CROP POST HARVEST PROGRAMME

EXPLORING MARKETING OPPORTUNITIES THROUGH RESEARCH, INDUSTRY AND USERS COALITION: SORGHUM POULTRY FEED

R8267(ZB 0337)

PROJECT FINAL REPORT

1 January 2003 – 31 December 2004

Core Partners

1. ANGRAU (Acharya NG Ranga Agricultural University), Rajendranagar, Hyderabad-500 030, Andhra Pradesh, India.

2. FFA (Federation of Farmers Associations), Shantinagar, Hyderabad-500 028, Andhra Pradesh, India.

3. APPF (Andhra Pradesh Poultry Federation), Hyderguda, Hyderabad-500 028, Andhra Pradesh, India.

4. JF (Janaki Feeds Pvt. Ltd.), Hyderguda, Hyderabad-500 028, Andhra Pradesh, India.

Managing Partner

Belum VS Reddy and P Parthasarathy Rao

Managing Partner's Institute

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

Project Final Report

Section A Executive Summary

A very brief summary of how the outputs of the project contributed to the purpose, the key activities and highlights of dissemination outputs. (Up to 500 words).

A unique feature of the project is the *Coalition approach i.e.*, the process in which distinct/independent entities/institutions/partners work together for the common goal with synergistic effect. Under the project, small sorghum growers (74 in number) from four villages of Mahabubnagar and Ranga Reddy districts of Andhra Pradesh were selected and supplied with the improved sorghum cultivars for *rainy season 2003*. The crop performance was monitored regularly and farmers were advised on the sorghum production practices to be followed for increased productivity. After harvest, the grain was bulked cultivar-wise and supplied to the feed manufacturers by the farmers and the feed formulations were prepared in the feed manufacturer's mill. Not only the participating farmers in the project, but also the other farmers of the village(s) expressed their utmost satisfaction with regard to grain and fodder productivity of improved cultivars. Seeing the enthusiasm and positive response of the farmers, more than 500 small landholder sorghum growers spread over 12 villages in the target districts were supplied with the improved cultivars seed in rainy season 2004. The *ICRISAT-private sector consortium* was also involved in supplying the seed to participant farmers. This ensures the role of private sector seed industry in project implementation. Preliminary attempts in linking farmers with the feed manufacturer were successful in that the farmers groups collected the surplus grain for marketing and the poultry feed manufacturers purchased. However, during 2004 the establishment of market link received a set back with insufficient surplus due to erratic and insufficient rainfall in crop growth period that resulted in shoot up of market prices making the sorghum as uneconomical for the feed manufacturers, but the farmers bulked and collectively sold the available surplus in the existing market.

A Steering Committee chaired by the representative from feed industry (Janaki Feeds) was formulated to closely monitor all aspects of PFTs and buying-in of the results by poultry industry. During one of the review and planning workshop held at ICRISAT, Janaki Feeds indicated the need for conducting some additional PFTs, which is more useful for poultry industry. Based on the perceptions of poultry producers and recommendations of Steering Committee, ANGRAU completed the feed trial i.e. part-by-part replacement of maize with sorghum. To improve the skin and shank colour of birds and yolk colour of eggs, *Stylo* was also included in one of the treatments. Conducting this additional part-by-part replacement trial was a result of rigorous discussions and continuous electronic media dialogue between the coalition partners that underpins the importance of coalition building and partnership projects. The trial results were disseminated to a larger group of poultry producers/feed manufacturers through stakeholders' mini-workshops, which received wide acceptance.

Decisions in the coalition building were taken on a mutual consensus basis based on the discussion of the problem or issue. The project manager/leader pushed through the activities/decisions reached by consensus without dominating or imposing his ideas and this also helped stakeholders to feel their individual importance in the project progress. The clarity

of the roles of coalition partners helped them to devote their time exclusively to the domain of their work, thus allowing sharing of responsibility. The success of the coalition system is because it provided an opportunity to the members to contribute knowledge in their respective fields, work towards a common goal with clearly defined roles and responsibilities, ability to articulate their problems and prospects and enthusiasm to work in groups and share the synergies.

The coalition system, thus, helped to present the right kind of incentives to benefit the poor sorghum farmers, feed manufacturers, poultry producers, and the scientists.

Section B Background

B.1 Administrative data

NRIL Contract Number: ZB0337	*Managing Partner(s)/Institution(s):* International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
DFID Contract Number: R8267	*Partner institution(s)* 1. ANGRAU (Acharya NG Ranga Agricultural University), Rajendranagar, Hyderabad-500 030, Andhra Pradesh, India. 2. FFA (Federation of Farmers Associations), Shantinagar, Hyderabad-500 028, Andhra Pradesh, India. 3. APPF (Andhra Pradesh Poultry Federation), Hyderguda, Hyderabad-500 028, Andhra Pradesh, India. 4. JF (Janaki Feeds Pvt. Ltd.), Hyderguda, Hyderabad-500 028, Andhra Pradesh, India.
Project Title: Exploring Marketing Opportunities through Research, Industry and Users Coalition: Sorghum Poultry Feed.	Target Institution(s) FFA, APPF and JF
Research Programme: Crop Post-Harvest Programme	Start Date: 1 January 2003 End Date: 31 December 2004
Thematic area: Improving access to markets	Budget (i.e. Total Cost): £ 82,865

Section C Identification and design stage (3 pages)

Poverty focus

How did the project aim to contribute to poverty reduction? Was it enabling, inclusive or focussed (see definitions below[1])? What aspects of poverty were targeted, and for which groups?
Please describe the importance of the livelihood constraint(s) that the project sought to address and specify how and why this was identified.

Inclusive, i.e., poor and non-poor farmers will also benefit. The poor sorghum growers would derive benefits from the development of a market for a crop they produce that underpins their livelihood. More specifically, that about 500 sorghum farmers in the targeted districts increased their household income by higher yields and better marketing arrangements through improved cultivars and marketing link with poultry feed manufacturers, respectively. Due to the improved technology, per unit cost of production will decrease benefiting the poor sorghum consumers. A spill over benefit would be derived from extending the institutional lessons learnt during the project to develop a small-farmer dairy linkage in the future. Marketing problem associated with grain mold due to untimely rains is predominant through out sorghum growing areas in the world, with >35million ha, of which about 5-6 million ha are in South Asia. Currently poultry industry is facing a shortage of grains for use in poultry feed. The situation would only get worse in the future since the poultry industry is growing at 10-12% per annum. The poultry producers and feed manufacturers are looking for alternative sources of feed grain. The project investigated alternative uses of a crop grown by the poor i.e., in poultry feed. The project also explored the institutional arrangements and established relationships between research, producers, and industrial users. The straw from sorghum crop would provide security for livestock and opportunities for earning additional income from sale of livestock products. The stover analysis emphatically proved that the stover digestibility of improved sorghum cultivars was superior to local cultivars. Women play an important role in livestock related activities benefiting much with the enhanced and good quality stover availability.

How and to what extent did the project understand and work with different groups of end users? Describe the design for adoption of project outputs by the user partners?

From the conception stage, the project-included all the stakeholders i.e., sorghum-growing farmers (Federation of Farmers' Associations), poultry producers (Andhra Pradesh Poultry federation), feed manufacturers (Janaki Feeds) and research institutions (ANGRAU, ICRISAT). A series of stakeholder meetings were organized to ensure the active participation of all members at every stage. By the second year of implementation of the project private sector also took active part by supplying improved cultivars for the project farmers at subsidized prices, which ensures the role of private sector in up scaling the project in future. The poultry producers are also showing interest to partner with sorghum growers by way of supplying poultry manure and purchasing the surplus sorghum produce in bulk quantities. The project also explored institutional arrangements to establish an organic linkage between research, producers and end users (poor consumers & industrial users) that will lead to their overall welfare.

[1] **Enabling**: addresses an issue that under-pins pro-poor economic growth or other policies for poverty reduction which leads to social, environmental and economic benefits for poor people
Inclusive: addresses an issue that affects both rich and poor, but from which the poor will benefit equally
Focussed: addresses an issue that directly affects the rights, interests and needs of poor people primarily

Institutional design

Describe the process of forming the coalition partnership from the design stage and its evolution during the project?

Is there an explicit institutional hypothesis? If yes, is it trying to attack a failure or inadequacy in a mechanism?

What other institutional factors were seen as being important?

The sorghum poultry coalition grew out of a long-standing partnership between the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the private sector. ICRISAT sorghum breeders and economists were aware that this crop had great potential. Production and consumption of sorghum has declined in the last thirty years but it remains important to poorer producers in mixed farming systems. Two previous DFID-funded projects identified this potential, and the two key constraints that appeared to be holding back the promotion of rainy season sorghum in poultry feed:

1. Poultry producers assumed that tannin and mold affected the quality of rainy season sorghum which would in turn reduce the health of the poultry birds,

2. The institutional links between the different stakeholder organisations (research institutes, poultry feed manufacturers, poultry producers and sorghum growers) were weak.

Although these projects had established contact with the private sector, they were not working together as partners systematically, or from the outset of the initiatives, so the impact of these projects was limited.

In 2002 Dr Andy Hall, then a Special Project Scientist at ICRISAT seconded from Natural Resources Institute (UK), encouraged a seed breeder scientist, Dr Belum Reddy, to attend a 1-day workshop organized by DFID. The topic was writing concept notes. Following this Dr B. Reddy and a colleague, economist P. Parthasarathy Rao, wrote a concept note about developing institutional linkages between different stakeholders in sorghum production and marketing. Within the note they identified the potential coalition members. The careful selection of member organisations relied on both long experience and personal contacts. Dr Belum V S Reddy had been working on sorghum systems for 27 years, and Mr P. Parthsarathy Rao for at least 5 years; between them they had made contact with a large number of representatives of seed companies, poultry feed manufacturers, farmers and so on, in the course of their work. They did not invite the individuals that they knew into the new coalition, but rather these contacts allowed them to find out easily and quickly who would have appropriate expertise for the coalition within those organisations.

A list of eleven organisations were drawn to take part in the sorghum coalition and then narrowed it down to four, in addition to ICRISAT, one from each interest group:

- Acharya NG Ranga Agricultural University (ANGRAU).
- Federation of Farmers Associations (FFA)
- Andhra Pradesh Poultry Federation (APPF)
- Poultry feed manufacturer- Janaki Feeds

Personal knowledge of the individuals in the organisation did not influence the choice of partners, and in all cases the personal contact was not the individual who subsequently became a representative on the coalition. But doors may have been more easily opened, and trust established more quickly, by use of these personal networks.

A meeting was convened with potential project partners October 2002 and discussed objectives and approach, agreeing to a shared overall goal – to improve the livelihood security of poorer farmers – as well as sub-goals that would meet the interests of each member organisation. This developed a, 'feeling of win-win situation for all the partners – breeders seeking the dissemination of their products to farmers, poultry scientists in developing new poultry feed rations, farmers looking for high productivity and high market value, feed manufacturers seeking for grain in bulk quantities'. Then the stakeholders met on four occasions to discuss roles and responsibilities, administration, communications and decision-making, and the budget, culminating in the development of a two-year plan.

The question of who should lead the coalition provoked considerable debate. Since the key beneficiaries were sorghum growing farmers, the FFA felt that they could lead the coalition. ICRISAT did not press its own case to be convenors but other members favoured them, saying that a research institute would be more appropriate because they were neutral – that is, not pushing for any particular interests, but rather the success of the whole project – transparent, and accountable. Their scientific remit also gave them considerable credibility.

It was also decided in the discussion about roles and responsibilities that a Steering Committee should be established to oversee the poultry feed trials. Since the whole enterprise depended upon persuading the poultry feed manufacturers that it was worth their while, Janaki Feeds were asked to convene that committee.

The longest discussion in these planning meetings focused on the budget, requiring careful negotiation between the public and NGO members of the coalition. They decided:

1. **ICRISAT** would create a secretariat with a data processing person, a full-time Visiting Scientist, proportion of four other scientists' time (amounting to under half of one full-time post). The other costs incurred were administration and the costs of seed multiplication;
2. **ANGRAU** were allocated a proportion of three scientists' time and the cost of experiments;
3. **Janaki Feeds** were given a grant for feed formulation costs but no time;
4. **Andhra Pradesh Poultry Federation** had a small amount allocated for publicity;
5. **Federation of Farmers Associations** had a staff member's salary, plus travel and publicity costs.

The coalition members discussed the advantages of trying to get the private seed industry involved, but when approached the response was lukewarm initially. By the second year, however, three seed supplier companies agreed to sell new varieties at a 50% subsidised price as a way of promoting them and stimulating demand among farmers.

Section D Implementation process (5 pages)

How was participation maintained among the different stakeholders (the Managing Partner(s) and the Core other Partners and, where relevant, user communities) in the research process?

The roles and responsibilities allocated to each member organisation by the coalition as a whole were both clear and appropriate to the task and the interests of each stakeholder organisation. As a result, the need for complex communication was kept to a minimum. It was required for updates, decision-making about the present and future, reviewing progress, and disseminating detailed results, but it was not as necessary for exerting pressure as it can be in advocacy coalitions. Whereas the latter often rely on communicating with a wider group, for example, to pressurise particular stakeholders to change their practices, communication within this coalition – which was mainly piloting rather than disseminating ideas – remained largely internal.

The mode or channel of communication used was varied according to context. Although regular communication was achieved by email and telephone, especially for quick updates, straightforward decisions or arranging meetings, face-to-face discussion was critical at certain points. It was only academics as a group who all relied heavily on email, in all the other groups only certain individuals used electronic communication very regularly while others preferred the telephone. Some had erratic or no access to the Internet, another did not know how to use a computer, and a third was perpetually worried about viruses. But the need for face-to-face discussion was not merely the result of the shortcomings of information and communication technologies (ICTs); it was essential for the process of consensual decision-making. Cognitive understanding of different points of view was vastly easier when people sat around a table rather than communicated through impersonal technology. This is much more easily achieved through direct contact partly because non-verbal communication plays such an important part in conveying messages.

The culture of the coalition put a high value on courtesy. Polite forms of address, showing concern, patience and flexibility for each other, seeking peaceful resolutions to problems rather than throwing down aggressive challenges, and following the customary rituals during more formal meetings, all contributed to this culture.

No stakeholder organisations or individuals sought to dominate or pressure each other. When farmers found that the quality of the sorghum had improved as a result of using the coalition's cultivars they increased their own consumption. This, as well as low yields due to late rains, has led to insufficient supplies for the poultry feed manufacturers. Rather than provoking hostility within the coalition, the other stakeholder organisations have tried to bring more farmers into the coalition and gently persuading existing growers to balance their short-term need for food with their longer-term interest in establishing marketing links that will lead to greater security in years when lower quality sorghum is produced. It is the lower quality sorghum that requires the new marketing opportunities offered by poultry feed manufacturers. The fact that the coalition members have a clear-shared interest in increasing the production and sales of rainy season sorghum undoubtedly makes communication between members

harmonious. The members are not dealing with severe conflicts of interest within the coalition or pressure from outside interest groups.

In conjunction with shared interests, and a non-domineering approach by all members, the individuals who belong to the coalition all work and reside in the same city (with one exception: a scientist who is based two hours drive away). It allowed frequent meetings, at short notice if necessary, with the minimum expenditure of time or other resources. The shared language and identity of all coalition members helped in reducing the potential for misunderstanding. All coalition members were from the state of Andhra Pradesh, shared the same framework of references (cultural, ecological, social, economic and political), and were Telugu speakers (most could also speak Hindi and English).

Informal communication or contact has been found to be a critical factor in the success of many networks. Workshops, review meetings, have been as important in providing opportunities for making and consolidating links as they were for conveying information. The ability of two particularly close members of the coalition from one organisation i.e., ICRISAT to exchange information, and discuss the best ways forward for the project, were greatly enhanced by two forms of informal contact: sharing a lift to and from work each day and smoking outside their office. Such informal discussion – without the strictures of an agenda or any emphasis on formal performance – allowed for creative and spontaneous thinking and consolidating relationships based on trust.

The coalition developed its methods of research to respond to the different types of evidence required to convince different groups of people. The scientists and poultry feed manufacturers required scientifically validated results, while the farmers needed to see for themselves. The coalition conducted experiments that generated evidence to satisfy scientists, but then also enabled some farmers to see for themselves, others to learn directly from the innovative farmers, and still more to be alerted to the market potential of sorghum through media reports, workshops and brochures in Telugu.

The coalition appears to have been highly successful in forging links between different sectors (research institutes, farmers, and industry). The financial profitability of growing new varieties has been surveyed with positive results. During farmer meetings in the village, for example when seeds were distributed, women have not only been present but expressed their views and asked questions, especially concerning the use of sorghum as fodder. As the people usually responsible for dairy production, women have a stake in the fodder that sorghum provides. They also contribute their labour to the sorghum-production system either as members of the farming household or as labourers. Furthermore, along with other household members, they may also benefit from greater availability of sorghum for home consumption. However, a survey of impact (including effects within the household) is planned for early 2005.

What were the major changes that took place during the implementation period? For each one, explain why they came about and how well did the project manage them?

There are no major changes in project implementation. However, during the review and planning workshop held at ICRISAT on 7 Oct 2003, Janaki Feeds indicated the need for conducting some additional PFTs, which is more useful for poultry industry. Based on the perceptions of poultry producers and recommendations of Steering Committee, ANGRAU completed the feed trial i.e. *part-by-part replacement* of maize with sorghum. To improve the skin and shank color of birds, Stylo was also included in one of the treatments. Conducting this additional part-by-part replacement trial was a result of rigorous discussions and continuous electronic media dialogue between the coalition partners that underpins the importance of coalition building and partnership projects. The trial results were disseminated to a larger group of poultry producers/feed manufacturers through stakeholders' mini-workshops on 19 January and 9 November 2004, which received wider acceptance. The PFT results proved that maize could be totally replaced with sorghum in feed ration with equal/better-feed efficiency.

During coalition partner meeting in August 2004, poultry federation representative expressed the need of conducting a trial with the commercial layer birds, which is also agreed by other coalition partners as important to convince the poultry producers in a better way. To address the interests of stakeholders ANGRAU started another trial with commercial birds. The results obtained so far are encouraging, it takes another 3 months to conclude, formally document and disseminate the results.

What were the strengths and weaknesses of your monitoring system? How did you use the Information provided by your monitoring system?

Another aspect of planning that the coalition rightly took extremely seriously was selection of partners. Echoed throughout all the literature on partnership and networking, the good choice of partners is certainly one of the key criteria in the success of any collective enterprise. It has been pointed out that it is better to have a small number of dedicated organisations in a network than dozens of marginally committed ones. The coalition followed this model as well as having a complete membership involved from start. The inclusion of no additional members might have also eased the process: the small group of organisations built up a cohesive way of working from the earliest planning stage. Because the coalition formed with the right partners to meet their objectives, any changes/additions were not necessary. If meeting narrowly drawn objectives, and demonstrating a new idea, this continuity has probably been extremely useful. Once the pilot project has proved the potential of sorghum, it is arguable, however, that broader representation will ensure that participation is scaled-up.

Three other aspects of management contributed to the success of this coalition and appear to be relevant to all types of networks:

1. All coalition members were involved in the negotiations about how resources would be divided between the members. The openness and transparency about the budget was important for establishing trust;

2. The monitoring framework and plan made the roles and responsibilities for each member appropriate and clear. Rather than having all stakeholders involved in all

activities, and thereby wasting their time and goodwill, the responsibilities were logically divided so that each was only involved when their expertise was needed and/or their own interests were being met;

3. Members accommodated to each other's practices, needs and perceptions where necessary. For example, ANGRAU agreed to conduct the tests twice to take into account the preferences of the private sector members.

ICRISAT, being the international organization, provided a level platform for all the members of the coalition. It has the well-established procedures to receive grants from international donors. Also, it has a good track record of delivery of the project outputs.

Members agreed for clearly defined and agreed roles of each coalition partner. Further, members agreed to ensure flexible responses through regular meetings- both formal and informal and direct communication through telephone, e-mails and letters. Members agreed to resolve conflicts through consensus process.

Major strengths of monitoring system are:

- ☞ The clarity and appropriateness of roles – agreed jointly at the beginning of the project – was recognised as an important ingredient of success. The monitoring plan, for example, stipulated the precise responsibilities of each partner organisation in relation

- ☞ Decisions in the coalition building were taken on a mutual consensus basis based on the discussion of the problem or issue. The project manager/leader pushed through the activities/decisions reached by consensus without dominating or imposing his ideas and this also helped stakeholders to feel their individual importance in the project progress.

- ☞ The clarity of the roles of coalition partners helped them to devote their time exclusively to the domain of their work, thus allowing sharing of responsibility.

- ☞ The coalition system provided an opportunity to contribute knowledge in their respective fields.

- ☞ Collaborative working arrangements in this research project for achieving the stated outputs boosted the confidence in all the coalition partners.

- ☞ The collective decisions made with the partners through continuous electronic media dialogue and regular review meetings provided opportunity for all the partners to reflect upon the issues and make necessary modifications on the way the coalition works.

The coalition system, thus, helped to present the right kind of incentives to benefit the poor sorghum farmers, feed manufacturers, poultry producers, and the scientists.

What organisations were involved at the end of the project? Were there changes to the coalition (joining/leaving) during the project? If yes, why?
Include a complete list of organisations involved, directly or indirectly, in the project and describe their relationships and contributions.

The careful selection of member organisations relied on both long experience and personal contacts. A list of eleven organisations was drawn to take part in the sorghum coalition and then narrowed it down to four. Personal knowledge of the individuals in the organisation did not influence the choice of partners, and in all cases the personal contact was not the individual who subsequently became a representative on the coalition. But doors may have been more easily opened, and trust established more quickly, by use of these personal networks. In addition to ICRISAT, one from each interest group:

Poultry experts: They chose *ANGRAU* for a variety of reasons, but principally because: ICRISAT had a memorandum of understanding with them (as they do with over half of the agricultural universities in the country), they are physically reasonably close, and they had expertise that would be essential to the project. Dr Belum Reddy first directed his enquiries to a personal contact at ANGRAU who then suggested who they should link with to ensure the coalition had expertise in poultry: the Poultry Experimental Station.

Sorghum farmers: A link with sorghum growers – to produce sorghum for testing new varieties and to supply in large enough quantities to industry – was obviously also required. The ICRISAT scientists chose the *Federation of Farmers Associations* (FFA) because they are "very active", and have a reasonable scientific capacity, experience in dealing with foreign donors, good links with the farmers, and a good reputation. Dr Belum Reddy already knew the Honorary Chairman Mr Chengal Reddy and the latter then suggested the most appropriate representative from his organisation.

Poultry feed manufacturers: The participants who would be most critical to the innovative side of the project – promoting the industrial use of sorghum – were the poultry feed manufacturers. If they could not be persuaded to use sorghum as an alternative to maize in poultry feed, then the coalition would fail. ICRISAT chose poultry feed manufacturer with great care; they invited *Janaki Feeds* to join the coalition on the grounds that they had already worked with ICRISAT, they had a reputation as a well-established and successful company, and the Directors had already shown that they understood the value of science. Other ICRISAT scientists had already worked with Janaki Feeds and knew one of the Directors.

Poultry farmers: The success of the project would also depend on the poultry farmers having confidence in the nutritional content of feed. Some larger-scale farmers make up their own feed, especially those producing layer rather than broiler birds, while others purchase it from feed manufacturing companies. ICRISAT chose the *Andhra Pradesh Poultry Federation* (APPF) because as another representative organisation with credibility it could reach a larger number of farmers than individuals could on their own. Mr Belum V S Reddy and Mr P. Parthsarthy Rao already had links with APPF, for

example when collecting information from them during the previous sorghum projects, but the particular individual invited was not one of their personal contacts.

Each coalition member had his or her own reasons for joining. The ANGRAU poultry experts, and the ICRISAT seed breeders, were interested in forming links with farmers and feed manufacturers to improve the uptake of their research outputs and findings. Like most agricultural research institutes, in the past both had relied heavily on academic publications to disseminate their work to other institutes and on other agencies to transfer findings to the end-users. They were anxious to work more closely with key stakeholder organisations from the outset of this new initiative to make sure that responsibility for all stages of the work – planning, innovation, dissemination – were jointly shared by all. This strategy, they felt, would maximise the impact on poverty reduction.

The sorghum farmers, represented by the FFA, saw the potential to increase the security of their livelihoods. In recent years farmers had suffered repeated droughts and low prices for their produce. The coalition offered them opportunities to grow higher yielding sorghum, which is a less risky crop than maize because it relies on less rain. Improved rainy season sorghum could provide both fodder for animals – which was of particular interest to women dairy farmers – as well as food for their own consumption. It could potentially be sold for industrial use as well. Since the latter relied upon convincing poultry feed manufacturers and poultry farmers that sorghum was as healthy for the birds as maize, there was an element of risk. But enough farmers judged that this risk was lower than the prospect of growing crops that could be utterly ruined if the rains failed.

Initially the poultry feed manufacturers – Janaki Feeds – were sceptical about 100% replacement of maize with sorghum. They had already been replacing small amounts of maize with sorghum in poultry feed, partly because the latter was cheaper but also because maize was becoming scarce. They had not conducted scientific tests, and had doubts about the nutritional value of replacing large quantities of maize, so they kept the amounts relatively small. They had a high opinion of the value of science, and of ICRISAT scientists in particular, because they had collaboratively developed a useful and cost-saving ‘ELISA kit’ together for assessing mycotoxins in poultry feed. So they agreed to meet because they trusted ICRISAT. But it was only when they scrutinised the evidence that sorghum was as healthy as maize that they saw the business potential.

The APPF saw the potential benefits to its members: if the farmers produced their own feed, then they would benefit from cheaper, more easily available sorghum or if they bought it from Janaki Feeds, or other feed manufacturers that followed suit, then they would spend less on purchasing feed than they would if they relied on maize for grain.

The careful and shrewd vision in selection of partners resulted in successful running of the project without any change in partners through out the program.

How will (have) project outputs affect(ed) the institutional setting?
How will the technical outputs of the project (if successful and if adopted) change the organisations and the relationships between them and in what way? Refer to the project's technical hypothesis.

Though, it is early to conclude on the changes in institutional setting, the approach of working different/distinct partners in coalition is novel. The experience is of immense importance for the institutes which are concerned with common goal and working independently. The generic lesions from this approach will give a way to capitalize the synergies while working in groups. The industry capacity in up taking the research inputs is greatly enhanced. The bargaining capacity of farmers associations while dealing with industry as well as research institutes is significantly improved. This experience will pave the way for the industry to forge alliances in future with research organizations and producers of raw material for effective delivery of services. The research institutes got new insights on industry needs and farmers choices, which make them to conduct future research with more applicability at end user level. The private sector participation in the project is a sign of enhanced public – private and farmer partnerships for mutual benefit. Poultry feed trails instilled a new confidence in the industry on the value of science for their business. This may lead to industry proactive partnerships in future.

Section E Research Activities (15-20 pages)
This section should include a description of all the research activities (research studies, surveys etc.) conducted to achieve the outputs of the project analysed against the milestones set for the implementation period.

A. BASELINE AND POST HARVEST SURVEYS

This part briefly highlights the findings from baseline surveys carried out in project villages on sorghum production, utilization and marketing. Cost of production of improved sorghum cultivars supplied under the project is then compared with the baseline data. Farmers' perceptions on the performance of improved cultivars compared to local varieties are reported here after.

1. Highlights from BASELINE SURVEY (*rainy season* 2002) in project villages.

Baseline survey of the selected respondents was conducted through structured schedules by direct interview method. The primary data on cropping patterns, product utilization, cost of cultivation of sorghum and its competing crops, livestock and fodder particulars, market surplus, asset structure, family economic profile, consumption pattern etc., were collected and analysed for rainy season (*Kharif)* 2002 season. Farmers' ranking of preferred characteristics in a new improved sorghum cultivars, reasons for growing local varieties and factors responsible for decrease in sorghum consumption overtime were also assessed. All the results were presented in tables numbering 1.1 – 1.7 and annexed.

Cropping pattern
The cropping pattern during *kharif* 2002 of the selected farmers is presented in annexed Table 1.1 (Mahabubnagar) and Table 1.2 (Ranga Reddy). Area allocated towards castor (84 acres)

was highest followed by sorghum + pigeonpea (49 acres) and cotton (35 acres) in Mahabubnagar district. On an average, 1.44 acres out of total cultivable land (7.04 acres) was allocated by each farmer for sorghum indicating the sample farmers' need for the crop to meet the food and fodder requirements of the household. Almost similar trend of cropping pattern was noticed in Ranga Reddy district also, except that more area was allocated towards maize followed by sorghum. But still on an average 1.17 acres out of total land area (5.57 acres) was allocated to sorghum in Ranga Reddy district. The grain as well as fodder yields of sorghum in both the districts were low because sorghum is grown in poor marginal soils and low-yielding local varieties dominate. Improved varieties were cultivated in all the crops except sorghum.

Utilisation of marketing surplus

Among all the crops in both the districts, sorghum is the crop with lowest market surplus that reflects the subsistence nature of this food crop. Sorghum was marketed through regulated market, weekly market at the mandal head quarter and village sales indicating the poor market demand for the crop in both districts. Table 1.3 reveals that sample farmers in Mahabubnagar and Ranga Reddy districts marketed 37% and 32% of local sorghum grain produced respectively. In contrast, about 70% of paddy was marketed in both the districts. For most other crops 100% produce was marketed due to non-consumption of those crops at the household level.

Cost of cultivation of sorghum and selected crops

Cost of cultivation of sorghum and selected crops like maize and cotton were compiled separately for Ranga Reddy district (1.4) and Mahabubbnagar district (1.5) of Andhra Pradesh for *Kharif* 2002.

Sorghum cultivars traits preferred by sample farmers

The farmers preferred characteristics in new improved sorghum cultivars were ascertained during baseline survey. The higher grain productivity was ranked first followed by fodder yield (Table 1.6). Superior grains as well as fodder were also considered important traits. Farmers want more marketable surplus of grain and fodder with superior quality to augment their incomes.

Changes in food use of sorghum

There has been a continuous decline in the consumption of sorghum as food over the last two decades. This in turn led to decline in sorghum price in the market. The reasons for decrease in consumption level are shown in Table 1.7. Increase in availability of rice due to higher - production and availability of subsidized rice through PDS, change in food habits, Govt. programmes supplying rice or rice based products under various schemes were the main reasons revealed by farmers for decline in sorghum consumption.

2. Highlights of POST HARVEST SURVEY (*rainy season* 2003) in project villages.

In Oct/ Nov 2003, after harvest of the crop, surveys were conducted to know the sample farmers' perceptions regarding the performance of improved sorghum cultivars supplied under the project. Specifically, farmers were interviewed on production related problems,

farmers preference to grow improved sorghum cultivars in *kharif* 2004, and costs and returns profile of improved as well as local sorghum varieties cultivated during *kharif* 2003. Farmers' perceptions on collective marketing of sorghum grain through farmers clubs, compared to the traditional marketing channels were ascertained. Tabulated results were annexed with table numbers from 2.1 to 2.6.

During *kharif* 2003, the sowings were delayed due to late onset of monsoon and were taken up between the last week of June to mid July (usually, first to second week of June in normal rainfall years) depending on the rainfall received in respective villages. The fields were regularly monitored for gypsum application, sowings, germination, timely fertilizer application, inter cultivation, weeding and harvesting. While monitoring, control measures for shoot fly and stem borer damage, basal and topdressing of fertilizer, physiological maturity of crop to help in harvesting and other recommended package of practices were explained to the farmers. During the meetings/ field visits in the selected villages, ICRISAT scientists illustrated proper harvesting stage of crop to avoid the grain mold problem, which otherwise leads to low market price

Table 2.1 indicates that the area and performance of improved sorghum cultivars supplied under the project. The performance of improved cultivars was superior compared to local varieties. The grain yield realized was around 2-3 times higher than the local cultivars.

Performance of improved sorghum cultivars

The cultivar–wise performance of improved sorghum cultivars as perceived by the sample farmers under the project during *kharif* 2003 are presented in Table 2.3. The performance of two cultivars i.e. CSV 15 and CSH 16 (out of four supplied) were more appreciated by the farmers due to higher yield and superior quality grain as well as fodder when compared to traditional varieties of sorghum.

Product utilization and marketing

Only few sample farmers realized good productivity of improved sorghum during *kharif* 2003, primarily due to unfavourable climatic conditions (late onset of monsoon, prolonged dry spells and continuous heavy rains during ear head emergence to grain development stages). Although the performance of improved cultivars was better than local varieties, only small quantities of sorghum were marketed by sample farmers in both the districts since the farmers retained the crop for home consumption to meet food needs (Table 2.2). Households in both districts utilized almost the entire stover production to feed their animals.

Cost of cultivation/ production

In addition to the ICRISAT supplied improved sorghum, around 26 per cent of farmers who were part of the project have grown the local (yellow) variety of sorghum during *kharif* 2003. The sorghum crop was harvested during last week of November to first week of December. The grain development stage of the crop coincided with continuous rains, which resulted in grain mold attack and lower yields than expected for both improved and local varieties in both the project districts. Detailed cost of cultivation was calculated and the same was published, which was also submitted along with Project Completion Summary sheet.

Overall performance of improved sorghum cultivars
The perceptions of farmers regarding the overall performance of improved sorghum cultivars supplied under project in their villages are compiled in Table 2.4.

Production related problems
Farmers revealed a few production related problems in the cultivation of improved sorghum cultivars as well as general farming problems (Table 2.5) Untimely rains at seed setting and grain development stage, leading to grain mold attack was a major problem in growing (both local and improved) sorghum. About 35% of the farmers did not follow the recommended package of practices for improved varieties. Poor quality of soil was another problem mentioned by one-fourth of the framers.

Collective marketing of sorghum grain
Farmers were asked about the current marketing channels for sorghum and their willingness to participate in collective/ group marketing of surplus sorghum production. A majority of farmers expressed interest to participate in collective marketing. Farmers felt that they can obtain higher prices through collective marketing and save on marketing and transport cost (Table 2.6). Currently, the project is exploring to link groups of farmers with surplus sorghum to poultry feed manufacturer who is willing to buy bulk quantities from a few sources. This will be the important factor to develop innovative marketing link proposed in the project.

B. GRAIN MOLD RESISTANCE AND CHEMICAL COMPOSITION OF THE IMPROVED SORGHUM CULTIVARS HARVESTED DURING 2002.

To know the levels of tannins, mycotoxins, (Aflatoxins and fumonisin) and phenolic components, chemical analysis of sorghum grain harvested during Kharif 2002 was conducted at ICRISAT. The grain mold resistance, metabolizable energy, amino acid profile etc, were also estimated.

Grain mold resistance
The grain mold resistance was tested on 1-5 scale, which is represented as TGMR (Threshed grain mold rating). The threshed grain mold severity of the selected sorghum cultivars is as follows (Table 3.1).

Table 3.1: **Threshed grain mold severity of the selected sorghum cultivars.**

Cultivars	Grain mold rating of threshed grains				
	Rep 1	Rep 2	Rep 3	Rep 4	Mean
CSH 16	2	2	2	2	2
CSV 15	2	2	2	2	2
PSV 16	2	2	2	2	2
S 35	3	3	3	3	3

Note: Each sample was sub-sampled in to four replicates with about 25 grams per replicate.

The sub-samples were assessed visually using a standard 1-5 scale, where
1= no mold
2= 1=10% grains molded
3= 11-25% grain molded
4= 26-50% grain molded
5= > 50% grain molded

Analysis reveals that all the sorghum cultivars contained 1-10% affected grains except S-35, which has 11-25%, affected grains.

Tannins and Phenolic compounds:
The levels of tannins and phenolic compounds (as catachin and tannic acid equivalents respectively) were analysed for the grain lots of improved sorghum cultivars and a local (yellow) sorghum variety, presented in Table 3.2

Table 3.2: **Tannins and phenolic compounds in the selected sorghum cultivars.**

Cultivar	**Tannins% (Catachin equivalents)**	**Phenolic compounds % (Tannic acid equivalents)**
CSH 16	0.023	0.247
CSV 15	0.038	0.357
PSV 16	0.030	0.312
S 35	0.023	0.292
Local Yellow	0.045	0.780

Note: Methanol-HCl extraction method was used for the estimation of tannins and Folin Denis' method for Phenolic compounds estimation.

The Chemical analysis revealed that the tannins (0.02% to 0.05%) and Phenolic compounds (0.25 to 0.78%) in all the sorghum cultivars were found low and did not exert any deleterious effects, if used as poultry feed.

Mycotoxins
Sorghum is susceptible to molds like *Fusarium moniliforme*, *Aspergillus flavus*, *Ochracus verricolor*, *Alternaria sps* and *Curvularia lunata*. These produce mycotoxins like aflatoxins, fumonisin etc., which may affect the nutritive value of sorghum. The selected improved varieties were estimated for the mycotoxin level (Table 3.3) at ICRISAT. The grain samples were subjected to 75% methanol extraction and toxins measured by ELISA method.

Table 3.3: **Aflatoxins and Fumonisin levels of selected sorghum cultivars.**

Cultivar	Aflatoxin level (µg/Kg)	Fumonisin level (µg/Kg)
CSH 16	11.7	1132.2
CSV 15	2.5	160.3
PSV 16	54	277
S 35	55.6	156.9

Note: The Indian standard permissible limit of aflatoxins and fumonisin in any food material is 30 µg Kg^{-1} and 5000 µg Kg^{-1} respectively.

The Analysis indicated that most of these sorghum cultivars could be used in poultry feed with out any adverse effects on poultry bird growth and development.

The studies indicated that naturally infected black sorghum was devoid of aflatoxins and could be used in poultry ration replacing 75% of maize.

Chemical composition and Metabolizable Energy (ME)

The chemical composition of selected improved sorghum cultivars, local (yellow) sorghum and maize are presented in Table 3.4. Sorghum contained more protein (9.56-11.79%) than maize (9.3%). Among the different sorghum cultivars, S 35 contained highest protein (11.79%). The amount of other extract, calcium and phosphorus were slightly less in sorghum. Crude fibre was higher in S 35 (4.02) followed by CSV 15, PSV 16 and CSH 16 than maize (2.19%). All sorghum cultivars had less ME than maize (3196-3422 vs. 3706 K cal Kg^{-1}). ME was variable in sorghum and lower by about 280-500 K Cal Kg^{-1} compared to maize.

Table3.4: **Chemical composition of selected improved sorghum cultivars.**

Particular	CSH 16	CSV 15	PSV 16	S 35	Local (yellow)	Maize
Dry matter (%)	92.13	92.57	92.98	93.44	92.00	92.00
ME (K Cal Kg^{-1})	3196	34.22	3402	3238	3196	3706
Crude protein (%)	10.13	9.56	10.96	11.79	10.40	9.30
Ether extract (%)	2.85	3.01	2.40	3.73	2.63	3.80
Crude Fibre (%)	2.48	3.20	2.81	4.02	2.00	2.19
Ash (%)	1.29	1.13	1.37	1.53	1.46	1.31
Nitrogen Free extract (%)	83.25	83.10	82.46	78.93	83.51	83.40
Calcium (%)	0.047	0.051	0.050	0.052	0.036	0.052
Phosphorus (%)	0.270	0.226	0.260	0.304	0.200	0.300

Amino acid profile

The amino acid contents (Table 3.5) were almost similar in all selected sorghum cultivars and maize. Sorghum was rich in tryptophan content than maize (0.09 to 0.12% vs. 0. 07%).

Table 3.5: **Amino acid profile of selected sorghum cultivars**

Parameter	Sorghum Cultivars				Maize
	CSH 16	**CSV 15**	**PSV 16**	**S 35**	
Methionine	0.16	0.15	0.17	0.17	0.18
Cysteine	0.18	0.17	0.18	0.19	0.19
Methionine+ Cystein	0.34	0.32	0.35	0.36	0.37
Lysine	0.20	0.20	0.20	0.22	0.27
Threonine	0.29	0.27	0.30	0.33	0.32
Trytophan	0.10	0.09	0.11	0.12	0.07
Arginine	0.34	0.33	0.36	0.40	0.44
Isoleucine	0.35	0.31	1.19	0.40	0.31
Leucine	1.16	0.99	1.19	1.31	1.07
Valine	0.45	0.40	0.47	0.51	0.42

C. POULTRY FEED FORMULATIONS WITH SORGHUM CULTIVARS

1. Performance of broilers on sorghum based feed rations

Experimental diets

Broiler starter (1-4 weeks age) and finisher (5-6 weeks) diets were formulated by replacing maize of control diet (maize, soybean meal and oil) with each of the five sorghum cultivars at 50%, 75% and 100% level by adjusting with oil and sawdust to make the diets iso-caloric, iso-nitrogenous including certain amino acids such as lysine, methionine and methionine plus cystein. All the sixteen diets of each of the broiler starter and finisher were formulated as per the NRC requirements 1994 (Tables 4.1 and 4.2).

Birds

Five hundred twelve day old commercial (Cobb) broiler females were randomly distributed to 64 groups and housed in battery brooder. Four such replicate groups were allotted randomly to each of the sixteen dietary treatments. Feed and water was offered *ad libitum* and standard management practices were adopted.

Data

Body weight gains, feed consumption were recorded weekly and feed efficiency (feed / weight gain) was calculated. Mortality during the experimental period if any was recorded. At completion of 42 days age, one bird from each replicate group was sacrificed by bleeding and birds were dressed. Shank and breast skin pigmentation was scored by visual method using Roche fan colour equipment to assess the carcass yellow pigmentation. The carcass weights, weights of certain visceral organs namely liver, spleen, pancreas, and bursa of fabricius were recorded; length of intestine and caecum were measured. Cost of feed was calculated for each of the diet and the cost of feed per kilo broiler live weight gain was assessed. Data was subjected to analyses (Snedecor and Cochran 1967).

Results

Performance data of broilers at 42 days age in terms of weight gains, feed consumption and feed efficiency, liveability and cost of feed per kg of body weight gain is given in Table 4.3. Body weight gains and feed consumption of broilers were statistically similar on sorghum diets at all inclusion levels compared to control diet. However, the feed efficiency was found to be significantly different ($P<0.05$). Better-feed efficiency was found on some of the sorghum cultivars namely CSV-15, CSH-16, PSV-16 and local variety at 100% inclusion level in place of maize. High yellow pigmentation was observed in broilers on feeding maize of control diet. Sorghum caused poor body pigmentation in broilers as measured by the appearance of yellow colour on shank and breast skin. Cost of feed (Rs.) per kg live weight gain was almost similar on sorghum-based diets as compared to control (maize based ration). Based on the results, it is concluded that sorghum cultivars can be included in broiler diets as a substitute to maize with out affecting the performance of broilers.

Table 4.1. **Composition Of Experimental Diets (Broiler Starter, 1-4 Weeks Age)**

Sorghum cultivars at different levels of inclusion replacing Maize																
Ingredient	**Control**	**CSV-15**			**CSH-16**			**PSV-16**			**S-35**			**LOCAL**		
		50%	75%	100%	50%	75%	100%	50%	75%	100%	50%	75%	100%	50%	75%	100%
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16
Maize	56.35	28	14	0	28	14	0	28	14	0	28	14	0	28	14	0
Soybean meal	35	35	35	35	34.3	34	34	34.3	33.5	33.5	33.5	32.5	32.5	34.3	34	34
Sorghum	0	28	42	56	28	42	56	28	42	56	28	42	56	28	42	56
Oil	2	2.98	3.53	3.98	4.03	5.1	5.8	3.48	4	4.5	4.1	5.2	6	4.03	5.1	5.8
Sawdust	2.777	2.119	1.56	1.097	1.747	0.95	0.245	2.275	2.54	2.031	2.457	2.31	1.506	1.85	0.95	0.38
Lysine	0.04	0.06	0.07	0.074	0.079	0.1	0.104	0.104	0.12	0.12	0.097	0.14	0.139	0.079	0.1	0.104
Methionine	0.243	0.251	0.25	0.259	0.254	0.26	0.261	0.251	0.25	0.259	0.256	0.26	0.265	0.151	0.26	0.126
*Constants	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Nutrient composition																
ME Kcal/Kg	3107	3107	3105	3109	3103	3104	3103	3105	3104	3104	3108	3105	3105	3103	3107	3103
CP %	22.2	22.21	22.3	22.17	22.23	22.3	22.2	22.3	22.26	22.23	22.3	22.2	22.3	22.26	22.3	22.28
LYS %	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
MET %	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
CYS %	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.35	0.36	0.36	0.36	0.36	0.36	0.36
M+C %	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1.96	1.96	1.96	1.96	1.96	1.96
Ca %	0.99	0.98	0.99	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.98	0.99	0.98	0.99	0.98	0.99
N.PP %	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42

Constants (kg): Dicalcium phosphate1.5, shell grit 1.5, common salt 0.314, trace mineral mixture 0.140,cygro 0.05, choline chloride (50%)0.05, Becomplex 0.02, vitamin AB2D3EK 0.02, Vitamin B12 (100ppm) 0.02, EcareSe 0.01, zinc sulphate, 5H2O0.01, Manganese sulphate5H2O 0.01

Table 4.2. **Composition Of Experimental Diets (Broiler Finisher, 5-6 Weeks Age)**

Sorghum cultivars at different levels of inclusion replacing Maize																
Ingredient	**Control**	**CSV-15**			**CSH-16**			**PSV-16**			**S-35**			**LOCAL**		
		50%	75%	100%	50%	75%	100%	50%	75%	100%	50%	75%	100%	50%	75%	100%
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16
Maize	60	30	15	0	30	15	0	30	15	0	30	15	0	30	15	0
Soybean meal	30	30	30	30	29.4	28.9	28.78	29.14	28.58	28.17	28.38	27.43	26.58	29.38	28.90	28.78
Sorghum	0	30	45	60	30	45	60	30	45	60	30	45	60	30	45	60
Oil	3	4	4.6	5.1	5	6.1	7.1	4.3	5.1	5.8	5.2	6.4	7.45	5	6.1	7.1
Sawdust	3.09	2.06	1.43	0.92	1.62	1.0	0.10	2.57	2.29	1.98	2.41	2.11	1.87	1.64	1.0	0.1
Lysine	0.10	0.12	0.14	0.15	0.15	0.17	0.19	0.16	0.19	0.21	0.18	0.22	0.25	0.15	0.17	0.19
Methionine	0.15	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.18	0.18	0.17	0.18	0.19	0.17	0.17	0.17
*Constants	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Nutrient composition, %																
ME Kcal/Kg	3211	3208	3214	3212	3205	3210	3207	3205	3210	3211	3208	3211	3205	3205	3210	3207
C.P, %	20.31	20.36	20.41	20.44	20.39	20.40	20.40	20.43	20.42	20.46	20.41	20.39	20.40	20.39	20.40	20.40
Lys %	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16
Met %	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
Cys %	0.34	0.34	0.34	0.34	0.34	0.34	0.33	0.33	0.32	0.32	0.33	0.33	0.33	0.34	0.34	0.33
Ca %	0.87	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
NPP %	0.41	0.41	0.42	0.41	0.41	0.42	0.41	0.41	0.41	0.41	0.41	0.42	0.40	0.41	0.42	0.41

Constants (kg): Dicalcium phosphate1.5, shell grit 1.5, common salt 0.314, trace mineral mixture 0.140,cygro 0.05, choline chloride (50%)0.05, Becomplex 0.02, vitamin AB2D3EK 0.02, Vitamin B12(100ppm)0.02, EcareSe 0.01, zinc sulphate, 5H2O0.01, Manganese sulphate5H2O 0.01

Table 4.3. **Performance of broilers fed on diets containing sorghum (42 days age)**

Parameter	Control	**Sorghum cultivars at different levels of inclusion replacing maize**														
		CSV-15			**CSH-16**			**PSV-16**			**S-35**			**LOCAL**		
		50 %	75%	100%	50%	75%	100%	50%	75%	100%	50%	75%	100%	50%	75%	100 %
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16
Weight gain (g)[1]	1779	1757	1816	1845	1781	1888	1833	1755	1841	1799	1863	1793	1821	1812	1800	1795
Feed consumption (g)[2]	3298	3302	3279	3220	3195	3214	3217	3163	3261	3171	3282	3275	3283	3242	3153	3098
Feed efficiency[3]	1.854 ab	1.879 a	1.805 ab cd	1.745 cde	1.794 bcd	1.702 e	1.755 cde	1.803 a bcd	1.771 cde	1.762 cde	1.762 cde	1.826 abc	1.802 a bcd	1.790 bcd	1.751 cde	1.726 de
Livability, %[4]	100	91	94	100	94	100	97	97	97	100	94	97	97	94	97	100
Cost of feed per kg live weight gain (Rs)	18.18	18.49	18.20	17.40	18.44	18.50	18.73	18.15	18.06	17.78	18.16	19.55	19.57	18.37	18.72	18.19

[1,2]Non significant

[3]Significant (P<0.05)

2. Performance of layers on improved sorghum based feed rations

Birds and housing: Five hundred four day-old commercial chicks of egg type (I.L.R.90 Jubilee) were distributed into 42 groups based on body weight. All the groups were randomly allotted to six treatments at the rate of seven replicate groups per treatment. Birds were housed in electrical battery brooders with a floor space requirement of 0.33 sq ft/bird up to the age of 8th week. At the end of 8th week, all the birds were shifted to grower cum layer cages by placing 2 birds /cage with a floor space requirement of 0.78 sq ft/bird up to 18th week age.

At the age of 24 weeks two hundred and fifty six birds were allotted to 32 groups (8 birds /group) based on their egg production and housed individually in a Californian 2-tier cages with a floor space requirement of 1.56 sq ft/bird. All the groups were randomly allotted to 8 treatments at the rate of 4 replicate groups per treatment.

Immunization and medication: A routine layer vaccination schedule was followed. All the birds were vaccinated against Ranikhet disease, Infectious bursal disease and Fowl pox. F1 Lasota (Ranikhet disease), Infectious bursal disease priming, F1 Lasota booster, Infectious bursal disease booster, Fowl pox, R.D. R2 B (Ranikhet disease) and R.D. R2 B (Ranikhet disease) booster were given at 8th day, 15th day, 29th day, 36th day, 50th day, 58th day and 18th week age respectively. A routine tiamutin medication was given through drinking water to all the birds at different ages during the growth period for prevention of mycoplasmosis.

Experimental diets: Sorghum was included part-by-part replacing maize at 0%, 50% and 100% of control diet. The dietary ingredient composition for chick and growing birds during 0-8 week and 9-18 week age respectively is given in Table 5.1. The respective diets were prepared in the form of mash and pellets. Thus a total of 6 experimental diets were prepared. Each of the dietary treatment was allotted to six replicate groups during growing period.

During laying period 4 experimental diets were prepared replacing maize of control diet part by part at 0%, 50%, 100% and 100%. In the 4th experimental diet (100% sorghum) *Stylosanthes* leaf meal was included at 3% level in place of deoiled rice bran for the source of dietary pigments for egg yolk colour. The dietary ingredient composition of layer diets is given in Table 5.2. The diets were prepared both in the form of mash and pellets.

Feed and water was offered *ad libitum* during the experimental period i.e 0-8 wk, 9-18 weeks age and 24-44 week age to chick, grower and layer respectively. Body weight, feed intake was recorded at 2-week interval during growing period. Feed conversion ratio (FCR) was calculated as feed / body weight at 8th week and 18th week age. Mortality if any during growing period was also recorded.

Layer trial data was collected for a total of 5 periods from 24 week to 44-week age each period comprising of 4 weeks (28d) duration. Egg production, mortality if any was recorded daily. Body weight, feed intake was recorded period wise. Two eggs on 3 consecutive days were taken from each replicate at the end of each period for egg quality traits. Eggs were weighed individually and internal egg quality parameters such as albumin index, yolk index, Haugh unit score, shell thickness and yolk colour score were measured period vise. Yolk colour score was measured by comparing the standard Roche Fan colour scale. FCR was calculated at the end of each period and expressed as feed (kg)/ 12 eggs and feed (kg) /Kg egg mass.

Feed cost up to 8th, 18th week age during growing period and also feed cost per egg during each period of laying stage was calculated.

Results:

Performance of egg type commercial chicken on feeding sorghum at different levels replacing maize of control diet is shown in Table 5.3. There was no significant difference between control and sorghum diets with respect to body weight feed intake and feed conversion ratio (FCR) up to 8th week age. During 18th week age there was a significant difference in body weight and feed intake among the treatment groups. The body weight and feed intake values were high in only control diet with mash form compared to that of other dietary treatments. However, FCR was not significant among the treatments. All the birds achieved standard body weight of 1.2 kg by the end of 18th week.

Performance of commercial layers on feeding sorghum diets for 4 periods (4x28 days) was given in Table 5.4. There was no significant difference in egg production among the treatment groups. Inclusion of *Stylosanthes* leaf meal at 3% in a diet comprising of sorghum in place of maize resulted in lower feed consumption compared to control. Significant differences were not observed among the mash and pellet diets. *Feed conversion ratio was similar in all the experimental diets*. Significant differences in egg weights among the treatment groups were observed. Pellet diets resulted in higher egg weights compared to mash.

Significant differences were not observed in internal egg quality parameters due to treatments. The yolk color of egg by visual score method indicated a proportionate reduction due to inclusion of sorghum in diets. Only 50% improvement in egg yolk color was achieved on sorghum diets when Stylosanthes leaf meal was included at 3% level compared to control diet. This shows that stylosanthes has contributed to a partial improvement in yolk colour (Table 5.5).

Feed cost for production of pullet chick and an egg on different sorghum diets fed for 4x28 d period was given Table 5.6. *Maximum reduction in feed cost was observed in diets on complete replacement of maize with sorghum* to the extent of Rs.0.59 and Rs.0.45 for mash and pellets respectively up to 8th week age. Similarly cost reduction on sorghum diets up to 18th week age was Rs, 3.04 and Rs. 1.39 in respect of mash *vs.* pellets. Higher benefit was observed in mash than pellet. Feed cost /egg was low in sorghum diets compared to control. Sorghum along with stylosanthes leaf meal at 3% lowered the feed cost per producing an egg. Mortality through out the experiment was normal. Inclusion of sorghum in layer diets caused proportionate decrease in yellow colour of yolk as compared to the control diet comprising maize. Addition of stylosanthes leaf meal in diets at 3% resulted in partial improvement of egg yolk colour.

Sorghum can be included in layer diets up to 100% in place of maize with out affecting egg production performance except egg yolk colour. Stylosanthes leaf meal in sorghum-based diet resulted in partial improvement of egg yolk colour as compared to maize based diet.

Table 5.1. **Experimental diets at different ages of commercial egg type chicken**

	Chick (0-8 wk)			Grower (9-18 wk)		
Ingredient	Control	Sorghum 50%	Sorghum 100%	Control	Sorghum 50%	Sorghum 100%
Maize	48	24	-	48	24	-
Sorghum	0	24	48	0	24	48
Soybean meal	22	22	22	15	15	15
Deoiled rice bran	14.55	14.55	14.55	23.55	23.55	23.55
Sunflower meal	12	12	12	10	10	10
Dicalcium phosphate	1.4	1.4	1.4	1.4	1.4	1.4
Calcite powder	1.4	1.4	1.4	1.45	1.45	1.45
Common Salt	0.3	0.3	0.3	0.3	0.3	0.3
Cocciodiostat	0.05	0.05	0.05	0.05	0.05	0.05
DL Methionine	0.1	0.1	0.1	0.05	0.05	0.05
Trace minerals	0.1	0.1	0.1	0.1	0.1	0.1
Vitamin mix	0.1	0.1	0.1	0.1	0.1	0.1
Total	100	100	100	100	100	100
Cost of Mash/kg (Rs)	7.61	7.47	7.32	7.05	6.91	6.77
Cost of Pellet/kg (Rs)	7.86	7.72	7.57	7.30	7.16	7.02

- Cost of maize and sorghum was considered at Rs. 6.00 $kg^{-1}$and Rs. 5.40 kg^{-1} respectively

Table 5.2. **Experimental diets of commercial layer diets**

Ingredient	Control	Sorghum 50%	Sorghum 100%	Sorghum 100% + Stylo 3%
Maize	50	25	0	0
Sorghum	0	25	50	50
Deoiled rice bran	15.45	15.45	15.45	12.45
Soybean meal	24	24	24	24
Stylosanthes leaf meal	0	0	0	3
DCP	1.5	1.5	1.5	1.5
Calcite powder	1.5	1.5	1.5	1.5
Shell grit/ Calcite powder	6.8	6.8	6.8	6.8
Common Salt	0.3	0.3	0.3	0.3
DL Methionine	0.25	0.25	0.25	0.25
Trace minerals	0.1	0.1	0.1	0.1
Vitamin mix	0.1	0.1	0.1	0.1
Total	100	100	100	100
Cost of Mash feed/kg (Rs)	7.94	7.79	7.64	7.58
Cost of Pellet feed/kg (Rs)	8.19	8.04	7.89	7.83

Table 5.3. **Performance of egg type commercial chicken during growth stage on sorghum diets**

Treatment		8th week age			18th week age		
		Body weight (g)	Feed intake (g)	FCR (Feed/gain)	Body weight (g)	Feed intake (g)	FCR (feed/gain)
Control	Mash	621	1901	3.061	1233[b]	6324[b]	5.130
	Pellet	658	1884	2.865	1202[a]	6129[a]	5.102
Sorghum 50%	Mash	637	1933	3.038	1201[a]	6100[a]	5.083
	Pellet	652	1911	2.935	1206[a]	6073[a]	5.037
Sorghum 100%	Mash	637	1897	2.978	1208[a]	6136[a]	5.083
	Pellet	645	1896	2.938	1202[a]	6176[ab]	5.138
SEM		16	41.1	0.091	9.4	76.9	0.071

Values baring different superscripts within a column are significantly (P< 0.05) different

Table 5.4. **Performance of commercial layer (White Leghorn) birds on sorghum diets**

Treatment		Egg production Hen-day%	Feed intake (g)	FCR/12 eggs (g)	FCR/kg egg mass (g)	Egg weight (g)
Control	Mash	87.1	117.1[d]	1.614	2.481	54.1[a]
	Pellet	86.7	116.5[cd]	1.615	2.377	56.6[c]
Sorghum 50%	Mash	84.9	112.3[ab]	1.603	2.426	55.1[ab]
	Pellet	86.6	115.3[bcd]	1.598	2.396	55.5[bc]
Sorghum 100%	Mash	87.4	115.3[bcd]	1.586	2.434	54.2[a]
	Pellet	87.9	112.6[ab]	1.543	2.341	54.9[ab]
Sorghum100% + Stylo 3%	Mash	85.3	111.1[a]	1.570	2.401	54.4[ab]
	Pellet	86.0	113.7[abc]	1.588	2.343	56.4[c]
SEM		0.92	1.61	0.040	0.068	0.57

Values baring different superscripts within a column are significantly (P< 0.05) different

Table 5.5. **Certain egg quality parameters in birds fed on sorghum diets**

Treatment		Haugh unit score	Albumen Index	Yolk index	Shell thickness (mm)	Yolk colour score
Control	Mash	75	0.072	0.383	0.361	++++
	Pellet	75	0.073	0.388	0.376	++++
Sorghum 50%	Mash	74	0.070	0.377	0.376	++
	Pellet	72	0.068	0.376	0.371	++
Sorghum 100%	Mash	73	0.073	0.379	0.369	+
	Pellet	74	0.070	0.368	0.355	+
Sorghum100% + Stylo 3%	Mash	72	0.067	0.370	0.371	++
	Pellet	72	0.066	0.394	0.355	++
SEM		1.6	0.003	0.011	0.006	

Table 5.6. **Feed cost for production of pullet chick and egg on different sorghum diets**

		Feed cost up to 8^{th} week (Rs)	Feed cost up to 18^{th} week (Rs)	Feed cost / egg (Rs)
Control	Mash	14.47	44.58	1.07
	Pellet	14.80	44.74	1.10
Sorghum 50%	Mash	14.44	42.15	1.04
	Pellet	14.75	43.48	1.07
Sorghum 100%	Mash	13.88	41.54	1.01
	Pellet	14.35	43.35	1.01
Sorghum 100%+stylo 3%	Mash	-	-	0.99
	Pellet	-	-	1.04

D. STOVER ANALYSIS OF IMPROVED SORGHUM CULTIVARS

Stover of improved sorghum cultivars (supplied as part of the project i.e., CSH 16, CSV 15, PSV 16, S 35) was collected along with local cultivars from project villages and analysed for stover quality parameters. At the time of harvest stover samples were collected.

Sampling Methods

Entire field of a farmer under particular genotype was divided into 4 quarters. From each quarter, one sample was collected randomly using one-meter square area sampler. All the plants in the one-meter square area were collected and computed mean of 4 samples data is treated as one replication i.e., each farmer field was treated as a replication. While sampling, due consideration was given to get samples from each of the predominant soil types of the region.

Laboratory Analysis

Stover samples were analysed at International Livestock Research Institute (ILRI) –South Asia Project, Patancheru, India. Stover crude protein content and stover *in vitro* digestibility were investigated using combinations of conventional nutritional laboratory analysis with Near Infra Red Spectroscopy (NIRS). For conventional analysis, nitrogen was determined by

auto-analyser and crude protein was calculated from nitrogen by multiplication with the factor of 6.25. *In vitro* digestibility was measured in rumen microbial inoculum using the *in vitro* gas production technique and equation described by Menke and Steingass (1988). In addition to these, kinetics of *in vitro* gas production like B (total gas produced in 96 h), C (time taken to produce 50% of the total gas produced), LAG (lag period to initiate gas production), and T ½ (rate of gas production) were estimated based on exponential model.

Results and Discussion

The REML variance components analysis (fixed model) indicated significant genotypic differences only for stover digestibility. It was interesting to note that non-significant mean squares due to either soil type or genotype* soil type interaction for both stover Nitrogen Dry Matter (NDM) content and Digestibility, suggesting limited role of soil type and genotype*soil type interactions. Thus the results clearly indicated the genetic options for enhancing stover quality traits.

Crude protein content in improved sorghum cultivars was significantly higher compared to local check **(**Table6.1). Among the improved cultivars, stover of CSH 16 had highest crude protein (2.656%) followed by S 35 (2.506%), CSV 15 (2.231%) and PSV16 (2.231%). In case of local sorghum cultivars, stover contained 2.406% crude protein, which is contrary to the popular belief among farmers' that improved cultivars are not as good as local sorghum cultivars for livestock. Complementing to the stover quality, the quantity obtained by the farmers with improved cultivars (weighted average of all four) was also higher i.e., 2297 kg ha^{-1} and 1560 kg ha^{-1}, whereas the stover yield of local sorghum is 1900 kg ha^{-} and 1260 kg ha^{-1} , in project villages of Mahabubnagar and Ranga Reddy districts, respectively. It was evident from the results that soil type did not have significant bearing on the crude protein content of the stover. In all observations the improved cultivars were found promising in comparison to local cultivars for crude protein content.

The digestibility of improved sorghum cultivars was found superior. It was observed from the results that among the cultivars analysed, S 35 had excellent digestibility (46.31%), followed by PSV 16 (46.02%), CSV 15 (45.93%) and CSH 16 (43.00%) The digestibility of local sorghum is 40.46% only. It was also clearly found that irrespective of the soil type, the improved cultivars are found superior to local cultivars for their stover digestibility. The result emphatically proves farmers apprehensions as misconceptions.

Table6.1: **Estimated mean values of sorghum stover NDM content and Digestibility**

Genotype	**NDM**	***Crude Protein Content**	**Digestibility**	**B**	**C**	**Lag**	**T 1/2 Lag HFT**
CSH 16	0.425	2.656	43.00	53.368	0.0292	-1.4607	22.02
CSV 15	0.357	2.231	45.93	57.231	0.0318	-2.148	19.936
PSV 16	0.357	2.231	46.02	57.405	0.0320	-2.5524	19.55
S 35	0.401	2.506	46.31	57.403	0.0322	-3.7284	18.43
Local/Check	0.385	2.406	40.46	53.722	0.0281	-0.4322	24.38

* Crude protein content = 6.25 X NDM

Information on any facilities, expertise and special resources used to implement the project should also be included.

Sprinkler unit: This is used for irrigating the sorghum plots at Regional Agricultural Research Station, Palem in Mahabubnagar district, a drought prone area where water is scarce.

Battery brooder: This brooder infrastructure facility was used for housing the experimental birds and conducting studies. The facility was used to conduct trials on performance of poultry birds with sorghum-based poultry feed rations.

Fibertec: This equipment procured under DFID project was used to analyse fibre in a more accurate way with less time.

Sorghum bulk cold store room: This storeroom with dehumidifier was used to store the sorghum grain after harvest without damage till the produce was delivered for poultry feed manufacturing. Otherwise the damaged grain will lead to misleading results. In addition to this split air conditioner facility of ICRISAT was also utilised.

Section F Project effectiveness

This section of the evaluation report uses the rating criteria for the purpose and your outputs previously used in your annual reports.

	Rating
Project Goal	X
Project Purpose	2
Project Outputs 1. Poultry feed formulations with sorghum cultivars available	1
2. Formation of sustainable farmer-scientist-industry coalition	1
3. Technology access to the target groups accelerated	2
4. Understanding coalition system as a process	1

1= completely achieved
2= largely achieved
3= partially achieved
4= achieved only to a very limited extent
X= too early to judge the extent of achievement (avoid using this rating for purpose and outputs)

Outputs (5 pages)

What were the research outputs achieved by the project as defined by the value of their respective OVIs? Were all the anticipated outputs achieved and if not what were the reasons? Your assessment of outputs should be presented as tables or graphs rather than lengthy writing, and provided in as quantitative a form as far as is possible.

I. POULTRY FEED FORMULATIONS WITH SORGHUM CULTIVARS AVAILABLE

1. **Broilers performed satisfactorily on sorghum based feed rations**

Sorghum cultivars contained more protein (9.56 to 11.79%) than maize (9.3%). Metabolizable energy in sorghum cultivars ranged from 3196 to 3422 K cal kg^{-1} against 3700 K cal kg^{-1} in maize. Aminoacid profile was almost similar except tryptophan content, which is high in sorghum (0.09-0.12%) than maize (0.07%). Tannins, phenolic compounds as tannic

acid equivalent and catachin equivalent were found low in all the sorghum cultivars (0.023 % to 0.045%). All the sorghum cultivars had low levels of grain molds and mycotoxins.

Performance data of broilers at 42 days age shows that sorghum could replace maize 100% (56 parts in starter and 60 parts in finisher diets) without affecting the broiler performance. Among the sorghum cultivars, CSV 15 (Rs. 17.16) followed by PSV 16 (Rs 17.62) were found superior and lowered the feed cost in rupees kg^{-1} live weight gain as against maize (Rs. 18.02). Further, pelletization improved the broiler performance over the mash feed on sorghum diets (Table 7.1). Despite the increased feed cost on pellet feeds (Rs. 0.25 kg^{-1}), the efficiency of broiler production was better on sorghum pellets than on mash. Inclusion of stylo santhus leaf meal at 3% in 100% sorghum-based broiler diets improved the shank and skin colour of carcass to a desired level. Carcass yields and abdominal fat on all sorghum diets as well as sorghum diet fortified with stylosanthus meal were comparable to that of maize. Thus, it appears that pelletization of 100% sorghum-based diet with stylo leaf meal at 3% besides improving the skin and carcass colour, improved the feed conversion ratio as well and there by lowered the feed cost in rupees kg^{-1} live broiler live weight gain.

Table 7.1. **Performance and economics of sorghum-based feed rations (pellet and mash forms) on broilers (up to 6 weeks age)**

Treatment	Weight gain[1] (g)		Feed intake (g)		Feed conversion ratio		Feed cost			
							Rs. kg^{-1} feed		Rs. kg^{-1} live weight gain	
	Mash	Pellet	Mash	Pellet	Mash	Pellet	Mash	Pellet	Mash	Pellet
Maize 100% (control)	1961^{bc}	1942^{bcd}	3495	3500	1.81	1.80	11.54	11.79	21.01	21.37
Sorghum 50%	2000^{cde}	2081^{e}	3589	3533	1.79	1.70	11.36	11.61	20.17	19.36
Sorghum 75%	1871^{ab}	2033^{de}	3442	3651	1.84	1.80	11.18	11.43	20.46	20.31
Sorghum 100% + Stylo 3%	1784^{a}	1974^{cd}	3512	3608	1.97	1.83	11.09	11.34	22.39	20.65
$SE_m \pm$	33.9		49.7		0.023		-		-	

[1]similar letter combinations in the columns indicate the non-significance of dietary treatments (P=0.05)

Note: Cost of maize and sorghum was considered at Rs. 6.00 $kg^{-1}$and Rs. 5.40 kg^{-1} respectively.

2. Egg production costs less with sorghum based diets

Grain molds, mycotoxins and tannins in sorghum often limit its use in poultry feeds. Certain sorghum cultivars released recently were known for higher grain yield, less susceptible to grain molds and low in tannin content. Use of such sorghum in diets for grower and layer birds was explored as part of this project. Growth study comprised of 6 diets @ 7 replicates fed to commercial egg type chicken (n=504) from day old to 18^{th} week age. Control grower diet contained 48% maize. Sorghum replaced maize at 0, 50, 100% in the form of mash and pellet. Layer feeding trial (n=256) comprised of 8 diets @ 4 replicates. Control layer diet contained 50% maize. Sorghum replaced maize at 0, 50, 100%. The later diet contained 3% S*tylosanthes* leaf meal (in place of deoiled rice bran) as a source of pigments. Birds were reared in cages, feed and water offered *ad-lib*. Body weight, feed intake was recorded and FCR was calculated at 8^{th} and 18^{th} week age. Egg production, mortality, feed intake, egg weight and egg quality parameters (2 eggs per replicate on 3 consequent days) were recorded.

FCR per 12 eggs, per kg egg mass; feed cost during growth and egg laying period was calculated.

There was no significant difference between control and sorghum diets with respect to body weight, feed intake and FCR up to 8th week age. The birds achieved standard body weight both on sorghum and control diets at 18th week. Sorghum diets resulted in cost reduction of mash and pellets to the extent of Rs. 3.04 and Rs. 1.39 per bird up to 18th week age (Table 8.2). Sorghum inclusion at different levels resulted in similar egg production as compared to control. The egg production ranged from 85-88% (Table 8.1). Yellow colour of the yolk reduced with the level of sorghum inclusion and is almost pale on 100% sorghum diets. *Stylosanthes* leaf meal improved egg yolk colour but was to the extent of 50% of control diet. Similar improvement of egg yolk colour was achieved with dietary marigold at 0.1%. Feed cost / egg in the order of sorghum inclusion vs control was Rs. 1.04, 1.01 vs 1.07 in case of mash feeding and Rs. 1.07, 1.01 vs 1.10 in case of pellet feeding. Feed cost per egg at 100% inclusion of sorghum with 3% S*tylosanthes* was Rs. 0.99 and 1.04 for mash and pellet forms of feed, respectively. Mortality of birds was within the range for both sorghum and control diets. (Prevailing market prices of sorghum (Rs 5.40 kg^{-1}) and maize (Rs 6.00 kg^{-1}))

The results empirically proved that sorghum can be included in layer diets up to 100% in place of maize with out affecting egg production performance except egg yolk colour. *Stylosanthes* leaf meal in sorghum-based diet resulted in partial improvement of egg yolk colour as compared to maize based diet. These findings are a great boon for the fast growing poultry industry which otherwise may face the constraint of short supply of feed.

Table8.1. **Performance of commercial layer (White Leghorn) birds on sorghum diets**

Treatment		Egg production Hen-day%	Feed intake (g)	FCR/12 eggs (g)	FCR/kg egg mass (g)	Egg weight (g)
Control	Mash	87.1	117.1^{d}	1.614	2.481	54.1^{a}
	Pellet	86.7	116.5^{cd}	1.615	2.377	56.6^{c}
Sorghum 50%	Mash	84.9	112.3^{ab}	1.603	2.426	55.1^{ab}
	Pellet	86.6	115.3^{bcd}	1.598	2.396	55.5^{bc}
Sorghum 100%	Mash	87.4	115.3^{bcd}	1.586	2.434	54.2^{a}
	Pellet	87.9	112.6^{ab}	1.543	2.341	54.9^{ab}
Sorghum100% + Stylo 3%	Mash	85.3	111.1^{a}	1.570	2.401	54.4^{ab}
	Pellet	86.0	113.7^{abc}	1.588	2.343	56.4^{c}
SEM		0.92	1.61	0.040	0.068	0.57

Table 8.2. **Feed cost for production of pullet chick and egg on different sorghum diets**

		Feed cost up to 8th week (Rs)	Feed cost up to 18th week (Rs)	Feed cost / egg (Rs)
Control	Mash	14.47	44.58	1.07
	Pellet	14.80	44.74	1.10
Sorghum 50%	Mash	14.44	42.15	1.04
	Pellet	14.75	43.48	1.07
Sorghum 100%	Mash	13.88	41.54	1.01
	Pellet	14.35	43.35	1.01
Sorghum 100%+stylo 3%	Mash	-	-	0.99
	Pellet	-	-	1.04

Note: Cost of maize and sorghum was considered as Rs.6 $kg^{-1}$and Rs. 5.40 kg^{-1} respectively.

II. FORMATION OF A SUSTAINABLE FARMER-SCIENTIST-INDUSTRY COALITION

Interactions with relevant organizations/stakeholders (crop breeders, poultry nutritionists, economists, farmer associations, poultry federation, poultry feed industry, private seed industry and farmers) who could contribute to the project were initiated based on knowledge/expertise showed by the organizations in their respective fields. Geographical proximity of the partner organizations was also considered as it helps in facilitating communications/physical meetings among the partners to improve the strength of coalition. Prior association or knowledge about partner individuals in the organizations was not considered as a factor.

During the subsequent meetings, the research problem was discussed extensively amongst the stakeholders and all were convinced that the outcome will benefit the poor sorghum growing farmers through creation of better marketing opportunities for the *kharif* sorghum grain as well as for the poultry industry that is on the look out for an alternative energy source in poultry rations due to large fluctuation in maize production and its availability. The research partners felt the need for further research/gap filling to identify improved sorghum varieties suitable for poultry feed rations.

Farmers were not able to sell surplus sorghum profitably due to low market prices and lack of access to markets for non-food use. Due to grain mold problem, the industry for alternative uses of sorghum has been exploiting the farmers by offering low prices. They expressed their willingness to try new high yielding improved sorghum varieties, bulk the surplus grain of all the farmers and explore innovative marketing opportunities. Thus, the feeling of "Win-Win" situation for all the partners—breeders seeking the dissemination of their products to farmers, poultry scientists in developing new poultry feed rations, farmers looking for high productivity and high market value, feed manufacturers seeking for grain in bulk quantities, etc. contributed for an effective team work.

During the preparation of PMF, the partners extensively discussed the role of each coalition partner and their contribution to the project. Budget allocation among partner institutions was also discussed and finalized. Subsequently, meetings were held on achieving milestones/ activities of each partner for year one of the project. Regular review meetings and interactions among partners monitored the progress of the project. Issues and problems related to project implementation were discussed and mutually agreeable solutions were worked out based on consensus. Thus, the consensus approach created a feeling of equal responsibilities in the coalition, which in turn helped to contribute their part to the success.

Identification of improved varieties and poultry feed formulations (output 1) was taken up in earnest and the findings were discussed in-depth in the meetings. Meanwhile, a Steering Committee was formed to look after all the matters related to Poultry Feed Trials (PFTs) and for buying-in of the feed trial results by the industry. The results [(i) sorghum can replace maize up to 100%, (ii) *Stylosanthes* imparts needed colour to the carcass] were disseminated to a larger group of poultry producers/feed manufacturers that received wide acceptance. The involvement of private sector – feed manufacturer in the prime role helped to "buy-in" the technology.

Meetings with farmers and encouraging them to adopt the recommended package of practices, field visits to observe the performance of improved sorghum cultivars supplied

under the project and the wide spread print media coverage regarding the project activities helped to win the confidence of the farmers.

Preliminary attempts in linking farmers with the feed manufacturer were successful. The poultry feed manufacturers were ready to buy the surplus grain and that the farmers' groups agreed to bulk the surplus grain. However, this activity received a little set back in 2004 because of

1. Prevailing market prices of sorghum were unusually high i.e., Rs 700-900/- per 100Kg. This peculiar situation was due to unsatisfactory performance of 2004 rainy season sorghum crop because of prolonged dry spell during crop growth periods. The crop was subjected to severe moisture stress at the time of vegetative growth stage as well as maturity stage.

2. The average rainfall of the district in 2004 was 353.1mm against normal rainfall of 563mm(Table 9.1).

Table 9.1: **Rainfall received at Regional Agricultural Research Station (RARS), Palem, Mahabubnagar District**

Month	**Rainfall (mm)**	**No. of Rainy days**
January	3.3	1
February	Nil	Nil
March	Nil	Nil
April	23.6	3
May	55	3
June	39.6	3
July	80.9	9
August	44	4
September	169.6	7
October	74.4	4
November	Nil	Nil
December	Nil	Nil
Total	**490.4**	**34**
District average (Actual)	**353.1**	
District average (Normal)	**563**	

3. Market price of maize was very low compared to sorghum i.e., Rs 480-515/- per 100 Kg. With these prevailing prices feed manufacturers were interested to purchase maize rather than sorghum for obvious cost advantage.
4. After experiencing the continuous droughts and crop failures for the last 3years (2001-2004), the farmers have become little more conservative, is thinking twice before selling the marketable surplus of food grains. This could be observed from the following Table 9.2. The arrivals of sorghum to the Jadcherla market yard (market yard existing in one of project mandal in Mahabubnagar district).

Table 9.2:**Arrivals of sorghum grain to JADCHERLA market yard in 2003 &2004 (month wise)**

Month	Arrivals in 100 Kg	
	2003	**2004**
January	*	138
February	*	231
March	*	154
April	72	89
May	75	103
June	80	62
July	68	36
August	19	10
September	94	2
October	175	43
November	138	7
December	257	*

* Data not available

5. Sorghum is the staple food crop in the project area; and hence kept for own consumption. In some cases distributed to their relatives, neighbours whose crop was a complete failure. This led to low realisation of marketed surplus than the potential.

6. However, farmers bulked the available surplus and collectively sold in the existing local market with remunerative prices with good net returns.

Farmers realized that they could have increased bargaining power through collective marketing and save on marketing and transportation costs. The industry is willing to link up if it is assured of large supplies from few sources.

III. TECHNOLOGY ACCESS TO THE TARGET GROUPS ACCELERATED

A. <u>For sorghum farmers</u>

Seed Distribution

Four improved high yielding sorghum cultivars namely CSH 16, CSV 15, PSV 16 and S 35, suitable for the agro-climatic area and known to be less susceptible to grain mold attack were selected and seed supplied to the sample farmers for 2003 *kharif* sowings. The seed was treated with Endosulfan dust and packed in cloth bags @ 3.5 Kg per bag, which is sufficient for one acre sowing as sole crop.

Leaflet

An information leaflet printed in local language was supplied along with the seed bag to enable the farmers to follow the recommended package of practices. The proven field performance of the distributed sorghum cultivars was also furnished in the leaflet.

Field visits
The fields were regularly monitored for gypsum application, sowing, germination, timely fertilizer application, inter cultivation, weeding and harvesting. While monitoring, control measures for shoot fly and stem borer damage, basal and topdressing of fertilizer, physiological maturity of crop to help in harvesting and other recommended package of practices were explained to the farmers. During the meetings/ field visits in the selected villages, ICRISAT scientists illustrated proper harvesting stage of crop to avoid the grain mold problem, which otherwise leads to low market price

B. <u>For poultry producers</u>

Stakeholder workshops were organised to disseminate the results of sorghum-based poultry feed trials. On 19th January 2004 a programme was conducted at ICRISAT to share the results on performance of broilers fed on sorghum diet. On 9th November 2004, another meeting was organised at ANGRAU and the participants were shown the on going poultry trials. Both the programmes were well attended by a large group of poultry producers and feed manufacturers. They appreciated the results as highly useful and suit the needs of poultry producers and poultry feed manufacturers.

Bulletin
An information bulletin printed in local language was supplied to all the participants of workshops. The bulletin contained the information on proven performance of broilers with sorghum-based diets in comparison to maize.

IV. UNDERSTANDING COALITION SYSTEM AS A PROCESS

Through coalition system all the partners are confident of achieving the outputs of the project working jointly at a faster pace. Coalition allowed to capitalize on the synergies from sharing of skills from different disciplines with each member playing his/her role in the project.

Decisions in the coalition building were taken on a mutual consensus basis based on the discussion of the problem or issue. The project manager/leader pushed through the activities/decisions reached by consensus without dominating or imposing his ideas and this also helped stakeholders to feel their individual importance in the project progress. The clarity of the roles of coalition partners helped them to devote their time exclusively to the domain of their work, thus allowing sharing of responsibility.

The partners worked together to address the common goal of poverty alleviation among poor sorghum growers. The coalition system provided an opportunity to contribute knowledge in their respective fields. Collaborative working arrangements in this research project for achieving the stated outputs boosted the confidence in all the coalition partners.

The scaling-up of the project further, in terms of benefiting more number of farmer groups by providing storage facilities, credit, technology etc. and linking them to the feed manufacturers is necessary to realize the benefits of this innovative marketing linkage. All the partners felt the need to continue the project; primarily to ensure that a substantial market is created for rainy-season sorghum owing the acceptance of sorghum- based poultry rations by poultry producers.

The collective decisions made with the partners through continuous electronic media dialogue and regular review meetings provided opportunity for all the partners to reflect upon the issues and make necessary modifications on the way the coalition works.

The coalition system, thus, helped to present the right kind of incentives to benefit the poor sorghum farmers, feed manufacturers, poultry producers, and the scientists.

For projects aimed at developing a device, material or process, and considering the status of the assumptions that link the outputs to the purpose, please specify:

a. *What further market studies need to be done?*
b. *How the outputs have been made available to intended users?*
c. *What further stages will be needed to develop, test and establish manufacture of a product by the relevant partners?*
d. *How and by whom, will the further stages be carried out and paid for?*
e. *Have they developed plans to undertake this work? If yes, what are they? If not, why?*

Further studies on

- ☞ Impact of project activities on gender (women)–extent of spill over impacts would be assessed in dairy sector, which is mostly under women control in rural areas.

- ☞ Extent of uptake of the research products will be surveyed. In this study the end users (poultry feed manufacturers, poultry producers and sorghum growing farmers) were surveyed regarding uptake of research products.

- ☞ Trials with commercial layers birds are going on. The trials are expected to complete by March 2005. Then, the finding will be compiled and disseminated through leaflet and brochures to the poultry producers and feed manufacturers.

The above-mentioned activities are planned to conduct during January to March 2005

The documented results will be published in international, national, local journals and suitable magazines to reach the intended users of the research products. The Andhra Pradesh Poultry Federation also has shown interest in circulating the results among the member poultry producers. They are also expressed interest to partner with sorghum farmer by supplying poultry manure and purchasing the surplus grain in bulk quantities directly from the farmers. This ensures the role of poultry industry in carrying the research products in future.

Purpose (2 pages)

Based on the values of your purpose level OVIs, to what extent was the purpose achieved? In other words, to what degree have partners/other users adopted the research outputs or have the results of the research been validated as potentially effective at farmer/processor/trader level?

A unique feature of the project is the *Coalition approach i.e.,* the process in which distinct/independent entities/institutions/partners work together for the common goal with synergistic effect. Under the project small sorghum growers (74 in number) from four villages of Mahabubnagar and Ranga Reddy districts of Andhra Pradesh were selected and supplied with the improved sorghum cultivars for *rainy season 2003.* To ensure that the farmers follow the recommended package of practices, a leaf let printed in local language (detailing the cultivars performance and package of cultivation practices) was provided along

with seed bag. The crop performance was monitored regularly and farmers were advised on the sorghum production practices to be followed for increased productivity. During the meetings with farmers in selected villages, we received positive feed back regarding the performance of supplied cultivars over the locally grown sorghums. During the field visit, ICRISAT scientists illustrated proper harvesting stage of crop to avoid the grain mold problem, which otherwise leads to low market price. The field visits were well covered by the local media. The fields were harvested during Oct-Nov 2003. The grain was bulked cultivar-wise and supplied to the feed manufacturers by the farmers and the feed formulations were prepared in the feed manufacturer's mill.

A post-harvest survey was conducted to know the farmers' perception regarding the performance of improved sorghum cultivars supplied under the project. Not only the participating farmers in the project, but also the other farmers of the village(s) expressed their utmost satisfaction with regard to grain and fodder productivity of improved cultivars. Seeing the enthusiasm and positive response of the farmers, in 2004 rainy season more than 500 small landholder sorghum growers spread over 12 villages in the target districts were supplied with the improved cultivars seed. The ICRISAT-private sector consortium was also involved in supplying the seed to participant farmers. The private sector is now aware of the project activities and will take the lead for large-scale dissemination of seed for sustainable sorghum production after the project ends. This ensures the role of private sector seed industry in project implementation. Preliminary attempts in linking farmers with the feed manufacturer were successful in that the farmers groups collected the surplus grain for marketing and the poultry feed manufacturers purchased the surplus grain.

A Steering Committee chaired by the representative from feed industry (Janaki Feeds) was formulated to closely monitor all aspects of PFTs and buying-in of the results by poultry industry. During one of the review and planning workshops held at ICRISAT, Janaki Feeds indicated the need for conducting some additional PFTs, which is more useful for poultry industry. Based on the perceptions of poultry producers and recommendations of Steering Committee, ANGRAU completed the feed trial i.e. part-by-part replacement of maize with sorghum. To improve the skin and shank colour of birds and yolk colour of eggs, *Stylo* was also included in one of the treatments. Conducting this additional part-by-part replacement trial was a result of rigorous discussions and continuous electronic media dialogue between the coalition partners that underpins the importance of coalition building and partnership projects. The trial results were disseminated to a larger group of poultry producers/feed manufacturers through stakeholders' mini-workshops, which received wide acceptance.

Decisions in the coalition building were taken on a mutual consensus basis based on the discussion of the problem or issue. The project manager/leader pushed through the activities/decisions reached by consensus without dominating or imposing his ideas and this also helped stakeholders to feel their individual importance in the project progress. The clarity of the roles of coalition partners helped them to devote their time exclusively to the domain of their work, thus allowing sharing of responsibility. The partners worked together to address the common goal of poverty alleviation among poor sorghum growers. The coalition system provided an opportunity to members to contribute knowledge in their respective fields. Collaborative working arrangements in this research project for achieving the stated outputs boosted the confidence in all the coalition partners.

Thus, through the innovative approach of research-farmers-industry coalition, the project was able to bring together all the stakeholders and establish market linkages between sorghum

growers and the industry. The success of the coalition system is due to provision of opportunity to the members to contribute knowledge in their respective fields, work towards a common goal with clearly defined roles and responsibilities, ability to articulate their problems and prospects and enthusiasm to work in groups and share the synergies.

The scaling-up of the project further, in terms of benefiting more number of farmer groups by providing storage facilities, credit, technology etc. and linking them to the feed manufacturers is necessary to realize the benefits of this innovative marketing linkages. All the partners felt the importance of the project; primarily to ensure that a substantial market is created for rainy-season sorghum following the acceptance of sorghum-based poultry rations by poultry producers.

The coalition system, thus, helped to present the right kind of incentives to benefit the poor sorghum farmers, feed manufacturers, poultry producers, and the scientists. All partners were assured of the benefits from this project independently.

- ✓ The crop breeder got feedback on the cultivars traits preferred by the farmers.
- ✓ The poultry scientists developed new sorghum-based feed formulations for poultry in lieu of maize, which benefit the poultry producers.
- ✓ The poor sorghum farmers benefited from the collaborative help/guidance from researchers, and from improved cultivars cultivation by implementation of the project at gross root level.
- ✓ The poultry feed manufacturers/poultry growers could be benefited from knowledge on poultry feed formulations and assured supply of sorghum grain.

Goal (1 page)
What is the expected contribution of outputs to Project Goal?

Established market links between industry/processor and farmers is a common phenomenon in crops like sugarcane, oil palm, etc. But for a low value crop like sorghum, attracting industry to buy surplus from smallholders is surely a rarity. In India, area under rainy season sorghum drastically declined over years, because of mold problem due to coincidence of harvesting period with prolonged rains in October and November, making it unfit for food but has the potential in industrial use. Many farmers grow sorghum in rainy season under subsistence conditions.

The project found a stable market in the poultry feed industry for rainy season sorghum. Indeed for India's fast growing poultry industry, the crop could be a potential alternative. With annual growth in broiler production at around 20%, and egg production rising 10% per year, Indian poultry producers are struggling with feed supply. The case would be worsened in future. The shortage is largely due to unmatching growth of maize production, which is the principal cereal ingredient in poultry feed, with growth rate hovering around 3 per cent annually resulting a huge gap between poultry industry demand and supply.

Trials conducted by Acharya N.G. Ranga Agricultural University as part of the project undoubtedly proved that maize could be replaced 100 per cent with sorghum with equal or better-feed efficiency. In part-by-part replacement trials, researchers at the ANGRAU have found that sorghum can replace up to 100% of the maize used in feed mixes, with no detrimental effect on bird growth and egg laying in case of broilers and layers, respectively. The tests on effectiveness of molded grain also found that using up to 75% moulded sorghum

grain in place of normal mold-free grain, made no difference to bird health & egg laying capacity compared to 100% clean grain. Large scale feed trials is now being carried out to test the new feed mixes with commercial layer birds.

Survey was conducted with highly positive results on performance of improved sorghum cultivars in comparison to local cultivars in farmers' fields. The yield of improved sorghum cultivars was higher than local cultivars by about 348% in Mahabubnagar and 350% in Ranga Reddy district. Benefit-cost ratio for local sorghum + pigeonpea intercropping were 1.35 and 0.98, it is 2.02 and 1.44, for improved sorghum + pigeonpea intercropping in Mahabubnagar and Ranga Reddy districts, respectively. Though the yields are not up to potential in the 2004 rainy season because of the severe moisture stress experienced by the crop during growth period, the farmers expressed their satisfaction on performance of improved cultivars.

The market link between the sorghum growers and the feed industry resulted from a coalition of farmers' associations, poultry feed companies and scientists, a coalition that all three groups are set to benefit from. The farmers have been given advice on cultivation and harvesting from the scientists, and have been supplied with improved seed by members of an ICRISAT-private sector consortium. They increased their annual income from the sale of sorghum and by bulking their grain and selling as groups, they have established a good bargaining position with the feed manufacturers. The manufacturers have also benefited, discovering the potential of sorghum as an alternative feed source, and gaining an assured supply. And the scientists have learned more about farmer preferences for sorghum traits, and about poultry feed formulations. Clearly the success of the project has depended in part on the coalition being able to offer the right kind of incentives to the various partners.

Understanding the process of successful coalition building is one of the anticipated outputs of the project. Preliminary meetings hosted by ICRISAT helped to cement work plans and responsibilities; periodic review and planning meetings were the venue for collective decision making, and rigorous, email-based discussions continued throughout, for example over the design of the feed trials. The coalition also set up a steering committee, chaired by a representative of the feed industry, with the task of promoting the use of rainy season sorghum to the private sector. In January and November of this year (2004) the findings from the feed trials were presented to a large group of poultry producers and feed manufacturers, generating broad acceptance for sorghum as a potential substitute for maize. It takes little more seasons to sustain the farmer-industry link, but if that proves durable, the implications are clear not only for others in India, but for sorghum growers and the poultry feed industry wherever the two are found together.

Section G – Uptake and Impact (2 pages)

Organisational Uptake *(max 100 words)*

What do you know about the uptake of research outputs by other intermediary institutions or projects (local, national, regional or international)? What uptake by which institutions/projects where? Give details and information sources (Who? What? How many? Where?)

Though it is too early to assess the uptake of outputs by intermediary institutions, experiences allow making some anticipation. Federation of Farmers Associations (FFA), Andhra Pradesh, one of the coalition partners is one such intermediary institution through which research outputs was realized by working with the sorghum farmers (no. 500 in Mahabubnagar and Ranga Reddy dists. of Andhra Pradesh) at gross root/field level. Farmers association experienced a new strength in bargaining with industry. The experience of federation of farmers

associations, will lead to learning for other grower associations to forge alliances/ partnerships in other crops /sectors/ areas. Acharya NG Ranga Agricultural University (ANGRAU), another coalition institute developed the new sorghum based feed formulations in lieu of maize, which will benefit the poultry producers and feed manufacturers as well as the farmers. The research institutes learning will give valuable basis for other institutes/organizations while conceiving the research problem.

End user uptake *(max 100 words)*
What do you know about the uptake of research outputs by end-users? Which end-users, how many and where? Give details and information sources

Sorghum growers, poultry producers, feed manufacturers (industry), seed producers and crop and poultry researchers are the major stakeholders in knowing the research outputs. Andhra Pradesh Poultry Federation (APPF) is facilitating for uptake of research outputs by poultry producers (no. 50 in and around Hyderabad, the capital city of Andhra Pradesh) and Janaki Feeds by feed manufacturers (no. 10 in and around Hyderabad, the capital city of Andhra Pradesh). The farmer groups would be facilitated through publication of user-friendly pamphlets on sorghum cultivation, chemical composition, sorghum poultry feed efficiency, coalition members networking and market-channels development in sorghum poultry feed sector. Further, these results are useful to the extension workers of the government and non-government organizations, federation of farmers associations and lastly government policy makers to apply and uptake the project outputs.

Knowledge (max 100 words)
What do you know about the impact of the project on the stock of knowledge? What is the new knowledge? How significant is it? What is the evidence for this judgement?

The research process in the project provided a valuable, empirical evidence to the sorghum based poultry diets as a potential alternative to maize. Performance of poultry birds both layers and broilers at different inclusion levels of sorghum in place of maize gave a more pragmatic and flexible results for the poultry feed manufacturers to prepare sorghum based poultry feeds as for the availability and cost advantage. The surveys on profitability of improved sorghum cultivars on farmers' fields and preferential traits were a useful feedback for sorghum breeders. Lessons learnt in forming coalitions will be of great use in making more wider and viable linkages in different crops and contexts.

Institutional (max 100 words)
What do you know about the impact on institutional capacity? What impact on which institutions and where? What change did it make to the organisations (more on intermediate organisations). Give details and information sources.

A positive impact on institutional capacity was observed with Federation of Farmers Associations (FFA) working as intermediary institution between ICRISAT and sorghum growers. In the similar way, Andhra Pradesh Poultry Federation (APPF) and Janaki Feeds work between ICRISAT/ANGRAU and poultry producers/feed manufacturers. ANGRAU awarded an MSc degree in poultry sciences division with the help of poultry feed trials conducted under the project. Dehumidifier (ICRISAT) and Fibretech, Battery brooders and sprinkler unit (ANGRAU) were purchased under this project that can provide services even after project ends. The approach of working with different/distinct partners in coalition is novel. The experience is of immense importance for the institutes which are concerned with common

goal and working independently. The generic lesions from this approach will give a way to capitalize the synergies while working in groups. The industry capacity in up taking the research inputs is greatly enhanced. The bargaining capacity of farmers associations while dealing with industry as well as research institutes is significantly improved. This experiences will paves the way for the industry to forge alliances in future with research organizations and producers of raw material for effective delivery of services.

Policy (max 100 words)
What do you know about any impact on policy, law or regulations? What impact and where? Give details and information sources

Project outputs provide valuable information to the policy makers in the government on inter linkages between smallholder producers and the end users through coalition system as an approach. This model can be applied to other crops and sectors/products. Commodity-based research and marketing players are brought together along with producers in a coalition system to enhance the profits to all the members of the coalition. The policy of contract farming may also arise between sorghum farmers and feed manufacturers in view of established marketing linkage through this project.

Poverty and livelihoods (max 100 words)
What do you know about any impact on poverty or poor people and livelihoods? What impact on how many people where? Give details and information sources.

The project investigated alternative uses for a crop grown by the poor. Marketing problem associated with grain mold due to untimely rains is predominant throughout sorghum growing areas in the world, >35 m ha of which about 5-6 m ha are in south Asia. The improved technology under this project benefited the sorghum farmers in marginal areas and poor consumers who cannot afford superior cereals. Surveys conducted on performance of improved cultivars in *kharif* 2003, also proved that the cost benefit ratio of the improved cultivars was 2.02 and 1.44 as against 1.35 and 0.98 of local cultivars in Mahabubnagar and Ranga Reddy district, respectively. In rainy season 2004, 500 poor sorghum farmers in Mahabubnagar and Ranga Reddy districts of Andhra Pradesh were benefited with the project, by way higher yields due to improved cultivars and market linkage.

Environment (max 100 words)
What do you know about any impact on the environment? What impact and where? Give details and information sources.

Sorghum being a low input crop and grown in marginal soils with most commonly associated problem of mold for rainy season produce, resulted in gradual decline in area in many cases leaving the land fallow which results in soil erosion. The development of new market and improved cultivars arise the interest of farmers in sorghum crop, expand the production of rainy season sorghum in marginal and fallow lands in dry lands. The stover availability and live stock preference indicated a growing positive interest in keeping dairy animals, which will improve the availability of farmyard manure for application to the field with a positive impact on soil fertility.

Core Partners ***Signature*** ***Date***

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ANNEXES

1. *Copies of the stakeholder, gender, livelihoods and environmental form included with the concept note.*
2. *Project Logical Framework*
3. *Partner (user) organisations work plan for adopting project outputs*
4. *Copies of diaries, coalition-meeting reports etc*
5. *Feedback on the process from Partners(s) and users (where appropriate)*
6. *Tabulated description of disseminated outputs (format from green book) – same as given in the PCSS and should include all published, unpublished and data sets. If any of the reports included in this annex has not been submitted to the programme previously, please include a copy (preferably an electronic copy or if not available a hard copy)*

ANNEXURE 1

Tables of baseline survey (1.1 - 1.7) and post-harvest survey (2.1 – 2.6)

Table 1.1 **Cropping Pattern of Sample Farmers in Mahabubnagar District, Andhra Pradesh, *kharif* 2002**

Crop	Farmers		Variety	Soil type	Area (acres[3])	Main product (kg/ acre)	By-product[6] (kg/ acre)
	No.	Percent to total					
Sorghum + pigeonpea	28	77.7	S[5]-Local yellow PP[6]-Local	Black –5[2] Dubba -10 Red -10 Sandy -1 Black -5	49	S[4]-324 PP[5]-36	1153
Pigeonpea	13	38.3	Local HYV-5[1]	Red -6 Black -2 Barka -5	34	235	-
Maize	3	8.3	JK Puja-2 Bio-seed-1	Red -3	10	910	700
Castor	21	58.3	Kranti-14 Aruna-7	Dubba -2 Red -12 Black -7	84	259	-
Horsegram	2	5.5	Local	Red -2	8	143	475
Bengalgram	1	2.7	HYV	Red -1	4	300	-
Cotton	7	19.4	Bunny-6 Brahma-1	Black -7	35	530	-
Sunflower	2	5.5	JK-1 Local-1	Black -2	5	180	-
Paddy	25	69.4	BPT 5204-20 Tella hamsa-5	Black -16 Red -9	66.5	2320	1193
Turmeric	1	2.7	HYV	Black -1	4	375	-
Tomato	5	13.8	Annapurna-5	Black –3 Red-2	4	2875	-

[1]Number of farmers growing the variety.
[2]No. of farmers growing the crop in that particular soil type
Chalka - red coloured with bigger pebbles and low fertility
Barka - light black in colour with low fertility and moisture retention capacity
Dubba - Light black or red coloured with sandy type of structure.
[3]1 Acre = 0.40 hectares
[4]Sorghum
[5]Pigeon-pea
[6]Straw/ fodder/ stover portion of the crop used as livestock feed

Table 1.2 **Cropping Pattern of Sample Farmers in Ranga Reddy District, Andhra Pradesh, *kharif*2002**

Crop	Farmers		Variety	Soil type	Area (acres[3])	Main Product (kg/acre)	By – Product[6] (kg/acre)
	No.	Percent to total					
Sorghum + Pigeonpea	27	71	S[4]-Local PP[5] -Vanapa mula seed	Black-9[2] Chalka-2 Barka-6 Red-10	41	S[4] -373 PP[5] -53	1219
Hybrid Maize	21	55	Kanchan Ganga - 15[1]	Red-9 Black-9 Barka-3	44.5	1339	758
Seed Maize	13	34	K.Ganga	Red-5 Black-8	23	858	891
Cotton	8	21	Bunny –6 Brahma -2	Black	31	593	-
Chillies	2	5	Agni – 1 JK -1	Black	4	762	-
Chillies (Wet)	2	5	Annapurna -2	Black	2	60	-
Safflower	6	15	Local Bhima	Black-4 Red -2	11	227	-
Bengalgram	3	7	Local	Black	11	177	-
Onion	1	2	Kurnool	Red	2	500	-
Paddy	3	7	BPT 5204 -3	Blcak	7	2471	1000
Tomato	5	39	Annapurna	Black-10 Red-5	20	2612	-
Carrot	5	13	B'lore Karoda	Black-4 Red-1	10	7100	-
Brinjal	2	5	Utkarsha	Black	6.5	5123	-
Beans	2	5	Annapurna	Black	2	1200	-
Coriander	5	13	HYV	Black	8.5	1160	-

[1]Number of farmers growing the variety.
[2]No. of farmers growing the crop in that particular soil type
Chalka - red coloured with bigger pebbles and low fertility
Barka - light black in colour with low fertility and moisture retention capacity
Dubba - Light black or red coloured with sandy type of structure.
[3]1 Acre = 0.40 hectares
[4]Sorghum
[5]Pigeon-pea
[6]Straw/ fodder/ stover portion of the crop used as livestock feed

Table 1.3. **District-wise Product Utilization during *Kharif* 2002**

Crop	No. of Farmers.		Main Product (100 kg)						By-Product (100 kg)			
	Not Marketed	Marketed	Production	Consumption	Marketed	Marketed quantity (%)	Price (Rs.100/kg)	Type of market[1]	Production	Utilization	Sold	Price (Rs/100 kg)
Mahabubnagar District												
Sorghum	14	14	159	100	59	37	463.5	RM-5[2] WM-3 VS-5	565	565	-	-
Redgram	5	13	97	21	76	78	1518.5	RM-10 VS3	-	-	-	-
Maize	-	3	91	-	91	100	485.0	RM-3	70	70	-	-
Castor	-	21	218	-	218	100	1501.5	RM-21	-	-	-	-
Bengalgram	-	1	12	-	12	100	1500.0	VT-1	-	-	-	-
Cotton	-	7	185	-	185	100	2158.3	VT-7	-	-	-	-
Sunflower	-	2	9	-	9	100	1350.0	VT-2	-	-	-	-
Paddy	-	25	1543	428	1115	72	628.3	RM-19 WM-3 VT-3	794	673	121	73
Horsegram	-	2	11	4	7	65	750.0	VT-2	38	38	-	-
Turmeric	-	1	15	-	15	100	1200.0	VT-1	-	-	-	-
Tomato	-	4	115	-	115	100	266.6	RM-4	-	-	-	-
Ranga Reddy District												
Sorghum	14	13	153	104	48	32	585.8	RM-7 VS-4 WM- 2	500	464	36	32
Pigeonpea	27	4	21	17	4	21	1575.0	VS-4	-	-	-	-
Hybrid Maize	-	21	596	-	596	100	522.3	RM-13 VT-8	337.5	10	327	5
Seed Maize	-	13	197	-	197	100	1583.3	CF	205	13	192	5

Safflower	6	-	25	25	-	-	-	-	-	-	-	-
Bengalgram	-	3	19	25	17	87	1550.0	VT-3	-	-	-	-
Cotton	-	8	184	-	184	100	2250.0	VT-8	-	-	-	-
Chillies-Dry	-	2	30	-	30	100	2000.0	VT-2	-	-	-	-
Chillies-Wet	-	2	120	-	120	100	375.0	RM-2	-	-	-	-
Paddy	-	3	173	55	118	68	627.5	VT-3	70	70	-	-
Brinjal	-	2	51	-	51	100	202.0	RM-2	-	-	-	-
Carrot	-	5	7	-	7	100	437.0	RM-5	-	-	-	-
Tomato	-	15	522	-	522	100	281.3	RM-15	-	-	-	-
Beans	-	2	24	-	24	100	475.0	RM-2	-	-	-	-
Coriander	-	5	9	-	99	100	440.0	RM-5	-	-	-	-

[1]No. of farmers marketing through that particular channel
[2]Type of marketing channel
RM- Regulated Market
VS- Village Sale
WM- Weekly market
CF- Contract Farming

Table 1.4. **Cost of Cultivation of Sorghum and Selected Crops in Mahboobnagar District of Andhra Pradesh: *Kharif* 2002.**

Cost Item	**Local Sorghum+** Pigeonpea	Local Sorghum	Maize	Cotton	Castor + Pigeonpea	Castor
A. Variable Costs (Rs./ acre)						
Human labour[1]	815.9	620.8	767.9	1533.9	2215.5	942.6
Bullock labour	504.2	557.7	682.3	625.9	1197.5	955.4
Machine labour	101.4	128.3	522.3	285.5	100.0	311.1
FYM	281.1	93.8	752.8	401.9	975.0	334.12
Seed: Main crop	39.3	30.1	468.5	1039.5	334.1	353.7
Seed: Inter crop	52.3	-	-	-	26.2	-
Fertilizer	173.7	251.0	605.3	794.6	562.5	399.1
Pesticides	38.8	-	-	2015.3	832.5	613.3
Weedicides	-	-	-	-	-	-
Transport	12.9	7.7	86.7	-	63.75	33.48
Interest on working cost	68.00	57.3	143.2	303.03	210.23	164.28
Subtotal	**2087.6**	**1747.0**	**4029.1**	**6999.9**	**6517.3**	**4107.1**
B. Fixed Costs (Rs./ acre)						
Land rent	436.8	436.8	794.5	794.5	871.6	677.2
Land revenues	0.5	0.5	0.5	0.5	0.5	0.5
Depreciation	25.4	15.8	71.6	71.9	60.0	62.0
Interest on Fixed Capital	1.9	1.9	4.6	4.6	4.2	4.4
Subtotal	**464.6**	**455.1**	**871.2**	**871.5**	**936.3**	**744.1**
Total Cost A+B	**2552.2**	**2202.1**	**4900.3**	**7871.5**	**7453.7**	**4851.3**
Grain Yield (100 kg/acre): Main crop	3.2	3.9	9.1	5.3	4.2	3.1
Price (Rs./100 kg): Main crop	463.6	463.6	485	2158.3	1375	1586.1
Grain Yield (100 kg/acre): Inter crop	0.4	-	-	-	0.50	-
Price (Rs./100 kg): Inter crop	1518.1	-	-	-	1550	-
Fodder Yield (100 kg/acre): Main crop	11.5	12.00	7.0	-	-	-
Price (Rs./100 kg): Main crop	41.5	41.5	5.0	-	-	-
Gross returns	**2526.7**	**2342.8**	**4448.5**	**11439.1**	**6618.8**	**5049.8**
Net returns	**-25.5**	**140.6**	**-451.8**	**3567.7**	**-834.9**	**198.5**
Output/ Input ratio	**0.9**	**1.1**	**0.9**	**1.5**	**0.9**	**1.0**

Total sample farmers surveyed: 36
Study area: two villages of Mahabubnagar district of Andhra Pradesh.
[1] includes the wages paid for the hired casual labour and family labour
1 Acre = 0.40 ha.
Source: Survey data from Project villages

Table 1.5 **Cost of Cultivation of Sorghum and Selected Crops in Ranga Reddy District of Andhra Pradesh: *Kharif* 2002.**

Cost Item	Local Sorghum+Pigeonpea	Local Sorghum	Maize + Pigeonpea	Maize	Cotton
A.Variable Costs (Rs./ acre)					
Human labour[1]	91.2	720.4	845.0	912.7	1708.2
Bullock labour	549.6	456.2	812.5	790.0	655.6
Machine labour	52.6	53.6	125.0	429.8	202.5
FYM	195.6	58.5	350.0	624.9	235.3
Seed : Main crop	36.4	28.3	490.0	444.6	950.4
Seed: Inter crop	31.1	-	27.50	-	-
Fertilizer	286.0	388.6	714.0	816.6	747.6
Pesticides	71.4	-	-	61.3	2410.9
Weedicides	-	-	75.2	153.8	-
Transport	15.1	13.1	30.0	121.5	-
Interest on Working cost	82.5	68.01	101.1	167.8	263.9
Subtotal	**2231.5**	**1786.9**	**3570.1**	**4523.5**	**6910.5**
B. Fixed Costs (Rs./ acre)					
Land rent	514.4	514.4	685.3	852.4	852.4
Land revenues	0.5	0.5	0.5	0.5	0.5
Depreciation	31.2	23.1	53.3	81.4	81.2
Interest on Fixed cost	2.15	2.15	3.77	6.2	6.2
Subtotal	**548.3**	**542.1**	**742.9**	**940.4**	**940.2**
Total Cost A+B	**2779.7**	**2327.1**	**4313.2**	**5463.9**	**7850.7**
Grain Yield (100 kg/acre): Main crop	3.7	4.63	8.01	13.4	5.9
Price (Rs./100 kg): Main crop	585.8	585.8	480.0	522.3	2250
Grain Yield (100 kg/acre): Inter crop	0.5	-	0.3	-	-
Price (Rs./100 kg): Inter crop	1575	-	1500.0	-	-
Fodder Yield (100 kg/acre): Main crop	12.2	13.8	9.0	7.6	-
Price (Rs./100 kg): Main crop	32.8	32.8	17.5	5.0	-
Gross returns	**3419.4**	**3166.5**	**4372.5**	**6993.9**	**13342.0**
Net returns	**639.6**	**839.5**	**59.4**	**1530.0**	**5491.8**
Output / Input ratio	**1.2**	**1.4**	**1.0**	**1.3**	**1.7**

Total sample farmers surveyed: 38
Study area: two villages of Ranaga Reddy district of Andhra Pradesh
[1]includes the wages paid for the hired casual labour and family labour
1 Acre = 0.40 ha.
Source: Survey data from Project villages

Table 1.6. **Farmers Ranking of Preferred Characteristics in New Improved Sorghum Cultivars: *Kharif* 2002**

Characteristics	Rank assigned by farmers
High grain yield	**I**
Higher fodder yield	II
Higher grain and fodder yield	III
Superior quality of grain (bold, lustrous, taste, colour, roti or bath making quality etc)	IV
Superior quality of fodder (leafy, slender, smooth, sweeter and palatable)	V
Pest/ disease resistant	VI
Drought resistant	VII
Suitability of soil & climatic conditions	VIII
More flour output (solid grains)	IX
Study area: Four villages of Mahabubnagar and Ranga Reddy districts in Andhra Pradesh Total number of farmer surveyed: 74 Source: Survey data from project villages.	

Table 1.7. **Reasons for Decrease in Sorghum Consumption Overtime**

	Reason(s)	Farmers	
		Number	Percent to total farmers
1	Availability of more rice through expanded irrigation facilities & at subsidized prices through Public Distribution System (PDS).	57	77
2	Change in food habits of the people	53	71.6
3	Sorghum roti or bath preparation is more time consuming	41	55.4
4	Government programmes like mid-day meal to schoolchildren, Antyodaya scheme; Old age pension, Annapurna, Public fair price shops etc. are more oriented towards rice and rice proucts.	34	45.9
5	More fuel requirement to prepare sorghum roti than rice	20	27.0
6	Younger generation do not know the preparation of sorghum foods	16	21.6
7	Sometimes availability of cheaper rice than traditional sorghum in the open market	16	21.6
8	Periodic grain mold problem in sorghum	11	14.9
9	Decreased in area and production under sorghum cultivation	7	9.5
10	Decrease in the family size	7	9.5
Study area: Two villages each in Mahabubnagar and Ranga Reddy districts of Andhra Pradesh Total number of farmers or households surveyed: 74 Source: Survey data from project villages			

Table 2.1 **District-wise area under sorghum, Sample farmers**

District	Crop	No of Farmers	Variety	Soil type	Area[3] (acres)	Main product (kg/ acre)	By-product[6] (kg/ acre)
Mahaboobnagar	Improved sorghum + Pigeonpea	34	CSH 16-9[1] CSV 15-10 PSV 16- 4 S 35- 7 And PP[3]- Local	Black- 4[2] Chalka- 12 Red- 6 Barka- 9 Dubba- 3	30.5	S[4]- 491 PP[5]- 209	938
	Local sorghum + Pigeonpea	13	S[2]-Yellow variety and PP[3]ocal	Chalka-6 Red-2 Dubba- 4 Black-1	15.7	S[4]- 111 PP[5]-154	774
Ranga Reddy	Improved sorghum + Pigeonpea	35	CSH 16-17 CSV 15-8 PSV 16- 6 S 35- 4 And PP[3] Local	Black- 3 Chalka- 12 Red- 8 Barka- 12	34	S[4] -218 PP[5]135	632
	Local sorghum + Pigeonpea	5	S[2]Yellow variety and PP[3]- Local	Red-2 Barka- 3	4.5	S[4]- 50 PP[5]- 102	511

[1]Number of farmers growing the variety.
[2]No. of farmers growing the crop in that particular soil type
Chalka - red coloured with bigger pebbles and low fertility
Barka - light black in colour with low fertility and moisture retention capacity
Dubba - Light black or red coloured with sandy type of structure.
[3]1 Acre = 0.40 hectares
[4]Sorghum
[5]Pigeon-pea
[6]Straw/ fodder/ stover portion of the crop used as livestock feed

Table 2.2. **District-wise Sorghum Utilization by sample farmers during *kharif* 2003**

District	Crop	No of farmers		Main Product (kg)							By-product (100kg)			
		Not mark-eted	Marketed	Production	Consumption	Other uses[1]	Marketed	Quantity marketed (%)	Price (Rs./ 100 kg)	Type of market[2]	Production	Utilized	Sold	Price (Rs./ 100 kg)
Mahabubnagar	Sorghum	34	4	175	118	3	26	22	419	RM-4[3]	406	406	-	-
Ranga Reddy	Sorghum	35	1	60	42	14	4	9	463	WM	238	210	28	15

[1] The kind payment made to the casual labor by the farmers (for harvesting and threshing operations)
[2]No. of farmers marketing through that particular channel
[3]Type of marketing channel

RM- Regulated Market
VS- Village Sale
WM-Weekly market
CF- Contract Farming

Table 2.3. **Performance of Improved Sorghums by Cultivar compared to Traditional Varieties: *Kharif* 2003**.

Characteristics	**Number of farmers**				**Percent of farmers to total**
	CSH 16	CSV 15	PSV 16	**Total no.**	
Higher grain yield than traditional varieties.	37	25	2	64	92.7
Superior grain quality than traditional varieties (*roti* is tastier and good)	28	21	2	51	73.9
Higher fodder yield than traditional	3	23	1	27	39.1
Superior fodder quality	5	17	1	23	33.3
Can't say because this year the climate is not suitable for growing sorghum.	4	6	3	13	18.8
All improved cultivars performance is below average due to unfavourable climatic conditions, but performed better than traditional sorghum	4	4	-	8	11.5
Total number of farmers or household surveys: 69 Source: Survey data from the project villages Study area: Two villages each in Mahabubnagar and Ranga Reddy districts of Andhra Pradesh.					

Table 2.4. **Farmers Perception on the Overall Performance of Improved Sorghum Cultivars supplied under the Project*: Kharif* 2003**

Characteristics	**Rank assigned by farmers**
High grain yield	1
Superior grain quality (bold/ lustrous/ tasty/ colour etc	2
Grain suitability for roti/ bath preparations	3
Drought resistant	4
High fodder yield	5
Superior fodder quality (sweeter/ palatable/ smooth/ more girth etc	6
Fodder suitability for animal feed/ fodder intake by animals	7
Suitability to the soil	8
Resistant to pests and diseases	9
Impact on milk productivity	10
Study area: Two villages each in Mahabubnagar and Ranga Reddy districts of Andhra Pradesh Total number of farmers: 69 Source: Survey data from project villages.	

Table 2.5. **Production related problems of Improved Sorghum Cultivars.**

Problem(s)	No. of Farmers
Grain mold attack (a periodic problem for sorghum cultivation)	20 (29.0)[1]
Labour shortage in the peak agricultural operations period.	32 (46.3)
Did not follow the recommended package of practices Suggested under the project (weeding, thinning, fertilization etc.)	24 (34.8)
Untimely rains affected the flowering, seed setting and grain development leading to lower yields than expected.	47 (68.1)
Threshability is lower than traditional varieties (grain attached to ear head is very tight)	8 (11.6)
Brittleness of fodder compared to fodder from traditional varieties	11 (15.9)
Soil related problems	18 (26.1)
Total number of farmers or household surveys: 69 Source: Survey data from the project villages Study area: Two villages each in Mahabubnagar and Ranga Reddy districts of AndhraPradesh. [1]Figures in parentheses indicate percent of farmers to total surveyed.	

Table 2.6. **Farmers Response on Collective Marketing of Sorghum Grain**

Factors	No. of Farmers	Percentage to total
Better price through bargaining.	38	55.1
Collective marketing will always be better than individual marketing in terms of price bargaining, marketing costs and time.	36	52.2
Saving of marketing costs and transport charges	31	44.9
Time saving (travel, waiting in the market yards etc.	27	39.1
Better than present marketing through village trader.	21	30.4
Collective marketing will grow with more farmers joining the group leading to a better marketing channel for sorghum	5	7.2
Total number of farmers or household surveys: 69 Source: Survey data from the project villages Study area: Two villages each in Mahabubnagar and Ranga Reddy districts of Andhra Pradesh.		

ANNEXURE 2

Stakeholder, gender, livelihoods forms

☞ **Which category of poor people will benefit from the project?**

E.g. small producers waged labour working in post-harvest activities, small agribusinesses, poor urban or rural consumers, informal sector traders. Benefits may be long-term and not experienced until after the project has ended.

Small-scale sorghum producers with less than 1 ha land. Small farmers in less assured, marginal and fragile lands may grow sorghum. Sorghum production underpins their livelihood strategy to meet the twin objectives of food and feed for livestock. After meeting their household demand these farmers are unable to dispose of the excess production. Owing to lack of marketing networks/ linkages they are unable to take advantage of the potential demand for sorghum in non-food uses. Recent studies carried out at ICRISAT have indicated growing demand for sorghum as feed grain, alcohol and starch manufacturing. Other potential uses include value added food products, for example, biscuits, bread, etc.

By bringing together science, industry and users and exploring innovative marketing channels the project would benefit the small sorghum farmers, who presently lack marketing linkages. The improved technology available due to the project will also enable poor consumers, who use sorghum as staple food, to have ready access to sorghum grain at affordable prices.

Since livestock rearing is women centered in poor households, the fodder component of the improved sorghum cultivars would potentially benefit women via sale of milk. Their decision-making power related to crops and livestock and household activities would thus be enhanced.

☞ **What livelihood problem(s), or opportunity (ies), experienced by these people, does the project address?**

It could be a technical, financial, socio-economic, institutional, policy-related or any other type of livelihood problem/opportunity. Remember that the project results must be potentially applicable to more than one DFID's focus countries to qualify for funding. This will be your project purpose

The poor are faced with the twin problems of weak social capital and access to markets. Weak social capital restricts their ability to influence market demand for the crop that they grow. The opportunity is to tap the growing demand for a crop that the poor produce through innovative linking of research and marketing.

The project would be investigating alternative uses for a crop grown by the poor. Marketing problem associated with grain mold due to untimely rains is predominant throughout sorghum growing areas in the world, >35 million ha, of which about 5-6 million ha are in South Asia. The improved technology under this project would benefit the sorghum farmers in marginal areas and poor consumers who cannot afford superior cereals. The project would explore the institutional arrangements and establish relationships between research, producers, and industrial users. Currently there exist poor linkages to markets for sorghum for industrial use including poultry feed.

The straw from sorghum crop would provide security for livestock and opportunities for earning additional income from sale of livestock products. Women play an important role in livestock related activities.

☞ **Which 'poverty reduction category' does the project come under: enabling, inclusive or focussed?**

Inclusive, i.e., poor and non-poor will also benefit
Various institutional and innovative marketing models will be tried such that the most vulnerable among the sorghum growers will stand to benefit from the project implementation. This would address the issue typologies of poor sorghum growing areas and consumers and identity different typologies for targeting the institutional models.

☞ **How will your research resolve the livelihood problem/opportunity?**
E.g. by reducing vulnerability; increasing livelihood options; improving equitable access to resource, knowledge, markets, or income- generating opportunities; reducing remoteness; raising returns on economic activity; strengthening ability to influence resource allocation or the political process; improving terms of trade; encouraging pro-poor policies for economic growth; influence business practice; etc.

The poor sorghum growers would derive benefit from the development of a market for a crop they produce that underpins their livelihood. More specifically, it is expected that about 500 sorghum farmers in the targeted districts increase their household income by 15% through the market chain. Due to the improved technology per unit cost of production will decrease benefiting the poor sorghum consumers. A spill over benefit would be derived from extending the institutional lessons learnt during the project to develop a small- farmer dairy linkage in the future.

Sorghum is widely grown in peninsular India. The project will help in identifying suitable sorghum varieties for poultry feed and demonstrate to poultry producers on the economics and quality effectiveness of the sorghum as feed ingredient in poultry feeds. Currently poultry industry is facing a shortage of grains for use in poultry feed. The situation would only get worse in the future since the poultry industry is growing at 10-12% per annum. The poultry producers and feed manufacturers are looking for alternative sources of feed grains. Imports of maize are prohibitive owing to higher landed cost of imported maize. Inclusion of sorghum in poultry rations will reduce the cost of production and improve its profitability and competitiveness in domestic markets the project would address this concern through linking sorghum producers, poultry farmers, and feed manufacturers. The coalition of FFA and APPF would ensure its wider dissemination in the long run if suitable varieties were identified and workable marketing and institutional model is set up.

☞ **Identify net adverse effects on the well being of any social group, which might result from widespread adoption of research outputs?**
E.g. increased drudgery, reduced livelihood choices, higher food or input prices, changes in land use, changes in access to and control over resources, reduced decision-making power, social conflict

We do not foresee any adverse effects on any social group from the adoption of the project outputs. However, intra-household issues of participating in the project will be observed/monitored particularly those related to role of women in decision making and access to benefits.

☞ H**ow does the livelihood problem/opportunity that you have identified affect men and women differently?**
Consider how the following gender differences are relevant to your proposal. Differences between men's and women's:

- *Roles and responsibilities;*
- *Needs and interests;*
- *Relations;*
- *Decision-making powers;*
- *Access to and control over resources.*

Since women play an important role in livestock related activities, the fodder from improved sorghum crop would have direct beneficial impacts on women besides men. Household studies have indicated that additional earnings from milk sales, etc., go directly for the welfare of the household, i.e., improved nutrition and education for the family members.

☞ **How will your expected outputs impact differently on women and men?**
Consider potential impacts of the project on men's and women's;

- *Roles and responsibilities;*
- *Needs and interests;*
- *Relations;*
- *Decision-making powers;*
- *Access to and control over resources.*

The income enhancing opportunities for sorghum producers would reflected in increased household income, which in turn would reflect in better food and health for women and children. Stover from sorghum crop would provide additional incentives for keeping milch animals. Women generally play an important role in livestock rearing and the additional income from livestock products are generally handled by women. Women would play an important role on decisions related to livestock and consequently crops. Livestock activities would also provide gainful employment for women. Women would thus have access to and control over livestock resources while men would have their hold on the land for growing crops. As indicated earlier, women's access to benefits due to the technology will be monitored among participating households.

☞ **What barriers exist to men's and women's involvement in project design, implementation and management decisions?**
E.g. times or locations of meetings, ability to travel, cultural norms, which exclude one gender from an area of decision-making

Women may not be able to actively participate in the project design, but can contribute to implementation of the project. Women may not able to travel long distances owing to other commitments, but can contribute time to decisions related to the project operating from their houses.

☞ **Describe the project communication strategy. Who has an interest in knowing the about your research outputs? Describe the network of people and organisations that are relevant to the application/uptake of project outputs. How will research outputs be disseminated?**

Sorghum growers, poultry producers, feed manufacturers; seed producers and crop and poultry researchers are the major stakeholders in knowing the research outputs. Further, these results are useful to the extension workers of the government and non-government organizations, Federation of Farmers associations and lastly government policy makers to apply and uptake project outputs.

Farmer self-help groups, farmer associations, commodity cooperative and institutional uptake of project outputs. One or several of these models will be tried and the most suitable one with pro poor benefit will be adopted.

Besides the proposed regular meetings of the coalition members and specific steering committee will be formed under the conveniship of poultry industry. This will help to buy in the outputs of the project by the industry for further uptake process.

The farmer groups would be facilitated through publication of user friendly pamphlets on sorghum cultivation, chemical composition, sorghum poultry feed efficiency, coalition members networking and market channels development in sorghum poultry sector. Further the proposed training camps to the target members will be helpful to disseminate the results.

☞ **How could the application/ uptake of the outputs be monitored and measured?**

It will be addressed through a separate project on uptake of the project results. However, initial indication of the uptake process can be gauzed by the mechanism identified under the project and form the basis for assessing the process in the consortium including farmers.

Environmental summary screening note (ESSN)

1. Project title: Exploring marketing opportunities through a research, industry and users coalition: sorghum poultry feed 2. Project cost: Pound Sterling ₤ 82,865for 2 years period 3. Duration: 2 years 4. Country: India
5. What are the potential significant environmental impacts (positive and negative) of the proposed research activity? No immediate effects on the environment
6. What are the potential significant environmental impacts (positive and negative) of widespread dissemination and application of research findings? Sorghum is a low input crop and develop new market for this crop would support the expansion of low input agricultural production. Increased cultivation of this drought

tolerant crop will prevent the land from keeping fallow thereby preventing soil erosion. Thus, positive environmental benefits are perceived.

7. What follow-up action required to minimise potentially significant negative impacts?
    - Who will be responsible for ensuring this action is taken?
    - What form of monitoring/objective verification?

   Negative impact is not expected; so no need for any action

8. How can positive impacts be enhanced/extended cost-effectively?

   Creating and enhancing the market for sorghum will encourage the farmers in increasing the area under sorghum cultivation and more positive results are obtained when farmers are made aware of the results. Hence, conduction of mini-farmer days for adoption will be beneficial.
    - Who will be responsible for ensuring this action is taken?

      ICRISAT and all managing partners will be jointly responsible

    - What form of monitoring/ objective verification?

      We propose to have external evaluation of the process of coalition and measures taken to enhance marketability of sorghum

9. This note completed by (managing partner(s)): Name: Belum V S reddy
   P Parthasarathy Rao
   Institution: ICRISAT
   Date:_____

   Endorsed or modified by Programme manager ……..
   Date: ……..

ANNEXURE 3

Project Logical Framework

Logical Framework of the DFID-CPHP project on

"Exploring marketing opportunities through research, industry and users coalition: sorghum poultry feed_ (**R8267- ZB0337**)"

Narrative summary	**Objectively verifiable indicators**	**Means of verification**	**Risks**
Goal			
National crop post harvest innovation systems respond to the needs of the poor	By 2005 evolving institutional and organizational arrangements stimulate pro-poor post-harvest innovations in South Asia.	Project evaluation reports. Partners' reports. Regional coordinators' annual reports. CPHP annual reports CPHP review 2005	National crop-post harvest innovation systems do not sustain the capacity to respond to pro-poor development objectives after programme completion
Purpose			
Creation of new marketing opportunities for crop grown by poor producers by developing sustainable economic inter linkages of farmer-scientist-industry innovative coalition systems	By 2005, 500 sorghum farmers in Ranga Reddy and Mahabubnagar districts of Andhra Pradesh increase their income by 15% through the market linkages established in sorghum-poultry feed chain through coalition approach.	Project reports Higher income of sorghum farmers Establishment of market linkages Functioning of coalition	Changes in government policies Partners not able to cooperate Also, depends on another mechanism (project) for more innovative systems
Outputs			
Poultry Feed Formulations with sorghum cultivars available	Five improved sorghum cultivars (about 2 tons) provided to 300 farmers in selected villages in Ranga Reddy and Mahboobnagar districts of Andhra Pradesh	Report from poultry feed trials both on-farm and on-station Report on economics of new technology Farm poultry trials using different combinations of sorghum	Seed production failure due to drought and untimely heavy rains, etc. Failure to provide sufficient grains to trials Lack of rains at grain development leading to

Formation of sustainable farmer-scientist-industry coalition	Principles of partnership Linkages among research scientists, farmers, FFA and feed manufacturers Institutional factors linking production and marketing chain	Function of the linkages effectively at field level	Non-matching of expectations of farmers and feed manufacturers due to government policies Change in government policy on prices of various cereals
Technology access to the target groups accelerated	Availability of improved cultivars seed on a commercial level Easy to use brochure available Training and extension activities Institutional framework for technology access	Report and publicity material Training camps Seed company sales	Change in government policies
Understanding coalition system as a process	Achieving project outputs Lessons learnt Problems/impediments	Report	None
Activities			
Output 1			
Activity 1.1	Screening of few improved sorghum cultivars from 2002 rainy season harvest to poultry feed efficiency		November 2002 to April 2003
Activity 1.2	Meeting of coalition members to discuss the functioning of the coalition system, poultry feed results, select cultivars for distribution to farmers and to chalk out the details of the large scale poultry feed trial		April 2003
Activity 1.3	Selection of villages, baseline surveys, distribution of seed and monitoring of sorghum crop in farmers fields leading to timely harvesting		Feb to October 2003
Activity 1.4	Carrying out the chemical analysis of		November 2003 to April 2004

	grain (carbohydrates, proteins, amino acids, tannins etc.,) and stover (N, NDF, Lignin and *in vitro* rate and extent of formulation), and on-station poultry feed trials on broilers and layers		
Activity 1.5	Grading of rainy season harvest for grain mold, conducting on-station trials (activity 1.4) and developing feed formulations by feed manufacturers		November 2003 to March 2004 April 2004 to August 2004
Output 2			
Activity 2.1	Meeting of coalition members to discuss the broiler and layer trials results and to chalk out future program. Debate on working of the coalition system leading to refine the principles for effective partnership		April 2004
Activity 2.2	Socio-economic, policy and institutional factors linking farmers and industry		December 2003 to April 2004
Activity 2.3	Survey on the institutional perceptions of stakeholders in sorghum production and market linkages in coalition system formed		November 2003 to February 2004
Output 3			
Activity 3.1	Information brochures on cultivation practices, chemical composition of kharif sorghum feed efficiencies of various cultivars with different grain mold levels of infection		April-May 2004 on cultivation practices October-November 2004 on poultry feed efficiency

Activity 3.2	Training farmers and small scale poultry producers on sorghum in poultry feed		April- May 2004 November 2004
Activity 3.3	Understanding institutional framework for technology uptake		May-October 2004
Activity 3.4	Commercial seed supplies of the selected cultivars through FFA/ANGRAU		May-August 2004 October-December 2004
Output 4			
Activity 4.1	Brainstorming among coalition members on lessons learnt		April 2003 April 2004 November 2004
Activity 4.2	External evaluation of working of coalition		October-December 2004

ANNEXURE 4

Partner organisation work plan for adopting outputs

ANGRAU	APPF	FFA	Janaki Feeds
With the conclusive evidence through the poultry feed trials conducted as part of the project, the scientists are in a better position to convince the poultry industry on efficiency of sorghum based poultry feed rations. Research outputs will be publicised widely through training programmes, literature circulation. Though there is no formal plan drawn as part of the university extension activity these results would be transferred to the intended users.	The organisation is planning to publish and circulate the results among its members, once the trials on commercial layers completed. So far the results are very encouraging, trials will be completed by March, 2005	The FFA is planning to strengthen the village level farmers associations with enhanced capacities in bargaining with industry.	Feed manufacturer increase the proportions of sorghum in poultry feed rations and /or completely manufacture feed rations with sorghum, provided the market price of sorghum is cost advantageous.

ANNEXURE 5

List of coalition meetings with brief report and list of field visits made by project staff

Meetings of coalition partners and other important activities at ICRISAT

10-10-2002 Discussion with Coalition partners to finalize PMF

16-10-2002 Discussion with Coalition partners to finalize PMF

06-11-2002 Discussion with Coalition partners to finalize PMF

08-01-2003 Sorghum cultivars (CSH 16, CSV 15, S 35 and PSV 16) screened from the 2002 *Kharif* harvest

10-01-2003 Screened Sorghum cultivars dispatched to ANGRAU for Preliminary Poultry Feed Trails (PPFT) and to Pathologist for grain mold scaling

17-02-2003 Detailed activities finalized with the Partners

17-03-2003 Selected Sorghum cultivars assessed for threshed Grain mold severity

17-03-2003 Milestones discussed and finalized with partners and submitted to DFID

15-04-2003 Proximate analysis of Sorghum cultivars completed

02-05-2003 Monitoring and Evaluation training workshop of DFID-CPHP

23-05-2003 Review meeting of coalition partners was conducted and following decisions arrived.

- All the partners agreed upon forming a steering committee to closely monitor all aspects of Poultry Feed Trails (PFT) and final findings for formulation of poultry feeds using different combinations of sorghum. The specific monitoring responsibility of the committee will be oversight, monitoring the project and quality of results.

The committee constitutes

Status	Name of the person	Organisation representing
Convener	Mr C L N Rao	Janaki Feeds
Co-convener	Dr V L K Prasad	ANGRAU, Poultry Scientist
Secretary	Shri Akkineni Bhavani Prasad	FFA
Members	Dr. D. Ramachandraiah	ANGRAU, Millet Scientist
	Mr. Sudhakar Rao	APPF
	Mr. P. Parthasardhy Rao	ICRISAT

- Study villages were selected in consultation with coalition partners

S No	Village	Mandal	District

1	Udityal	Balanagar	Mahabubnagar
2	Gangapur	Jadcherla	
3	Kandwada	Chevella	Ranga Reddy
4	Manmarry	Shabad	

10-07-2003 Visited the poultry experimental station, ANGRAU and observed the ongoing preliminary poultry feed trails.

29-07-2003 Coalition partners (ICRISAT and Janaki feeds) visited the poultry experimentation station at ANGRAU to have insight regarding sorghum as poultry feed.

29-08-2003 Report of chemical analysis for tannins estimation in the selected four sorghum cultivars along with the local (yellow) sorghum received.

19-09-2003 Coalition partners (ICRISAT and Federation of Farmers Associations) conducted a meeting in Gangapur village of Jadcherla mandal followed by a field visit.

07-10-2003 A one-day review and planning workshop of the project was held at ICRISAT, attended by the representatives of all coalition partners along with the sorghum farmers (seven in number) from four villages selected for the project.

14-10-2003 ICRISAT, the managing partner of the project conducted a farmers meeting in Kandwada (one of the selected villages) of Chevella mandal and visited the sorghum fields of selected farmers.

24-11-2003 Dr Andrew Barnett from DFID, UK visited ICRISAT to evaluate the project progress. He visited FFA and met all the coalition partners. He gathered the needed information from all the coalition partners individually. Later in the afternoon, he visited the Poultry Experimentation Station of Acharya NG Ranga Agricultural University (ANGRAU) and observed the sorghum poultry feed trials and acknowledged the sensitivity arrangements made to the project by the coalition partners. He appreciated all the sorghum poultry feed coalition partners for their dedicated effort in successful implementation of the project.

10-12-2003 Review meeting of coalition partners was held at ICRISAT. The partners discussed various issues regarding procuring the sorghum grain from the farmers, procuring the project equipment, grain requirement for large-scale PFTs, stover sample collections, reports to be submitted to donors and budgetary matters.

19-01-2004 The STAKEHOLDERS meeting was held at ICRISAT on 19th January 2004 participated by all coalition partners of the project. The main focus group is poultry producers. Prof. VLK Prasad of ANGRAU delivered a keynote address on “poultry feed trials using improved sorghum grain”. The aim of the meeting is to disseminate the broiler PFT results to a larger group of end users (poultry producers) conducted at ANGRAU by using the 2002 *kharif*

harvested improved sorghum grain. Felicitating Dr VLK Prasad followed the meeting.

20-01-2003 Report on levels of Tannins and Phenolic compounds estimated for the 2003 *kharif* harvest from farmers' fields was received.

26-01-2004 Report on threshed grain mold severity scaling for the *kharif* 2003-harvested grain from farmers field was received.

29-01-2004 The report on Micotoxins (Aflotoxins and Fumanosin) estimated for the procured sorghum grain from the farmers' fields (2003 *kharif* harvest).

11&12-03-04 CPHP of DFID organized a Writeshop on 'Developing Institutional Outputs' at ICRISAT.

25&26-03-04 Ms Mary Underwood, Training and Development Consultant of DFID visited ICRISAT and reviewed the project progress, especially the steps taken for coalition building and the poverty eradication possibilities through the project. She visited the PFT's at ANGRAU on 26-03-04. Later in the afternoon, she met all the coalition partners at FFA office. She appreciated the excellent coalition arrangements among the partners to derive the stated outputs of utilization of sorghum in poultry feed manufacturing.

7 & 10-03-04 Hybrid sorghum seed was procured from the private seed companies for distributing to the project farmers. The cultivars are JK Jyothi from JK seeds and MLSH 296 and Paras Pradhan from emergent genetics.

14-05-2004 Review meeting of coalition partners was held at ICRISAT. The partners discussed various issues regarding Developing Poultry Feed Formulations with sorghum grain procured from farmers; Progress of Large-scale poultry Feed Trials; Poultry feed efficiency of sorghum- A broacher prepared for training the poultry producers; Questionnaires prepared for activities 2.2 and 2.3 mentioned in PMF; Forming/ strengthening the farmers groups in target villages; Selection of villages and farmers for 2004 *kharif* sowings; Distribution of seed; Equipment procured under the project; Reports sent to donors and Budget receipts and disbursement.

09-06-2004 ICRISAT partners visited the Large-scale layer PFTs being conducted at Poultry Experimentation Station of ANGRAU.

23-08-2004 Review meeting of coalition partners was held at ICRISAT. The partners discussed various issues regarding Poultry Feed Formulations with sorghum grain procured from farmers; Progress of Large-scale poultry Feed Trials; Poultry feed efficiency of sorghum- A broacher prepared for training the poultry producers; Forming/ strengthening the farmers groups in target villages; Status of seed distribution in project villages; Decided the venue and dates for conducting field visits to the project farmers (last week of Sep) and training programme to poultry producers (8^{th} sep 2004 at ANGRAU); Reports sent to donors and Budget receipts and disbursement.

2-11-2004 Miss. Emma Crewe, Anthropologist, DFID visited ICRISAT and discussed about the project

3-11-2004 Miss. Emma Crewe visited ANGRAU and discussed with Dr A Rajasekhara Reddy and also made a visit to FFA and discussed with Mr P Chengal Reddy, about project activities.

4 -11-2004 Miss. Emma Crewe visited Janaki Feeds and discussed about project activities with Mr Madhu, Director.

9-11-2004 The STAKEHOLDERS meeting was held at ANGRAU on 9th November 2004 participated by all coalition partners of the project. The main focus group is poultry producers. Dr A Rajasekhara Reddy of ANGRAU delivered a keynote address on "sorghum based poultry feed rations – a potential alternative to maize". The aim of the meeting is to disseminate the PFT results to a larger group of end users (poultry producers) conducted at ANGRAU.

6&7-12-2004 Organised a two day write shop at ICRISAT by CPHP, CRISP and ILAC on writing institutional histories of CPHP projects.

Field Visits made:

S No	Date	Place(s)	Purpose
1.	16-04-2003 & 17-04-2003	Mahaboobnagar	Collection of Region wise & Mandal wise data for district profile preparation
2.	18-04-2003	Ranga Reddy	Collection of Region wise & Mandal wise data
3.	06-05-2003	Jadcherla & Balanagar	Collection of village wise data for the selection of study area
4.	08-05-2003	Chevella & Shabad	Collection of village wise data for the selection of study area
5.	21-05-2003	Polepally & Gangapur villages of Jadcherla mandal	Identification of producer beneficiaries (Preparing the list of sorghum growers) for seed distribution
6.	21-05-2003	Udityal & Motiganpur villages of Balanagar mandal	Identification of producer beneficiaries (Preparing the list of sorghum growers) for seed distribution
7.	22-05-2003	Gollapally & Kandwada villages of Chevella mandal	Identification of producer beneficiaries (Preparing the list of sorghum growers) for seed distribution
8.	22-05-2003	Shabad & Kakloor villages of Shabad mandal	Identification of producer beneficiaries (Preparing the list of sorghum growers) for seed distribution
9.	27-05-2003	Udityal of Balanagar & Gangapur of Jadcherla mdl	Four improved sorghum cultivars seed (CSH 16, CSV 15, S 35 and PSV 16) was distributed for *Kharif* 2003 sowings
10	28-05-2003	Kandwada of Chevella & Manmarry of Shabad	-Do-

		mandals	
11	17-06-2003	Kandwada of Chevella mdl	Gypsum was supplied to 12 selected sorghum farmers
12	15-07-2003	Udityal of Balanagar & Gangapur of Jadcherla mdl	Pre-testing of baseline survey schedule; Fields of selected farmers were visited for germination check & Explained the recommended package of practices to be followed.
13	16-07-2003	Kandwada of Chevella & Manmarry of Shabad mandals	-Do-
14	06-08-2003	Udityal village of Balanagar Mdl	Collection of agro-economic (primary) data from the selected sorghum growers by using pre-tested BASE LINE SURVEY SCHEDULE.
15	07-08-2003	Gangapur village of Jadcherla Mdl	-Do-
16	11-08-2003	Kandwada village of Chevella Mdl	-Do-
17	12-08-2003	Manmarry village of Shabad Mdl	-Do-
18	19-09-2003	Gangapur of Jadchrla mandal	Organized a farmers meet and explained about the activities and future plan of action to the farmers who have sown the improved cultivars of jowar for the DFID-ICRISAT project. The scientists also addressed the press & media people. The sorghum fields of participated farmers of the project were visited (Explained the importance of proper weeding, thinning, fertilizer application, harvesting stage to avoid mold damage etc.,)
19	14-10-2003	Kandwada village of Chevella mandal	Conducted a farmers meeting in Kandwada village of Chevella mandal and visited the sorghum fields of selected farmers.
20	17-10-2003	Gangapur village of Jadcherla mandal	To collect the sorghum fodder samples for nutritional analysis.
21	28-10-2003 to 04-11-2003	All the project-selected (four) villages.	Collected the fodder samples from the project-selected farmers for nutritional analysis. (Total 240 samples consists of improved sorghum, local sorghum and maize fodder samples)
22	03-12-2003 to 05-12-2003	All the project-selected (four) villages.	Collected the primary data regarding the performance of ICRISAT supplied cultivars against local sorghums using a pre-tested interview schedule (Base-line Survey Schedule-Part II)

23	15-12-2003	Udityal village of Balanagar mandal	Procured the Improved Sorghum grain produced by the project farmers and handed over to Janaki Feeds through ANGRAU for preparing the feed formulations for Large-scale poultry feed trials.
24	19-12-2003	Gangapur village of Jadcherla mandal	- Do-
25	18-05-2004	Udityal village of Balanagar mandal of M'Nagar dist	Improved sorghum cultivars seed (JK Jyothi) was distributed for *Kharif* 2004 sowings.
26	19-05-2004	Uddandapur and Gollapalli of Jadcherla mdl of M'Nagar dist	Improved sorghum cultivars seed (CSV 15) was distributed for *Kharif* 2004 sowings.
27	20-05-2004	Burgupalli of Jadcherla mdl of M'Nagar dist	Improved sorghum cultivars seed (CSV 15) was distributed for *Kharif* 2004 sowings.
28	22-05-2004	Kandwada and Gundala villages of Chevella mdl of Ranga Reddy dist	Improved sorghum cultivars seed (MLSH 296 and Pradhan) was distributed for *Kharif* 2004 sowings.
29	25-05-2004	Urella and Urella (Mondivagu) villages of Chevella	Improved sorghum cultivars seed (JK Jyothi and MLSH 296) was distributed for *Kharif* 2004 sowings.
30	26-05-2004	Ibrahimpally village of Chevella mdl	Improved sorghum cultivars seed (CSV 15) was distributed for *Kharif* 2004 sowings.
31	28-05-2004	Basthepur and Khanapur of Chevella Mandal	Improved sorghum cultivars seed (CSV 15) was distributed for *Kharif* 2004 sowings.
32	1 to 2-06-04	All mandals	All the project selected villages of the 3 mandals were visited and the seed was distributed
33	13 to 14-06-04	All mandals	Monitored the sowing operation in all the project-selected villages.
34	15 to 16-07-04	All mandals	Monitored the sowings/ weeding operation in the entire project selected villages.
35	5 to 11-08-04	All mandals	Monitored the weeding and thinning operations in the entire project selected villages.
36	12 to 13-08-04	All mandals	Demonstrated the shoot fly attack in late sown crop and make aware the farmers to control the pest.
37	1 to 2-09-04	All villages	Strengthening the farmers clubs/ associations and facilitating to form into rythu clubs where they do not exists. Explained about the project activities, importance of forming in to clubs, advantage of bulking and collective marketing of produce etc.,

38	08-09-2004	Udityal village of Balanagar mandal, Mahbubnagar district	The sorghum fields of participated farmers of the project were visited and ICRISAT scientists demonstrated the proper harvesting stage of crop to avoid grain mold attack. Before the field visit the partners conducted a training programme for the project farmers of the village and explained in detail the project activities, crop management practises, importance of forming rythu clubs/ associations, advantages of marketing linkage and collective marketing etc.,
39	6 to 10-09-04	All villages	Monitoring the crop and advising the farmers on best harvesting time.
40	14 to 16-10-04	All villages	Advising the farmers on grading and bulking.
41	1 & 2-11-04	All villages	Advising the farmers for collective marketing.
42	1-12-2004	All villages	Collected data from RARS, Palem on rainfall and on arrivals of sorghum from Jadcherla market yard

ANNEXURE 6

Dissemination outputs

Publications

PARTHASARATHY RAO, P., RAGHUNADHA REDDY, G., BELUM V.S. REDDY, and KRISHNA REDDY, K. (2004) Economics of improved sorghum cultivars in farmers fields: *kharif 2003*. International Sorghum and Millets Newsletter, 45: 40-42.

LAKSHMITULASI, S., RAJASHEKHER REDDY, A., RAGHUNADHA REDDY, G., PRASAD, V.L.K., RAJU, M.V.L.N., RAO, C.L.N., BELUN V.S. REDDY., PARTHASARATHY RAO, P., and RAMACHANDRAIAH, D. (2004) Performance of broilers on sorghum-based diets. International Sorghum and Millets Newsletter, 45: 37-39

Other Dissemination of Results:

Reference Type (as in NRIL green citation guidelines)	Citation Details	YES/NO**
Factsheets, booklets, information leaflets	REDDY, B.V.S. (2003) Multiple uses of improved kharif sorghum cultivars. 500 copies. International Crops Research Institute for Semi Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India. 6 pp. [Leaflet] [Telugu] {A leaflet in local language was provided to the participating farmers wherein all the details regarding the cultivars performance, package of practices to be followed, background and aim of the DFID funded project etc., were published.}	Submitted
Newspaper and magazine articles	AGRICULTURAL CORRESPONDENT (2003) ICRISAT's encouragement in sorghum development. *Andhra Bhoomi*, 29 May.p. 12. [India]	Submitted
Newspaper and magazine articles	AGRICULTURAL CORRESPONDENT (2003) Multiple uses of kharif sorghum cultivars. *Vaartha*, 30 May.p. 8. [India]	Submitted
Newspaper and magazine articles	AGRICULTURAL CORRESPONDENT (2003) Field visits by ICRISAT scientists in Gangapur. *Andhra Jyothi*, 20 September.p. 1 and 5. [India]	Submitted
Newspaper and magazine articles	AGRICULTURAL CORRESPONDENT (2003) ICRISAT scientists observed sorghum crop. *Vaartha*, 20September.p. 8. [India]	Submitted
Newspaper and magazine articles	AGRICULTURAL CORRESPONDENT (2003) Kandwada selected by ICRISAT for sorghum	Submitted

	development. *Eenadu,* 15 October.p. 12. [India]	
Workshops, seminars, open days, training courses, farmer field schools, exchange visits	PRASAD, V.L.K. (2004) Poultry Feed Trials using Sorghum. International Crops Research Institute for the Semi Arid Tropics, Patancheru, Andhra Pradesh, India, 19 January 2004 [One-Day Training Workshop for 30 Poultry Producers, Feed Manufacturers and Farmers][Telugu]	Submitted
Factsheets, booklets, information leaflets	REDDY, A.R (2004) Profitable poultry feed rations from improved sorghum cultivars. 500 copies. Acharya N G Ranga Agricultural University (ANGRAU), Hyderabad, Andhra Pradesh, India. 4 pp. [Leaflet] [Telugu] {A leaflet in local language was prepared, wherein all the details regarding the economic advantage and feed efficiency of sorghum in poultry feed rations, and background and aim of the DFID funded project etc., were published.}	Submitted
Newspaper and magazine articles	AGRICULTURAL CORRESPONDENT (2004) Grow high yielding cultivars of Sorghum for higher returns. *Andhra Bhumi* 9th September.p. 5. [India]	Submitted
Radio and TV programmes, Interviews and reports	RAGHUNATHA REDDY, G. (2004) Sorghum for poultry feed: making the link, ***WREN media-world radio for environment***, September 2004, 5.28 mins. UK [Radio interview] [National] [English] www.wrenmedia.co.uk	Script Submitted
Newspaper and Magazine articles	AGRICULTURAL CORRESPONDENT (2004) Mouldy sorghum finds its niche. New Agriculturist Magazine, WREN media UK, November 2004 [English] www.new-agri.co.uk	Submitted
Radio and TV programmes, Interviews and reports	BELUM VS REDDY AND GURAVA REDDY, K. (2004) New initiatives in sorghum marketing, Eenadu Television, 8th November 2004, [18:30] 5 mins. [TV interview] [Local] [Telugu]	
Workshops, seminars, open days, training courses, farmer field schools, exchange visits	RAJASEKHARA REDDY, A. (2004) Sorghum based Poultry Feed Rations – A Potential Alternative to Maize. Acharya N G Ranga Agricultural University, Hyderabad, Andhra Pradesh, India, 9 November 2004 [One-Day Training Workshop for 40 Poultry Producers, Feed Manufacturers and Farmers][Telugu]	Submitted
Radio and TV programmes, Interviews and reports	GOWDA, C.L.L., RAO, C.L.N. and NARASIMHA REDDY, E. (2004) ICRISAT efforts in making sorghum based poultry diets- a potential alternative to maize, Eenadu Television, 12th November 2004, [18:50] 5 mins. [TV interview] [Local] [Telugu]	

Conferences, workshops, symposia	CLL GOWDA, BELUM VS REDDY, P PARTHASARATHY RAO, A RAJASEKHAR REDDY, CLN RAO, AND G RAGHUNATHA REDDY. (2004) Building Coalitions for Producer-Market-Processor Linkages: A Case Study of Sorghum for Poultry Feed. APAARI Expert Consultation on Post-harvest Technologies, 1-3 December 2004. Thailand.	Submitted
Radio and TV programmes, Interviews and reports	GURAVA REDDY, K. (2004) CRISP workshop on rural innovations, Eenadu Television, 24th November 2004, [18:55] 3 mins. [TV interview] [Local] [Telugu]	
Newspaper and magazine articles	AGRICULTURAL CORRESPONDENT (2004) Rainfed Jowar has golden future- ANGRAU, ICRISAT research. Eenadu 7th December .p. 6. [India]	Submitted

Key data sets generated

S.No	Dataset
1	BELUM V.S. REDDY., PARTHASARATHY RAO, P., RAGHUNATHAREDDY, G., AND KRISHNA REDDY, K. (2003) Baseline survey schedules. International Crops Research Institute for Semi Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India [Unpublished dataset]
2	BELUM V.S. REDDY., PARTHASARATHY RAO, P., RAGHUNATHAREDDY, G., AND KRISHNA REDDY, K. (2003) Input-output information of improved sorghum cultivated during kharif 2003-2004. International Crops Research Institute for Semi Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India [Published dataset]
3	BELUM V.S. REDDY., PARTHASARATHY RAO, P., RAGHUNATHAREDDY, G., AND GURAVA REDDY, K. (2003) Socio-economic policy and Institutional factors linking farmers with feed manufacturers. International Crops Research Institute for Semi Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India [Unpublished dataset]
4	BELUM V.S. REDDY., PARTHASARATHY RAO, P., RAGHUNATHAREDDY, G., AND GURAVA REDDY, K. (2003) Institutional perceptions of stakeholders in sorghum trade and market linkages. International Crops Research Institute for Semi Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India [Unpublished dataset]