

Public Health Risk in Dairy Chain in Pakistan

Professor Ghulam Habib

Livestock & Dairy Specialist

PEEP, Lahore

Outline.....

- **Introduction**
- **Problem statement**
- **Milk Infections**
- **Mycotoxins in milk**
- **Toxic metals in milk**
- **Milk Adulterants**
- **Chemical & Drug residues**
- **Way Forward**



Introduction

- Food-borne diseases are a threat and are responsible for >50% cases of mortality to children
- Bacterial milk contamination causes:
 - Milk spoilage
 - Milk-born zoonotic diseases
- Non bacterial contamination & adulterants in milk are on rise in Pakistan and has sparked consumers health concern
- Dairy industry in Pakistan is dominated by unpasteurized milk & informal markets ---open to contamination

Problem Statement

- Risks of milk safety hazards in informal market are high and undocumented in Pakistan
- Previous studies on public health risks along the milk chain in Pakistan are ;
 - scarce
 - unorganized
 - poorly designed
 - based on traditional less sensitive diagnostic tests
 - used piece meal approach

Milk Infection & Contaminants

Microbial

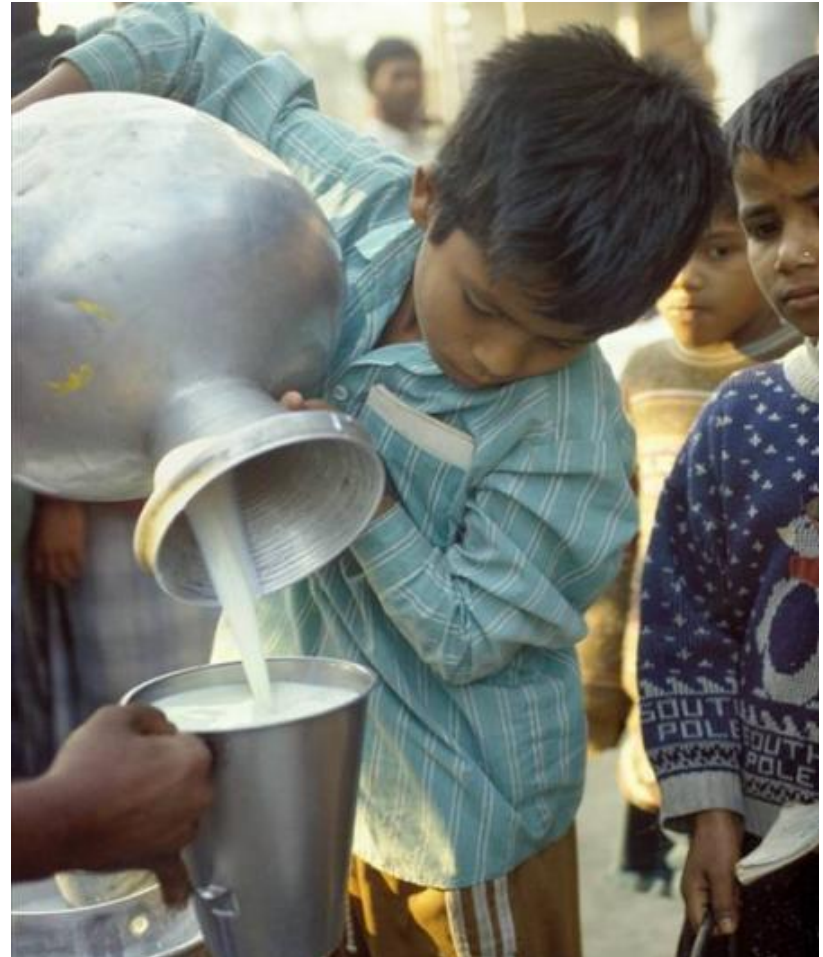
- Brucella spp.
- Campylobacter spp.
- Escherichia coli (STEC)
- Listeria monocytogenes
- Salmonella spp.
- Staphylococcus aureus
- Mycobacterium spp.
- Yersinia enterocolitica
- Cryptosporidium, etc.....

Chemical

- Heavy metals (Pb, CU, Cd etc.)
- Aflatoxins /mycotoxins
- Pesticides and other agro-chemicals
- Drug residues (antibiotics, anti-inflammatory, etc.)
- Hormones
- Adulterants (Non-food chemicals)

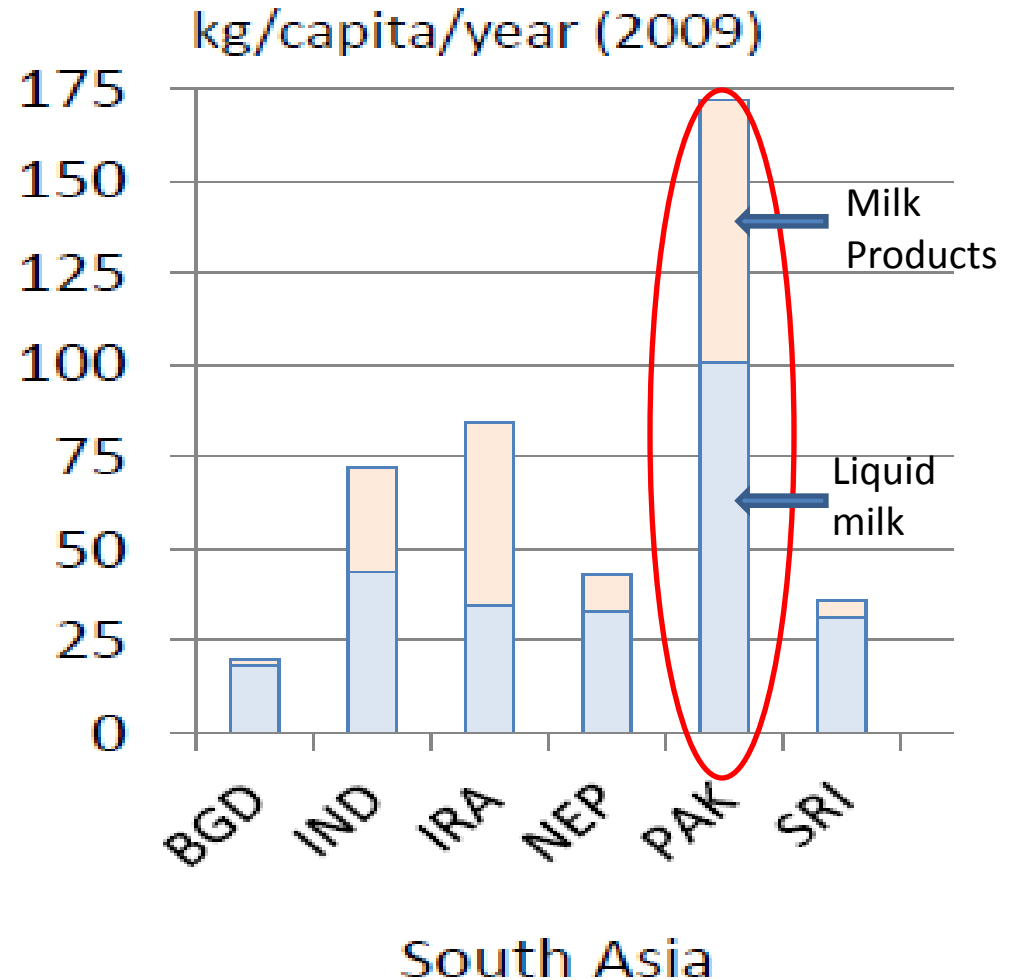
Entry Points

- Systemic cow diseases (e.g. bovine TB, brucellosis)
- Infection of the cow's udder (mastitis)
- Bacteria that live on the skin of cows
- Environment (e.g. feed, feces, dirt, washing utensils/equipment)
- Insects, rodents, and other animal vectors
- Human actions
 - accidental
 - deliberate



Exposure: Milk Consumption

High milk consumption in Pakistan poses greater Public Health Risk



Brucellosis

- **Agent**: Gram-, non-motile, cocco-bacillus
- **Ecology**: Concentration in milk, urine and genital fluids of infected animals
- **Manifestation**: Undulating fever, arthralgia, arthritis, orchitis, endocarditis
- **Illness**: severe, not self- limiting



Occupational Groups	Hospitalized patients in Peshawar	Positive cases (SPAT)	Positive %
Farmers	256	84	32.8
Employees	226	66	29.2
Others	196	53	27.0

High prevalence in human in KP

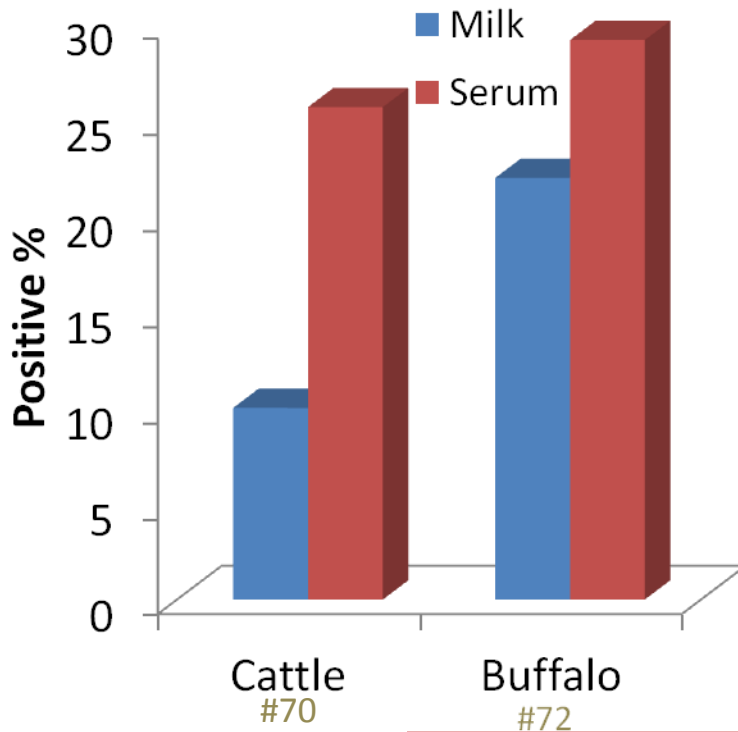
Brucellosis in High Risk Groups in District Faisalabad

Occupationally Exposed Groups	Samples	SAT Positive	PCR Positive
Veterinary Professionals	33	7 (21.2%)	2 (6.06%)
Livestock farmers	48	23 (44.2%)	9 (17.30%)
Butchers	14	7 (50.0%)	3 (21.4%)
Total	95	37 (38.94%)	14 (14.7%)

Farmers relatively at high risk

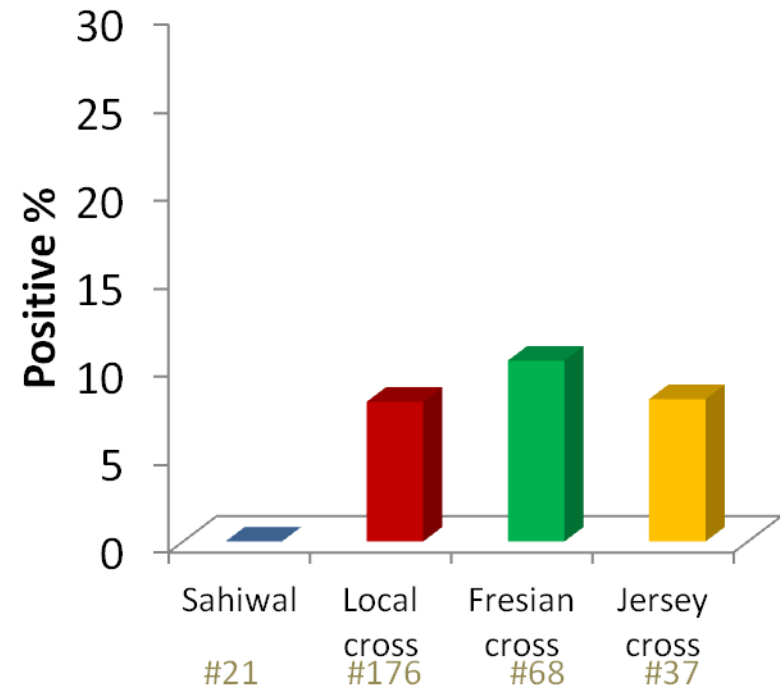
Prevalence of brucellosis in cattle & buffalo in KP

Peshawar District
Test: PCR



Shamim et al. 2014

Bannu & Laki Marwat Districts
Test: SPAT



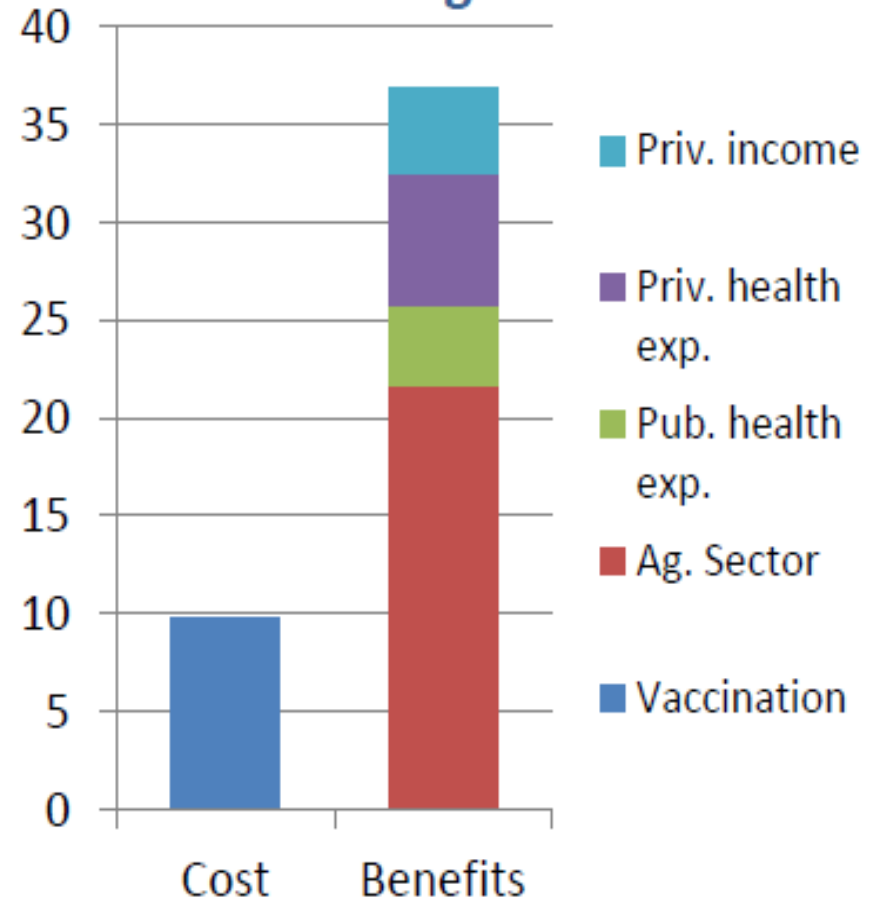
Bakhtullah et al. 2014

Other studies show that brucellosis is
higher in buffalo than cattle
Higher in Sheep, goats than cattle
Higher in exotic than local breeds
High in urban than rural

Brucellosis

- One of the **most widespread zoonosis** in the world after Rabies.
- Brucellosis has a considerable impact on animal and human health, with **wide socio-economic impacts**
- Endemic in Pakistan
- Transmitted thru drinking un-boiled milk & handling cows/buffaloes

C-B of 10-year vaccination in Mongolia



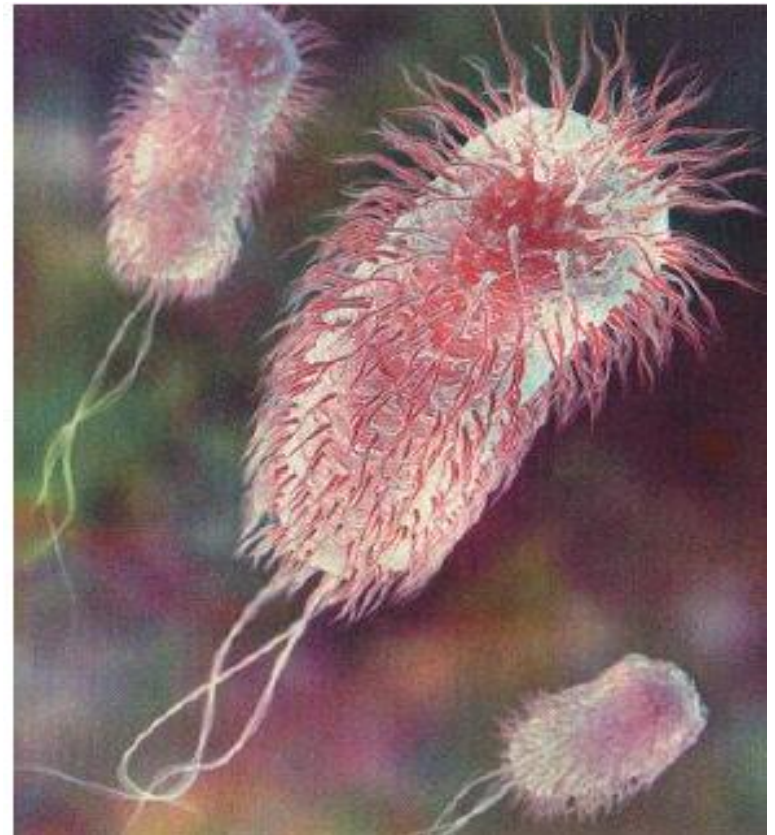
Escherichia coli (O157:H7)

Agent: Gram- motile rod, high genetic diversity

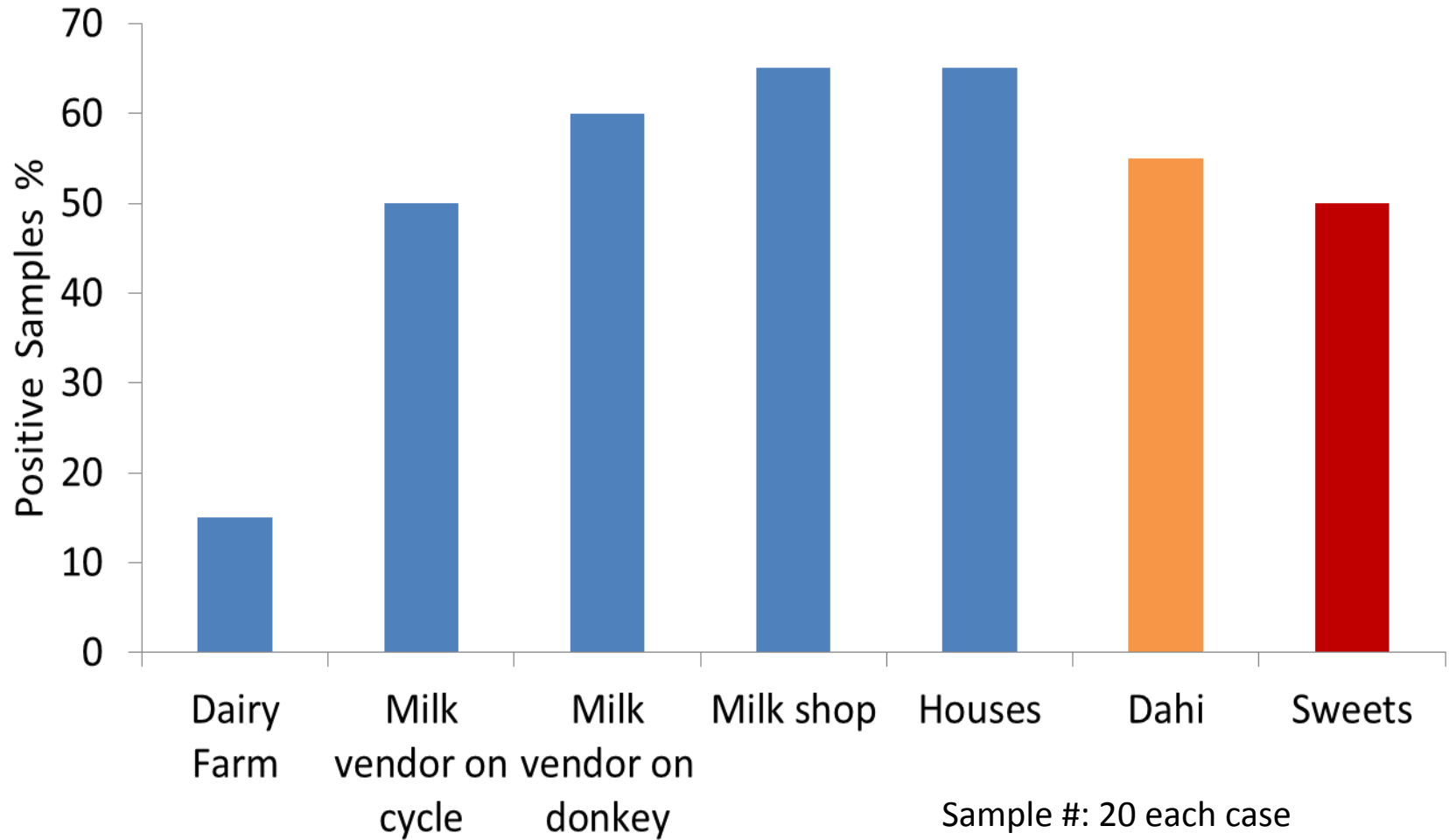
Ecology: Commensal in lower intestine of warm-blooded animals

Manifestation: severe acute hemorrhagic diarrhea, vomiting, abdominal cramps, severe kidney problem in children & brain problems in elderly

Illness: severe but usually self-limiting



High milk contamination by notorious *E.Coli* in Pakistan

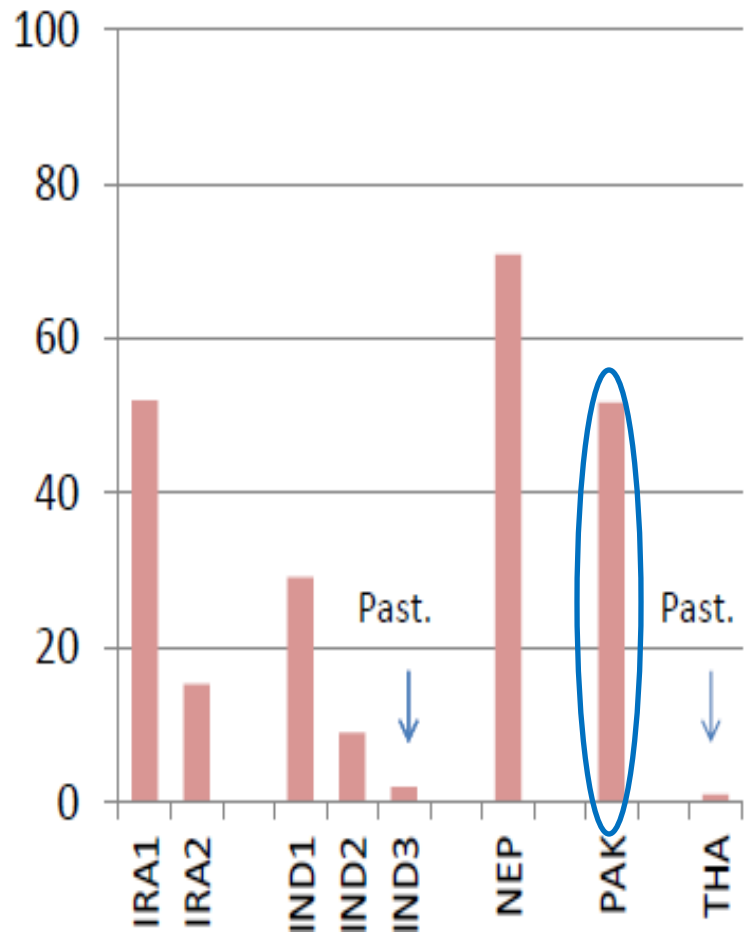
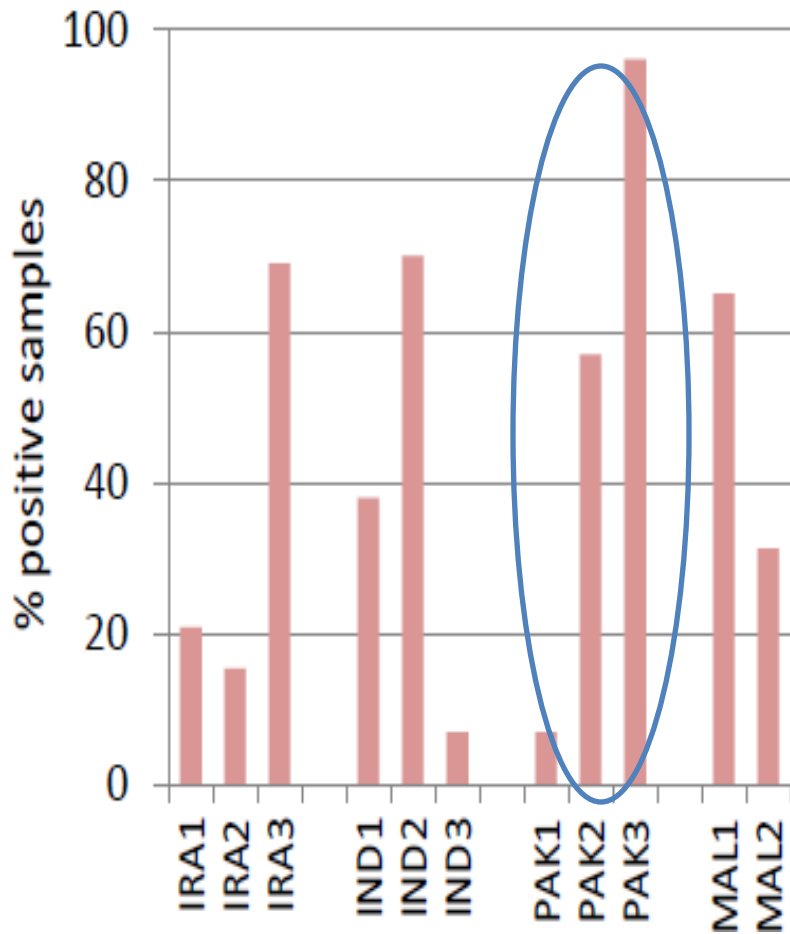


Sample #: 20 each case
Location: Tandojam
Soomro et al. 2002

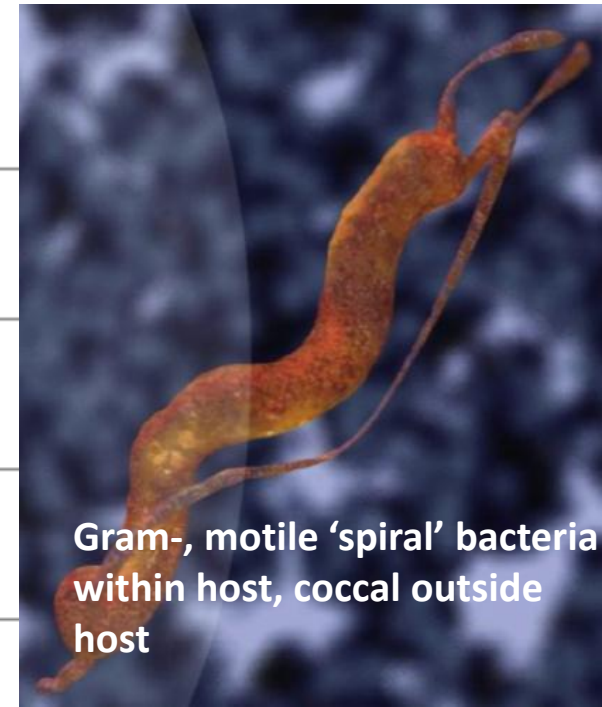
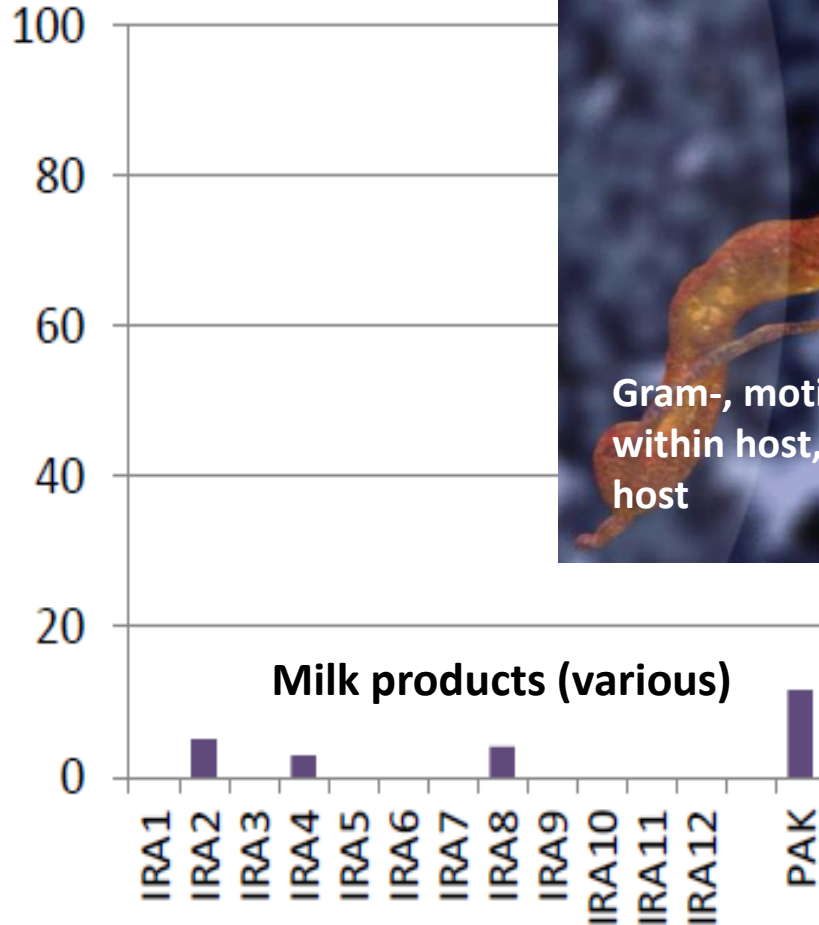
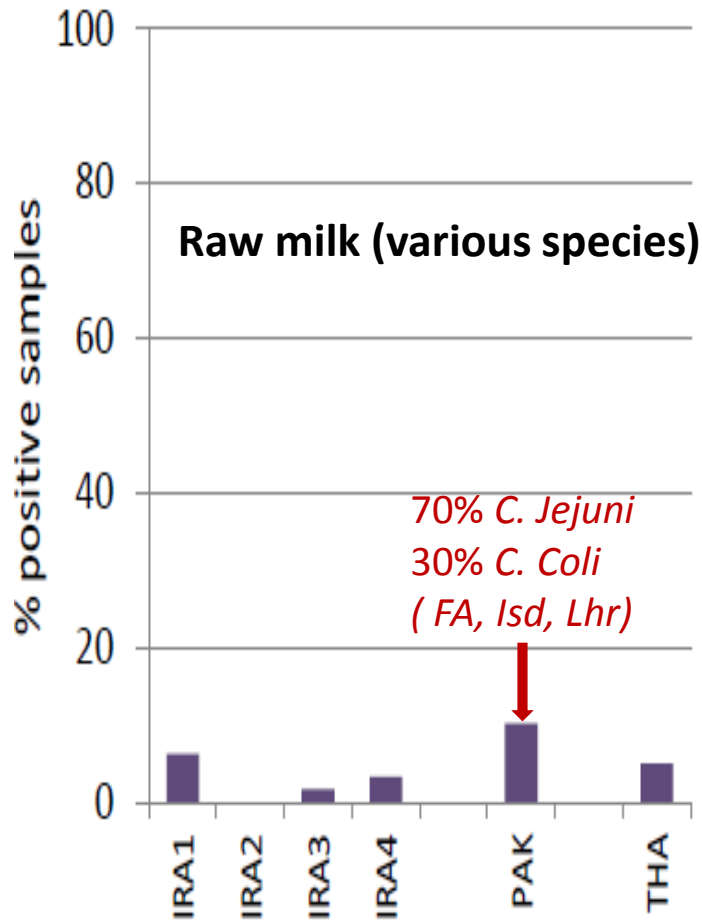
E. coli, all Serotypes

Raw milk (various species)

Past. milk & products (various)



Campylobacter jejuni & *coli*



Manifestation: diarrhea with cramps, fever and pain & nervous system disorders

Salmonella enterica

Manifestation: Diarrhea, fever, vomiting, and abdominal cramps & may cause serious complications in vulnerable individuals

Illness: serious but usually self-limiting



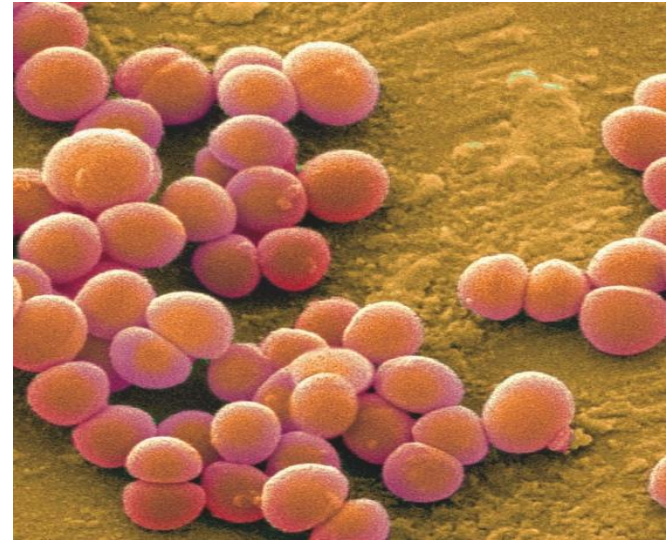
	Positive Salmonella	Mean Count (CFU/ml)	Reference
Pakistan (Distt. Lahore, 10 locations)	100% bulk sample (#100)	4600 to 5600	Farhan & Salik, 2007
India (5 location)	70% Bulk sample (#50)	-	Pant et al. 2013

Staphylococcus aureus

Milk samples from 10 locations in District Lahore all positive

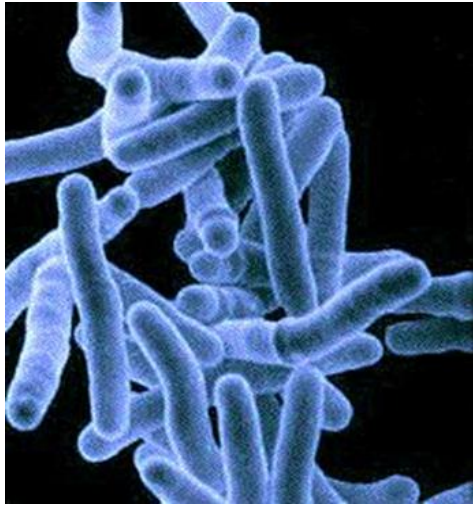
Count ranged from 7.1 to 12.6×10^6 cfu/ml (Farhan & Salik, 2007)

Whole milk & Ice creams potential source



Gram+, clustered coccal bacteria

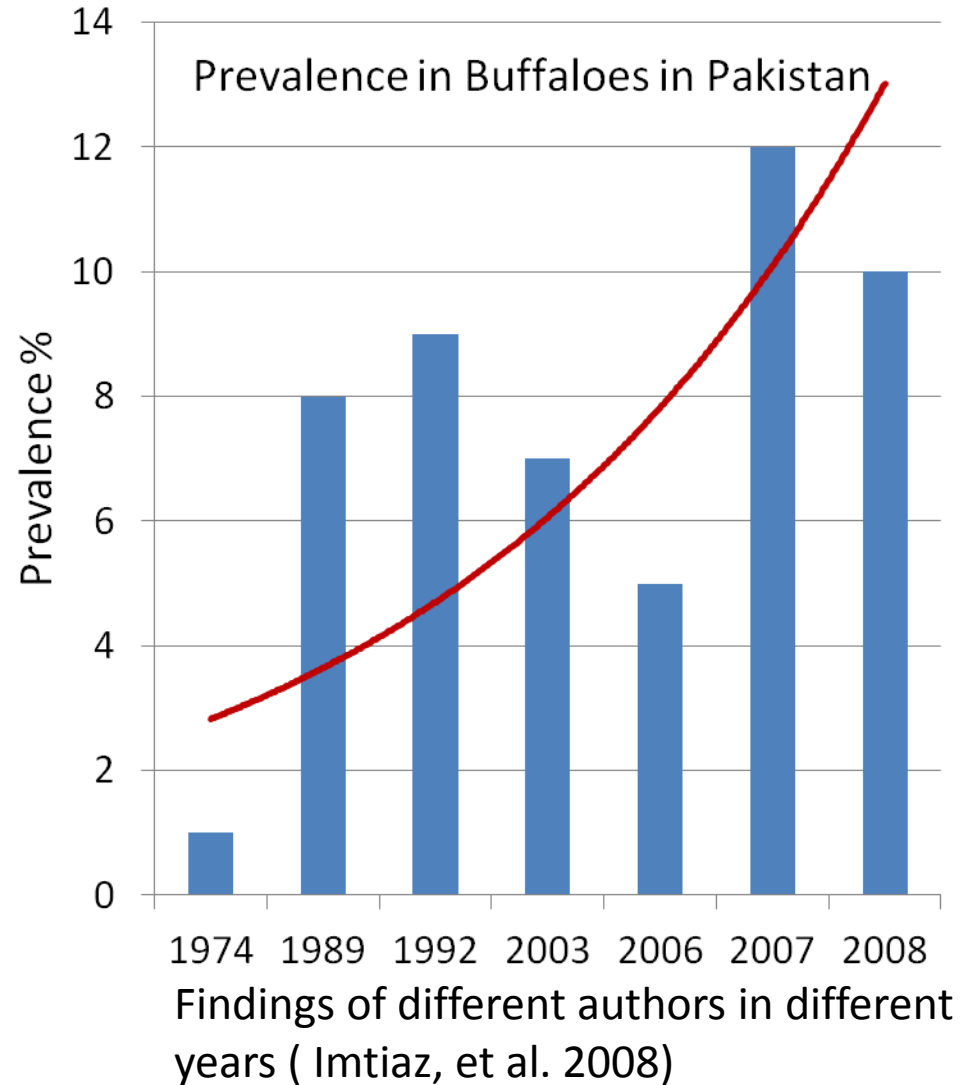
Toxin-induced abdominal pain, cramping, diarrhea, vomiting and fever



Mycobacterium.....

Milk & Feaces as main source of infection spread

56% of the Positive buffalo were found shed mycobacteria in milk & feaces



Mycotoxins

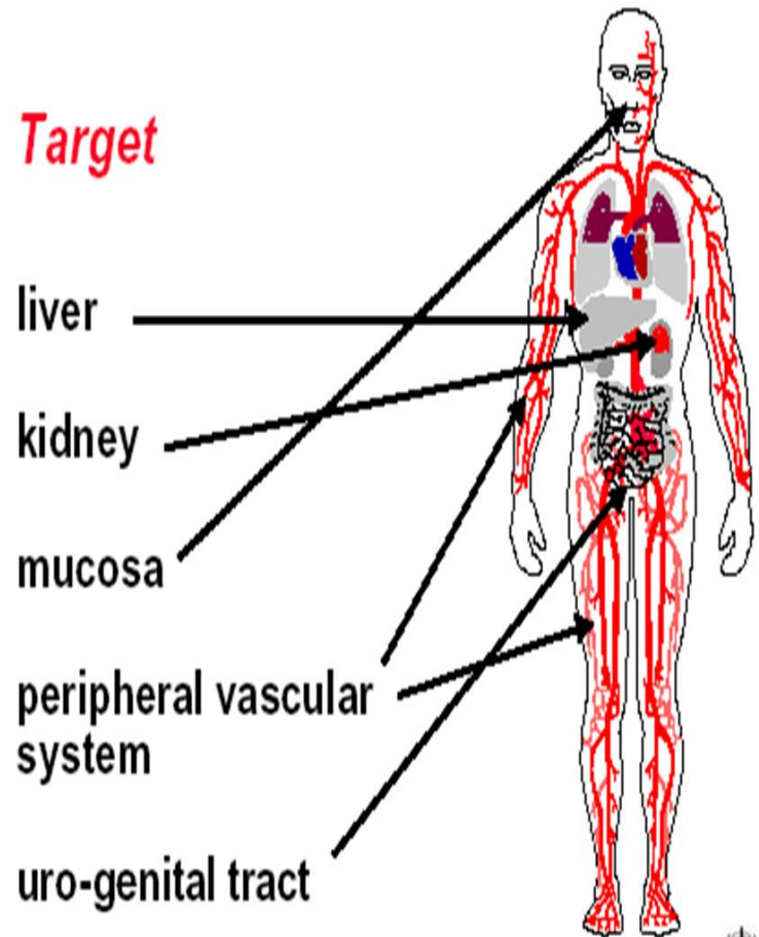
- Class of toxins produced by molds *Aspergillus flavus* & *A. parasiticus*
- Approx. 20, of which B1, B2, G1 and G2 most common
- Aflatoxins M1, M2 - metabolites of B1 and B2 - in the milk of animals fed on moldy feed
- MRL in milk: USA 500 nano-gram/lit; EU 50 ng/lit

Mycotoxins as Animal-Agriculture Issue with negative impact

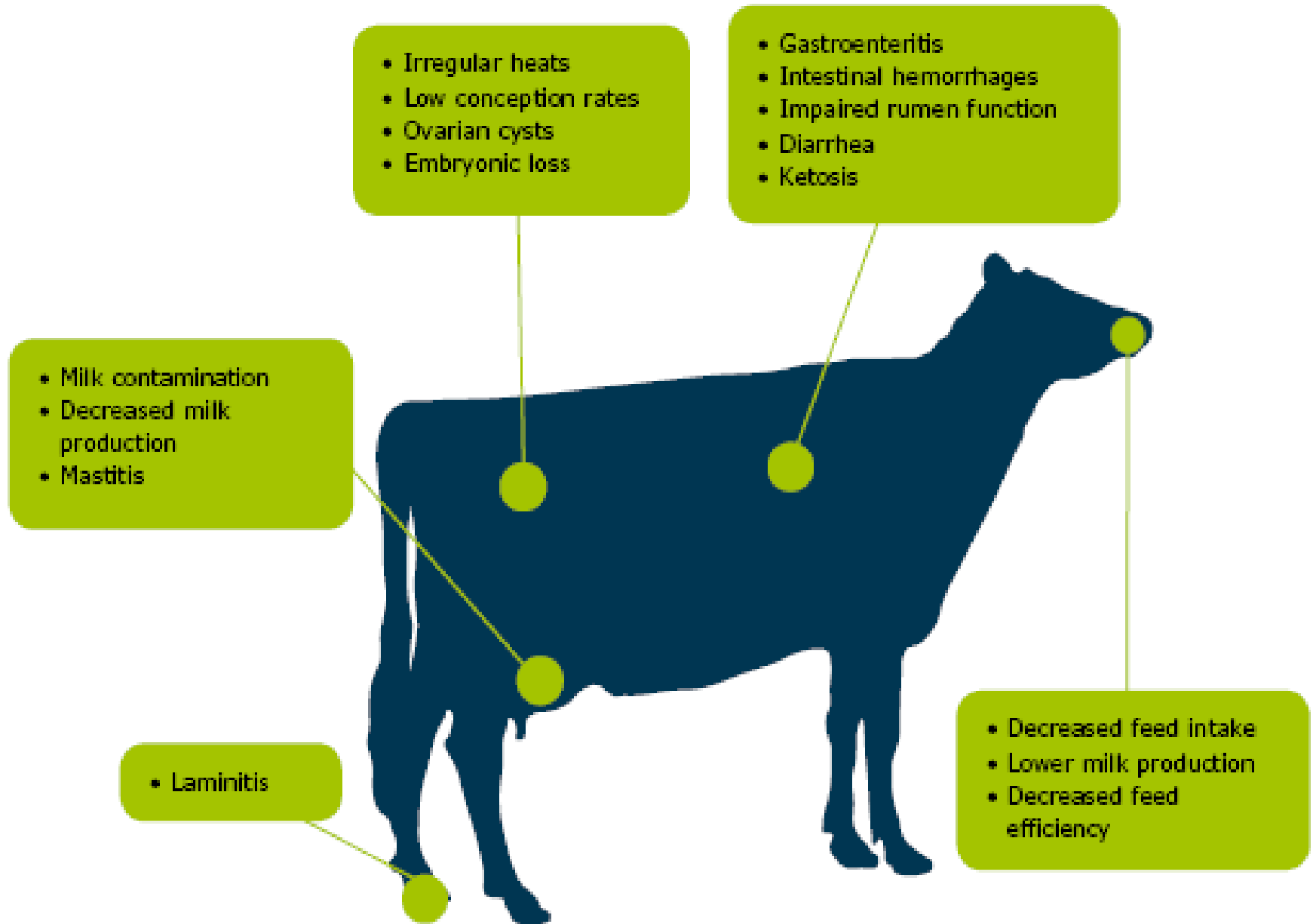


Target organs of Mycotoxins

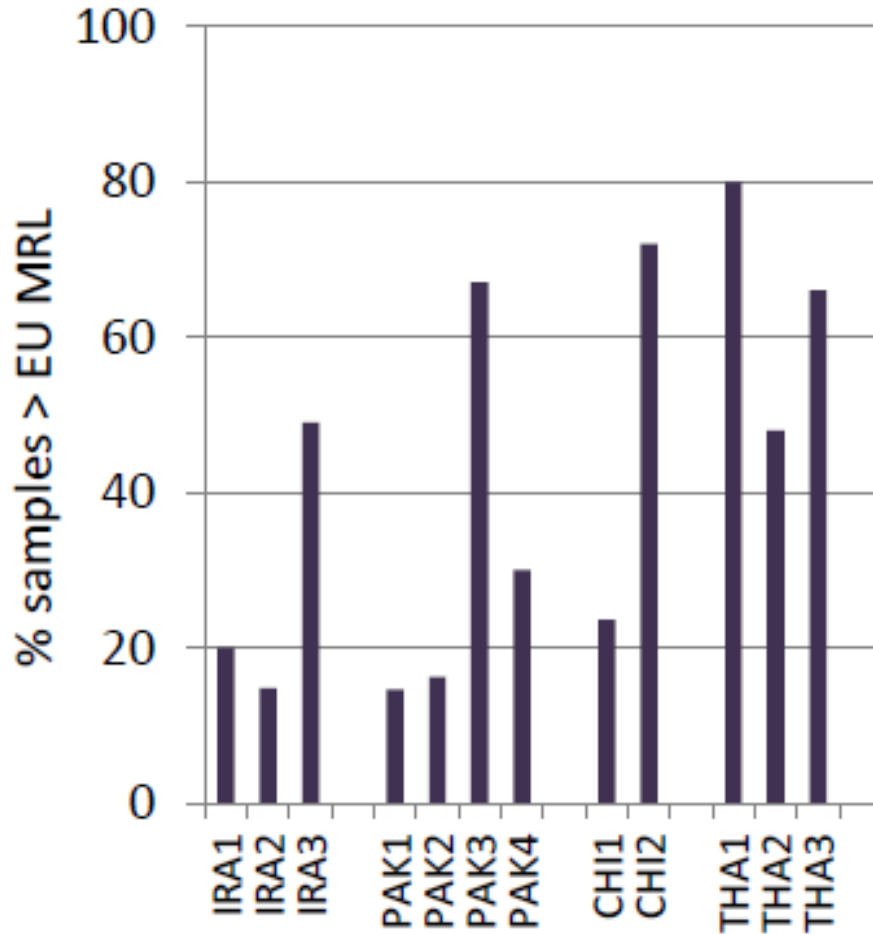
- Damage the liver leading to necrosis, cirrhosis and cancer
- Suppress the immune system
- Acute poisoning:
Abdominal pain, vomiting, convulsions, edema, hemorrhaging
- Chronic poisoning:
Growth and development impairment, liver cancer



Mycotoxins impact in dairy cows

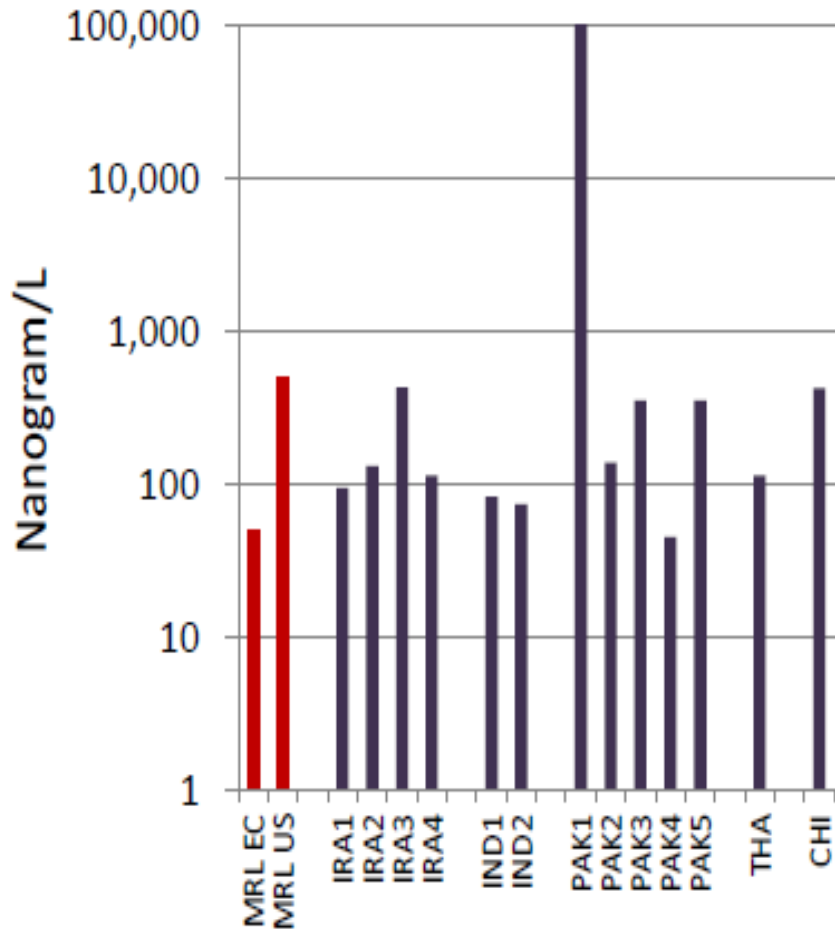


AFM1 in Milk

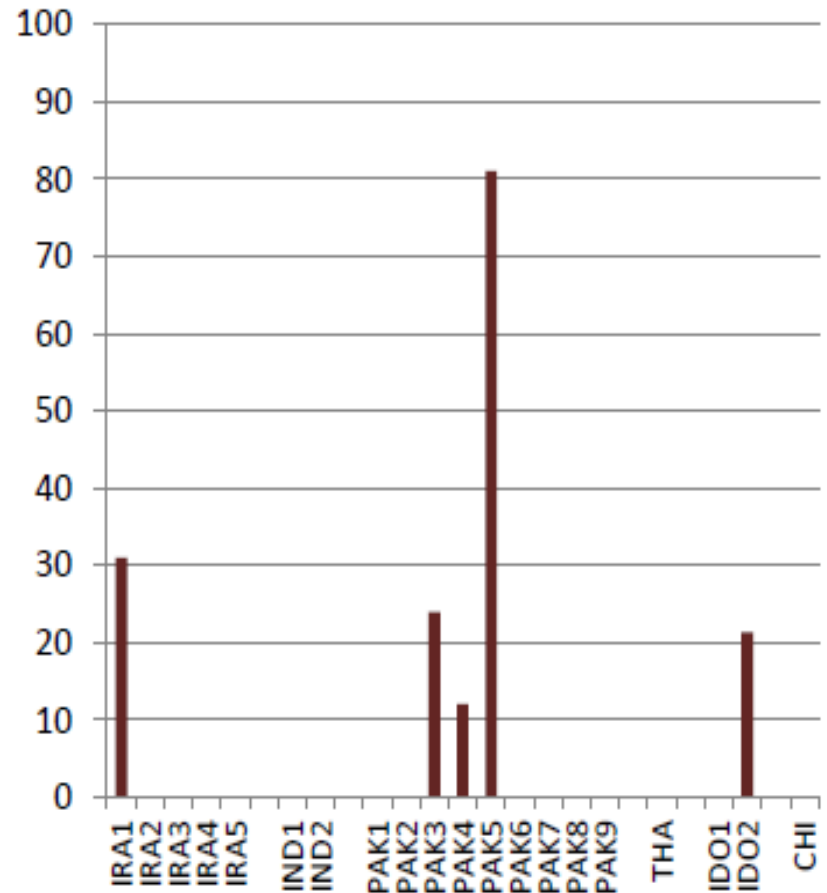


AFM1 in Milk

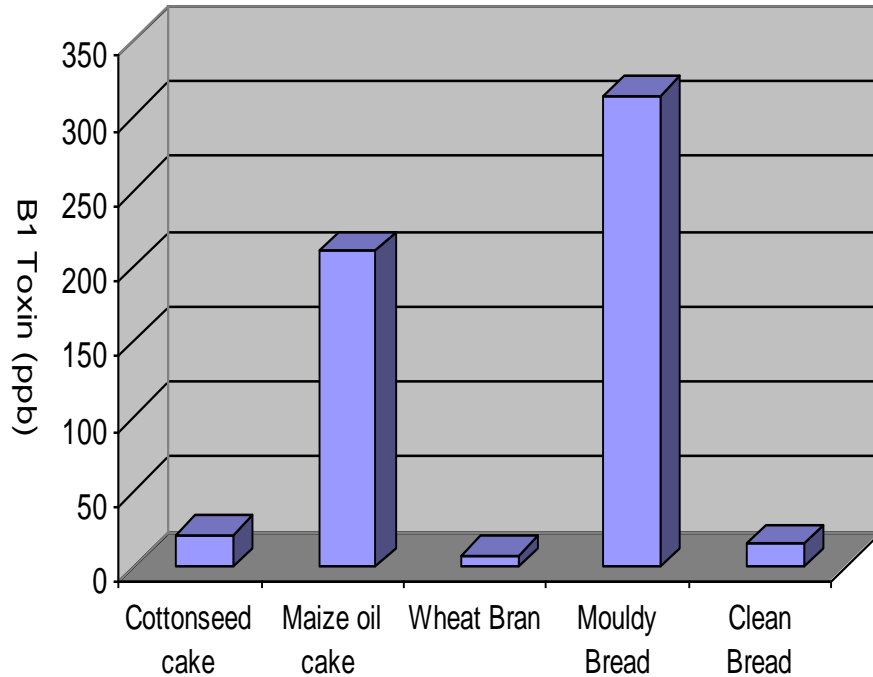
Max AFM₁ concentrations found



% Samples > US MRL



Toxin Level in Local Feeds & Buffalo Milk



Aziz et al., 2011



Feed	B1 (ppb)	M1 ($\mu\text{g}/\text{lit}$)	Milk yield (l/day)
Concentrate + Normal bread	94	0.39	7.7
Concentrate + Moldy bread	281.75	0.92	6.5

Aziz et al., 2011

Mycotoxin Excretion in Milk (Punjab)

	Sample #	Positive %	AFM (ug/lit or kg)	% Exceeded EU limit
Local milk shop	175	78%	0.002 – 1.6	29%
Household milk	40	62%	0.03 - 1.9	45%
Dairy Farm	17	88%	0.002 – 0.79	41%
Sweet shop	138	97%	0.01 – 1.5	78%

Asma et al. 2012

Study-2 (Jabbar M. et al 2013)

31 % Local Milk samples- : 0.252 ug/liter

97% Local Sweets samples: 0.480 ug/kg

Vs

EU permissible Standard 0.05 ug/liter

400-800% higher AFM1

AFM1 in UHT milk samples in Karachi

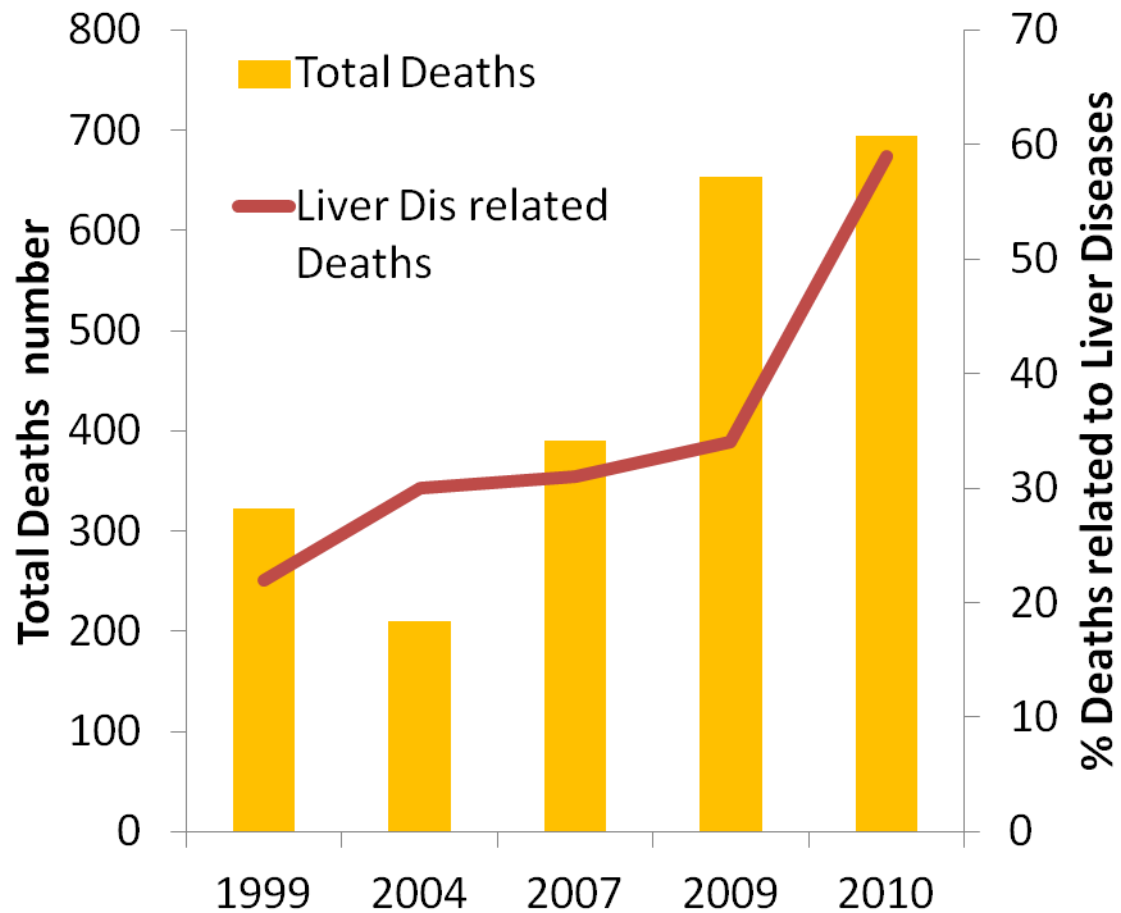
	Sample #	Positive	AFM1 ng/lit
Company -A	20	3 (15%)	49.8 – 102.8
Company-B	30	4 (13%)	29.3 - 98.8
Company-C	30	2 (7%)	39.3 – 90.6
Fresh Milk (4 location)	60	20 (33%)	42.1 – 342.6

(Raza , 2006)

Annual Deaths and Liver Disease Related Mortality (case study Pakistan)

- **High mycotoxins ingestion contribute to liver diseases**
- **Every 4th patient admitted in medical ward has liver related disorders in Pakistan**

<http://www.jpmsonline.com/jpms-vol2-issue2>



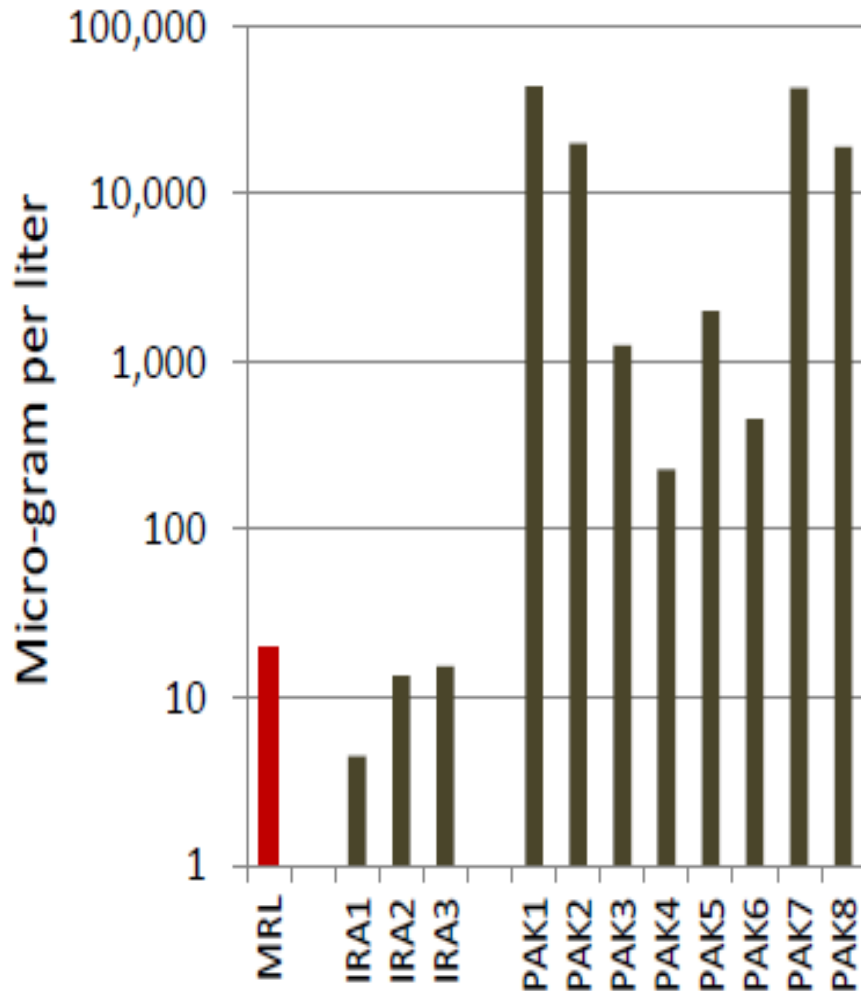
Umar & Bilal. 2012

Heavy metals in Milk

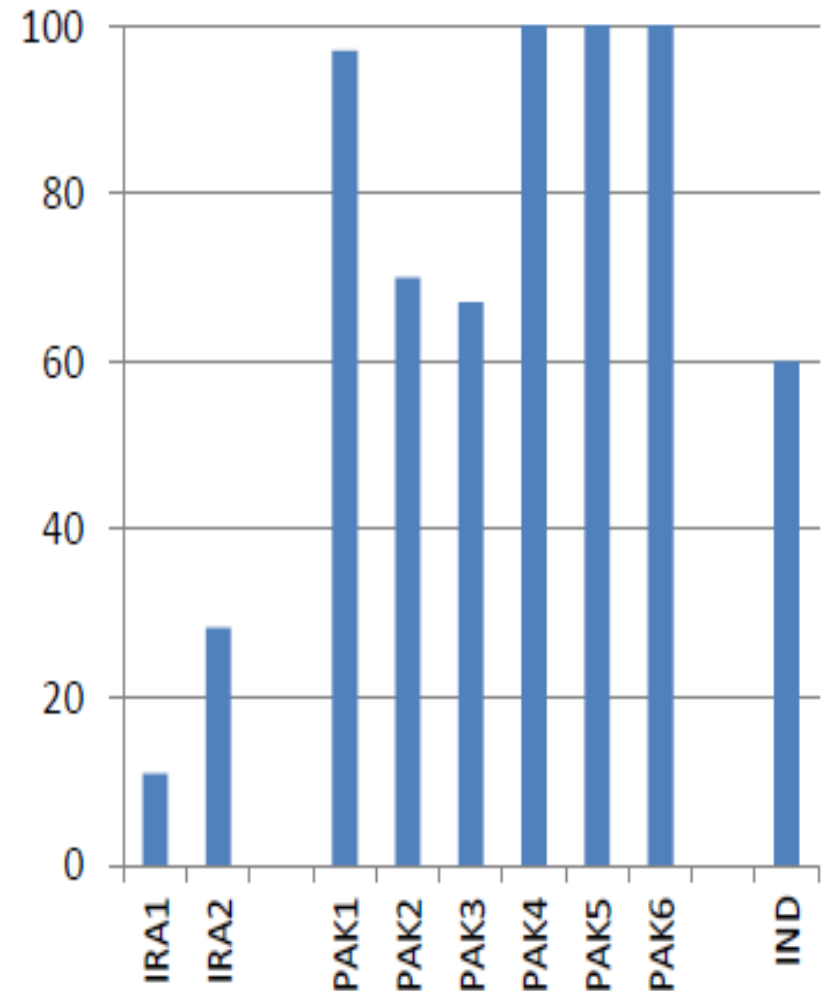
- Cadmium, copper, chromium, **lead (Pb)**, etc.
- **Sources**: Sewerage water use for drinking, irrigation, washing, industrial production processes, road traffic
- **Accumulation in kidneys, liver and bone-marrow,**
- Interferes with development of **nervous system** (children at high risk !!)
- Symptoms: abdominal pain, headache, anemia, seizures, coma
- Effects on kidneys and blood reversible, those on nervous system not
- MRL in milk: 20 micro-gram per liter

Pb Contamination of Milk

Mean Pb concentration in milk



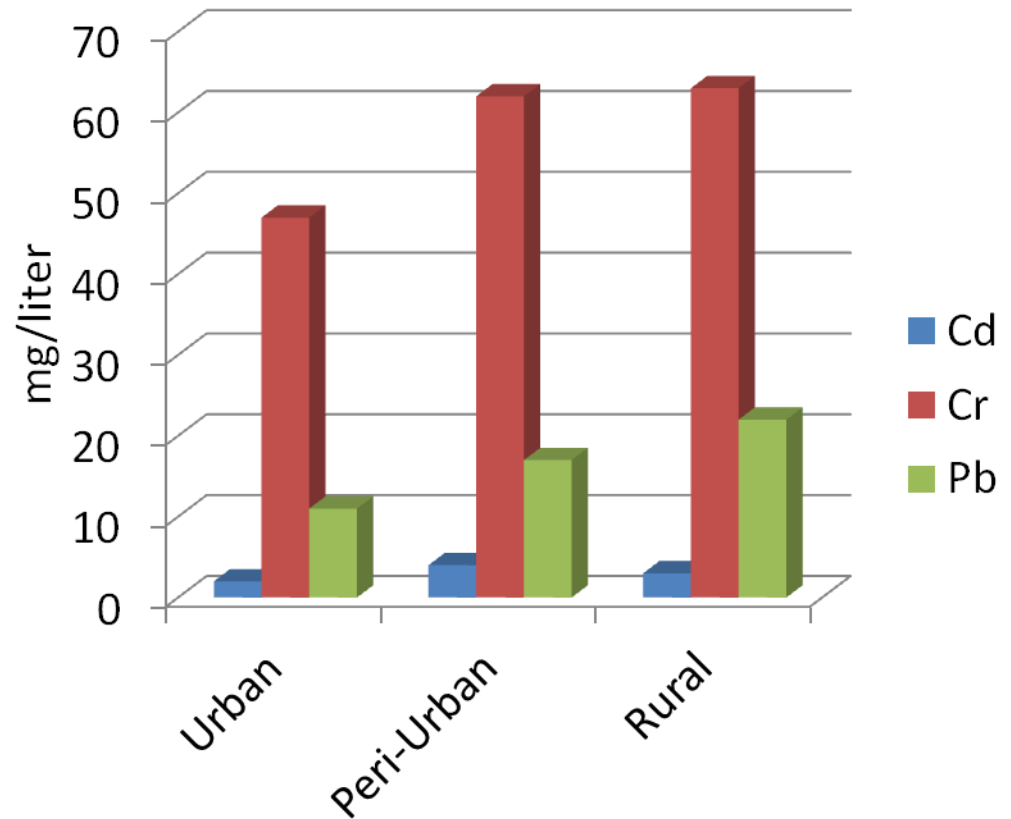
% samples exceeding MRL



Heavy Metal in Buffalo Milk around Peshawar

High Correlation
Coefficient of Milk &
Water contents ($R^2= 0.82$)

Water source as major
cause of high metals in
milk (drinking, washing,
irrigation)



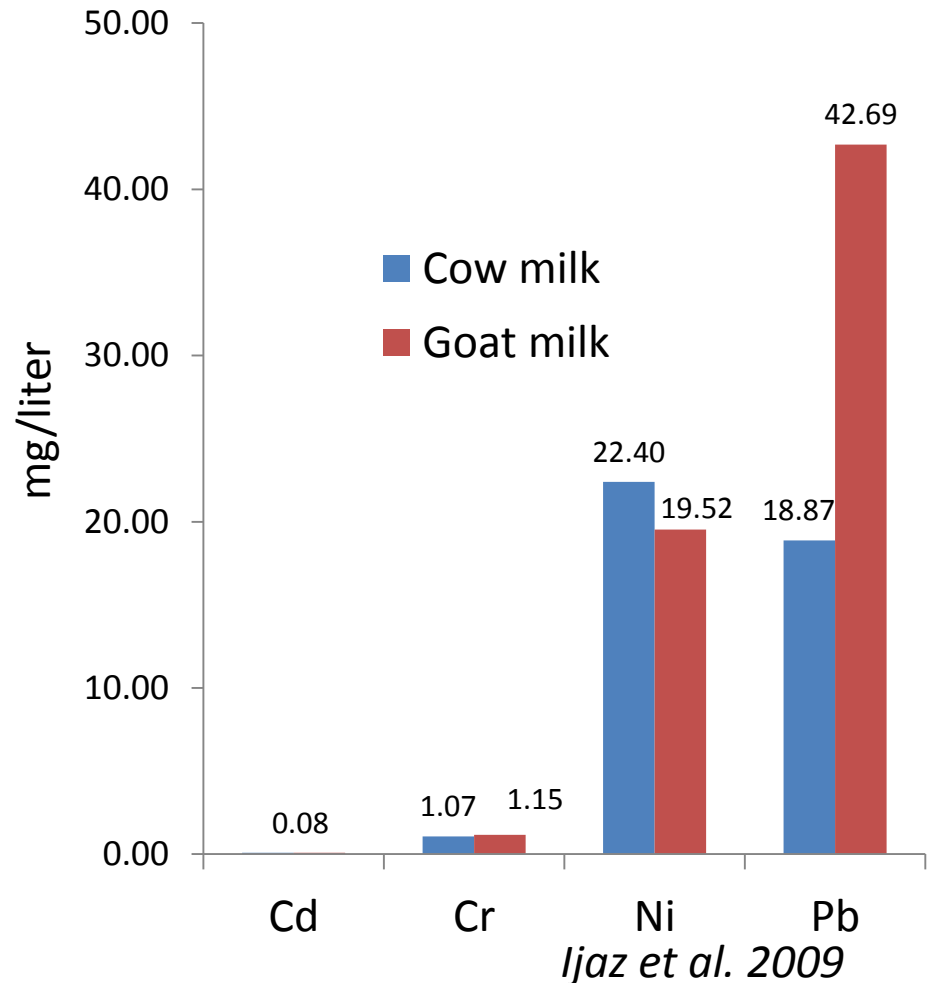
(5 farms per Zone, 4 buff/farm)

Rajwali, 2010

Heavy metal in milk of cows & goats raised along sewerage drain in Faisalabad

Daily Intake Vs WHO Tolerable limit

	From 215 ml milk (ug)	Tolerable limit ug/d/person
		7016
Cd		
Cr	229	60
Pb	4057	245
Ni	4816	275



Toxic metals in milk samples from different sources in Hyderabad City

Tasneem et al. 2009

	Farm (6x10) ug/lit	Shops (6x10) ug/lit	Packed (6x10) ug/lit
Al	1660 ± 187	1750 ± 156	1860 ± 137
Cd	44.2 ± 2.31	56.3 ± 3.14	54.2 ± 2.84
Ni	211 ± 15.3	223 ± 22.6	215 ± 14.7
Pb	47.6 ± 5.21	55.2 ± 4.23	50.6 ± 4.82

- Higher levels of toxic elements in milk from shops (bulk milk & exposure to traffic pollutants)
- Packed milk higher in toxic metal than milk sampled from farms

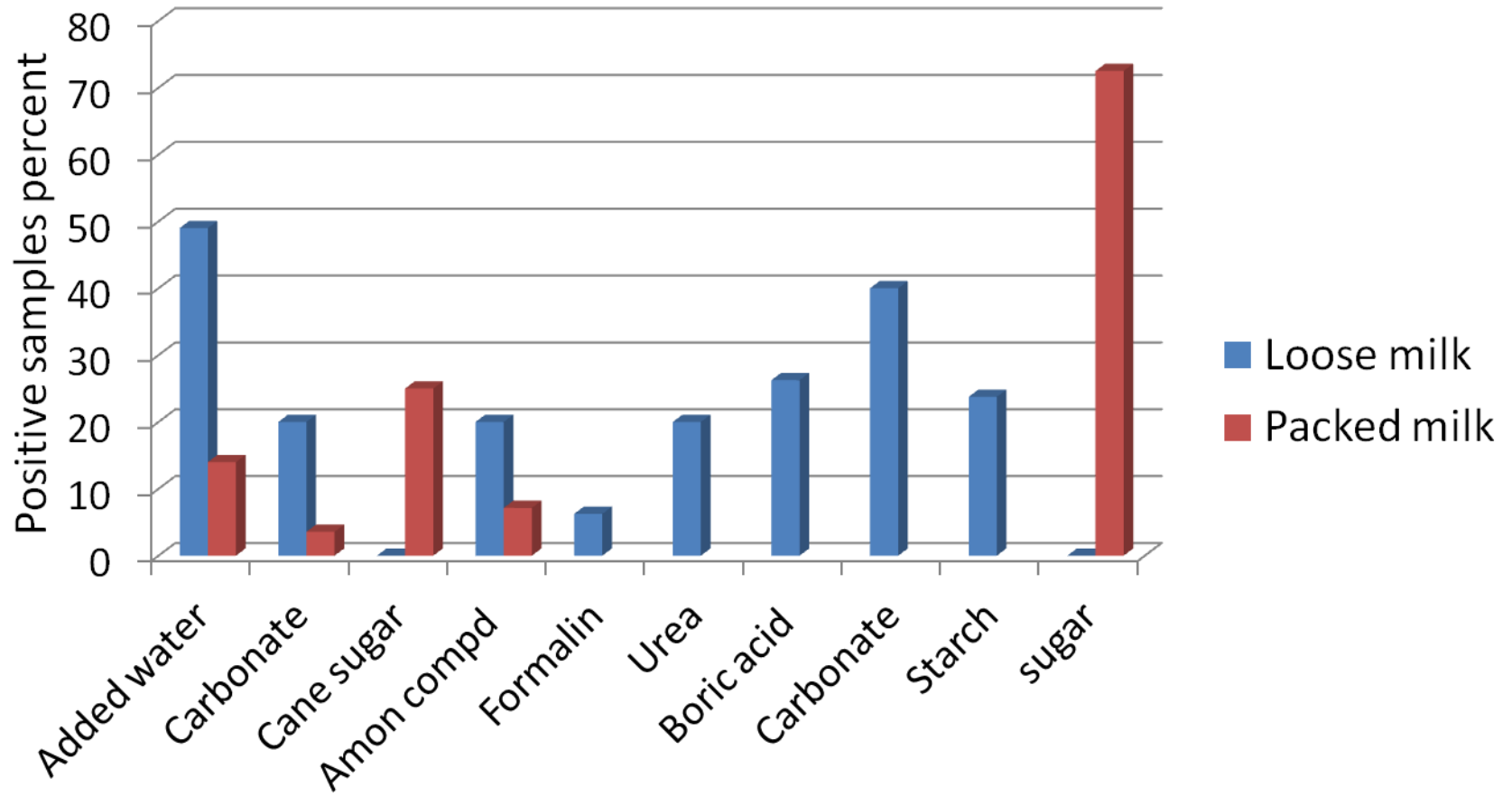
Adulterants in milk in Pakistan

Urea / Melamine (as protein booster)	30%
Substandard cooking oil	70%
Powdered water chestnut	40%
Formalin	35%
Penicillin for enhancing thickness & fragrance	47%
Hair removing powder	27%
Soda bicarb/Borax	35%

(Vety Views and News June 8-15, 2010)

Adulterants in loose and packed milk

(QCL-UVAS, 2009)



Pesticides in cow milk

(200 samples collected from 2 location near Faisalabad;10/loc/month)

	ppm	MRL (WHO 1997) ppm
Cyhalothrin	0.38 ± 0.02	0.20
Endosulfan	0.26 ± 0.02	0.50
Chlorpyrifos	0.072 ± 0.01	0.01
Cyprmethrin	0.085 ± 0.02	0.05

17-20% milk samples exceeded MRL

Enter through feed consumed by the animal

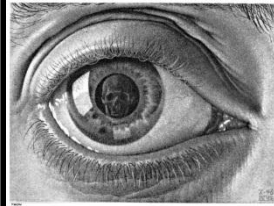
High risk of pesticides in milk---poisoning

Infants at high risk of neurodevelopmental problems

(Faqir Mohammad et al. 2012)

Pesticide Toxicity

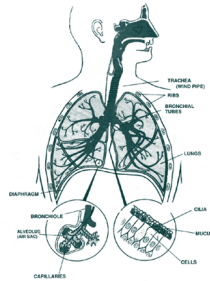
Signs and Symptoms in Adults



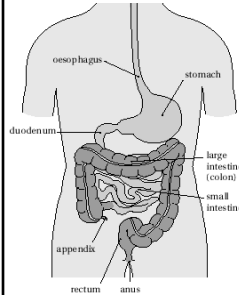
Eye



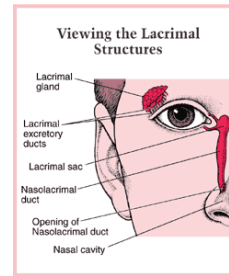
CNS



Lungs



GI



Glands



Muscle



Heart

- Miosis
- Blurring

- Fatigue
- Dizziness
- Headache
- Tremors
- Ataxia
- Seizures
- LOC
- Coma
- Insomnia
- Mental A

Tightness
Wheezing
Cough
Rhinorrhea

Abd. cramps
Nausea
Vomiting
Diarrhea

Drooling
Sweating
Tearing

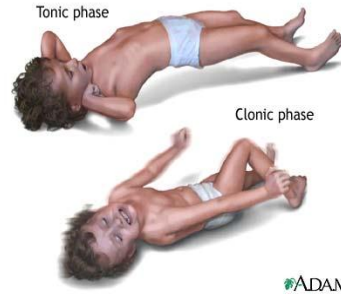
Weakness Cramps
Fasciculations

Tachy
Brady
↑ BP
↓ BP

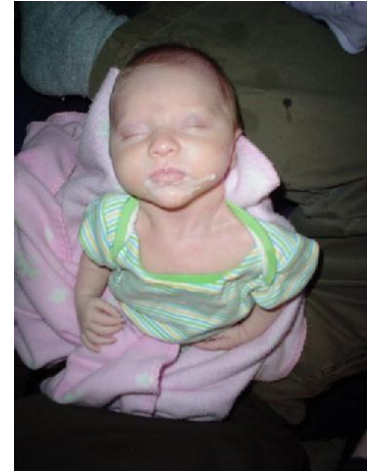
Signs of Pesticide Poisoning in Children



Lethargic
sleepy



Seizures



Coma

Can be confused with the flu

Hormones

- Growth hormones used for milk increase
- Oxytocin use for milk let down

Impact on

Animal Health & reproduction ?

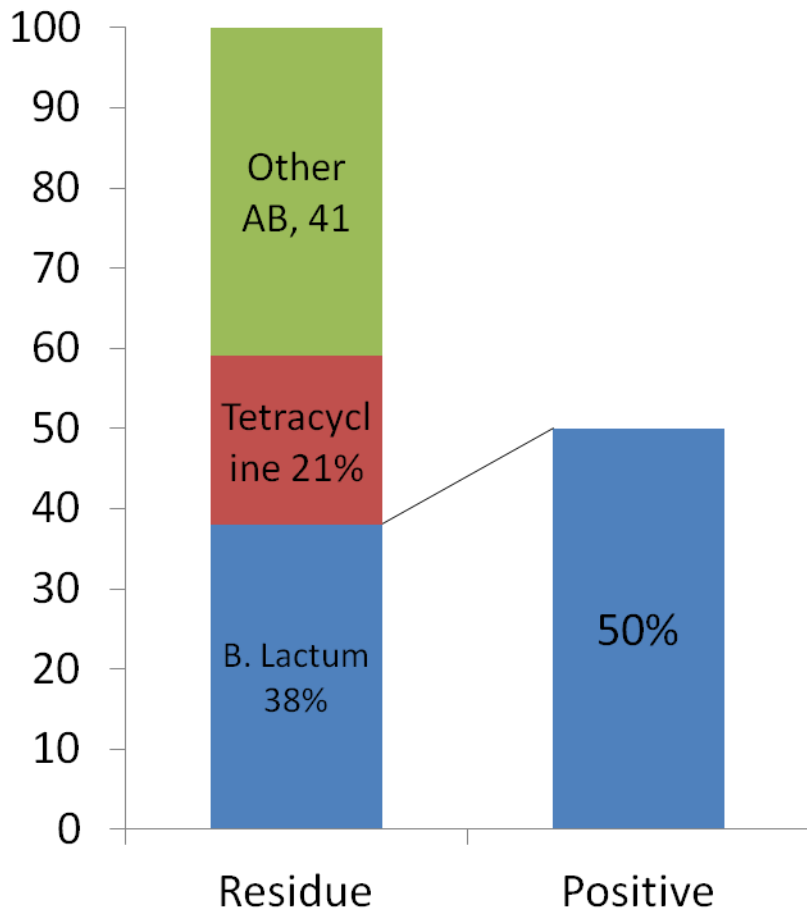
Human Health ?

Unknown in local context ?

Drug and Antibiotic Residues in milk

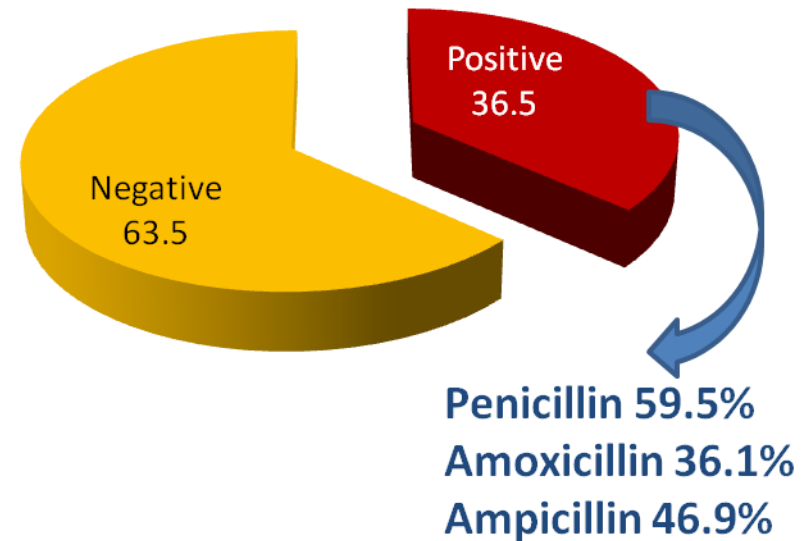
- Residues of about 80 drugs identified in animal source food by US-FDA
- Antibiotics are most frequently & indiscriminately used in Pakistan
- β - lactam is the oldest group of antibiotics which are frequently used for the treatment of sick animals in Pakistan.(Penicillin, Ampicillin Oxacillin, Amoxicillin, Dicloxacillin,Cephalexin and Cephairin)
 - implicated in a wide variety hypersensitivity reactions of multisystems (Skin, bone marrow, lungs, liver and heart)

Antimicrobial Drug Residues in milk in Sindh



*Sampling from 5 cities
Mangsi et al. 2014*

B. lactum in Unprocessed milk samples from various sources # 137



Khaskhali et al, 2008

Way Forward

- Raising Farmers and Consumers **awareness** on human health threats in milk
- Focused, properly planned & transdisciplinary research using modern & sensitive techniques - **Quantitative Risk Assessment**
- Understanding the whole dairy value chain to **identify entry points** for milk contamination
- Highlight **economic impact** of reducing milk born health hazards
- Development of easy, accurate and cheap field level **tests for quick screening**
- **Monitoring, Legislation, Regulation**
- Evidence based advocacy to **inform policy decision** for legislation

USAID
Punjab Enabling Environment Project
(PEEP)

Stakeholders

**Government
of Punjab**

Universities

Stakeholders

**Private Sector
Entrepreneurs**

Civil Society

**Business
service
agencies**

Development Objective
*Increased Incomes and Employment in
Livestock, Dairy & Horticulture sectors*



Accelerate
advocacy for
policy, regulatory
and institutional
reforms through
private sector

Support
institutional
capacity building
to sustain
enabling
environment
reforms

Mobilize major
private sector
investments in
the target sectors

“If you can’t measure it, you can’t manage it.”



Thanks