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# Value Chain Analysis of Maize Seed Delivery System in Public and Private Sectors in Bihar§

**Ranjit Kumar[a]*, Khurshid Alam[a], Vijesh V. Krishna[b] and K. Srinivas[a]**

[a]National Academy of Agricultural Research Management (NAARM), Rajendranagar, Hyderabad- 500 030, Andhra Pradesh
[b]International Maize and Wheat Improvement Centre (CIMMYT), Regional Office, New Delhi-110 012

**Abstract**

Bihar has emerged as one of the most promising states for maize production in India, where it is cultivated in all the three seasons, viz. *kharif*, *rabi* and *summer*. This offers an opportunity for strengthening maize supply chain from seed to end-use. Different systems of maize seed delivery co-exist in the state. This study has been conducted in the Samastipur district (the largest maize growing district) of Bihar in 2010-11 and is based on surveys of seed producers, farmers, seed distributors, private seed companies and public research institutions as to understand the delivery system of maize seed in a value chain perspective. The study has mapped the value chain of public and private seed systems and has brought out the need for a greater emphasis on integration of different stakeholders involved in the chain. Appropriate backward and forward linkages of maize growers with seed companies are likely to generate better returns from maize. The enabling environment from the government policies to support services needs to be reoriented towards enhancing efficiency in seed delivery in the state.

**Key words:** Maize seed, delivery system, value chain analysis, backward & forward linkages, seed supply, seed sector, Bihar

**JEL Classification:** M31, Q12, Q13, Q16, Q18

## Introduction

Technology is a force for disruptive change, and the maize seed industry has been one of the pioneer examples of such a change. Maize is produced worldwide on 162 million hectares (Mha) in more than 180 countries, including 125 developing countries with a total production of 844 million tonnes (Mt) (FAOSTAT, 2012). About two-thirds of the total maize in the developing world is produced in low and lower-middle income countries. Hence, maize plays an important role in the livelihoods of millions of poor farmers in the developing world. Often, they are too poor to afford quality seeds and other essential inputs and are exposed to significant production and market risks. Together with rice and wheat, maize provides at least 30 per cent of the food calories to more than 4.5 billion people in 94 developing countries (von Braun *et al*., 2010). According to an estimate by the International Food Policy Research Institute (IFPRI), the demand for maize in developing countries is expected to be doubled by 2050 (Rosegrant *et al*., 2008) on account of its varied uses such as in food, feed, food sweeteners, starch, oil, proteins, alcoholic beverages, etc.

In 2010-11, India produced 21.28 Mt of maize from 8.50 Mha as compared to only 1.73 Mt from 3.16 Mha

* Author for correspondence,
Email: ranjitkumar@naarm.ernet.in

§The paper is based on a pilot study on "Dissemination of maize seed and the seed value chains in Eastern India" conducted in the year 2010-11 in collaboration with CIMMYT Regional Office, New Delhi.

in 1950-51. There has been a consistent growth in maize yield and additional 2-4 Mt of maize grains are added every decade to the national pool. Such a tremendous performance of maize could only be possible due to resurgence of a strong seed supply chain. Despite increasing role of multinationals and private sector in maize seed systems, many poor farmers rely on local seed companies that supply mostly open-pollinated varieties, developed chiefly by the public institutions. The interesting corollary in the case of rice is that almost half the rice seed sold in Andhra Pradesh is produced by the private companies, even though most of the varieties are developed by the public sector (Tripp and Pal, 2001).

Small seed companies play an important role in boosting crop production. They produce seed adapted to the local micro-environments. The seed has attributes similar to those of farmers' traditional varieties in terms of toughness and suitability to local conditions, but provides higher yield. Small- and medium-sized seed companies can reach poor farmers with varieties that can give higher and reliable yields, and so have potential to contribute to their food security and income (Morris *et al.,* 2003; Barrett, 2008; Langyintuo *et al.,* 2010). However, to accelerate regional spill-over, different approaches are needed for the transfer of genetic materials developed by the public research institutions to small seed companies through policy harmonization and market development.

Against this backdrop, the present study has attempted to (i) map the value chain of maize seed under public research institutions and a small private seed company; (ii) their role in dissemination of improved maize cultivars in Bihar state, and (iii) study the backward and forward linkages of maize growers with these institutions.

## Data and Methodology

The study was conducted in the Samatipur district of Bihar. With an average yield of 3.53 tonnes per hectare, it is the most important maize-producing district in the state. The study is based on the primary and secondary data. The stratified random sampling method was used for selection of farmers; and snowball sampling method for other stakeholders. Primary data were collected in 2010-11 from the farmers using semi-structured questionnaire and in close interaction with various stakeholders such as Rajendra Agricultural University-Pusa, Regional Research Stations of Indian Agricultural Research Institute-Pusa (Bihar), State Agricultural Department, farmers, dealers, distributors, and seed company. Secondary data were collected from the literature available with the public and private seed producers and distributors.

A total of 150 maize farmers, 25 maize seed farmers, 5 seed distributors, 10 seed dealers, and one private seed company viz. Masina Seed Pvt. Ltd. were selected for understanding the private sector maize seed value chain. Two public sector research institutions — Rajendra Agricultural University (RAU), Pusa, Samastipur and Indian Agricultural Research Institute (IARI) regional station, Pusa — were also selected for a comparison.

### Value Chain Analysis

A value chain is a sequence of related business activities (functions) from provision of specific inputs for a particular product to primary production, transformation and marketing, up to the final sale of a particular product to the consumer (GTZ ValueLinks, 2008). It also includes the set of operators performing different functions, viz. producers, processors, traders and distributors of a particular product linked by a series of business transactions through which the product passes from primary producers to end-consumers. Thus, value chain actors, responsible for transmission of materials, information and/or services, share an interest in the end-product because changes in the end-market affect them both collectively and simultaneously.

**Mapping —** Mapping is a central element of value chain analysis. It is used to show the flow of transactions from sourcing of raw materials and inputs, to production, processing, marketing and final sale. The maps can also illustrate costs, value addition at each stage, secondary services important to each stage, critical constraints, and the relative clout of players along a value chain.

**Participatory Approach —** Each actor along the chain impacts value creation. The actors performing different functions and exerting different levels of clout often have very different perspectives on critical opportunities, bottlenecks and the potential of different interventions. Hence, value chain analysis demands participation of full range of stakeholders (Kaplinsky, 2000). This range includes buyers, processors,

producers, input suppliers, and public agencies and associations that impact industry, trade, labour and commercial regulations and practices.

The present analysis starts from cost of production data compilation from various public agencies like RAU Samastipur, IARI regional station and from its own field surveys, and crosschecking with the data from All India Co-ordinated Research Project (AICRP) on maize, commercial farmers' and private companies. Figures used in the analysis are the estimates of the representative sample of farmers adopting advanced technology of farming (improved seed, fertilizers and pesticides). Other costs (transport, handling, etc.) are the expenses actually incurred across the value chain. The value added at each financial transaction in the chain has been construed from the difference in its value (in terms of ₹/kg).

## Results and Discussion

### Production Performance of Maize

In the past two decades, maize production has outpaced all other foodgrains in India. Its area grew at an annual rate of 2.02 per cent and yield at 2.07 per cent, despite having little access to irrigation water. Andhra Pradesh and Karnataka are the leading states in production as well as yield of maize. Bihar ranks 5$^{th}$ in production and 6$^{th}$ in acreage with a production of 1.55 Mt of maize from 0.62 Mha area (Table 1). Though, the area expansion and yield improvements in the state have not been as significant as elsewhere, the state has been experiencing a steady growth in maize yield. The average yield of maize in Bihar is 2.28 t/ha, almost closer to the national average. It may be noted that growth in maize yield in Bihar is more stable than in other states and therefore, the study assumes significant importance for the sector as a whole.

### Maize Production

In Bihar, maize is cultivated three times in a year. Interestingly, the state has the largest winter (r*abi*) maize area (0.39Mha). With significantly higher yield, farmers are more encouraged to grow *rabi*-maize and consequently, *kharif*-maize has shown a declining trend in recent years. Besides Samastipur, other major maize-growing districts are Khagaria, Katihar, Begusarai, Madhepura, Purnea and Bhagalpur.

The average size of landholding in the Samastipur district is 0.75 ha, well below the national average of 1.41 ha. The cropping intensity in the district is 1.29 as against the state average of 1.37. Maize production in the district has increased from 122 thousand tonnes in 1999-2000 to 208 thousand tonnes in 2008-09, while after stagnating for few years, the acreage under the crop has increased from 46.4 thousand ha to 58.9 thousand ha during this period. Increase in maize production is mainly due to higher yield in the *rabi*-season, which has been recorded as high as 7 t/ha. The average yield has increased from 2.63 t/ha in 1999-00 to 3.53 t/ha in 2008-09.

### Maize Seed Sector

The policy reforms during mid-1980s have brought major changes in India's maize seed industry. Since seed laws were liberalized during late-1980s, private investment in maize research has risen sharply, and seed companies have captured a significant share of the market (Singh *et al.*, 2002; Pal and Tripp, 2002). Farmers are mostly dependent on the private seed companies for maize seeds and public sector's stake in maize seeds is less than 10 per cent. Most of the private companies spend 10-12 per cent of their revenue on research and development. On the other hand, the government efforts for boosting seed production and distribution in the state are well versed with the schemes like *Mukhyamantri Tivra Beej Bistar Yojana* (Chief Minister's Rapid Seed Extension Program), *Beej Gram Yojna* (Seed Village Program), Seed Production on Government farms and distribution of subsidized certified seed. The phenomenal increase in seed production in the year 2009 may be taken as an upshot of these initiatives (Figure 1).

The *kharif*-maize has the largest share of the total area under the crop (42-43%), followed by *rabi*-maize (31-32 %) and *summer*-maize (25-26 %). The seed replacement ratio (SRR) for maize is high (> 60%) in the state as compared to the national average of 48.5 per cent (Task Force on Bihar, 2008). There is a gradual increase in hybrid seed production which has resulted into a high SRR. The decrease in certified seed production in 2008 was mainly due to abiotic stresses like widespread flood, badly affecting 13 districts of north Bihar, a major maize-producing region. The *kharif*-season is less preferred for seed production due to problems like waterlogging, flood and disease

**Table 1. Production performance of maize in major states of India**

| State/ UT | Area ('000 ha) | | | *CGR (%) | Production ( '000 tonnes) | | | *CGR (%) | Yield (kg/ha) | | | *CGR (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TE 1990-91 | TE 2000-01 | TE 2010-11 | and CDV (1990-2010) | TE 1990-91 | TE 2000-01 | TE 2009-10 | and CDV (1990-2010) | TE 1990-91 | TE 2000-01 | TE 2009-10 | and CDV (1990-2010) |
| Andhra Pradesh | 302 | 460 | 823 | 6.20 (11.3) | 602 | 1479 | 3512 | 10.0 (24.7) | 1995 | 3239 | 4441 | 3.4 (13.1) |
| Karnataka | 253 | 596 | 1213 | 8.50 (12.7) | 674 | 1803 | 3099 | 8.1 (24.3) | 2660 | 3033 | 2927 | -0.34 (13.1) |
| Madhya Pradesh | 872 | 866 | 823 | -0.20 (3.0) | 1296 | 1292 | 1108 | 0.05 (21.8) | 1486 | 1490 | 1270 | 0.08 (20.4) |
| Maharashtra | 106 | 296 | 753 | 8.50 (22.0) | 127 | 416 | 1726 | 13.0 (36.3) | 1199 | 1432 | 2586 | 3.65 (16.9) |
| Rajasthan | 940 | 952 | 1098 | 0.90 (3.9) | 1280 | 1006 | 1643 | 3.3 (27.0) | 1363 | 1057 | 1567 | 1.68 (24.7) |
| Uttar Pradesh | 1130 | 953 | 763 | -2.00 (5.4) | 1407 | 1289 | 1149 | -1.3 (14.8) | 1247 | 1361 | 1462 | 0.56 (12.4) |
| All India | 5905 | 6412 | 8368 | 2.02 (3.9) | 8947 | 11567 | 18469 | 4.42 (11.2) | 1515 | 1804 | 2289 | 2.07 (7.8) |
| Bihar | 686 | 690 | 622 | -1.00 (8.4) | 1108 | 1530 | 1549 | 1.0 (10.2) | 1613 | 2229 | 2275 | 1.98 (8.7) |
| #Samastipur district, Bihar | — | 46.7 | 51.8 | 1.2 (11.5) | — | 111.4 | 172.1 | 5.8 (23.8) | — | 2387 | 3289 | 4.6 (15.4) |

*Notes:* CGR = Annual compound growth rate

CDV = *Cuddy Della Valle Index (*Cuddy and Valle, 1978).

Figures within parentheses indicate instability, i.e. CDV = Co-efficient of variation $*(1-R^2)^{0.5}$, where $R^2$ is the adjusted coefficient determination of the trend regression.

#For the Samapstipur district (study area), area, production and yield are given for TE 2000-01 and TE 2008-09, while CGR and CDV were estimated for the period 1998 – 2008.

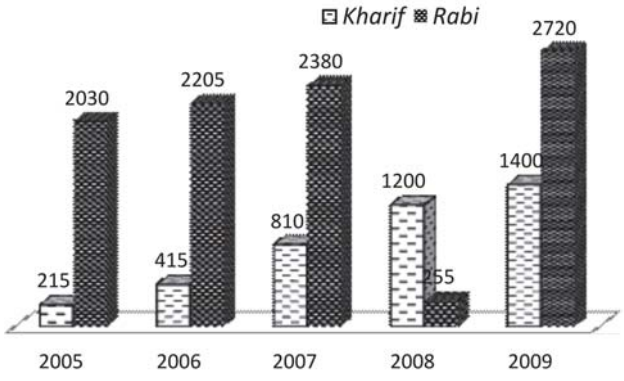


**Figure 1. Certified maize seed production ('000 tonnes) in Bihar**

incidence, while in the *rabi*-season, water availability is a limiting factor.

Both traditional and hybrid strains of maize are grown in Bihar. Area shares of hybrid maize in the total maize area in *kharif* and *summer* seasons are about 40 per cent and 70 per cent, respectively in the state. Thus, the production of hybrid maize in these two seasons constitutes nearly 45 per cent and 72 per cent, respectively (Task Force on Bihar, 2008). However, in the field surveys conducted in the Samastipur district, it was observed that farmers mostly prefer Open Pollinated Varieties (OPVs) for growing maize during the *kharif* and *summer* seasons, because of their higher tolerance to abiotic and biotic stresses. Hybrid maize is cultivated mainly during *rabi*-season because of low incidence of pest, and abiotic stresses and hence high yield (Table 2).

**Table 2. Season-wise adoption of different maize varieties by sample farmers in Samastipur, Bihar: 2010**

| Season | OPVs (%) | Hybrid (%) |
|---|---|---|
| *Kharif* | 96 | 4 |
| *Rabi* | 5 | 95 |
| *Summer* | 73 | 27 |

## The Market Map

The market map is a conceptual and practical tool that helps identify policy issues which may be either hindering or enhancing the functioning of seed value chain, and also the institutions/ organizations providing the services (e.g., market information, quality standards) that different actors need in order to make better informed decisions (Figure 3). The Market Map is made up of following three inter-linked components:

(1) Value chain actors (farmers, seed companies, dealers, distributors, etc.)

(2) Enabling environment (infrastructure and policies, institutions and processes that shape the market environment), and

(3) Service providers (business or extension services that support the value chains' operations).

The major actors in the maize seed value chains are seed companies, input suppliers (including manufacturers, wholesalers and retailers); producers; and institutional setup of state and central governments.

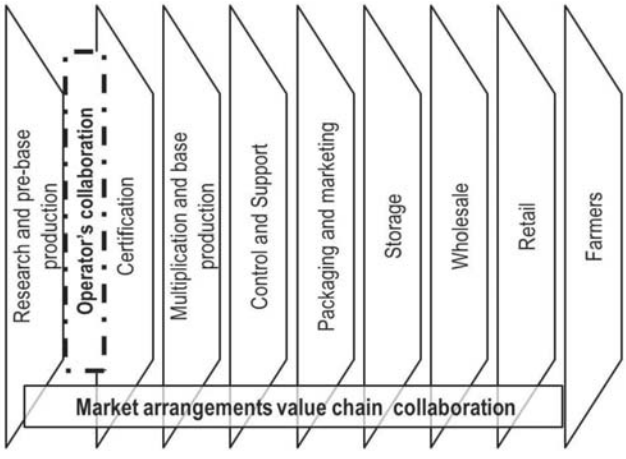


**Figure 3. Main steps in the seed value chain in Bihar**

## Value Chain Actors

**Seed Producing Agencies —** New seed varieties are developed by the universities and ICAR research station in Bihar, besides by the large/medium private suppliers such as ProAgro, Pioneer (PHI India), Monsanto, NSL, BISCO, Masina Seeds Pvt. Ltd, etc. The most common varieties of maize grown in the Samastipur district are listed in Table 3. There are some farmers who still grow traditional varieties of maize. Therefore, there is enough scope for expansion of newly developed hybrids/OPVs suiting to local environment.

Seed companies generally opt for seed production under contracts. The companies provide the parent seed (in case of hybrids 2♂:6♀ ratio) and extension services to the farmers. They buyback the harvested raw cobs at a pre-determined price. For the study, a detailed semi-structured interview was conducted with the officials

**Table 3. Most common hybrids and OPVs of maize cultivated in Samastipur district**

| | |
|---|---|
| Hybrids | MBP-555, MBP-708, NHM-360, Super-900M, X08, Pinacle-708, Super-900M Gold, JKMH-502, NK-6240, 30V11, SMH-390, NHM-909 (*Raja*), NHM-234 (*Kamdhenu*), 30V92, DK-701, HHB-146, MP-406, SeedTech-2324, KH-5991, 31Y45, HQPM-1, RHM-1, RHM-2, RHM-3, RHM-4, RHM-5, *Shaktiman*-1 to 4 (QPM), etc. |
| Composite | *Devki, Laxmi, Swan* and *Hemant* |

of Masina Seed Pvt Ltd. The company has its production base and processing plant at the Khanpur block of Samastipur district.

**Input Suppliers —** Input suppliers include fertilizer and agri-chemical companies, government distributors, small wholesalers (dealers)/retailers (distributors), and even smaller retail shops that sell small quantities of seed, fertilizer and pesticide to farmers. Combinations of different fertilizers like DAP, urea, NPK (usually 20-20-20), muriate of potash (MOP), and to a lesser extent, micronutrients such as zinc and sulphur are widely used in the production of maize. Pesticides are used for both production, storage and seed treatment.

**Government Distributors —** The Bihar branch of the National Seed Corporation and *Bihar Rajya Beej Nigan Limited* supplies a less than half of the seeds to the farmers at subsidized rates, and the rest of the demand is met by private companies or farmers use their own seeds. The National Seed Corporation has four distribution channels: government, cooperatives, parastatal entities, and private certified dealers.

**Wholesalers/Distributors —** Input wholesalers at the district level buy seeds, pesticides, and fertilizers from the government and other private players in the nearby cities. They supply inputs to village input stockists/ retailers. Some of the wholesalers also supply pesticides, fertilizers along with seeds directly to large farmers as well as to small retailers. They usually earn around 10 – 15 per cent margin on sale of maize seed. The average share of maize seed for these distributors was around 11.5 per cent of their total business value.

**Retailers/Dealers —** Input retailers operate small shops in the villages/ local market. They buy seeds and other inputs from the private wholesalers. They sell a number of maize varieties along with various fertilizers produced by different manufacturers. They earn usually a margin of 20 – 30 per cent on sale of maize seed. The average share of maize seed business is around 11 per cent of their total business value.

**Producers-Farmers —** Farmers in the study area grow wheat, rice, maize, mustard seed, a variety of pulses and horticultural crops. Most of the farmers have been practising the same crop rotation pattern of rice and wheat on the same fields for years rather than alternating with other crops. Smallholder farmers use grain for family consumption, and the surplus is sold in the open market.

### The Enabling Environment

The enabling environment consists of critical factors that shape the value chain ecosystem and operating conditions. These "enabling environment" factors are created by organizations (national and local authorities, research agencies etc.), and institutions (policies, regulations and practices) that are beyond the direct control of economic actors in the value chain. The purpose of charting this enabling environment was to understand the factors that affect the entire value chain, and to examine the powers and interests that are driving the change (Figure 4). This knowledge helps determine the avenues and opportunities for realistic action, lobbying and policy entrepreneurship.

### Service Providers

**Business and Extension Services —** In most effective value chains, the actors who actually form the chain (i.e. transact the main product) are supported by business and extension services from other enterprises and support the organizations catering different needs such as input supplies (seeds, fertilizers, irrigation, etc.), market information (prices, trends, buyers, and suppliers), financial services (such as credit, savings or insurance), transport and logistics, etc. There is a consistent need for all the chain actors to access these services timely and efficiently. The Market Map framework is concerned with mapping these services that support, or could potentially support, the value chain's overall efficiency.

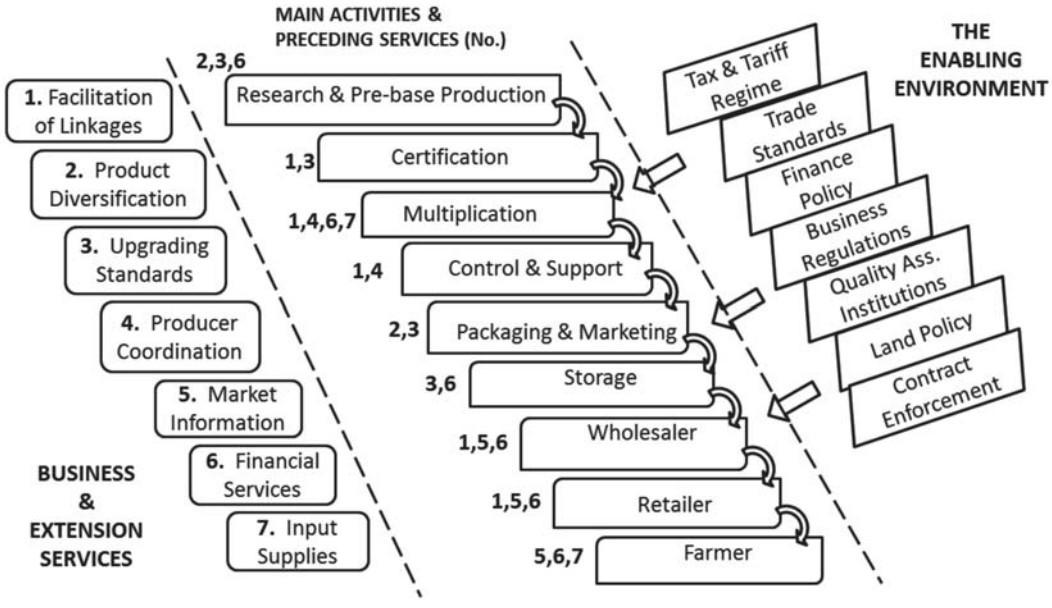


**Figure 4. Different services involved in maize seed value chain**

## Value Chain Analysis of Maize Seed in Samastipur District

Three maize seed value chains that existed in the Samastipur district were (Figure 5):

- Private maize seed value chain
- RAU, Pusa, Samastipur maize seed value chain
- IARI Regional Station maize seed value chain

## Private Seed Value Chain (*Masina Seed Pvt. Ltd)*

There are around 43 private seed companies in the state registered with the Bihar Seed Certification Agency. Most of these companies produce seed on their own farms and sell it after labelling their own brand. Masina Seed Pvt. Ltd is a medium-size company located at Masina village in the Khanpur block of Samastipur district. The company is registered under the Company Act, 1956. It produces maize seed in the nearby villages under the formal contract with the farmers. It provides parent seed to the farmers in 2:6 ratio (♂/♀) at ₹ 110/kg. The extension services are provided free of cost. Farmers produce seed and have an informal agreement to sell it to the company. The operational production cost for the farmers is estimated to be ₹ 14460/acre which is equivalent to around ₹ 589/q of cob, translating into cob yield of 24.55 q/ acre (or 3.9 t/ha of grain yield). During 2010, company bought back maize cob for seed purpose at ₹ 875/q (Table 4). Thus, the farmer got an operational profit of about ₹ 286/q of cob or about ₹ 7000/ acre.

**Table 4. Estimated maize seed cost to private seed company: 2010**

| Particulars | Cost (₹/q) |
|---|---|
| Cob | 875 |
| Raw seed* | 1458 |
| Processing and packaging cost | 1300 |
| Storage cost | 800 |
| Marketing cost** | 1073 |
| Transportation cost | 600 |
| Total cost | 5231 |

*Notes:* *Raw seed conversion from cob 65 per cent
**Marketing cost ranged between 20 and 30 per cent

After considering the conversion cost from cob to seed, the procurement cost of the hybrid seed to the company was estimated to be around ₹ 14.60/kg. The company does in-house processing & packaging, storage and marketing of the seed which cost around ₹ 13/kg, ₹ 8/kg and ₹ 10.73/kg, respectively. Transportation cost was estimated to be ₹ 6/kg. In the process of sale of seeds, the distributor gets a margin of 10 - 15 per cent, while the dealers get 20 - 30 per cent. In the whole process, company has the margin of around ₹ 58/kg. Finally, farmers purchase the hybrid seed at ₹ 170/kg from retailers.

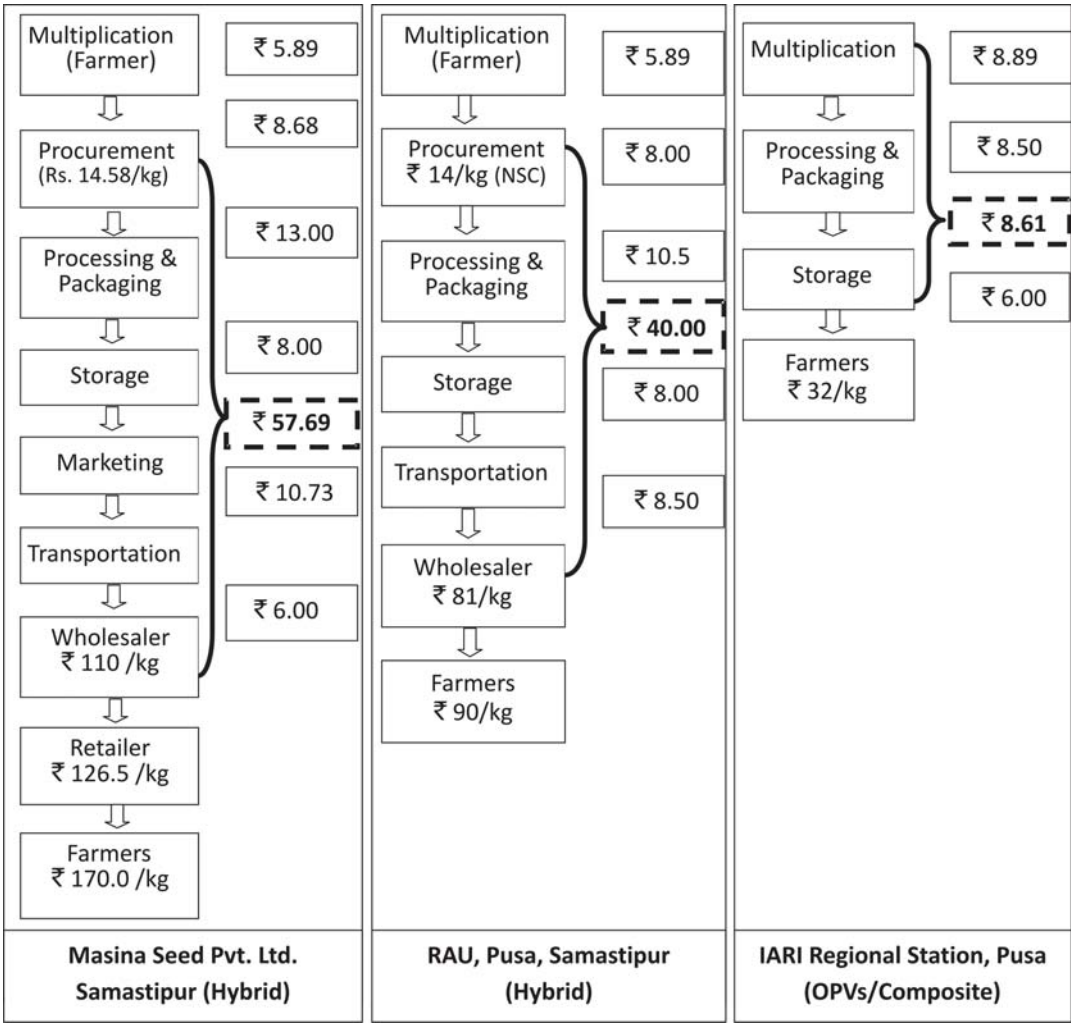


**Figure 5. Mapping multiple co-existing maize seed value chain in Samastipur district, Bihar**

## RAU, Samastipur Seed Value Chain

The Rajendra Agricultural University, Samastipur, also produces maize seed on its own farm and also on farmers' fields. However, it doesn't have any formal contract with the farmers. It supplies parent seed at reasonable price (not disclosed by the officials nor could be contacted from the concerned farmers) to farmers and provides extension services free of cost. The production cost is almost similar to that for the private company (₹ 5.89/kg). The University procures seed from farmers at the price at which the National Seed Corporation (NSC) procures (₹ 14/kg in 2010-11). The preliminary in-house processing & packaging, storage and transportation costs were estimated to be about ₹ 10.50/kg, ₹ 8.00/kg and ₹ 8.50/kg, respectively. The entire seed was being sold from University's sale counter. The seed was then either sold to distributor/ wholesaler at around 10 per cent discount on retail price, or directly to the farmers at the rate of ₹ 90/kg. At the end, the University has the margin of around ₹ 40 - 50/kg.

## IARI Regional Station Maize Seed Value Chain

The regional station of IARI located in the RAU campus is also involved in seed production of Open Pollinated Varieties (OPVs) of maize at its own farm. The station is not involved in maize seed production at farmers' field. Though under the farmer's participatory seed production program, it has the provision to distribute the parent seed to the farmers on limited scale and purchase back the seed after multiplication at a price 25 per cent more than the price paid by NSC. The station also produces seed of OPVs on its own farm. The production cost (operational) at

its own farm was estimated at ₹ 8.89/kg. It markets seed directly to the farmers at ₹ 32/kg. The station has a lean margin of around ₹ 9.00/kg after meeting all the cost of OPVs seed production.

## Backward and Forward Linkages in Maize Seed Value Chain

### Horizontal Linkages

There appeared to be no horizontal linkages in the functioning of the value chain from farmer (producer) to the end-user farmers of maize grower. Some Self Help Groups (SHGs) were there in the villages, while few co-operatives were doing the group buying of the agri-input maize growing.

### Vertical Linkages

Vertical linkage was strong between the seed companies and contract farmers. There was a written contract agreement between farmers and companies. Companies provided parent seed and extension services to the farmer. The farmers paid only for the seed cost, whereas the extension services were made available free of cost. In the agreement, the contract farmer had to deposit ₹ 700/ acre as security money. After harvest, farmers sold the raw cobs to company (₹ 875/q in 2010-11). In case of breach of contract by the farmer, he loses the security money. Seed companies have the forward linkages also with the distributors/wholesalers. Company supplies the seed as per the prior demand to their registered distributors. Down the value chain, distributors in turn supply the seed to their dealers/ retailers.

The public sector agencies like RAU or IARI Regional station have no formal contract with the maize seed grower farmer. After harvest, if the farmers wish, can sell their seed or get certified and labelled from these agencies. For instance, in the previous season, IARI regional station had buy-back provision for the seed at 25 per cent above the NSC price (RAU seed production division also had some of their registered distributors). It supplied the seed to them as per prior demand on 10 per cent discount.

## Performance of OPVs and Hybrid Maize

Hybrid maize performed better at farmers' fields, particularly during the *rabi* season as compared to OPVs performance. From field survey, the production costs for maize varied from ₹ 9360/acre to ₹ 13180/ acre (Table 5). Gross margins also varied from ₹ 1170/ acre to ₹ 10110 /acre, depending on the yield of the crop (Figure 6). This huge variation indicates inefficiencies in input-use besides adoption of different types of seeds. Even though, production cost was higher in the case of hybrids (₹ 13180/acre) than OPVs (₹ 9360/acre), it was compensated by the higher yield of hybrids.

**Table 5. Estimated maize production cost per acre**

| Particulars | Unit cost (₹/Unit) | Quantity | Cost range (₹) |
|---|---|---|---|
| Ploughing | 400 | 4-5 times | 1600-2000 |
| Irrigation | 640 | 2-5 times | 1280-3200 |
| Seeds | 70-170 | 8 kg | 560-1360 |
| DAP | 650 | 2 Bags (50 kg) | 1300 |
| Urea | 300 | 3 Bags (50 kg) | 900 |
| MOP | 300 | 1 Bag (50 kg) | 300 |
| Zinc | 45 | 10 kg | 450 |
| Pesticides/ Herbicides | 150 | 1 (No.) | 150 |
| Labour | 100 | 25-40 (No.) | 2500-4800 |
| Total | | | 9360-13180 |

*Notes:* Yield* =10.21q/acre -24.57 q/acre;
Gross Margin**= ₹ 1170/ acre to '₹ 10110/ acre
* Yield is average of all the three season for OPVs and hybrids, respectively.
**Based on sale price of '₹ 1000/quintal

A wide variation was observed in maize yield realized by the sample farmers across seasons and types of maize grown. Out of 150 maize-growers surveyed, hybrids were cultivated by 137 farmers (fully or partially) during *rabi* season, 4 in *kharif* and 5 in *summer* season, while OPVs were grown by 105 farmers during *kharif*, by 17 farmers during *summer* and by 2 farmers only during *rabi* season. Productivity level of the OPVs varied from 562 kg/acre during *summer* to 1350 kg/acre in winter (*rabi*) season. Contrary to it, the productivity of hybrids varied from about 600 kg/acre in *summer* to as high as 4285 kg/ acre in *rabi* season (Figure 6).

During *kharif* season, farmers harvested an average maize yield of 788 kg/acre for OPVs, and 975 kg/acre of hybrids. In the *rabi* season, the average maize yield

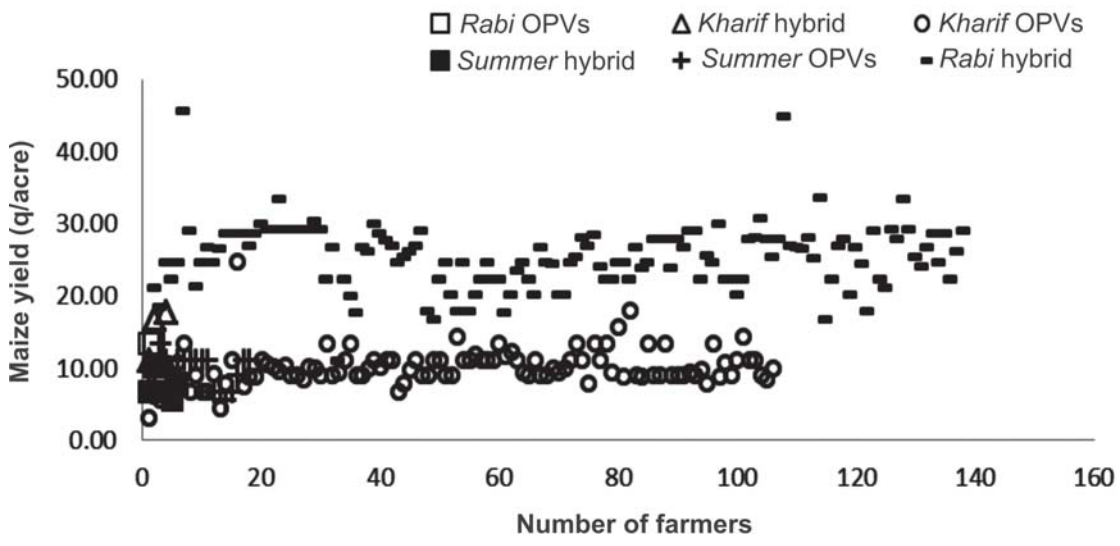


**Figure 6. Performance of hybrids and OPVs at sample farmers' field in Bihar**

of OPVs and hybrids were 1350 kg/acre and 2561 kg/acre, respectively. During *summer* season, farmers harvested grain yield of 1023 kg/acre and 1375 kg/acre from OPVs and hybrids, respectively. Market share of hybrids was little higher than that of OPVs. Hybrid had a higher acreage in *rabi* but in *summer* and *kharif* seasons, the OPVs dominated, because of little yield difference between hybrids and OPVs.

**Challenges Faced by Maize-growers**

Constraints to maize production faced by the farmers were analyzed and are presented in the radar map on a scale of 0-3 (0 means no constrain and 3 depicts the highest level of constraints) (Figure 7). Farmers reported that major challenges were uncertain climate conditions like drought and flood, poor information access, lack of credit availability, poor

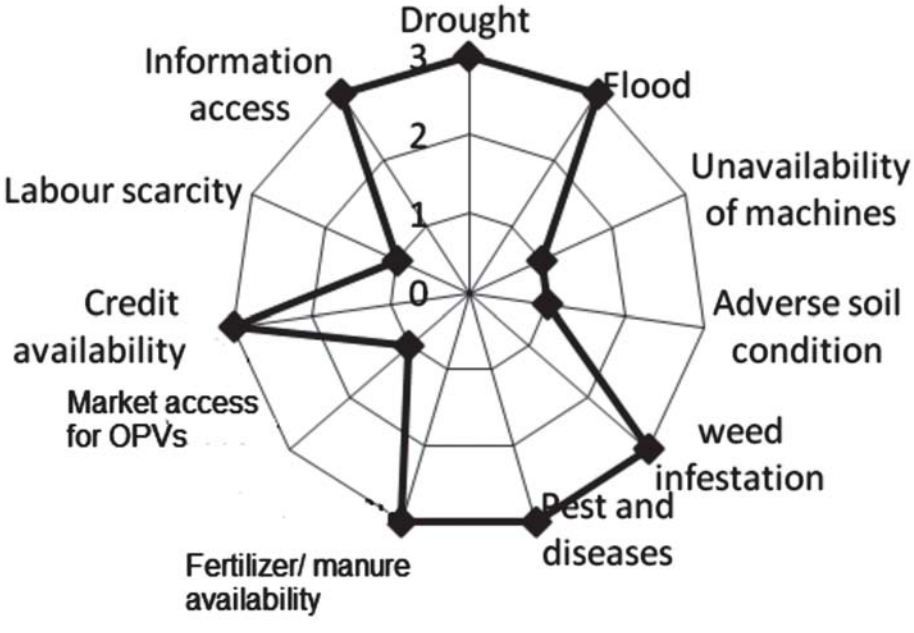


**Figure 7. Major constraints faced by maize growers in Samstipur, Bihar**

input availability, and high weed infestation. Whereas labour unavailability, mechanization, adverse soil condition and market access for input as well as output were the minor constraints. Maintaining isolation distance was the most critical for hybrid seed production, but was a major challenge for the hybrid seed producer. On the other hand, breach of contract between parties, brand identity and brand copycat, under-developed infrastructure, re-packing of seed down the value chain, lack of co-ordination and sharing of information among players were the other constraints at the market place.

## Conclusions and Policy Implications

Bihar has emerged as one of the most promising states in terms of maize production in India. However, performance of maize seed industry in the Bihar state has been adversely affected by the non-price constraints. Despite release of many improved cultivars (hybrids and OPVs) by various seed companies and public institutions, the new maize varieties have not been taken up by the farmers as enthusiastically as was expected. This may be due to inadequate facilitation of the promotional activities and weak horizontal linkages among research, extension and seed companies.

It has been observed that public research institutions though have adequate R&D facilities, lack the marketing bent to popularize their products. The farmers have also felt that the improved varieties need huge capital investment in terms of assured irrigation and fertilizer to respond to their potential. This has undermined the extent of adoption of certified maize seed with the probable consequent effect of high seed prices brought about by reduced economies of scale. There is need to harmonize existing laws and regulations governing the seed sub-sector besides ensuring good and stable producer prices; quality farm inputs and improved extension services. Public research institutions should also evolve measures to take their products to the growers, demonstrate the potential of the seeds developed and produce the seed materials adequately to fill the gap left open by the private players. Most importantly, development of efficient and integrated maize grain market is essential to drive the sector hand-in-hand with the maize seed sector in the region.

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