sup&gt;c&lt;/sup&gt;</td>
<td>53.05&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>NDF</td>
<td>35.09</td>
<td>33.57</td>
<td>43.94&lt;sup&gt;c&lt;/sup&gt;</td>
<td>38.72&lt;sup&gt;d&lt;/sup&gt;</td>
<td>58.83&lt;sup&gt;c&lt;/sup&gt;</td>
<td>47.18&lt;sup&gt;d&lt;/sup&gt;</td>
<td>68.97&lt;sup&gt;c&lt;/sup&gt;</td>
<td>53.05&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>ADF</td>
<td>30.32</td>
<td>27.26</td>
<td>40.83</td>
<td>43.56</td>
<td>51.21</td>
<td>49.06</td>
<td>61.36&lt;sup&gt;c&lt;/sup&gt;</td>
<td>44.82&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Hemicellulose</td>
<td>46.55</td>
<td>48.13</td>
<td>55.67&lt;sup&gt;c&lt;/sup&gt;</td>
<td>27.04&lt;sup&gt;d&lt;/sup&gt;</td>
<td>72.90&lt;sup&gt;c&lt;/sup&gt;</td>
<td>40.69&lt;sup&gt;d&lt;/sup&gt;</td>
<td>82.68</td>
<td>80.41</td>
</tr>
<tr>
<td>Cellulose</td>
<td>33.40</td>
<td>36.13</td>
<td>38.05</td>
<td>40.81</td>
<td>56.55&lt;sup&gt;c&lt;/sup&gt;</td>
<td>44.73&lt;sup&gt;d&lt;/sup&gt;</td>
<td>56.36&lt;sup&gt;c&lt;/sup&gt;</td>
<td>50.84&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Nutritive value

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digestible crude protein (DCP) %</td>
<td>2.71&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.38&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.29</td>
<td>1.03&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.49</td>
<td>2.92&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.16</td>
<td>2.72&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total Digestible Nutrients (TDN) %</td>
<td>48.58&lt;sup&gt;a&lt;/sup&gt;</td>
<td>45.97&lt;sup&gt;b&lt;/sup&gt;</td>
<td>49.30&lt;sup&gt;a&lt;/sup&gt;</td>
<td>45.33&lt;sup&gt;b&lt;/sup&gt;</td>
<td>51.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>49.33&lt;sup&gt;b&lt;/sup&gt;</td>
<td>53.41&lt;sup&gt;a&lt;/sup&gt;</td>
<td>49.18&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Metabolizable Energy (ME) (M cal/kg of DM)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Healthy</th>
<th>Diseased</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.76&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.66&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.64&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.85&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.78&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.93&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.78&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

ME value is calculated using the NRC (1978) formula.

<sup>a</sup>,<sup>b</sup> P<0.05
<sup>c</sup>,<sup>d</sup> P<0.01
lower in cattle and buffaloes fed sorghum straw but not in those fed diseased groundnut haulms. Diseases had no apparent effect on CF digestibility of crop residues. But feeding diseased groundnut haulms to cattle or buffaloes reduced the digestibility of NDF, ADF, hemicellulose and cellulose (Table 3) significantly (P<0.01 to P>0.05). In case of sorghum straw, diseases significantly (P<0.01) lowered the NDF and hemicellulose digestibility but not ADF and cellulose digestibility in buffaloes, whereas in cattle, feeding of diseased sorghum straw had no effect on fiber fractions digestibility.

Digestibility in ruminants is highly correlated positively with protein content and negatively with fiber content (Church 1980). Nutrients digestibility was low in diseased crop residues due to loss of some vital nutrients like CP and soluble carbohydrates resulting in increased amount of fiber fractions. Further increased content of phenol in diseased residues binds with protein, thereby adversely affecting its digestibility. In addition, nucleic acid content is much higher in diseased residues, which contributed to reduced CP digestibility (Tripathi and Chiranjeevi 1976). Lower digestibility of NDF, cellulose and hemicellulose fractions of diseased GN haulms could be due to its higher lignin content resulted from shedding of leaves.

**Effect of diseases on nutritive value**

Effect of diseases of sorghum and groundnut crops on nutrient digestibility has reflected on the nutritive value of their residues expressed in terms of digestible crude protein (DCP) and total digestible nutrients (TDN) in cattle and buffaloes. DCP (P<.01) and TDN (P<0.05) content of diseased sorghum straw was reduced significantly by 55.02 and 8.05 percent in buffaloes, 49.08 and 5.37 percent in cattle and that of diseased groundnut haulms by 47.29 and 7.92 percent in buffaloes and 55.01 and 3.56 percent in cattle (Table 3) compared to those fed healthy crop residues.

**Conclusion**

From these findings, it can be concluded that diseases of sorghum and groundnut crops have devastating effect on nutrient composition, dry matter intake, *in vitro*, *in sacco* and *in vivo* digestibility of nutrients and nutritive value of sorghum straw and groundnut haulms when fed to cattle and buffaloes. Further research should be aimed at the effects of feeding diseased crop residues on growth, milk production, rumen fermentation patterns and immune response of animals in order to assess the quality of residues as livestock feed. Strategies to overcome the effects of plant diseases on crop residue quality need to be worked out.
References


India has the largest population of ruminants in South Asia, and livestock production is an integral part of mixed farming systems. However, in recent times, specialized peri-urban/urban dairy production has been developed by the landless in many areas. The so-called "livestock revolution" will provide opportunities for increased production of milk to meet the requirements of the 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 quality feed resources throughout the year. As common property resources for grazing continue to dwindle with increased cultivation, so the dependence on crop residues (mainly cereals and legume crops) and agro-industrial by-products will increase in importance. Presently, in the semi-arid regions of India, crop residues account for 50-70% of the total dry matter fed to large ruminants. However, the fodder quality of crop residues is often low and technologies for improvement of fodder quality through chemical and biological treatment of straw were largely unsuccessful due to water, labor and capital constraints. Breeding for improved dual-purpose cultivars with superior grain and crop residue fodder quality through multidimensional crop improvement with close collaboration of plant, animal and social scientists was shown to overcome afore-mentioned constraints.

Impact of groundnut variety ICGV 91114 on milk yields

In the Deccan Plateau in Andhra Pradesh, traditional dual-purpose groundnut crops provide most of the fodder resources fed to large ruminants. Surveys of sample farmers in project villages indicate that groundnut accounts for 61-75% of the cropped area under rainfed and irrigated conditions. Groundnut haulms provide >50% of dry fodder, and >25% of haulm is exchanged in the village. Also, the farmers purchase 75% of paddy straw from distances 100 - 150 km away, and 50% of sorghum straw from nearby villages. The traditionally
used cultivars were susceptible to a number of foliar diseases that reduced pod and haulm production and haulm (fodder) quality. Using the participatory approach and multidimensional crop improvement, cultivar ICGV 91114 was identified as highly responsive to disease management practices. It was also found to have high levels of tolerance to drought, and had superior dual-purpose characteristics. Comprehensive village level studies showed that ICGV 91114 mean pod yields and haulm yields were 15 and 17% higher respectively than those of local cultivars.

Milk yields in dairy animals (mostly buffaloes but also dairy cows) fed haulms from improved cultivar ICGV 91114 were about 10% higher (total daily yield 4.36 kg/d) than when animals were fed the local cultivars TMV 2 and JL 24 (total daily yield 3.92 kg/d). About 70-80% of milk is sold through both formal and informal channels, and income from sales ranges from 15-25% at the household level. The advantage from growing improved cultivars is therefore threefold: 1) higher pod yields, 2) higher haulm yields and 3) higher milk yields from dairy animals fed the haulms. The impact that cultivar ICGV 91114 is likely to have on the production of groundnut in Anantapur has been studied based on the performance of the cultivar in relation to the existing cultivars, ie, TMV 2 and JL 24, the two prominent varieties in the region. Adoption rates have been assumed at very conservative levels of 2, 4, and 8 percent for the period 2005-2009 for both dry and irrigated groundnut. The area under groundnut in the district is assumed to be stable at 0.8 million hectares per annum for the period of assessment. For the dairy enterprise it is assumed that 70% of the dry fodder requirement of milch animals is met by the haulm of groundnut and remaining 30% by paddy and sorghum straw. The price of pods is assumed to be Rs 16.50 per kg and milk Rs 9 per kg. Accordingly, the incremental benefit during 2005 would be around Rs 60.6 million that comprises Rs 51.4 million due to groundnut crop and Rs 9.2 million due to the dairy segment. The incremental benefit progressively increases to Rs 121.3 in 2007 and Rs 242.5 million in 2009.

**Sorghum: Higher stover yield and quality**

The importance farmers give to stover quality was one of the major factors for the adoption of improved sorghum varieties/hybrids, since farmers felt that stover fodder quality is lower in improved cultivars when compared to traditional cultivars. With this background, improved sorghum cultivars were evaluated in comparison to traditional cultivars in farmers' fields for stover quality traits under the DFID funded project on *Exploring marketing opportunities through a research, industry and users coalition: Sorghum poultry feed* aimed at enhancing the access and availability of rainy season sorghum for poultry feed rations. The digestibility of ICRISAT/partner-released improved sorghum cultivars were
found superior. Among the cultivars analyzed, S 35 had the highest digestibility (46.3%), followed by PSV 16 (46.0%), CSV 15 (45.9%) and CSH 16 (43.0%). The digestibility of local sorghum was only 40.5%. It was also found that irrespective of the soil type, the improved cultivars are found superior to local cultivars for their stover digestibility.

Thus, the prospects for enhancing the genetic potential of sorghum cultivars for stover digestibility were evident. While the improved cultivars were on par with the local cultivars for NDM content irrespective of soil type, they were significantly superior to local cultivars for stover digestibility in *burka* and red soils. The study provides sufficient evidence to dispel farmers' perceptions about improved cultivars having poor stover nutritive value and digestibility. The improved cultivars (eg, CSV 15) are on par with the local varieties (yellow pericarp type) for fodder yield but their grain productivity is significantly higher.
Feeding diseased vs healthy groundnut haulms: Farmers' perceptions

V Ramalinga Reddy (Gummallakunta, Bathalapalli Mandal, Anantapur District)

ICRISAT scientists (Suresh Pande and his group) gave me four varieties of groundnut seed: ICGVs 89104, 91114, 92020 and 92093 as a trial. Of these, ICGV 89104 and 91114 are early maturing, and 92020 and 92093 are medium-maturing cultivars. All these cultivars are high yielding and gave 50-60 bags/ha (40 kg/bag) of pod and very high yield of haulm, under proper management. These cultivars were also more resistant to insect pests and diseases. The fodder from these varieties was kept separate and fed to milch animals and there was a definite increase in milk yield as a result. I observed that health of buffaloes also improved.

ICGV 91114 matured in 90 days after sowing. It withstands drought better than the local variety. It can be grown under rainfed conditions as well as under irrigated conditions. ICGV 89104 has very small pods and as such is not acceptable to farmers in this area.

In my opinion, ICGV 92020 is also a good variety. Pod and fodder yields are excellent and the cultivar also withstands pests and diseases. While ICGV 91114 is suitable for rainfed as well as irrigated conditions, ICGV 92020 is suited only to irrigated conditions. Both these varieties gave higher fodder and pod yields than local cultivars.

P Indiramma (Jalalapuram, Bathalapalli Mandal, Anantapur District)

Fodder from ICGV 91114 was very good for milch animals. The fodder was less diseased and retained more leaves. My buffaloes started to give one extra liter of milk after being fed residue from this variety. The cultivar also yielded 1 1/2 times more pods than the local variety. I observed the crop both in kharif and rabi and the crop was excellent in both seasons. The crop matures 15 days earlier than our local variety. I sowed 45 kg seed and obtained 35 bags of 40 kg each.
International agriculture research centers such as ICRISAT, ICARDA, CIAT, CIP, ICRAF and HTA, non government organizations (NGOs), traditional community groups have jointly initiated the multi-partner Fodder Innovations Project to enhance livelihoods of poor livestock keepers. They seek to do this through increasing the use of fodder through adoption of fodder innovations. The project took up fodder innovations on a pilot basis in 12 watershed villages in 2004 in partnership with Accion Fraterna/Rural Development Trust (AF/RDT), Anantapur.

AF/RDT has conducted participatory rural appraisals (PRAs) to prepare an action plan for 2004. The PRA methods used include various space related aids such as social mapping, livestock resource mapping, service and opportunities mapping; time related PRA methods such as time line, trend analysis, seasonality diagrams and matrix ranking; and scoring methods and force field analysis pertaining to issue of livestock and fodder.

The outcome of the PRA exercises clearly indicated that:

1. All livestock owners face shortage of fodder every year. They have been purchasing paddy straw, groundnut haulms or sorghum stover to supplement their crop residues.
2. Due to shortage of fodder in continuous drought-prone areas, livestock farmers have resorted to distress sales or migrating to canal command areas with their cattle.
3. Application of farmyard manure to fields has reduced considerably due to the reduction in animal population. Most farmers have shifted to using chemical fertilizers.
4. There is a great reduction of crop yields over the years due to the non-application of farm yard manure to fields.

During PRA exercises, farmers came up with the following resolutions to overcome the fodder shortages.

• Concentrate on dual-purpose groundnut cultivar ICGV 91114 that yields more grains and provides fodder with greater nutrition.
• Take up seed multiplication of dual-purpose groundnut varieties at the village level.
• Raise fodder value crops as part of intercrops and mixed crops.

1 Field Coordinator, Fodder Innovations Project, AF/RDT, Anantapur, Andhra Pradesh, India.
• Raise fodder value trees such as subabul and linseed in the village common property resource lands (CPR lands). Also broadcast *Stylosanthes hamata* seeds in CPR lands and protect them.

• Raise fodder value trees and broadcast *S. hamata* seeds on field bunds to meet fodder shortages.

• Take up dairy programs to support livelihoods during drought years.

• Upgrade existing milch animals for better milk yields.

• Take up green fodder crops in some part of irrigated lands.
Session IV: Harvest management and marketing of pod and fodder (haulms) in groundnut
Management of harvesting in groundnut

S Vasundhara

Groundnut is the major oilseed crop in Anantapur and is grown in about 8 lakh ha under rainfed conditions. The rainfall distribution and occurrence in this district is most unpredictable. Keeping this in view, farmers in this region take up sowing of groundnut immediately after the first rains from mid-June till 15 August during kharif.

Soils are shallow (15-20 cm) with relatively poor water retention, and so farmer seek to utilize available soil moisture and take up sowing quickly. Thus, there is only a short period available for groundnut sowings by using available machinery and manpower.

This competition for machinery continues for other operations like weeding and intercultivation until harvest. All these operations are time bound as timing affects yield directly.

Our observations at the Agricultural Research Station, Anantapur reveal:

- Crop growth is minimum during the moisture stress period.
- Crop recovers from moisture stress on receiving sufficient rainfall.
- Growth is faster after recovery from stress.
- Crop duration is extended if moisture stress occurs. Duration differs depending on the stage at which stress occurs.

Usually farmers harvest groundnut (when rains have been received) between 85-95 DAS because of stem rot and also assuming that no further rains will be received. This resulted in:

- Low shelling percentage.
- Not benefiting fully from late leaf spot control measures. At harvest, if the land has received light showers, farmers will prefer to harvest by hand pulling, resulting in competition for labor.

In order to avoid this and get maximum benefit from existing conditions, farmers could:

- Effectively utilize plant protection sprays by extending crop duration for a reasonable period depending on soil and crop conditions.
- Avoid competition for labor by using a cattle pair or machinery.

This would result in additional yield with increased shelling percent at no extra cost. This practice could substantially increase yields and shelling percentage in Anantapur.

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1 Senior Scientist (Plant Breeding), ARS, ANGRAU, Anantapur, Andhra Pradesh, India.
The present marketing system for groundnut: Constraints and opportunities

V Reddappa Reddy

Introduction

Any discussion on marketing of agricultural output generally includes a few factors: marketing support from the state government and private traders, exploitation of farmers by both these agencies, failure of the state to provide opportunities for producers to fix the prices of agricultural goods themselves, and non-remunerative prices fixed by the state government.

I believe that there is scope to go beyond these and that this will, if properly exploited, help the farming community. The present paper is an attempt to discuss the 'scope' and the arguments I make and examples I take are based on discussions I had with farmers of Bathalapalli mandal who were supplied with new groundnut seed of the variety ICGV 91114.

Let me specify however that these are only stray ideas, and may not work in the field. Moreover, these ideas are presented from the perspective of farmers who attended the meeting at ICRISAT-ANGRAU, Anantapur, rather than researchers.

Increasing the profit margin

Farmers generally take into account gross incomes from farming. It is a matter for pride for them to grow and sell as much as they can. Net returns are usually too subtle for them to grasp. Let me explain. For example, one farmer spends Rs 10000 producing groundnut. He earns a gross amount of Rs 16000 and is happy with this. He forgets that he borrowed money at an interest of Rs 2 per hundred per month and has to pay Rs 2000 towards interest. He also forgets that the bullocks he uses to raise the crop must be fed throughout the year, costing a further amount of Rs 2400 for fodder. He hardly realizes that his actual profit is only Rs 1600. How to maximize the farmer's profit must be part of any research on farming.
The first generation farmers

Seed of cultivar ICGV 91114 that was used by farmers in these trials are not ordinary seed. The variety has been developed by researchers after years of effort. The seed and IDM technology was supplied to farmers free of cost. Although farmers have used these resources and reaped outputs, they have not marketed them the way it might have been expected.

To elaborate, seed of this cultivar ICGV 91114 is not available outside these sites. These farmers are first generation farmers and as such, with proper information and advertisement - dissemination about the cultivar's characteristics and yield levels - they could have commanded excellent prices for this seed. Unfortunately, farmers have ignored such a possibility, and sold them as they would any other local cultivar of groundnut.

Absence of grading

Farmers are not very appreciative of grading, as it costs them more. Groundnut farmers tend to mix all varieties of groundnut, ignoring moisture levels and quality of the pods. All varieties are pooled together and sold at a cheaper rate.

Likewise, a majority of farmers mix their haulms, while they would have benefited more storing and selling them separately, specially to cattle owners from peri-urban areas, who are particular about better quality haulms.

Needed: A proactive approach

One of the IDM strategies is to have all farmers in a village come together to arrange fires in the fields to attract and destroy pests. Farmers have baulked at this very simple practice and it has been difficult to mobilize farmers into conducting the exercise.

Other scientists have recommended the construction of farm ponds to protect the groundnut crop during the critical dry season. Again, farmers have held back ostensibly on account of the cost, which was Rs 50000. Consequently, scientists also put forward a different model for the farm pond that cost only Rs 8000. This also, however, has received no positive response from the farmers at this conference. By implication, they are depending on the state government to help in the construction of the pond. Now my question is: 'When farmers spend several lakh of rupees digging bore wells that may or may not give them water, when they routinely collapse under the weight of heavy debts, why can they not spend a sum of Rs 8000, construct community farm ponds, and partially guarantee their crops?'
We face several problems in marketing groundnut produce at local markets. If we sell the produce in our own village, the middleman takes the produce on credit and doesn't pay promptly. Businesspersons from Tamil Nadu came to our villages and purchase produce on cash payment provided we give them one kg pod extra per bag (41 kg/bag). We have preferred to do this over the years.

The popular variety TMV 2 can be sold for oil to the mills, while JL 24 can be sold as kernels also. Businessmen from Kalahasti prefer JL 24 and they buy groundnut only in the months of November and December @ Rs 800 to Rs 1000 per bag of 40 kg pods. We prefer to sell pods rather than kernels because it involves less labor. If we had a machine to dehull pods, we would have liked that because it would have meant that the husk - which is very good manure - would’ve remained with us. When sold as kernel, we save on transport charges, get better rates, and further benefit from the fact that shells can be recycled to the field and reduces fertilizer bills.

If the seed quality is good, it is better to decorticate and sell as seed. On the other hand, if produce is of slightly inferior variety, it is best to sell them as pods. Some discretion needs to be used when marketing groundnut.

Marketing new varieties is a problem as traders reduce the prices of pods from new cultivars. We request scientists and government agencies to look into these problems.
Session V: Linkages and seed systems
Sorghum for mixed crop-livestock systems in the Deccan Plateau

BVS Reddy

Introduction

Sorghum is one of the most important food and feed crops in the arid and semi-arid tropics of the world. Sorghum being C_4 species with higher photosynthetic capacity, and greater nitrogen and water use efficiency is relatively more drought-tolerant than other comparable cereals such as maize and comes up well in areas where it is difficult to cultivate maize. It can be cultivated in problematic soils (acidic and saline) and in a range of temperature (15 to 45°C) conditions. It fits well in a range of cropping systems with pigeonpea, cowpea, groundnut etc. In India, sorghum is the third most important food grain after rice and wheat. In the Deccan Plateau of Andhra Pradesh, postrainy season sorghum area and production (337,000 ha and 332,000 t) are higher than figures for the rainy season (258,000 ha and 254,000 t) (CMIE 2004).

Adaptations

Sorghum is grown in both rainy and postrainy seasons. While rainy season sorghums are grown both in vertisols and alfisols, postrainy sorghums are predominantly grown on vertisols using residual soil moisture. In regions where irrigation facilities are available either through open wells, borewells or canals, sorghums are also grown in the summer.

Uses

While grains from rainy season-adapted sorghums are used mostly for poultry and livestock feed, alcohol and starch manufacturing (Kleih et al. 2000), stalks (stover) are used for animal fodder. Best food quality grains (lustrous, bold and semi-corneous) come from postrainy season-adapted cultivars. Stover from postrainy season sorghum is also highly valuable as animal fodder. Sorghum stover is an integral component of maintenance rations of ruminant livestock, especially of smallholder farmers. For farmers, both grain and stover (crop residue) are of equal importance in both seasons and market value of harvested stover almost equals harvested grain (Seetharam et al. 1995).

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1 Special Project Scientist (Breeding), ICRISAT, Patancheru, Andhra Pradesh, India.
Constraints

In Andhra Pradesh, sorghum grain and stover productivity in rainy (1.0 t/ha and 2.5 t/ha) and postrainy seasons (0.9 t/ha and 2.25 t/ha) at farmers' field level is lower than productivity at research stations (6 t/ha and 12 t/ha in the rainy season and 4 t/ha and 10 t/ha in the postrainy season). Among reasons are damage due to shoot fly and grain mold during the rains and shoot fly and terminal drought post rains.

Improved cultivars

Several improved cultivars (based on ICRISAT's improved germplasm or their derivatives) for both rainy and postrainy season adaptations have been developed and released for cultivation in Andhra Pradesh and/or throughout India by ICRISAT in collaboration with Indian Council of Agricultural Research (ICAR), state agricultural universities and private seed companies.

Rainy season

CSV 15: A medium duration (110 to 115 days), high yielding, dual-purpose variety released in India by the Indian Sorghum Program in 1994. CSV 15 has a tan plant color with thin and highly juicy stems with 13% sugar and a grain yield of 2.9-3.1 t/ha and a fodder yield of 12.0-13.0 t/ha.

PSV 16 (Palem Sorghum Variety 16): A medium duration (105 to 110 days) variety developed at Regional Agricultural Research Station, Palem, Andhra Pradesh, and released for cultivation in Andhra Pradesh. It has a tan plant color with juicy stalks (12% sugar). Grain yield of 3.0-3.5 t/ha and fodder yield of 8.0-10.0 t/ha with pearly white and medium bold grains (3.2 g/100-seeds). It is tolerant to drought and major insect pests such as shoot fly and stem borer and diseases like grain mold.

CSH 18: A medium duration (105 to 112 days), grain mold-tolerant hybrid developed at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Indore, Madhya Pradesh, and released for cultivation throughout sorghum-growing regions in India in 2000. Plant color is tan with thick and juicy stems (16% sugar content). Grain yield of 4.8-5.5 t/ha and fodder yield of 9.0-10.0 t/ha with pearly white and medium size grains (2.8 g/100grains).

PSH 1 (Palem Sorghum Hybrid 1): A dual-purpose medium duration (105-110 days) hybrid, developed at Regional Agricultural Research Station (RARS), Palem, Andhra Pradesh, and released for rainy season cultivation in the state in 1998. Plant color is tan and it has thick and juicy stems. Its grain yield is 4.5-4.8 t/ha and fodder yield, 11.0-12.0 t/ha with cream-colored medium sized grains. It is tolerant to shoot fly, stem borer and rust.
JK Jyoti: A dual-purpose medium duration (105-110 days) hybrid developed by JK Agri-genetics, Secunderabad, Andhra Pradesh. Plant color is tan with thick and juicy stems. It produces a grain yield of 4.0-4.5 t/ha and fodder yield of 8.0-10 t/ha with cream-colored lustrous bold grains (3.6 g/100 grains). It is tolerant to drought and pests.

MLSH 296: A dual-purpose medium duration (104-108 days) hybrid developed by Mahendra Hybrid Seeds Co Ltd, Jalna, Maharashtra. It has a tan plant color with medium thick stems. It produces a grain yield of 4.0-4.5 t/ha and fodder yield of 8.0-10 t/ha with pearly white bold grains (3.5 g/100 grains). It is tolerant to drought and aphids.

Paras Pradhan: A dual-purpose medium duration (105-110 days) hybrid developed by Emergent Genetics India Pvt. Ltd. It has a tan plant color with medium thick stems. It produces a grain yield of 4.5-5.0 t/ha and fodder yield of 8.0-10 t/ha with bold, white and globular grains (3.2 g/100 grains). It is tolerant to lodging.

Postrainy season

NTJ 2 (Nandyala Tella Jonna 2): A dual-purpose late-duration (125-130 days) pure line variety developed at RARS, Nandyal, and released for postrainy season cultivation in Andhra Pradesh in 1990. It has a tan plant color with thick and juicy stems with 18.5% sugar content. It produces grain yield of 3.0-3.2 t/ha and fodder yield of 10 t/ha. Grains are pearly white and bold (3.3 g/100 grains).

SPV 1411 (Parbhani Moti): A dual-purpose medium duration (115-120 days) postrainy season adapted variety derived from GD 31-4-2-3, a landrace selection (IS 33844-83) developed at ICRISAT. It was developed and released by Marathwada Agricultural University, Parbhani, as 'Parbhani Moti' for postrainy season cultivation in Maharashtra in 2002. It produces a grain yield of 3.5-3.7 t/ha and a fodder yield of 7.2-7.5 t/ha. The grains (3.3 g/100 grains) are pearly white and bolder than the popular variety M 35-1 (3.1 g/100 grains). Its protein and free sugars contents and bhakri making and stover qualities are significantly superior to SPV 1359 and comparable to M 35-1.

SPV 422: A dual-purpose medium-duration (110 to 115 days) postrainy season-adapted variety derived from good grain population. It has a tan plant color with red plumes and juicy stalks. It produces a grain yield of 3.5-4.0 t/ha with good thresh ability and fodder yield of 10-11 t/ha with creamy white grains bolder than that of M 35-1.
Irrigated areas

In the regions where irrigation facilities are available, grain sorghum hybrids are grown especially in the summer season. Hybrids such as JK Jyoti, MLSH 296, Paras Pradhan, PSH 1 and CSH 18 are suitable for cultivation at this time. Forage sorghums are popular in irrigated tracts, especially in peri-urban areas in all seasons ie, rainy, postrainy and summer seasons. Of late, sweet sorghum cultivation is also becoming popular in irrigated tracts.

1. Forage sorghum
The growing dairy industry has resulted in greater demand for cattle fodder. Among forage crops, sorghum offers great potential to supplement fodder resources because of its drought tolerance, wide adaptation, rapid growth, high green and dry fodder yields and good quality (Pahuja et al. 2002). The improved cultivars for the postrainy season such as NTJ 2, SPV 1411 and SPV 422, and rainy season cultivars such as CSV 15 are excellent sorghum varieties for fodder. Some other promising, high-yielding, tillering and non-tillering fodder sorghum varieties with juicy stalks are listed in Tables 1 and 2. Farmers tend to have apprehensions about stover quality of improved cultivars; however, stover quality traits such as stem sweetness, leafiness and digestibility of improved sorghum cultivars are better or at the least on par with local varieties (Table 3).

2. Sweet sorghum
With the Government of India's policy to blend ethanol in petrol and diesel at 5% level and the likely increase of this proportion upto 10% in a phased manner, the use of sweet stalk sorghums for ethanol production is assuming

<table>
<thead>
<tr>
<th>Variety</th>
<th>Brix's reading at maturity</th>
<th>Fresh fodder yield (t/ha)</th>
<th>Grain yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 33558-1</td>
<td>21.67</td>
<td>54.88</td>
<td>0.35</td>
</tr>
<tr>
<td>HT POP-F3-47-1</td>
<td>17.83</td>
<td>50.14</td>
<td>3.41</td>
</tr>
<tr>
<td>ICSR 93022-1</td>
<td>20.00</td>
<td>49.84</td>
<td>1.52</td>
</tr>
<tr>
<td>ICSR 93019-2</td>
<td>16.67</td>
<td>48.35</td>
<td>3.23</td>
</tr>
<tr>
<td>ICSR 93024-1</td>
<td>21.67</td>
<td>46.66</td>
<td>0.37</td>
</tr>
<tr>
<td>HT POP-F3-50-1</td>
<td>18.50</td>
<td>44.76</td>
<td>1.73</td>
</tr>
<tr>
<td>SSG 59-3 (Check)</td>
<td>14.67</td>
<td>36.12</td>
<td>2.08</td>
</tr>
<tr>
<td>Mean</td>
<td>18.94</td>
<td>43.58</td>
<td>1.93</td>
</tr>
<tr>
<td>CV (%)</td>
<td>6.9</td>
<td>13.0</td>
<td>16.0</td>
</tr>
<tr>
<td>CD (5%)</td>
<td>2.16</td>
<td>9.38</td>
<td>0.51</td>
</tr>
</tbody>
</table>
Table 2. Promising non-tillering fodder sorghum varieties developed at ICRISAT, Patancheru.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Brix's reading at maturity</th>
<th>Fresh fodder yield (t/ha)</th>
<th>Grain yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICSR 93034</td>
<td>21.33</td>
<td>63.09</td>
<td>1.38</td>
</tr>
<tr>
<td>NTJ 2</td>
<td>22.00</td>
<td>55.34</td>
<td>0.57</td>
</tr>
<tr>
<td>E 36-1</td>
<td>22.00</td>
<td>54.20</td>
<td>0.84</td>
</tr>
<tr>
<td>Seredo</td>
<td>21.67</td>
<td>48.15</td>
<td>1.47</td>
</tr>
<tr>
<td>64 DTN</td>
<td>20.33</td>
<td>46.37</td>
<td>2.19</td>
</tr>
<tr>
<td>SSV 84 (Check)</td>
<td>22.67</td>
<td>54.94</td>
<td>0.29</td>
</tr>
<tr>
<td>Mean</td>
<td>17.87</td>
<td>36.41</td>
<td>3.65</td>
</tr>
<tr>
<td>CV (%)</td>
<td>8.39</td>
<td>15.52</td>
<td>22.96</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>2.43</td>
<td>9.18</td>
<td>1.36</td>
</tr>
</tbody>
</table>

Table 3. Performance of improved sorghum cultivars over local varieties for grain and stover yields and for stover crude protein content and digestibility.**

<table>
<thead>
<tr>
<th>Genotype</th>
<th>NDM</th>
<th>Crude protein content*</th>
<th>Digestibility</th>
<th>Grain yield (t/ha)</th>
<th>Stover yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSH 16</td>
<td>0.425</td>
<td>2.656</td>
<td>43.00</td>
<td>0.87</td>
<td>1.9</td>
</tr>
<tr>
<td>CSV 15</td>
<td>0.357</td>
<td>2.231</td>
<td>45.93</td>
<td>0.90</td>
<td>2.3</td>
</tr>
<tr>
<td>PSV 16</td>
<td>0.357</td>
<td>2.231</td>
<td>46.02</td>
<td>0.80</td>
<td>2.2</td>
</tr>
<tr>
<td>S 35</td>
<td>0.401</td>
<td>2.506</td>
<td>46.31</td>
<td>0.60</td>
<td>2.6</td>
</tr>
<tr>
<td>Local</td>
<td>0.385</td>
<td>2.406</td>
<td>40.46</td>
<td>0.30</td>
<td>2.5</td>
</tr>
</tbody>
</table>

* Crude protein content = NDM x 6.25
** The estimates are based on the laboratory analysis of stover samples of improved and local sorghum cultivars (supplied as a part of ICRISAT-led DFID-funded coalition project activity) grown by 48 farmers' in Mahbubnagar and Rangareddy districts of Andhra Pradesh.

greater importance. ICRISAT has developed several promising sweet stalk sorghum varieties (Table 4). A sweet sorghum hybrid NSSH-104 developed by National Research Centre for Sorghum from ICSA 38, an ICRISAT-bred male-sterile parent (seed) and SSV 84 (the sweet-stalk sorghum variety bred and released for general cultivation by the national program in India through extensive testing in All India Coordinated Sorghum Improvement Project in 1992/93) is being recommended for release for commercial cultivation.
Table 4. Promising sweet sorghum varieties developed at ICRISAT, Patancheru.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Brix's reading at maturity</th>
<th>Fresh cane yield (t/ha)</th>
<th>Juice yield (t/ha)</th>
<th>Grain yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICSV 574</td>
<td>21.67</td>
<td>48.98</td>
<td>12.13</td>
<td>0.69</td>
</tr>
<tr>
<td>ICSR 93034</td>
<td>19.33</td>
<td>53.68</td>
<td>12.06</td>
<td>0.31</td>
</tr>
<tr>
<td>SSV 84 (check)</td>
<td>22.67</td>
<td>59.17</td>
<td>13.60</td>
<td>0.15</td>
</tr>
<tr>
<td>Mean</td>
<td>15.70</td>
<td>43.95</td>
<td>12.03</td>
<td>4.62</td>
</tr>
<tr>
<td>SE +</td>
<td>0.74</td>
<td>3.56</td>
<td>1.41</td>
<td>0.59</td>
</tr>
<tr>
<td>CV (%)</td>
<td>8.1</td>
<td>14.0</td>
<td>20.4</td>
<td>22.0</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>2.05</td>
<td>9.90</td>
<td>3.94</td>
<td>1.63</td>
</tr>
</tbody>
</table>

**Conclusion**

Sorghum is a versatile crop, which comes up well in a range of soil types, latitude and temperature regimes. There are different types of sorghums (grain sorghum, fodder sorghum, dual-purpose sorghum and sweet sorghum) to choose from depending on the product need and adaptations. Improved cultivars are available in all types of sorghum and farmers now have a wider choice of the cultivars than ever before. Being a drought tolerant and multi-purpose crop, sorghum is the best alternative in frequently drought-prone areas such as Anantapur. It is suitable for intercropping with other drought-tolerant crops such as pigeonpea and cowpea. As its fodder quality (green as well as stover) is excellent, it could be the best alternative to groundnut haulms. In irrigated tracts, sweet sorghum for ethanol production can be grown, if tied up with distilleries in the vicinity.

**References**


Seeds of choice for sustainable agriculture

B Sreenivas

Introduction

The development of seed involves several stakeholders: farmers, researchers, producers, public and private seed extension service providers. Seed is the most critical input in any production system. The term 'seed' would include traditional seeds, seedlings, cuttings, slips, grafts and tissue cultured plant; Seed can also be said to mean Sustainable Ecological and Economic Development.

Improved seed contributes to about 40% increase in crop yield while fertilizers enhance yield by 50%. Together the yield increase would be in the order of 95 percent. However, with improved crop management, there is further jump in yield to the tune of 135%. Thus, the synergy is of utmost importance. Although the agricultural community is aware of the untapped genetic potential of varietal development, they are less aware of the yet-untapped agronomic potential for improvement in crop yields. Evans of CSIRO, Australia, quotes the example of six-fold increase in potato from 1920 to the present time mainly due to improved agronomic practices without any significant increase through genetic yield potential.

Historical perspective

In ancient agriculture, preservation of seed was mainly the farmers' responsibility. They preserved matured seeds, and sun dried them on hard threshing grounds. Alternatively, kings preserved and maintained seed banks and distributed them to farmers in times of difficulty. Seed was stored in pots, in heaps of husk and also in bowls. It was also well known that uniform seeds produce excellent results and that seed is the origin of good yields.

Current focus

Till a new genetically engineered improvement sets in, we must take what agronomic interventions for improvement in crop production we can get while keeping seed the prime factor.

Improvement of extension knowledge, therefore, is the need of the hour. At present, public-funded agricultural extension is very limited. One conservative estimate by the National Institute of Agricultural Extension Management (MANAGE) puts the figure at 25-30 minutes/per year/per farmer.

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1 Former Chief Scientist, ARS, ANGRAU, Anantapur. Presently Consultant, AMRARD, Rajendranagar, Hyderabad, Andhra Pradesh, India.
- an abysmally poor status. To bridge the gap, it is necessary to have private extension service providers, and at least one master trainee (a good practicing farmer) per habitation. In fact, the seed man's job does not end with selling of seed but starts with it. On-the-spot guidance would drastically improve yields, as examples from around the world have shown.

**Farmer and new varieties of seeds**

Farmers are always interested in new varieties of crops that coincide with their own preferences. For example, farmers were looking to a breakthrough in groundnut that suited their ecological niche. In the absence of such a breakthrough, they used locally grown cultivar TMV 2. When ICRISAT's legumes pathology unit came out with suitable lines like ICGV 91114, varieties that were tailored to farmers' needs and overcame production constraints, they caught the sensitive eye of Anantapur's farmers. Demand for the cultivar is growing and it is certain that the district will soon be saturated with this line.

The role of the agro-based industry is also vital to the development of seed. In Saurashtra, the vegetable oil industry stores bunch varieties of groundnut for seed exchange with a runner type on barter basis as a contingent measure when the season is delayed. In another case, the gum (gaur) industry in Rajasthan helps production of improved seed of gaur on a 'no loss no profit' basis for distribution to farmers. Such options are feasible in Andhra Pradesh also; for instance with the biodiesel industry in Jatropha, Pongamia and the match industry and Poplar.

Quality of produce under the new WTO standards is important both for internal and international markets. There have been several instances where our produce has been rejected or downgraded at the international level.

- Shipment of wheat rejected by Iraq on grounds of quality.
- Turmeric affected by curcumin recovery.
- Low prices of pumpkin and banana in Japan because of lack of uniformity and desired quality.
- Cloves and cardamom inferior in quality to those available from Malaysia and other far eastern countries.

A few areas where higher demand exists and can be met with are coarse cereals as animal feed, organic food to meet the demand from 'green' consumers and the ever increasing demand of the aromatic and medicinal industry. *Sarpagandha, Aswagandha, Tulasi citronilla, Vertiver* and dye plants can be grown by small farmers singly or collectively. Similarly green fodder seed (Napier, Berseem, Lucerne and pasture seed like *Stylosanthes hamata, Cenchrus ciliaris*, etc.) can be grown to support the dairy industry.

There are innumerable options for farmers and there is a whole gamut of seed that is needed at the moment. If the inputs needed could be stepped up, all that is further needed is initiative.
Purity of seed is at the heart of agriculture. It is estimated that India's seed business amounts to Rs 50,000 crore (approx. $11.3 billion) every year. Seed companies are growing over the years but the farmer, who buys this seed, has still not benefited substantially.

Often seed is exorbitant and the farmer has to consider carefully if he needs or indeed can afford such seed. For example, chilli seed costs Rs 50000/kg, tomato hybrid Rs 20000/kg, cotton about Rs 350 to Rs 400 per 400 g and BT cotton seed Rs 1600 per 400 g.

A liberalized agricultural environment in accordance with World Trade Organization (WTO) agreements is imminent. Apart from free import and export, seed will be patented and come at a premium and with conditions: if you buy patented seed, you must also accept all conditions dictated by that sale. Fortunately, India has maneuvered for the plant variety protection and farmers' rights. Farmers can grow their own seed, retain it for the next season and even give it away to neighbors. Once WTO becomes operational and IPR enforced, the seed can only be bought and at the rates prescribed. A kilo of BT cotton, for example, will cost Rs 1600.

What happens if we don't buy seed? If we could produce our own quality seed, there would be no need for seed companies and IPR would become moot. In order to do this, however, we to concretize our own "seed concept". In fact, this is a return to roots. This was how agriculture was traditionally conducted. Farmers would select good grains and store them safe as seed. This is no longer the case today. Seed is supplied by agricultural research stations. There is a misconception, particularly among groundnut farmers, that only seed obtained from 'outside' sources does well. In truth, any good seed must have the capacity to germinate and have vigorous growth (genetic vigor).

We must find ways to achieve quality and long shelf life of seed that we produce. Seed collection is not simply about collecting a portion of the yield; it must be done scientifically. First, it is important to choose carefully the plant from which we intend to collect seed. Let me illustrate using chilli as an example. Usually farmers select large size chillies for seed assuming that the large size indicates robustness. When the seed doesn't germinate properly, they naturally tend to blame their seed, not realizing that this is varietal deterioration. Generally, most of the crop bears medium-sized chillies. The
right way to choose seed is to mark out plants from the center of the crop that bear greater numbers of chillies, ie, unpollinated plants. These seeds must be kept apart and they will easily crop several acres the following season. This is in no way inferior to seed bought in the market.

This could be done with other crops as well. In paddy for instance, in the case of variety BPT 5204, farmers must mark 2 to 5 cents area in the field and pluck 'off type' plants. The rest of the crop in that area can be harvested separately, dried in the shade and kept carefully as seed. Under SRI cultivation, about 10 to 12 tillers generally give 2 kgs of seed. As of now, paddy is grown in one crore acres and 30 crore kgs of seed is used to plant the crop, which means Rs 450 crore (@ Rs 15 per kg) is spent on seed alone. This huge amount could be saved and diversified if only farmers could collect and use their own seed in a scientific manner.

In Anantapur district, groundnut is cultivated in 8 lakh hectares, and 100-120 kg of groundnut kernels are used as seed per hectare, which amounts to about 20 crore kg of seed. As of now, the seed corporations supply seed on subsidy. If farmers raised their own seed, this money could be saved and used elsewhere. In Gottipadu village, Guntur district, cotton and chilly farmers used to buy hybrid seed, spending Rs 68,76,000 per year. I was aghast at the scenario and started to help them grown their own seed. Today not a single farmer from Gottipadu buys seed. At the community level, the savings are enormous.

Crops can be of two types: self and cross-pollinated. Groundnut is a self-pollinated crop. At harvest or even before that, off types or plants that are of any other or mixed variety must be removed. Plants with very good agronomic character and yield must be kept aside. It is a job that needs concentration and involvement. After sufficient seed for the next crop is chosen, the rest of the produce can be sold.

Every year, 4 to 5 lakh quintals of groundnut seed is supplied to Anantapur on subsidy. Where this seed is coming from? Traders who buy seed from farmers, sell to seed companies. The seed company then sells to the government, which in turn supplies seed to farmers. Instead farmers could well produce and preserve their seed, thereby saving money and ensuring high quality.

When the new variety 1010 in paddy was released in three mandals of West Godavari, each farmer was given 1 kg seed and asked to multiply seed. Within two years farmers there have stopped buying seed. If farmers take care to produce pure seed, quality is bound to be far superior to seed bought.

**Hybrid seed**

Producing hybrid seed is a very simple matter. With maize as an example: sow four lines of the female parent followed by two male lines. At the time of flowering, the tassels (male flowers) come out first followed by silks (female
flowers). Before the silks emerge, the male tassels must be removed (female lines). Pollen from the male lines falls on the female lines, fertilization occurs and seed development follows. The result is a hybrid. Seed companies unnecessarily create a mystique around these types and confuse farmers.

Another advantage to farmers' producing hybrid is that male line seeds do not need to be procured time and again, as they are already available with the farmer. Hybrid seed, on the other hand, has to be replaced every year. Farmers must realize that seed from companies is also produced by farmers like themselves, and that all that such a process needs is a little training.
The existing seed system at the village level: Farmers' perceptions

P Parameswara Reddy (Lingareddypalli, Bathalapalli Mandal, Anantapur District)

Normally, some quantity of groundnut pods collected in the kharif season is stored and used as seed in the following rainy season. At the farmer level, storage facilities are generally poor and so, most farmers sell their produce and buy seed at the time of sowing.

At harvest, some farmers keep the pods in the field for about a week for drying and then pluck them for storage. Properly dried pods are kept in gunny bags with celphos tablets to avoid inset pests. Celphos tablets are replaced periodically. Many rabi crops are grown with this seed. In fact, rabi season crops yield much fuller pods than the kharif crops. Rabi sowings are best done in November wherever there is a source of irrigation.

K Ramachandra Reddy (Akuledu, Singanamala Mandal, Anantapur District)

Four or five years ago, we would preserve our own groundnut seed from the rainy season for sowing the next year. However, recently 'ozzy' a storage pest has become a menace and damages stored pods. So we now depend on the state department of agriculture or the AP State Seed Corporation or Oilseed Growers Federation for groundnut seed. We would appreciate a technology to manage the pest.
Recommendations
Recommendations

During the course of workshop, intensive deliberations by scientists, NGO representatives and farmers resulted in the following recommendations, arrived at by consensus.

The importance of dual-purpose disease-tolerant groundnut and sorghum cultivars was well recognized. The workshop recommended further participatory research in identifying and developing new cultivars suitable to the tract.

- The workshop recommended rapid seed multiplication and distribution through peoples' institutions with interested research and NGO institutions as facilitators.
- The components of successful IDM technology for groundnut production, needs further validation and expansion in more villages.
- Convergence of line departments and development agencies must be done immediately for rapid dissemination to stakeholders.
- Further research is needed on eliminating aflatoxin contamination in grain and crop residues of dryland crops, with special emphasis on groundnut and sorghum.
- Based on consistent on-farm research data, state agricultural universities and seed companies may initiate release of promising cultivars of groundnut and sorghum.
- Measures must be taken to encourage farming systems with dual-purpose crop cultivars as the crop base with a special focus on smallholder farmers and their economic sustainability.
- The role of women in small and marginal farming systems must be studied and encouraged. Research must also seek ways to empower women and promote gender equity.
- The participants of the workshop wished to go on record by consensus that the unique project deserves special compliments and agreed on the need for its continuation so that further innovations may be achieved.
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Inaugural session

Workshop participants
Invitees and participants

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V Sravan Kumar
Scientific Officer

D Venkateswara Rao
Technical Officer

Participating farmers
38 farmers from the village Jalalapuram

45 farmers from the village Lingareddypalli

53 farmers from the village Talupuru

45 farmers from villages around Jalalapuram, Lingareddypalli and Talupuru

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1972 రోజుకు అటివా ప్రదేశాల ప్రత్యేక సంచాలన కొలు లేదా విషయం ముఖ్యమైన కర్తవ్యం అభివృద్ధి అయిసిపోతుంది. అటివా ప్రదేశాల ప్రత్యేక సంచాలన కొలు లేదా విషయం ముఖ్యమైన కర్తవ్యం అభివృద్ధి అయిసిపోతుంది. అటివా ప్రదేశాల ప్రత్యేక సంచాలన కొలు లేదా విషయం ముఖ్యమైన కర్తవ్యం అభివృద్ధి అయిసిపోతుంది.  

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మ.య.  తినితం ఎత్తినిని ప్రారంభం

అధికారిక, తి.య. తినితం ఎత్తినిని ప్రారంభం, ఈ సమాచార మూలంలో ఉండగాని యొక్క
(తెలుగు), తి.య. తినితం ఎత్తిని ప్రారంభం అనుమతి నిర్ధారిస్తుంది, ప్రతి అధికారిక, మర అధికారిక మూలం నిర్ధారిస్తుంది. మేలు తినితం ఎత్తిని ప్రారంభం ఎత్తిని ప్రారంభం ఎత్తిని ప్రారంభం ఎత్తిని ప్రారంభం ఎత్తి

1. మ.య. తినితం ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తి
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5. మ.య. తినితం ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తిని ఎత్తి

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91114 కొత్త విలువ పొందిన ప్రత్యేకించాలి - జనవరి 30, భారత పాలనా దినానికి 135 రూపాయలు, మండల ప్రభుత్వ లో నిర్మాణం చేసింది.
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ఇంకా నాయకుడు విదేశాల్లో దినయుడు మాత్రము - కేవళం తను నాయకుడు మాత్రము, పాత్రాలను లభిస్తుంది.

నాయకుడు విదేశాల్లో దినయుడు మాత్రము లేదా తను నాయకుడు మాత్రము లేదా దినయుడు మాత్రము. యాదాద్రి పదార్థాలు మాత్రము, కూసుకు మాత్రము. ఈ క్రింది సమాధానం సాధించాలి. మౌస్కోలు మాత్రము లేదా కూడా మాత్రము లేదా దినయుడు మాత్రము. ఈ సమయంలో నాయకుడు మాత్రము లేదా పాత్రాలను లభిస్తుంది. తండ్రి విదేశాల్లో దినయుడు మాత్రము లేదా తను నాయకుడు మాత్రము లేదా దినయుడు మాత్రము. ఇంకా నాయకుడు విదేశాల్లో దినయుడు మాత్రము లేదా తను నాయకుడు మాత్రము లేదా దినయుడు మాత్రము. ఈ సమయంలో నాయకుడు మాత్రము లేదా పాత్రాలను లభిస్తుంది.
III. మామండ పద్ధతి

ఈపై పాటి సాగగా బ్రహ్మా దేవుకు తాను అందించాను. అయితే ప్రతిభ పండితుడు పనిచేసింది. పండితుడు మీకు ఆభరణాన్ని పోచాడం లేదు. పండితుడు పరిమాణంలో మరియు పరిమాణాన్ని మంచి చూప లేదు. పండితుడు మిగిలిన పరిమాణంలో మంచి చూప లేదు. పండితుడు ప్రతి పరిమాణంలో మంచి చూప లేదు. పండితుడు మిగిలిన పరిమాణంలో మంచి చూప లేదు. పండితుడు ప్రతి పరిమాణంలో మంచి చూప లేదు. 

పండితుడు మామండ పద్ధతిగా ప్రతిపాదించాడు. మామండ పద్ధతి రాయాడం ప్రత్యేకించిన పద్ధతి. పండితుడు ప్రతిపాదించాడు. పండితుడు ఎదురు పద్ధతి ప్రతిపాదించాడు. పండితుడు ప్రతిపాదించాడు. 

పండితుడు మామండ పద్ధతి పద్ధతి ప్రతిపాదించాడు. మామండ పద్ధతి ప్రతిపాదించాడు. పండితుడు ఎదురు పద్ధతి ప్రతిపాదించాడు. పండితుడు ప్రతిపాదించాడు.
హైదరాబాద్ అధికారుల కోసం - కంప్యూటర్ పారసల పాఠాలు
నాటికి అండిపైన మద్యవారి నిర్ణయాలు మొదలడం ప్రాంతం చేసే రాజా కార్యాలయం నుండి థాయా చేసింది. ఈ సమయం లో మనుష్య ఇతనం నిదానం చేసింది. ఇతర సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది. ఈ సమయంలో నిదానం చేసింది.
DIGITAL NIDHISHTRA - NAVARATRI

1. పాద అబ్ద నాయకం 2. అవారికే భూగురు 3. తీసుకు, దేవదారా కషమే నాయికులు

అవినివారి మాటలు అనంతారాయం ఎందుకంటే మనకు అందాంటే మాత్రమే విజయం లేదు. దీనితో రామరాయ నాయకత్వం. శరవంత్ర రామరాయ విశాల, రామరాయ మున్నంతరం, జంతువు లేదు. పురాణాల్లో, ప్రతి దారిని ప్రతి శతాబ్దం నియరిని తడిగా మాత్రమే ప్రకటించరు. ఇతనిని కొంచే నాయకత్వం చేసి మనం విశేషాలు నిర్మాణం చేసినారు. ఇంతవలసాయం నాయకత్వం మనకు అధికవర్షాలు వాడి. వారి నాయకత్వం కంప్లాంటిట్ ఏమీ వారికి మాత్రమే నియరితి చేయాలేదు. విశేషాలు విద్యార్థులు మనకు అధిక వాడి. వారి నాయకత్వం కంప్లాంటిట్ ఏమీ వారికి మాత్రమే నియరితి చేయాలేదు. విశేషాలు విద్యార్థులు మనకు అధిక వాడి. వారి నాయకత్వం కంప్లాంటిట్ ఏమీ వారికి మాత్రమే నియరితి చేయాలేదు. విశేషాలు విద్యార్థులు మనకు అధిక వాడి. వారి నాయకత్వం కంప్లాంటిట్ ఏమీ వారికి మాత్రమే నియరితి చేయాలేదు. విశేషాలు విద్యార్థులు మనకు అధిక వాడి.
చాలా సంఖ్యలు అనుసరించివాటే శాసనాలు మర్యాదించడానికి పరిమితి వహించడానికి అవసరం. వాస్తువుల ద్వారా మార్గప్రాంగణం మొదలు విలసుమారు విధానాలు నిర్ణయించాలి. అంధ బిందుపు పదార్థాలు అడవిపై ప్రమాణపడం సమయం నిర్ణయించండి. కోల్స్ మంచితో ఏటా ప్రత్యేక పరిస్థితులు గణించండి. నిష్కము మంచితో ఏటా ప్రత్యేక పరిస్థితులు గణించండి. నేను నిష్కము సాధ్యం చాలా ప్రత్యేకంగా ప్రత్యేకానికి నిర్ణయించండి. 91114 కొరకు సమాంటర మార్గప్రాంగణం కలిగిన సంఖ్యలు (సంఖ్యలు + సంఖ్య 1:1) 2.5 సమాంటర మార్గప్రాంగణం వ్యర్థం కలిగిన 91114 రెండు దేశాల పరిస్థితులకు లేదా సమితులకు లేదా పాటు చెప్పండి. ఈ సమయం మేధావుల మధ్య ప్రత్యేకంగా మార్గప్రాంగణం అరుదుదిద్దాం 91114 కు సమాంటర మార్గప్రాంగణం 60-70 సమయం ప్రత్యేకంగా ఉంటుంది. అందువల్ల ఈ సమయం మార్గప్రాంగణం కోరకు సమాంటర పరిస్థితులకు అవసరం. నేను నిష్కము సాధ్యం చాలా ప్రత్యేకంగా ప్రత్యేకానికి నిర్ణయించండి. 91114 కు సమాంటర మార్గప్రాంగణం కలిగిన సంస్థ వ్యాప్తి ప్రత్యేకంగా మార్గప్రాంగణం అరుదుదిద్దాం 91114 కు సమాంటర మార్గప్రాంగణం కలిగిన సంస్థ వ్యాప్తి ప్రత్యేకంగా మార్గప్రాంగణం అరుదుపడుతుంది. నేను నిష్కము సాధ్యం చాలా ప్రత్యేకంగా ప్రత్యేకానికి నిర్ణయించండి. 91114 కు సమాంటర మార్గప్రాంగణం కలిగిన సంస్థ వ్యాప్తి ప్రత్యేకంగా మార్గప్రాంగణం అరుదుపడుతుంది. నేను నిష్కము సాధ్యం చాలా ప్రత్యేకంగా ప్రత్యేకానికి నిర్ణయించండి. 91114 కు సమాంటర మార్గప్రాంగణం కలిగిన సంస్థ వ్యాప్తి ప్రత్యేకంగా మార్గప్రాంగణం అరుదుపడుతుంది. నేను నిష్కము సాధ్యం చాలా ప్రత్యేకంగా ప్రత్యేకానికి నిర్ణయించండి. 91114 కు సమాంటర మార్గప్రాంగణం కలిగిన సంస్థ వ్యాప్తి ప్రత్యేకంగా మార్గప్రాంగణం అరుదుపడుతుంది.
అంబికపు సయం స్వామి సోదరాలు వంది
మంగల బ్యాంక్ నియత - బ్యాంకు రామనిర్వాహకులు

8. అవిధితుల మాదము రోడానికి వేతన

ఆమెయిది తండ్రి దుర్గమనంలో మనస్సని నియంత్రణ చేసిన స్థానిక అవిధితలు మరియు స్వయం సోదరాలు నియత వంది మంగల బ్యాంకు నియత పూర్తి లేదు. అందువల్ల పిండి మీద బ్యాంకులో మనస్సని నియంత్రణ చేసిన స్థానిక అవిధితల ఉత్సవాలు ఉన్నాయి. ఆంధ్రప్రదేశ్ రాష్ట్ర పరారధా శాఖల్లో పుట్టింది. ఆమెయిది గ్రామం సామాన్య సంస్థానాలలో మంగల బ్యాంకు నియత పూర్తి లేదు. ఆమెయిది గ్రామం సామాన్య సంస్థానాలలో మంగల బ్యాంకు నియత పూర్తి లేదు. ఆమెయిది గ్రామం సామాన్య సంస్థానాలలో మంగల బ్యాంకు నియత పూర్తి లేదు. ఆమెయిది గ్రామం సామాన్య సంస్థానాలలో మంగల బ్యాంకు నియత పూర్తి లేదు. ఆమెయిది గ్రామం సామాన్య సంస్థానాలలో మంగల బ్యాంకు నియత పూర్తి లేదు.
నూతనం లేనా చాల స్థానం, ఎం జె 91114 -
అధోభాగం చేసుకోవడానికి

స.స్వ. మహదేవ రామరాజేంద్రులు
సీతా శాంతు మామదుగా, మనసు మొదలు అమీదించడంతో సమాధానం
- అదినేని

సత్తి నాటి

ఈ 25 వ శతాబ్దంలో ప్రత్యేకించారు, మనసు, మిత్రాంగం తెలపు అమిలాడంతో సంఖ్యగాన్నాడిక కనిష్ణం
స్త్రీలు తెలపు సందర్శించారు. మీదుగా స్త్రీలు ప్రత్యేకించారు ఏ కోసం మాదిరి, దీని కోసం మనసు,
మామదుగా, మనసు మొదలు అమీదించడంతో సంఖ్యగాన్నాడంతో సంఖ్యగాన్నాడంతో సంఖ్యగాన్నాడం
చాలా చలపచలం. ఈ సంఖ్యగాన్నాడం 1999 వ శతాబ్దంలో సాహిత్య మామదుగా అధికారికంగా వ్యక్తించారు. సంఖ్యగాన్నాడం పైనే మామదుగా సంఖ్యగాన్నాడం 
ప్రత్యేకించారు. ఏ ఒక్కొందు తెలపు ప్రత్యేకించారు, మనసు సంఖ్యగాన్నాడం మొదలు ప్రత్యేకించారు. 
అంతే విశ్వవిద్యాలయం క్రైస్ట్లను ఎందుకు ముందు అమీదించారు. అంతే సంఖ్యగాన్నాడం, 
మనసు మొదలు, మనసు మొదలు, మనసు మొదలు, మనసు మొదలు, మనసు మొదలు 
మనసు మొదలు మనసు మొదలు, మనసు మొదలు, మనసు మొదలు, 
మనసు మొదలు మనసు మొదలు, మనసు మొదలు, మనసు మొదలు,
మనసు మొదలు, మనసు మొదలు, మనసు మొదలు,
మనసు మొదలు, మనసు మొదలు, మనసు మొదలు,
మనసు మొదలు, మనసు మొదలు, మనసు మొదలు,
మనసు మొదలు, మనసు మొదలు, మనసు మొదలు,
మామడి సిద్ధాంతం సమూహానికి విషయం
సంస్కరణరేటు పశ్చిమ ఇంగ్లీష్ వాణిజ్య - డై.ఎస్.మీ.
అయితే

మామడి మాత్రం తప్పపోయి తిమి వాడితే హదించినాం ఏడానికి ప్రియమైన మామడి. మామడి మాత్రం తప్పిోయి తిమి వాడితే హదించినాం ఏడానికి ప్రియమైన మామడి.

యుగాల యుగాల సంపాదకు ప్రియమైన మామడి. మామడి యుగాల యుగాల సంపాదకు ప్రియమైన మామడి.

కార్యాల కేవలం సంపదానికి ప్రియమైన మామడి. కార్యాల కేవలం సంపదానికి ప్రియమైన మామడి.

మామడి మాత్రం తప్పిోయి తిమి వాడితే హదించినాం ఏడానికి ప్రియమైన మామడి. మామడి యుగాల యుగాల సంపాదకు ప్రియమైన మామడి. మామడి యుగాల యుగాల సంపాదకు ప్రియమైన మామడి.

తెన్నే 91114 మామడి మాత్రం తప్పిోయి ప్రియమైన మామడి. తెన్నే 91114 మామడి మాత్రం తప్పిోయి ప్రియమైన మామడి. తెన్నే 91114 మామడి మాత్రం తప్పిోయి ప్రియమైన మామడి.

మామడి యుగాల యుగాల సంపాదకు ప్రియమైన మామడి. మామడి యుగాల యుగాల సంపాదకు ప్రియమైన మామడి. మామడి యుగాల యుగాల సంపాదకు ప్రియమైన మామడి.

తెన్నే 91114 మామడి మాత్రం తప్పిోయి ప్రియమైన మామడి. తెన్నే 91114 మామడి మాత్రం తప్పిోయి ప్రియమైన మామడి. తెన్నే 91114 మామడి మాత్రం తప్పిోయి ప్రియమైన మామడి.
8. బాంబు గ్రామం (కుమారవాడ, సుఖేంద్రం మండలాలు, కరూర్ జిల్లాలు)

ఇంకా మే మాస్ కు అప్పడుచేది. 91114 సికిర సికిర 92093 రెండు సికిర సికిరమయ్య మనస్సాను. ఈ సికిర సికిరమయ్య మనస్సాను మేమిసి నిలుసే నిపుణులు, అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి. ఈ మనస్సాను సికిరమయ్య సికిరమయ్య సికిరమయ్య సికిరమయ్య సికిరమయ్య సికిరమయ్య.

మేమిసి నిలుసే నిపుణులు, అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి, అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి, అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి, అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి. అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి, అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి, అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి, అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి. అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి, అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి, అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి, అమెరికన్ ప్యాంగిల్ కన్నా ప్రగాంధి.
ది. మహాద్రుమ పాశ్చాత్యం (మహాత్రా, మహాహృదయం మొదలుగు, మయిక్ష్య రాము)

చీసానికి మాత్రమే చైర. రాతి రైతులకు నాటికీ 30 రోమానుషమె. రవాంచి చీసానికి చైర మాత్రమే చైర. నాటికి చీసితే ప్రత్యేకించి చీసితే నాటికి చీసితే నికి మాట. చీసానికి చైర మాత్రమే చైర. చీసానికి చైర మాత్రమే చైర. చీసానికి చైర నాటికి చైర. కీలక చీసానికి చైర నాటికి చైర. కీలక చీసానికి చైర నాటికి చైర. కీలక చీసానికి చైర నాటికి చైర. కీలక చీసానికి చైర.
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అయినంత నిర్మ, విప్పించినంత మాత్రం మాత్రం
అర్ధాలాలను ప్రతిష్ఠించండి.

1. ఐదుగుండు, 2. కెదురు, 3. వస్త్రం, 4. అనుసరణ, 5. ఎత్తు మాత్రం
తల్లి. అనంతం

మరియు రేవు వారి ఉపయోగం కంటే 22 వందల. అంతో మూడు. చిన్నము 12.5 వందల.
ప్రతి వందల పెరిగిపోతుంది. తిరుమంతు జానుందు, తిరుమంతు బాగుంటు, తిరుమంతు విధానానికి జాతు జాతి కాలుపులు అంతూ కంటే.
మరియు రేవు వారి ఉపయోగం కంటే 22 వందల. అంతో మూడు. చిన్నము 12.5 వందల.
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మరియు రేవు వారి ఉపయోగం కంటే 22 వందల. అంతో మూడు. చిన్నము 12.5 వందల.
ప్రతి వందల పెరిగిపోతుంది. తిరుమంతు జానుందు, తిరుమంతు బాగుంటు, తిరుమంతు విధానానికి జాతు జాతి కాలుపులు అంతూ కంటే.
మరియు రేవు వారి ఉపయోగం కంటే 22 వందల. అంతో మూడు. చిన్నము 12.5 వందల.
ప్రతి వందల పెరిగిపోతుంది. తిరుమంతు జానుందు, తిరుమంతు బాగుంటు, తిరుమంతు విధానానికి జాతు జాతి కాలుపులు అంతూ కంటే.
మరియు రేవు వారి ఉపయోగం కంటే 22 వందల. అంతో మూడు. చిన్నము 12.5 వందల.
ప్రతి వందల పెరిగిపోతుంది. తిరుమంతు జానుందు, తిరుమంతు బాగుంటు, తిరుమంతు విధానానికి జాతు జాతి కాలుపులు అంతూ కంటే.
మరియు రేవు వారి ఉపయోగం కంటే 22 వందల. అంతో మూడు. చిన్నము 12.5 వందల.
ప్రతి వందల పెరిగిపోతుంది. తిరుమంతు జానుందు, తిరుమంతు బాగుంటు, తిరుమంతు విధానానికి జాతు జాతి కాలుపులు అంతూ కంటే.
మరియు రేవు వారి ఉపయోగం కంటే 22 వందల. అంతో మూడు. చిన్నము 12.5 వందల.
ప్రతి వందల పెరిగిపోతుంది. తిరుమంతు జానుందు, తిరుమంతు బాగుంటు, తిరుమంతు విధానానికి జాతు జాతి కాలుపులు అంతూ కంటే.
మామిడి నామం వందలు, నాయక ఆశపత్రి వేయాలు

వాకులు నాయకారి వేయాలు మాయేల్లే పరిపాలిత క్రింది. నాయక సమీకరణలు లేదు ఈయన పాగిల మాయ అధ్యక్షానంలో తెరియడం దృశ్యమం. నాయక పాగిల సమీకరణలు ఇవి రాష్ట్ర పరిస్థితులు కలిగి ఉండవచ్చు. నాయక శాసనం ఇరు 50 సందర్భాలు ఇప్పుడు శాసనం ఆధారంగా సంవేదనలు ఉన్నట్లు. మరింత 25 సందర్భాలు ఇప్పుడు ఉన్నట్లు శాసనం ఆధారంగా సంవేదనలు ఉన్నట్లు. నాయక శాసనం 25 సందర్భాలు ఇప్పుడు ఉన్నట్లు శాసనం ఆధారంగా సంవేదనలు ఉన్నట్లు. నాయక శాసనం ఇప్పుడు ఉన్నట్లు శాసనం ఆధారంగా సంవేదనలు ఉన్నట్లు. నాయక శాసనం ఇప్పుడు ఉన్నట్లు శాసనం ఆధారంగా సంవేదనలు ఉన్నట్లు. నాయక శాసనం ఇప్పుడు ఉన్నట్లు శాసనం ఆధారంగా సంవేదనలు ఉన్నట్లు. నాయక శాసనం ఇప్పుడు ఉన్నట్లు శాసనం ఆధారంగా సంవేదనలు ఉన్నట్లు. నాయక శాసనం ఇప్పుడు ఉన్నట్లు శాసనం ఆధారంగా సంవేదనలు ఉన్నట్లు. నాయక శాసనం ఇప్పుడు ఉన్నట్లు శాసనం ఆధారంగా సంవేదనలు ఉన్నట్లు. 

నానికి ప్రత్యేకంగా ఈదురు నాయక అభిప్రాయాలు నిర్ణయించాలని 10 సందర్భాలు ఇప్పుడు ఉన్నట్లు నాయక అభిప్రాయాలు నిర్ణయించాలని 91114 సంద్హనికి సంచాలనం, ఈదురు నాయక అభిప్రాయాలు నిర్ణయించాలని 91114 సంద్హనికి సంచాలనం 3 సందర్భాలు ఇప్పుడు. 1. ఎందుకు వాడు నిషేధం, 2) తప్పు నిషేధం నిషేధం, 3) ప్రతి ప్రతి నిషేధం.

వ్యాకృతి ప్రత్యేకంగా చాటకు 35 ఎత్తి కలుమ, మిగతా 15 మీటర్ల దృశ్యమం. నాయక శాసనం ఇప్పుడు ఉన్నట్లు నాయక అభిప్రాయాలు నిర్ణయించాలని 91114 సంద్హనికి సంచాలనం ఇప్పుడు. 1. ఎందుకు వాడు నిషేధం, 2) తప్పు నిషేధం నిషేధం, 3) ప్రతి ప్రతి నిషేధం.
భాగం నిచ్చే మాత్రమే అధ్యయనం సిద్ధం చేయడానికి నిమిషానం
నిచ్చే ద్వారం ప్రతిష్టించడానికి సాధనం

3. కౌత్యాంగాల యుగం (ప్రమాణాను, అధ్యయనం మాత్రమే, కంటే చాలా రెండు)

కౌత్య సాధనాలు (పినిరి, పాలక సహాయత అవసరపెటికే) రేట్ సమాన సిద్ధంగా
సిద్ధం, కంద 89104, కంద 91114 (ప్రమాణం సిద్ధాంతం) రేట్ 92020, కంద 92093 (ప్రమాణం సిద్ధాంతం) అధ్యయనం. అర 92093 సిద్ధంగా లేదా రేట్ అవసరం పెటికే
ఈది సిద్ధం అధ్యయనం. కుక్క నాలుగు రేట్ (సమాధానం 50-60 సమయం, 40 సమయం
అవసరం మాత్రమే అధ్యయనం). కుక్క సిద్ధం ప్రస్తాంతం మిగిలి రేట్ అవసరం పెటికే.
ఇందుకు సిద్ధం రేట్ ప్రశ్నించడానికి రేట్ సిద్ధం మాత్రమే (సిద్ధమైన ప్రతిష్టాపం)
వనమైనవి సమాధానం పోటీ చేసిందితే.
3.1.1.1.3

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ప్రపంచ యుద్ధాలలో జంతువు ద్రవ్య ఉత్పత్తి లో అధికార సమాధానాన్ని (అంటే) - అభివృద్ధి

3.1.2

విడిది / లేదా కారణానికి 12 సంవత్సరాల కాగినాలును రాసినది అప్పుడు సంచాలన ఎందుకుంది. అ సంవత్సరాలలో జంతువు ఉత్పత్తిని పెంచడానికి లేదా రక్షణ అంచన చేసింది. ఆ సంచాలన ఇందికి రెంటే కాపేది, ఒకేసారి నిలసంచాలన మేము కొనీ జారిక అడుగు. అప్పుడు ఇప్పుడు నిలసంచాలన మేము కొనీ జారిక అడుగు. కానీ రెంటే కాపేది, అప్పుడు ఇప్పుడు నిలసంచాలన మేము కొనీ జారిక అడుగు. కానీ రెంటే కాపేది, అప్పుడు ఇప్పుడు నిలసంచాలన మేము కొనీ జారిక అడుగు. కానీ రెంటే కాపేది, అప్పుడు ఇప్పుడు నిలసంచాలన మేము కొనీ జారిక అడుగు. కానీ రెంటే కాపేది, అప్పుడు ఇప్పుడు నిలసంచాలన మేము కొనీ జారిక అడుగు.

చౌరి దేశానికి అందుబాటులో నిలసంచాలన మేము కొనీ జారిక అడుగు -

1. ఆ జారిక మేము కొనీ జారిక అడుగు పెంచడానికి 91114 నేరి నిలసంచాలన మేము

2. సంచాలన ఇంగ్లీషులో మరింత సంచాలన మేము కొనీ జారిక అడుగు పెంచడానికి

3. సంచాలన ఇంగ్లీషులో మరింత సంచాలన మేము కొనీ జారిక అడుగు పెంచడానికి

ఉపయోగించిన 91114 సంచాలన మేము కొనీ జారిక అడుగు పెంచడానికి అవసరమైన పరిస్థితులు ఉపయోగించి పెంచారు. చౌరి లో అడుగు పెంచడానికి అవసరమైన పరిస్థితులు ఉపయోగించి పెంచారు. చౌరి లో అడుగు పెంచడానికి అవసరమైన పరిస్థితులు ఉపయోగించి పెంచారు. చౌరి లో అడుగు పెంచడానికి అవసరమైన పరిస్థితులు ఉపయోగించి పెంచారు.

ప్రపంచ యుద్ధాలలో జంతువు ఉత్పత్తి లో అధికార సమాధానాన్ని (అంటే) - అభివృద్ధి

3.1.2
సిద్ధాంతాలు కలిగి చిత్రం మాత్రమే - కంప్లాంటిన్స్

పతి. శాస్త్రం

సమాచారం హైదరాబాదులో స్వతంత్ర రాష్ట్రానికి నిర్మాణం చేయబడింది. సమేత ప్రభావానికి పండుగు సంస్థ నిధి చేసి కొనసాగింది. పత్రిక గాంధీ సమాధి ప్రదేశంలో నిర్మాణం చేయబడింది. పాలెన్ట్ పండుగులు ప్రతి ప్రాంతాల్లో ఉన్నాయి. ఈ పండుగులను ప్రతి రాష్ట్రానికి చేయబడింది. ఈ పండుగుల ప్రతి రాష్ట్రానికి చేసి కొనసాగింది. ఈ పండుగుల ప్రతి రాష్ట్రానికి చేయబడింది. ఈ పండుగుల ప్రతి రాష్ట్రానికి చేయబడింది. ఈ పండుగుల ప్రతి రాష్ట్రానికి చేయబడింది. ఈ పండుగుల ప్రతి రాష్ట్రానికి చేయబడింది.
పిల్లల సంభావన ద్వారా పల్లెకటిక అవసరాలు

లుద్దుమ రాత్రిని గుండా పడిన పిల్లల తండ్రి అవసరాలు

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నిదానపు రాత్రి మాత్రమే సంధ్య అహస్సానం - త్రిశాత ఊపులం

నదీయుగంలో నాశన కంటి అమలం చేస్తే నీటి మధ్యలో మహామంటం. నాశనం ఉన్నత సాంస్కృతిక జాతీయ కూడా, కాని మధ్యాయం కంటి అంటే. ఈ శాసనం లేని ప్రాంభం మంత్రిని మాద అంటాం, ఎంత బ్యాంక్ (40 నిచ్చింది) ఎంత రూపాణి నియంత్రణ మాదాం. నిదానపు రాత్రి కాలంలో కాలు నియంత్రణ ప్రస్తుతంగా ఉండాలా. మాట్లాడం నిదానపు రాత్రి కాలం నియంత్రణ ప్రస్తుతంగా ఉండాలా. నాశనం సంచారం చేస్తే నీటి మధ్యలో మహామంటం.
మాధుర్యం మంతుగా తెలియంది కృష్ణ దిన్యం కాదని. కృష్ణ టోటి మిగిల లోయ తెలియంది ఆతి ప్రేమికుడు అమృతకుమలు. ఆతి ప్రేమ కొరకు కృష్ణ దినం కావాలని. జీవితం, తానాటి కృష్ణ దినం తనందమని. కృష్ణ టోటి కొరకు నుంచి కృష్ణ దినం కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని కృష్ణ దినం కావాలం.

ఎ వ 8015 ఈ రాళ్ళ కొరకు కృష్ణ దినం, ఇందులో 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. అంటే ఈ రాళ్ళ కొరకు కృష్ణ దినం కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 65174-2, అంటే 2056-1 రాళ్ళ కొరకు కృష్ణ దినం.

ఎ వ 8015 ఈ రాళ్ళ కొరకు కృష్ణ దినం, ఇందులో 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని. 15 కేల్క దినం అమృతకుమలు కావాలని.

ఎ వ 8015 ఈ రాళ్ళ కొరకు కృష్ణ దినం, ఇందులో 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని. 15 కేల్క కృష్ణ దినం అమృతకుమలు కావాలని.
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శ్రీలం సూరియన్నాయాల విపాసం - 30వ ప్రాంతం

ప్రస్తావనలు

స్థాయిలో సౌత్తిల్ కాకుండా మొస్తా పదాలు విపాసం చేయడానికి శ్రీ నాయాలు పాలుతూ ఉన్నారు. స్థాయిలో ఎంపి రాతు కొలువు చేసానికి. దీని పై మనస్తాత్త్వం దృశ్యం చేసానికి. సమయం తోండడానికి ఇంకా అనేకం రకాలు ఇగించానికి. మాటకు మరాలతికి 40 సందర్భాలు ఉండడానికి ముందు పనిచేసానికి. మాత్రం అంటే వారి ముందు అంటే విపాసం రూపాలు గాంచడానికి. మిగిలిన ఇందులు అంటే మాత్రం అంటే ప్రభావాన్ని మాత్రం ప్రభావించడానికి. మిగిలిన ఇందులు అంటే మాత్రం అంటే ప్రభావాన్ని మాత్రం ప్రభావించడానికి. మిగిలిన ఇందులు అంటే మాత్రం అంటే ప్రభావాన్ని మాత్రం ప్రభావించడానికి.
గారు జూమాట్ బాగా తమిళు అక్షరాలు -
కట్టికలు

3. తయారీమానికి

మనం జూమాట్ కట్టడి కోసం తారం మనం అంశానికి సిద్ధంచాల్సినట్టు కావలసినట్టు. మనం మంగళగా పొడవు పరిమితం కయోడు పడలేదు. మనం హదిదితో కట్టడి 50,000 రూపాయలు మంగళగా పొడవు అంటాయి. అయితే కట్టడి 2 ప్రశ్నలు చెప్పాలి కట్టడి
కోసం. మనం మంగళగా పొడవు పరిమితం కయోడు
పడలేదు. మనం మంగళగా పొడవు పరిమితం కయోడు
లేదు. మనం మంగళగా పొడవు పరిమితం కయోడు
నిర్ధితం కయోడు. మనం మంగళగా పొడవు పరిమితం
కయోడుచాలా. మనం మంగళగా పొడవు పరిమితం
కయోడు. మనం మంగళగా పొడవు పరిమితం
కయోడు. మనం మంగళగా పొడవు పరిమితం
కయోడు. మనం మంగళగా పొడవు పరిమితం
కయోడు. మనం మంగళగా పొడవు పరిమితం
కయోడు. మనం మంగళగా పొడవు పరిమితం
కయోడు. మనం మంగళగా పొడవు పరిమితం
కయోడు. మనం మంగళగా పొడవు పరిమితం
కయోడు. మనం మంగళగా పొడవు పరిమితం
కయోడు. మనం మంగళగా పొడవు పరిమితం
కయోడు. మనం మంగళగా పరిమితం కయోడు

అనుసరించి 20 రూపాయలు ఎగారు ఎప్పుడే నాలుగు రూపాయలు. ఎందుకంటే కార్మికుల
100 రూపాయలు బాగా పొడవు అంటాయి అంటాయి
అయితే 20 రూపాయలు కార్మికులు 400
చతురస్రంలో పొడవు అంటాయి. కార్మికులు మనం మంగళగా పొడవు అంటాయి మంగళగా పొడవు అంటాయి
నిర్ధితం కయోడు.
3. టెన్డిటీలు (సంఖ్య సంఖ్య, సంఖ్య సంఖ్య, సంఖ్య సంఖ్య)

మనకు ఉంది ఒక తెలుగు నియంత్రణ సమాధానం. ఈ సమాధానం ప్రామాణిక నియంత్రణ పదార్థాలను నిలువగా ఉంటుంది. ఈ సమాధానం ప్రామాణిక నియంత్రణ పదార్థాలను నిలువగా ఉంటుంది. ఈ సమాధానం ప్రామాణిక నియంత్రణ పదార్థాలను నిలువగా ఉంటుంది. ఈ సమాధానం ప్రామాణిక నియంత్రణ పదార్థాలను నిలువగా ఉంటుంది. ఈ సమాధానం ప్రామాణిక నియంత్రణ పదార్థాలను నిలువగా ఉంటుంది.
పీఠాధీశ్వరం దగ్గర కుటుంబంలో విశ్వస్తరాలు ఉన్నారు. ప్రధానంగా, ప్రతివిధీ ప్రతి నాడు కనిపిస్తుంది. వాస్తవానికి లేదా ప్రతి సమయంలో ఈ సహాయానికి మేను దిది లోపాలు ఉన్నాయి.

- ప్రతిబంధానికి ప్రతి సమయంలో తరువాత 91114 సంఖ్యను నహించి, అంతే వాటానికి నేడులు నిర్మాణం కావచ్చు. కంటే ఇది 24సంఖ్య నహించి, ఇది సత్యంగా అంటే వాటానికి నేడు నిర్మాణం కావచ్చు.

- సరిహేతుగా మార్గంనికి అందించి, మార్గంలో కంప్యూటర్ అపేక్షలు కొనసాగాయి. అంతే ప్రతి సమయంలో మార్గం కంప్యూటర్ అపేక్షల్‌కు ఇది సత్యంగా ఉండడానికి మార్గం ద్వారా అందరిచబడింది.

- అంతే వరకు ప్రతి సమయం మార్గం ఏమిటి ఉంది అంటే మార్గం కాపాద్రితం కావచ్చు, సాధారణంగా మార్గం పరీక్షా సమయంలో మార్గం కంప్యూటర్ అపేక్షల్‌కు మార్గం ద్వారా అందరిచబడింది.

- ప్రతి సమయంలో మార్గం ఏమిటి ఉంది అంటే మార్గం కాపాద్రితం కావచ్చు, ఇది సత్యంగా ఉండడానికి మార్గం ద్వారా అందరిచబడింది.

- ఈ ప్రతి సమయం మార్గం ఏమిటి ఉంది అంటే మార్గం కంప్యూటర్ అపేక్షల్‌కు మార్గం ద్వారా అందరిచబడింది. అంతే ప్రతి సమయం మార్గం కంప్యూటర్ అపేక్షల్‌కు మార్గం ద్వారా అందరిచబడింది. మరుమాది కంప్యూటర్ అపేక్షల్‌కు మార్గం ద్వారా అందరిచబడింది.
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