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LOCAL VILLAGE SEED SYSTEMS AND PEARL MILLET SEED QUALITY IN NIGER

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SUMMARY

Donors have invested more than US$45 million in seed production projects in Niger during the past two decades. These investments have largely failed. Public seed systems consistently supplied less than 2% of the total national seed planted by farmers. Through subsidies, seed prices represent less than one-third of the average cost of seed production. In contrast, at the village level, most farmers consistently obtain pearl millet (*Pennisetum glaucum*) seed from their own harvests, from neighbours or from village markets. Seed is of acceptable quality and a range of varieties is available. Village seed systems offer a cheaper and more efficient means of delivering seed to farmers. Future investment in seed systems development should target improvements in the capacity of village seed systems to maintain and distribute seed security stocks in drought years. Efficient seed producers or groups of farmers in each community should be identified and encouraged to become entrepreneurs tasked with the multiplication and distribution of new pearl millet varieties.

INTRODUCTION

Pearl millet (*Pennisetum glaucum*) is an important food and cereal crop for millions of people throughout the semi-arid tropics of West Africa. Normally, it is produced by small-scale farmers in complex, diverse and drought-prone environments and in low-fertility soils receiving between 300 and 600 mm annual rainfall. Between 1998 and 2000, pearl millet accounted for about 81% of the total cereal production and was planted in over 71% of the total cereal-cultivated area in Niger (FAO, 2001). It also contributed to about 77% of the per capita cereal consumption between 1994 and 1996 (Nelson and Ndjeunga, 1999). Other than management and labour, seed is often the only major input allocated to pearl millet production. The availability of high quality seed in the quantity needed is a pre-requisite for enhancing seed and food security needs for the people in Niger.

During the last 20 years, international donor agencies and the government of Niger have invested over US$45 million in seed multiplication and distribution projects (Table 1). Research, extension, rural development projects and non-governmental organizations (NGOs) have all been involved in developing or disseminating varieties, producing or distributing seed. To a large extent, however,

Table 1. List of executed seed multiplication and distribution projects in Niger.

Project	Period of involvement	Contribution (US$)	Sources of funding
1) Niger Cereal Project (PCN)	1976–1981	17 583 430	USAID/Niger
2) Support to Agricultural Production (PAPA)	1982–1989	25 537 000	USAID, FED, ACDI, IBRD, Italy, Niger USAID/Niger
3) Development of Seed Activities in Niger (PDASN)	1990–1993	2 292 000	USAID/Niger
TOTAL	1976–1993	45 412 43	

PCN: Projet Céréalier National
PAPA: Projet d'Appui à la Production Agricole
PDSAN: Projet de Développement des Activities Semencières au Niger
USAID: United States Agency for International Development.
FED: Fonds Européen de Développement.
ACDI: Agence Canadienne de Développement International.
IBRD: International Bank for Reconstruction and Development.

these investments have failed. Public seed schemes have consistently supplied less than 2% of the total national seed needs (Table 2) despite substantial subsidies that represent more than two-thirds of the average production cost (Table 3). During the period of involvement with seed projects, farmers, NGOs and rural development project managers complained of poor access to, and late delivery of seed. High transaction costs were incurred in distributing seed to a large number of scattered farmers. Because of the small number of points of sale and poor assessment of the demand, less than 30% of pearl millet seed produced was actually sold (Mazzucato and Ly, 1993).

During and after the seed projects, the private sector, citing limited market potential, showed little interest in multiplying and distributing seed, especially of open-pollinated crops with high multiplication ratios such as pearl millet. Similar experiences were found in other countries, for example Zimbabwe, where seed

Table 2. Pearl millet area planted, total seed production by variety and seed production units, and proportion of the total seed produced to total seed planted in Niger, 1991–1995.

		Year				
		1991	1992	1993	1994	1995
Variety:	HKP	27.9	20.2	21.0	166.8	55.5
	CIVT	199.7	22.2	25.4	95.2	23.9
	ZATIB	0	0	0	1.4	2.2
	P3KOLLO	0	0	7.5	6.1	5.6
Total improved seed (t)		227.6	22.4	53.9	269.5	87.2
Area planted ($\times 10^3$ ha)		4386	4939	3860	4935	5229
Estimated total seed planted (t)†		14620	16463	12867	16450	17430
Ratio of improved over total seed planted		1.56	0.26	0.42	1.64	0.50

† This assumes a seeding rate of 10 kg ha^{-1} as actually practiced by farmers, and a renewal rate of 3 years as suggested by the seed division in Niger.

Table 3. Profitability of seed production units (SPU) in Niger in 1996.

Seed production units	Profit or losses (cfaf)	Average cost†	Profit margins (cfaf kg^{-1})	Seed prices (cfaf kg^{-1})	Grain prices (cfaf kg^{-1})‡
SPU of Lossa	−515 250	1633	−1383	250	157
SPU of Magaria	−905 475	1151	−1021	130	151
SPU of Kourougoussao	−385 362	305	−155	150	97
SPU of Guecheme	−2 356 675	880	−755	175	131

† These costs do not include depreciation on heavy capital items such as the buildings inherited during the PCN project.
‡ Nominal consumer grain prices at planting period in the nearest market (average June and July) Source: Seed Production Units and SIM/OPVN (1998).
SIM: Systèmes d'Information sur les Marchés.
OPVN: Office des Produits Vivriers du Niger.
US$ 1.00 ≈ 300 cfaf before the 1994 devaluation.

systems are relatively well advanced (Rohrbach, 1997). Seed companies concentrate on maize, soyabean and sunflower where they can achieve higher profit margins in order to obtain competitive returns on their research and marketing investments. In contrast, most millets, groundnut and sorghum are planted to unimproved cultivars and farmers' saved varieties (Neuendorf, 1995).

Thus, there is a combination of poor public sector performance and lack of private sector interest. This combination may create a void in the seed market that needs to be filled. Also, there are signs that the informal seed sector is responding well to the challenge. This informal system supplies the majority of seed planted in Niger (as in most developing countries).

This paper assesses the structure, conduct and performance of seed markets at the village level and highlights the relative contributions of both formal and informal sectors to local village seed systems. It concludes by examining how government and donor investments could be better targeted to improve the performance of village seed markets. The findings can be applied also to Chad, Burkina Faso and other countries in the semi-arid tropics of West and Central Africa that face similar situations.

ANALYTICAL FRAMEWORK

A country's seed sector can be defined as a set of institutions involved in the multiplication, processing and distribution of seed. Two different parts of the system can be distinguished as the formal and the informal seed sectors. The former can be defined as a framework of institutions linked together, including government seed companies, or parastatals, and private commercial companies that have domestic or multinational origins. The latter sector consists both of individual farmers retaining seed from previous harvests and farmer-to-farmer seed exchange based on barter, social or other obligations by which farmers could obtain their seed requirements (Cromwell, 1996) (Fig. 1).

At the local village level, the division between these two sectors may not be

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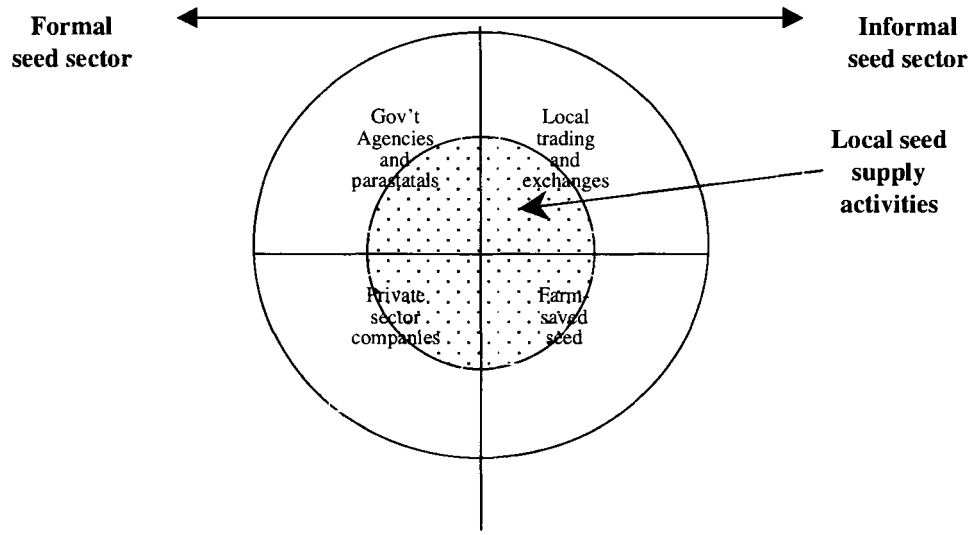

Fig. 1. Major divisions of the seed supply systems.

adequate, because local-level seed activities draw on resources from both the formal and informal sectors. Assessing the relative contributions of each in the multiplying and supplying of seed at the local village level is a necessary condition for the improvement of local village seed systems. The contribution of each sector to seed supply at the village level was assessed with regard to five major seed sector functions including: (i) variety maintenance and availability, (ii) multiplication, (iii) quality, (iv) storage and security stocks, and (v) distribution.

METHODOLOGY AND DATA

Three sets of data were gathered, one each at the institutional, farm and rural household levels, to assess the contribution of the formal and informal seed sectors in multiplying and distributing pearl millet seed at the local village level.

Data from institutions and members were obtained from an informal survey during September–October 1996. The respondents included: four pearl millet breeders; five managers of seed multiplication centres; five regional directors of agriculture; the head of the seed division, two NGOs (Care International and CARITAS); one private seed grower, the President of the large cooperative, Union Nationale des Coopèratives Agricoles (UNCA); and the Director of Agriculture.

Household-level data were gathered from a survey of 302 rural households conducted during June-July 1997. The survey focused on different aspects of the seed market including sources of seed, amount traded, type of seed transactions, and magnitude of seed stocks in 1996 and 1997. Rainfall was considerably better in 1995 than in 1996. This allowed comparison of seed purchase behaviour between years with good and poor rainfall.

A total of fifty-eight villages were selected using a stratified random sampling based on agro-ecological zone and accessibility to the main road. Agro-ecological zone was defined by a 75-d length of growing period (LGP) line corresponding approximately to 400 mm of rainfall. Villages located within five kilometres of the main road were assumed to be accessible, and any others were not accessible. Within each stratum, a minimum of 12 villages were chosen and three to ten households were sampled per village, depending on village population size. Overall, 302 households were sampled of which 20% were located in the more drought-prone areas (less than 75 d LGP) and about half were located in poorly accessible areas.

In order to assess the quality of farmers' seed stocks, seed samples were collected from farmers. Only 48 samples were collected, though, because the survey started after most farmers had planted their seed. The physical purity of the seed was assessed visually and the samples were analysed for the presence of seed-borne fungal diseases using the blotter test. In each sample, the fungal genus of all isolates was identified by examining the sporophores under a microscope (Abbasher, 1994).

In order to assess the genetic purity of seed planted by farmers, sixteen farmers and farms were sampled in the Maradi department of Niger. Information on farmers' perceptions of seed purity was gathered and field data on genetic purity collected. Farmers in Maradi were likely to have been exposed to new varieties because several development projects operate in the area.

On each farm, four 10×10-m plots were examined. The plots were selected to represent a wide range of genetic purity. In each plot, data were collected on various factors that could explain grain yields. These factors included plant density, fertilizer use, use of ridges and crop residues. Also gathered were data on the frequency of off-types (shibra and non-shibra), dummies on uniformity of height, measurements of plant height, panicle shape and length, shape and colour of the grain, 1000-grain mass and yield of panicles.

STRUCTURE AND OPERATION OF LOCAL VILLAGE SEED MARKETS

Pearl millet variety availability

Since 1975, national and international research institutes have developed and released 17 varieties adapted to a wide range of agro-ecological zones (Table 4) and there are at least eight varieties reported to be in the pre-release stage (namely ICMV 89305, ICMV 92222, ICMV 94206, MTTY 97, MTDO 97, MTDO 92, MTTY 92 and GB 8735). A large pool of varieties is available but seed production and promotion of these varieties has been limited. From 1991 to 1995, seed was produced for only four (CIVT, HKP, P3Kollo, ZATIB) of the 17 varieties (Table 2).

These findings are consistent with household survey results indicating that farmers are able to grow and maintain a wide range of cultivars at the local village level. For example, in the surveyed areas farmers grow up to 33 varieties of which

Table 4. List of varieties developed and released in Niger.

Pearl millet varieties	Agro-ecological zone (mm rainfall)	Crop-cycle (d to maturity)	Average potential yield (t ha^{-1})	Year of development
1. HKP	350–500	80–90	2.0	1975
2. HKP_3	280–350	70–75	1.5	1983
3. P_3 KOLLO	500–600	90–95	2.5	1977
4. CIVT	450–600	80–90	2.5	1977
5. HK	450–600	70–75	2.0	1975
6. MORO-P1	200–300	90–95	1.8	1985
7. GR-P1	450–600	70–75	2.5	1985
8. ANK-P1	300–350	70–75	1.0	1985
9. HKB-Tift	< 300	70–75	2.0	1982
10. H-80-10-GR	300–400	80–85	2.3	1980
11. T-18-L	> 250	85–95	2.0	1982
12. ITMV 8304	300–400	80–85	2.5	1983
13. ITMV 8002	300–400	80–85	2.5	1980
14. ITMV 8001	400–500	80–85	2.5	1980
15. SOUNA III	> 600	Intermediate	2.0	1982
16. ZATIB	300–600	Intermediate	1.5	1981
17. HKB-P1	> 300	Intermediate	2.0	1982

Source: Institut National de la Recherche Agronomique du Niger (INRAN), 1994.

only three are improved varieties (CIVT, P3 KOLLO, HKP). On average, 15 pearl millet varieties are grown and maintained per department and 17 varieties per agro-ecological zone.

Despite great efforts in variety development and release, the returns to breeding investment are limited, largely due to the low promotion of varieties. Many farmers still grow their local varieties and improved varieties occupy less than 2% of the national pearl millet area. Efforts by the formal seed systems to promote improved pearl millet varieties are warranted. The consistent use of improved varieties may make it easier for farmers to maintain this germplasm on their own. Farmers have little access to seed of other varieties. Uptake of newly released varieties is essential for realizing a return for past breeding efforts.

Pearl millet seed multiplication

Despite the large investments in seed multiplication and distribution projects, the formal seed sector has consistently produced a negligible share of the seed planted by farmers in Niger.

In contrast, most households maintain and use their own seed stocks. Survey results indicate that in 1997, 88% of households obtained their planting seed from the previous harvest, 15% obtained seed from relatives, neighbours or friends, 14% purchased seed from the local market and 3% obtained seed from development projects, NGOs, seed production units or research stations. Farmers rely heavily on their own stocks, supplementing these if needed with gifts or purchases from neighbours and relatives. Village markets are suppliers of last resort. In 1996 for example (since 1995 was a relatively good year), 94% of households drew seed

Table 5. Proportion of seed (%) planted from alternative market sources by agro-ecological zone and road accessibility in Niger, 1996-1997.

Agro-ecological zone	Less than 75 days of LGP				More than 75 days of LGP			
Road accessibility	Poor access		Good access		Poor access		Good access	
Year	1996	1997	1996	1997	1996	1997	1996	1997
Number of observations	27		30		124		115	
Seed sources:								
Own seed stocks	99.7	81.7	97.4	83.2	92.8	87.0	90.8	77.3
Friends, neighbours, relatives	0.3	2.4	1.3	1.0	2.6	5.9	2.7	10.2
Village markets	0.0	15.9	1.3	3.2	4.4	6.7	5.7	12.3
NGOs, projects, SPU, and RC	0.0	0.0	0.0	12.6	0.1	0.4	0.9	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.00	100.00	100.00

SPU = seed production unit and RC = research centre

from their own stocks and very few resorted to other sources. This behaviour was consistent across agro-ecological zones and village accessibility. The magnitude of seed demand by sources follows the same trend. Farmers drew the largest share of their planting seed from their own stocks (Table 5).

Future investments in seed production should be targeted, therefore, not only at the formal system but also to improve the informal seed system.

Pearl millet seed quality

The formal sector in Niger defines seed quality in terms of the International Seed Testing Association (ISTA) standard – high germination rate (97–98%), low moisture content (12%) and a high level of physical purity (98%). In addition, genetic purity of about 98% is required through field inspections. In the informal sector, observable grain characteristics such as inert matter content, uniformity of colour, uniformity and large grain size, shape, texture and low incidence of insect and disease attack are the main seed quality criteria used by farmers (Table 6). Although germination rate may be an important standard in the informal market, the farmers surveyed did not consider it to be an important criterion, probably because they do not encounter major problems with germination. This in turn may be due to three factors that may compensate for poor germination: fairly low moisture content, low incidence of fungal attack, and the relatively high seed rates of 10 kg ha^{-1} used by farmers.

During the last five years, seed production units have not been monitoring seed quality. NGOs, rural development projects and farmers purchasing certified seed complain of poor germination rates and are reluctant to purchase seed from state seed projects. Even in Lossa, where basic seed is produced, the germination rates average only 70%. This is far below the ISTA standards.

In contrast, local village seed systems offer seed of acceptable quality to end-users and even according to FAO standards (FAO, 1993). Laboratory tests indicate that farmers' seed stocks have levels of germination, moisture content and low incidence of seed-borne fungal diseases, acceptable to the end users. Viability

Table 6. Ranking of alternative seed quality traits pursued by farmers in local seed systems in Niger, expressed as percentage of respondents.

	Ranking			
	1st criterion	2nd criterion	3rd criterion	4th criterion
Uniformity of colour	11.8	8.1	10.1	3.0
Uniformity of shape	4.4	7.8	12.8	2.0
Uniformity of texture	6.4	4.1	1.4	0.7
Uniformity of grain size	17.6	19.3	15.9	6.4
Low moisture content	7.4	18.2	8.8	2.0
Low inert matter	44.9	24.0	9.8	1.7
Low insect/disease attack	2.0	10.5	7.4	1.0

testing of samples obtained from farmers showed germination rates averaging 88% (range 71–98%) which is well above the 70% cut-off level of the FAO quality-declared seed system. Half the 192 seed lots showed germination rates above 87.5%. There was no difference in germination rate across agro-ecological zones and village accessibility but differences were found in moisture content across agro-ecological zones. Moisture content averaged 9% (range 7–17%), with only 10% of samples above 12%. These rates were higher in more humid areas (LGP >75 d) but, even in these areas, moisture content was not so high as to affect germination rates.

The health of the farmers' seed stocks was good. Incidence of the most prevalent fungi was low in the surveyed areas, except for *Curvularia lunata* (25%), *Fusarium moniliforme* (15%), *Fusarium oxysporum* (15%), and *Fusarium semitectum* (12%). The percentage of seed infected per seed lot was estimated to average 8% (range 0–26%). Significantly more fungi were found in the more humid areas. However, fungal attack did not cause serious germination losses because most of these fungi attack seeds at plant maturity. In addition, these pathogens are seed contaminants on the seed surface only and do not attack the embryo. Therefore, the viability of seed may not be affected. With regard to analytical purity, few damaged grains and little inert matter was found. On average, 5 out of 100 grains were damaged per seed lot.

Overall, farmers draw most of their planting seed from their own stocks, and farmers' seed stocks have proven to be of acceptable quality according to farmers' preferred traits or FAO standards. In general, the formal seed system contributes little to the improvement of seed quality. Unless proven otherwise, investment in improving seed quality with regard to seed health, germination rate or level of humidity is not warranted.

Pearl millet seed purity

Lack of genetic purity could be an important yield reducer because of yield-potential differences between varieties in mixtures, or due to genetic segregation.

Table 7. Estimated model, factors explaining grain yield.

Variable	Coefficient	*s. e.*
Variety (0 = local, 1 = Improved)	0.480	0.650
Planting density	−0.006	0.019
Percentage of off-types	−13.350	1.980*
Use of fertilizers (0 = No, 1 = Yes)	1.160	0.750
Use of ridges (0 = No, 1 = Yes)	−0.120	0.500
Use of crop residues (0 = No, 1 = Yes)	2.780	0.680*
Variety × use of mineral fertilizers	−3.180	1.180*
(Constant)	7.170	1.050

* significant at less than 1%,
Adjusted $r^2 = 0.43$

The problem is potentially serious in open-pollinated crops such as pearl millet. The farmers surveyed in Maradi-Niger were all aware of the importance of genetically pure seed. Their main reasons for maintaining purity were to ensure high production and to retain the characteristics of the varieties. However, because of land constraints, their behaviour seemed to be inconsistent with their claims. Measurements recorded from 16 farmers' fields revealed that isolation distances were inadequate. One hundred metres is the minimum required to maintain seed purity and farmers' fields were closely surrounded by neighbouring fields on which were grown, on average, two different varieties.

Survey results show a high degree of genetic heterogeneity in farmers' fields. Of the 64 plots randomly sampled, only 14% of plots were judged to be uniform; these were located in the middle of the fields. On average, 22% of the plants were off-types of which 65% were shibra. The average pearl millet yield was estimated to be 446 kg ha^{-1} and farmers reported that there was no significant yield difference between local and improved varieties. Similarly, there was no difference in the percentage of off-types between improved and local varieties. However, significant and negative correlations were found between the percentage of off-types and grain yields (-0.52), indicating that lack of seed purity may depress yields. Similarly, a simple linear regression of some purity factors on pearl millet yields indicated that the higher the percentage of off-types, the lower the yields (Table 7).

These results are consistent with findings on research stations indicating that each 1% increase in shibra results in a grain loss of 1%, equivalent to about 11 kg ha^{-1} (Kumar and Andrews, 1984). While 80% of the farmers recognize having shibra in their fields, they claimed not to know how to resolve the problem (or of other off-types) because shibra can only be observed at maturity. Other farmers claimed that shibra is very early maturing and is consumed prior to harvest.

Further investigation is required to assess the economic losses due to the presence of off-types. For farmers to maintain seed purity and remove off-types would require some re-allocation of time and land. There is little evidence, however, that the returns from labour and land respectively allocated to remove

off-types and maintain isolation distances are higher than the returns of labour and land allocated to other competing uses.

Pearl millet seed storage

Seed storage is an important function performed in any seed system. Poor storage may result in poor seed quality in the form of poor germination rate, high moisture content and high incidence of fungal or insect attack. Farmers in Niger store their seed in well-ventilated granaries. Often, the seed is stored as unthreshed panicles or bunches of panicles and rarely is it stored in the form of grain. This reduces insect damage. Other traditional storage techniques such as the use of ash, tree bark, and leaves were not found. The average storage time is about seven months, which corresponds to the time span between harvest and planting. Few farmers were found to store seed for more than a year.

Overall, farmers store their seed well only in the short term and they do not complain about the quality of their seed stocks. There is no need to invest in training farmers to store seed in the short term. Thus the intervention of the formal seed system with regard to short-term seed storage is unwarranted. Little is known, however, of the farmers' ability to maintain long-term seed storage. This would be essential if they had to hedge against seed security needs. The next section reviews government's and farmers' resolution of seed security stock needs.

Pearl millet seed security stocks

According to national estimates, 20 and 39% of villages suffered cereal grain shortages in 1996 and 1997 respectively. These estimates do not consider seed shortages *per se*, but infer that villages with grain deficits also suffer seed deficits. Accordingly, government estimates state that seed shortages in 1996 and 1997 amounted to 10 000 and 20 000 t respectively, of which 60% is pearl millet seed (MAG/EL, 1998). These figures are over-estimates, given that the seed requirements for Niger's entire pearl millet area are about 17 000 t.

In contrast to official estimates, survey results indicated that very few villages were completely short of planting seed. Only one village Garbey Gommande reported a complete lack of seed because of very poor yields. In 1997, survey results indicated that 27% of households held seed stocks of less than their planting requirements. This was not perceived as a problem since these households could obtain seed from friends and family or purchase seed from the local village markets. Because little information is provided on the quality of seed in the local village markets, further investigation is required to assess the capacity of local village seed systems to handle seed security stocks.

Pearl millet seed distribution

Seed production units in Niger have encountered many difficulties with respect to the logistics and high transport costs of distributing seed to widely scattered farmers located in poorly accessible areas. Partly because of poor or late

distribution, less than 30% of the total seed produced by the formal sector was actually planted.

In contrast, the informal system is efficient at supplying seed to end-users. Survey results indicate that about 60% of the farmers surveyed participated in the informal market. Of this number, 68% were net seed suppliers and 32% were net seed recipients. Often, the seed suppliers who are the main pearl millet seed traders are also large producers of grain. On average, the total production of pearl millet grain is estimated to be 2194 kg for a seed supplier and 1420 kg for a seed recipient. Future seed programmes should target these seed suppliers and assist them in undertaking seed distribution. This would strengthen the ability of the informal system to cope with drought-related periods of seed shortage.

Formal market transactions are not flexible. Irrespective of agro-ecological zone and accessibility, most were carried out in cash. In contrast, village market seed transactions are flexible and dominated by cash, followed by barter, exchange and free transactions, regardless of agro-ecological zone and accessibility. In 1997, 50% of pearl millet seed traded within the rural community were cash transactions, 30% were free gifts, and the remainder were barter transactions. A similar trend was observed in 1996. Similar patterns were reported in Malawi and southern Zimbabwe. Cash transactions are likely to be observed in large communities, where farmers may not know the level of each other's holdings of seed stocks. This problem is lessened in smaller communities that are made up of farmers with families who interact frequently and share risks. Survey results indicated that 97% of gift transactions are located in more favourable environments where more farmers hold large seed stocks. Barter transactions are less common. The level of reciprocal obligations to sustain such transactions needs further consideration.

The average quantity of seed traded varied according to the type of transaction and the agro-ecological zone. Cash transactions are larger on average: 28 kg compared with 7 kg for free gifts and 8 kg for bartered. In the poorer environment, survey results indicated that, in 1996 and 1997, there were no barter or gift transactions. Farmers travelled an average of 11 km to purchase seed. The cost of seed acquisition in these environments may be high due to high transport costs.

Large-scale and efficient farmers or farmer groups should be encouraged and tasked with the multiplication and distribution of seed. The government's role should be limited to the supply of breeder or basic seed to such farmers or farmer groups.

Pearl millet seed pricing

Seed pricing in relation to production costs determines the sustainability of seed multiplication and distribution activities. Comparisons between seed and grain prices are important especially for varieties or composites where one cannot expect seed price to be far above grain price because grain is a perfect substitute for seed.

During and after the period of involvement with projects, seed production units operated with heavy losses. Between 1985 and 1988, the average production cost of certified improved millet seed was estimated to be 1720cfaf kg^{-1}, whereas it was sold to farmers at 130cfaf kg^{-1} (Rachmeler, 1991). Even after project funds ran out, seed prices were still heavily subsidized. In 1996, it was estimated that for every dollar invested in producing seed, seed production units subsidized between 50% and 90% of the production costs (Table 3).

For varieties or composites, one cannot expect seed price to be far higher than grain price in that grain is a perfect substitute for seed. Therefore, the seed production units are forced to sell seed far below the average production costs. Because seed production is costly, seed production units would need to sell seed at prices 4-11 times the average grain prices to be financially sustainable. Clearly, seed production units cannot be sustainable with the current pricing structure, and the market will not bear the high prices needed for sustainability. The informal seed system appears to be more sustainable with its more attractive pricing scheme – seed price equal to grain price.

APPROPRIATE ROLES OF THE FORMAL AND INFORMAL SECTORS

The local village seed systems work relatively well. A range of varieties is available and, collectively, farmers are able to maintain a wide range of varieties. A large proportion of the seed planted comes from their own seed stocks. Farmer-to-farmer and trader-to-farmer exchanges are the main distribution channels. Farmers' seed stocks are of acceptable quality. Overall, almost all functions are well performed by farmers at the local village level (Table 8).

Both systems should continue to be involved in strengthening the local seed capacity and serve the very complex needs of the small-scale farmers. Farmers use a large number of varieties of each crop and many look for intra-varietal variation rather than uniformity and stability. Current formal seed systems have offered a large pool of improved varieties but few of these reach the farmers. In order to increase the returns to breeding investment, improved varieties would have to be promoted. Consequently, donor funding should target the multiplication of breeder or basic seed of the many varieties developed by the formal seed systems and offer this for further multiplication by qualified small-scale seed producers.

The informal system should be assisted in the development of strategies to cope with seed shortage especially during drought years. Therefore, a large share of donor investment should target improvements in the capacity of village seed systems to maintain and distribute seed security stocks in drought years. Efficient seed producers or farmers groups and associations in each community should be identified and encouraged to become entrepreneurs tasked with the multiplication and distribution of new pearl millet varieties.

This situation could change, however, if new varieties or hybrids that yield significantly more than local or current varieties are made available in the market. Then, the role of the formal seed systems could be limited to providing breeder

Table 8. Current performance assessment of seed activities performed by both the formal and informal pearl millet seed sectors in Niger.

	Seed sector	
Activity	Formal	Informal
Variety development/selection	Moderate	Moderate
Varietal maintenance	Moderate	Moderate
Variety transfer/dissemination	Weak	Strong
Quantity of seed supplied	Weak	Strong
Seed quality (germination rate)	Weak	Moderate
Seed storage	Moderate	Moderate
Seed promotion/distribution	Moderate	Strong
Seed security stocks	Weak	Moderate
Cost of seed production	Weak	Strong

seed to efficient farmers, groups of farmers or cooperatives, or to the private sector to produce other levels of seed classes (foundation, registered and certified seed) and facilitate the interaction between farmers, research institutes, rural development projects and NGOs.

Past investments in seed systems have been grossly misdirected. Rather than additional support for the formal seed system, future investment should target the development of local seed systems. This new strategy will require additional investments in farmer or farmer-group training in seed production. Such training could be conducted through NGOs or well established local organizations. The role of the formal seed system could be limited to providing breeder and foundation seed to efficient farmers or group of farmers who would then produce foundation, registered and certified seed. The formal sector could also facilitate interaction between farmers, research institutes, rural development projects and NGOs.

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