"THE BATTLE AGAINST TRANSBOUNDARY ANIMAL DISEASES IN NIGERIA AND SOME WEST AFRICAN COUNTRIES"

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(Public Lecture)

INTRODUCTION

The President of the Nigerian Academy of Science, the Chairman of the occasion, distinguished Fellows of the Academy, our Fellows for today's induction, invited guests, gentlemen of the press and media, ladies and gentlemen.

It gives me great pleasure to have been chosen to give this lecture. I have chosen this title because in recent years some animal diseases have become increasingly important in terms of their economic or zoonotic impact in Nigeria as well as its neighboring countries.

TRANSBOUNDARY ANIMAL DISEASES

Transboundary Animal Diseases (TADs) are defined by Food and Agriculture Organization Emergency Prevention System (FAO/EMPRES) as those animal diseases that are of significant economic, trade, and/or food security importance for a considerable number of countries; and which can easily spread to other countries and reach epidemic proportions and where control/management, including exclusion, requires co-operation between several countries. The occurrence of any of these diseases in any country may compromise food security through serious loss of animal protein and/or loss of draught animal power for cropping, may lead to significant production losses in meat, milk, and other livestock products.

It may also make it impossible to up-grade the production capacity of indigenous livestock importation breeds through high-producing exotic breeds which are usually highly susceptible to these diseases. The prohibitive cost of control of these diseases increases, very significantly, production costs while TADS in a country may disrupt or inhibit trade in livestock and livestock products and, in effect, adversely affect national export economy. Some transboundary animal diseases such as Highly Pathogenic Avian Influenza (HPAI) or Rift Valley fever are transmissible to humans (zoonosis) and therefore have public health consequences of varying magnitude. Others like Rinderpest may lead to decimation of wildlife population and therefore have environmental impact as well as adversely affect tourism and recreational opportunities for individual countries.

In Nigeria, with the global eradication of Rinderpest, the most important TADS that may have serious negative impacts on our food security are Peste des Petits Ruminants (PPR), African Swine Fever (ASF), Highly Pathogenic Avian Influenza, Newcastle Disease (ND) of poultry, and Contagious Bovine Plueropneumonia (CBPP). Other TADs that are prevalent but with less dramatic effects on our national food security include Foot and mouth disease (FMD), Lumpy Skin Disease (LSD), and Sheep and Goat Pox.

Rinderpest is a highly infectious viral disease of cattle, buffaloes, and some wildlife characterized by fever, necrosis of the oral cavity and alimentary canal, severe diarrhoea, and death in up to 90% of a susceptible herd. The disease entered Nigeria in 1886 through Chad killing 80-90% of the Fulani cattle. The 1983-85 outbreaks in Nigeria according to Nawathe and Lamorde (1985) caused a few Fulani herdsmen to commit suicide while others gave up their traditional profession of cattle tending. The first internationally coordinated control programme in West Africa between 1962 and 1969 (Obi 1993) cost an estimated $16.4

million while a latter programme, the Pan African Rinderpest Campaign (PARC) involved 24 countries and about 65,000 personnel and technicians.
Peste des petits ruminants is a severe fast-spreading disease of domesticated and some wild small ruminants characterized by sudden onset of depression, fever, discharges from the nose and eyes, sores in the mouth, disturbed breathing, diarrhoea, and death.

The disease was first reported in Cote d'Ivoire in 1942 (Gargadenec and Lalane 1942) who because it resembled rinderpest (Peste bovine; bovine plague) gave it the name Peste des Petits Ruminants (Small ruminant Plague). In subsequent years, the disease came to be recognized in Benin Republic, Senegal, Nigeria, Ghana and, eventually, in most countries of West Africa. It is now known that the disease is widespread in countries of sub-Saharan Africa including Ethiopia and Sudan, as well as in Saudi Arabia, Oman, United Arab Emirates, Lebanon, Israel, Kuwait, Jordan, Iran, Yemen, Turkey, and Iraq. Outbreaks of PPR are now known to be common in India, Pakistan, Nepal, Bangladesh, and Afghanistan. It has been speculated that the recent increased geographical distribution of the disease derives from improved methods of laboratory diagnosis as well as increased awareness since it is obvious that PPR had for many years been confused with other diseases which present similar clinical and pathological features as PPR.

African Swine Fever (ASF) is a highly contagious viral disease of domestic pigs characterized by fever, hyperemia of the skin, incoordination, diarrhoea, and pneumonia. It may cause high morbidity and high mortality and is a serious transboundary animal disease with the potential for rapid international spread.

First described by Montgomery in 1921 in Kenya, ASF has subsequently been reported in most countries in southern and eastern Africa, where the virus is maintained either in a sylvatic cycle between warthogs (Phacochoerus aethiopicus) and ticks of the Ornithodoros moubata complex or in a domestic cycle that involves pigs of local breeds, with or without tick involvement. Countries where endemicity is confined to the sylvatic cycle include Kenya, Namibia, Botswana, Zimbabwe and northern South Africa. A cycle in domestic pigs apparently occurs in Angola, the Democratic Republic of the Congo, Uganda, Zambia, Malawi, northern Mozambique and probably the Congo (Brazzaville), Rwanda, Burundi and Tanzania. Madagascar experienced ASF for the first time in 1997-98; it caused serious losses and has not yet been eradicated.

In West Africa, ASF has been endemic in Cameroon since the first reported outbreaks in 1982. It is endemic in southern Senegal, the Gambia, and probably Guinea Bissau and the islands of Santiago and Mao in the Republic of Cape Verde. The disease has been present in this focus since at least 1958-60.

In Nigeria, an outbreak of ASF occurred in 1973 in a piggery in Abeokuta, Ogun State where all the 3000 pigs in the farm died from the disease. In October 1997, ASF was reported in Benin, rapidly followed by Togo and in September 1997 the disease surfaced in free-ranging pigs in four local government areas of Ogun state, of Nigeria that have common borders with Benin Republic. The disease was first seen in villages alongside the lagoon, passing into Nigeria from Benin Republic. Dead pig carcasses were seen in the lagoon and there was evidence that boats were traveling along the lagoon selling pig meat in Badagry market and nearby villages. By December 1997 ASF was reported in Badagry in Lagos State, Nigeria and from the Lagos and Ogun state foci, the disease eventually spread to Osun, Oyo, Ondo, Ekiti, Edo, Delta, Anambra, Enugu, Abia, Rivers, Bayelsa, Akwa-Ibom, Cross-River, Benue, Kaduna, and Plateau states of Nigeria. By October 1998, about 125,000 pigs had died of the disease in nine states resulting in an estimated loss of N1.0 billion. In October 1999, ASF was reported in Ghana. All of the countries in sub Saharan Africa that have significant pig populations must be considered to be infected, potentially infected, or at risk from ASF.

Highly Pathogenic Avian Influenza (HPAI) is a viral disease affecting the digestive, nervous, and respiratory systems of all domestic and wild birds that is characterized by respiratory, reproductive, digestive and/or nervous signs with high morbidity and mortality with an incubation period of few hours to few days. It is highly contagious and infectious and may be fatal in humans. The disease affects all ages, but is more serious in the young.

Avian Influenza Viruses (AIVs) are members of the family Orthomyxoviridae and genus Influenza A. The influenza viruses that constitute this family are classified into types A, B or C based on differences between their nucleoprotein and matrix protein antigens. AIVs belong to type A. Influenza viruses are further categorized into subtypes according to the antigens of the haemagglutinin (H) and neuraminidase (N) projections on their surfaces. There are 16 haemagglutinin subtypes (H1-H16) and 9 neuraminidase subtypes (N1-N9) of influenza A virus, and AIVs viruses have representatives in all of these subtypes. Additional H17 and H18 types have been described in bats not birds. However, to date all highly pathogenic AI viruses that cause generalized rather than respiratory disease belongs to either the H5 or H7 subtypes. For example, the classical fowl plague virus is H7N7 and the virus responsible for the major epidemic in the eastern United States in 1983/84 was H5N2. However, not all H5 and H7 viruses are virulent for poultry. In 2013, Influenza A H7N9 emerged in China with low pathogenicity in birds but caused high morbidity and case fatality in humans. In Nigeria, HPAI emerged in epidemic proportions in 2006.

I will now focus on the diagnosis and control of Rinderpest, PPR, and HPAI where I played significant roles at various stages of the battles. For effective control of any of these diseases, you must have a good diagnostic technique to be able to quickly detect the disease and take measures to restrict it to the primary focus and prevent spread and take measures to control and possibly eliminate the disease. For the diagnosis of Rinderpest, the following techniques had been used: Agar gel Immunodiffusion test (AGID). (Scott and Brown 1961), Immunoperoxidase staining (Salvakumar et al (1981) (Dandio and Obi 2001), Immuno-capture Enzyme linked

Immunosorbent Assay (ELISA) (Libeau et al 1997), Reverse transcriptase Polymerase Chain Reaction (RT PCR) (Barret et al 1993), Indirect ELISA for antibody detection (Anderson et al 20016), and monoclonal antibody based Competitive ELISA (Libeau et al 1997). For both PPR and Rinderpest control, a robust, specific, and sensitive diagnostic test is imperative. In co-operation with Dr. Ken McCullough of the Institute for Animal Health (previously called The Animal Virus Research Laboratory) Pirbright, UK, we decided to immuno-engineer monoclonal antibodies by fusion of spleen cells of Balb/C mice which had been immunized with the Nigerian PPR virus (NIG. 75/1) and Kenyan Kabette Rinderpest virus. A Monoclonal Antibody (MAB) is a highly specific antibody secreted by a single cell's progeny - (Clone) usually directed against not just a protein of an antigen but indeed an epitope on the protein.

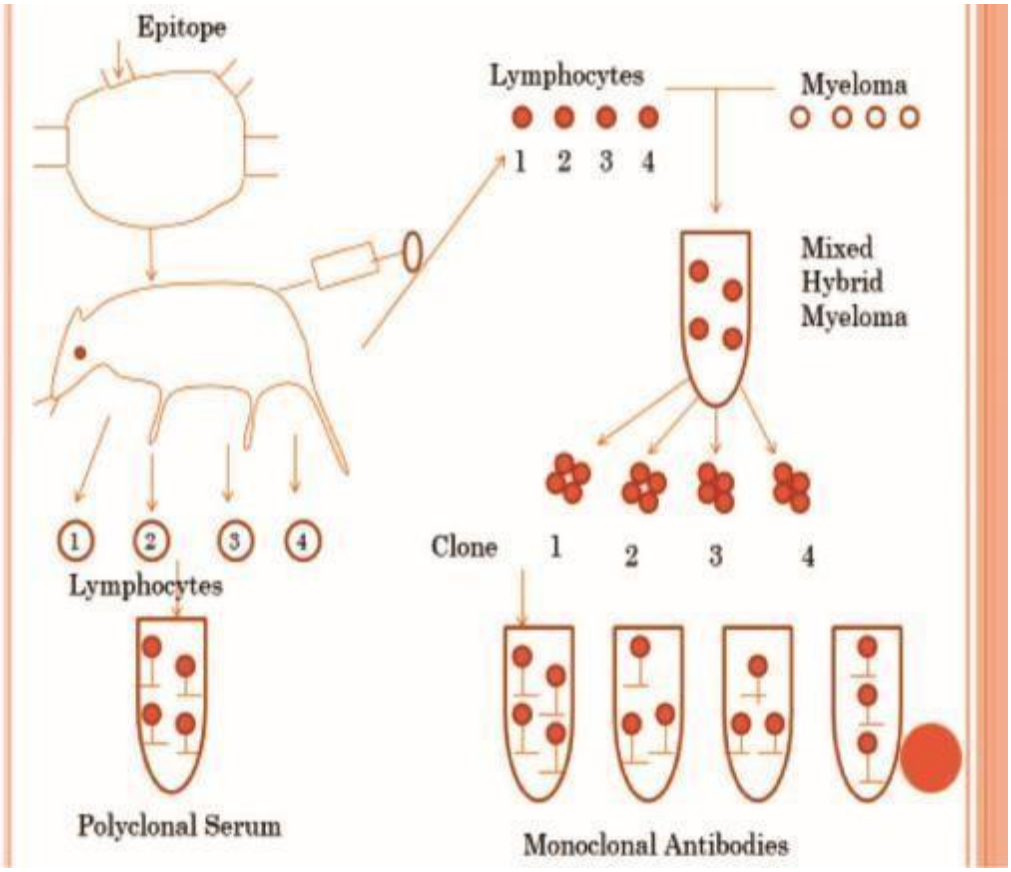

Fig. 1: Basic principles of Monoclonal Antibody Production.

We were able to produce monoclonal antibodies against the nucleocapsid (N), Matrix (M) and the Fusion (F) proteins of both viruses. Indeed, I produced the first Monoclonal antibodies against the PPR virus. These MAbs were then used in both indirect and competitive ELISA to diagnose both PPR and Rinderpest. The most exciting result was the production of MAbs which were used to differentiate the two closely related diseases. The immunization of mice for MAb production may take about four weeks to three months depending on how many booster doses of the antigen one is required to give and the class of antibodies (IgG, IgM or IgA) one intends to produce. From fusion to harvesting of the antibodies may take another three months. To reduce the time required for Mab production and reduce reagent and labour costs we developed a combined fusion-cloning method in which the fusion cocktail was treated with aminopterin 24 hours after fusion followed by blind semi-solid cloning in aminopterin-free media. We therefore succeeded in reducing the Mab generating interval from above three months to about 4 weeks.

Having read from literature that successful MAb production depended on spleen cells of immunized mice that are in the blast transformation phase, I produced MAbs by fusion of splenocytes of mice that has been given a single intra-splenetic injection of the PPR virus followed in three weeks by another shot intravenously. This technique reduced the immunization time from above three months to 3 weeks.

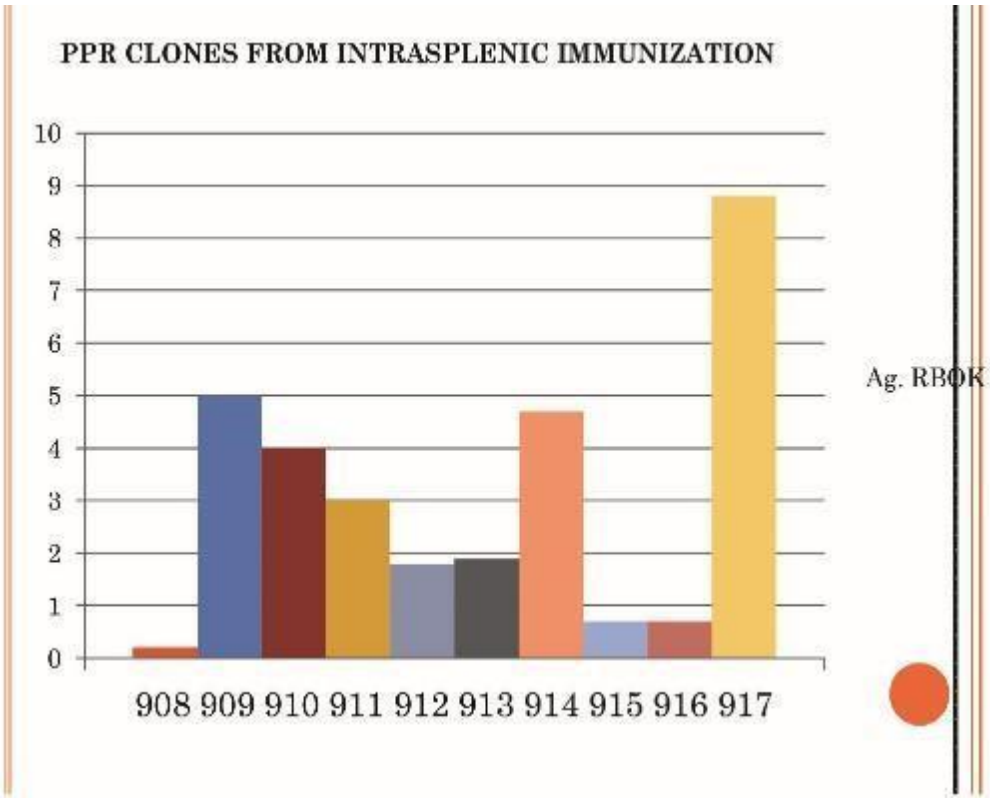

Fig 2: Reactivity of ten MAbs produced from Intra-splenic immunization of mice against Rinderpest virus (Note clones 908, 915, and 916 do not react with Rinderpest virus antigen).

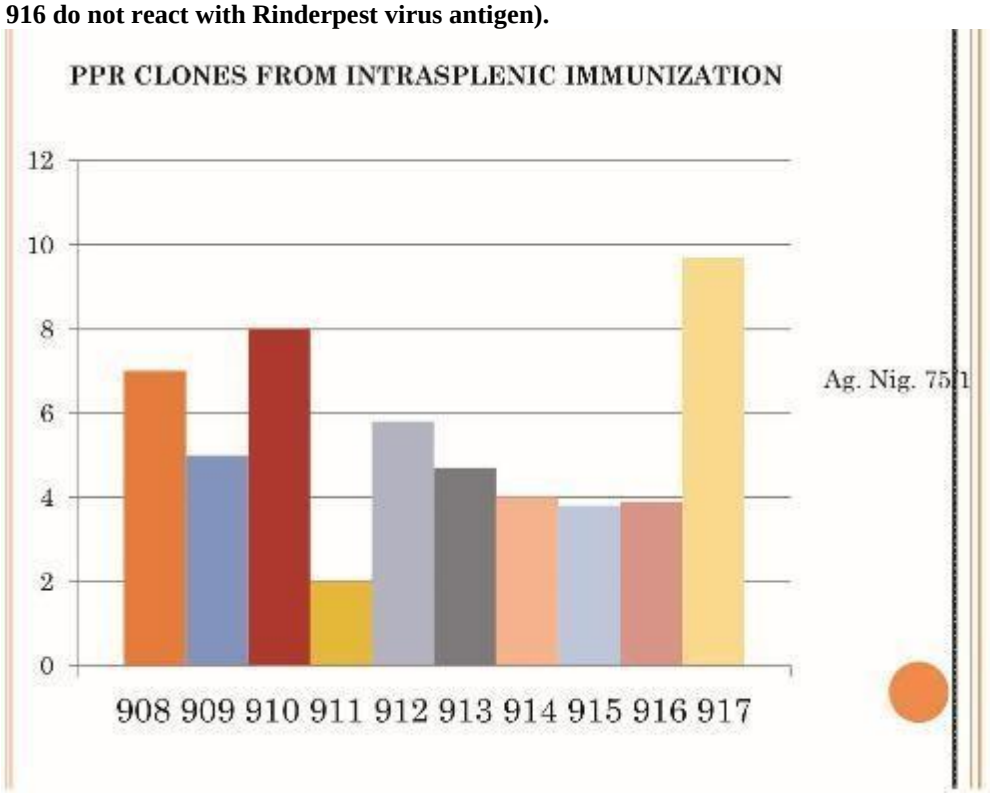

Fig 3: Reactivity of ten MAbs produced from Intra-splenic immunization of mice against PPR virus.

In competitive ELISA to assess the reactivity of our MAbs, against PPR isolates from Nigeria, Ghana, Únited Arab Emirates, Sudan, and Oman as well as Rinderpest isolates from Nigeria, Saudi Arabia,

Tanzania, Oman, Egypt, Lebanon, Kuwait, and Yemen, we identified MAbs that reacted with all the PPR and Rinderpest isolates, two that reacted with rinderpest but not PPR isolates, and some that reacted with viruses from some but not other geographical areas or zones. We thus had in our hands potential reagents that would enable us say that the aetiological agent is either Rinderpest or PPR and vice-versa and another that traces back the origin of the disease to particular geographical regions.

Together with my colleagues in Ibadan and post-graduate students we were able using the PPR MAbs, to develop a DOT-ELISA whose advantages over ELISA include the facts that it uses less quantities of reagents, has shorter incubation period, better signal-noise ratio therefore resulting in less false positive results, and can be read visually without need for a spectrophotometer. In addition, we developed an

immuno-peroxidase staining of paraffin fixed and wax-embedded tissues (that had been stored for up to ten years) thus enabling retrospective diagnosis of the disease.

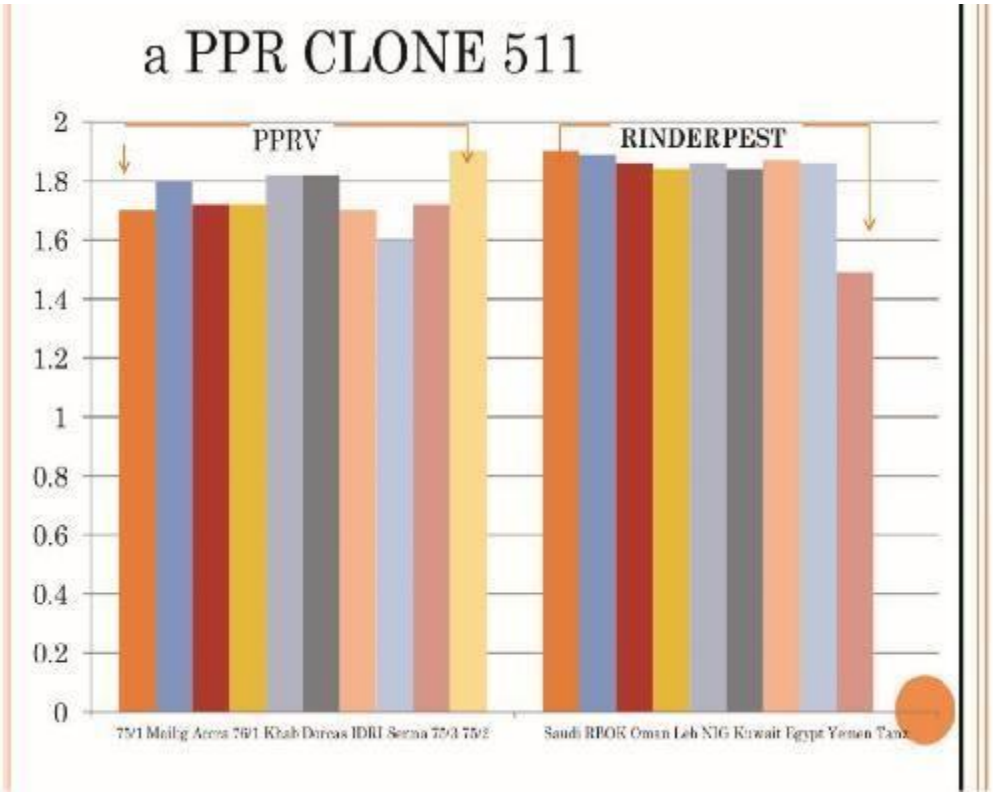

Figure 4: Cross-reactive Clone 511.

Our PPR and Rinderpest MAbs. were used in indirect and competitive Enzyme Linked Immunosorbent Assay (ELISA) to assess the reactivity against PPR isolates from Nigeria, Ghana, United Arab Emirates.

I also studied the effect of the method of virus growth (supernatant or cell associated virus), time of virus harvest, and different chemical treatment regimens on the reactivity of Rinderpest and PPR virus antigens. I found out that it was best to harvest the virus at maximum cytopathic effect before the cells detached from the growth bottles and that although both supernatant and cell-associated virus harvests gave good results in ELISA test/the supernatant antigen gave less background noise. (Obi 1993).

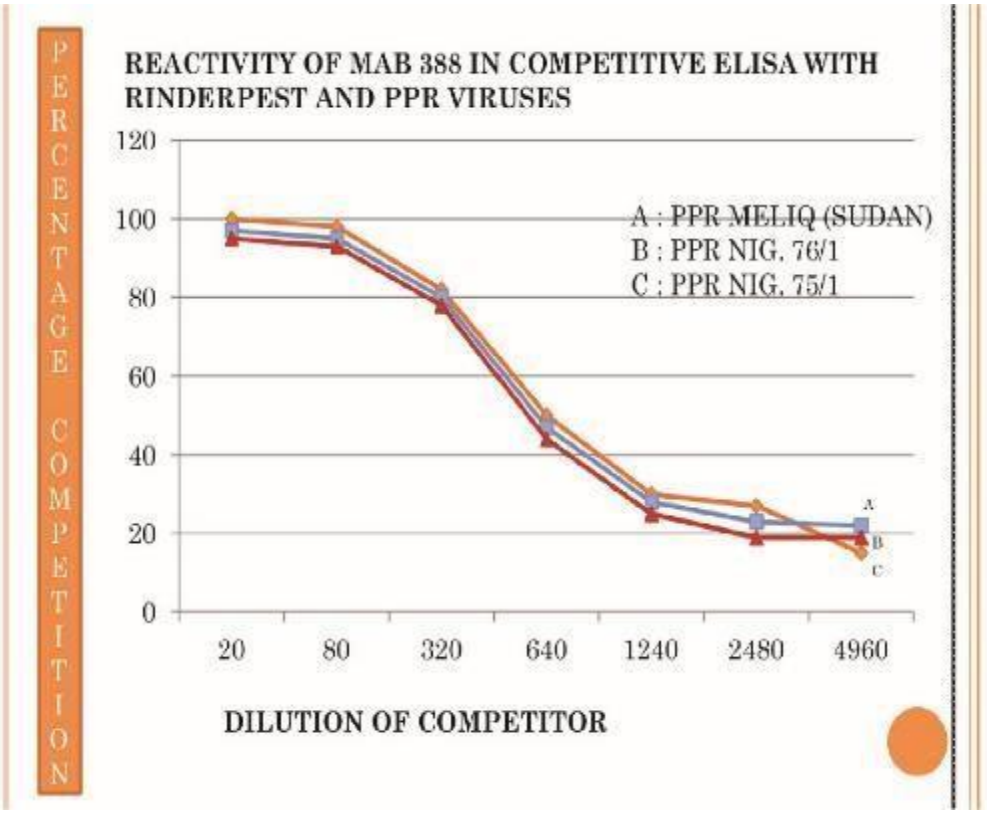

Fig.5: Reactivity of MAb 388 with PPR viruses.

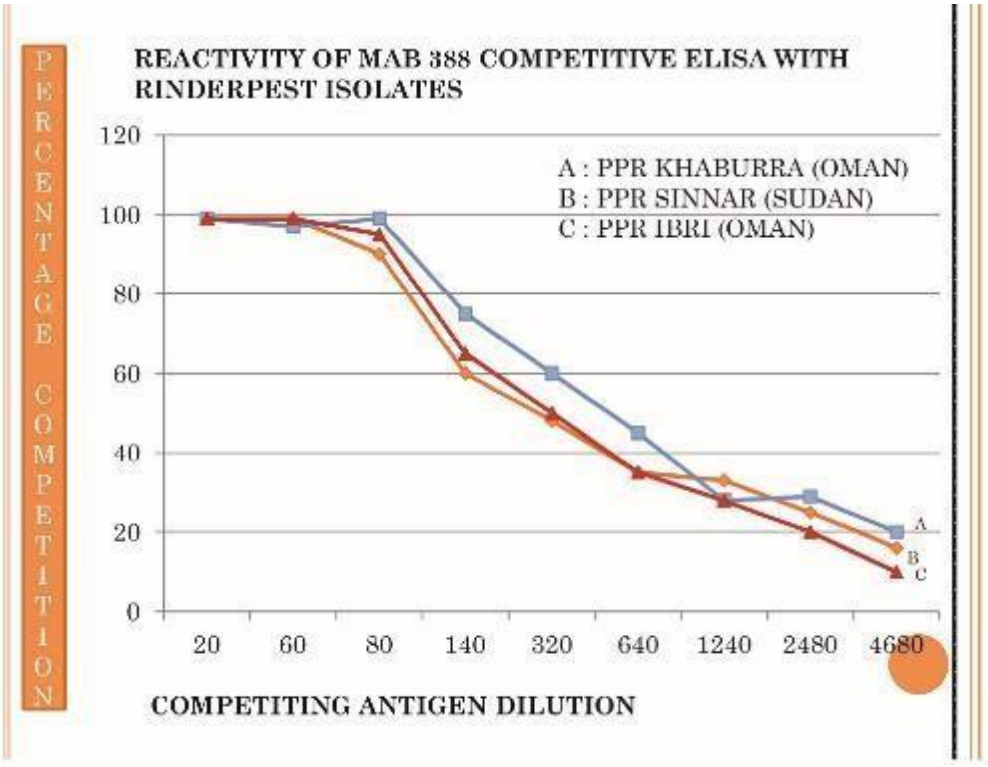

Fig. 6: Reactivity of MAb 388 with PPR viruses

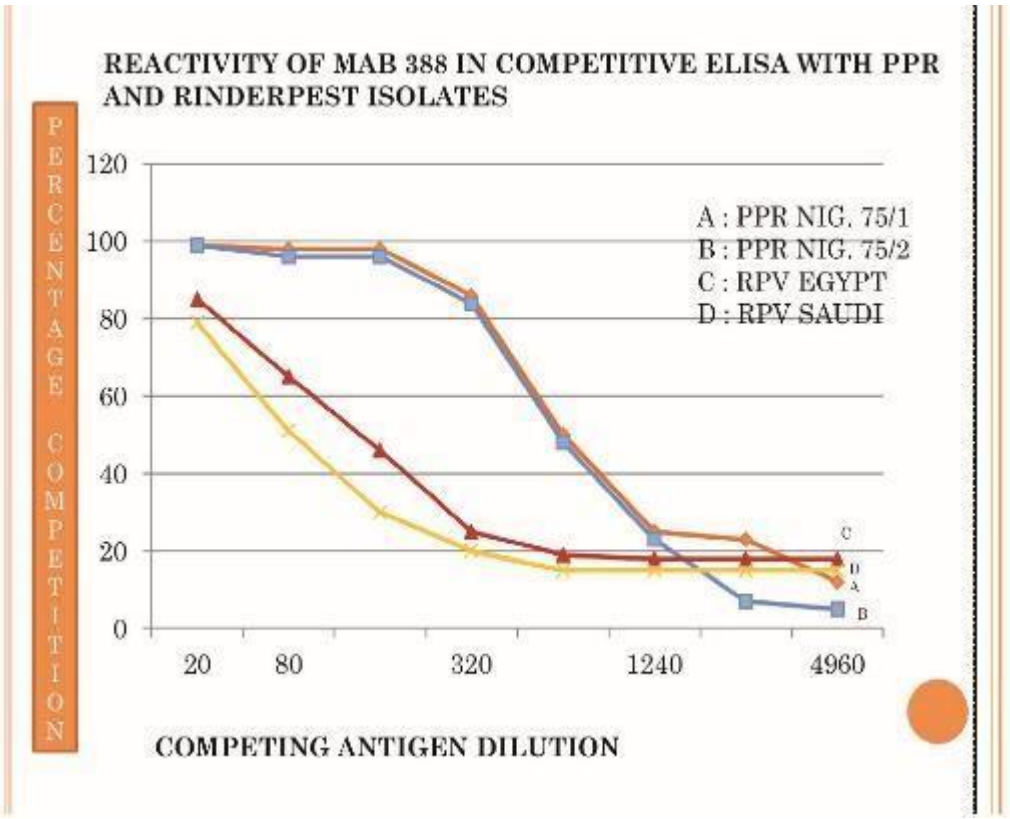

Fig. 8: Reactivity of MAb 388 with Rinderpest and PPR viruses

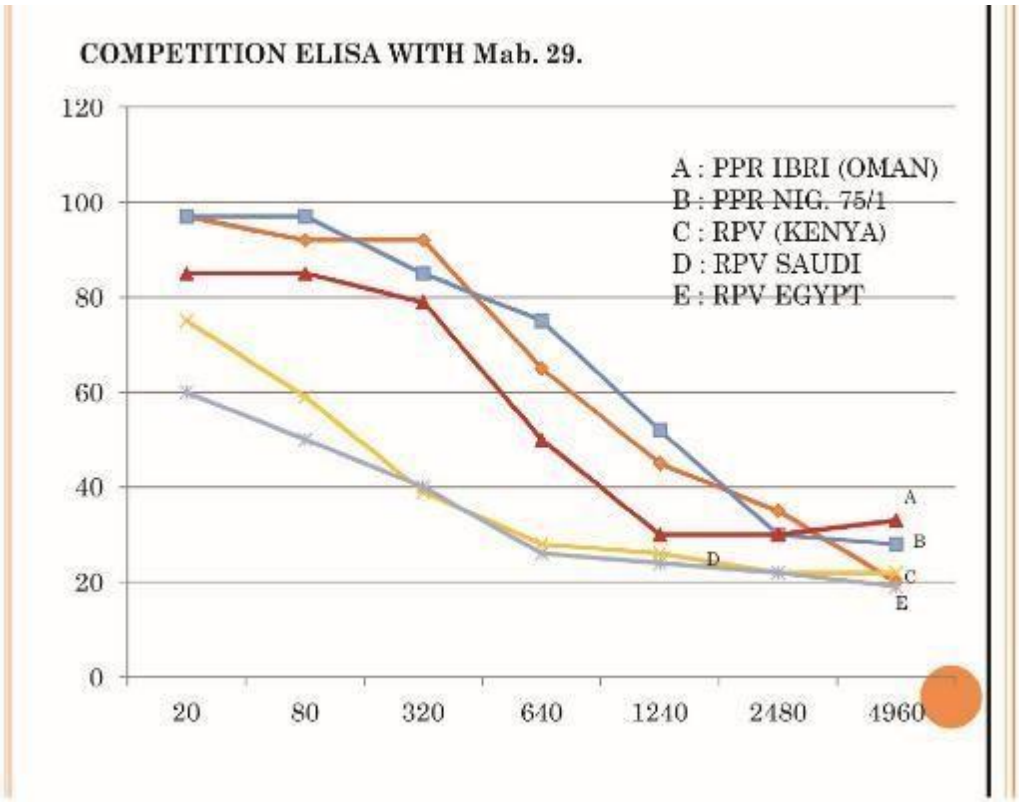

Fig. 9: Differentiation of some PPR from some Rinderpest viruses.

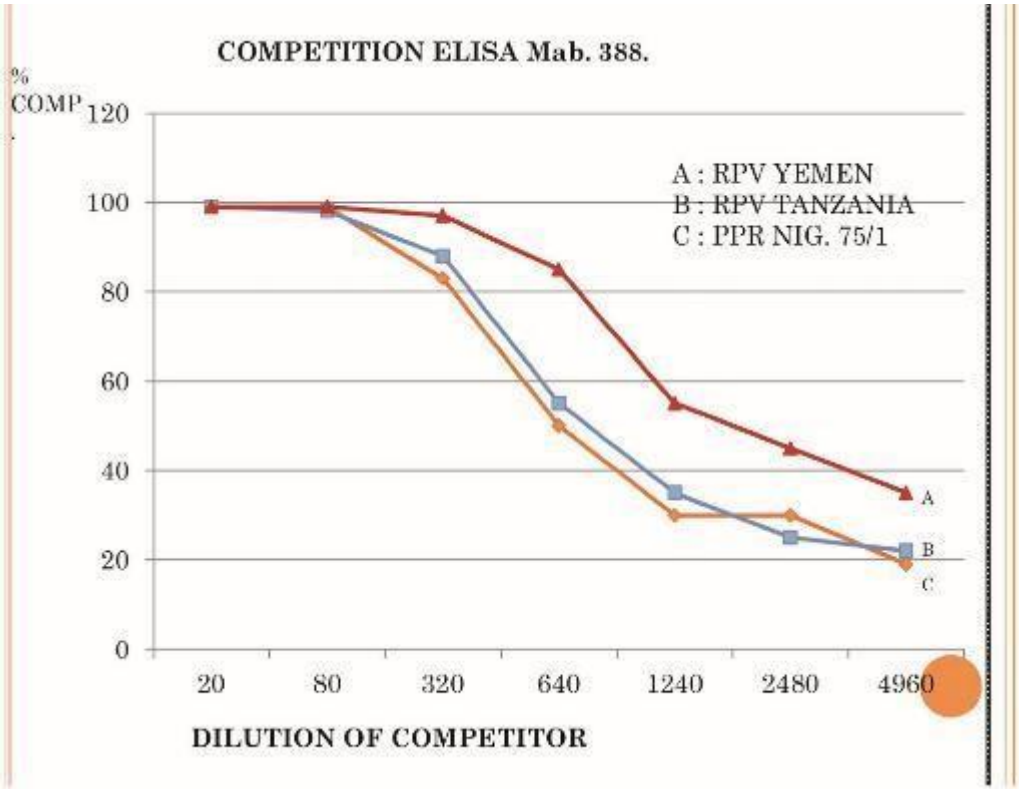

Fig. 10: Differentiation of some PPR from some Rinderpest viruses.

CONTROL AND ERADICATION OF RINDERPEST

The control and eventual global eradication of Rinderpest was a drawn-out battle that spanned many years. The first control method was by immunization of cattle with serum of recovered animals (semmer et al 1893). This was followed by administration of immune serum followed by live virus (serum-virus) method. Although this produced long-lasting immunity, the immunity was not perfect as some of the vaccinated animals developed overt clinical disease. This method soon gave way to attenuated vaccines produced by treatment with Eucalyptus chloroform or formalin (AU-IBAR 2011). Again, the immunity was inconsistent and sometimes short-lived. Other vaccines that were used included goat-adapted vaccines, egg-attenuated, and rabbit-attenuated vaccine (Edwards 1930, Plowright (1962) Nakamura et al 1938). It was not until later that Plowright produced an attenuated vaccine by serial passage in tissue-culture; Tissue Culture Rinderpest Vaccine (TCRV). This was the vaccine that was used world-wide including Nigeria in the last battles against Rinderpest and the production of thermo stable TCRV (House and Mariner 1996) contributed to eventual global eradication of the disease.

In Nigeria, the control of Rinderpest was carried out in three phases; the Joint programme 15 (JP 15) from 1962-1973), the Pan African Rinderpest Campaign (PARC) 1986-1999, and the Pan African Control of Epizootics (PACE) 1999-2007. Under the PARC, three viral Epidemiologists- Dr. K. Majiyagbe of the National Veterinary Research Institute (NVRI) Vom, Professor C.D. Ezeokoli of ABU Zaria, and myself from the University of Ibadan, were required to sero-monitor the Rinderpest vaccination to ensure effectiveness of the vaccinations. In 1990, I examined a total of 7352 sera from 188 herds in 15 states in South-West, South-East, and South-South Nigeria and found that, despite vaccinations, only 40.4% of the animals were immune. In 1992 and 1993, only 35.3% and 44.9% were immune respectively. One may wonder why the antibody levels were so low. It was either that vaccinations were not being done, or because of factors inherent in the method of storage, transportation, or administration of the vaccines. A good vaccine should be cheap, safe, fast-acting, require a short interval between administration and induction of immunity, amenable to administration with other vaccines, and stable for long periods under tropical conditions. The Plowright Rinderpest vaccine is highly heat labile and requires cold storage from manufacture to administration. Hence, global rinderpest eradication benefited from the production of heat-stable tissue culture vaccine (House and Mariner 1996).

HIGHLY PATHOGENIC AVIAN INFLUENZA (HPAI) IN NIGERIA

HPAI was first reported in Italy 1878, South Africa 1961, USA 1971, Australia 1975, England 1979, Ireland 1983, Mexico 1994 and Pakistan 1994. In recent years, HPAI has become topical in Asia including Peoples Republic of China (1996), Hong Kong (1997, 2001, 2002, and 2003), Cambodia, Indonesia, Japan, Malaysia, Republic of Korea, Laos, Taiwan, Thailand, Vietnam, Turkey and Romania (2005) (OIE 2005). The most serious epidemic in recent times was in Hong Kong (1997-1998 and 2003), the Netherlands (2003), and South-Korea 2003.

Avian Influenza Viruses (AIVs) are members of the family Orthomyxoviridae and genus Influenza A. The influenza viruses that constitute this family are classified into types A, B or C based on differences between their nucleoprotein and matrix protein antigens. AIVs belong to type A. Influenza viruses are further categorized into subtypes according to the antigens of the haemagglutinin (H) and neuraminidase (N) projections on their surfaces. There are 15 haemagglutinin subtypes and 9 neuraminidase subtypes of influenza A virus, and AIVs viruses have representatives in all of these subtypes. However, to date all highly pathogenic AI viruses that cause generalized rather than respiratory disease belongs to either the H5 or H7 subtypes. For example, the classical fowl plague virus is H7N7 and the virus responsible for the major epidemic in the eastern United States in 1983/84 was H5N2. However, not all H5 and H7 viruses are virulent for poultry.

As a result of the threat of H5N1 disease spreading into Nigeria from parts of Africa and Asia, an Expert Committee under my Chairmanship and technical guidance was set up in December 2005 to develop strategies towards prevention of the introduction of Avian Influenza into Nigeria, develop a surveillance network against the disease, and prepare an emergency preparedness plan for the disease in Nigeria. The risk factors of introduction of Avian Influenza into Nigeria included the fact that the country lies in the East Africa/West Asia fly ways and the North Atlantic flyway of the migratory birds. Also the presence of AI in South East Asia and South Africa and increased trade and human traffic with Nigeria increases the risk of introduction of the disease. The present expansion of infection zone of AI is due to globalization and relative ease of movement and transportation. Nigeria's long porous borders and informal livestock movement/trading across the border especially at border markets and smuggling/illegal movement of poultry and poultry products into Nigeria as well as inadequate veterinary quarantine facilities and manpower are additional risk factors.

The risk of sustenance of the disease is considered high due to structure of the poultry industry in Nigeria consisting predominantly of backyard poultry with little or no biosecurity and peri-urban and urban commercial poultry production with minimum to moderate biosecurity and constant introduction of new birds from relatively unknown and unverifiable sources. In addition, the rearing of flocks of different species of poultry and different ages together as well as uncontrolled livestock and poultry movement within the country as a result of lack of enforcement of animal disease control laws and regulations in the country increases this risk. Reduced poultry/human interface, lack of organized poultry marketing and existence of open live poultry markets characterized by interspecies mixing, poor sanitary conditions lack of registration and licensing of poultry farms, hatcheries and establishments as provided by the law increases the risk of sustenance. In addition, inadequate early warning and early reaction capabilities including inadequate experience of most animal health workers in the recognition and diagnosis of HPAI, deteriorating animal health delivery services due to inadequate funding, and inefficient restructuring programme of the veterinary services, poor communication facilities for dissemination of information on AI and other TADs, lack of funding for compensation of livestock/flock owners in the event of slaughter of their animals for purposes of disease control, improper disposal facilities, and sale and consumption of sick and dead birds are added risk factors.

The Committee therefore concluded that the risk of HPAI being introduced into the country may be considered as moderate to high while the risk of its establishment and spread within the country may be rated as very high. In addition, the probable socio-economic as well as the public health consequences may be considered as very severe should the disease be introduced into Nigeria. Based on the results of risk analysis of HPAI in Nigeria, the Committee recommended that our overall policy should be modified involving slaughter of clinically affected poultry with full compensation, safe disposal of dead carcasses, adequate disinfection and decontamination, and appropriate disease surveillance to determine the origin and extent of the disease. An action plan dealing with HPAI emergency which defined the command chain from the rural setting through the state veterinary services to the national veterinary service was developed. In addition, public awareness campaigns were to be emphasized in the programme. It was therefore to Nigeria's credit that a contingency plan was in place well ahead of the advent of HPAI into the country unlike most other African and Asian countries.

The Federal Government of Nigeria officially declared the presence of Highly Pathogenic Avian Influenza on February 8, 2006. Although contingency plans for dealing with introduced HPAI had been prepared before the outbreaks, the plans had no political and legislative support for implementation before the disease struck. The HPAI emergency received immediate attention and response from the President of

Nigeria leading to the setting up of an Avian Influenza Crisis Management Centre (AICMC) in the banquet hall of the Presidential Villa and the introduction of some compensation to affected farmers whose farms had to be depopulated in an effort to contain the disease. Three Committees, namely, the Steering, the Technical, and the Communication Committees were also formed in the AICMC to guide and coordinate AI disease control efforts.

The Food and Agriculture Organization in Nigeria; FAO-NG, acting as the leader of an international response, set up immediately an AI control room in the United Nations (UN) building and formed an AI Task Force. FAO-NG in collaboration with USAID and the French Embassy organized training workshops for animal health technicians and stakeholders in emergency preparedness and response to AI.

Assistance in the form of needed Personal Protective Equipment (PPE) was received from USAID, United States Department of Agriculture's Animal and Plant Health Inspection Service (USDA/APHIS) and the Government of Israel. Technical assistance was also given by the French Embassy, EU, DFID, the Japanese Government, and the World Bank. Despite control measures, the disease spread eventually to 97 Local Government Areas of 25 states and the Federal Capital Territory as of early March 2008.

The reaction of the international community to the status of HPAI was dominated by public fear and worry about 'imminent, ominous, inevitable overdue' pandemic. A tendency of construction of 'dangerous places, countries, and people where disease comes from was noticed in the utterances of highly placed individuals and organizations to the extent that Nigeria was described as a 'distributor of disease (HPAI) in one international telephone conference where the individual forgot I was participating in the telephone conference. Attitudes ranged from Western anxieties about globalization, outbreaks emerging from 'disrupted primordial settings', and 'protecting the conditions of modernity where disease is controlled unlike in primitive backward unregulated contexts where diseases emerge'. With particular reference to Nigeria, HPAI was at different times said to be endemic, entrenched or dug-in, terms that were reminiscent of under-developed, developing or least developed. Based on the above concerns, the international community put great pressure on Nigeria to adopt vaccination as additional control measures. Indeed, the EU was prepared to assist Nigeria with about 4 million Euros should the country agree to adopt vaccination. The international position was that vaccination is a single tool in a comprehensive strategy involving Bio-security, Surveillance, and Elimination of virus by stamping out, decontamination, and safe disposal of carcasses. Vaccination, if properly carried out was said to protect against disease and deaths as well as prevent contact transmission. Because of worldwide epidemic dimension of AI and because of increased risk of human pandemic, vaccination was deemed desirable.

But at that time, available conventional vaccines included inactivated homologous LPAI H5N1 or inactivated heterologous LPAI, H5N2, H5N7. Inactivated homologous vaccine was said to give good immunity in the vaccinated but one could not differentiate vaccinated from field infected poultry. Conversely, inactivated heterologous vaccines gives good immunity and one can differentiate vaccinated from field infected (DIVA technique) birds. H5N2 Vaccine had been evaluated experimentally (Swayne Georgia, USA) and found to give full protection and reduced virus excretion 1000-10000 times over unvaccinated birds. Field studies (Hong Kong) showed that the vaccine blocked virus transmission from 18 days' post vaccination and vaccinated birds did not transmit the virus. However, the results of field vaccination against H5N1 in-+21qZ43 9} +0. +*--*+ Hong Kong, Vietnam and Cote d'Ivoire were variable because of lack of complete understanding of the epidemiological, logistic, and post vaccination monitoring factors that should inform vaccination strategies.

Officials of the Federal Department of Livestock and Pest Control Services argued that although it was true that disease had spread to new areas, for example the South West, the stamping out strategy implemented in the infected states was assumed to be reasonably successful since no new cases of disease had been reported in the depopulated and decontaminated areas. They also claimed that vaccination does not protect against infection, only against disease. That means that vaccinated birds could continue to maintain the virus and pollute the environment and if the situation is not properly managed, could cause the disease to become endemic in the country. It should be pointed out that although vaccination did not afford 100% protection, the few birds that may not be immune may shed virus but virus load in aggregate would be lower compared to a situation where no vaccination is carried out. Also, the enormous cost of nationwide mass vaccination, which they claimed must be repeated 2 - 4 times per annum, could not possibly be mustered within the required time. There was no firm commitment from any agency to support the full cost of vaccinating the national flock. Procurement and importation of vaccine must be centrally controlled to prevent introduction of unsuitable and unsafe vaccines of dubious origin into the country. Other Nigerian government opinion included that vaccination should be regarded as a second line of defense after biosecurity, the decision to vaccinate must be taken in advance and thoroughly considered and not in a haste. They insisted that effective surveillance, disease monitoring and a technique for differentiating infected from vaccinated animals (DIVA) should be in place before vaccination would be adopted. Although they claimed that protective immunity using the inactivated vaccine lasts about or less than two months, published results in HPAI scientific literature showed that vaccine-induced immunity lasts for about one year after initial vaccination followed 4-6 weeks later by a booster dose.

Nigeria's insistence that a detailed investigation should be carried out to determine the epidemiological status of the disease in the country, especially among rural poultry, as well evaluate the effectiveness of the current actions being implemented to control the disease, (modified stamping out involving depopulation, decontamination, movement restriction and payment of compensation) should be carried out to determine the need for vaccination was justifiable. Although this was never stated, there was the possibility that the international community-driven

vaccination was possibly a trap which will militate against Nigeria's export trade in poultry and poultry materials to neighboring West African countries since it was not easily possible to differentiate vaccine antibodies from those due to field challenge.

Although the official Nigerian position was against vaccination, as a control option, investigations carried out by FAO-Nigeria Team confirmed un-approved use of two types of vaccines, a heterelogous H5N2 mainly in the South West and bivalent H5N9/H7N1 vaccines in Kaduna and Plateau states by poultry farmers. Contrary to the claims from the FDL&PCS that the vaccines spread HPAI into uninfected farms, it is my considered opinion that vaccination procedures characterized by the use of contaminated clothing and equipment such as syringes/needles and de-beakers by private professional and nonprofessional animal health service providers may have been responsible for disease spread.

The overall policy for HPAI emergency Nigeria was to restrict the disease to the primary foci, eradicate the disease in the shortest possible period and limit the economic and public health impact using modified stamping out which involved quarantine and slaughter of infected poultry with full compensation; sanitary disposal of destroyed poultry and contaminated poultry products according to standard operating procedures; quarantine and movement control on poultry and poultry products in the infected areas or zone and decontamination of facilities, products and equipment to eliminate the virus on infected premises and prevent spread to other areas. This was strengthened by active disease surveillance to determine the source

and extent of the infection and effective public awareness campaign to elicit cooperation from large scale commercial and back yard poultry owners.

The Avian Influenza Active Disease Surveillance was carried out in all the 36 States of the Federation and the Federal Capital Territory (FCT) while the Live-Bird Market Surveillance study was carried out in 54 markets in 26 states in which HPAI had been confirmed. The Active HPAI surveillance was designed in a way to ensure 95% probability of detecting one positive case given a 20% prevalence of HPAI in the study area. A total of 4,064 tracheal, 3,913 cloacal, and 3,166 serum samples were examined during the nation-wide HPAI surveillance study while 4,501 tracheal, 4,484 cloacal, 616 carcasses, and 4,275 serum samples were examined in the targeted live-bird market surveillance. Data obtained from questionnaires that were administered to the poultry owners indicated about 6.5% prevalence of HPAI in the study area and failure to detect one virus or viral antibody positive case may have indicated that the prevalence of HPAI in mainly non-commercial rural extensive poultry may be less than 20%. Given an estimated 140 million birds in the country and 95% confidence, it was calculated that the maximum number of H5N1 positive birds will be 85,705 (0.06%). It is being recommended that a customized participatory rural disease search be carried out in the village scavenging poultry production system.

It was observed that majority of the LBMs hold on daily basis without any resting period and is situated right in the middle of the larger markets and birds sold amidst marketers of other food items and related market wares. It is being recommended that at least one day in the week should be set aside for the cleaning and disinfection of LBMs and that many of the LBMs should be relocated out of the major markets or at the worst separate poultry sections should be created out of the main markets. This should form part of the restructuring and rehabilitation programme for poultry production and marketing systems in Nigeria.

Fig.11: Domestic chickens. Pigeons ducks all in one basket in a LBM in Nigeria.

Fig 12: Young chicks kept in a basket on top a metal cage holding Old birds.

The observed and common practice for mixed species of poultry to be sold together, housed in the same cages, including young chicks, creates likely sources of introduction of HPAI into hitherto uninfected villages since replacement stocks for village poultry keepers are purchased from these markets. It is being recommended that a study be carried out to help establish, as part of a pro-poor HPAI control programme, the desirability, feasibility and sustainability of a scheme for the production by the rural farmers, individually or as cooperatives, of day-old local/indigenous chicks as replacement stock for the village poultry producers.

Generally, the level of bio security in the LBMs was found to be un-acceptably poor. Poultry cages, mainly constructed from wood or cane were not cleaned, sick birds were not usually separated from the healthy ones, are either sold at lower prices or slaughtered and processed for human consumption to minimize losses. Facilities for safe disposal of dead birds were grossly inadequate. Considering the fact that about 85% of the poultry sold in these markets are slaughtered in the LBMs at customer's request, it is being recommended that a more bio-secure system of mechanized slaughter and processing of poultry should be an integral part of any restructuring of the poultry marketing and processing system to reduce human exposure to the virus.

The isolation of H5N1 virus in 5 out of the 54 LBMs from chickens in three states, from a sick duck in one state and detection of Avian Influenza genetic materials from a chicken in another state, confirmed that LBMs are important in the spread and maintenance of HPAI in Nigeria and also points to a high risk of human exposure to the virus in LBMs. It is recommended that that LBM surveillance should be carried out at least twice a year. Fifty Newcastle Disease Virus (NDV) isolates were obtained from 17 of the 26 states from chickens, guinea fowls and a pigeon indicating that NDV is widely prevalent in the country despite repeated vaccinations that are routinely carried out in various farms. It is being recommended that the Nigerian Government should use the opportunity of the HPAI emergency to mount a similar response to ND and that ND surveillance should be integrated into any HPAI disease surveillance.

The project achievements include, the carrying out of the first nation-wide active disease surveillance in poultry in Nigeria, the establishment of an effective system of sample collection, preservation and dispatch to the national laboratory in satisfactory conditions within 24-72 hours, as well as capacity building by training 207 field surveillance officers in HPAI disease surveillance and 8 university laboratory scientists in modern techniques for the diagnosis of HPAI. Others include confirmation of H5N1 virus in LBMs in Nigeria and thus indicating a role in the spread of HPAI in the country and human exposure to the virus. The project succeeded in the identification of essential characteristics of the LBMs including management systems and levels of biosecurity that would be useful in any planned restructuring of the poultry marketing and processing industry in Nigeria and highlighted the need for a new initiative on Newcastle Disease control in Nigeria as an integral part of HPAI response.

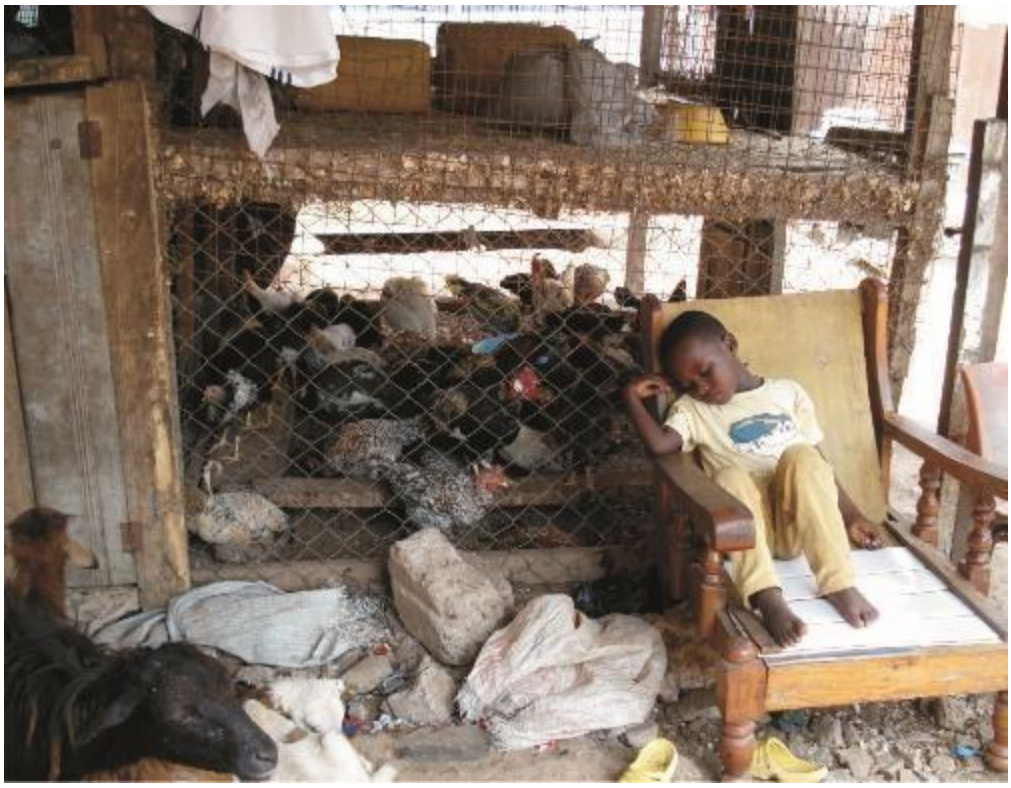

Fig 13: Innocent boy asleep outside/near a cage AI present or not.

I was then recruited subsequently as the Regional Coordinator of Stamping Out Pandemic and implement improved biosecurity in selected LBMs and small-scale poultry farms in Ghana, Mali, Cote d'Ivoire, and Benin Republic. STOPAI provided motorized and Nabual sprayers, water hoses, nose masks, strong brushes, gloves, Sodium Hypochlorite (bleach), plastic poultry transport cages, improved metal poultry cages, developed standard operating procedures, and national consultants. The national consultants trained 30 livebird marketers in Ghana, 15 in Benin, 30 in Mali and these were required to train cohort marketers. We also introduced improved biosecurity in two live bird markets in Ghana, Benin, and Mali. Two demonstration farms were used to train farmers from other regions showcasing simple affordable, but effective, on-farm biosecurity measures. We assisted the formation and registration of egg seller's associations and fowl seller's associations in these countries.

We established working partnerships with these private organizations: the Projet de Development de Aviculture au Mali, and Association National des Aviculturs Modernes and Munivipla Council in Mali, Association des Usagers des Marches Pour Actions Citoyennes Union National Des Aviculteurs

Professionnels Du Benin and the directorate of Veterinary Services n Benin The Ghana National Poultry Production Association Kumasi and Domeh Fowl Sellers and Kunmasi Egg Sellers Association and Kumasi Ga North Greater Accra Municipal Council. Others include the Directorate of Veterinary Services the Proveto the IPRAVI and Angre Cocovico in Cote d'Ivoire. We also used local artisans in the fabrication of equipment such as metal cages and killing/bleeding cones thus enhancing acceptance and local ownership of the project.

I will like to suggest that the design of improved equipment like transport cages and market place housing should build on traditional designs and utilize locally available materials so that they can be produced locally. Also, government services should broker continued support for national poultry associations and establish functional private-public partnerships leading to association-based disaster insurance schemes and establish consumer targeted safe poultry awareness campaigns.

For example, traditional cages for housing poultry in LBMs and transportation are made of wood, ropes, and bamboo. But it was interesting to find metal replicas of the bamboo conical Baskets that are popular in many west African LBMs in Benin. The shape and design is maintained but metal instead of bamboo is used in the construction.
The transport cages in Niger are very interesting. They are affordable, easy to assemble and transport, and cost effective. Although they pose some challenges, they provide good opportunity to come up with some alternative that is durable, cost-effective, and amenable to cleaning and disinfection.

Fig 14: A killing/bleedings cone manufactured in Cote d'Ivoire

Fig 15: A marble top table for slaughter and processing of poultry, easy to wash and disinfect (produced in Mali)

Fig 17: Transportation of poultry in a bus in Niger.

Fig. 18: An effective but cheap foot bath at the entry to a poultry farm in Benin

Fig.19: Cheap fence for a small-scale poultry farm in Benin

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References

1. AU-IBAR (2011) The eradication of Rinderpest from Africa. A Great milestone.
2. Anderson J. Corteyn. M and Libeau G (2006) Diagnosis of Rinderpest Virus and Peste des Petits Ruminants virus pp 163-184.
3. Barret T Amarel-Doel C Kitching R.P and Gusev A (1993) Use of the polymerase chain reaction in differentiating rinderpest field virus and vaccine virus in the same animal. Rev. Sci. Tech. Off. Int5.Epiz. 12 865-872.
4. Dandio M (1989) The application of indirect immunoperoxidase technique in the detection or Peste des Petits Ruminants virus antigen in formalin-fixed Paraffinembedded caprine tissues. MSc. Thesis University of Ibadan Nigeria.
5. Edwards J T (1930) The Problem of Rinderpest in India. Bull.Imp. Inst.Agri. Res. Pusa 199 1-16.
6. House J. A and Mariner J.C (1996) Stabilization of rinderpest vaccine by modification of lyophilization process dev. Biol.Stand.82 235-244.
7. Libeau G Saliki J T and Diallo A (1997) Caracterisation d'anticorps monoclonaux diriges contre les virus de la peste bovines et de la peste des petits ruminants: identification d epitopes conserves ou de specificite stricte sur la nucleoproteine Rev. Med. Vet. Pays trop. 51 171-190.
8. Nakamura J Wagatuma S and Fukusho (1938) On the experimental infection with rinderpest virus in rabbits 1. Some fundamental experiments J. Jap. Soc.vet. Sci.17185-204.
9. Nawathe D.R. and Lamorde A G (1985) Recrudescence of Rinderpest in Nigeria. Vet. Rec. 113 156-157.
10. Obi T.U (1993) The Art and Science in Animal Disease Diagnosis. Inaugural Lecture University of Ibadan 16 Dec 1993. pp.23.
11. Plowright W (1962) The application of monolayer tissue culture techniques in Rinderpest research 11: the use of attenuated culture as a vaccine for cattle. Bull. Off. Int. Epizoot. 57 253-276.
12. Salvakumar R. Padmanaban V.D and Balaprakasam R.A. (1981) Immunoperoxidase technique in the diagnosis of Rinderpest Cherion Madras 19. 137-139.
13. Scott G.R. and Brown R.D (1961) Rinderpest diagnosis with special reference to the agar gel double diffusion test. Bull.Epiz. Dis.Afr. 9. 83-120.
14. Semmer E (1893) Rinderpest infection und immunisierung und scutzipfung gegen rinderpest. Berl. Tierarztl wochenschr. 23. 590-591.