



An Assessment of Maize and its Value Chain in Bihar

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ABSTRACT

Background: Maize also known as *Zea mays* L. is a popular crop in most of the developing countries and cultivated across the world because of its nutritional benefits and its multiple use. Bihar is one of the major maize growing states in India. An analysis of production and its value chain will help the state in providing the further direction for policy making.

Methods: The current study explores the status of maize production in Bihar in terms of growth rate and instability index based on the available secondary data for maize production in Bihar from 2000-2021. It also develops a framework of its value chain in the state based on the available secondary related to its inputs and production.

Result: The study identifies that the production and yield of maize crop in Bihar have a positive growth trend with a instability ranging between low to medium in case of rabi and summer maize which shows that it is a promising crop in Bihar for improving the income of the farmers. The analysis of the maize value chain reveals that the cost of cultivation of maize in Bihar is ₹56047.96 per hectare whereas the cost of production is ₹1412.98, the major actors in the value chain includes small and marginal farmers, private agro dealers, Krishi Vikash Kendra (KVKs), ATMA, state and central agricultural universities and BRLPS along with Farmer Producing organisation.

Key words: Cost, Government initiative, Maize, Marketing channels, Value chain.

INTRODUCTION

Maize is considered as a popular cereal crop and is cultivated widely throughout the world. It has high carbohydrate, fat, protein, minerals and some vitamins. The presence of carotenoids (β -carotene, cryptoxanthin and β -zeacarotene having *Pro Vit A* activity) makes it an important crop which could be used to solve the problem of protein malnutrition presence in the world (DAMC, 2019). Maize is one among the three most important food crops that are produced and consumed as major source of food calories by the human being (Awika, 2011). In the various parts of Africa and Mesoamerica maize contributes almost 20% of food calories, furthermore it is an important source of food calories to 4.5 billion people in 94 developing countries (Shiferaw *et al.*, 2011). Moreover, maize is also used as an animal feed and an important industrial ingredient for various sectors including starch, food processing, bioethanol because of its molecular versatility (KPMG *et al.*, 2014). It is also known as the queen of cereals as it has the higher genetic yield potential and wider adaptability under diverse environment differing in terms of soils rainfall and weather (Prusty *et al.*, 2017; Dhakre and Sharma, 2010). Different types of maize are grown in highly diverse climatic condition across the world. Not only this maize generates an employment opportunity for more than 650 million people at farm level and by growing maize farmers could be able to save 90 per cent water and 70 per cent power (FICCI and PwC, 2018).

Global maize production and India

The global production of maize is 11,41,360 thousand tonnes spread across area of 1,96,357 thousand hectare with yield of 5813 kg/hac (Mo A and FW, 2022). India ranks 6th position in the world maize production (Fig 1). In India,

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maize is sown during *Kharif*, *Rabi* and spring period. Fig 2 indicates the major states producing maize in India are Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, West Bengal, Rajasthan, Bihar, Andhra Pradesh, Uttar Pradesh and Telangana.

Maize is also identified as a crop for doubling farmers' incomes in India. Bihar is one among the major state producing maize. The growing demand of maize is because of its used in sectors like cattle feed, Processed food like corn flakes *etc.*, biofuel production *etc.* It is considered as an important fodder crop grown in India (Kumar *et al.*, 2014).

MATERIALS AND METHODS

The data for the analysis of the study had been taken from various secondary sources. The data related to production, yield and yield of maize in Bihar is taken from various issues of Bihar Economic Survey Conducted by Government of Bihar (2007-2021). The data related to the cost of cultivation and production of maize is taken from Ministry of Agriculture and Farmer welfare (n.d.) for the year 2019-20. Further in order to

access the current status of storage unit available and its capacity utilization in Bihar reports of Food Corporation of India (2022a) and Food Corporation of India (2022b) have been utilised. In order to develop the current frame work of maize value chain in Bihar various literature had been consulted.

In the above study to calculate the status of maize in Bihar the data of area, production and yield were used to calculate the compound annual growth rate (CAGR) for last 21 year, using the following functions:

$$Y = ab^t$$

$$\ln Y = \ln a + t \ln b$$

$$b = \ln(1+r)$$

Where,

Y= Dependent variable= Area/Production/Yield of maize crops.

a= Constant.

t time period (1,2,3.....n).

Where,

2000-01= 1 and so forth.

b= Regression coefficient (growth rate in the series).

Further the compound annual growth rate is computed by $r = (\text{antilog } b - 1)$.

When multiplied by 100 it gives compound annual growth rate.

$$\text{CAGR (\%)} = r = (\text{Antilog } b - 1) \times 100$$

For computing the Instability Index Cuddy-Della Valle Index is used which is calculated in terms of, Cuddy-Della Valle Instability Index (%) which is an improvement over coefficient of variation method as the later overestimates the level of instability in a time series data while the former accommodates the trend that is present in a time series data (Kumar *et al.*, 2013).

$$CV \times \sqrt{1 - R^2}$$

Where,

CV = Coefficient of variation in per cent.

R^2 = Adjusted coefficient of determination from a time trend regression.

Also, in this study simple averages are used to analyse large data set.

$$A = \frac{1}{n} \sum_{i=1}^n a_i$$

RESULTS AND DISCUSSION

Maize in Bihar

Bihar is one of the major maize growing states in India. In Bihar major maize growing districts are Katihar, Purnea, Begusarai, however the highest yield of maize was recorded in Araria district as per Economic survey 2021-22. In the recent years Bihar has emerged as one of the promising states for maize production. The area, production and yield of Maize crop in Bihar from 2000-01 to 2020-21 reveals that in past years the yield and production of maize crops has shown a tremendous growth in Bihar.

Table 1 below depicts that the production and yield of *rabi* maize and summer maize is fairly high in Bihar. The table also shows that the *rabi* and summer maize crop had

registered a positive growth in terms of area, production and yield in Bihar. The *rabi* maize had registered a growth rate of 8.38% and 5.28% in term of production and yield. Also the area under the *rabi* maize had registered a significant growth in the study period *i.e.* 2.93% as compared to summer maize and *kharif* maize which is 0.45% and - 0.92 per cent.

While the *kharif* maize in Bihar had shown a negative growth in terms of area the production and yield under had registered a meagre growth. This may possibly happen because of waterlogging which is one of the major abiotic stress in Bihar. The districts falling in the Gangatic area such as Patna, Begusarai, Khagaria, Bhagalpur and Koshi regions which includes namely Katihar, Saharsa, Purnia, Khagaria, Madhepura, Kishanganj, Araria and Supoul are flood prone. As such in this case the *kharif* crops may face waterlogging at various stages during harvesting which may result in low yield and production. The area under the maize shows a low instability while the instability index is high for *kharif* maize whereas the *rabi* maize which shows a promising growth in term of both production and yield had a medium instability index. Summer maize has also a medium and low instability in production and yield respectively. Thus, the production and yield of maize crop in Bihar have a positive growth trend with a instability ranging between low to medium which shows that it is a promising crop in Bihar for improving the income of the farmers.

The concept of value chain

The concept of value chain was given by Michael Porter in 1985 according to which value chain is a set of interlinked value creating activities performed by an organisation, these activities may begin with procurement of raw materials go through processing in various stages and finally reaches the ultimate consumer. Value chain of a company is linked to its upstream supplier and downstream buyer forming a series of chains termed as value system (Kazmi, 2011). Hence value chain assessment of an agricultural commodity is a set of interlinking activities where each activity results in adding value to the product; it consists of various function that convert raw material into a finished product, various supporting institutes and macroeconomic framework like financial services, subsidy, laws and regulation, extension and advisory services *etc.* and value chain actors such as farmers, input suppliers, intermediaries *etc.* Who performs the functions. Fig 3 depicts a probable value chain of an agriculture commodity.

The main elements of any value chain include

Functions

Function of value chain represented by input supply, production, collection, processing and retailing.

Actors

Actors of the value chain includes local marketers, small holder farmers, input supplier *etc.*

Supporting

Supporting Institutes includes regulating agencies international research organisations, NGOs, credit institutes, research and development organisations.

Maize value chain in Bihar

Functions

The major function in maize value chain consists of Pre-production stage, Production process and harvesting stage,

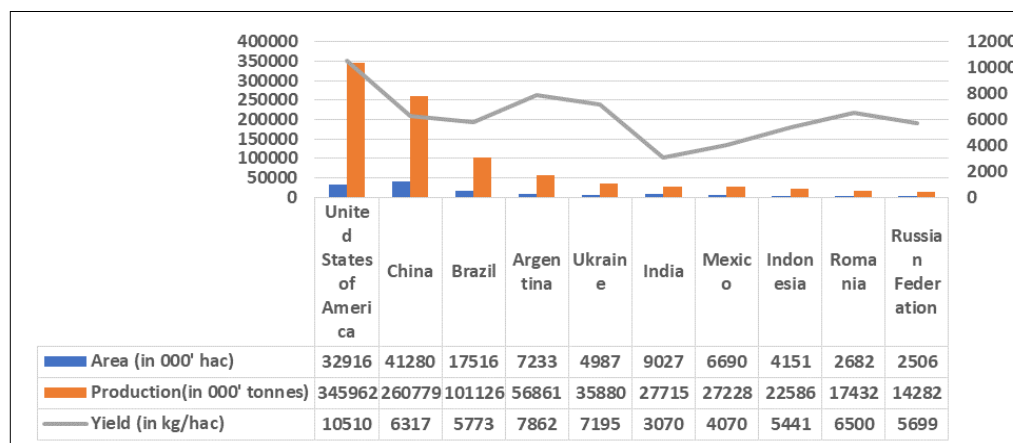


Fig 1: Maize global scenario.

(Source: Mo A and FW, 2022).

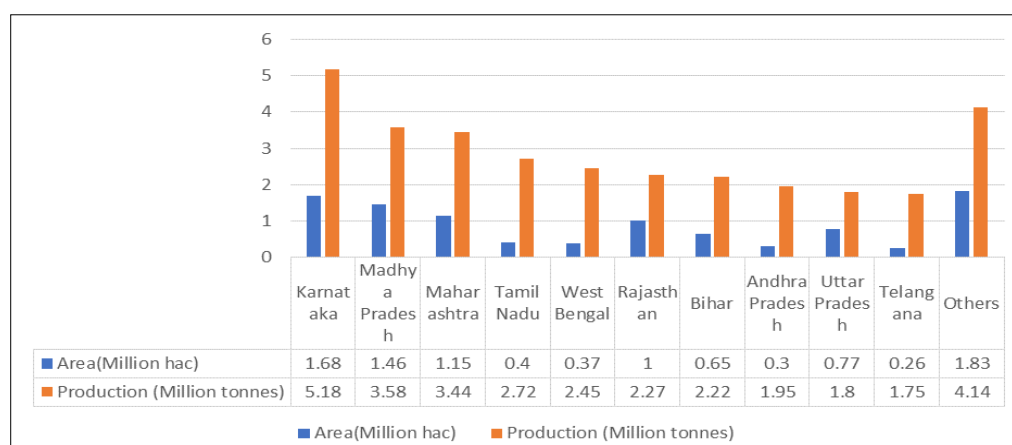


Fig 2: Fourth Advance estimate of maize area and production (2020-21).

(Source: Mo A and FW, 2022).

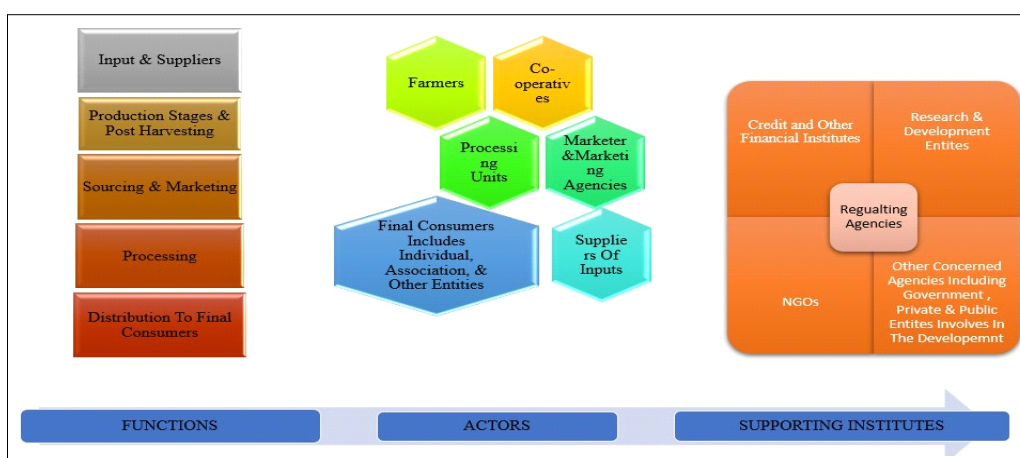


Fig 3: Agriculture commodity value chain.

post-harvest which includes storage and processing, Marketing activities.

Pre-production stage

The pre-production stage mainly consists of basic operations in maize which includes mainly land preparation and sowing of seeds, fertilization, weeding and sowing of seeds and selection of seeds (DAMC, 2019).

The method of land preparation differs depending upon farmers economic status and land owned generally it is observed that farmers used both tractors and animals for ploughing (Otieno, 2019). During ploughing 50 kg of DAP, 50 kg of Urea, 25 kg of potash are used with some organic manure. However, in case of Bihar there are limited evidences of using bio techniques to protect the fertility of land for future crops (Kumari *et al.*, 2015). Pesticides are used in production storage and seed treatments.

In the recent year there is a gradual increase in hybrid seed production which has resulted into high SRR in maize. Table 2 states the SRR in Bihar over the year have been positive.

During the *kharif* season seed production is less preferred due to water logging, flood and disease incidence

while in limited water availability is an issue. The study done by (Kumar *et al.*, 2012), reveals that farmers prefers open Pollinated Varieties in *kharif* seasons since these varieties could tolerate abiotic and biotic stresses and hybrid maize are preferred in *rabi* season as pest and abiotic stresses are low. Universities and ICAR research station developed new seed varieties in Bihar other players are the large and medium suppliers such as ProAgro, pioneer (PHI India) *etc.*

Production and harvesting stage

Table 3 indicates that cost of cultivation of maize in Bihar is `56047.96 per hectare whereas the cost of production is `1412.98 quintal which includes managerial cost also and the yield per hectare is 41.22165 quintal per hectare (Mo AFW, n.d.).

Post harvesting stage

The major operations under post-harvest operations includes drying, threshing, winnowing, grain storage, transportation and milling. The traditional post-harvest practices include sun drying, manual and animal-based threshing, traditional farm level storage (FICCI and Yes Bank, 2021). Both manual and mechanical threshing are

Table 1: Growth and variability of maize in Bihar from 2000-2021.

Maize crop based on seasonality	Instability index (%)			CAGR (%)		
	Area	Production	Yield	Area	Production	Yield
<i>Kharif</i>	7.78	32.76	28.92	-0.92***	0.79	1.72
<i>Rabi</i>	5.53	28.25	21.67	2.93***	8.38***	5.28***
<i>Summer</i>	6.92	18.89	14.98	0.45*	4.25***	3.78***

Note :***Indicates significance at 1%, **Indicates significance at 5%, *Indicates significance at 10%.

Table 2: Distribution of certified seed and seed replacement rate for maize crop.

Year	<i>Kharif</i> maize			<i>Rabi</i> maize		
	Requirement (000' quintal)	Supply (in 000' quintal)	SRR (in percentages)	Requirement (000' quintal)	Supply (in 000' quintal)	SRR (in percentages)
2004-05	16.5	11.382	40%	18.65	20.734	45%
2005-06	21.5	10.32	50%	20.3	22.942	50%
2006-07	41.5	20.88	50%	55.00	54.2	60%
2007-08	50	42.39	56%	75	74.34	74%
2008-09	41.58	42.85	57%	80	78.21	78%
2009-10	45	28.95	58%	85.85	87.15	102%
2010-11	49.14	33.015	65%	90	92.62	92%
2011-12	49.1	41.7	82%	60	61.9	100%
2012-13	75	61.5	82%	130	114.8	85%
2013-14	95	19.1	20.15%	130	126.4	85%
2014-15	NA	NA	NA	226.45	207	90%
2015-16	90	9.05	10.45%	90	70.65	80.66%
2016-17	90	11.96	13.82%	112.5	108.78	87.02%
2017-18	81.7	13.05	15.97%	73.1	72.68	85.51%
2018-19	82.65	13.42	16.90%	87	82.7	87%
2019-20	83.6	21.02	26.80%	74.8	100.46	99.40%
2020-21	NA	8.55	10.70%	NA	105.71	100.30%

Source: Various issues of Bihar economic survey (Government of Bihar 2007-2021).

prevalent among farmers also farmers prefer sun drying mostly and for storage jute bags are preferred by the farmers.

Storage is another factor that affects the quality of maize better storage results in maintaining the quality of the maize and less loss in physical quantity during storage. Table 4 reveals the current number and capacity of storage available in Bihar. The government as well as private player exist in this sector however there is further scope of expansion so that the produced can be stored during distress sale

especially in rabi season. Traditional sources of storages are also used by the farmers.

The food processing sector is still in nascent stage in Bihar. The rising income and changing lifestyle of rural and urban Bihar lead to change in consumption pattern and hence there is a surge in demand for packaged food items. Maize is one of the sector in food processing industry in Bihar that is considered by Government of Bihar as a high priority sector for development. The state currently offers substantial

Table 3: Estimates of cost of cultivation of maize in Bihar.

Particulars	Year: 2019-20	` per hectare		
Operational cost		Total cost	Material and labour Input	Rate per unit
I. Operational cost				
1.1.1 Human labour	Family	9233.57	326.5	29.74
1.1.2 Attached		0		29.74
1.1.3 Casual		8637.37	274.34	
1.1.4 Total human labour		17870.94	600.84	29.74
1.2.1 Machine labour	Hired	6021.26		
1.2.2 Owned		36.95		
1.2.3 Total cost of machine and owned labour		6058.21		
1.3 Seed		2717.4	19.47 kg	139.57
1.4 Fertilizer	Fertilizer	4082.88	140.058 kg	29.151
1.5 Manure		35.44	0.355 qtl	99.959
1.6 Insecticides		0		
1.7 Irrigation charges		7314.59		
1.8 Crop insurance		0		
1.9 Miscellaneous		1.2		
1.1 Interest on working capital		901.46		
Total operational cost				38982.12
2 Fixed costs				
2.1 Rental value of owned land		15649.95		
2.2 Rent paid for leased-in-land		0		
2.3 Land revenue, taxes, cesses		112.05		
2.4 Depreciation on implements and farm building		396.75		
2.5 Interest on fixed capital		907.09		
Total fixed cost				17065.84
Total cost [1+2]				56047.96

(Source: MA and FW, n.d.).

Table 4: Number and capacity wise storage with FCI in Bihar.

(As on July 2022)

Agency wise	Number of storage unit available with FCI	Storage capacity with FCI (in lakhs metric tonnes)
FCI owned	12	4.07
Central warehousing corporation	8	0.69
State government	1	0.03
State warehousing corporation	34	3.21
PEG (Under private entrepreneur guarantee scheme)	19	2.53
Other (under private warehousing scheme, private parties)	7	0.74
Total hired	69	7.21
Total (FCI owned + hired)	81	11.28

(Source: Compiled from various report of Food Corporation of India 2022a and 2022b).

investment opportunities in the field of maize processing. The major opportunity includes the feed units which are maize based for ex: cattle feed, fish meal, poultry feed, food processing units, Starch Manufacturing Unit and other products made from maize. It does not include primary processing like grading sorting etc (Department of Industries, 2017).

Marketing activities

The various agencies involved in the assembling of maize are farmers, village level traders, Merchants, wholesaler and Retailers, cooperatives, various government organisation like FCI, State government. Jeevika also known as Bihar Rural Livelihood Promotion Society (BRLPS), Maize Processor and stocker etc. Some commonly identified marketing channel of maize in Bihar are shown in Fig 4.

A maize grower normally sales it through the above-mentioned channel. Few growers also take the route of BRLPS. Few large and medium farmers sales through Mandis also. Railway point maize trading through licensed commission agents and traders is also used by the maize growers who are licensed and sold he produce to poultry feed and other industries. The major criteria for selecting a channel depends upon the return that the producer is getting, commission charges, transportation cost etc. Normally farmers prefer shorter channel with minimum market cost. The major mandis for maize in Bihar are Gulab Bagh Mandi, Naugachia, Khagaria.

Actors

Major actors in the maize value chain are farmers which includes small and marginal farmers, medium and large

farmers, who are the producer of the crop. Fig 5 shows the top five maize producing district in term of area and production based on the triennium average (TE) for 2018-21 in Bihar.

TE average (2018-21)

In these districts a majority of the 81% (Table 5) of the farmers have less than 1 ha. of Land holding. Hence majority of the maize growing farmers are small and marginal whereas only 6% of the farmers are having more than 2 hac landholdings (NABARD, 2021).

In the field of maize processing altogether there are 43 units as on august 2016 of which 32 units were operational (Sinha *et al.*, 2018). The Annual Survey of Industries 2018-19 states that currently 884 registered food processing units are operating (Mo SPI, 2021).

The distribution of seed in Bihar is done mostly by private agro dealers and Krishi Vikash Kendra (KVKs). The information related to seed is provided to farmers majorly through District Agriculture Officer from the state and KVKs by the central government. In addition to these two ATMA (Agricultural Technical Management Agency) also provides service related to pesticides, fertilizers and mechanisation. Furthermore, there are several small farmers association like Vaishali Agriculture Small Farmers Association Bihar Mahila Samakhya Society at the village level which provide a range of services to their member farmers which include mainly access to fertilizer, quality seed, support for collective marketing of products etc. Few of the FPOs like Aranyak Agri Producer Company Limited (AAPCL) Promoted by Jeevika has been able to deliver high price to the maize growers.



Fig 4(i)



Fig 4 (ii)



Fig 4 (iii)

Fig 4: Some commonly identified marketing channel in Bihar.

Supporting services and macro economic environment

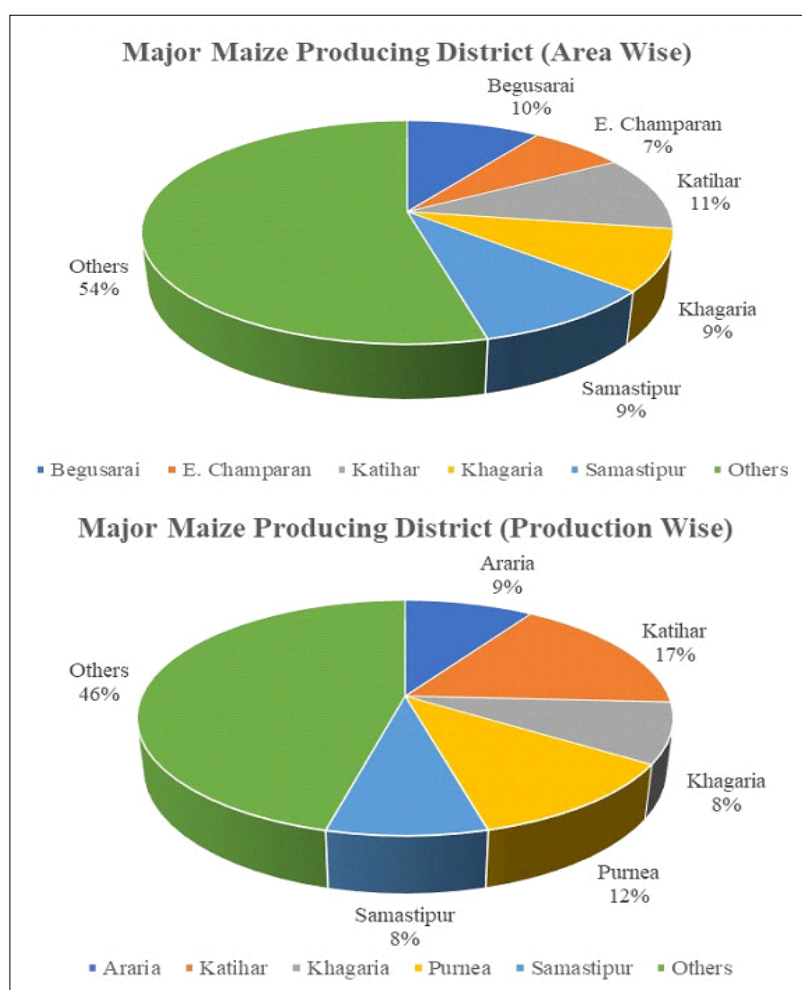
The various supporting services includes services provided by the financial institution and intermediaries such as commercial bank, Regional Rural Banks, cooperative, insurance companies for providing credit to meet long term and short-term requirements, crop insurance for risk

mitigation. Agriculture extension services for better information and knowledge related to various practices in maize crops. In Bihar currently two agricultural universities and Krishi Vikash Kendra's are operating for providing support to farmers in agriculture. Regional Maize Research and Seed Production Centre, Begusarai, established in May

Table 5: Pattern of landholdings of major maize producing districts.

Districts	≤ 1 Ha		>1 to ≤2 Ha		>2 Ha	
	Total holdings		Total holdings		Total holdings	
	Numbers	Percentage	Numbers	Percentage	Numbers	Percentage
Araria	77152	48	63132	40	19464	12
Katihar	377624	90	27788	7	14881	4
Khagaria	83844	72	20971	18	11092	10
Samastipur	318209	86	31085	8	22062	6
Purnea	193208	88	16503	7	10921	5
Begusarai	263027	76	78710	23	6254	2
E. Champaran	436087	84	40170	8	45563	9
Total	1749151	81	278359	13	130237	6

(Source: Compiled from various issues NABARD, 2021).

**Fig 5:** Major maize producing districts in Bihar (Production and area wise).

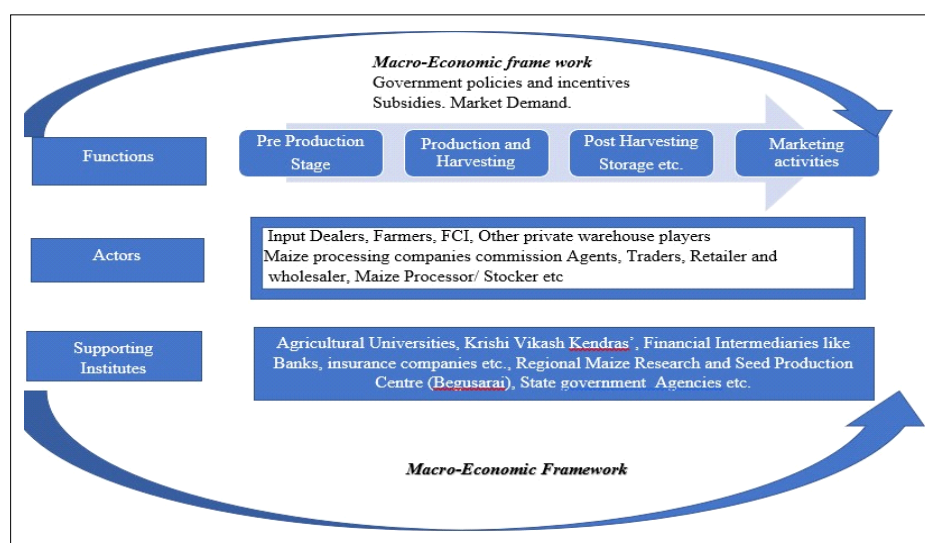


Fig 6: A conceptual framework of maize value chain in Bihar.

1997 to provide support for developing maize hybrid varieties suitable for eastern zone. The centre is also engaged in extending various maize technologies to farmers through field demonstration kisan melas etc.

Furthermore, state government is also taking various incentives for maize producer. Maize is considered as priority sector for investment under food processing sector by Government of Bihar. Other stakeholders include NGOs, Jeevika, the State Rural Livelihoods Mission unit in Bihar. Based on above discussion, Fig 6 depicts the present value chain of maize crop in Bihar.

CONCLUSION

Maize is considered as an important crop for doubling farmers income because of its use in various sectors and it is also a rich source of carbohydrate protein and vitamin. Several empirical research Proper analysis of maize value chain could be helpful for improving the yield and production of the crop. Value addition in maize crop will help the farmers to get good realisable value. In addition to this intervention on the part of the state government to promote farmers associations would help the small holders to strengthen their bargaining power and getting access to fair market price. A proper business model for the development of these association will help in boosting their income at grass root level.

Conflict of interest: None.

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