THE ECONOMICS OF MAIZE SEED PRODUCTION AND UTILIZATION IN PAKISTAN

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Abstract

The key economic issues concerning development of an effective maize seed industry for Pakistan are addressed in this paper. Pakistan's maize sector has been severely curtailed through lack of an effective seed industry. The main reasons for this are reviewed. The paper provides estimates of the losses of productivity that arise from having only very low volumes of commercial seed of improved maize in Pakistan. In the irrigated plains, these losses are 18%, while in the less-developed mountains and rainfed plateaus, they are 11%. Future prospects for seed of improved varieties and hybrids are good in Pakistan.

However, hybrids are unlikely to be profitable in less-favoured areas, even though improved open-pollinated varieties will be. The changes necessary to stimulate the maize seed industry are presented. Special emphasis is given to developing a commercially-oriented and viable sector, in which local small scale seed enterprises play a vital role.

Introduction

By any standard you care to use, the current seed system for maize in Pakistan needs change. There are low rates of use of commercial maize seed, low levels of use of recently-released maize varieties, farmers are poorly informed about improved maize varieties and farmers in many areas are unable to buy commercial maize seed. The lack of a viable seed system has been the number one cause of slow development of the maize sector in Pakistan. The lack of an effective seed industry means lost opportunities for farmers, users of maize and the nation and means that the payoff to maize research is being severely stifled.

Numerous studies attest to this. Virtually all reports undertaken on maize in farming systems of Pakistan in the 1980s rate the lack of an effective seed system as a serious constraint to improved productivity (Hussain et al., 1986, Byerlee and Hussain 1986, Byerlee et al. 1987, CIMMYT 1989).

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Special seminars and studies have been conducted to attempt to improve the situation (Industry Council for Development, 1987, NWFP Agric. Univ. 1989), but little apparent progress is to be observed where it matters most, in farmers' fields (Asghar and Longmire, 1990).

This paper addresses some key economic issues associated with the slow development of the maize seed sector of Pakistan, as well as proposing some changes needed to develop it. Seven main questions are addressed, as follows:

What is the extent of use of improved maize seed in Pakistan?

Why is the use of improved maize seed so low in Pakistan?

Why has a viable seed industry not developed in Pakistan?

What are the costs to Pakistan of not using improved maize seed more widely?

What are the prospects for developing the seed industry for improved open-pollinated maize varieties?

What are the prospects for hybrid maize seed?

What changes are needed for development of a viable commercial seed industry for maize?

Basically, within Pakistan, there exist two major maize economies: (1) maize grown on the irrigated plains, primarily in Central Punjab, but also in the irrigated plains of NWFP and a small area of Sindh, and (2) maize of the higher areas, including the rainfed plateaus, the mountain valleys and mountain terraces. Approximately 40% of the maize area of Pakistan is in the irrigated plains. Considerably more development has occurred in the irrigated plains than in other areas.

Some key indicators comparing the two maize economies of Pakistan are presented in Table 1. The differences between the two maize economies of Pakistan are important when it comes to understanding the economics underlying maize seed. While many variations can be found within specific ecologies and farming systems, the indicators in Table 1 broadly give the picture.

Use of improved maize and maize seed in Pakistan

Pakistan has one of the lowest levels of use of improved maize varieties in the developing world. For Pakistan and Azad Kashmir the share of total maize area which was planted to improved maize, including open pollinated varieties and hybrids, in 1989 was 26%. In the rainfed plateaus and mountains this percentage was only 12%. This compares with an average for all developing countries of 51% (in 1985-86).

Table 1. Characteristics of the two main maize economies of Pakistan.

	Irrigated plains	Plateaus & mountains
Total area ('000ha)	350	515
Median farm size (ha)	3.2	1.1
Irrigated area (%)	100	20
Improved maize area (%)	48	13
Median seed rate (kg/ha)	38	69
Seeling (%)*	24	72
Area thinned (%	45	80
Specialist fodder (%)	41	2
Average yield (t/ha)	1.9	1.2

Source: Asghar and Longmire (1990).

* Seeling is ploughing maize with a bullock or tractor 3-4 weeks after planting to provide the first thinning of the crop and to control weeds.

Use of commercial maize seed as a share of the total maize seed planted is also very low in comparison with other countries. Only about 10% of the maize area of Pakistan was planted with commercial maize seed in recent years (the remainder was seed retained by farmers or obtained from other farmers who are not specialist seed growers). This compares with an overall average of developing countries of 43%. The share of area planted to maize hybrids in Pakistan was about 3% in 1989, compared to 38% for developing countries overall (in 1985-86), a tenfold difference.

Why is use of improved maize seed low?

There are three main reasons why the uses of improved maize and of commercial maize seed are low in Pakistan: varieties can be unsuited to local conditions, the dual purpose use of maize for fodder and grain, and the unavailability of seed.

In certain environments, particularly high altitudes, drier rainfed environments and areas with poorer growing conditions, many of the improved varieties may not exhibit sufficient yield advantages for farmers to prefer them to their own local maize. In some of these stressed maize environments, local varieties may match and, in some cases, out perform improved maize on certain criteria. A very important criterion to farmers is early maturity, since over 90% of the maize grown in Pakistan is preceded or followed by a winter crop. Generally, however, studies indicate that for the main maize areas of Pakistan, improved va-

rieties out perform local ones and, when seed is available, farmers have a very strong preference for the improved varieties.

Another important factor for low adoption of improved maize in Pakistan is the crop's dual purpose role, as a source of fodder and grain. This is especially the case in the maize economy of the higher areas. In the irrigated plains there is a much higher proportion of specialist maize, with grain and fodder being grown in separate fields. With dual purpose maize, planting densities are exceptionally high, often exceeding 100 kg/ha. Farmers then thin the crop, typically right through to harvest, with often almost one half the value of the maize crop coming from its fodder. With dual purpose maize, some improved varieties are out performed by local varieties at the high planting densities that optimize the total value of output of grain and fodder. These high planting densities also have a big bearing on the economics of buying commercial seed, especially hybrids.

The third main reason for the low use of improved maize in Pakistan is the unavailability of seed. Various studies conducted in selected maize areas of Pakistan (certainly not the most isolated areas) indicated that very few farmers had knowledge about improved varieties. For example, Hussain et al. (1986) found in 1984 that 91% of maize growers in Mardan District, probably the most developed in NWFP, were unaware of the main recommended variety, Sarhad White. Extension agents and the seed sector have made little effort to promote improved varieties (Byerlee et al. 1987). For the most part, this is because Pakistan does not have a well organized maize seed industry and relatively little certified maize seed is provided to farmers.

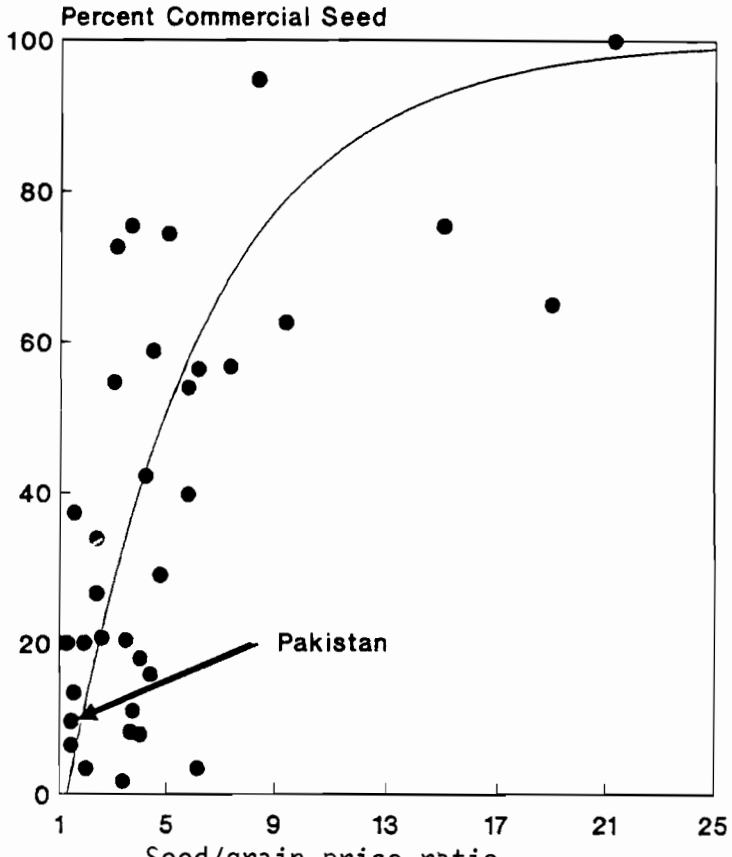
Why does Pakistan lack a viable maize seed industry?

The provision of commercial seed for maize, as for other major crops, has been dominated by the public sector. More recently, private seed firms have been encouraged to produce and distribute seed, notably hybrids. However, to date no major breakthrough has been made in marketing seed on a large scale.

There are three outstanding reasons why Pakistan lacks a viable maize seed system. First and foremost is the emphasis on seed production in the public sector at the cost of private seed production. In the past, there were policies restricting entry into the seed sector. As well, over regulation made private firms shy to invest. Direct government involvement and the creation of public seed agencies has stifled entrepeneurial development of the seed sector overall, both in the private and public sectors. The performance of the public sector in maize seed production and marketing has been very disappointing in Pakistan. The performance is probably below the rather mediocre contribution of public seed agencies in most developing countries (CIMMYT 1987).

Low seed pricing combined with control over access to basic seed also hindered growth in maize seed production. Pakistan has maintained the lowest prices for maize seed of all developing countries (CIMMYT, 1987). At about 1.3 times the grain price, official maize seed prices are insufficiently high to cover the costs of producing and marketing quality seed of improved varieties. Thus, there is little incentive for public and private seed production, and even less for distribution.

Some indication of the importance of seed pricing in stimulating greater use of improved maize is shown in Fig. 1. This shows the relationship between the seed to grain price ratio and the share of commercial maize seed in total maize area planted for a number of developing countries. A strong positive relationship between seed prices and commercial maize seed use is observed for the 33 countries included. Note the position of Pakistan on the chart. This is strong evidence that farmers are prepared to pay high seed prices when quality seed is available. By keeping prices low, the policies have stifled commercial seed production and ensured its unavailability for many Pakistani farmers. Rather than helping farmers, low seed prices have seriously hindered them.



Note: For 33 developing countries. Source: CIMMYT, 1987.

Fig. 1. Commercial maize seed to total maize seed (%) by seed:grain price ratio.

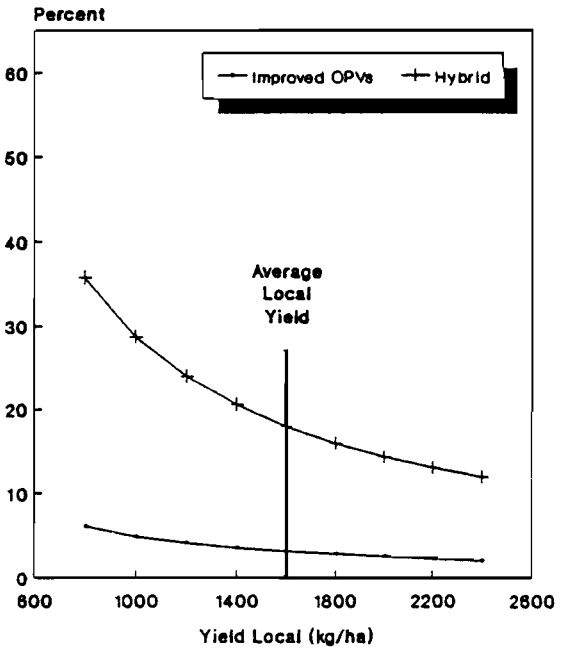


Fig. 2. Yield advantage needed to repay cost of commercial seed, irrigated plains.

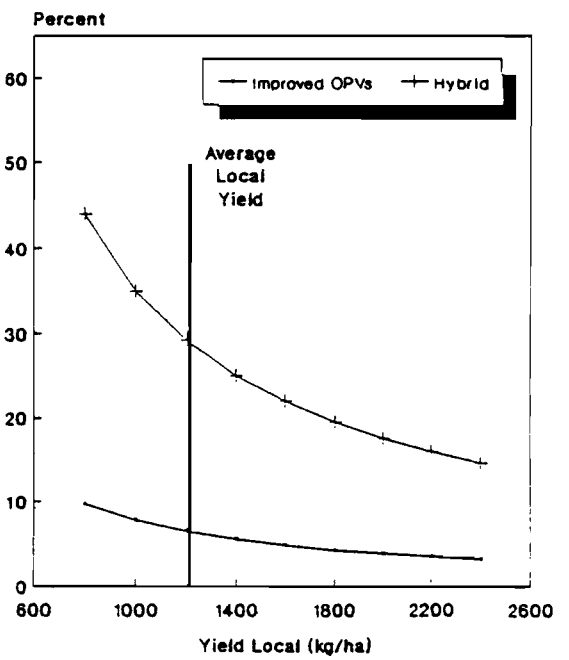


Fig. 3. Yield advantage needed to repay cost of commercial seed, mountains.

Another important reason for the lack of a viable seed sector has been the low availability and the lack of access to basic seed. This has meant that enterprising farmers have not been able to develop local maize seed production. In many villages of Pakistan, there are farmers who could readily perform the functions of producing and marketing seed of improved varieties, provided they had access to basic seed. Sadly such access has not been available, being monopolized by the public seed agencies. For hybrid seed production, Pakistani-based seed companies now have access to most inbred lines from overseas that are of potential for Pakistani conditions.

Costs of not using improved maize seed more widely

There are several consequences for Pakistan of low use of improved maize. First is lost productivity, especially in grain production, but also in fodder. There is also a greater disease loss associated with using local varieties. However, the selection process for much local maize seed provides a sizeable buffer against widespread disease outbreaks (the bulk of farmers select local maize seed on the cob in the threshing floor, thus selecting only those genes which produce attractive healthy cobs).

There is little evidence suggesting major quality differences between local and improved maize in Pakistan. Farmers generally prefer white maize for eating, but most improved white maize measures up to local varieties in quality. For feed grain and fodder, improved maize also generally matches the quality of local varieties. One offsetting positive factor from low use of improved maize is the slightly improved timeliness that stems from local maize. This is translated into improved profitability and productivity of the maize-winter crop system, especially for the winter crop. However, evidence in Asghar and Longmire (1990) suggests that, overall, maturity differences are not great between local and improved varieties for given altitudes and ecologies.

The main differences in yields between local and improved maize have been used to calculate the productivity gains that could come from wider use of improved maize varieties. In the mountain regions, on-farm trials suggest that the grain yield advantage of improved maize varieties can average about 500 kg/ha (Byerlee et al., 1987). In the irrigated plains, the advantage may more typically average 900 kg/ha (Asghar and Longmire, 1990). For hybrids, the advantages will be even greater with sufficient time for local adaptation. These and typical differences in fodder yields for the mountains and irrigated plains are presented in Table 2.

Using farmer prices of grain, fodder and seed, and additional harvesting costs, the additional returns from using improved maize varieties are then calculated (Table 3). The productivity difference per hectare between improved maize and local can be computed by dividing the net returns (per ha) of improved

seed over the value of output of local maize (Table 4). Improved maize in the irrigated plains is estimated to yield an avrrage productivity gain per hectare of 33%, while the equivalent figure is 16% for the mountains. For hybrids, the advantage is estimated to be 43% in the irrigated plains, and 22% in the more favoured parts of the mountain.

Table 2. Assessing the extra net returns in farmers' fields from improved open pollinated varieties and hybrids, compared to local maize.

	Irrigated plains	Plateaus & mountains
Grain Yield (t/ha):		
Local	1.6	1.2
Improved OPVs	2.4	1.7
Hybrids 1/	2.8	2.0
Fodder yield (tDM/ha) 2/		
Local	3.2	3.6
Improved OPVs	3.6	3.6
Hybrids	3.6	3.6
Total value of output (Rps/ha) 3/		
Local	5280	6240
Improved OPVs	7440	7640
Hybrids	8440	8480
Extra Costs (Rs/ha) 4/		
Improved OPVs	415	374
Hybrids	894	893
Extra Net Returns (Rs/ha)		
Improved OPVs	1745	1026
Hybrids	2266	1347

1/ The grain yield advantage of hybrids in relation to improved open pollinated varieties is based upon CIMMYT (1987).

2/ The ratios of fodder to grain yields in Fischer and Javed (1986) were used to estimate these fodder yields. The grain: fodder yield ratios varied according to planting density, type of maize and location.

3/ At the following prices: Irrigated plains, grain 2.5 Rps/kg, fodder 0.4 Rps/kg; mountains, grain 2.8 Rps/kg, fodder 0.8 Rps/kg. Approximate exchange rate: 1 US = 21 Rps.

4/ Additional to those with local varieties, including extra seed costs (see Table 4 for assumptions), fertilizer costs (extra 10kg N/ha for OPVs and 20kg N/ha for hybrids, all at 7Rps N/kg) and harvesting costs (at 15% of value of grain).

Weighting these by the potential areas of improved maize in both environments, the potential productivity gains in aggregate are calculated. The potential areas for improved varieties represent the likely upper limits of adoption, as judged from experience in other countries with similar growing environments.

Table 3. Estimating the productivity gains from improved maize varieties and hybrids in Pakistan.

	Irrigated plains	Plateaus & mountains
Estimated productivity Gain per hectare (%) 1/		
Improved OPVs	33	16
Hybrids	43	22
Current share of area (%)		
Local	52	88
Improved OPVs	41	12
Hybrids	7	0
Potential share of area (%)		
Local	0	20
Improved OPVs	50	70
Hybrids	50	10
Aggregate productivity gain (%) 2/	18	11

1/ Calculated as the additional net returns per ha divided the value of output per ha of the local variety.

2/ Productivity gains were calculated by computing weighted-averages of productivity, using the current share of area and the potential share of area as weights. The gain is simply the percentage increase in the potential productivity over the current level.

Overall, the productivity gains associated with use of improved maize up to its potential are 18% in the irrigated plains and 11% in the mountains. Although these figures seem comparatively low, such gains would translate into sizeable income and profit gains for maize farmers, as well as the nation. What then are the prospects for realizing such productivity gains with wider use of improved maize?

Prospects for open-pollinated maize seed

The prospects for open-pollinated maize seed in Pakistan are

conditioned by demand for this type of seed, as well as its availability. Ultimately, with a well-functioning seed sector, factors affecting demand will have the major bearing on how much commercial seed is produced.

The demand for seed is primarily determined by the following factors (CIMMYT, 1987):

Seed rates per ha, and area planted to maize

Grain yields likely to be achieved by different seed types

Prices of different seed types, prices of grain and costs of harvesting, threshing and storing or selling

Costs of other inputs for growing different types of maize

Risks of low germination or having to replant

Number of years before seed must be replaced

Costs of financing the maize seed purchase.

Using simple marginal economic analysis, the yield advantages needed to repay the cost of seed for different environmental conditions (as represented by yield of local maize) have been computed. This has been done for improved open-pollinated seed and hybrid seed under typical assumptions for the irrigated plains and for the mountains of Pakistan. The main assumptions employed in this analysis are presented in Table 4.

The main findings are presented in Figs. 2 and 3, showing the extra yields needed to repay the cost of commercial seed of improved open pollinated maize varieties and of hybrids for a range of local yield levels. The average yields of local maize in 1989 are presented, as well.

These results indicate that considerable demand potential exists for commercial seed of open pollinated maize varieties in Pakistan. Only under very low yield conditions is it likely that the extra yield from using commercial seed varieties will not repay the cost of the seed. This is so for both the irrigated plains and the mountains. The ability to use seed of improved open pollinated varieties for three years or so before it is badly contaminated and mixed is one reason for the strong potential demand.

Given that there is strong potential demand, the issue for greater use of seed of improved varieties in Pakistan is availability of seed and availability of varieties which are superior to local maize. The issue of seed availability is taken up later in this paper.

Table 4. Main assumptions employed in calculating needed yield advantage of improved maize seed over local seed to repay costs of investment in commercial seed.

	Irrigated plains	Plateaus & mountains
Average seed rate (kg/ha): [1]		
Local	45	70
Commercial OPVs	35	55
Hybrids	30	40
Seed to grain price ratio:		
Local	1.3	1.3
Commercial OPVs	3.0	3.0
Hybrids	6.0	6.0
Harvesting costs (% of output)	15	15
Number of years using improved seed:		
OPVs	4	4
Hybrids	1	1
Rate of contamination (%) [2]	33	33
Needed returns to cover		
Capital cost & risk (%)	100	100

1/ Based on Asghar and Longmire (1990). Hybrid seed rates are likely to be lower because of higher seed prices and agronomic recommendations.

2/ The rate at which new seed of OPVs is contaminated through cross-pollination and mixing with local varieties.

Potential for hybrid maize seed

The hybrid maize seed market is still in its infancy in Pakistan. Hybrids are well established in spring maize production in the irrigated plains only, thanks to some innovative developments by Rafhan Maize Products, a major maize processing company. Other companies are aiming to build markets for their hybrids in the main summer season. Hybrids are virtual-ly nonexistent in the rainfed areas of Punjab, NWFP and Azad Kashmir. The few that are planted in the main maize season are in the irrigated plains.

The main reasons for slow development of hybrid maize have been technical as well as institutional. High seed rates and the lack of suitable hybrids for local conditions have been the main technical reasons. The main institutional reasons have been ba-

sically the same as those stifling growth of the seed sector overall.

Figs. 2 and 3 imply there is a sizeable potential market for hybrid maize seed in Pakistan. The potential for hybrids in the irrigated areas is very strong. Judging from Fig. 2 and from the acceptance of hybrids with Rafhan Maize Products, at least 50% of this area has the potential to be planted to hybrids when they are properly adapted and marketed in the future. Results from a number of countries suggest that small farmers will adopt hybrids when they perform well, in terms of yield, disease resistance, quality, duration and so on.

There is also some potential for maize hybrids in the mountain valleys, the rainfed areas and the better maize areas in the mountains. However, hybrids are unlikely to extend widely in these marginal environments of Pakistan. In conditions where the yield of local maize is near or below about 1.5t/ha, hybrids are unlikely to sufficiently out perform local varieties to warrant the annual investment in seed by farmers. The potential for hybrids in the mountains is probably only 10-20% of the total area.

For the mountains and plateaus, there is much more potential for seed of open pollinated varieties than hybrids. Thus hybrids are likely to be economical to farmers in most of the irrigated plains and some of the more-favoured higher areas. This implies the need for development of an effective seed system in which hybrids and open pollinated improved varieties will play important roles.

Changes needed

A number of changes are needed to develop a viable maize seed sector for Pakistan. Many of the details of such changes have been documented (NWFP Agric. Univ., 1989). This concluding section provides an overview of the most critical changes.

Foremost among the changes needed is the development of a commercially oriented maize seed sector. This means developing a strong viable private sector in seed production and marketing. Some broad policy and institutional changes will encourage this. The main ones are:

Prices of commercial maize seed should be determined by the market and should be deregulated. The setting of seed prices should be solely the commercial judgement of those involved in producing and marketing the seed.

Public seed agencies should not be subsidized and should be subject to the normal commercial business standards. They should be free to determine staffing, investment and pricing and should be expected to meet the usual requirements of private companies servicing agriculture.

International trade in seed should be free, subject to the usual phytosanitary and product trade standards applied.

Entry into the seed sector should be free, subject to the usual business standards applying in Pakistan. Of particular importance, seed producers should be held responsible for the quality of their products through honesty in labelling.

With these changes, the framework would exist for the emergence of a viable seed sector. There would be no need to subsidize private seed production, since prices should provide the incentive to invest. Some time would be needed for the seed industry to develop and to adjust to these new conditions. The best strategy the government could provide would be to set a clear policy framework and to hold to this while the sector gets on with its own financing and development.

There are three specific items that could be provided that would be of considerable assistance. Firstly, it is unlikely that large companies will build a sufficiently large market for seed of improved maize varieties. There are very few cases where this has happened worldwide. The main reason for this is the lack of proprietary rights with seed of improved open pollinated varieties. There needs to be development of small local seed enterprises if seed of improved varieties is going to be widely available to farmers in the poorer and less developed areas.

Local seed enterprises could readily develop providing they have good access to basic seed. They would likely be entrepreneurial farmers who have invested in simple seed conditioning equipment and who take care to grow good quality commercial maize seed. These local entrepeneurs would be well placed to develop local markets and outlets for their seed. These local seed producers should also act as key communicators with research, extension and those responsible for basic seed production.

Secondly, there is a strong need for the development of a seed association in Pakistan. This would be a body of all parties involved in seed production and marketing. An important function would be to provide a register of seed growers, who could then label their seed with the association's imprimatur. An important function of the association would be to work with Governments to ensure that the legislative conditions are there to encourage a viable seed sector.

The association should also act as a body for exchange of ideas and information on seed. It should also encourage training and research in seed production and marketing. There is an important need for education and training in seed production and marketing in Pakistan. The association could provide the impetus for such training, which could come from special courses at universities, and through research and extension officers. Examples of excellent courses exist in other countries, and these could

readily be modified to Pakistani circumstances.

Finally, important changes need to be made in the production of basic and prebasic seed. Basic seed should be produced by specialist seed growers in the private sector. It should not be produced on public research stations. Nor should its production be the sole responsibility of public seed agencies. Growers of basic seed should be required to register with the seed growers association but free to sell basic seed to any commercial seed producer, at prices they determine. Basic seed producers should be obliged to report their seed sales to the association and there should be a sizeable number of such producers.

Prebasic seed production should be the responsibility of the relevant provincial research institutes. Prebasic seed should be made available to basic seed producers at prices re- flecting the marginal cost of producing prebasic seed on the re-search stations.

In conclusion, we believe that Pakistan urgently needs to make important changes to the maize seed sector to encourage its development. Without change, little progress is like with the maize sector. The challenge is to turn the needed changes into reality. It is time for action.

References

Asghar, C., and J. Longmire. 1990. Chartbook of Maize in Pakistan and AJK 1989. PARC/CIMMYT Paper 90-5, PARC/CIMMYT Collaborative Program, Islamabad.

Byerlee, D.R., and S.S. Hussain. 1986. Maize production in NWFP: A review of technological issues in relation to farmers' circumstances. PARC/CIMMYT Paper No. 86-1, PARC/CIMMYT Collaborative Program, Islamabad.

Byerlee, D.R., A.D. Sheikh, Kiramat Khan and M. Ahmad. 1987. Diagnosing research and extension priorities for small farmers: Maize in the Swat valley. PARC/CIMMYT Paper No. 87-19, PARC/CIMMYT Collaborative Program, Islamabad.

CIMMYT. 1987. CIMMYT World maize facts and trends: The economics of Commercial Maize Seed Production in Developing Countries. CIMMYT, Mexico, D.F.

CIMMYT. 1989. Maize research and development in Pakistan. PARC/CIMMYT Collaborative Program, CIMMYT, Mexico, D.F.

Fischer, K.S. and H.I. Javed. 1986. Production of maize grain and fodder in the North West Frontier Province and Islamabad Capital Territory of Pakistan. PARC/CIMMYT Paper No. 86-3, PARC/CIMMYT Collaborative Program, Islamabad.

Hussain, S.S., M Ahmad, M. Haq Nawaz, and Shaukat Hayat. 1986. Maize in the irrigated farming systems of Mardan District: Implications for research and extension. PARC/CIMMYT Paper No. 86-6, PARC/CIMMYT Collaborative Program, Islamabad.

Industry Council for Development. 1987. Proc. of the Seed Industry Seminar, April 7-9, 1987. IDC, in Collaboration with USAID, Islamabad. New York, USA.

Khan, Kiramat, D. Byerlee, M. Ahmad, Md. Saleem, and E.J. Stevens. 1986. Farmer managed verification of improved maize technology: Results and Experiences from Swat, 1985. PARC/CIMMYT Paper No. 86-12, PARC/CIMMYT Collaborative Program, Islamabad.

NWFP Agri. Univ. 1989. Seed Industry Workshop, March 19-21, 1989. NWFP Agric. Univ., Peshawar, Pakistan.