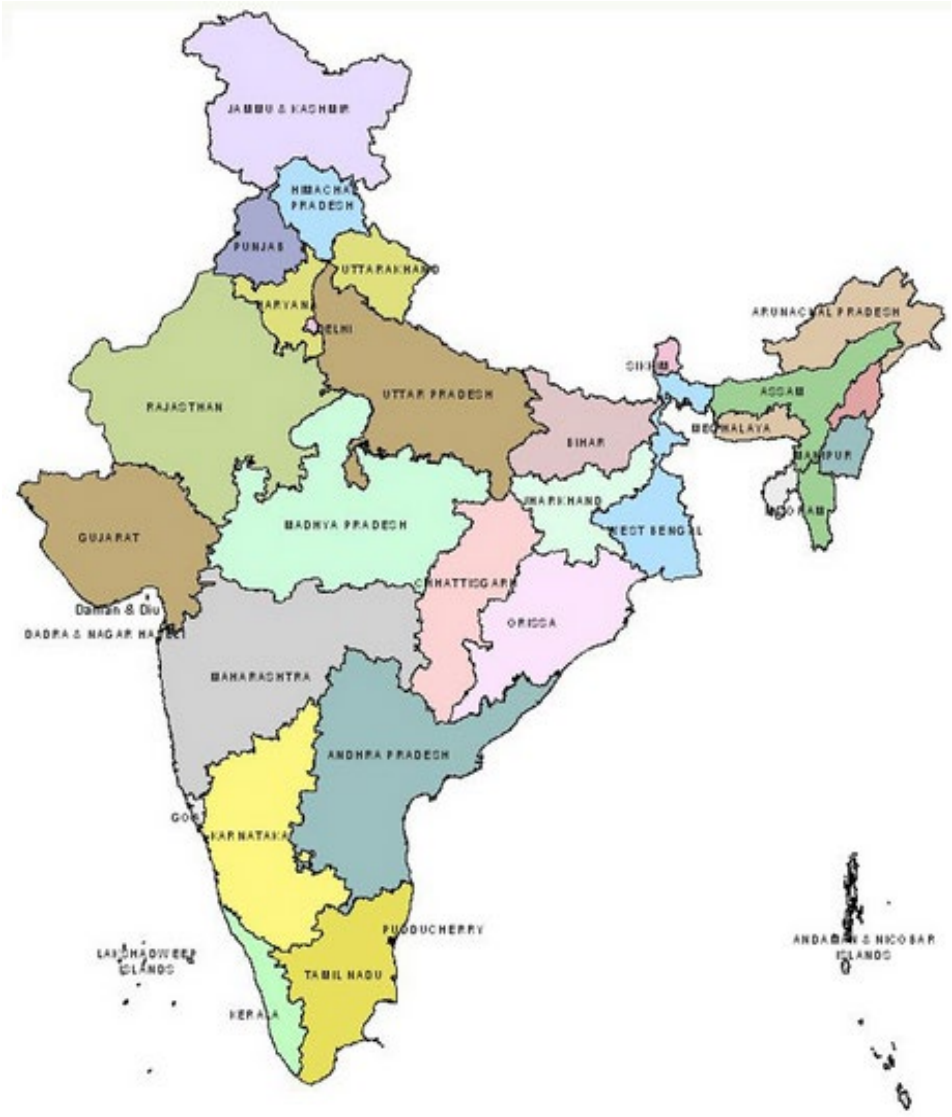
Post-Harvest Unit Operations Management to Reduce PHL

Dr. R.K. Singh, Director

Central Institute of Post-Harvest Engineering & Technology Ludhiana, Punjab

(An ISO 9001-2015 Certified Institution)

India Food Production – Key Facts



- **Food grains : 284 MMT**
- **Oilseeds : 31 MMT**
- **Pulses : 23 MMT**
- **Millets : 11.56 MMT**

Post-Harvest Losses (2012-15)

CROP	% Loss, minimum	% Loss, maximum
Cereals	4.65 (Maize)	5.99 (Sorghum)
Pulses	6.60 (Green gram)	8.41 (Chick pea)
Oilseeds	3.08 (Cottonseed)	9.96 (Soybean)
Fruits	6.70 (Papaya)	15.88 (Guava)
Vegetables	4.58 (Tapioca)	12.44 (Tomato)

Post-harvest losses in wheat

Operations							Total loss in farm operations
Harvesting	Collection	Threshing	Winnowing/ cleaning	Drying	Packaging	Transport	
1.43 ± 0.47	0.56 ± 0.22	1.43 ± 0.41	0.40 ± 0.19	0.07 ± 0.09	0.10 ± 0.07	0.08 ± 0.04	4.07 ± 0.29
Storage channels							
Farm	Godown	Wholesaler	Retailers	Processing unit	Total loss in storage		Overall total loss
0.53 ± 0.14	0.03 ± 0.02	0.10 ± 0.07	0.02 ± 0.01	0.17 ± 0.04	0.86 ± 0.13		4.93 ± 0.20

Food grain loss

- According to MoFPI loss : 23 MMT (8%)
- Cost of production : Rs. 10 - 12 per kg
- Loss of inputs: Rs. 23000 crore
- MSP of paddy: Rs. 18150 per tonne
- MSP of wheat : Rs. 19250 per tonne
- Monitory value: Rs. 45000 crore

Total Economic Value of the Losses

(Computed for the prices of 2014 and production of 2012 - 13)

Produce	Loss Value, Rs crores / annum
Cereals	20,698
Pulses	3,877
Oilseeds	8,278
Spices / Plantation Crops	9,325
Fruits	16,644
Vegetables	14,842
Livestock Produce	18,987
TOTAL	92,651(14603 m $)
Food Grains, plantation crops, spices	42,178 (6666 m $)
Perishables	50,473 (7936 m $)

Grain Storage scenario

- 65% production is held by farmers for their use
- Total storage capacity with Govt. agencies: 87.7 MMT
- Covered storage : 75 MMT
- Covered Area Plinth : 12.7 MMT
- Storage gap estimated : 25 MMT
- Mostly horizontal storage in warehouse
- Steel vertical silo is most effective
- Silo capacity: 1.18 MMT (PPP mode)
- Govt PEG scheme: 13.45 MMT

Storage Systems

Bag Storage

CAP Storage

Silo Bulk Storage

Bulk Storage in Metal Bin

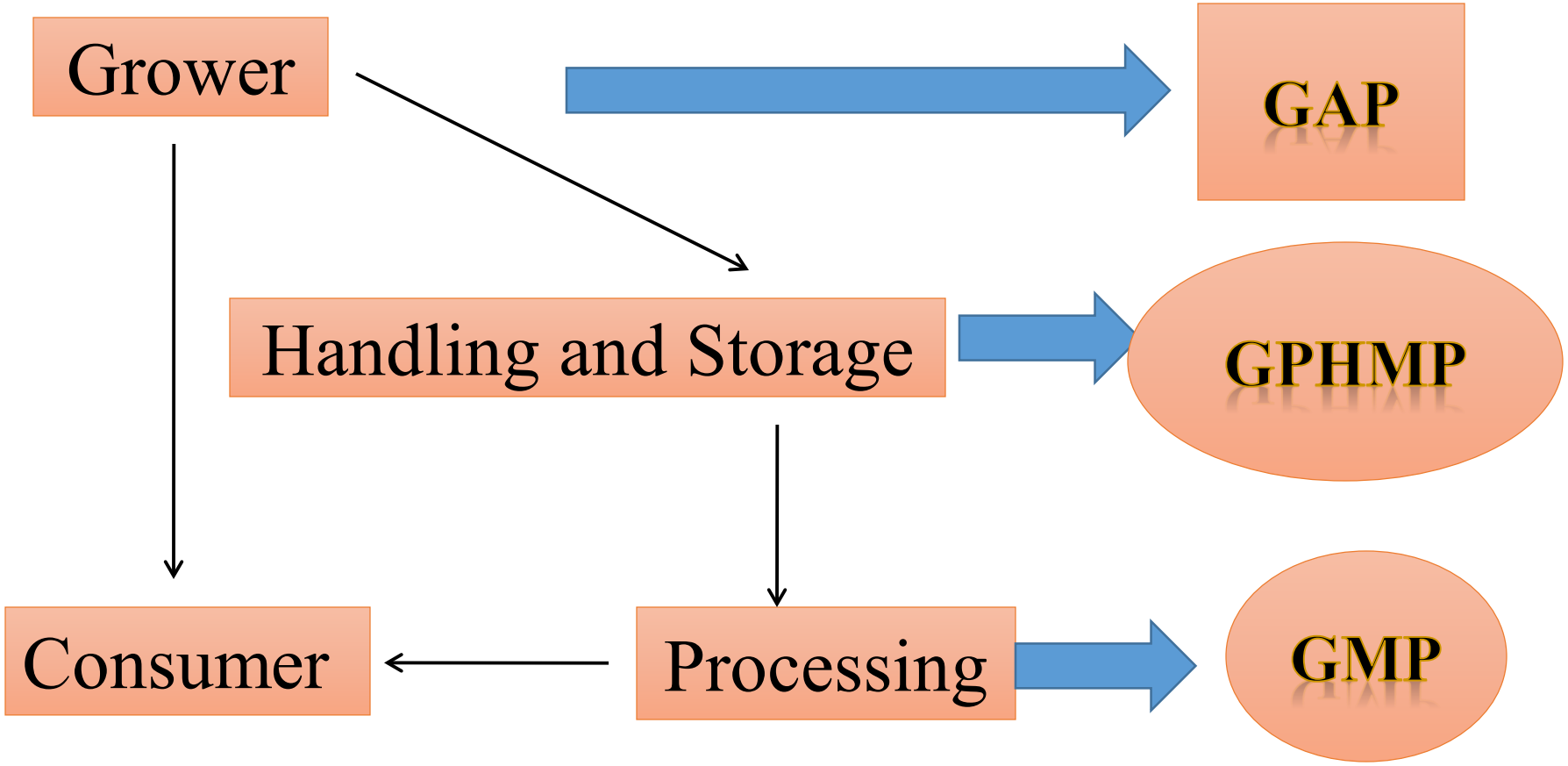
Post Harvest Management

Quality of harvested commodities cannot be improved further, however can be retained by controlling rate of metabolic activities using appropriate post harvest handling, processing and value addition operations. Thus post harvest management includes following practices:

1. Good Agricultural Practices (GAP)
2. Good Post Harvest Management Practices (GPHMP)
3. Good Manufacturing Practices (GMP)

GOOD AGRICULTURAL PRACTICES (GAP)

Why it is so important?



How to reduce the losses

- Harvest at appropriate stage (MC : 23-28%) to avoid shattering losses
- Use of appropriate capacity machinery for Harvesting and threshing
- Proper drying (MC 12-14%) before storage
- Improving on-farm storage of grains
- Use of metal silo in place of traditional structure
- Shift from bag storage to bulk storage in vertical silo
- Primary processing facilities in production catchment

Storage: A good storage structure should

- Provide protection from common storage loss agents such as insect, pests, rodents, moulds, birds and man
- Maintain an even, cool and dry storage environment
- Not allow re-wetting of grain by either moisture migration or rain
- Allow monitoring and temperature control
- Offer reasonable protection from thieves, natures vagaries or any other factor of physical damage

- Allow aeration as it helps in keeping down the relative humidity of interstitial gases
- Provide moisture barriers that insulate walls of storage room and transit vehicles
- proper air spaces between pallets and room walls to ensure proper air circulation
- Proper sanitization and fumigation to prevent growth of pathogens

Post-Harvest Management

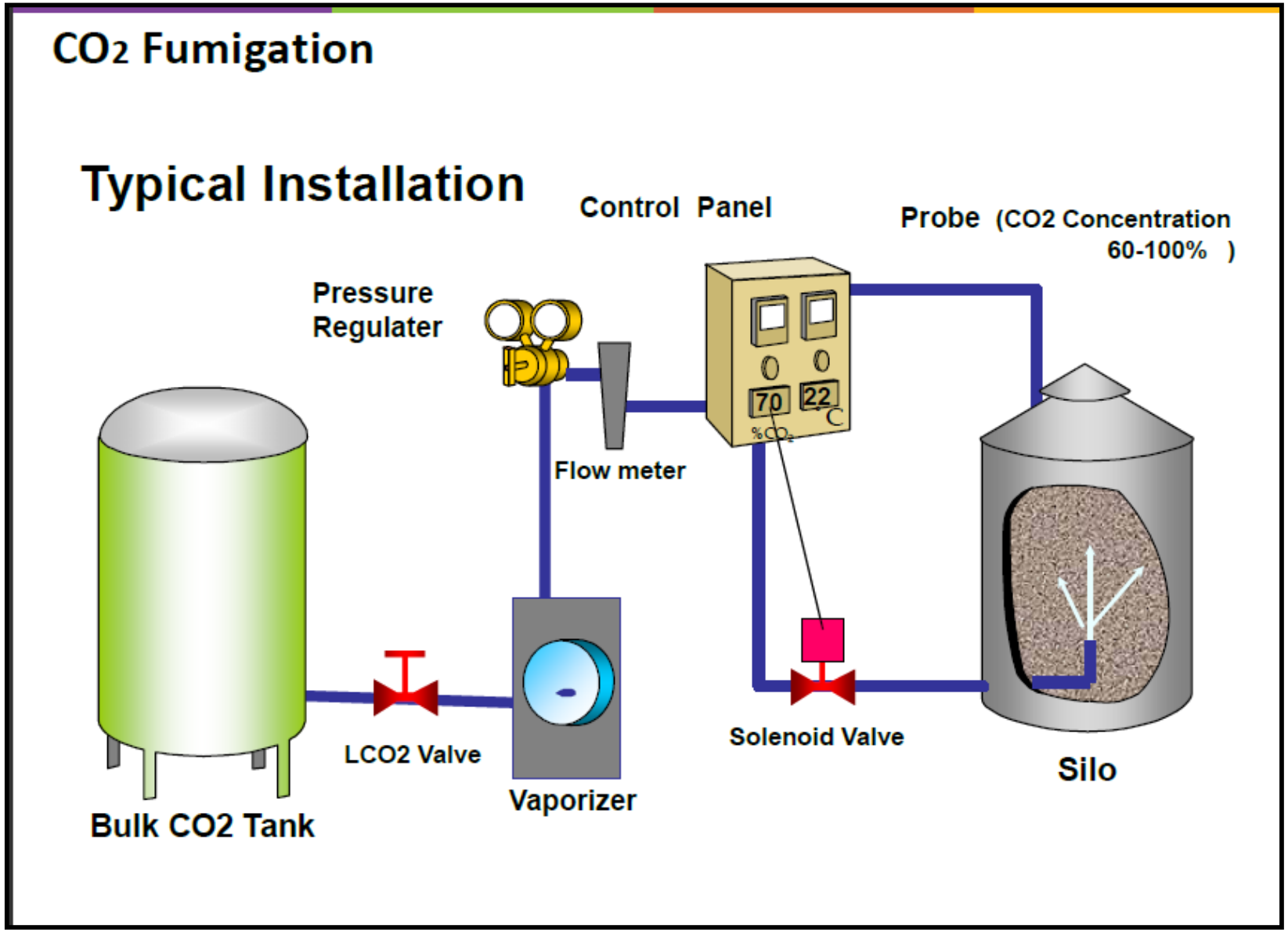
- Drying of grain after harvest
- Proper and uniform drying to avoid wet and hot spots
- Proper sanitation during drying and temporary storage to avoid contamination and protection from pests like insects, rodents and birds.
- Primary/ initial processing techniques should be proper enough to avoid losses in threshing and winnowing by mechanical methods.
- Selection of proper packaging, transportation and storage facility. Aeration and fumigation
- Preventive measure should be given preference before storage and based on necessity curative measures may employ

Hermetic Storage for Pulses with CO_2 Fumigation

- The two most commonly used chemicals approved for fumigation: PHOSPHINE and METHYL BROMIDE.
- Methyl Bromide found to deplete the ozone, and its use is now restricted.
- Grain handlers are therefore left with only one alternative: PHOSPHINE
- Single selection pressure can result in insects overcoming the effect
- Future development of insect resistance to phosphine, could make it difficult to maintain the “zero tolerance” requirement unless alternative methods are found.

- 25 kg Green gram (SML-668 variety) was stored in Pilot storage bins made of acrylic.
- Insects were separately reared on Green gram in stock colonies at 25 ± 1 °C, 70 ± 10%
- Stored Green gram was infested with minimum 15-30 insects
- CO_2 was injected at different concentrations for different residence time (5, 10, 15, 20 % for 18, 24 and 48 h) with three replications for each treatment
- Air tightness was ensured
- Headspace Gas Analyzer (SYTEMAC make) was used to measure CO_2 concentration at the start and at the end of the exposure with a gas syringe containing samples of 25 ml volume
- When evaluating the effect of treatments on adult insects the tubes were kept for 24 h after treatment. The no. of living insects in each tube was counted and the percentage mortality was calculated based on the initial number of individuals placed in each tube

Envisaged Fumigation setup at Pilot scale



Fumigation setup in pilot bins

Mortality of adult Callosobruchus at different CO2 concentration and residence time

CO_2 concentration(%)	Mortality (%)		
	18 h	24 h	48 h
5	30	61.66	70
10	40	78.33	100
15	75	100	100
20	100	100	100

- 15 % concentration of Carbon dioxide for residence time of 24 h achieved 100 % mortality of adult *Callosobruchus maculatus* insect
- No significant effect on Cooking Properties
- No significant effect on the swelling capacity and swelling index
- The hydration capacity and hydration index were not affected before and after fumigation
- No significant effect on soaking time.
- No significant effect was found on the thousand grain mass (g) and average sphericity (%) of seeds before and after fumigation of 6 months.
- Similarly, no effect was found on the bulk density (kg m^{-3}), and porosity(%)

Microwave-assisted Disinfestation of Rice and Wheat

Insects under study for rice

Rice weevil (Sitophilus oryzae)	
Red flour beetle (Tribolium castaneum)	
Flat grain beetle (Cryptolestes sp. and Laemophloeus sp.)	

Insects under study for wheat

Lesser grain borer (Rhyzopertha dominica)	
Khapra beetle (Trogoderma granarium)	
Red flour beetle (Tribolium castaneum)	

Treatment of Non-basmati rice in continuous microwave system

Mortality of Insects

Effective treatment to achieve 100% mortality without significantly affecting grain quality

Grain type	Effective treatment range
Basmati rice	30-40 s
Non-basmati rice	30-40 s
Wheat	50-60 s

Note: Duration of treatment depends upon Grain layer thickness, grain moisture content, microwave power used etc

GRAIN SAVED IS GRAIN PRODUCED

Post harvest management and value addition to our unique agricultural wealth can bring prosperity to rural (real) India

Thank You !!!