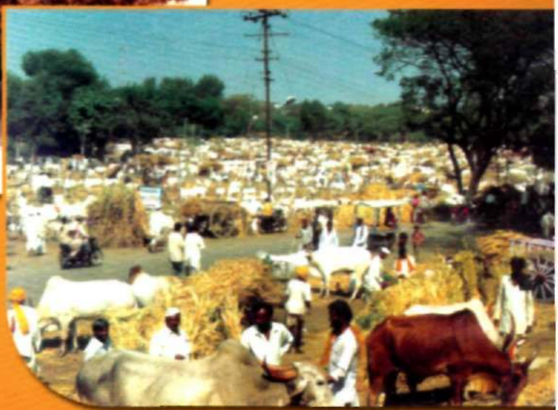
Evaluation of the Effects of Plant Diseases on Yield and Nutritive Value of Crop Residues Used for Peri-urban Dairy Production on the Deccan Plateau of India



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Abstract

Traditional sorghum is susceptible to foliar and stalk diseases. Similarly, groundnut cultivars are also prone to complex fungal foliar diseases. The quantity and nutritive value of their residues are likely to be affected by these diseases besides grain and pod yields. The present study has addressed these issues. The project provided an unique framework to bring together social, plant and animal scientists to address the effects of plant diseases on nutritive value of crop residues on the institutional, village and the peri-urban dairy production level. Information has been collected from on-farm surveys of disease incidence on the Deccan Plateau in Andhra Pradesh, India. Perceptions of farmers and fodder traders regarding the effects of diseases have been solicited. On-station trails have been conducted to quantify disease effects and their mitigation through management practices. Short-term animal feeding trials were undertaken to measure the effects of diseases on digestibility and voluntary intake in buffalo and cattle.

The project not only documented and quantified the impact of plant disease on crop residue nutritive value but also identified possible approaches and solutions to the problems. The study found that disease management in these crops would benefit quality of crop residues used in dairy production, increase income and quality of milk.

Acknowledgments

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S Pande and P Parthasarathy Rao

Summary proceedings of a workshop held at ICRISAT, Patancheru, India
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Contents

Preface

The workshop 'Evaluation of the Effects of Plant Diseases on Yield and Nutritive Value of Crop Residues Used for Peri-urban Dairy Production on the Deccan Plateau of India' was held from 19-22 February 2003 at ICRISAT, Patancheru. The workshop was sponsored by International Crops Research for the Semi-Arid Tropics (ICRISAT), International Livestock Research Institute (ILRI), Acharya NG Ranga Agricultural University (ANGRAU) and National Resources Institute (NRI). It was funded by the Department of International Development (DFID), UK.

The objective of the workshop was to critically review the results of the studies conducted over the last three years, examine and discuss how to make best use of the findings. It was further discussed how far these findings demanded continued research work. Participating in these discussions were farmers/farmer representatives, fodder traders, village-level veterinarians, extension specialists, NGOs, 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.

We hope that information in this volume will help in strengthening on-farm management practices to control plant diseases and improve nutritive yield of crop residues.

Editors

Executive summary

Participants and stakeholders

The Department of International Development (DFID) funded project 'Evaluation of the Effects of Plant Diseases on the Yield and Nutritive Value of Crop Residues Used for Peri-urban Dairy Production on the Deccan Plateau in India' (ZA0287/ R7346) was held from 19-22 February 2002 at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru. The workshop was attended by 27 stakeholders representing farmers, fodder growers, fodder traders, scientists, NGOs, animal, plant (breeders/pathologists/physiologists) and social scientists from national and international agricultural systems (Appendix 1). Farmers, milk producers, fodder traders, village level veterinarians and scientists presented their findings from phase 1 of the project. Perception notes, impressions and research perspectives on planned phase 2 of the project were also discussed. Thematic topics delivered and discussed during the three-day stakeholder workshop are given in Appendix 2.

Background and rationale

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. More recently, specialized peri-urban dairy farming has been developed by landless in many areas. In this system, fodder is brought daily into peri-urban areas from surrounding rural areas. It is forecasted for the coming 25 years that human population growth in south Asia and particularly in India together with higher per capita incomes will substantially increase the demand for livestock products such as milk and meat. This 'livestock revolution' will provide increasing opportunities for marketing livestock products and improve livelihoods, provided major constraints like inadequate supply of good fodder can be conquered. In future, given the shrinkage of common property resources for grazing and overall shortage of arable land, crop residues and agro-industrial by-products will provide major fodder resources.

On the Deccan Plateau in the State of Andhra Pradesh, India, sorghum and groundnuts are major sources of crop residues for livestock feeding. Sale of crop residues to peri-urban dairy producers can account for more than 50% of the income derived from cropping. On the Deccan Plateau, large areas are under sorghum and groundnut. These crops need to provide both grain and fodder. The increasing importance of sorghum straw is reflected in its market price and in some parts farmers get more income from sorghum stover than grain. Groundnut in Andhra Pradesh, which accounts for more than 21 % of the total production in

India, is a very important oilseed crop. Groundnut crop residues are potentially of high quality and are commonly exchanged for food, feed (for example, rice straw and sorghum stalks) and locally traded within villages or community.

To summarize, high fodder value of sorghum and groundnut crop residues will directly alleviate feed constraints without additional investments and increase pressure on communal property resources. It is against this background that the current project *(ZA0287/R7346)* was conceived. Traditional sorghum cultivars are susceptible to foliar and stalk diseases and commonly grown groundnut cultivars are susceptible to foliar diseases. The quantity and nutritive value of their residues are likely to be affected by these diseases besides grain and pod yields. The present project has addressed these issues.

The component studies have generated a wealth of important data (see Main findings). Information has been collected from on-farm surveys of disease incidence in three states of India, while the 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, on-station short-term animal feeding trials have been undertaken to measure the effects of diseases on digestibility and voluntary intake in buffalo and cattle.

Objectives of the workshop

The objectives of the stakeholders' workshop at the end of phase 1 of the project were to critically review the results of the studies conducted over the last three years, examine and discuss how to make best use of the findings of the work. It was further discussed how far these findings demanded continued research work. Participating in these discussions were farmers / farmer representatives, fodder traders, village-level veterinarians, extension specialists, NGOs, natural and social scientists. The specific objectives of the final workshop were:

- To synthesize results
- To finalize recommendations
- To discuss the need and form of further research

Main findings

It was unanimously agreed that the project provided a unique framework to bring together social, plant and animal scientists to address the effects of plant diseases on nutritive value of crop residues on the institutional, village and the peri-urban dairy production level. There was a general agreement that the project not only documented and quantified the drastic impact of plant disease on crop residue value but also identified possible approaches and solutions to the problems.

Findings from participatory rural appraisal

1. Pests and diseases reduce the quality of crop residues that lead to feed rejections and depressions in productivity.
2. Farmers prefer dual-purpose sorghums and groundnuts with disease-free green leaves and stem borer-free stalks.
3. Fodder quality is important for the poor in rural population, as it constitutes the main source of feed for cattle and buffalo.
4. Poor are the most concerned about fodder quality, as they depend on its sale as a source of additional cash income.
5. The poor and the medium-wealth categories are involved in milk sales, a loss in fodder yield combined with inferior quality can cost them dearly.

Findings from plant disease scientists

1. Sorghum foliage and stalks are infected by several diseases like: anthracnose, leaf blight, downy mildew, maize stripe viruses, rust, charcoal rot, zonate leaf spot and oval leaf spot.
2. Sorghum diseases reduce the crop residue yield (20-40%) annually on the Deccan Plateau in India.
3. Sorghum diseases largely managed by host plant resistance, good agronomy and management through host nutrition.
4. Dual purpose high yielding, disease resistance varieties are available and there is an urgent need to strengthen and promote a village level seed multiplication and distribution system.
5. Three foliar diseases namely early leaf spot, late leaf spot and rust commonly affect groundnut. In addition to these major diseases, two viral diseases (bud and stem necrosis), stem rot and collar rot were also found to affect groundnut haulm and pod yield.
6. Foliar diseases of groundnut occur concurrently on the same plant in the same crop cultivar and reduce haulm and pod yield (45-75%) every year on the Deccan Plateau.
7. Groundnut diseases can be effectively controlled by growing disease resistant varieties and need-based use of fungicides on moderately resistant varieties. Further, new technologies such as weather-based disease forecast system (weather-based advisory system) can be used to manage foliar diseases.
8. Dual-purpose groundnut varieties with higher pod and haulm yields than farmers' varieties are available. The comparative advantage of disease resistant groundnut varieties over local varieties have been demonstrated on a few selected farmer fields.

9. Farmers' perception and opinions through farmer participatory on-farm research on validation of integrated groundnut disease management has revealed their interest in the research approach. This led to quick dissemination of research results (such as resistant variety and timely application of need-based fungicidal protection) to end-users. This activity encouraged farmers to produce healthy disease-free haulm and higher pod yields.
10. Dual purpose high yielding, disease resistance groundnut varieties are available and there is an urgent need to strengthen and promote a village level seed multiplication and distribution system.

Findings from animal nutritionists

1. In sorghum, digestibility losses (losses in stover yield multiplied by losses *in vitro* digestibility) of stover due to early infection of maize stripe virus (MstV) was >64% for leaves and >83% for stem.
2. Anthracnose disease of sorghum reduces stover quantity in all genotypes investigated. In comparison, the effects on stover quality were genotype-dependent and less severe.
3. The losses in total digestibility of the late leaf spot and rust infected groundnut haulms were up to 70%.
4. Two genotypes of groundnut maintained a high *in vitro* digestibility (> 65%) even under highest disease pressure.
5. Positive relationships were found for pod yields and digestible stover yield (the products of haulm quantity and haulm *in vitro* digestibility).
6. Animal feeding trials have shown that healthy sorghum stalks and groundnut haulms had higher digestibility and voluntary feed intake than diseased residues in both cattle and buffalo.

Recommendations

Further priorities and related work plans were intensively discussed among different groups of participants. It was believed that this unique project deserves extension so that gains made in the phase 1 can be further expanded. Based on the farmers' perception and stakeholders' experiences and opinions, following are the revised recommendations:

- Seed multiplication and distribution of the dual-purpose disease resistant sorghum and groundnut varieties is urgently needed.
- There is a need to initiate and scale up the dissemination of moderately resistant groundnut varieties to foliar diseases along with validation of available on-farm disease management practices.

- Efforts should be made to organize and strengthen seed multiplication and distribution at village level through self-help groups (SLG) and NGOs (specifically for groundnut, as private seed sector does not exist).
- Stem borer was identified as an additional pest-constraint, reducing the stover quality of sorghum cultivars.
- Fortunately stem borer resistant high yielding dual-purpose sorghum cultivars are available. Therefore, it was decided that in the second phase of the project efforts would be made for seed increase and on-farm validation of stem borer resistant cultivars that will lead to their dissemination.
- Based on the available stem resistant varieties, private seed companies and other organizations such as state seeds corporations are in the process of developing stem borer resistant hybrids. There is also a need to multiply seeds of stem borer resistant lines and initiate farmers' participatory validation and selection of pest resistant varieties.
- Preliminary investigations on the estimation of aflatoxin (AFM_1) contamination in milk were alarming. Therefore, the group recommended to further strengthen AFM_1 estimation and aflatoxin contamination in the crop residue.
- Dual purpose high yielding, disease resistance varieties are available and there is an urgent need to strengthen and promote a village level seed multiplication and distribution system.
- Monitor measures taken to encourage animal production at smallholder level.
- Determine the role of women in animal husbandry and evaluate means of empowering and promoting gender equity.
- Effect of disease crop residues on animal productivity/health need to be investigated by longer-term animal experimentation.
- Goats can be a model animal for quantifying revenues from milk production on diseases, healthy crop residues and investigate the flow of mycotoxins in the food-feed chain.
- Simple laboratory technique should be developed and validated along with the animal performance trials.
- Possible synergistic supplementation effects of groundnut haulms on sorghum stover on animal performance.

Opening remarks

Derrick Thomas[1]

On behalf of the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) and National Resources Institute (NRI), I would like to welcome you all to this stakeholder's workshop on 'Diseases on yield and nutritive value of crop residues' funded by the Department for International Development (DFID). Collaboration between the two institutions dates back to 1970s when NRI was a scientific arm of the British overseas aid program. Now, NRI is a part of the University of Greenwich and continues to make inputs into consultancy, advisory and research work in natural resources development. Our presence in the university sector has added a postgraduate study dimension to our portfolio of activities.

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 ruminant 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 the area of common property resources for grazing continues to decline with increased cultivation, the dependence on crop residues and agro-industrial by-products as feed resources will continue to increase.

The principal crop residues used as fodder are from cereals and pulses. On the Deccan Plateau in Andhra Pradesh, India, sorghum and groundnuts are major sources of crop residues. Sale of cereal crop residues to peri-urban producers can account for more than 50% of the income derived from cropping. Large area of dual-purpose cultivars of sorghum are grown on the Deccan Plateau. These cultivars 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. 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 Andhra Pradesh. It accounts for more than 21% of the total production in India. Although crop residues are a major roughage source

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for dairy animals in India, the 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 *in vitro* studies of nutritive value in the laboratory, but also *in vivo* assessment in both buffalo and cattle. In addition to two international agricultural research centers, the work has involved national agricultural research institutes (NARS) and non government organizations (NGOs) and provided a training opportunity for postgraduate students. What more can one ask from a single project?

The component studies have 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.

Accordingly, the purpose of this stakeholders' workshop is to: critically review the results of studies conducted over the last three 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. Natural and social scientists, representatives of the two international centers, NARS and NGOs, farmers and fodder merchants are represented in the workshop.

Crop-livestock technologies and the innovation systems framework as a tool for addressing the institutional context of livestock research

Andy Hall[1] and Rasheed Sulaiman[2]

There Is a widespread recognition of the critical role that institutional contexts play in determining the direction and success of efforts to generate, disseminate, exchange, promote and apply new knowledge in livestock and other agricultural sub-sectors (Biggs 1990, Hall et al. 2001). Similarly, sustainable rural livelihood framework identifies institutions as a key transforming structure, mediating livelihood outcomes for the poor. Recent and on-going research in India, has made significant progress in developing and applying new conceptual and analytical approaches to evaluate institutional contexts of research and identify emerging opportunities to strengthen innovation through partnerships (Hall et al. 2002). At the core of this work it has been identified that there is a need for significant institutional learning and change as part of the process of developing systems that support pro-poor innovation.

The issue of institutional reform for technology transfer in the livestock sector has been present for quite some time, though it has not given rise to the same level of research as in other areas of developing country agriculture. In 1992, for example, a review of the (then) International Laboratory for Research on Animal Diseases (ILRAD)[3] concluded that while ILRAD's scientific activity could hold on its own with best international standards there were serious problems concerning the connectedness of ILRAD's laboratory work with its primary client group, poor livestock keepers. A related feature was poor linkages with national and regional research centers in cognate fields.[4] More recently, a number of studies in India on the livestock sub sector have highlighted the importance of institutional issues. Devendra et al. (2000) have discussed the way institutional factors impinge on the relevance and effectiveness of the research system. In particular, the way in which rigid disciplinary segregation of research organizations, coupled with a tradition of poor communication and rivalry between disciplines has lead to an

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[3] ILRAD has since been merged with the International Livestock Centre for Africa (ILCA) to form the International Livestock Research Institute (ILRI).

[4] See Report of The Third External Programme and Management Review of the International Laboratory for Research on Animal Diseases (ILRAD), Rome, United Nations Food and Agriculture Organisation, 1992.

inability to adopt a holistic farming systems research approach. Lack of interface with relevant crop research institutes further weakens the research system. Devendra at al. (2000) also highlight the weak client focus of research and particularly a lack of understanding of marketing and social institutions required to sustain technical and economic change in rural contexts.

Matthewman et al. (1997) examined the current provisions for the delivery of livestock related information. In the public sector extension system, training and visit system have not only been heavily biased towards production, but also suffer from a set of widely recognized problems. These include: top-down approach to technology transfer, lack of need-based problem identification, no feedback of system performance, extension messages favoring wealthier livestock keepers, focus on a high input approach system and lack of gender sensitivity. Extension efforts from the Department for Animal Husbandry in the State are focussed on animal health information and services rather than animal production issues. Earlier work by Schiere (1993) made broadly similar conclusions but placed more emphasis on the institutional relationship between research and extension.

Such problems illustrate the way State-sponsored processes for generating and disseminating technical innovations are circumscribed by fundamental institutional constraints that tend to diminish the impact of any technical innovations achieved. In a review of the provision of livestock support services in India, the World Bank (1996) concluded that there is a need to redefine public and private sector roles in the livestock sector. In particular, it emphasized the need to recognize areas where the market will be able to provide goods and services. This would be prudent to implement policy and institutional reform to allow the private sector to take a lead in such areas. Recent evidence also suggests that veterinary extension services have been provided by some private sector organizations as part of health product promotions (Sulaiman and Sadamate 2000). Implication of this approach for poor livestock keepers warrants closer examination before implementation. The World Bank (1996) also recognized a continuing role for Indian public agencies in areas of basic research and agricultural extension activities, although the potential and mechanism for interaction with the private sector were not made apparent.

While significant institutional issues still need to be addressed in the public sector, institutional developments in for-profit and non-profit (including the NGOs) private sector are creating new opportunities for the generation, dissemination and application of livestock knowledge. For example, a few cooperatives and market institutions have led significant increase in animal productivity gains. However, the same cooperative marketing initiatives have been criticized because of replicability and equity problems (Doornbos and Nair 1990). The NGO sector has increasingly seen livestock as an entry point for the landless, particularly woman, and has itself been an important mechanism for technology dissemination (Rangnekar 1993; Matthewman et al. 1997; Alsop et al. 1999). Private research foundations like the Bharatiya Agro-Industries Foundation (BAIF) also play a role in adapting and disseminating technology for the poor (Matthewman et al. 1997).

This type of institutional development is sporadic. A few have made attempts to restructure activities towards a more poverty-focused agenda. However, they represent an important illustration of how institutional innovations can complement technological innovations by acting as mechanisms to support the dissemination, use of new knowledge and shift its governance towards poor stakeholders. Equally, such mechanisms have the potential to link the poor and their agendas with organizations engaged in developing new technology. While this holds great promise, it also raises a number of questions like: How should institutional developments and constraints be evaluated? What type of conceptual framework could be employed for this analysis? How can these developments be leveraged to ensure that the poor benefit and are linked to new knowledge? How can the poor be engaged by the knowledge system? How can a more productive role be created for public sector livestock research institutes? What are the respective capacities of different institutional players and which are the ones that are likely to be important for the poor?

In addressing these questions in the other agricultural research sectors, Hall et al. (2001) adopted contemporary technology policy analysis tools from the developed world and adapted them for analysis of developing countries' agricultural sector. An important aspect here was the use and adaptation of 'national system of innovation' conceptual framework of Lundvall (1992). Fundamental aspect of this approach has been the focus on understanding innovations in systems terms. The key here is to identify the web of interactions that link both organizations involved in related pieces of research as well as organizations involved in disseminating technology. In other words, the focus of analysis is on the entire system of different organizations that together generate, disseminate and utilize new knowledge and the institutional context, which shapes the outcome of this process. An important component of this approach is the focus on institutional innovations and novel partnerships that involve wider participation in decision-making and engage the poor more effectively in this system. A critical tool from a policy perspective is the way innovation systems thinking allows a holistic mapping of knowledge flows; identification of the respective roles and capabilities of different actors involved in knowledge generation and diffusion; and to distinguish impediments to the development of these holistic, integrated processes.

It is perhaps useful to reflect briefly on the way this approach differs from other (standard) ways of addressing the institutional issues associated with the problem of ensuring that technology impinges on the lives of poor people. A great deal of discussion on this issue in the context of livestock has focused on improving formal extension activities, with the emphasis on improving the intensity, content and geographic spread of technology messages. More recently and in part of the response to the failed training and visit (T&V) approach, participatory elements have been suggested as better ways of prioritizing livestock keepers information needs and tailoring messages in a more narrowly targeted way.

The underlying implication from these recommendations is that 'extension' is an appropriate institutional focus for capacity-building efforts to improve the knowledge absorption of the poor. Implied here is an acceptance of a linear model of agricultural innovation in which knowledge generation, dissemination and application represent separate tasks. It is functionally and administratively useful to create separate institutions to perform these tasks. Innovation systems thinking denies these distinctions, conceptualizing these tasks as linked, iterative processes occurring as a result of the collective efforts of a system of institutional nodes. The implication is capacity building needs to be thought as a system in wide terms. In fact, building of capacity to operate in a system fashion is often a key to the starting point. In other words, the innovation systems approach allows analysis to move away from thinking that dissemination is a purely extension or information transfer issue.

Others, notably Rolling (1988), acknowledged that there are multiple sources of information in agricultural knowledge information system (AKIS). However, such approaches do not directly address issues associated with institutional underpinnings of generation, adaptation and use of knowledge information and technology. Nevertheless, while not presenting such a holistic conceptualization of the innovation process, AKIS and related approaches contain many relevant tools.

Another approach to disseminate livestock technology is to redivide responsibility between public and private sectors. Neo-classical economic theory would suggest that a fairly watertight distinction can be made between types of product and services that the market will allocate resources and the public sector will have to remain responsible for market failure. While it is common for international financial institutions to argue along these lines (see World Bank 1996), the boundary is never so distinct and is liable to change over time. Innovation systems thinking allows the analysis to move on from 'to privatize or not to privatize' debate. It views both public and private agencies as nodes in a system and concentrates on defining the roles and capabilities of public sector in the overall systems perspective. Strong pro-poor elements can be built into this type of analysis.

We conclude by providing principle of innovation systems framework that might prove valuable in evaluation and planning of technology development in the crop livestock sector.

- It focuses on innovation (rather than research) as its organizing principle. The concept of innovation in a broad sense is the activities and processes associated with generation, production distribution, adaptation and use of new technical, institutional and organizational or managerial knowledge.
- Conceptualizing research as part of the wider process of innovation helps to identify the scope of the actors (public, private, research, enterprise, technology user sectors) involved and the wider set of relationships in which research is embedded.
- Since it recognizes the importance of technology producers and users, their roles are context specific and dynamic. It breaks out of the polarized debates of technology push versus demand-pull theories. Instead of that it recognizes both processes are potentially important at different stages in the innovation process.
- It recognizes that the institutional context of organizations involved, particularly in wider environment, governs the nature of relationships, promotes dominant interests and shapes outcome of the system as a whole. This aspect is enormously important for introducing a poverty focus agenda. The framework provides a lens to examine which agendas are being promoted and highlighted in areas where the voice of the poor can be promoted.
- It recognizes this as a social system. In other words, it does not just focus on the degree of connectivity between different elements, but also the learning and adaptive process thus making this a dynamic evolutionary system.
- It is only a framework for analysis and planning and as such it can draw on a large body of exiting tools from economics, anthropology, evaluation, management and organizational sciences and so fourth.

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Genesis of the project and its objectives

S Pande[1]

I would like to welcome you all to the stakeholders' workshop on 'Evaluation of Plant Diseases on Crop Residues' funded by the Department for International Development (DFID). This project was a timely initiative particulary when Consultative Croup on International Agricultural Research (CGIAR) centers have begun addressing the issues together to alleviate poverty, malnutrition and improve the livelihood of rural poor. Two CGIAR institutes, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and International Livestock Research Institute (ILRI), have joined hands with the Natural Resources Institute (NRI), UK, to address the adverse effects of plant diseases and insect damage on fodder value of groundnut haulms and sorghum stover. Furthermore, this new inter-institutional partnership focuses on strategic targets and key opportunities for improving the well-being of poor and also ensure that the outcome of this project will improve their lives by increasing functional linkages between research, extension, farmers and markets.

Crop and livestock are an integral part of farming systems of the semi-arid tropics (SAT) throughout the world. Sorghum and pearl millet are the keystones in the integrated crop livestock systems in SAT. Demand for animal products (meat, milk and eggs) in developing countries is increasing rapidly and this has led to a demand of sorghum and pearl millet as dual-purpose varieties (crop residues and feed grain). According to a few estimates, more than 95% of the world's groundnut area and 94% of the world's production is in Asia and Sub-Saharan Africa. A large amount of it is grown in small farm holdings, mostly by women. There has been a significant increase in demand for edible oils and groundnut production. This has led to an annual increase in area and yield of groundnut. Also haulms provide quality fodder for livestock. Development of improved technologies for oil and haulms will directly help the SAT farmers to generate additional income.

The value of sorghum and groundnut crop residue in the crop livestock system of SAT was based on ample, independent and mutually supporting evidences provided by small farmers. Furthermore, it was observed that good quality fodder of crop residues was important for better milk production. Thus, there was an authentic demand for high quality sorghum stover and groundnut haulms. However, there are no evidences to support these opinions and observations.

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This DFID-supported project on crop livestock matched the objectives of ICRISAT's global theme 'Enhancing crop livestock productivity and system diversification'.

The results of the work undertaken to address the effect of plant diseases on crop residues of sorghum and groundnut on the Deccan Plateau in India will be of relevant to the SAT of south Asia and Sub-Saharan Africa. It has been acknowledged that sorghum and groundnut crop residues are widely used in India for feeding dairy cattle and buffaloes. During cropping seasons, plant diseases attack these crops, which in turn can affect the quantity and nutritive value of residues and grain yield. This results in reduced milk production. Furthermore, preliminary talks with fodder traders (specifically sorghum traders, as there is no regulated markets for groundnut as it is battered within the farming community) emphasized that diseases adversely affect the pricing and profit of crop residues. It is strongly believed that no producer or consumer groups will be at a disadvantage by the outcome of the project and there will be no extra burden on farm labor. In the Deccan Plateau, since women are more involved with animals and milk production, any improvement in development of livestock sub sector will promote gender equity.

The project mainly is adaptive and has strategic aspects. It is adaptive because its outputs will directly be validated in farmer fields. It is strategic because it will develop clear understanding of limitations and compatibility of technologies that will help in evaluating crop and disease management practices. This will improve the quantity of crop residues and will quantify the quality of the crop residue following precised *in vitro* digestibility and animal feeding trials. The project will function at a production system scale using an inter disciplinary approach. It will scale up technologies by extrapolating results from on-station research to wider application domains. Socioeconomic studies will examine policy and institutional issues that are likely to encourage adoption of appropriate technology for increasing the crop residue quality.

Specific research objectives of the project are:

- Improve methods for control of pests in pastures and forage crops in intensive dairy production units
- Assess the importance of plant diseases on yield and nutritive value of groundnut and sorghum crop residues
- Modify and extend an existing on-farm management practices to control diseases beyond grain harvest period

I hope with our united efforts we will be able to manage diseases in sorghum and groundnut in resource farmer fields and also expand into regions where it can play a greater role in sustainability of the crop and livestock interaction.

Analytical approaches to assessment of nutritive quality of diseased crop residue

M Blummel[1]

Introduction

Several international crop improvement programs experienced rejection of so called improved genotypes by crop-livestock farmers because of inadequate fodder quality in the crop residue (Blummel et al. 2002a/b). This clear manifestation of farmers demand for good fodder quality in crop residues was further corroborated by participatory appraisal studies (Rama Devi 2000; Underwood et al. 2000) and impact assessments (Kristjianson and Zerbini 1999). It resulted in an institutional collaboration between International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and International Livestock Research Institute (ILRI) to improve crop residues at source through appropriate genotype breeding and selection (Blummel et al. 2002a/b). More recently, ICRISAT-ILRI collaborative work recognized the potentially devastating effect of plant diseases on the fodder value of crop residues (Bandyopadhyay et al. 2001; Ramateke et al. 2002). The present talk discusses some laboratory and animal experimental analysis that can be used to describe advancement in fodder quality in crop improvement and reductions in fodder quality through plant disease.

Animal experimentation

Animal experimentation serves two purposes. The first is to validate laboratory (chemical, *in vitro* and physical) measurements by comparisons with digestibility, intake, weight gain and nitrogen balance measured in sheep and goats. This objective is particularly important for disease-effected residues, which might have implications for animal cell metabolism. These effects might not be easily visible in chemical, *in vitro* and physical analysis. The second objective of animal experimentation is to provide economic base line data about possible revenues from live stock products. This economic data is important for decisions in possible trade-off scenarios involving income from grains/pods and residues. Animal experimentation is not used as a routine methodology but a maximum of 20 widely varying treatments (genotypes or diseases) are actually tested *in vivo.*

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Chemical analysis

These are routine laboratory analyses that commonly measure nitrogen, cell wall content, composition and sugar content. They are relatively quick and simple and therefore attractive when many samples require analysis as is the case in crop improvement programs. However, on the whole, they detect and predict differences in nutritive quality of crop residues insufficiently (Blummel et al. 2002a).

In vitro analysis

In general, *in vitro* tests - which are based on the inoculation of smaller amounts of substrate with rumen microorganism under closely controlled conditions in the laboratory - are indispensable tools for ruminant nutritionists. These tests are largely free of the disadvantages associated with direct *in vivo* animal experimentation, which is more costly, tedious, difficult to control and impractical when only small amount of feed is available as is the case in crop improvement work. There are two distinct approaches to *in vitro* studies: measuring substrate disappearance; and measuring appearance of fermentation products. But more information about fodder quality can be obtained by combining the two approaches in *in vitro* studies (Blummel et al. 1999; Blummel and Fernandez-Rivera 2002).

Physical or structural analysis

Chemical and *in vitro* analysis use sample ground to pass a sieve of 1 mm mesh size. This results in loss of information relating to the structure of the plant. However, animals are usually not offered ground crop residues but long residues or chopped pieces. Animals need to reduce pieces of fodder by chewing and rumination to a smaller particle size, which is actually close to 1 mm. The more resistant the fodder structure to size reduction, the lower will be the fodder intake. We assess resistance of plant structure to particle size reduction by measuring the electrical energy required to reduce a defined amount of crop residue to a 1 mm particle size (Blummel et al. 1996).

Near infrared spectroscopy

This is a non-evasive, non-chemical technique based on the reaction of typical chemical bonding that characterize for example protein, carbohydrate and fat with infrared emissions. Calibration and validation procedures are required. They are based on chemical, *in vitro* and physical analysis of crop residues. However, a maximum of 20% of an entirely new set of samples (for example, new crops) are required for calibration and validation procedures. The fodder value of the remaining 80% can be quickly and cheaply predicted by near infrared spectroscopy (Prasad et al. 2002).

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Effects of feeding healthy versus diseased jowar straw and groundnut haulms on voluntary dry matter intake and nutrient utilization in buffaloes

K Sivaiah[1], Ramachandra Ramteke[2] and S Pande[3]

Introduction

India has the largest livestock population in south Asia that includes 273 million cattle and buffaloes. Livestock production in India is mainly a small-scale rural activity that forms an integral part of an age-old system of mixed farming. Due to decline in grazing areas with increased crop cultivation, industrialization and housing, the livestock have to depend on crop residues and agro-industrial by-products. However, the National Commission on Agriculture (1976) advocated that 5% of the cropped area should be cultivated with green fodder to meet the minimum requirement for livestock feeding. The projected demand for livestock *feed* in 2000 was estimated to be 950 million tons of dry fodder and 1135 million tons of green fodder against the availability of 450 and 320 million tons, respectively in 1991.

The major crop residues used as fodder are from cereals followed by pulses, jowar straw and groundnut haulms form a major source for livestock feeding in India mainly in Andhra Pradesh, Maharashtra and Madhya Pradesh. On the Deccan Plateau in Andhra Pradesh, sorghum and groundnut straw form the major source of fodder for livestock (14 million tons). During the growing season, plant diseases like anthracnose, rust and leaf blight attack the jowar crop. Foliar disease, leaf spot, stem rot and leaf minor are common in groundnut. These affect the quantity and quality (nutritive values) of these crops. This results in reduction in the performance of ruminants in terms of growth and milk production. Furthermore, there is evidence that diseased crop residues command lower prices in the fodder market (Rama Devi et al. 1999).

Since, buffaloes have been found to utilize coarse roughage quite efficiently in comparison to other ruminant species it has been proposed to undertake the research work in buffaloes. In the present investigation, buffaloes were fed with healthy and diseased jowar straw (H-112) and groundnut haulms (TMV-2) obtained from ICRISAT, Patancheru.

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Objectives

- to determine the chemical composition of healthy and diseased fodder
- to study the *in vitro* and *in sacco* dry matter digestibility
- to analyze *in vitro* gas production and digestible organic matter
- to study the voluntary dry matter intake of healthy and diseased fodder
- to study the nutrient digestibility and nutritive value of healthy and diseased fodders in buffaloes

Materials and methods

Jowar straw (H-112) and groundnut haulms (TMV-2) were procured from ICRISAT, Patancheru. Proximate analysis and fiber analysis were carried out using AOAC (1997) and Goering and Van Soest (1970), respectively. *In vitro* dry matter digestibility was estimated by modified Tilley and Terry method (1963) using rumen liquor obtained from buffaloes. *In sacco* evaluation was done in fistulated adult male buffaloes as per the procedure of Kempton (1980). Effective dry matter degradability (EDDM) was done by using computer model as per McDonald (1981) with rumen outflow rate of 0.04 ha^{-1}. *In vitro* gas production was determined by Hohenhein gas test (Menke et al. 1979) and gas volume was recorded at different time intervals. From gas production, digestible organic matter was calculated using the following regression equation:

DOM = 14.88+0.889x (Gas ml/200 mg DM)+0.45CP+0.65 ash

Four adult male buffaloes were taken for digestion trial using randomized block design (RBD). Nutrient requirements were calculated as per the Indian Council for Agricultural Research (ICAR) (1998). A preliminary period of 21 days followed by a five-day collection period was adopted for feeding healthy and diseased jowar straw and groundnut haulms, alternatively. Digestibility coefficients were calculated by a different method except for healthy groundnut haulms. The data was analyzed statistically using Snedecar and Cochren (1980) and Duncan multiple range test (Duncan 1955).

Results

The chemical composition of healthy (T_1) and diseased (T_2) jowar straw (H-112) variety was 90.75, 87.76 for dry matter (DM); 93.78, 93.93 for organic matter (OM); 5.40, 3.91 for crude protein (CP); 0.99, 1.00 for either extract (EE); 33.05, 38.20 for crude fiber (CF); 54.34, 50.82 for NFE; 6.22, 6.07 for total ash; 66.96, 69.57 for neutral detergent fiber (NDF); 47.59, 48.86 for acid detergent fiber (ADF); 19.37, 20.71 for hemicullulose; 35.03, 38.41 for cellulose; 10.17, 9.03 for lignin and 2.39, 1.42 per cent for silica, respectively, on dry matter basis.

In vitro dry matter digestibility (IVDMD) value for (T_1) and (T_2) reported were 37.37 and 31.21 per cent, and EDDM value calculated was 36.1 and 27.80 per cent, respectively.

The *in vitro* gas produced (IVGP) at 48 hr recorded was 41.51 and 35.11 ml/ 200 mg DM and digestible organic matter (DOM) at 48 hr calculated was 59.14 and 51.78 per cent for (T_1) and (T_2).

For healthy (R_1) and diseased (R_2) groundnut haulms (TMV-2) the chemical composition estimated was 91.00, 89.94 for DM; 87.90, 90.75 for OM; 10.77, 8.43 for CP; 1.40, 0.62 for EE; 28.27, 41.00 for CF; 47.46, 40.90 for NFE; 12.10, 9.05 for total ash; 70.14, 71.58 for NDF; 45.50, 55.54 for ADF; 24.64, 16.04 for hemicellulose; 33.54, 43.41 for cellulose; 8.17, 10.60 for lignin; and 3.79, 1.53 per cent for silica, respectively on dry matter basis.

IVDMD values recorded were 58.07 and 43.06 per cent and EDDM observed was 58.50 and 38.10 per cent for R_1 and R_2, respectively. The IVGP at 48 hr recorded was 51.50 and 42.13 ml/200 mg DM and DOM at 48 hr calculated was 73.00 and 62.00 per cent for healthy (R_1) and diseased (R_2) groundnut haulms.

The *in vivo* digestibility coefficient of DM, OM, CP, EE, CF, NFE, NDF, ADF, hemicellulose and cellulose for healthy (T_1) and diseased (T_2) jowar straw were 48.32, 44.19; 52.40, 47.08; 42.47, 26.35; 50.69, 58.92; 47.16, 48.65; 55.74, 48.03; 43.94, 38.72; 40.83, 43.56; 55.67, 27.04; and 38.05, 40.81 per cent, respectively.

The per cent dry matter intake recorded was 1.85 for T_1 and 1.70 for T_2. The DCP and TDN value recorded were higher in (T_1) ie, 2.29, 49.30 per cent when compared to (T_2) 1.03 and 45.33 per cent.

In healthy (R_1) and diseased (R_2) groundnut haulms, the *in vivo* digestibility coefficient were 58.57, 50.17 for DM; 61.73, 55.42 for OM; 47.91, 32.29 for CP; 32.81, 36.29 for EE; 58.83, 59.21 for CF; 65.55, 57.25 for ADF; 82.68, 80.41 for hemicellulose; 56.36, 50.84 for cellulose, respectively. The per cent dry matter intake recorded was higher (2.56%) in R_1 as compared to R_2 (1.73%). The DCP and TDN values were higher in R_1 with 5.16 and 53.41 per cent as compared to R_2 with 2.72 and 49.18 per cent.

Conclusions

1) In healthy and diseased jowar straw and groundnut haulms the CP, NFE content were higher, whereas, fiber fractions were lower when compared to diseased straw.
2) The IVDMD and *in sacco* DMD was higher in healthy straw when compared to diseased straw.
3) *In vitro* gas production and DOM was higher in healthy jowar straw and groundnut haulms. This may be due to higher CP and NFE.

4) Feeding diseased straw resulted in lower voluntary DMI when compared to healthy straw because of less palatability.
5) The nutrient digestibility for healthy straw showed significant differences with DM, OM, CP, NFE, NDF and hemicellulose with high digestibility.
6) The nutritive value (DCP, TDN) was higher in healthy straw when compared to diseased straw due to higher digestibility of proximate nutrients.

Based on this we conclude that the healthy straw of jowar (T_1) and groundnut (R_1) were found to be superior to the diseased straw of jowar and groundnut. Further research on microbiological, fungal and rumen fermentation patterns of diseased straw is needed to assess the quality of straw for feeding livestock.

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Socioeconomic issues - A review

Rama Devi Kolli[1]

Introduction

This study has been conducted on crop residues in sorghum and groundnut-based cropping systems in Mahabubnagar and Chittoor districts of Andhra Pradesh (Rama Devi et al. 2000). An analysis of farmer perceptions that were expressed during participatory rural appraisals (PRAs) prompted us to probe further into farmers' crop management practices and milk consumption patterns of dairy households versus their economic status.

Objectives

a) To gain insights into the pest and disease control measures adopted by farmers in sorghum and groundnut cultivation, and
b) To understand the effect of milk consumption patterns on farmers as dairy has became an economic activity (selling milk) in sorghum and groundnut-based cropping systems.

Pest and disease management

Farmers' practices of pest and disease management are very rudimentary and are more in response to distress situations rather than regular practices of crop management. Unpredictable rainfed cropping environment, high risk and cost of cultivation, low value and remuneration of crop residues combined with lack of access to technical information, pest management and low cost effective systems are a few causes for this state of affairs. Under these conditions, debt-ridden farmers (especially groundnut farmers) shy away from any major investments in crop production activities. They tend to use only the bare minimum essential requirements or emergency measures. These findings reiterate the findings from the earlier participatory rural appraisals.

Impact of dairy on nutritional status

Introduction of commercialization of dairy activity has not led to any reduction in the consumption of milk among villagers/milk producers. The farmers have not deprived the nutritional status of their households by succumbing to the lure of increased cash earnings. Farmers in dairy intensive villages have continued to

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maintain their milk consumption levels even when they were actually in a position to secure better nutritional and living standards through higher sales of surplus milk and assured incomes.

The findings of PRAs are published in ICRISAT information bulletin no. 60. Based on these results, it was decided to carry out additional follow up surveys in both these areas on a small-scale basis, mainly for clarification of certain issues.

It was decided during 2000 - 2001 to undertake two follow up surveys. The first one was carried out to:

(a) Gain insights into the pest and disease control measures adopted by farmers in sorghum and groundnut cultivation, and

(b) Understand the effect on milk consumption patterns of farmers due to the shift of dairy into an economic activity in sorghum and groundnut-based crop livestock systems.

The second study pertaining to sorghum fodder markets was undertaken to get an overview of the relationships between supply, price and quality aspects of dry sorghum fodder in the Hyderabad fodder markets. The focus of the study is limited to assessing the role of the quality aspects of the fodder in price determination during various periods of supply keeping in view the foliar pest and disease infections on the crop.

Fodder markets are usually in control *of* handful wholesale commission agents. This creates a monopolistic condition in the fodder market and oligopolistic conditions in the chopped fodder market. Traders and small/medium peri-urban dairy units procure their fodder needs under the conditions determined by such markets. Due to such a situation, quality parameters are confined to physical characteristics that have higher marketability and as interpreted by traders. Concerns for animal health is given low priority.

Traders and small/medium dairy unit holders are generally unaware of the effect of foliar pests and disease-infected fodder on animal health. Hence, specific effects of foliar pests and diseases do not get reflected in the price fixation irrespective of the highs and lows of supply situation. The only aspect that is harped about is the 'blackening' aspect. This arises due to post-harvest management practices. On the contrary big dairy units, based on professional advice, procure fodder in large scale directly from fields and are in a position to choose good quality fodder that is relatively free from foliar pest and disease infections.

Variations in price irrespective of the period/season of supply or demand is generally low in chopped fodder market. This is due to better quality fodder supplied from clean and drier *rabi* white sorghum stover. However, pest and disease infections are greatly obscured. Peak rates of whole fodder on the other hand fluctuate greatly depending on the seasonality of supply irrespective of the quality.

Therefore, it can be summarized from the above findings that animal health is at stake due to:

a) Lack of awareness among both traders and peri-urban dairy producers about the specific effects of foliar pest and disease infections of sorghum crop on animal health.

b) Underplaying the importance of the effect of such visually obvious infections on animal health by traders.

Thus, it is not awareness per se that cause the usage of disease infected sorghum crop residues. Here the problem requires to be tackled from two different angles:

- Right from producing farmers to the end peri-urban dairy producers, a large-scale awareness on specific effects of quality fodder on animal health with special reference to pest and disease infestations should be brought about. Bring about large scale awareness among all the players in the fodder market
- The second and most important approach lies in institutionalizing certain regulatory mechanisms to safeguard animal health and thereby the quality *of* milk.

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Crop residues in mixed farming systems

P Parthasarathy Rao[1]

Mixed crop-livestock systems

Mixed crop-livestock farming is a common and dominant form of animal husbandry in India. Crop residues and by products are the major source of feed. In rural areas, maximum amount of milk is produced which also meets the needs of urban population. Specialized nomadic communities played an important role in the case of ovine but even here rural households - both cultivators and non-cultivators - carried most of the total stock.

The demand for milk and meat is growing due to rise in income, urbanization and change in consumer preferences towards a more diversified diet. Recent estimates of expenditure elasticities (Paroda and Kumar 2000) indicate low to negative elasticities for cereals and pulses, but high elasticities for milk (0.60), meat, fish and eggs (0.89). High expenditure elasticities coupled with high income and population growth has lead to a rising demand for livestock products. This is reflected in the increase in indirect demand for feed and fodder resources. In India, crop residues from cereal and pulse crops are an important source of livestock feed, followed by grasses from grazing land, green fodder crops and concentrates.

Role and importance of crop residues

Crop residues from dual-purpose crops like rice, wheat, sorghum, pearl millet and oilseeds are the most important source of feed. At the all-India level, they account for 61% of the total feed on dry matter basis, up from 50% in the early 1970's. In more than a third of the districts, crop residues account for more than 60% of the total feed per livestock unit. The dependence on crop residues is higher in marginal and semi-arid districts where alternative source of feeds are limited. In the recent years, the price of crop residues particularly for coarse straws increased faster than grain prices. For example, for sorghum the grain to straw price ratio in Sholapur market declined from around 5:1 in early eighties to 3:1 by mid nineties (Kelley and Parthasarathy Rao 1996).

Farmers value both grain and fodder equally. Farmers clearly perceive a range of fodder quality parameters important for breeding - leafiness, thin stem, color, palatability, etc and a few complex ones that relate to plant traits like strength to animals. Plant disease is an important component of fodder quality.

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Farmers perceive that reduction in milk yield is due to diseased fodder. This is reflected in lower market prices for diseased fodder of sorghum and groundnut.

Cultivated fodder species have been introduced and evaluated in experiments in both temperate and tropical zones of India. The results obtained were impressive. It was observed that there was an increase in yield of dry matter, improved nutritive value for livestock and enhanced soil fertility. However, the opportunities for pasture development in small-scale farming systems still remain to be fully exploited. Cultivated forages still account for only 3.4% of the total cropped area, mainly in irrigated agriculture (Kelley and Parthasarathy Rao 1994).

Crop residues are low in metabolized energy and crude protein. Since crop residues are the most important feed resources in the arid and semi-arid regions of the country, considerable research effort has gone into improving their nutritional value through physical, biological and chemical treatment of straws. However, the on-farm adoption of these technologies has been low mainly due to improper fit of technology in the farming system, low resource availability, high cost of land, labor, capital in alternative uses and lack of significant and visible economic benefits. Another option is, supplementation through high protein oil cakes, green fodder and tree leaves. Small farmers and landless laborers do not have resources to invest in supplementation strategies. In the recent years, breeding programs for dual-purpose crops with emphasis on grain, straw yield and quality have been taken up. Crop management and disease management are the emerging viable alternatives to increase productivity and quality of crop residues.

Milk and meat productivity

Despite substantial increase in livestock outputs like milk, meat and eggs, there is a big gap between yields obtained and potential yields. Mean annual yield of indigenous cattle was 618 kgs, while the lactation yield on research farms for some of the important milch breeds varied from 1137 kgs to 1931 kgs. Average milk yield of crossbred cows was 2127 kgs a year as against the obtainable lactation yield range of 2326 kgs to 3196 kgs. Similarly in case of buffalo, the annual milk yield was 1333 kgs, while the obtainable yield varied between 1111 kgs and 1855 kgs per lactation depending on the breed.

Total meat production in the country between 1989 and 1997 grew at a rate of 4.6 per cent per year. However, rise in meat production is largely due to increase in number of animals slaughtered, as yield growth is negligible in case of almost all the species. A number of factors are responsible for poor meat productivity and growth therein. Large animals (cattle and buffalo) are raised mainly for milk and provide meat as an adjunct. The slaughtered animals are usually poor in quality.

Conclusion

For marginal and small farmers animal husbandry based on family labor, residues and by products of crops grown on their own land would continue to be a substantial source of employment and income. While increase in crop production is essential, increased animal production as a complement to agriculture could be a source of substantial additional income. Measures to encourage small farm animal production must therefore be an important aim of the policy. In rural households, women play an important role in animal husbandry and therefore any encouragement here means empowering women and promoting greater gender equity.

Recommendations

- Need to work out improved utilization options for crop residues in different agro ecoregions.
- Better understanding of farmer perception of fodder quantity, quality and need of technology.
- Understanding the effects of environmental factors and disease incidence on plant physiology and straw quality.
- Need for new institutional approach to pest and disease management (farmer field schools).
- Study impact of disease-free fodder on milk, meat yields and income of small farmers.

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Effect of diseases on yield and nutritive quality of groundnut and sorghum crop residues

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Groundnut

Crop residue (haulms) of groundnut *(Arachis hypogaea* L.) is used widely in the semi-arid tropics (SAT) for feeding dairy cattle and buffalo. In the growing season, groundnut crop is attacked by many fungal pathogens that affect the yield and quality (nutritive value) of the residue. On the Indian Deccan Plateau, commonly grown local cultivars of groundnut are susceptible to late leaf spot (LLS) caused by *Phaeoisariopsis personata,* early leaf spot caused by *Cerecospora arachidicola* and rust caused by *Puccina arachidis* . These together cause a yield loss of more than 50% (Pande et al. 2001).

Objectives

- To determine the effects of foliar diseases (LLS and rust) on yield, and
- To quantify the effects of these diseases on nutritive quality of crop residue.

Materials and methods

Effect of disease management practices on the severity of foliar diseases and yield

Four groundnut genotypes ICGVs 91114, 92020, 92093 andz TMV 2 and three treatments (management practices) were included in this experiment. The design of the experiment was split-plot with treatments (disease management practices) as main plots and genotypes as sub plots with three replications. Treatments consisted of intensive management (IM), moderate management (MM) and no management (NM) practices to control foliar diseases. In IM practice, fungicide *Kavach* (chlorothalonil) was applied as a foliar spray at a 10-day interval from 30 days after sowing (DAS) till maturity. In MM practice, fungicide was used economically to maintain moderate level of foliar diseases. In NM practice, fungicide was not applied throughout the crop season. Severity of foliar diseases was scored on 1-9 rating scale from 45 DAS till maturity.

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In vitro evaluation of haulms (residue) for quality (nutritive value)

At the time of maturity, about 20 plants from each plot were harvested, pods were hand picked and plants were cut at the collar region. Haulms (stems and leaves) were oven dried at 50℃ till they attained a constant weight. The dried crop residue (haulms) of these genotypes was evaluated for nitrogen and protein content, production of fermentation gas and *in vitro* digestibility.

Results

Significant differences *(P>0.05)* in the severity of foliar diseases were observed between management practices and cultivars. Severity of foliar diseases was low in ICGV 92093 and high in TMV 2 in all management practices (Table 1). Highest haulm and pod yields were obtained in the intensive management practice than no management practice in all cultivars. Significantly higher haulm and pod yields were recorded in the cultivar ICGV 92093 and lowest in TMV 2 in all management practices (Table 1).

In vitro evaluation of haulms (residue) for quality (nutritive value)

Significant differences were found between cultivars and management practices for nitrogen, fermentation gas and total digestibility. Significantly higher quantities of nitrogen, fermentation gas and higher per cent digestibility were observed in all the cultivars in intensive management than no management (Table 2).

Sorghum

Sorghum (*Sorghum bicolor* L. Moench) crop residue is used widely as fodder for cattle. The principal crop residues used as fodder are those from cereals followed by pulses. Local cultivars of sorghum commonly grown on the Indian Deccan Plateau are susceptible to several foliar and stalk diseases. Of these, maize stripe virus disease and anthracnose caused by *Colletotrichum graminicola* are the major ones affecting grain, fodder yield and quality (Pande et al. 1998). Generally, diseased fodder commands lower prices in markets. Farmers' sale of sorghum crop residues to peri-urban milk-producers accounts for a substantial income from cropping in rural areas (Rama Devi et al. 2000).

Objectives

- To determine the effects of maize stripe virus diseases and anthracnose on the yield of crop residue, and
- To quantify the effects of these diseases on quality (nutritive value) of crop residue.

Materials and methods

Effect of maize stripe virus disease (MstV) on stover and grain yield

Three sorghum genotypes ICSV 745, ICSV 93046 and M 35-1 were used in this field trial during the 2000 post-rainy season. Diseased and healthy treatments were maintained for all the cultivars. Diseased plots of all cultivars were artificially inoculated at 20 days after emergence with adult plant hoppers *(Peregrinus maidis* [Ashmead]) and were repeated 10 days later. Plants in healthy plots were treated with carbofuran granules. Disease score on per cent MstV incidence were recorded at 7-day interval starting from 10 days after inoculation till maturity. At physiological maturity, leaves, stems and panicles of all plants from central four rows of each plot were collected. The leaves and stems were dried, weighed and then used for *in vitro* digestibility analysis. Panicles were thrashed from each plot and the grains were sun dried. Dry weights of the grains were recorded and calculated per hectare.

Effect of anthracnose disease on stover and grain yield

The experiment consisted *of* five cultivars, Bulk Y, Yellow Jowar, H 112, Is 3089, Local FSRP and six treatments with three replications. Treatments consisted of (1) D_{min}- no/minimum disease (2) D_{max} - Maximum disease by inoculating with *C. graminicola* (3) D_1 - 10-25% of disease achieved by inoculation and fungicide application (4) D_2 - 26-50% of disease achieved by inoculation and fungicide application (5) D_3 - 51-75% of disease achieved by inoculation and fungicide application and (6) D_N - No inoculation and no fungicide application (natural). Design of the experiment was split-plot with treatments (disease levels) as main plots and cultivars as sub plots. Disease scoring was done on per cent severity (five plants in each plot were tagged and scored) from 10 days after inoculation till maturity at 7-day intervals. Fodder (stem) quality based on external and internal stem discoloration was rated on 1 -9 rating scale. At physiological maturity, ten plants in each plot were harvested, dried and weights were recorded.

Results

Effect of maize stripe virus disease (MstV) on stover and grain yield

Significant differences in mean cumulative incidence of MstV, stover yield and grain yield were observed between the cultivars and the treatments. Significantly, higher stover and grain yields were obtained in healthy plots and lower yields were recorded in diseased plots in all cultivars. Digestibility was significantly high in healthy plots than diseased plots in all the cultivars (Table 3).

Effect of anthracnose disease on stover and grain yield

Severity of anthracnose was significantly low in minimum diseased plots than other treatments in all cultivars (Table 4). Higher stover and grain yields were recorded in minimum diseased plots than other diseased treatment plots (Table 5). Production of fermentation gas was more in minimum diseased plots than maximum diseased plots indicating more digestibility in all cultivars (Table 6).

Conclusions

We no longer aim to achieve absolute control, but rather an economic reduction in disease level. Therefore, it is the natural integrated disease management approach that calls for an adequate combine of all control methods available to increase production of these crops. Disease management in these crops will benefit quality of crop residues used in dairy production, increase income and quality of milk. However, despite good intentions, the distance between a plant pathologist and farmer is great. Therefore, there is a need to narrow down the distance between technology generated in the field of disease management, their transfer and adoption to achieve sustainable yields of pod/grain and fodder at small holders.

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Table 1. Foliar diseases score on 1-9 rating scale, haulm and pod yields (groundnut genotypes) under intensive, moderate and no management practices of foliar diseases (late leaf spot and rust) during 2000 rainy season.

	Disease score on 1-9 rating scale			Haulm yield (t ha^{-1})			Pod yield (t ha^{-1})		
Genotype	IM	MM	NM	IM	MM	NM	IM	MM	NM
ICGV 91114	3.0	5.0	8.7	2.35	1.99	1.45	1.51	1.34	1.03
ICGV 92020	2.0	3.3	6.0	3.29	3.02	2.90	2.39	2.19	1.95
ICGV 92093	2.0	3.0	4.0	3.58	3.27	3.01	2.41	2.20	1.98
TMV 2	3.0	5.0	9.0	2.15	1.45	0.97	1.19	0.85	0.55
LSD 5%		0.55			0.24			0.14	

IM = Intensive management; MM= Moderate management; NM = No management

Table 2. *In vitro* fermentation gas, per cent nitrogen and per cent digestibility of groundnut genotypes under intensive, moderate and no management of foliar diseases (late leaf spot and rust) during 2000 rainy season

	Parameters								
	Fermentation gas			Nitrogen (%)			Digestibility (%)		
Genotype	IM	MM	NM	IM	MM	NM	IM	MM	NM
ICGV 91114	48.2	43.6	35.2	2.2	2.0	1.9	66.2	62.7	54.9
ICGV 92020	47.7	46.8	44.8	2.1	2.1	1.9	64.7	65.2	62.3
ICGV 92093	48.9	47.0	44.6	2.5	2.5	2.4	67.5	66.5	63.7
TMV 2	48.3	42.6	30.3	2.0	2.0	1.8	65.9	61.2	51.4
LSD 5%		2.78			0.41			2.77	

IM = Intensive management; MM= Moderate management;

NM =No management

Fermentation gas (ml/200mg DM) at 24 h after incubation

Table 3. Mean incidence, severity, stover and grain yields of MstV infected sorghum

			Yield (t ha^{-1})[1]					
	Mst V incidence[1]		Stover		Grain		Digestibility (%)[1]	
Genotype	D	H	D	H	D	H	D	H
ICSV 745	17.6	0.0	4.59	5.90	4.67	5.48	1.40	2.55
ICSV93046	37.7	0.0	8.41	11.72	2.45	4.21	4.00	4.57
M35-1	25.8	0.4	8.26	8.83	3.20	3.64	4.90	4.07
LSD 5%	18.0		3.37		2.02		0.73	

[1] The values presented are the mean of three replications

D= Diseased; H= Healthy

Table 4. Mean anthracnose severity[1] in different cultivars of sorghum at maturity

Disease level	Bulk Y	Y Jowar	H 112	L.FSRP	IS 3089
Minimum	1.67	1.93	1.07	2.87	0.47
Maximum	66.67	93.33	100.00	93.33	44.00
10-25%	28.00	33.00	57.33	33.33	26.33
26-50%	47.67	52.00	71.67	48.33	32.67
51-75%	65.33	74.00	86.33	75.00	46.67
Natural	56.67	18.33	79.00	19.67	28.33
LSD 5%			9.77		

[1] The values presented are the mean of three replications

Table 5. Effect of anthrocnose on stover and grain yields in different cultivars of sorghum at maturity

Disease	Bulk Y		Y Jowar		H 112		L.FSRP		IS 308	
level	S	G	S	G	S	G	S	G	S	G
Minimum	5.59	1.64	13.27	3.99	16.23	3.66	12.19	4.57	8.87	1.61
Maximum	4.64	1.86	11.59	3.88	12.57	1.94	11.55	3.79	8.08	2.44
10-25%	5.56	2.21	12.11	4.68	13.18	2.79	11.93	4.28	10.17	2.47
26-50%	4.42	1.97	11.98	4.26	12.83	2.86	11.79	3.42	7.72	2.37
51-75%	4.67	2.05	10.86	4.01	12.12	2.49	11.67	3.85	8.34	2.76
Natural	5.2	1.95	11.46	4.77	13.85	*2.77*	11.15	4.09	7.9	2.64

LSD 5% For stover 1.52; For grain 0.52

S=Stover; G=Grain

Table 6. Effect of anthracnose on production of fermentation gas

Parameter	Minimum disease	Maximum disease
Cumulative gas production (ml/ 200mg)	38	33

Management of aflatoxin in groundnuts: An example of aflatoxin M_1 in milk

Farid Waliyar[1]

A project on 'Strategies for reducing aflatoxin levels in groundnut-based food and feed in India: A step towards improving health of humans and livestock' funded by the Department for International Development (DFID) with the following objectives was carried out at the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) in collaboration with other partners.

- Assessment of existing pre-harvest, post-harvest handling and storage practices of farmers, other stakeholders and socio economic context and identification of factors constraining these practices using participatory rural appraisal (PRA) techniques.
- Assessment of aflatoxin contamination at pre-harvest, post-harvest handling and storage.
- Characterization of toxigenic and non-toxigenic *Aspergillus flavus* and *Aspergillus parasiticus* isolates.
- Factors contributing to pre-harvest contamination.

For this meeting we are reporting the work carried out on aflatoxin in milk.

Aflatoxins are potent carcinogenic, mutagenic and immuno-suppressive agents, produced as secondary metabolites by the fungus *Aspergillus flavus* and *A. parasiticus* on wide range of food products. Aflatoxin contamination of agricultural commodities has gained global significance as a result of their deleterious effects on human as well as animal health and its importance to international trade. Aflatoxin M_1 (AFM_1) is a major metabolite of aflatoxin B_1 found in milk of animals that have consumed feeds contaminated with aflatoxin B_1. The toxic and carcinogenic effects of AFM_1 have been convincingly demonstrated in laboratory animals and therefore AFM_1 is classified as a class 2B human carcinogen. According to the Food and Drug Administration, USA, AFM_1 in milk should not exceed 0.5 ng/mL. AFM_1 is relatively stable during pasteurization, storage and preparation of various dairy products and therefore AFM_1 contamination poses a significant threat to human health, especially to children, who are the major consumers of milk.

Our investigation showed that the incidence and level of AFM_1 in milk samples varied from 0.6 to 48 ng/ml (Table 1). Fifty one per cent samples contained AFM_1. It was observed that the contamination of AFM_1 was greater (93%) in samples obtained from peri-urban areas than those from rural areas (34%). It is

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note worthy to observe that 50% incidence was in powdered milk samples intended for infants and 30% in milk-based confectionery. But the number of samples tested was insufficient to obtain an accurate picture of the incidence of contamination.

The major feed ingredients for cattle in peri-urban areas of Hyderabad city are cotton cake, groundnut cake, rice bran and straw. We analyzed some of the ingredients for aflatoxin content. Majority of cotton and groundnut cakes were contaminated with aflatoxin at levels exceeding 500 ng/g and the highest was 3000 ng/g in one sample. They may be contributing to the high levels of AFM_1. High incidence of aflatoxins in various ingredients of cattle feeds has been reported from India. This can be attributed to prevalence of such optimum climatic factors as temperature and humidity for mold growth. However, more detailed study is needed in order to understand the various factors that contribute to high versus low AFM_1 contamination. Animal feeding trials are required to establish the linkage between feed quality and AFM_1 contamination in milk and milk by products.

Table 1. Evaluation of groundnut seed samples from 25 farmer fields (Ananthapur) for *Aspergillus flavus* infection and aflatoxin contamination

		Farmer practice		Improved practice	
S no.	Farmer	*A. flavus* (%)	Aflatoxin (mg/kg)	*A. flavus* (%)	Aflatoxin (mg/kg)
1	Raghava Reddy	1.33	2.73	1.67	1.97
2	Pedda Narayana	7.00	570.63	6.33	176.50
3	Chinna Narayana	1.00	0.00	2.00	70.60
4	Pedda Sanjanna	7.67	796.20	1.67	1.47
5	Ramachandra Reddy	2.00	1.97	4.67	98.87
	Mean of 10 farmers	2.77	138.68	2.27	38.77

Effect of spotted stem borer damage on fodder quality in sorghum

HC Sharma[1]

Spotted stem borer (*Chilo partellus)* is the key pest of sorghum in Asia, southern and eastern Africa. Stem borer damage affects both grain yield and fodder quality. It begins the damage of sorghum on 15-day seedlings and continues till harvest. It affects all plant parts, except the roots. The initial symptoms of borer infestation are leaf scarification caused by the early instar larvae feeding in the plant whorl. The older larvae leave the leaf whorl and bore into the stem at the base and damage the growing point. Damage to the growing point results in dead heart formation. This in turn leads to quantitative losses in yield and stem tunnelling qualitative losses on fodder. It also tunnels into the peduncle up to its rachis. Assessment of crop losses caused by stem borer damage on different genotypes is essential for determining the status of the pest and the economic threshold levels.

Avoidable losses

Fodder and grain yield are highest when the crop is infested at 15 days after emergence (Taneja and Leuschner 1985). Avoidable losses in grain yield were 0.0-100.0% in CSH 1 and 0.0-65.0% in HC 260 (Singh 1995)

Increase in borer infestation lead to a considerable decrease in dry matter yield, protein content, *In vitro* dry matter digestibility (IVDMD) and silica content in both sweet (HC 171) and non-sweet (HC 260) cultivars of forage sorghum (Singh 1995). The IVDMD, which takes into account all known and unknown factors affected by borer damage, decreases significantly (by about 13—16%) at 50% borer infestation. The observed decrease in IVDMD is mainly due to corresponding increase in fiber (NDF and ADF) and lignin contents. The decrease in protein content in infested plants could either be due to use of proteins by insect, reduction in protein synthesis or increased activity of proteolytic enzymes. Hemicellulose and cellulose, which form the bulk of cell wall components of plants, are important source of energy for the ruminants. The levels of these constituents in general were higher in stem borer infested plants in comparison with non-infested plants. The nuetral detergent fiber (NDF), which is positively correlated with acid detergent fiber (ADF), increased with an increase in borer infestation (Arora et al. 1987; Singh 1995). Increase in lignin was because of spotted stem borer infestation, which may be the main cause for reduction in

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IVDMD (Arora et al. 1975). Thus, it is obvious that spotted stem borer damage results in both qualitative and quantitative losses in sorghum. There were large differences between the genotypes in parameters used to measure the quality loss in fodder caused by borer damage.

Economic threshold levels (ETLs) vary over seasons and locations and with the level of resistance to the stem borer damage. There is a reduction of 1.0057 g $plant^{-1}$ with a unit increase in stem tunnelling for sorghum hybrid CSH 8R (Mote 1986). A unit increase in stem tunnelling and leaf injury results in a decrease of 0.59 and 0.002 units of grain yield, respectively (Kishore 1990). ETLs for spotted stem borer have been estimated to be 5-25% dead hearts at 20 DAE under different levels of protection (Taneja and Leuschner 1989; Singh 1995). Therefore, it is important to quantify the quantitative and qualitative losses due to stem borer in sorghum and identify borer-resistant genotypes that are useful both for fodder and grain purposes.

Outputs

- Assessment of stem borer associated losses in fodder yield and quality in sorghum.
- Assessment of economic thresholds for quantitative and qualitative losses in fodder yield.
- Identification of stem borer resistant sorghum genotypes for use as dual-purpose (fodder and grain) cultivars by the farmers.

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Importance of groundnut fodder and dairy activities

B Jayanna[1]

Rural Reconstruction Society (RRS) is a voluntary organization working for an integrated rural development in the villages of Kurabalakota mandal in Chittoor district. Some of the society's programmes are:

1) Self-governance or community organizations through formation of self-help groups (SHGs).
2) Health programs carried out for preventive and curative aspects.
3) Non-formal education for school dropouts and non-entrants in the schools vocational training programs for youth and women.
4) Agriculture and animal husbandry: The areas where we are working depend mainly on agriculture labor and with no irrigation sources, except small irrigation tanks and wells. Since rainfall has been very less in the last four years, severe drought made people migrate in search of employment.

We have been working with the Agriculture Man Ecology (AME) since 1997. Our main focus is on dryland groundnut with participatory technology development (PTD). On an experimental basis, a package of improved technology for groundnut cultivation resulted in better yields, higher shelling percentage and healthy crop residues when compared to traditional practices in the area.

Dairy is an important activity in this area. Small and marginal households depend on dairy for their daily earnings. Main supply of fodder is groundnut crop residues and grass grown around little water sources. Dairy animals are given special care. They are fed with healthy mixture of nutritive value feeds that include green fodder, locally available and cultivated grass for excess milk yield. Sale of milk in the area is an important income-generating source. Small farmers and landless people also maintain dairy but they do not grow fodder crops. They depend on collection of grass from bunds and common lands to feed their animals, which normally leads to less milk production.

The farmers are not aware of the ill effects of diseased groundnut fodder. They only know that it reduces milk yield. Farmers know that if animals consume diseased and muddy groundnut fodder, they suffer from indigestion and diarrhea. More awareness has to be generated on ill effects of pests, diseased fodder and quality.

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Effect of diseased haulms on health of animals

AS Chalapathi Rao[1]

The groundnut haulms are spoiled due to three reasons:

1) Rains damage haulms stacked along with pods and this results in discoloration.
2) While stacking, farmers usually sprinkle BHC 10 to 20% on groundnut haulms. This is to prevent pests and termites but eventually this gets absorbed into the haulms.
3) Diseases and pests affect groundnut haulms.

Due to the ensuring rainy season and other activities like sowing, the usual practice adopted in my area is to stack groundnut haulms in fields. The farmers crucially feed these haulms from January to June (before onset of monsoon). When the diseased fodder is fed to the livestock symptoms like indigestion, enteritis and epitasis are observed.

If the cattle are fed on the diseased fodder for two of three days, perhaps the damage is not much. But if they are fed for a longer period then it may lead to dehydration and sometimes death in cases where proper veterinary care is not available. All this results in a decreased milk yield.

Preventive measures

1) Proper post-harvest technology should be developed to prevent damage to groundnut haulms. The measures should be farmer-friendly and cost-efficient.
2) Disease-resistant hybrid groundnut seeds suitable to local areas should be developed.

I think this is the right occasion to open my mind. Though the research institution developed proper technology it was not acceptable to the farmers. This was mainly because:

1) Farmers think that paddy straw with urea supplementation is laborious and time consuming.
2) There is weed in fodder seed.

Therefore, I feel that the technology should be amended according to the farmers needs or more extension should be done through voluntary organizations having proper inputs to popularize the program.

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Participation and opinions of farmers on foliar disease management in groundnut

Saraswathi[1] (Tettu village)

I am a farmer and have one-acre (0.4 ha) dryland for agriculture in Tettu village, Chittoor district. I grow guine grass for my cattle in half an acre and groundnut in the rest of the field for my family. Since 4 years, I am growing groundnut as per the practices recommended by the Rural Reconstruction Society (RRS). But I have not been getting good yields because of the unfavorable weather conditions and insect pests. When the crop was sprayed with Bavistin, leaf spot was controlled. According to my observation, if this diseased fodder is fed to cattle the yield of milk reduces.

Both fodder and pods are equally important to me, otherwise I cannot save my cows. New varieties supplied by ICRISAT scientists through RRS are not only good in fodder and pod yields but also in quality of fodder. These new varieties are less susceptible to diseases like leaf spots and most of the leaves are in tact with the plant. I request ICRISAT scientists to provide some more improved cultivars for betterment of small farmers like me.

* * *

N Gopal[1] (Tettu village)

Groundnut is the main crop in Tettu village, Chittoor district. The crop suffers from diseases and insects every year and this results in poor haulm and pod yields. Groundnut haulms (fodder) are very important as they provide valuable and nutritious fodder to our cattle. We store the fodder after harvest in November and feed cattle in summer when no green grass is available. We feel that, if we feed stored groundnut fodder, the yield of milk reduces. Hence, we do not feed groundnut fodder to the cattle.

Every year right from seedling to maturity stage, the groundnut crop suffers from insects and diseases. We are following the instructions given by the Department of Agriculture and Rural Reconstruction Society to prevent these disasters. Even then we are not getting good quality fodder and pod yields. Last year, we cultivated groundnut cultivars supplied by ICRISAT. Fodder and pod yields were high and the quality of fodder was very good. This high quality fodder was very nutritious to milk animals. Most of the farmers have dairies and they sell milk to the nearby urban areas. High yielding dual-purpose groundnut cultivars will help us in obtaining higher returns through mixed farming. We can get food for our children from anywhere but it is very difficult to procure quality fodder for our cattle. Hence, we request ICRISAT scientists to supply improved groundnut varieties, which give high fodder, pod yields and quality fodder.

* * *

J Yerram Reddy[1] (Pichelavandlapalli village)

I have five acres of dryland and two acres of wetland for agriculture in Pichelavandlapalli village, Chittoor district . I also have cows. In my wetlands, I grow guine grass in half an acre for my cattle and paddy in rest of field for my family. In the dryland, I grow groundnut along with pigeonpea and cowpea as mixed/inter crop. I generally feed guine grass to milky cows and groundnut fodder to other animals. I can confidently state that when diseased fodder is fed to cows the milk yield will come down. This is because during harvest the diseased groundnut fodder gets wet in the rain. This fodder is dried before storing. When this is fed to animals in summer it leads to diarrhea and respiratory problems.

Groundnut is susceptible to many insects and diseases. Last year, ICRISAT scientists visited our village and supplied seeds of improved varieties through RRS. We followed the practices as per their advice. These varieties had less disease incidence. They gave high pod and haulm yields. Since we are not aware of controlling these diseases and insect pests, we request all scientists present here to teach us better disease management methods. We are ready to follow all the practices in groundnut cultivation to achieve higher fodder and pod yields.

[1] All farmers spoke extempore in local language.

Experiences about sorghum fodder from improved varieties and animal health

P Ramulu[1]

In 1995-96, the Indo-Swiss Project for Andhra Pradesh (ISPA) distributed sorghum seed ICSV 745 to farmers of Bhootpur mandal. The seed distribution was done by ISPA to encourage farmers to grow high yielding cultivars to obtain higher grain and fodder yields. During this year, our farmers obtained higher fodder and grain yields from this cultivar than local sorghum cultivars. During 1996-97 and 1997-98, ISPA again distributed the seeds of improved sorghum varieties which where resistant to diseases and stem borer. During that season, diseases and stem borer damage was much less than the local cultivars. In 1998-99 and 1999-2000, our farmers used their own seed stored from the previous season and obtained higher grain and stock yields.

During 2000-2001 seasons, ICRISAT supplied free seed of ICSV 745 to 65 farmers in this mandal. All the farmers obtained very high grain and fodder yields from this cultivar. I request scientists from ICRISAT to supply improved cultivars like ICSV 745 to the farmers of this mandal to obtain more returns. We have not encountered any problem from cattle feeding on the fodder of this cultivar.

Our farmers have learnt many things in this seminar and I am sure they will follow these for cultivation of sorghum.

[1] junior veterinary officer, Hamistapur village, Mahabubnagar district.

Participation and opinions of farmers on disease management in sorghum

M Buchanna[1] (Hastinapur village)

In my village in Mahabubnagar district, since 1995-96 we are growing sorghum cultivar ICSV 745. This cultivar is giving us not only more grain but also fodder which is very tasty. The cattle eat the fodder completely without any wastage. If there are rains during harvest, the fodder becomes black and probably the taste changes. Then, the cattle do not eat the fodder completely and there is wastage. Since our district is drought-prone, we need improved drought and disease-resistant cultivars. We have been getting duel benefits from ICRISAT research and expect the same in future for the betterment of poor farmers.

* * *

T Ramamohana Rao[1] (Machinenipally village)

To achieve higher grain and fodder yields, it is very important to sow sorghum in the month of June/July. Diseases and insects like ergot, smut, shoot fly and *striga* cause severe losses to grain and fodder yields in sorghum. In our village in Mahabubnagar district we are finding it very difficult to control these diseases at individual level. If we have moral and technical support from organizations like ICRISAT, we can do much better in this aspect.

We grow grasses like Co-1, NB 21, *Para, Basner,* etc for our cattle. The milk-yielding cattle are fed with this grass. Dry sorghum and groundnut fodder are given to non-milk yielding cattle like bullocks and buffaloes. Farmers are not in a position to do research to identify varieties suitable for dual purpose. Hence, institutes like ICRISAT can transfer their technology to farmers. We are ready to accept your suggestions and advice.

[1] Both farmers spoke extempore in local language.

Participation and opinion of fodder traders

S Singh[1] and N Sharma[1]

The dairy activities are carried out on a small scale at an individual household level. The household activities are networked through an informal dairy cooperative at village level that takes responsibility of milk collection and transportation to urban centers. The Department of Animal Husbandry has assisted in the introduction of crossbred animals and animal health issues. Additionally, public enterprises such as the Andhra Pradesh Dairy Development Cooperative (APDDC) and private enterprises like Heritage provide information and subsidies on seeds of fodder crops and concentrates. Their extension activities do not include fodder quality perceptions and its relationship with animal health. However, clean crop-residues used for fodder are considered as nutritious fodder.

Farmers do not grow sorghum or groundnut exclusively to cater to the needs of the fodder markets. The supplies to the fodder markets are made from the small proportions of fodder that are sold from individual villages. Furthermore, fodder sales takes place usually after the requirements of the farmers for home consumption are fulfilled. The sales are made 3-4 months after harvest. Residual stocks of post-rainy season sorghum are usually sold in July and August of the following year. Several farmers sell their produce even earlier during the months of May-June or depending upon cash need. Those who do not own ruminants usually sell fresh fodder stocks and a majority of them belong to the poor category.

Groundnut farmers, in general do not sell the crop residues. They normally exchange groundnut haulms for paddy or other cereal crop residues. Thus, no formal fodder markets exist for groundnut crop residues. Most of the groundnut residues are usually consumed on site and its demand within a village is high. Transportation of the dry fodder is a major constraint to its marketing. There is an urgent need to focus research on improving the fodder quality, as farmers report 50% fodder losses between harvest and sale. Sorghum fodder quality and its pricing is based on genotype and area in which it is grown. While *rabi* (post-rainy season) clean haulms of groundnut fetch more prices when exchanged for other cereal crop residues.

[1] Fodder traders, Hyderabad market. As recorded by the reporter. Both traders spoke extempore in local language.

Appendix

Appendix 1. Participants

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P Ramulu
Junior Veterinary Officer, Hamistapur village, Mahabubnagar district

M Butchanna
Farmer, Hamistapur village, Mahabubnagar district

T Ramamohan Rao
Farmer, Machinenipalli village, Mahabubnagar district

Saraswati
Farmer, Tettu village, ANGRAU (post), Chittoor district

N Gopal
Farmer, Tettu village, ANGRAU (post), Chittoor district

J Yerram Reddy
Farmer, Pitchilavandlapalli village, Chittoor district

B Jayanna
President, Rural Reconstruction Society (RRS), ANGRAU (post), Madanapalli, Chittoor district

AS Chalapathi Rao
Veterinary Surgeon, Veterinary dispensary, ANGRAU (post), Madanapalli, Chittoor district

Shankar Singh
Whole fodder trader, Hyderabad

Navratan Sharma
Chopped fodder trader, Hyderabad

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Derrick Thomas

Media

Durga Vallebha (ETV)
Eenadu: Newspaper

Appendix2. Topics addressed and discussed at stakeholders workshop

Opening remarks and introduction of the project	Derrick Thomas
Crop live stock technologies - innovation systems framework	Andy Hall
Objectives of the meeting	Suresh Pande
Analytic approaches to the assessment of nutritive quality of diseased crop residues - A status report	Michael Blummel
Effect of feeding healthy v/s diseased sorghum straw and groundnut haulm on voluntary dry matter intake and nutrient utilization in buffaloes	K Sivaiah, R Ramteke Suresh Pande
Socioeconomic issues - A review	K Rama Devi
Crop residues in mixed farming systems	P Parthasarathy Rao
Effect of diseases on yield and nutritive quality of sorghum and groundnut crop residues	Suresh Pande, JN Rao R Bandypadhayay K Sivaiah Michael Blummel
Managements of aflatoxins in groundnut: An example of aflatoxin M_1 in milk	Farid Waliyar
Effect of stem borer on fodder quality of sorghum	HC Sharma
Importance of groundnut fodder and dairy activities	B Jayanna
Experiences about diseased groundnut fodder and animal health	Chalapathi Rao
Participation and opinions of farmers regarding foliar disease management in groundnut	Saraswati/N Gopal Yerram Reddy
Experiences about diseased sorghum fodder and animal health	P Ramulu
Participation and opinions of farmers regarding disease management in sorghum	T Ramamohan Rao
Participation and opinion of fodder market traders regarding marketing of diseased and disease free fodder	Shankar Singh Navratan Sharma
Future work plan development and recommendations	In groups

Visit to stakeholders activity base and experiments:

- Farmers
- Researchers experiment plots and laboratories
- Traders
- Selected peri-urban dairies

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About ICRISAT

The semi-arid tropics (SAT) encompass parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, chickpea, pigeonpea and groundnut - five crops vital to life for the ever-increasing populations of the SAT ICRISAT's mission is to conduct research that can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services and publishing.

ICRISAT was established in 1972. It is supported by the Consultative Group on International Agricultural Research (CGIAR), an informal association of approximately 50 public and private sector donors. It is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP) and the World Bank. ICRISAT is one of 16 nonprofit, CGIAR-supported Future Harvest Centers.

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