

INFORMATION EXCHANGE IN COMMERCIAL SEED MARKETS IN RAJASTHAN

Robert Tripp and Suresh Pal

Although it is widely agreed that the private sector should take major responsibility for input delivery, concerns are often expressed about the degree to which commercial firms address the needs of resource-poor farmers. This paper examines the performance of the pearl millet seed market in a part of Rajasthan that is gradually increasing its utilisation of commercial inputs. The analysis focuses on the exchange of information between farmers and seed providers. About two-thirds of the farmers plant commercial pearl millet seed (public or private hybrids). They easily distinguish between hybrids and local varieties, but relatively few farmers are able to recognise the names or characteristics of the different commercial hybrids. Farmers are also confused about the names of public and private seed companies. When choosing which seed to purchase, farmers tend to rely on the advice of other farmers or merchants. Information flow from farmers to seed companies and plant breeders is also deficient. Despite these problems, commercial seed market expansion has had a positive effect on farm productivity. Suggestions are made for improving farmers' awareness of the characteristics of the seed market and for providing more opportunities for farmer feedback regarding varietal performance.

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Acronyms

AICCIP	All India Coordinated Crop Improvement Programmes
ARS	Agricultural Research Station
ATC	Adaptive Trial Centres
DOA	Department of Agriculture
ICAR	Indian Council for Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
KVKs	Krishi Vigyan Kendra (farmer training centre)
MVs	modern varieties
NSC	National Seed Corporation
OPVs	open pollinated varieties
RSSC	Rajasthan State Seed Corporation

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1 INTRODUCTION

Recent policy changes in many developing countries have sought to encourage commercial seed enterprises. At the same time, public seed companies are being privatised or at least being forced to compete in an open market. The expectation is a more efficient response to farmers' demands for seed. Private seed companies however currently do most of their business with commercially-orientated farmers. This is not surprising, as cash crops are more likely to generate the income required to purchase inputs and larger farmers usually have better access to input markets. If national seed policies envision an expanding role for commercial seed markets, how will resource-poor farmers be served? Will commercial seed enterprises invest in targeting the needs of farmers with less market power? Will farmers who have little experience with input markets be able to make effective choices from among a range of products?

The answers to these questions depend on how information is exchanged in formal seed markets. Efficient markets depend on buyers and sellers having adequate access to information. There is universal agreement however that agricultural research and extension have been inefficient providers of information. Extension messages often do not reach their intended targets and agricultural research does not always pay sufficient attention to the needs of its clients. There is hope that a more competitive, commercially orientated market for agricultural technology will resolve some of these inefficiencies, but concerns remain. Adequate information channels must be established and particular attention must be placed on information exchange with the resource-poor farmers who are most likely to be left behind.

This paper examines these issues through a case study of pearl millet seed markets in Rajasthan. The first section provides a description of the case study area and the following section outlines the study methodology. We then summarise pearl millet seed use and examine farmers use of hybrid seed. This is followed by an examination of farmers' knowledge of the seed market and of other aspects of seed management. The next two sections describe how information is delivered to farmers, and how information passes from farmers to seed providers. The final sections present suggestions to address information deficiencies, propose some specific interventions and draw conclusions.

This study focuses on the use of pearl millet seed in an area of eastern Rajasthan known as Shekhawati. The study was conducted in part of Sikar District and adjoining parts of Jhunjhunu and Churu Districts. In this area, as indeed in most of western Rajasthan, pearl millet (*Pennisetum glaucum* [L.] R.Br.) is an important cereal crop. Approximately half of India's total pearl millet area is in Rajasthan (Directorate of Agriculture, 1995). Most of Shekhawati is included in Rajasthan's agroclimatic zone IIa (Transitional Plain of Inland Drainage), where annual rainfall is 300-500 mm and the soils

are sandy loam to loam. Part of the study area in Churu District falls within Zone Ia (Arid Western Plain), where rainfall is lower and soils are loamy to coarse sand (Rajasthan Agricultural University, 1995).

The rainy season (*khariif*) extends from June until September. Besides pearl millet, principal *khariif* crops include mung (*Phaseolus mungo*), moth (*Phaseolus acontifolius*), guar (*Cyamopsis tetragonoloba*), cowpea (*Vigna sinensis*) and sesame (*Sesamum indicum*). These crops are often intercropped with pearl millet. Pulses, particularly guar, are also planted as sole crops in rotation with pearl millet. In some parts of Shekhawati there is growing access to supplemental irrigation, as farmers have been able to take advantage of a Government of India/World Bank project that subsidises the provision of sprinkler irrigation equipment. This development has provided greater security for *khariif* crops and has contributed to a rapid expansion in winter irrigated *rabi* planting of crops such as wheat and mustard.

Before Independence, Shekhawati was a confederation of feudal states owing (and often contesting) allegiance to the prince of Jaipur. Land was controlled by hereditary landlords (*zamindars*) and a share of grain production was collected from cultivators as revenue. The land reforms that took place after Independence abolished the *zamindari* system and gave tenancy rights to cultivators. This has been accompanied by increasing political power of the *jat* cultivator caste. The protected status of Rajasthan as a princely state before Independence limited the incursion of large-scale capitalist agriculture that occurred in some other parts of British India. This relative isolation, combined with the almost complete reversal in status of cultivators and landlords after Independence, has meant that the resulting agrarian structure is dominated by a "middle peasantry relying on family labour" (Sharma, 1998:197). Agriculture in Shekhawati is limited by low and variable rainfall, but the advent of sprinkler irrigation has stimulated agricultural investment. The area has an extensive system of primary and feeder roads and there are a number of market towns where a wide range of agricultural inputs can be purchased.

The farmers of Shekhawati have access to various pearl millet varieties. Besides the local landraces that many farmers continue to grow, the commercial seed market offers an increasingly diverse selection. Public sector plant breeding in India is carried out by research institutes affiliated with the Indian Council for Agricultural Research (ICAR) and by the state agricultural universities. This plant breeding system has been immensely productive for pearl millet and for many other crops. The system has been further enhanced by the presence of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), whose pearl millet breeding programme regularly exchanges materials and collaborates with India's public and private sector plant breeders.

A recent compilation (Rajasthan State Seed Certification Agency, 1997) lists 97 (mostly public sector) modern varieties (MVs) of pearl millet that have been notified for Rajasthan since 1969.¹ Some of these are open-pollinated varieties (OPVs), but increasingly they are pearl millet hybrids.² High investment in public sector plant breeding has been accompanied by the development of a public seed system. The Rajasthan State Seed Corporation (RSSC) and the National Seed Corporation (NSC) are both important providers of pearl millet seed in Rajasthan.

A particular incentive for private activity in pearl millet seed is the availability of hybrid technology. Hybrid seed is produced by crossing two inbred parents. The resulting hybrid vigour contributes to higher yields, but the second generation seed loses much of this advantage. Hence a farmer is likely to buy hybrid seed each year, rather than saving seed from the previous harvest. There are currently more than 30 private companies in India involved in the breeding and marketing of their own pearl millet hybrids. A few of these are multinationals, but the majority are Indian-owned enterprises. There are also many other private seed companies (some of them quite small) that produce and sell seed of public hybrids and OPVs.

During the 1980's, liberalisation of India's seed laws provided a major impetus to the development of the private sector. Although most seed of public varieties sold is certified seed (under the control of the state seed certification agencies), India's seed regulations now permit the sale of 'truthfully labelled' seed. The label is required to state the varietal identity and certain minimum parameters for seed quality (such as germination and moisture content). The majority of the private hybrids are sold as truthfully labelled seed.

Although seed markets are more developed in a number of other states, sales of commercial pearl millet seed have increased rapidly in Rajasthan. Precise figures are not available, but various industry sources estimate that approximately 4,000 mt of pearl millet seed were sold in Rajasthan in 1997. The majority of this seed is sold by private seed companies, with less than one-quarter being supplied by the public sector (RSSC and NSC). Seeding rates for pearl millet are among the lowest for any grain crop (3-4 kg per ha). With this seeding rate, the seed sold is enough to plant at least 1 million ha, or 20-25 per cent of Rajasthan's pearl millet area.

The use of formal sector pearl millet seed varies greatly in Rajasthan, with some areas growing almost exclusively local varieties and other areas heavily dependent on seed of MVs. Shekhawati was chosen for this study because it occupies an intermediate position in seed practices. There is increasing use of purchased pearl millet seed, but local varieties are also widely grown. The study seeks to understand how information flows between farmers and seed providers during this transition to the use of formal seed markets in a risk-prone area dominated by smallholder farmers. Pearl millet in Shekhawati offers an unusual opportunity to observe the dynamics of an emerging seed market. But it must be emphasised that this is not a typical case of resource-poor farmers interacting with a commercial seed market. Attempts to study farmers' interaction with

the seed market are often hampered by a shortage of attractive varieties, underdeveloped seed enterprises, regulatory restrictions, infrastructural problems, high seed costs or significant rural inequalities. The relative absence of such limitations in the present case makes it possible to concentrate our attention on information flow in the seed market. In summary, the elements that contribute to making pearl millet seed in the Shekhawati region of Rajasthan a 'best case scenario' for studying an emerging seed market include:

- An impressive record of successful plant breeding in both the public and private sectors that has produced a wide range of attractive varieties;
- Competent, experienced public seed corporations that are capable of producing and delivering large quantities of seed;
- An exceptionally dynamic private seed sector, with companies producing and selling their own varieties as well as those of the public sector;
- A seed regulatory system that allows seed to be marketed as either certified seed or truthfully labelled seed;
- Adequate rural infrastructure, with most farmers having access to roads and input markets;
- A relatively equitable agrarian structure, with large numbers of smallholders who are increasing their use of purchased inputs;
- A very large national market for seed;
- A crop whose seed requirements are very low, so that even the cost of the most expensive commercial hybrid is affordable for most farmers.

Such a scenario is perhaps unique to India. However, there may be lessons to learn for other developing countries which are promoting the development of the private sector.

2 THE RESEARCH

This study was conducted in two parts. Initial visits were made to public and private seed companies and their distributors in Jaipur, the capital of Rajasthan, during June-July 1997. (Earlier visits had been made to ICRISAT and to some private seed company headquarters in Hyderabad.) Visits were also made to various offices in the Rajasthan Department of Agriculture (DOA). In Shekhawati, visits were made to seed wholesalers and retailers, DOA extension offices, and the Agricultural Research Station at Fatehpur. In addition, informal discussions were held with farmers in about 20 villages visited during 10 days of travel in the region.

The second part of the study was a formal questionnaire administered to 127 farmers in 13 villages during December 1997. The villages were randomly selected from five *tehsils* (administrative areas). These *tehsils* had been purposively selected because they showed either high or moderate use of pearl millet MVs, so the rate of MV use discussed here should not be taken as necessarily representative of all of Shekhawati. Within each village, 10 farmers were randomly selected from lists of landholders that had been collected earlier.³ Most of the interviewed farmers were male, with only three women in the sample.

3 PEARL MILLET SEED USE IN SHEKHAWATI

The average farm size in the survey area is 5.8 ha and the average millet planting is 1.6 ha⁴. Mean reported millet yields from the fields surveyed in 1997 were 0.92 mt per ha. Fields with access to irrigation had much higher yields (1.32 mt) than dryland fields (0.76 mt)⁵, although this may partially reflect soil quality differences rather than irrigation *per se*, which is seldom applied to pearl millet. Precise data on seeding rates were not collected, but the general impression is that many farmers plant at well below the recommended rate of 3-4 kg seed per ha. Nearly half (48 per cent) of the pearl millet farmers planted only hybrids in 1997, while 18 per cent planted both hybrids and local varieties and the remaining 34 per cent planted only local varieties. In most cases a field was planted with only one variety, but in eight per cent of the cases farmers mixed two varieties, either a local and a hybrid or two hybrids. Most farmers had only one field of pearl millet, but some planted two or three fields.

A survey of 26 seed dealers in Shekhawati found four public sector hybrids for sale in 1997 (Box 1). These are produced by RSSC, NSC, and several private companies. Although several public OPVs are also produced, none was found for sale with the surveyed dealers. There are approximately 20 private seed companies selling proprietary hybrids in Rajasthan, although only about half of these appeared to be active in Shekhawati in 1997. The farmers in the survey were growing the four public hybrids as well as private hybrids from six companies (Table 1). In addition, a significant proportion of farmers were growing hybrids whose identity was unknown.

Most farmers buy hybrid seed from merchants. The district capital Sikar has more than 30 seed dealers, while smaller towns may have only one or a few dealers. There is a fairly complex distribution network and it is often difficult to draw a distinct line between wholesale and retail

operations. Small village merchants and sometimes individual farmers, may buy seed in bulk from a dealer for later resale in the village. A merchant may sell seed from both public and private companies. Some of the dealers sell a wide range of crop and vegetable seeds, and some also sell chemical inputs. At the opposite end of the scale, there are shops that sell pearl millet seed as a minor addition to their principal business, such as stationery, electrical goods or tailoring. In addition, the public seed companies have depots in many district capitals where farmers can buy seed. Public sector seed is also sold by cooperative societies that can be found in larger towns.

The majority of farmers in the survey (87 per cent) obtained their hybrid seed from commercial sources; another six per cent obtained their seed from cooperatives, and the remaining seven per cent used hybrid seed saved from a previous harvest or obtained from a neighbour. Not all farmers use MV seed. As Table 1 indicates, 39 per cent of the surveyed fields were planted with local pearl millet varieties. This seed is either farm-saved (91 per cent) or obtained from other farmers (9 per cent).

Pearl millet seed is generally sold in 3 kg and 1.5 kg bags. The private companies have offered seed in the smaller bags for some time, while RSSC is just about to introduce the 1.5 kg size. Prices of pearl millet seed range from Rs6-7⁶ per kilogram for farm-saved seed sold to neighbours to Rs40-80 per kilogram for private hybrids. While hybrid seed prices may be as much as 20 times the grain price, quantities of seed required are so small that farmers rarely complain about the cost. Although seed of the same public hybrid costs less from RSSC or NSC than it does from private companies, this does not seem to be an important influence on farmers' choice of seed.⁷ One private company uses the fact that its (proprietary) hybrids are the most expensive (and, by implication, the best) as a selling point. No instances of pearl millet seed purchase on credit were found in the survey, although farmers regularly seek credit for more expensive inputs.

Hybrid	Characteristics
MH-179	85 - 90 days maturity. Conical heads and small bristles (which deter bird damage but make harvesting more difficult). Known by its nickname <i>moucharia</i> ("whiskered"). Notified in 1986.
MH-169	85 - 90 days maturity. Cylindrical heads and no bristles. Slightly taller than MH 179. Notified in 1987.
BK - 560	80 - 85 days maturity. An old variety that showed susceptibility to downy mildew and was denotified; farmer pressure caused it to be renotified. Originally notified in 1980.
HHB - 67	65 - 75 days maturity. A short-statured hybrid whose rapid maturity makes it particularly appropriate for drought-prone areas. Known to many farmers as "60 days". Notified in 1990.

Variety	Number of fields	
Public Hybrids	(35)	
MH-179	11	
MH-169	1	
BK-560	16	
HHB-67	7	
Private Hybrids (by company)	(41)	
B	1	
C	31	
D	3	
E	3	
G	1	
I	2	
Unidentified Hybrids (subtotal all hybrids)	(24)	(61%)
Local Varieties	64	39%
<i>Jakhrana</i>	36	
<i>Other named varieties</i>	7	
<i>Unnamed local varieties</i>	21	
TOTAL	164	100%

Hybrid use

Before proceeding to analyse information flow in the seed market, we need to examine farmers' rationale for using hybrids. Although 66 per cent of the survey farmers were using pearl millet hybrids on at least part of their fields, the patterns of adoption are complex. Hybrid use in Shekhawati confounds any simplified notions that divide farmers into categories such as 'progressive' and 'traditional', or 'adopters' and 'laggards'. The use of pearl millet hybrids responds to a set of biological and socio-economic conditions that vary across farms and villages. Farmers continue to test and compare local varieties and hybrids, but certain patterns emerge regarding variety choice.

Box 2 summarises the most important factors that influence farmers' choice of variety. Pearl millet is used for both grain and fodder and the yield and quality of both components are important. Adaptability to uncertain rainfall patterns is also critical; particular hybrids and local varieties each offer advantages depending on the timing and duration of a drought. One of the most important factors in variety choice is the presence of striga (*S. lutea*), a parasitic weed that is prevalent in low rainfall areas and on lighter soils (Rao, 1986). The hybrids have been found to tolerate striga much better than the local varieties.⁸ The reasons for this are not perfectly understood, but breeders speculate that the rapid early growth of the hybrids allows them to escape the worst effects of striga.

The choice between local varieties and hybrids and among particular hybrids, is thus not always an easy one. Farmers must balance a number of factors, and they must take account of their own particular farm conditions and economic needs (e.g. grain versus fodder). Table 2 presents a summary of farmers' opinions when asked to make distinctions between local varieties and hybrids. Such a comparison is useful but severely limited. There is considerable variation within the category "hybrid", for instance, just as there is within local varieties. Farmers' favourable or unfavourable assessments of varieties necessarily depends on the particular hybrids or local varieties they have been planting.⁹

Table 2 Farmers' opinions on Pearl Millet varieties

Factor	Farmers' Response	
	"Hybrid"	"Local"
Performs better in good rains	72%	28%
Performs better in poor rains	58%	42%
Has better fodder quality	26%	74%
Has better food quality	11%	89%
Resists striga	97%	3%

Farmers in the survey area have a long history of experience with pearl millet MVs—by 1997, 84 per cent had planted a pearl millet MV at least once. The majority of farmers did not begin experimenting with the hybrids until the mid- to late 1980s. Furthermore, not all farmers who have tried hybrids continue to use them. The survey revealed a wide range of experience. Some farmers who had been unhappy with a hybrid in the past returned to try a different one and were pleased; others had grown several hybrids with unsatisfactory results and relied on local varieties.¹⁰

Table 3 summarises the socio-economic characteristics of farmers and relates these to hybrid use. There is relatively little of the differentiation by resources, age or education that sometimes is associated with the adoption of agricultural technology. Hybrid users tend to have slightly larger landholdings and to be more likely to sell pearl millet grain. Individual field characteristics further upset conventional notions of adoption behaviour. Although hybrids are more likely to receive fertiliser than local varieties, the local varieties are somewhat more likely to be planted in irrigated fields and to be monocropped. By far the most striking field characteristic influencing variety choice is the prevalence of striga in the survey village.^{11,12}

Farmers have a good understanding of their own conditions and necessities and are able to assess the performance of the varieties they plant. But how adequate is their knowledge of the varieties that are actually available in the market? We now turn to an analysis of information flow.

Box 2 Factors influencing farmers' choice of Pearl Millet variety	
Factor	Importance
Grain yield	When there is adequate moisture the hybrids tend to out-yield the local varieties.
Grain quality	Pearl millet is used to make several staple food preparations, including unleavened bread (<i>roti</i>). The local varieties are usually preferred. Aesthetics also play a role and farmers are attracted to some of the bold-seeded hybrids.
Fodder yield	Pearl millet stover is fed to animals and fodder yield is often as important as grain yield. Taller local varieties are seen to yield more fodder, although hybrids planted at higher density can give satisfactory fodder yields.
Fodder quality	The fodder must be palatable for animals. The local varieties are generally superior in this regard.
Moisture availability	With good rainfall or access to irrigation the hybrids produce higher grain yields than the local varieties. Performance in drought is complex. An early-maturing hybrid may outperform a local variety if planted late, after an early drought. However, some local varieties are better able to withstand a drought that occurs after planting.
Striga	The parasitic weed (<i>S. lutea</i>) is a serious problem in the sandier soils of the area, particularly where supplemental irrigation is not available. Hybrids are better able to escape the effects of striga.

Table 3 Socio-economic characteristics and hybrid use

Characteristic	Farmers planting at least some hybrid	Farmers planting only local varieties	Significance*
Age	49.7	48.7	NS
Years school	4.8	3.8	NS
Total landholding (ha)	6.1	4.3	<.05
Kharif grazing area (ha)	1.0	8.7	NS
Number cattle	1.1	0.9	NS
Number buffalo	1.3	1.2	NS
Number camels	0.4	0.1	<.01
Litres milk sold	4.2	1.1	<.1
Percent of pearl millet sold	20.1	7.3	<.1

*t-test

4 FARMERS' KNOWLEDGE OF VARIETIES

Farmers divide the seed of pearl millet (and most other crops) into two categories, *desi* and *sankar*. *Desi* signifies a local variety, although some farmers say that once purchased seed has been grown on their farm for several seasons it "becomes *desi*." To Hindi-speaking plant breeders, the term *sankar* has a precise meaning, signifying a hybrid. Farmers, on the other hand, use the term *sankar* for any purchased seed, whether it is an OPV or a hybrid. All farmers are able to state whether the pearl millet they are growing is *desi* or *sankar*, but many do not know the exact names of their pearl millet varieties. One-third of the farmers who are planting local varieties simply call them "*desi*" and are unable to recall a specific name. By far the most prevalent *desi* pearl millet is "Jakhrana", a variety that apparently originated in villages to the north-east of the study area and where some farmers still travel occasionally to acquire fresh seed (T. Hash, pers. communication). Five other named *desi* varieties were also grown by one or two farmers each.¹³

There is considerable confusion regarding *sankar* varieties, with only 18 per cent of farmers knowing the name of the variety they were growing. Only one-quarter of the hybrid users are able to state both the variety name and company of the hybrid they are using, and one-quarter have no information whatever. The public hybrids generally have letter-number denominations (see Box 1). Proprietary hybrids can be identified by the name of the company and a number (or letter-number) denomination. Examples of the latter (from among the hybrids available to Shekhawati farmers) include "Proagro 9402", "Nath 301", "Plantgene PG5822", and "Mahyco MBH163". In theory, the number code should be sufficient to identify a variety in a shop, but the codes are idiosyncratic and difficult to remember.

Farmers may remember the name of a company, or all or part of a variety code, but rarely both. Remembering only the company name is of limited value because many companies offer several hybrids with distinctly different characteristics (plant height, maturity, etc.). Farmers' confusion regarding company and variety names limits a company's ability to market a range of its products. A bad experience with one hybrid from a particular company will often send the farmer looking for something

completely different, rather than trying another of the same company's products.

The confusion in nomenclature extends to public varieties and companies. A farmer may know the name of the public hybrid he/she is using, but will often not be able to state whether it was produced by a public or private seed company. Four public hybrids are readily available in Shekhawati. Farmers in the survey could recall planting three of these,

although they often did not know the exact names. The most common public hybrid is BK-560, sold by NSC and a number of private companies. More farmers can accurately recall this name than that of any other hybrid. This is almost certainly linked to the fact that it is the oldest public hybrid now available and one of the first to be marketed in the area.

The more recently released MH-179 is fairly widely grown, but the majority of farmers do not know its name. Instead, they identify it by its characteristic of bristled heads. The bristles help keep birds from the ripening grain, but make harvest more difficult because the bristles penetrate the sacks of cut heads that the harvesters carry on their backs. Farmers most commonly know MH-179 as "whiskered" or "hairy". It is currently the only public hybrid available in the area with bristles, although several proprietary hybrids also have this characteristic. MH-169, a non-bristled public hybrid released shortly after MH-179, is widely available in shops, but only one farmer could give its name. Whether some of the "unknown" *sankar* recorded in the survey may be MH-169 is uncertain, but it has neither a name nor characteristics that are easily identified by farmers.

HHB-67 is a very early maturing public hybrid which was developed for drought situations and is particularly appropriate for planting when the onset of the rains is late. Only six out of 127 farmers knew its name (Table 4). It was more commonly identified as "60 days" (although its actual maturity is a little longer than this); "cooperative society" (presumably because the variety was promoted by the cooperatives); or "Haryana" (in reference to the agricultural university where it was developed). Knowledge of HHB-67 is only slightly higher among farmers without access to irrigation who would be most likely to benefit from such a variety.

The concept of "company" is confusing for many farmers. When asked for variety names they often simply give the name of a company. When asked to name seed companies, many farmers give state or place names where they believe seed is produced or companies are located (e.g., "Andhra Pradesh", "Tamil Nadu", "Hyderabad"). A farmer can use "Andhra Pradesh" to signify one company, while his neighbour uses the same term for a completely different company. Various attempts to probe farmers' knowledge of seed companies are summarised in Table 5. Two public and nine private seed companies (coded by letter) are listed.

Table 4 Recognition of the hybrid HHB-67

Response	Number of farmers	
HHB-67	6	(5%)
"Haryana"	9	(7%)
"60 days"	17	(13%)
"Cooperative"	5	(4%)
Incorrect names or no response	90	(71%)
TOTAL	127	

(Farmers were asked to name the early-maturing hybrid)

Column 4 reports the results of a question asking farmers to name all companies they know that produce pearl millet seed. Column 5 summarises the results of an exercise where farmers were shown pictures of pearl millet seed bags. Those who claimed to recognise the bag were then asked to name the company. Knowledge of company names is quite low. The most widely recognised companies were "C", whose hybrid many farmers were planting in 1997, and "B" a company which has been one of the most important in the area in recent years. Next in level of recognition was RSSC, the state seed corporation. Very few farmers who correctly identified the companies could give the names of specific hybrids.

It is instructive to compare farmers' experience with other seed. Farmers buy seed of various crops, usually from shops but sometimes from other farmers. The extent to which they know the names of the varieties they are buying varies by crop. The highest degree of recognition is for wheat, where farmers have a relatively small number of public varieties to choose among.

In summary, farmers' knowledge of the names of the hybrids they are planting is far from perfect, and their knowledge of alternative hybrids available in the market and alternative varieties available in other farmers' fields, is even less adequate. All farmers can distinguish between general features of *desi* and *sankar* varieties and they use this information in deciding whether or not to plant hybrids. But neither *desi* nor *sankar* are homogeneous categories and much of the information that farmers use to select within these categories is based on their own, necessarily limited, past experience.

5 OTHER KNOWLEDGE: CERTIFICATION, SEED QUALITY AND HYBRID MANAGEMENT

Given farmers' incomplete knowledge of variety and company names, it is not surprising that they are even less familiar with the concept of seed certification. All seed produced by the public companies is certified. Most of the seed of public varieties produced by private companies is also certified (if only because this currently allows the company a tax advantage). Seed of most private varieties is not certified (because these varieties have not been notified), but is sold as truthfully labelled. All seed bags carry a label corresponding to the truthful labelling requirements, and certified seed carries a blue certification

Table 5 Farmers' knowledge of seed companies (N=127)

Co.	Planted in 1997	Recalled from previous 5 years	Able to name company	Able to name company after seeing bag
RSSC	8	-	10	20
NSC	1	-	3	13
A	5*	1	5	13
B	1	9	11	31
C	31	1	28	39
D	3	3	9	14
E	3	2	3	6
F	0	0	1	5
G	1	0	0	3
H	0	0	0	14

*includes public varieties

label. Farmers were shown photographs of the two types of labels and were asked if they could distinguish between them. Only 13 farmers (10 per cent) said there was a difference, and only three farmers mentioned the term certification; none of these could give a satisfactory explanation of the concept. A sample of 12 seed dealers were also questioned about the certification tag and they also failed to give an accurate explanation of its significance. All of the dealers recognised it as a certification tag, but only a few said it represented some type of government test and only one mentioned field inspection.

Farmers were also asked about experience with low quality seed—in terms of variety performance or physical quality. A number of farmers had complaints, but their responses are difficult to interpret. Many did not remember the name of the variety or company in question. The issue is further complicated by the difficulty in distinguishing seed quality problems from crop management or varietal deficiencies. The public and private seed companies that supply pearl millet seed are, for the most part, well-established and reputable firms. But seed quality is affected by storage and transport conditions and undoubtedly some problems occur. There are also examples of fraud. A widely discussed case occurred in Rajasthan a few years ago, when the distributor for a major company allegedly filled some of the company's bags with market grain and sold them. The DOA has input inspectors who monitor the seed for sale in shops, but their resources are adequate for only the most cursory inspection. Farmers seem to adopt a fairly cynical attitude and accept that a certain proportion of the inputs they buy will be adulterated or misrepresented. One farmer was found intercropping seed of two of the most expensive commercial hybrids; when asked to explain the strategy he said that it was one of risk avoidance—"I don't trust anything I buy in a package".

Another important issue is that of hybrid management. Because hybrid vigour is lost or diminished in the second generation, farmers are expected to buy fresh hybrid seed each year. When hybrid seed is introduced it often takes some time for farmers to learn that seed cannot be saved like that of local varieties. Studies on hybrid pearl millet from drier areas of Rajasthan report a considerable amount of recycling of hybrid seed (Kelly *et al*, 1996). In

Table 6 Sources of information on hybrids

Source	All 1997 hybrids	1997 public hybrids	Past hybrid use
Another farmer	48 (48%)	21 (62%)	25 (22%)
Shopkeeper	36 (36%)	7 (21%)	72 (64%)
Extension	12 (12%)	5 (15%)	12 (12%)
Other/not known	4 (4%)	1 (3%)	3 (3%)
TOTAL	100	34	113

Figures may add to more than 100% due to rounding

Shekhawati, however, only seven per cent of the 1997 hybrid use was recycled seed. Although 16 per cent of the farmers claimed to have had some experience with recycling hybrids, the majority of these reported their experience to be satisfactory. Hybrid recycling is liable to be more prevalent for pearl millet in marginal areas where yields are lower and seed costs are thus relatively higher. Most farmers in the study area are accustomed to buying fresh hybrid pearl millet seed, although there is little evidence that they would be able to distinguish between an OPV and a hybrid (see Kshirsagar *et al.*, 1987).

6 SOURCES OF INFORMATION

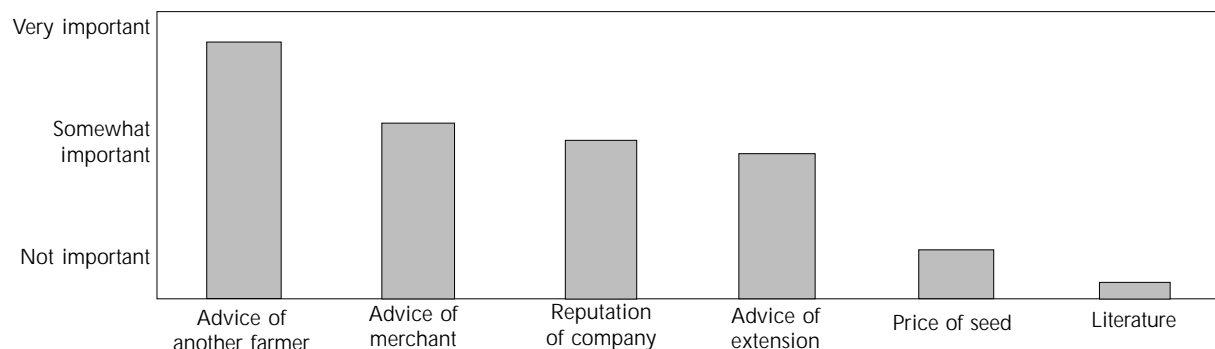
Some farmers experiment with new varieties before using them on their entire field. It is not uncommon to find farmers mixing *desi* and *sankar* varieties in the same field. The two can easily be distinguished and farmers can thus make comparisons under similar conditions. In addition, the mixture is a form of risk avoidance; if one variety fails to perform, the other one may compensate. Some farmers will acquire a small amount of seed (or use only part of the packet they have purchased the first year) and test the new variety on a part of their field. During the course of the study, several farmers were observed planting small amounts of two or three hybrids in their fields and making careful observations.

However, farmers often plant their entire field to a new variety, even though they have never grown it before. Where do they get the information that gives them the confidence to make such a change? Farmers' sources of information are reported in Table 6, which shows that the most common source of information is other farmers. Figure 1 confirms the importance of farmer advice. One farmer may ask

another for his opinion, but more commonly a farmer will see an attractive variety in a field and ask the owner for its name. Although in some cultures jealousy or suspicion makes the exchange of this type of information difficult, farmers in Shekhawati appear to openly discuss their experience regarding different varieties. Farmers may sell seed of local varieties (and occasionally advanced generation seed of hybrids) to their neighbours. While the topic of pearl millet varieties is certainly not the most common item of discussion among farmers, there is a certain amount of information exchange that helps farmers make decisions about what type of seed to acquire. Farmer-to-farmer communication is likely to be more effective within villages than between them and this may help explain the concentration of particular hybrids in a relatively few villages.

The tendency to "follow the crowd" helps explain the dominance of certain hybrids at particular times. The hybrid produced by company "C" has become very popular in the past two years, farmers are attracted to its relatively greater height (providing more stover) and high grain yield. The company produces several pearl millet hybrids, but only one is currently available in Shekhawati which has replaced several other private hybrids that were popular a few years ago. Whether this dominance continues remains to be seen.

Another significant source of information about hybrids is shopkeepers. Many farmers go to a shopkeeper with the intention of buying *sankar* seed, and rely on him/her to recommend an appropriate type. Good advice is more likely from established seed dealers (who have experience with a range of products) rather than from someone who is selling one or two types of pearl millet seed as a sideline. Most dealers know the basic characteristics of the different hybrids they sell. They add to their knowledge through feedback from their customers and by seeing what is in demand. But dealers cannot be expected to tailor recommendations for the range of specific farming conditions in the area. The quality of dealers' information also depends a great deal on the relationship between the shopkeeper and the farmer. If the shopkeeper sees the farmer as a potential client for the future, he will take more care in his recommendation. Of the farmers purchasing hybrid seed in 1997, 61 per cent had purchased seed or other inputs from the same shopkeeper previously. Several farmers in one village related how a shopkeeper (with whom they had many past dealings) gave them a discount on this year's seed because his

Figure 1 What factors are important in choosing a hybrid?

recommendation last year had not been a good one. Dealer recommendations are also influenced by the margin they can charge for particular brands. The margin for public sector seed is usually lower than that of private companies, for instance, and hence dealers have an incentive to sell the private brands. Competition among companies or distributors often leads to differences in margins between brands.

An additional factor must be considered when understanding farmers' decision-making regarding pearl millet seed choice. In an area of uncertain rainfall, many planting decisions are taken at the last minute. If a farmer wishes to use formal sector seed he/she will often depend on a quick visit to the nearest town to buy seed from among the types immediately available. These conditions restrict farmers ability to make considered choices on seed sources and helps explain why the results of hasty decisions are often poorly remembered.

Perhaps surprisingly, the extension service is not an important source of information, even for public varieties (Table 6). Extension advice is rated of only moderate importance by most farmers. A summary of various public extension techniques is presented in Table 7. "Minikits" are small packets of seed of new varieties distributed to farmers. KVKs (*Krishi Vigyan Kendra* or farmer training centres) run courses and demonstrations and the ARS (Agricultural Research Station) at Fatehpur organises demonstrations. Notable features include the low number of farmers with any experience of these methods and the low proportion of farmers who remember the names of the varieties that were promoted.

Private seed company efforts at extension, through field days or village visits, do not seem to have much impact on farmer decision making. Farmers rarely, if ever, refer to private company field days or village visits when discussing the information they use to choose varieties. Companies sometimes undertake village promotion—making a pitch over a loudspeaker and distributing pamphlets (or, less frequently, seed). A few companies prepare little cellophane packets with a handful of seed of a new variety for dealers to distribute to customers. Dealers also are occasionally provided with bags of seed they can give to favoured or influential customers.

Other types of advertisement (wall paintings, pamphlets, posters, calendars, etc.) are much more common. It is difficult to assess their direct impact, beyond perhaps occasionally planting the name of a company in a farmer's mind. Company image is undoubtedly important; one company representative said that the pearl millet seed business is "65 per cent image and 35 per cent genetics". One of the reasons that farmers more easily recognise the hybrid of Company C is that it is sold in a distinctive plastic bag.¹⁴ Brand positioning is a constant battle and dealers speak candidly about the strategies and failings of the companies they represent. The farmers of Shekhawati have a rudimentary, but expanding knowledge of these companies. Farmers occasionally transfer their experience with seed of one crop to that of another from the same company. But these farmers are relative newcomers to the seed market, and it can be argued that most of a company's efforts to establish a reputation are aimed at the dealers who will promote the varieties, rather than at the farmers themselves.

Table 7 Variety promotion

Type of promotion	No. of participants in any year	No. who recall the variety recommended
Demonstration	16	3 (19%)
Advice from DOA	19	2 (11%)
Minikit	9	2 (22%)
Advice from KVK	15	4 (27%)
Advice from ARS	4	1 (25%)
Literature	8	3 (38%)

7 INFORMATION FROM FARMERS

The previous discussion concentrated on the type of information made available to farmers. Of equal importance are the pathways allowing farmer experience and opinion to pass back to plant breeders and seed companies.

The public system has several mechanisms for assessing varietal performance. Pearl millet varieties developed by state or national institutions enter a nation-wide testing system under the All India Coordinated Crop Improvement Programmes (AICCIP). The AICCIP system tests the varieties in standard trials over several years. The release and notification of a variety depends upon its performance in these tests. Many private companies enter their pearl millet hybrids in the AICCIP testing system as well; indeed, the majority of varieties in the final stages of recent AICCIP pearl millet trials are private hybrids. These trials take place in several parts of the country, although it is argued that this testing system is not adequate to distinguish performance under a range of growing conditions (Virk et al., 1996). In any case, there is little or no room for farmer input.

The strategy of minikits was designed to address this deficiency. In theory, small seed packets (0.5 kg) of a pearl millet variety being considered for release are distributed to farmers by extension agents. The extension agent is responsible for completing a 'reaction card', recording the variety's performance, management and any farmer reactions. These data are then collated and passed to the plant breeders. Unfortunately, the system rarely works like this. The collection and transmission of data at sub-district, district and state levels is subject to delay and breakdown and useful information rarely finds its way back to the plant breeder. Of equal importance, there is rarely enough seed of varieties under test for a minikit programme, so most of the seed distributed through minikits is of varieties already released, notified and on the market. Thus even in the best of cases, the minikit is simply a demonstration tool, rather than a way of obtaining farmer feedback.

Variety notification is a national function, managed by the Central Sub-committee on Crop Standards, Notification and Release of Varieties. A variety may be notified for the entire country or, more likely, for particular states or ecological zones. In most of India, non-notified varieties can be sold as truthfully labelled seed. In the past three years, the Rajasthan DOA has set up a

separate programme for approving varieties for sale in the state. A meeting is held in which data from various sources are considered before granting permission for the variety to be sold. Increasing reliance is being placed on the performance of the varieties at trials in state Adaptive Trial Centres (ATCs), small research stations located throughout Rajasthan. This state-level approval is unusual (perhaps unique) for India and is the cause of some concern from companies, who argue that the results from ATCs are wholly inadequate to judge the performance of a variety. Once again, even if such trials are competently managed, they provide little possibility of meaningful farmer input. The public seed companies base their indents (requests for source seed) for particular varieties on the experience of past sales, but this is a slow and imperfect way of gauging farmer experience, particularly as farmers' choice of variety is rarely based on a rational assessment of options available. In short, there is no effective link between farmers, extension and public agricultural research that would contribute to a more responsive plant breeding and seed provision system.

In the private sector, the discipline of the market contributes to somewhat more effective feedback. Companies soon respond to increasing sales of a particular variety and poor sales will be enough to eliminate a variety from the company's portfolio. But this feedback is far from perfect and the reasons for a variety's success or failure may not always be apparent or immediately useful to the breeding programme. There is little evidence that private breeders seek contact with representative farmers. Nor is there much evidence of testing under more marginal conditions. Companies do few demonstrations at the village level; any comprehensive programme would be prohibitively expensive. Instead, the companies rely on their distributors and dealers. Some of these have good contacts with farmers and can pass useful information back to the companies. These contacts however, tend to be with larger and more influential farmers.

8 ADDRESSING INFORMATION DEFICIENCIES

Information is a key to economic development (North, 1990). Imperfections in the flow of information lead to high transaction costs, which in turn lower the possibilities of enterprise growth and development. It is imperative that such transaction costs be addressed if seed systems are to grow and diversify.

In the present case, farmers would profit from knowing more about the performance and availability of new varieties. They would also gain from being able to assess seed quality, or at least from knowing how to complain about it. Lowering the perceived risk of dealing with an unknown seed system would encourage more farmers into the market. Seed companies and breeders could also take advantage of better information. Their research and sales efforts would be more effective if they had a better idea of farmers' conditions and priorities. But the provision of better information itself constitutes a significant cost. Farmers' experimentation or their search for market

information can require considerable time. On the other side, organising contacts and research with farmers may require a significant investment of time and resources from plant breeders or seed companies. Both sides want to make sure that efforts to lower transaction costs will lead to worthwhile results. We cannot expect perfect information flow, but we can ask what interventions are feasible to improve the efficiency of the seed system in Rajasthan. This section discusses several possible ways of improving the flow of information between farmers and seed providers. They include: extension programmes to acquaint farmers with the nature of the seed industry; increasing attention to seed merchants as important sources (and recipients) of seed system information; clearer labelling and naming of varieties; and a programme of local-level variety testing. In each instance, we will discuss both the benefits and also the costs of the intervention.

Possible interventions

Farmers in Shekhawati are just beginning to participate in the commercial seed system. They have little understanding of the firms that sell seed or how to distinguish among them. They do not know what to look for on a bag of seed, or how to complain if they are not satisfied with the performance of the seed they purchase. It should be possible to develop simple educational materials, to be delivered by the extension service, KVKs and others, that help make farmers more familiar with the elements of a formal seed system. On the face of it, such a programme should be fairly inexpensive, especially because it could be a general strategy to cover various crops. Such a strategy would require that the public extension system invest in helping farmers take advantage of the private seed sector. Seed dealers' or producers' associations might help by producing their own materials that acquaint farmers with the nature of the seed industry.

The public sector should also pay more attention to seed dealers and distributors. Private companies have no effective outreach programme, but rely instead on their dealers. A stronger partnership could be developed between public agricultural institutions and input dealers. Such a strategy would not be very expensive and could pay significant dividends. Rajasthan's current five-year plan for agriculture (Rajasthan DOA, nd) takes a step in this direction by proposing more support for the establishment of village-level private input dealerships. But the current scarcity of input dealers is most likely due to low demand. If the DOA were to invest in more effective promotion of seeds and to promote closer collaboration with input dealers it is likely that a wider network of input entrepreneurs would emerge spontaneously.

A particularly effective improvement in the seed system would be clearer labelling and naming of varieties. When only a few varieties are on the market, farmers can remember names or at least characteristics that help them distinguish between the alternatives, but when farmers face more than two dozen varieties

and at least 10 different companies they are likely to become confused.¹⁵ This can lower their incentive to enter the market. Another problem is the tendency in both the public and private systems to produce a stream of new varieties, whether or not these represent true improvements. For public breeders, variety release is the primary method for career advancement. For private companies, there is great pressure to produce “something new” to keep attention from shifting to the competition. These trends are in a sense inevitable, but at the very least it should be recognised that farmers have much less time and patience than plant breeders remembering numbers and codes.

Perhaps the most important weakness in the current system is the lack of any effective mechanism for local-level variety testing under the conditions that farmers actually face. Section 7 discussed weaknesses in the minikit programme and other variety testing schemes. Farmers are thus denied the opportunity to gain first-hand experience with new varieties and plant breeders cannot obtain useful feedback before seed companies invest in a production effort. The DOA would perform a great service if it helped establish a system of village-level variety testing. This would require working with interested farmers and would involve some instruction in the techniques of simple trial management. It should not require any inputs beyond those that the farmers normally use, because the purpose is to test varieties under farmer management. Public breeding institutes and private companies should both be interested in donating seed, learning from the results and perhaps even visiting the sites. The growth of the seed industry in the US in the early part of this century featured such variety testing by local “crop improvement associations” and similar bodies (Fitzgerald, 1990). Public universities and private companies participated in such trials.

The development of a comprehensive local-level variety testing and demonstration capacity would certainly require substantial extension resources, however and such a programme would have to be initiated on a pilot basis. One source of funds for such a system in Rajasthan would come from the curtailment of the current variety screening system through the ATCs, which provides little information about variety performance under actual farming conditions. Mandatory government variety testing systems are unable to address the multiple conditions and priorities that farmers face (Tripp and Louwaars, 1997). Abandoning this system runs the occasional risk of allowing poor varieties into the market, but opens plant breeders and seed companies to a much wider and more complex set of demands and possibilities. An alternative testing system that features local control would place more responsibility in the hands of the farmers who stand to actually gain from the results. If a variety performs poorly in the local test it is unlikely that farmers can be convinced to buy it.

9 CONCLUSIONS

This study has examined the flow of information in an area where farmers are beginning to gain experience with an exceptionally complex seed market. Our analysis has tended to point to the problems that are encountered and to suggest possible remedies. But we must also emphasise that despite a number of gaps and weaknesses, a significant transfer of information takes place. On at least a superficial level, the market functions. Farmers use various sources of information, especially their own experience, discussions and observations with other farmers, and the advice of seed merchants. Farmers are gradually building a more complete picture of the advantages and disadvantages of hybrid varieties and beginning to distinguish among certain hybrids.

The results certainly dispel any concerns about the capacity of resource-poor farmers to take advantage of commercial seed systems. Although they have relatively little experience with agricultural input markets, the farmers of Shekhawati generally make reasonable choices with respect to sources of pearl millet seed. But despite this relatively successful transition to the use of commercial seed markets, there is still room for improvement in the exchange of information.

Progress in agricultural research (public or private) is usually incremental rather than revolutionary. Gains in plant breeding, such as increased disease resistance or improved fodder quality are relatively subtle. If farmers are to take advantage of these improvements they need to be able to make careful distinctions between the varieties available in the market. This means going beyond the gross differences between *desi* and *sankar* and learning how to distinguish between companies and their various products. Our study shows that information at this level of precision is not yet widely distributed.

The lack of appropriate mechanisms for diffusing such information means that much of the investment in public agricultural research does not achieve its intended impact. Useful varieties remain unknown or under-utilised. Similarly, private companies are (understandably) more likely to invest in information about “image” than about “genetics” if they see this as a more effective way to compete. This does not imply that an attractive package can sell a poor variety, but a significant number of farmers will be denied the full benefit of the advances of private research if adequate information is not available. With an absence of appropriate feedback, both public and private research will not have the incentive to explore new niches and address the full range of opportunities.

Our suggestions seek to build upon those elements of the market that already work and to strengthen those areas where there are deficiencies. Hence we urge that more attention be given to the role of input merchants as sources of information for farmers and as potential conduits of feedback to plant breeders. The importance

of information exchange among farmers underlines the priority of establishing local-level variety testing capability. As well, more emphasis should be placed on providing basic seed market information (variety descriptions, company names, and how to understand what is written on a seed bag).

Finally, we end with two cautions. First, we have drawn this data from an area where a complex seed market has only been in existence for a short time, so further improvements in its efficiency are to be expected.¹⁶ In addition, the Indian seed sector is one of the most dynamic in the world, so the experience of Rajasthan may not be directly translatable to all other countries.

The second caution relates to more general concerns about information and agricultural development. We have seen serious deficiencies in the way that relatively straightforward information about seed and varieties is exchanged. Many of the hopes of agricultural research are pinned on much more complex technologies for crop management, that require sophisticated systems of information exchange. If problems are evident in the arena of seeds and varieties, the implications for the importance of lowering the information costs of other agricultural technology provision present a significant challenge.

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ENDNOTES

1. Before a crop variety can be produced as certified seed in India, it must be notified by a committee within the (Federal) Ministry of Agriculture.
2. In this paper, the term 'hybrid' is used to mean the product of a cross between two inbred lines. Although local varieties are open-pollinated, the term 'OPV' will refer only to MVs. The term 'variety' will be used for any MV (hybrid or OPV) or local variety.
3. It was not possible to complete the sample in one village, where only seven farmers could be interviewed.
4. If the two villages in the *panchayat samati* of Ratangarh (where holdings are larger and land quality is poorer) are excluded, average holding is 4.4 ha (and average millet planting is 1.3 ha). Statistics from these areas indicate an average of about 3.5 ha of agricultural land per household (Census of India, 1991), indicating that our sample is fairly representative.
5. Fields that received fertiliser had higher yields (1.16 mt) than those without fertiliser (0.83 mt). On average, hybrid yields (0.93 mt) were indistinguishable from those of local varieties (0.90 mt). A three-way analysis of variance (variety, irrigation, fertiliser) confirmed the overwhelming importance of irrigation access to farmers' yields, and showed no significant interactions among these three factors.
6. \$1 is equivalent to Rs43.
7. An analysis of the diffusion of the pearl millet OPV WC-C75 in Maharashtra in the mid-1980s showed that farmers reacted *negatively* to the low price of its seed. Farmers associated quality with higher price (Kshirsagar *et al*, 1987)
8. Striga prevalence was assessed through interviews with farmers and village leaders. No measurements or field observations were taken during the survey.
9. At least two important diseases can affect pearl millet production in Rajasthan. Ergot is commonly found in years of high rainfall at crop maturity. Farmers in the sample complained of ergot, but felt that all varieties were equally susceptible. Downy mildew is also a serious problem for much of India's pearl millet, but it apparently is not prevalent in Shekhawati.
10. An analysis of the characteristics of those farmers who have never used hybrids reveals little to distinguish them from their neighbours (age, farm size) except that they have less schooling (2.0 years versus 5.0 years, $p < .01$).
11. Logistic regressions using various combinations of the factors examined in Tables 5 and Endnote 11 confirm that hybrid use is strongly related to striga prevalence and more weakly related to fertiliser use. With respect to socio-economic factors, only milk sales and camel ownership are related to hybrid use in the logit analysis. Explanations for these latter two correlations are not immediately obvious.
12. Only 17 per cent of local varieties were grown with fertiliser, compared to 34 per cent of hybrids (in 1997); irrigation was applied to 35 per cent of local varieties, but only to 23 per cent of hybrids; 58 per cent of local varieties and 75 per cent of hybrids were intercropped in 1997; and in 94 per cent of cases where hybrids were grown there was a high prevalence of striga in the village compared to only six percent of cases where local varieties were grown.
13. Although 71 per cent of farmers using local varieties report that they select heads for seed before storage, only 13 per cent report doing any selection of seed while the crop is still in the field.
14. Indeed many farmers call Company C's hybrid "plastic bag", although at least one other company also sells pearl millet seed in plastic bags. The company's attractive bag makes its product more distinctive, but the hybrid's popularity among farmers is based more on its perceived agronomic advantages.
15. Several of the farmers in the survey asked if we could leave them the pictures of seed bags we used in the questionnaire; they felt they were a useful reference. The Rajasthan DOA has recently taken an important step by producing a pamphlet that describes the different (public) wheat varieties that are available. Such pamphlets are needed for other crops.
16. Current research by NCAP is exploring these issues in Behror, Alwar District, Rajasthan, where farmers have longer experience with commercial seed markets.

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