



Sustainable poultry (meat and eggs) production in Pakistan: Challenges and Opportunities



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Biotechnology and
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Research Council



GLOBAL DEMAND FOR MEAT

2005 vs 2050
(in tonnes)

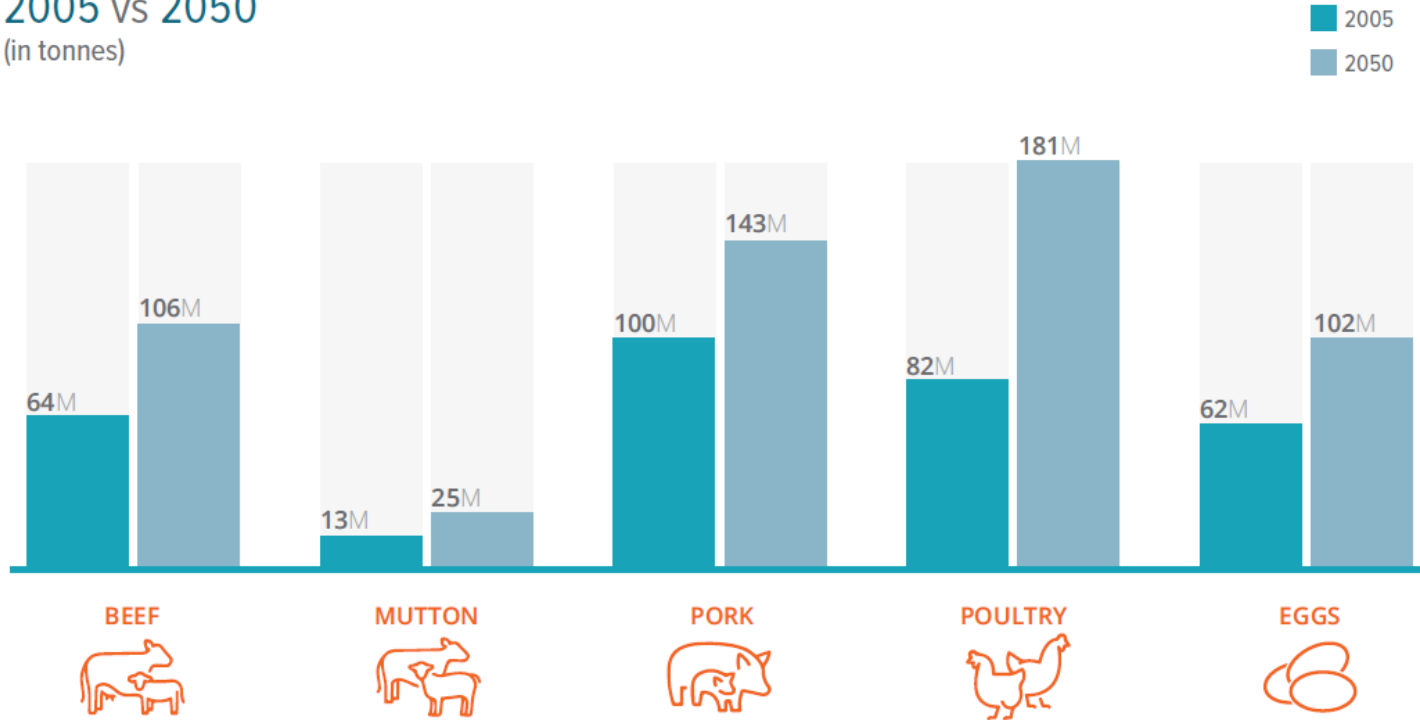
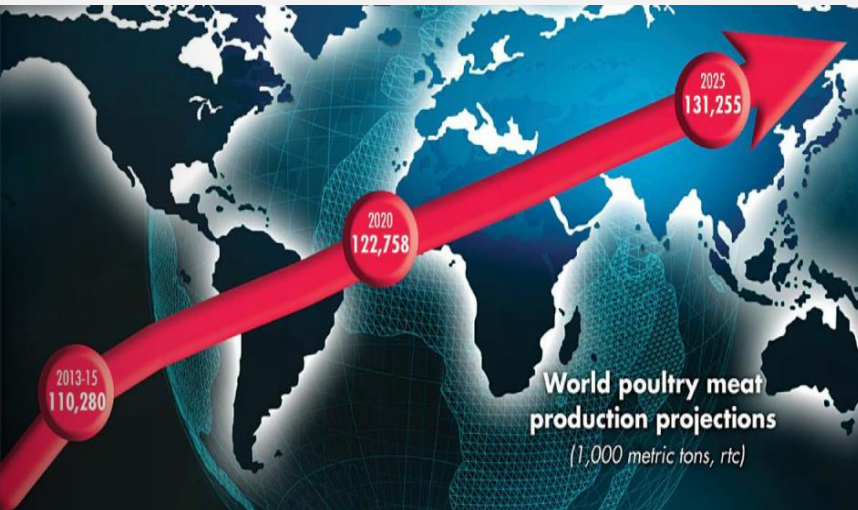
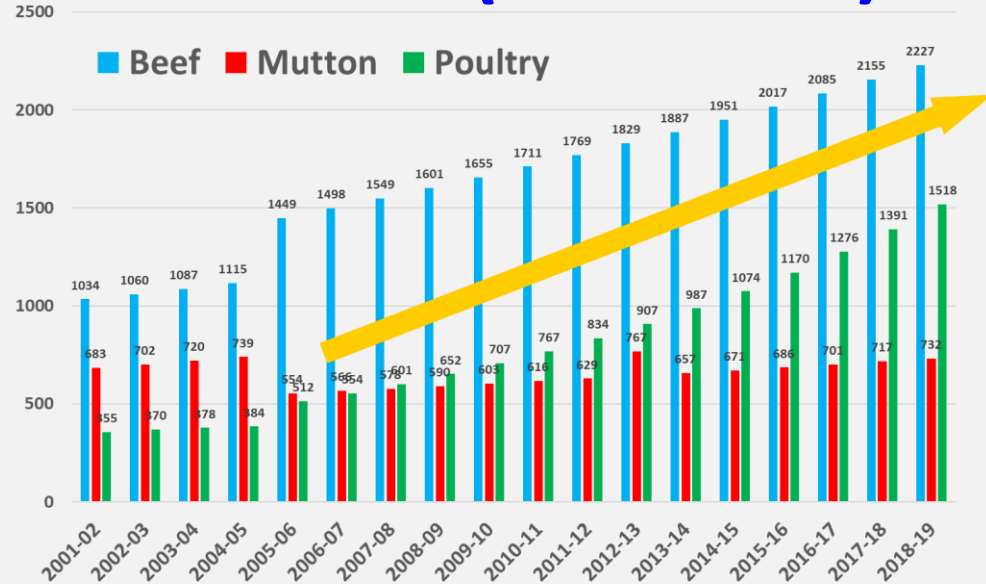


Figure 2: Global demand for meat in 2050 (adapted from FAO, 2012; Gates Notes 2013)

Global poultry production is expected to grow by 24 percent over the next decade



Meat Production in Pakistan (000 Tons)



Source: Economic Survey of Pakistan 2018-19

Demand for meat in Pakistan is going even more faster rate than the globally predicted

Global imbalance in production and availability of livestock products

One billion hungry



Two billion overweight



Chickens: A Solution to Global Poverty?



It has been eye-opening for me to learn what a difference they can make in the fight against poverty. It sounds funny, but I mean it when I say that I am excited about chickens.

- Bill Gates

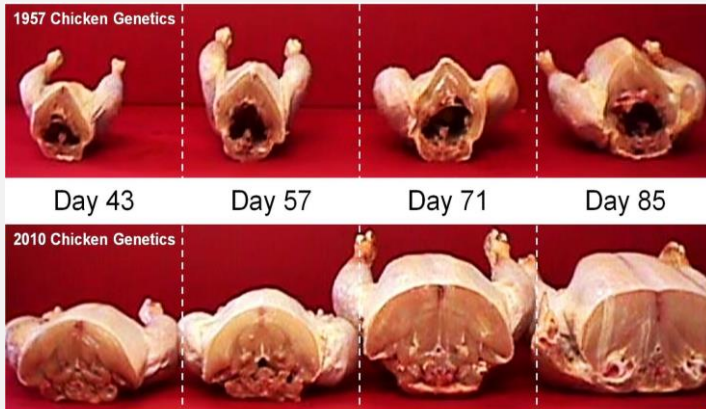


The Chicken Plan and Poverty Alleviation in Pakistan

US media lauds PM Imran Khan "Chicken Plan", terms vital for reducing poverty in Pakistan



Poultry Industry has made significant advances in meat and egg production in the few decades



Commercial Poultry Sector has become one of the key Contributor to the Pakistan Economy & Jobs

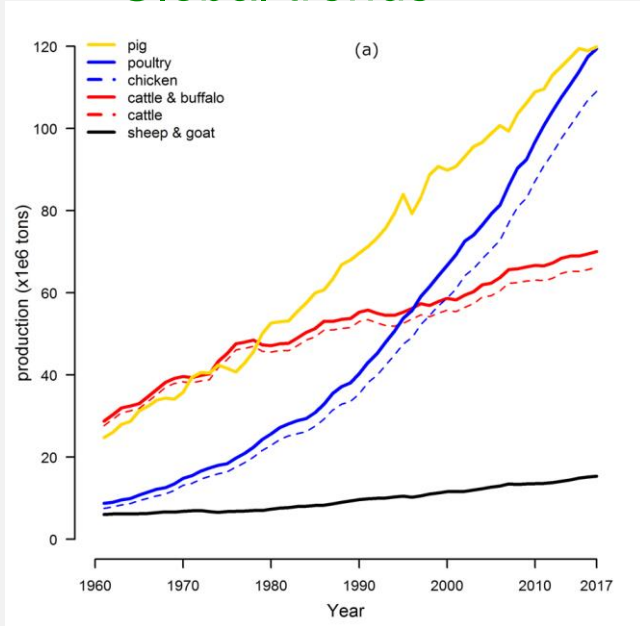
- Investment = > RS 700 billion
- Contribution in GDP = 1.4%
- Employment generation = 1.50 Million
- Contribution in Agriculture = 7.5 %
- Contribution in Livestock = 12.7 %
- Poultry Meat Share = 34 % of total meat
- Annual Growth rate = 8-10 %

- Punjab province having major contribution
 - More than 70% of broiler production
 - About 80% of egg production
 - About 85% of feed production
 - 100% processing and value addition

Changing composition of meat production and demand

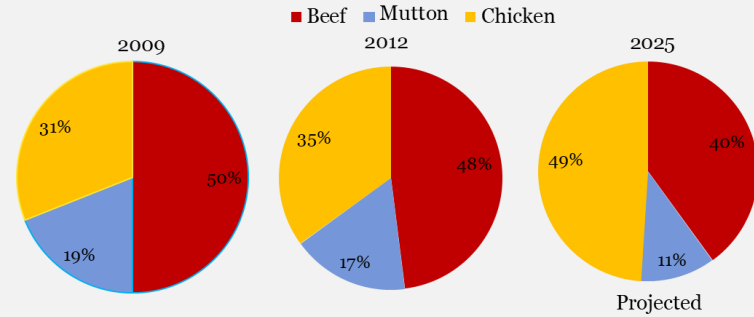
2017: ~120 billion broiler chickens and ~ 80 million metric tons of eggs (~114 trillion)

Global trends



Marius Gilbert & Guillaume Fournie, 2018

In Pakistan

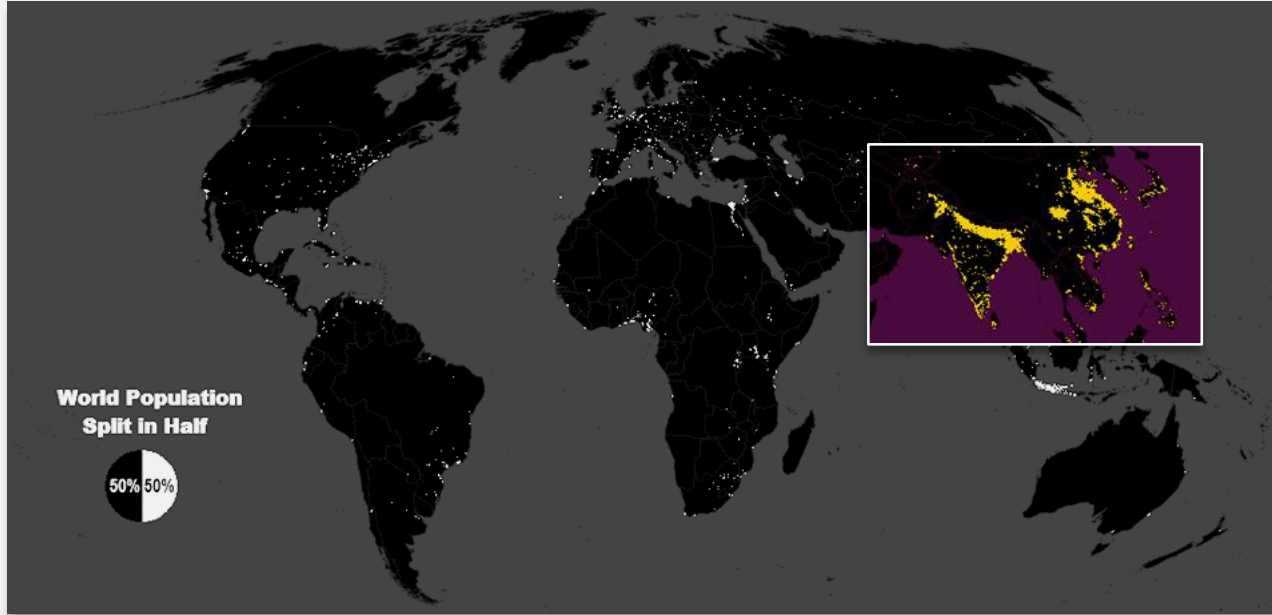


>18% increase during last few years

**HOW IS THIS be
SUSTAINABLE?**



POULTRY DEMAND IS LINKED TO HUMAN POPULATION DENSITY



46% of the world population is in yellow

From <http://metrocosm.com/world-population-split-in-half-map/>

**Human behaviours are key to this real world challenge:
How to achieve sustainable food production without
increasing risk**

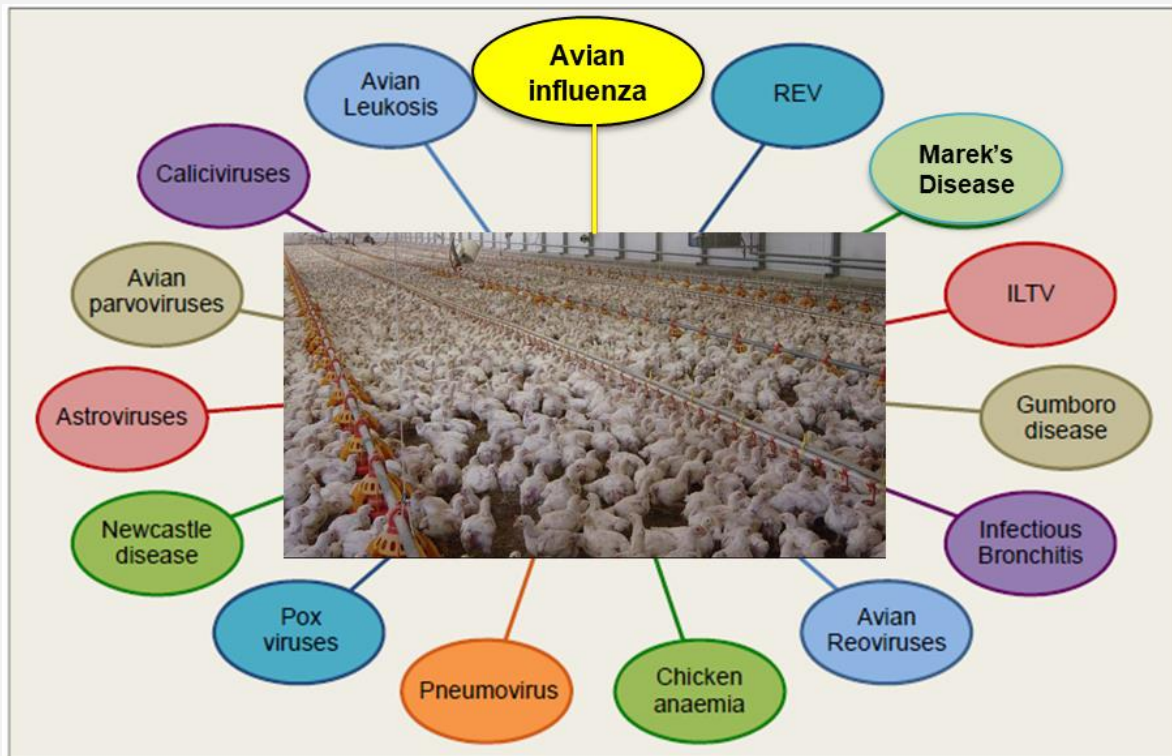
How we can meet this demand ?

WHAT ARE THE CHALLENGES FOR INTENSIFICATION?



People, poultry, pathogens and the environment they inhabit

Threat of Infectious diseases remain a major threat for sustainable growth



Some of the diseases have devastating effects on health & welfare of animals and farmers livelihood.



Avian Influenza



Infectious bronchitis



Marek's disease



Newcastle disease

Sudden spread of avian flu in Poland, Vietnam

Cases are also reported in India, Taiwan and Bulgaria

Over 65,000 hen to be culled in bird flu outbreak in Poland

Associated Press | JANUARY 3, 2020 — 7:35AM



Photo: Marcel van Hoon

According to Polish sources another 350,000 commercially held birds on 3 farms are at risk within the containment zone with a 3 kilometer radius.

H5N3, H6N1 in UK

11 December 2019

The discovery of the H5 strain of avian flu at the Suffolk farm in December led to a cull of 27,000 chickens.

10 February 2020

Farmers placed on alert after bird flu case in Scotland

© 10 February 2020

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Saudi Arabia reports H5N8 bird flu on farm: OIE

The outbreak, which occurred in the central Sudair region, killed 22,700 birds, the OIE said, citing a report from the Saudi agriculture ministry.

The other 385,300 birds in the flock were slaughtered, it said.

H5N1 & H5N6 in China

News | Feb 3, 2020

China reports H5N1 case

China has reported a case of H5N1 avian influenza on a poultry farm in the Hunan province.

Authorities said the highly pathogenic strain of H5N1 had killed 4,500 birds on a farm with a flock of 7,850 birds. Further culling of some 18,000 took place to try to contain the disease's spread.



Vaccines are central to the current control strategies

Typical vaccination schedule for breeder flocks

bird age	Vaccine
1 day	Marek's disease,
6–7 days	NDV and AIV H5, H7 & H9
14–21 days	NDV, IBV, adeno-4& adeno-8
14–28 days	IBD, AIV H5, H7 & H9
4 wk	NDV /IBV & AIV H9
6-8 wk	Infectious Laryngotracheitis (ILT)/ adeno/ Reo
8–10 wk	IBD/APV (SHS)
8–10 wk	NDV/IBV, Adeno-4& Adeno-8
10–12 wk	Encephalomyelitis
10–12 wk	Fowlpox/EDS
10–12 wk	Chicken infectious anemia (CAV)
10–12 wk	ILT
12–14 wk	NDV, IBV
16–18 wk	IBV, APV (SHS)/EDS
16–18 wk	NDV,IBV (killed) AIV H5, H7 and H9
Every 60–90 days	NDV/IBV/H9

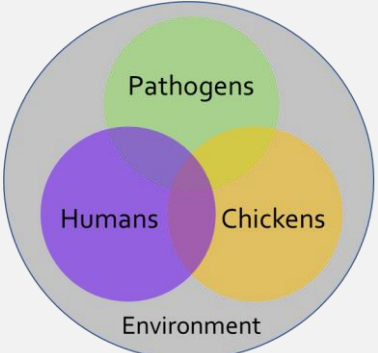
Vaccine Failure

- **Widespread antigenic diversity**
- **Emergence of new viruses**
- **Mixed infections of pathogens**
- **Immunosuppressive pathogens**
- **Poor quality vaccines**
- **Suboptimal vaccination practices**

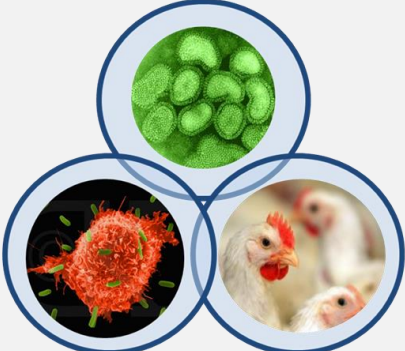
Despite multiple doses of vaccines, the viruses continue to persist in the vaccinated flocks and cause disease outbreaks



Detailed understanding of the diseases are very important for innovations in control



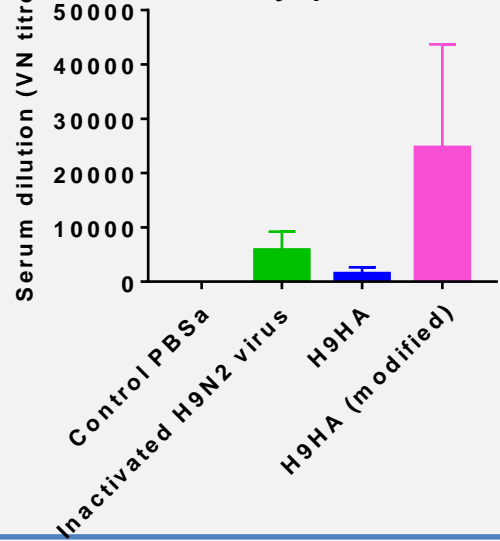
What are the viral attributes associated with the disease?



How does the immune system respond to viruses?

What features of virus-host interactions result in disease?

3 fold > protective immunity
14 day pv

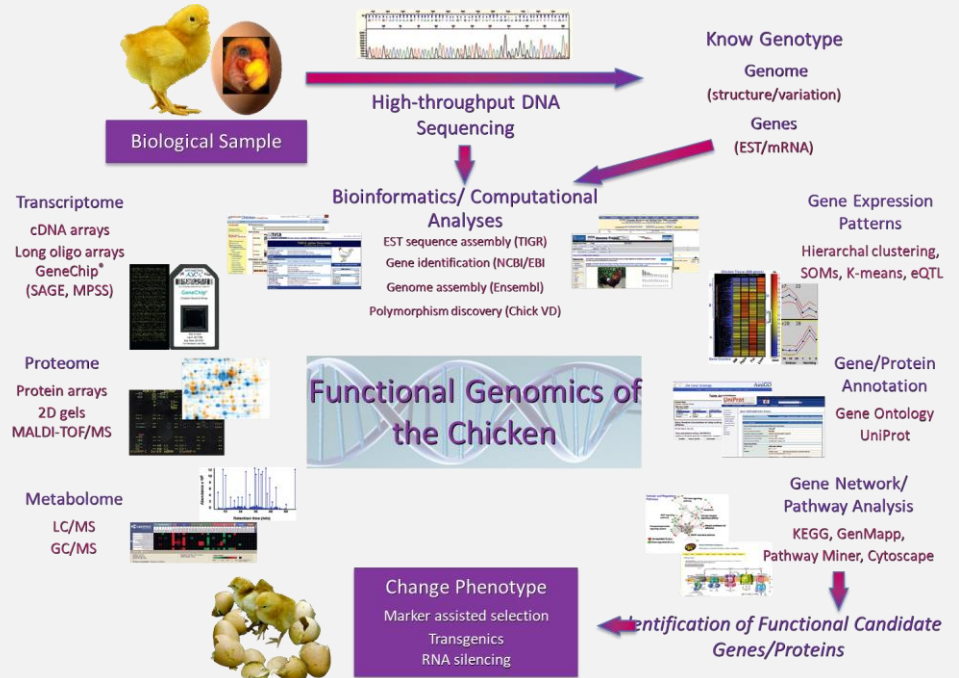


Selectively delivering antigens to chicken immune cells enhanced the antigen uptake and induced faster and stronger antibody responses

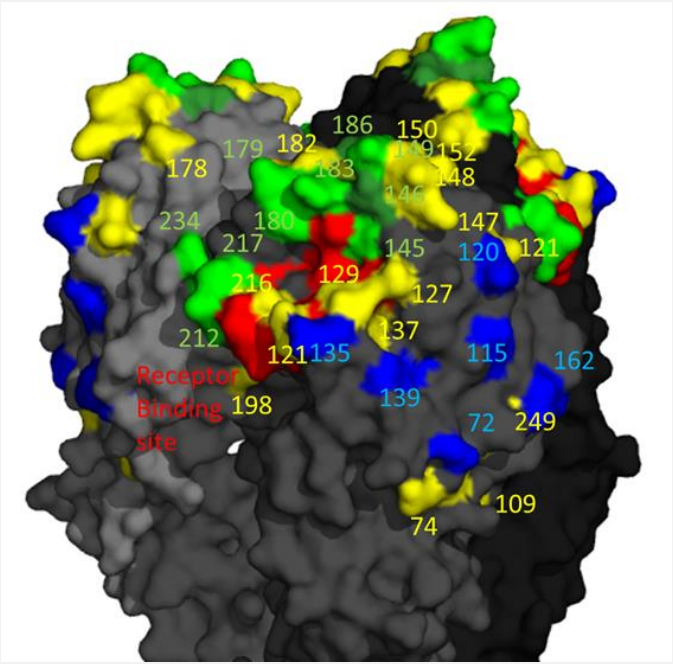
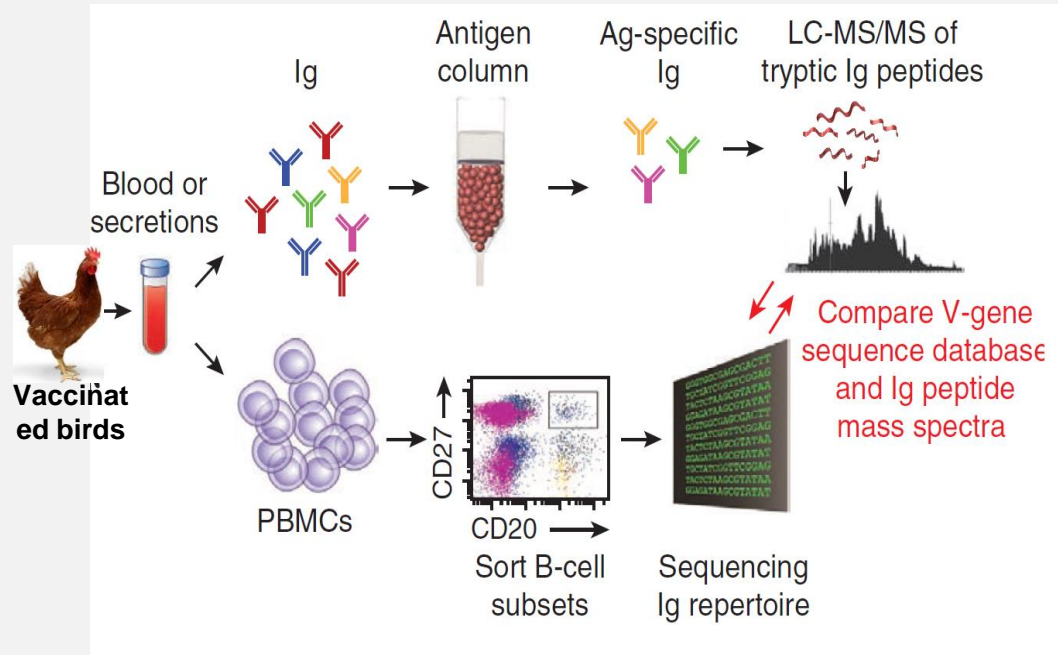
Multinational and Multidisciplinary collaboration and technical innovation can provide some of the solutions for these emerging challenges

- Next generation technologies

- Breed improvement
- Disease and climate adaptable breeds
- Pathogens finger printing, diversity monitoring, risk assessment and vaccine selection




B-cell epitope discovery and Reverse Vaccinology



H9HA antigenic sites that modulates antigenicity and vaccine failure.

New vaccination and prophylactics replacing antibiotics use



 **vaccines** 

Article

Engineered Recombinant Single Chain Variable Fragment of Monoclonal Antibody Provides Protection to Chickens Infected with H9N2 Avian Influenza




Deimante Lukosaityte ¹, Jean-Remy Sadeyen ¹, Angita Shrestha ¹, Joshua E. Sealy ¹, Sushant Bhat ¹, Pengxiang Chang ¹, Paul Digard ² and Munir Iqbal ^{1,*}

Vaccines 2020, 8, 118; doi:10.3390/vaccines8010118 www.mdpi.com/journal/vaccines



 **vaccines** 

Article

Application of HDR-CRISPR/Cas9 and Erythrocyte Binding for Rapid Generation of Recombinant Turkey Herpesvirus-Vectored Avian Influenza Virus Vaccines



Pengxiang Chang ¹, Faisal Ameen ², Joshua E. Sealy ¹ , Jean-Remy Sadeyen ¹, Sushant Bhat ¹ , Yongqing Li ^{3,4}  and Munir Iqbal ^{1,4,*}

Vaccines 2019, 7, 192; doi:10.3390/vaccines7040192 www.mdpi.com/journal/vaccines

 **vaccines** 

Article

Generation of A Triple Insert Live Avian Herpesvirus Vectored Vaccine Using CRISPR/Cas9-Based Gene Editing

Na Tang ^{1,2}, Yaoyao Zhang ^{1,3}, Yashar Sadigh ¹ , Katy Moffat ¹, Zhiqiang Shen ², Venugopal Nair ^{1,4,5,*}  and Yongxiu Yao ^{1,*}

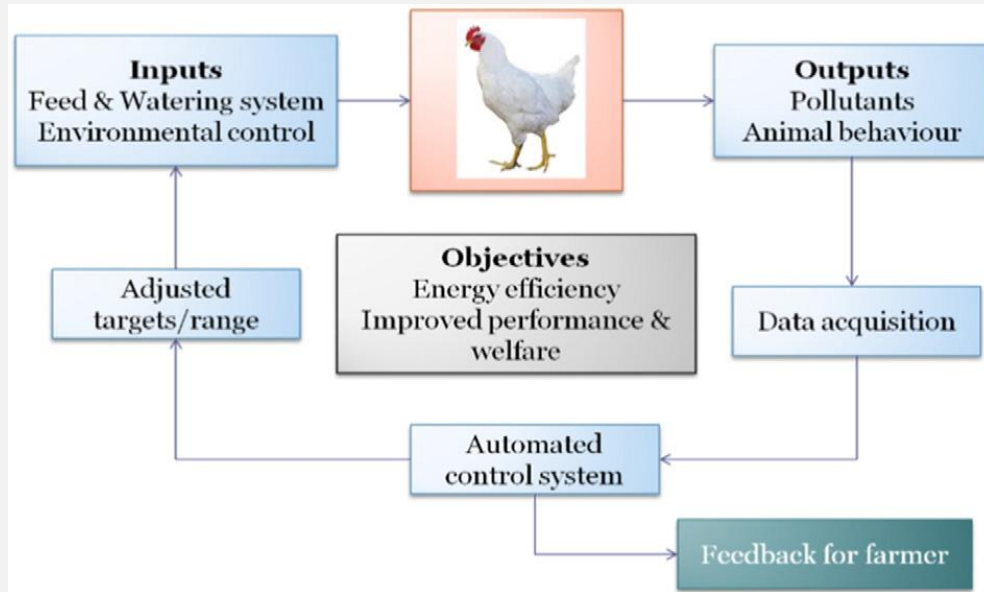
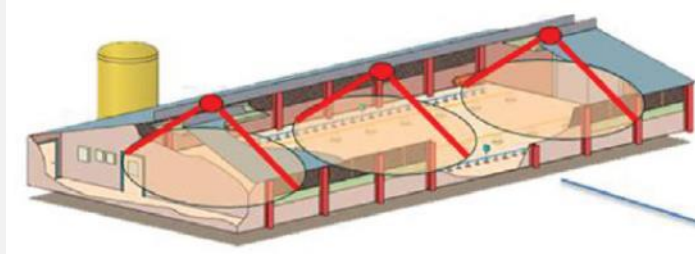
Vaccines 2020, 8, 97; doi:10.3390/vaccines8010097 www.mdpi.com/journal/vaccines

- Single dose of vaccine induce lifetime protection against multiple pathogens
- Mass vaccination (in ovo) or to day-old chicks at hatchery

in-ovo injection systems (Semi-automatic vaccinator)



eYeNamic monitoring of broiler behavior



Robotics to transform poultry production



https://www.wattagnet.com/articles/32563-robotics-in-poultry-production-to-transform-sector?utm_source=KnowledgeMarketing&utm_medium=email&utm_content=Poultry%20Update&utm_campaign=18_01_12_Poultry%20Update_Friday&eid=148815942&bid=1971754

Robotics to transform poultry production



Need for rapid and sensitive diagnostic tools

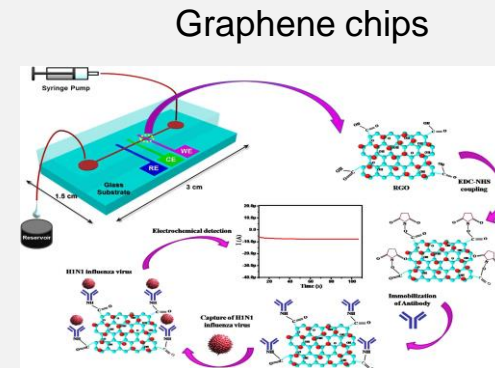
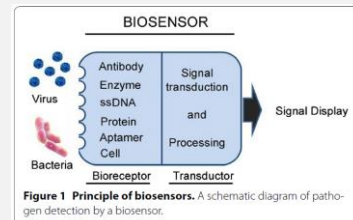
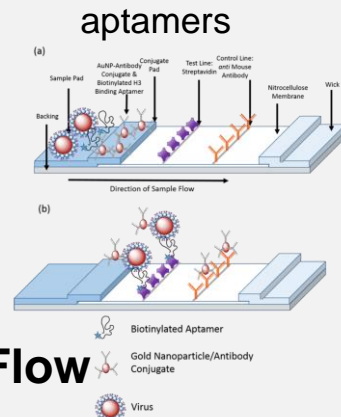
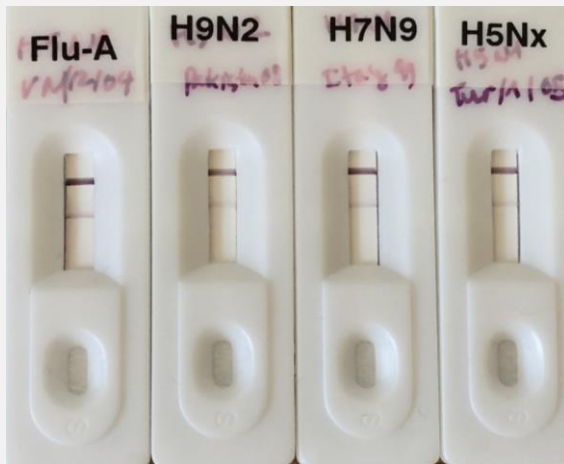
analytical chemistry

DOI: 10.1021/acs.analchem.7b01149
Anal. Chem. 2017, 89, 6781–6786

Dual Recognition Element Lateral Flow Assay Toward Multiplex Strain Specific Influenza Virus Detection

Thao T. Le,[†] Pengxiang Chang,[‡] Donald J. Benton,[§] John W. McCauley,[§] Munir Iqbal,[‡] and Anthony E. G. Cass^{*†}

Novel Dual Recognition Element Lateral Flow Assays (DRELFA)



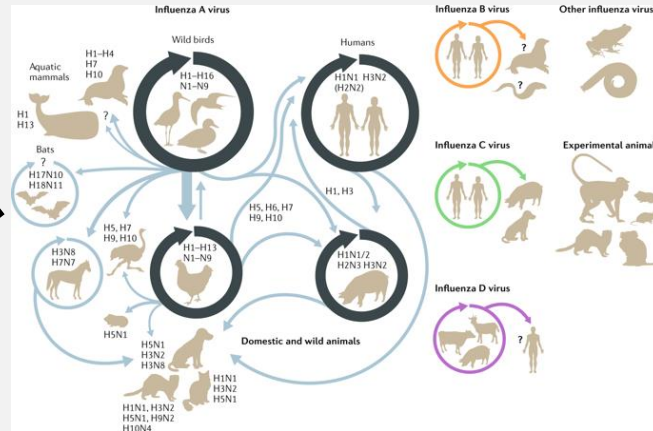
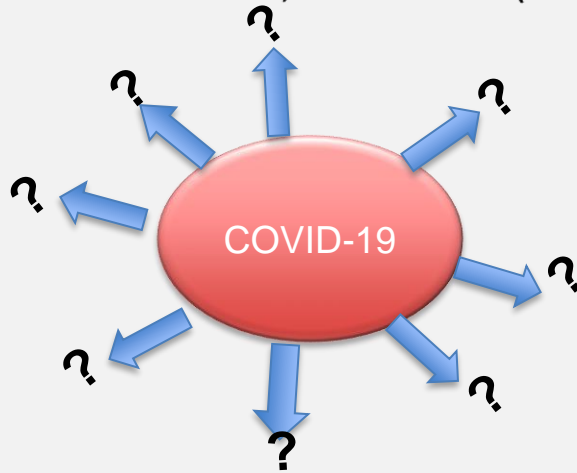
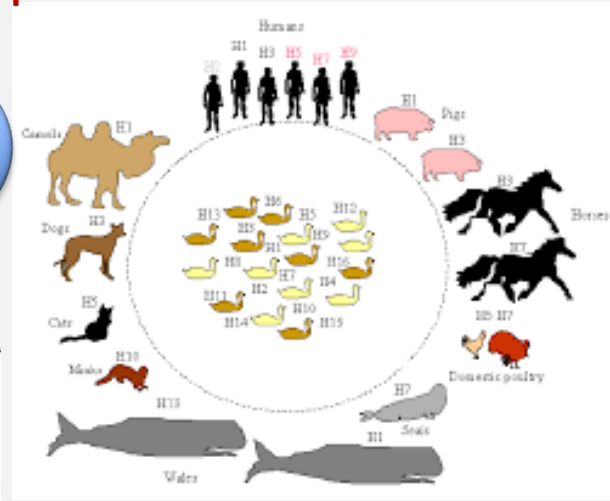
Biggest threat: Zoonosis and pandemic

Enhanced characterisation of prevailing viral strains and **Formalising a pipeline for risk assessment** of different domestic and wild animal pathogens

H5N1 cases >860; deaths 544 (since **2003**)

H7N9 cases >1623; deaths 620 (since **2013**)

Avian
Influenza
viruses



Controlling infections in animals = Reduction in zoonotic transmission

Key Conclusions

- Many avian viral diseases are truly panzootic affecting poultry and wild birds
 - Endemic in some regions; reincursions in others- prospects for immediate control poor!
- Multiple selection pressures increasing viral diversity
- We can expect further outbreaks with novel emerging and re-emerging avian influenza and other animal viruses in next months/years..?
- Continued and future threat to global food security/human health

Future perspectives for global poultry production

Understanding pathways for introduction of new disease threats

- Ongoing threat from infected nearby countries- H5 viruses
- Endemic strains ie H9N2
- Virus variability; correlates for infection risks and vaccine failure

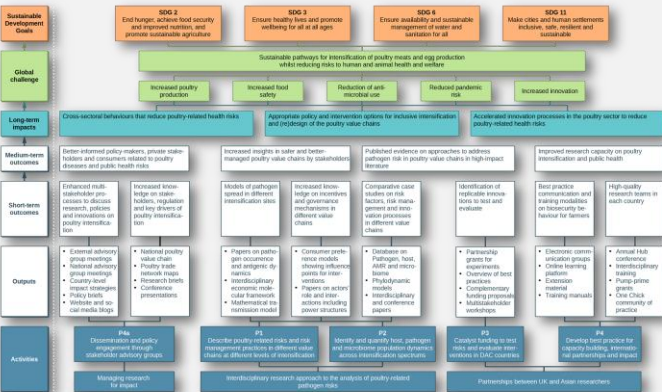
Solutions at global scale for better interventions

Better veterinary vaccines and diagnostics

Global Challenges = Collaborative working



Complex pathways to achieve sustainable and safe food production



55 Investigators
 9 Countries
 30 LMIC
 21 Female, 34 Male
 25 Early career
 (<45 years old)

Acknowledgements

AIV group (current team)

- Munir Iqbal
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- Pengxiang Chang
- Sushant Bhat
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- Deimante Lukosaityte
- Angita Shrestha
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- Stefan Dascalu
- Thusitha Karunarathna
- Holly Everest

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- Anabel Clements
- Pam Lithgow
- Yashar Sadigh
- Beata Adamiak
- Yongqing Li
- Michelle Hill
- Kolli Reddy
- Erasmus Kotey

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Dr Abdul Rehman (PRI Rawalpindi)
Professor Tahir Yaqub, UVAS Lahore
Dr Khalid Naeem (NARC)

Collaborators

- Prof John McCauley, Director, The Francis Crick Institute,
- Prof Ian Brown, APHA
- Dr Marek Slomka, APHA
- Dr Sharon Brookes, APHA
- Professor Tony Cass, Imperial College, London
- Prof Yipeng Sun, China Agricultural University
- Prof Yongqing Li (BAAAFS), China
- Prof Jinhua Liu, China Agricultural University
- Professor Fiona Tomley RVC, London
- Professor Paul Digard, The Roslin Institute
- Dr Adrian Smith, University of Oxford
- Dr Ian Tarpey, MSD Animal Health,
- Professor Yoshihiro Kawaoka. University of Tokyo
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- Dr Juliet Bryant, Fondation Merieux., France.
- Professor Wendy Barclay, Imperial College
- Professor Amal Zagazig University,, Egypt.
- Dr To Long Thanh, (NCVD) Hanoi, Vietnam.
- Dr Andrew Dalby University of Westminster. UK.
- Professor Alain Townsend, University of Oxford, U
- Dr Simon E. Hufton, NIBSC,
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- ,

