Management of Aflatoxins and control of Khapra beetle in Maize produced in Pakistan

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Introduction

- **Maize is the 3rd important food grain crop of Pakistan with estimated production of 9.5 million tons in 2024-25. This is less than production of 10.634 million tons during 2023-24.**
- **Out of the maize production in 2023-24 about 9.739 million tons was produced in Punjab and 0.886 million tons in KPK.**
- **The contribution of maize in agriculture value added product is 3 percent and 0.7 percent in GDP.**

Top Exporters of Maize in the World

(Value-Billion USD, Quantity-Million Tons)

Exporters	2020		2021		2022		% Share in World exports	Major Export Markets
	Value	Quantity	Value	Quantity	Value	Quantity		
World	36.70		51.90		62.87			
United States of America	9.58	51.88	19.02	69.72	19.03	58.60	**30.3**	**China,** Mexico, Japan
Brazil	5.85	34.43	4.19	20.43	12.26	43.39	**19.50**	Iran, Spain, Japan
Argentina	6.05	36.88	9.06	39.95	8.61	33.01	**13.70**	**Viet Nam**, Korea, Peru
Ukraine	4.88	27.92	5.89	24.68	5.99	25.18	**9.50**	**China**, Romania, Spain
France	1.72	4.55	1.94	4.30	2.37	5.16	3.80	Spain, Netherlands, Germany
Romania	1.23	5.71	1.94	7.06	1.99	5.54	3.20	Spain, Italy, Netherlands
Poland	0.32	1.49	0.63	2.29	1.30	3.88	2.10	Germany, Netherlands, UK
South Africa	0.56	2.59	0.81	3.33	1.21	3.92	1.90	Taipei, **China**, Japan, **Viet Nam**
India	0.39	1.77	0.94	3.62	1.12	3.49	1.80	Bangladesh **VietNam** Nepal
Russian Federation	0.40	2.29	0.69	2.94	0.85	2.52	1.30	Turkiye, Iran, Korea

Top Existing Markets of Pakistan Maize (Value-USD, Quantity-MT)

Country	2022-23		2023-24		2024-25	
	Value	Quantity	Value	Quantity	Value	Quantity
Grand Total	**190.5**	**630,389.1**	**421.2**	**1,843,580.0**	**155.8**	**643,265.1**
Viet Nam	80.5	256,033.7	211.3	925,266.7	43.2	186,312.4
Sri Lanka	13.0	36,469.4	48.3	198,727.3	42.5	160,345.9
Philippines	0.2	500.0	25.0	99,163.3	30.5	123,164.0
Afghanistan	1.6	25,199.4	5.3	52,787.2	9.4	51,750.4
Malaysia	36.9	126,273.0	59.7	263,661.5	9.4	37,562.7
Oman	15.0	47,013.1	23.7	98,779.5	7.2	28,237.3
Bangladesh		-	10.9	42,866.2	4.2	17,440.6
Qatar	4.3	12,755.2	7.4	29,203.5	2.3	9,045.7
Bahrain/Kingdom Of Bahrain	7.6	21,174.1	5.7	22,068.9	1.9	6,891.8
United Arab Emirates	1.9	7,317.2	4.4	27,452.9	1.1	7,500.0

Reasons for the decrease in Pakistan's Maize Exports

Major reasons behind the decrease in exports of Maize

1. Aflatoxins in maize
2. Khapra beetle infestation in maize
3. Pesticide Residues in maize and food preparations (In significant)
4. Microbiological contamination (In significant)

Non-Compliance of agro products

Produce	2023	2024	2025
Rice in EU due to Pesticide Residues	36	68	16 collective PR & A
Rice in EU due to Aflatoxins	13	20	
Chilies in EU due to Pesticide Residues	6	-	
Chilies In EU due to Aflatoxin		23	
Maize Collectively on account of aflatoxin and Khapra infestation		80	

Understanding of Aflatoxins

WHAT ARE AFLATOXINS?

- **Aflatoxins are naturally occuring metabolites synthesized by two types of fungi – *Asparigus flavus* and Aspargillus *p*arasiticus**

- **Aflatoxins contaminate dietry staples including maize, rice, ground nuts, chillies, dry fruits, animal feed, milk, etc**

WHY ARE AFLATOXINS IMPORTANT

- Aflatoxins are proven to be mutagens, carcinogens and teratogens
- They produce disease called “Aflatoxicosis”
- Aflatoxin B-1 produces cancer and affect liver by producing liver cirrhosis, necrosis and carcinoma and by suppressing by the immune system

Pre and Post Harvest Factors that Contribute to Aflatoxins

- **High temperature**
- **High humidity**
- **High moisture content**

Permissible limits for Aflatoxins

Different contries have set different limits of tolerance

COUNTRY	LIMIT
India	30 ppb
Pakistan	30 ppb
USA	20 ppb
Australia	15 ppb
China	20 ppb
Egypt	10 ppb (5 B1)
Japan	10 ppb
Russia	5 ppb B1
European Union (processed)	4 ppb (2 B1)
European Union (unprocessed)	10 ppb (5 B1)

Key to Aflatoxins Management

- Harvesting of mature crop
- Immediate thrashing after harvest
- Immediate and appropriate drying after harvest
- Cooling right after drying before bagging
- Storage in well ventilated and clean stores
- Proper periodic aeration in case of silo storage

Farm Level

- Use of disease free and healthy seed
- Implementation of GAP, GDP, GSP using suitable pesticides for the control of pest and diseases
- Proper drying using suitable drying surfaces
- Measure to control mixing of damaged and undamaged crop
- Development of rapid and cheap procedures for determining aflatoxin by the farmers
- Technical support to the farmers

Market Level

- Using suitable, ventilated stores for storage
- Reorganisation of central market structure to eliminate the mixing of fresh and old crop
- Developing a system to assess aflatoxin
- Training and resource development for operators working in the marketing channel
- Provision of support to farmers on quality level
- Implementation of grading standards based on scientific lines

Public Sector

- Investment and support to the public sector organisations for undertaking research on pre and post harvest problems
- Development of legislature framework for preventing the marketing of substandard products
- Organising training of stakeholders through farmer field schools and other dissemination procedures
- Development of reference laboratories for determining aflatoxins

Management of Khapra Beetle in maize

What is Khapra Beetle

- Khapra beetle (*Trogoderma granarium*) is an insect pest that is known to infest more than 90 commodities
- The primary host is wheat but it also damages Barley, Oats, Rye, Maize, Rice, Flour, Malt, Noodles, Chilies, Dry Fruits, Oilseeds etc.
- Khapra is a storage pest and also infest the packaging material.
- The adults are short lived and damage is caused by larvae. The insect can survive up to 9 months without any food and live in diapause
- Khapra is rated as one of the most destructive insect and is considered a quarantine pest.
- Pakistan in the past has faced bans on the export of rice by Russia and Mexico due to presence of this pest.
- Our Maize consignments (more than 65) have been intercepted by Vietnam and Malaysia last year and both the countries have sent alert notifications.

Sources of infestation

The prime source of infestation are:

1. **Use of old jute bags**
2. **Infested godown**
3. **Transporting vehicle**
4. **Docks**
5. **Improper fumigation**
6. **Mixing of old and new crop**

Why is khapra a quarantine pest

- Khapra is a very difficult insect to kill
- It is very destructive for stored products
- It can feed on several commodities
- It can live for 9 months without food
- It can survive at variable temperatures
- It closes its breathing tubes during fumigation
- It enters In diapause under un-favorable conditions

Difficulties in control of Khapra

Many countries around the world has spent billions of dollars to eradicate khapra from their territories and are conscious to prevent its re-introduction

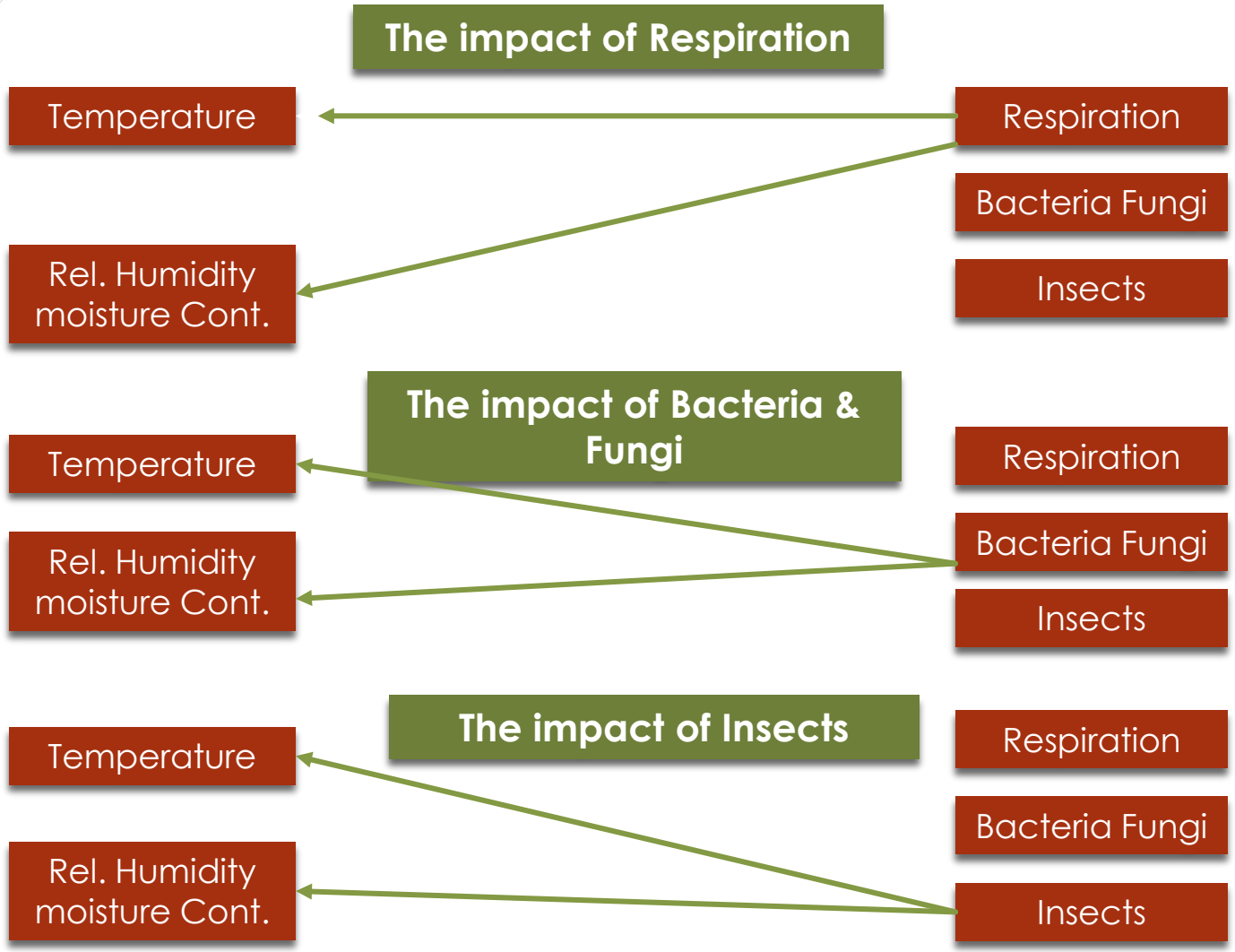
Rate of Propagation of Grain Pests

Insect Species	Averarge number of eggs per female	Average time takes to complete one generation (days)	Progeny of one pair in time (months)		
			(1)	(2)	(3)
Angoumois Grain moth (sitotroga cerealella)	100	26-28	50	2,500	125,000
Khapra Beetle (Trogoderma granarium)	102	24-30	51	2,602	132,651
Rice Weevil (Sitophilus Oryzae)	200	28-30	100	5,000	250,500
Lasser Grain Borer (Rhizopertha dominica)	400	24-30	200	20,000	2,000 million
Red Flour Beetle (Tribolium Castaneum)	450	26-30	225	25,312	2.8476 millon

Five Principles to keep maize free from khapra during storage

- Keep grain cool and dry.
- Keep storage biologically clean.
- Protect from pests.
- Inspect regularly.
- Undertake control measures in case infestation is detected.

The Biological Feedback Mechanism



Practical Application of Pesticides to Control Pests in Stored Products

Pesticides are applied in food storage and processing premises or to grain with the following objectives in mind:

1. **Prevention - to ensure that an empty structure in which is intended to keep food is free of pests.**
2. **Protection - to ensure the safekeeping of food stored in a warehouses.**
3. **Correction - to combat infestations which have developed.**

What is a Fumigant?

- A fumigant is a chemical which exists in the required temperature and pressure in sufficient concentration to be lethal to a pest providing the exposure to that chemical conc. Lasts for an adequate period of time.

- All fumigants are respiratory poisons.
- All fumigants kill all stages of an insect egg larvae pupae adult

Types of Fumigants

1. Phosphine (dosage 3-5 g per cubic meter)

2. Methyl Bromide (dosage 60-80 g per cubic meter)

Properties Of Common Fumigants

	Phosphine	Methyl Bromide
Formula	PH3	CH3Br
Molecular weight	34	95
Boiling Point	-87.0	3.6
Specific gravity (gas) (air=1.0)	1.2	3.3
Vapour Pressure at 30C (atm)	42	2.5
Conversion factor g/m3 to ppm (30oC, 1 atm)	730	260
Flammability Limits in air (v.v)	>1.7%	13.5-14.5%
Solubility in water (v/v)	0.2	3.4
Specific gravity at 30OC, (Liquid, kg/L)	-	1.7

Pre-Requisites of Fumigation

- **Air Tight Enclosure**
- **Application and Retention of Lethal Dose (Concentration x Time)**

Impact of Godown Leakiness on Gas Retention

- **If the Godown Leakiness is 50% then 1000 ppm dose after 24 hours will only be 500 ppm and after next 24 hours 250 ppm.**

- **Thus, on the 4th day of Fumigation, the Lethal Concentration will not be there.**

Minimum Duration of Fumigations with Phosphine

Temperature oC	Duration of fumigation, days after application of fumigant
>12o	Do not use phosphine
12-20	14
22-25	12
26-30	10
<30	10

- Do not attempt to fumigate for less than the minimum exposure period recommended. Where possible give the maximum possible exposure period. If in doubt, fumigate for 15 days.
- Recommendations for minimum exposure periods issued by manufacturers of phosphine formulations are often too short for full control to be achieved in many instances.

Usage of Methyl Bromide

Situations	Considerations
a) Stacks under gas proof sheets	- Piping layout and Jets. - Walls or channels. - Sheeting and sealing.
b) Space or " in-store" fumigation	- Adequate distribution. - Retention of gas and sealing.
c) Chamber-type fumigation i) Atmospheric fumigation. ii) Fumigation	- Correct loading. - Dosing and circulation. - Aeration.
d) Silos	- Forced circulation. - Leakage.
e) Ships	- Adequate distribution. - Retention of gas in treated areas. - Hazards to crew. - Delay and costs.
f) Flour and other finely divided commodities.	- Vaporization of fumigant. - Residues/

Options for Godown Fumigation

- Dosage Rate — High Normal Low
- Application Type — Single Multiple
- Level of Resistance — Susc. Resistant
- Exposure Period — 5, 6 ,7,8,9,10 + Days
- Gas Retention of Godowns — 0-X% SD
- Wind speed — X -Y changes X-Y% MD Y+ = No.

Take-Away Messages

- Keep the grain dry, cool and clean
- Do not harvest immature crop containing high moisture content
- Dry the harvested crop to minimize fungal growth
- Store in a neat and insect-free godown where other commodities are not stored
- Do not mix good and bad quality grain
- Fumigate using appropriate procedure with recommended dosage for sufficient duration to kill khapra and other insects

Thank You!