Paper Presented at the International Conference on Livestock Services for Enhancing Rural Development, Beijing, China 16-22 April, 2006

A MULTI-STAKEHOLDER APPROACH TO SEED SYSTEMS OF FOOD-FEED CROPS FOR SMALLHOLDER FARMERS IN THE TROPICS.

R.L. Roothaert[1], O.O. Olufajo[2], P.G. Bezkorowajnyj[3], Ch. Ravinder Reddy[4], V.L. Prasad[4].

[1] International Livestock Research Institute, Addis Ababa, Ethiopia
[2] International Livestock Research Institute, Kano, Nigeria
[3] International Livestock Research Institute, Hyderabad, India
[4] International Crop Research in the Semi-Arid Tropics, Patancheru, AP, India
r.roothaert@cgiar.org

Improved dual-purpose food-feed crops have potential to raise income and improve the lives of smallholder farmers in the tropics. In many cases farmers rely on crop residues as a source of fodder and a focus on dual-purpose crops has been considered as having greater potential to address fodder scarcity constraints than planted forages per se. New varieties of food-feed crops have been developed and are liked by farmers but adoption has generally lagged behind. This paper describes the crucial role of seed production and distribution systems for scaling out dual purpose food-feed crops in Nigeria and India. Some comparisons are made with seed systems for forages elsewhere in the tropics. In Nigeria and India participatory varietal selection trials identified new varieties of cowpea and groundnut that were preferred by farmers. Recently, an actor linkage approach has been introduced to facilitate seed systems in Nigeria and India. Case studies are presented on efforts to enhance sustainable public-private partnerships in seed production of dual purpose crops. The private sector has the capacity to move fast in new markets for forage seeds, while the public sector can provide crucial demand related information such as location, type, and amounts of required seeds. Smallholder artisan seed production, storing and distribution systems can co-exist with private sector seed systems. For food-feed seed innovation systems to thrive, policy reforms are necessary, especially in the public research and development institutes. Enhancing the capacity and a new mind set of all actors involved is necessary to tap the full potential of forage seed innovation systems to make an impact on smallholders' lives.

Introduction

In many parts of the semi-arid tropics, crop residues are the main source of feed for livestock. In India, crop-residues from dual-purpose crops including rice, wheat, sorghum, pearl millet, pulses and oil seeds account for up to 60% of total feed (Parthasarathy Rao and Bhowmick, 2001). In the northern part of Nigeria, the major source of feed are crop residues of sorghum, maize, millet, cowpea and groundnut. Despite the massive amounts of crop residues saved and fed to livestock, feed shortage and low quality feed remains a major constraint to smallholder livestock production. In 2003, the Systemwide Livestock Program of the CGIAR[5] started a project in India and Nigeria, funded by DFID[6], to increase access of resource poor livestock farmers to improved fodder technologies. These technologies consist of dual-purpose legume and cereal varieties that have higher food and crop residue yields, better feeding value of crop residues, and management practices that improve either yields or feeding value, or both. For instance, IITA[7] in collaboration with ICRISAT[8], ILRI[9] and IAR[10], developed an early maturing cowpea variety that matures within 60 days and that has high yields of pulses. This variety is harvested in such early stage that it enables another cowpea variety to be cultivated in the same season on the same land, which produces large amounts of high quality fodder. The second variety matures when the rains have stopped, which enables good harvesting of both pulses and haulms for fodder. An impact study for dual-purpose cowpea varieties showed that farmers perceive many types of benefits from these improved crops, such as: higher cash sales of beans, fodder, and animals fed the fodder; healthier household members; and fewer fertiliser and pesticides needed. Gross farm revenue from sales of cowpea grains and fodder was 61,000 Naira for adopters of improved cowpea varieties, versus 11,000 Naira for the non-adopters (Kristjanson et al, 2005). In India, an improved dual-purpose groundnut variety, ICGV91114, produces higher pod and fodder yields than the local variety, and has the potential to raise milk production by 10% due to high feeding value of its haulms (ICRISAT, 2006).

Planted forages have made significant contributions to improve livelihoods of smallholder farmers in sub-humid uplands of Southeast Asia. In East Kalimantan, Indonesia, for example, cash income from sales of livestock and manure resulted in an increased gross margin of 35% per household for those who had adopted improved forages versus those who had not. Cut and carry systems of forage also saved 24% labour in terms of days worked per year (CIAT, 2004). The forage scenario, however, seems to be differ among regions in the tropics. From 1999 to 2003, a joint IITA and ILRI project evaluated the use of herbaceous legumes by farmers in the sub-humid and semi-arid zones of Benin and Nigeria. Forages were grouped into three types: dual-purpose legumes - for food and feed, forage legumes – for feed, and cover legumes – for soil improvement. In all villages, regardless of the agro-ecological zone, dual-purpose

[5] Consultative Group on International Agricultural Research
[6] Department for International Development, UK
[7] International Institute of Tropical Agriculture, Nigeria
[8] International Crops Research Institute for the Semi-Arid Tropics, India
[9] International Livestock Research Institute, Nairobi
[10] Institute of Agricultural Research, Nigeria

legumes were the most popular in terms of requests for seed, seeds saved and area planted. Farmers' reasons for it were that they could benefit from them directly in terms of grain for family consumption as well as income generation, with the bonus of more livestock feed, especially in the semi-arid zone (GTZ, 2003). The explanation for the difference of preference for forage types between Southeast Asia and the other regions (e.g. Nigeria and India) must be sought in the farming systems. In West Africa and South Asia, farmers are used to local varieties of dual purpose crops such as groundnut and cowpea, and know how to grow, store, process and market them. Growing an improved variety requires little change in practices. In southeast Asia, these dual purpose crops are relatively uncommon.

Adoption of dual-purpose crops.

In Nigeria, at least two projects have dealt with extensive on-farm research on dual-purpose crops: the BMZ project from 1999 to 2003 (GTZ, 2003), and the DFID project from 2003 to 2006 (ILRI, 2004). The BMZ project in Nigeria consisted of two international centres, ILRI and IITA, and two national research institutes: University of Hohenheim (Germany) and IAR (Nigeria). Four villages were selected in the semi-arid zone, covering a gradient of farming intensification. Participating farmers were selected through a workshop. In each village demonstration trials were established which were largely managed by the research team, but farmers also had an opportunity throughout the three year project to test forages themselves. Farmers' individual rational for experimenting with and adoption of herbaceous legumes were also evaluated through group and individual discussions. Results of the research showed that groundnut was the most popular dual-purpose legume, followed by soybean, and then by cowpea. Groundnut was appreciated for its high grain yield, soybean mostly for its marketability, and cowpea for grain yield and forage. Towards the end of the project, farmers started to appreciate forage legumes such as *Centrosema pascuorum* and *Macrotyloma uniflorum* for their palatability foremost, and secondly for their biomass production. Forage legumes were more often cultivated in the less intensive systems, where ample land for fallow was available. Forage legume cultivation was also skewed towards the richer wealth categories, where the pressure for quick and direct impacts was less. Key challenges for the BMZ project were:

- Ensuring integration of natural resource management issues through multiple partners and responsibilities.
- Balancing and promoting complementarity between social and biophysical science approaches. Related to this was the lack of correlation between farmers' perception and biophysical results from formal demonstration plots, and the question it generated about the usefulness of demonstration plots.
- Dependence on well trained field technicians, who played a crucial role in the implementation of the project.

The DFID project looked at how on-farm successes with dual-purpose crops could be scaled out. Potential sites were considered within these areas, with respect to demand for fodder, availability of resources and delivery systems for fodder interventions, and

partnerships in existing projects. Through these partnerships, the project started in the first year with activities that exposed farmers and partners to the technology and that helped integration into their farming systems. The following year the emphasis moved from increasing technical results on ground to more process oriented approach such as partnership building and developing synergies with other partners to make the scaling out process more sustainable. Formal partners included international organizations, national research and extension institutions, NGOs, and farmer groups. As in the BMZ project, demonstration plots with best bet forages were established in pilot sites. In addition, several farmers per site were given a chance to establish test plots on-farm with the best bet options from the demonstration plots. These on-farm test plots were designed by scientists but farmers managed these plots themselves. A technician or extension agent was located in each village to work closely with the farmers, facilitating focus group discussions to record farmers' observations and perceptions and to provide a forum for learning from each other. Individual farm visits provided additional farmer feedback. Farmers were impressed with groundnut (RMP12 and UGA2) varieties for its high biomass and retention of leaves during harvest; cowpea IT93K-452-1 for its early maturity; and cowpea IT90K-277-2 and IT89KD-288 for their high grain and fodder yield. Farmer field days were conducted at the various pilot learning sites to scale up and out the fodder technologies. An institutional scaling up process was started through inviting local, state, and federal government officials to field days. Direct scaling out by reaching more farmers was facilitated through inviting large numbers of neighbouring farmers to the field days, and through farmer to farmer exchange visits. The project grew from 90 participating farmers in the first year to more than a 1000 farmers testing dual-purpose crops and forages 2 years later.

The DFID project also operated in India simultaneously. The research consisted of demonstration plots, focus groups discussions, farmer managed on-farm trials, field days, and household surveys. Farmers in the dry land districts selected dual-purpose cultivars of groundnut, sorghum and pigeon pea. Yields and prices of grain dominated the decision of better-off farmers to select varieties, while for poor and women farmers, both grain and fodder yields as well as quality of fodder were the selection criteria. The most preferred dual-purpose crop variety has been groundnut ICGV 91114 due to its high grain and haulm yields, and its drought tolerance. Over 400 farmers across many villages have now adopted this variety.

The original scaling out strategy of the DFID project in Nigeria was characterised by relatively heavy investments:

- Establishment of researcher managed demonstration plots in each pilot site, and field days around the demonstration plots
- Employment and coaching of technicians by international centres, stationed at various sites, who supported government extension workers and provided direct services to farmers.
- Provision of micro credits directly by the project in the form of seeds, fertiliser and chemicals on loan to farmers before the planting season.

In 2005, the scaling out strategy was revised. Investments in demonstration plots were minimised, and in stead farmer fields of those who had adopted dual-purpose crops or

forages were used as demonstration to other farmers. Plans were made to experiment with different forms of information systems for rural farmers, such as radio programs, to partially replace the direct information providing roles of employed technicians. Micro-credits provided by the project were scaled down and more farmers paid agro-inputs up front. Another challenge for scaling out was the availability of seeds. In Nigeria, the demand for seeds of some particular varieties, such as the cowpea varieties IT93K-452-1, IT90K-277-2 and IT89KD-288 and groundnut varieties UGA2 and M572-80I has been growing steadily. In the third year of the project the demand for seeds of the improved cowpea and groundnut varieties increased beyond supply.

Seeds systems of dual-purpose crops

In the smallholder mixed cropping systems in the tropics, farmer inter-cropping practices dictate the type of cultivars and the level of biodiversity to be maintained and supported through seed production systems. The vulnerability of their farming systems adds another layer of complexity to their need for seed production and delivery systems. More than 80% of crops in developing countries are sown from seed stocks selected and saved by farmers (e.g. Delouche, 1982; Osborne and Faye, 1991). An exception are the seeds of hybrid crops, where in order to maintain hybrid vigour farmers need to replenish seeds every year. Hybrid seed systems are highly centralised, either through the private sector (e.g. Nigeria) or through both private and public sector (e.g. India). Within the seed sector of hybrid crops, maize, sorghum, and rice have a significant impact on feed availability through their crop residues. Seeds of non-hybrid dual purpose grains, legumes and oil crops find their way largely through the informal seed system. Farmers sourcing seed off-farm will usually obtain seed from other farmers and often farmer communities identify certain individual farmers as reliable sources of good quality seed. In Ananthpur district, India, the proportion of farmers functioning as seed producers cum distributors is very small. Furthermore, it is often difficult to establish whether these local seed suppliers are making a conscious effort to produce high quality seed or if they are simply well endowed farmers who always have surplus grain to sell as "seed" during the next planting season. Seed sources have been related to wealth status, with rich farmers maintaining their own seed stocks but poor farmers needing to buy or borrow seed every year. Storage of farm saved seed and borrowing of groundnut seed is vanishing due to continuous drought, poverty, problems with storage pest like groundnut bruchid (*Carydon serratus*), and a sense of insecurity among seed lenders due to occurrence of frequent droughts in the area. Hence, farmers in

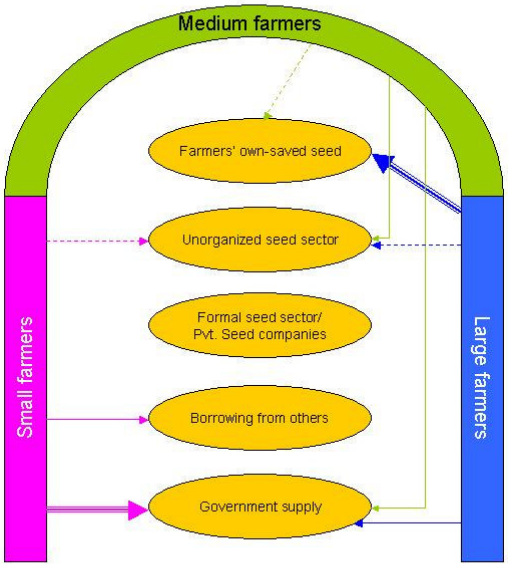

Figure 1. Seed delivery systems for groundnut in south India.

Ananthapur district, irrespective of their land holding sizes, are increasingly depending on government subsidized seed supply (Ravinder Reddy 2004). About 60- 70% of farming community in the District depend on government seed supply, which hardly meet 30-40% of their total seed requirement. Hence, farmers look to other sources like oil mill companies, local groundnut traders, or purchase with in the village from big farmers to fully meet their seed requirement (Fig 1).

Groundnut seed distribution by government plays an important role during drought years. The process adopted by the government for seed distribution, is by calling tenders from seed traders for supplying groundnut seed in a particular area and the lowest bidder gets the tender to supply seed. The important aspect here is to note that there is no specification of variety to be supplied to a particular agro-climatic zone. The bidder procures seed from the unorganized markets, oil mill companies, or groundnut traders. Seed is cleaned, graded, packed and supplied to farmers without any tag of variety name. A result of this system, farmers often sow mixtures of varieties in their fields and the cycle continues every year. Frequent occurrence of droughts during the last ten years has reinforced this syndrome, especially in Ananthapur District, where groundnut is a major crop.

Farmers in Nigeria have been multiplying seeds of dual-purpose crops themselves, but only in small amounts enough for their own use and little for distribution to others. The decentralised state government agricultural development projects (ADP) also produce seeds of agricultural crops, but their structure prevents them from swiftly adjusting the production process to meet changed or increased seed demand. Even if seed stock is available, ADPs lack the logistics and the means to supply farmers in remote rural places. There is a national policy in place which dictates that the ADPs hand over the responsibility of agricultural seed production to the private sector. However, this hasn't happened yet.

Box 1. The DFID fodder innovation project consists of the following partners in Nigeria:

- Kaduna State Agricultural Development Project (KADP)
- National Livestock Projects Division (NLPD)
- Institute for Agricultural Research, Samaru (IAR)
- National Animal Production Research Institute, Shika (NAPRI)
- Lake Chad Research Institute, Maiduguri (LCRI)
- Promoting Sustainable Agriculture in Borno (PROSAB)
- Bauchi State Agricultural Development Programme (BSADP)
- Justice, Development and Peace Commission (JDPC)
- Justice, Development and Peace Movement (JDPM)
- Federal Livestock Department (FLD)
- Oyo State Agricultural Development Programme (OYSADEP)
- Premier Seeds Ltd.
- National Seed Service (NSS)
- International Institute of Tropical Agriculture (IITA)
- International Livestock Research Institute (ILRI)

A multi-stakeholder approach to enhancing seed systems

The project decided to use a tool called 'actor linkage mapping' (Biggs and Matsaert, 2004) to analyse existing patterns of information flow in the fodder seed system, identify weak links among actors, and agree on action plans to improve them. A meeting was organised to introduce the method of actor linkage approach, and to analyse the

fodder seed system in Kaduna State. Representatives from KADP, NLPD, IAR, NAPRI, an NGO, ILRI, NSS, and a private seed company participated (Box 1), while ILRI facilitated the discussion.

During the first meeting of the actor oriented approach, actors in the fodder seed system in Kaduna State were identified. A heated debate then started on the mandates of the various organisations versus their actual activities and linkages with others in the fodder seed innovation system. In almost every case, perceptions from outsiders about effective linkages of an organisation was different from the organisation's own perceptions. It required modesty from all participants and a conducive environment to reach consensus on the quality of actual actor linkages in the system. Figure 2 is a graphical illustration of all existing linkages, based on consensus from this meeting.

The private seed company revealed that it was hesitant to produce seeds of new crops. Ninety five percent of its business was related to production and marketing of hybrid maize seeds, which had a guaranteed and voluminous market demand each year. The company believed that new cowpea and groundnut varieties did not have a guaranteed market. The risk was too great that these new seeds could not be sold the following year, and would become unviable if stored too long. During this discussion it became clear that there was a lack of information flow about which new varieties are in demand, who is demanding the new seeds, where these communities are, and what amount of seeds are needed.

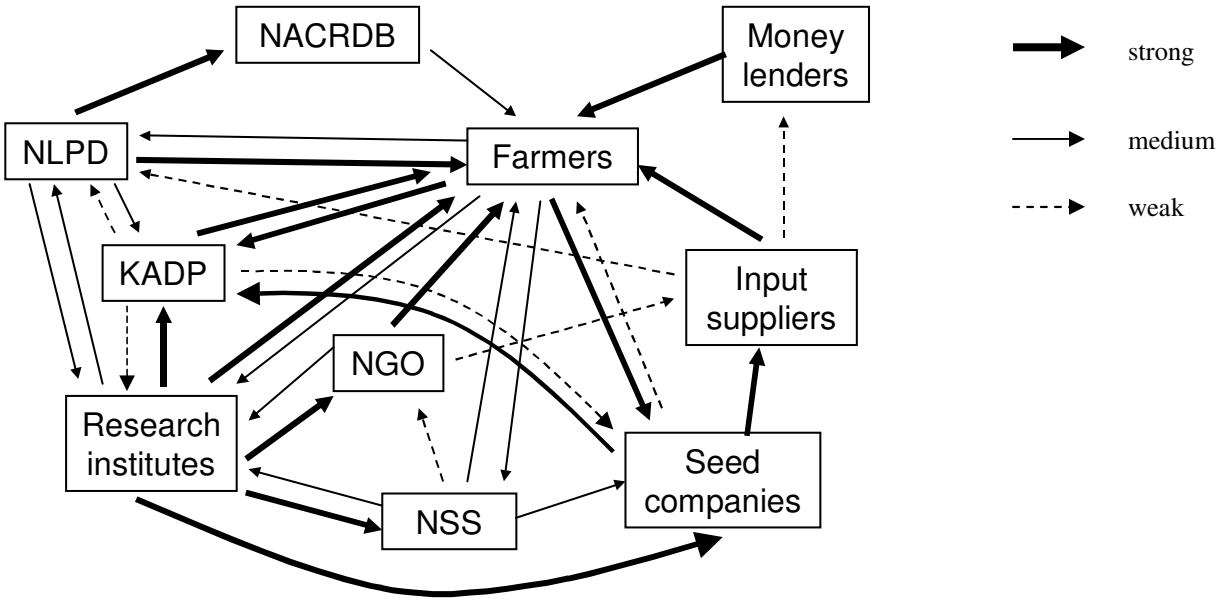

Figure 2. Qualitative linkages (flows of information and goods) among actors[11] in the fodder seed innovation system in Kaduna State, describing the ***actual*** situation.

[11] NACRDB - Nigerian Agricultural Credit and Rural Development Bank

The actor linkage map exercise revealed that there was a critical link between the private seed sector and the farmers through the input suppliers. They were considered the most efficient and direct suppliers of seeds and other related inputs to farmers, even in remote rural areas. However, there were very few and weak input supplier linkages with other actors in the system. The input suppliers depended on the seed companies for supply of seeds. The seed company in turn depended mostly on the research institutes for supply of breeder seeds. The active flow of information based on participatory research with farmers, and feedback about preferences of crops and demand of seeds was not channelled to input suppliers and seed companies.

It is important to interpret the actor linkage map well. In the map a strong link is portrayed from farmers to the seed company, but this only represents the flow of seeds that out-grower farmers produce for the seed company on a contract basis. The map also showed that the unofficial private money lenders are a more important source of credit to small farmers than the official bank. For scaling out of technology packages involving inputs on loan, this is relevant information.

Several points for follow up were agreed during the first meeting:

- Information about the type, amount and location of demand of seeds of food-feed crops would be compiled and shared with seed companies.
- The project would start a pilot experiment on the reduction of risks for seed companies who produce new varieties of seed for smallholder farmers.
- A training programme would be launched for input suppliers on technological and socio-economic aspects related to new food-feed crops.
- A follow up meeting would be organised to monitor changes and to include other relevant actors in the process, such as input suppliers, which had not been invited during the first meeting.

An agreement was signed between the project (convened by ILRI) and a private seed company. According to this agreement, the company would produce a ton of 'risky seeds', while ILRI would absorb the risk in case the seeds were not sold in the 2006 growing season. This was a one-off trial activity with the aim to trigger diversity of commercial seed production. The production of seed is on-going at the time of writing.

In the second actor meeting, additional actors were invited, among which also a seed production officer of KADP. The officer shared detailed information on significant amounts of seed dispersal from KADP to farmers in 2005. This information encouraged the private sector, who were invited to capture this market. In turn, the seed company shared information about their network of ten zonal company officers in the country, who are close contact with input suppliers in every State, forming a network consisting of about 1800 input suppliers. This network could be utilised to its full advantage, not only for distribution of food-feed crop seeds, but also to disseminate technical and socio-economic information about the food-feed technologies.

A strategy was developed for dissemination of technical food-feed crop related information to input suppliers and farmers. The team would attend annual meetings with input dealers organised by the seed company. IAR agreed that it would produce posters to capture the attention of input suppliers who were going to attend these meetings. In addition, IAR would produce summary tables about recommended agronomic practices of the food-feed crops, and detailed extension leaflets. It would also be relatively easy to provide these extension materials to the zonal officers of the seed companies who could further disseminate them. This would lead to increased awareness not only among farmers but also among input suppliers.

Lessons learned

The challenges of seed systems for improved varieties of dual-purpose crops can be summarised as follows:

- Demand for forage affects the demand for seeds.
- Improved varieties such as cowpea require modified agronomic practices, and lead to additional and new benefits. Few farmers are familiar with these.
- Most varieties are open pollinated and farmers can produce their own seeds which reduces the interests of private seed companies to get involved.
- An information system on the nature of the demand for seeds (type, quantity, locations) has not been developed
- Lack of market orientation of and adverse policies for smallholder livestock production negatively affects the demand for fodder

Yet seed systems of dual-purpose crops have an advantage over forage crops. For forage seed systems, in addition to the constraints mentioned above, there is another constraint due to the technical aspects and expert skills required for production of forage seeds. In contrast to dual-purpose crops, forages have not been bred or selected for ease of seed harvesting and quantity of seed production. Their seeds often ripen over a long period, they scatter, and some are very small in size or hidden – hardly visible to the unpractised eye. Harvesting seeds of dual-purpose crops is relatively easy.

We learned that an actor oriented approach doesn't need to be perfect from the start. When new essential actors are discovered, they can be introduced during subsequent sessions. The actor oriented approach has facilitated a process of learning by doing with progressive achievements. However, one should not use this approach very lightly. The usefulness of the approach is highly dependent on whether the individuals involved can accept the differences between the mandates of their institutions, and their actual performances. The distinction between the two directions of each linkage is also an essential analytical tool. If the approach is used carelessly, it will end up on the pile of other discarded participatory tools which had their important applications but which have been abused so often in the past.

We found that a culture of mutual suspicion existed between some public institutions and seed companies. There was a tendency to accuse each other during meetings. It is important that this was observed and recognised. Acceptance of one's own shortcomings

in the past is an attitude that needs to be acquired and is an essential step for making further progress. Discourse during the meetings should nevertheless focus on opportunities and planned activities within the boundaries of reality. In the process of improving the quality of actor linkages, individual personalities play an important part and are at least as important as institutional goals and cultures. A capable outside mediator is necessary to create a non-threatening environment and to nurture trust among actors.

The actor oriented approach is not only a useful tool to enhance innovation systems, it is also an appropriate tool for participatory and process monitoring and evaluation (ME). Traditional ME activities are low on the priority list of many partner organisations in the project. In the past, it has had its main application to study accountability. The purpose of participatory and process monitoring and evaluation is not only to aid accountability, it is more particularly intended to provide a mechanism for joint reflection, learning and adjustments of plans and objectives. The actor oriented approach facilitates this. Information generated is primarily meant for internal use. However, generic lessons learned can be disseminated and contribute to policy reforms.

There are two types of information flows that are essential for enhancing public private partnerships in forage seed systems: (1) the information flow about type, location and quantity of demand and (2) information flows about the technological aspects associated with new forage germplasm. In order to maximise the opportunity of the extended network of input dealers, these dealers need to know more than the name and the price of the product, in this case food-feed crop seed, which they are selling. If they can advise farmers on the multiple benefits of these food-feed crops, the optimum cropping patterns and its management requirements, farmers' interest and demand for these seeds will increase.

Involving private seed companies in production and distribution of non-hybrid seeds of promising technologies has great scope for fast scaling out. It would not necessarily form a threat to artisan seed production enterprises. Farmers sell seeds to other farmers at a lower price than the seed companies do, and will therefore remain an attractive alternative which can operate in parallel to the private commercial sector. Farmer to farmer seed exchange, co-operative or other local seed production and distribution mechanisms will probably increase in volume year after year, and might eventually surpass the volume of that of seed companies. The long term interest of seed companies can be sustained by the fact that they produce certified seeds, which have an added value for those who can afford it. Secondly, many smallholder farmers are not able to save their seeds for a period of nine months or longer, and might have to purchase new seeds from time to time.

The cases from India and Nigeria show the need for institutional reorientation reinforced by policy change. In India, local seed markets based on farmer to farmer exchange are popular but are not adequately linked to systems for improved seeds. Locally operating institutions such as NGOs, government extension services and others can improve these links. Some farmer seed producers have the potential to expand as specialized seed

enterprises, but would need training in market development. Most importantly though, sustainable, competitive groundnut seed systems will require substantial reorientation of government philosophies and programs. Rather than attempting to directly supply seed to farmers, government programs will need to provide support services that allow developing formal and informal seed enterprises to respond to farmer demand for seed. In Nigeria, a great potential exists for private seed companies to take up the role of dissemination of improved dual-purpose crop seeds and technical information into the far and remote corners of the country. The public sector through the State ADPs need to change their policy to reduce their monopoly on implementation of agricultural development services and constantly engage in a discussion with other actors to capitalize on opportunistic partnerships that can enhance seed production and distribution and information systems that benefit the rural poor.

References

Biggs, S., Matsaert, H., 2004. Strengthening poverty reduction programmes using an actor-oriented approach: examples from natural resources innovation systems. Agren Network Paper No.134. ODI.

CIAT, 2004. RETA 5866: Fourth Agriculture and Natural Resources Research at CGIAR Centers: Developing Sustainable Forage Technologies for Resource-Poor Upland Farmers in Asia. Final report, 2000 - 2003. Centro International de Agricultura Tropical/ Asian Development Bank, Cali, Colombia, pp. 44.

Delouche, J.C. 1982. Seeds quality guidelines for the small farmer. In: Proceedings of the Conference on Improved Seed for the Small Farmer, 9-13 August, CIAT, Cali, Colombia.

GTZ, 2003. Development of strategies to promote farmer utilisation of herbaceous legumes for natural resource management. Final report. International Institute of Tropical Agriculture (IITA) and International Livestock Research Institute (ILRI), Ibadan, Nigeria.

ICRISAT, 2006. Impacts in Asia.
http://WWW.icrisat.org/Achievements/impactsAsia.htm.

ILRI, 2004. Enhancing livelihoods of poor livestock keepers through increasing use of fodder. Report for Department for International Development (DFID), UK. International Livestock Research Institute (ILRI), Nairobi, pp. 73.

Kristjanson, P., Okike, I., Tarawali, S., Sing, B.B., Manyong, V.M., 2005. Farmers' perceptions of benefits and factors affecting the adoption of improved dual-purpose cowpea in the dry savannas of Nigeria. Agricultural Economics. 32: 195-210.

Osborn, T and Faye, A. 1991. Using Farmers participatory research to improve seed and food grain production in Senegal. Winrock International Institute for agricultural development. Development studies paper series. Winrock, Arlington, USA.

Parthasarathy Rao, P., Bhowmick, T., 2001. Database development, typology construction, and spatial temporal analysis of crop-livestock systems in India. Progress Report 1. ICRISAT, Patancheru, India, pp. 56.

Ravinder Reddy, Ch. 2004. alternative seed delivery systems- Village based seed Banks. Paper presented in, "ICRISAT-Asia in-house review", 24-26 November, 2004.