PROPOSED STRATEGY FOR CONTROL AND ERADICATION OF RINDERPEST FROM PAKISTAN

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ABSTRACT

Eradication of rinderpest is imperative for developing an export-oriented livestock industry in Pakistan. Drawing mainly from the Indian and African perspectives, a control and eradication strategy has been proposed. The main components of this strategy include active surveillance of the disease, control of animal movement, evolving a national disease reporting system, establishment of a national reference laboratory, training of veterinary and field staff, sero-monitoring of vaccinated animals, establishment of an independent central quality control laboratory, development of a cocktail vaccine, and implementing a concerted research programme on this potentially devastating transboundary disease of ruminants. Some potential limitations of the programme have also been listed.

Key Words: Rinderpest; Cattle plague; Bovine typhus; Eradication programme.

The disease

Rinderpest, long regarded as the most devastating transboundary pestilence of cattle (Anonymous, 1996), is an acute or subacute febrile, highly contagious viral disease of even-toed ungulates. It is characterised by necrotic stomatitis, gastro-enteritis, dehydration, leukopenia and death. The disease kills an estimated 2 million cattle and buffaloes annually in developing countries (Chakrabarti, 1997).

An RNA virus (Paramyxovirus) belonging to genus *Morbillivirus*, known since 1902 (Nicolle & Bay, 1902) causes the disease. The virus is antigenically similar to measles virus in humans, canine distemper virus in dogs and *peste des petits* (PPR; kata) virus in small ruminants (Kingsbury *et al.*, 1978). Cattle and buffaloes are the predominant species affected by the disease but other ungulates like swines, sheep and goats are also susceptible (Scott *et al.*, 1986). Our indigenous cattle like Sahiwal and Dhanni are more resistant as compared to the pure exotic lines or cross-bred cattle. Free living African wild animals (elands, wild buffaloes, giraffe, lesser kudu, and warth hog) have been found to suffer from the outbreaks of rinderpest. Laboratory animals like mice, guinea pigs, rabbits can also contract the disease. The virus has also been recovered from leeches, ticks, horse flies, house flies, mosquitoes, tsetse flies and lice (Scott, 1985).

The disease is mainly transmitted from animal to animal and from herd to herd through direct contact and by inhalation. Incubation period is 2–15 days and the disease may be acute or subacute depending upon the virulence of the virus strain involved, the innate resistance of various breeds of cattle and buffaloes involved and the presence of secondary infections with latent pathogens, especially protozoa. Mortality may be as high as 90% (Scott, 1985; Yilma, 1989).

Diagnosis of the disease is not an uphill task as the history of outbreaks, clinical findings, gross lesions, morbidity rates, mortality and post-mortem lesions are quite characteristic (Anderson *et al*, 1996). Bovine viral diarrhoea (BVD) is the only disease that masquerades closely with rinderpest. Like rinderpest it can also occur in explosive outbreaks but mortality rate is low and the disease is usually sporadic.

There is no specific treatment for this disease. Nevertheless, antiserum, if available, @ 1 mL/kg b.wt. IV is of lifesaving value, especially when administered during the early stage of the disease or first day of fever (Hall, 1977). Antibiotics and chemotherapeutics are used to control the secondary bacterial and protozoal infections. Large doses of fluids and electrolytes are also administered to counteract excessive dehydration (Radostits *et al.*, 1994).

Control of the disease can be achieved by vaccination with tissue culture rinderpest vaccine (TCRV) (Plowright & Ferris, 1957; Plowright, 1972) administered @ 1 mL/animal SC (after reconstituting the ampoule in 100 mL sterile chilled distilled water). In most developing countries including Pakistan, it is difficult to maintain a 'cold chain' needed for the traditional vaccines including TCRV. The use of a new DNA-recombinant vaccine (viz. JP15) is now-a-days being recommended due to its remarkable stability at ambient temperatures, easy handling and farmers' friendly vaccination procedure (Pritchard, 1988; Yilma *et al.*, 1991). In the face of an outbreak, the disease can be controlled by slaughtering the infected animals, by restricting the stock movement and by vaccinating all

the neighbouring animals. The present discourse represents a proposed plan, drawn from the Indian and African perspectives, which *mutatis mutandis* can be adopted to control and possibly, eradicate this dreadful disease from Pakistan.

Historical perspective

The disease has been playing havoc since time-immemorial. It is known in various parts of the world with different names, all describing its catastrophic nature like "cattle plague", "bovine typhus", "oriental rinderpest", "contagious ox typhus", "peste bovine" and "teschuma". The earliest documented evidence are from European countries which date back to 376–386 AD (Chakrabarti, 1997). According to some reports, the disease is believed to have originated somewhere in China in pre-Roman times and thereafter spread worldwide (Ali, 1995). Following its devastating death toll in Europe, the first veterinary college was established at Lyon in France in 1762. In 1880 the disease was stamped out from the European countries, North and South Americas. The disease has also been eradicated from Belgium, Italy, Australia and Phillipines. Pan African epizootic of 1889 is thought to be due to importation of Indian cattle to Somaliland (Reid, 1981). Similarly, the disease in the Western Hemisphere occurred following importation of Indian Zebu cattle in Brazil in 1921 and in Australia in 1923. The disease is still prevalent in Asia and Africa (Maurer, 1970; Nawathe & Lamorde, 1984; Yilma, 1989; Nawathe & Shittu, 1990; Dutta *et al.*, 1991; Al-Anbari & Jassim, 1992; Rossiter *et al.*, 1998).

Current situation in Indo-Pakistan sub-continent and neighbouring countries

Due to recent advances in the viral and epidemiological knowledge on the rinderpest as well as development of its effective tissue culture and DNA-recombinant vaccines, the disease has been successfully eradicated from various parts of the world, leaving the infected areas only in Asia, Middle East and Africa. As regards Asia, most countries have been free from rinderpest since long. Iran has been free from rinderpest since 1982 owing to their control policy which included testing and restriction of movement of susceptible animals and annual vaccination (Roustai, 1985). In India, last pandemic culminating in a death toll of 70% cattle occurred in 1964–65. In that country, following the installation of National Rinderpest Eradication Programme (NREP) in 1955–56, morbidity and mortality rates have significantly reduced to 0.002 and 0.0009%, respectively, and the disease has been placed in fourth and third places respectively among the 5 endemic bovine diseases viz. Foot and mouth disease, rinderpest, haemorrhagic septicaemia, anthrax and black quarter (Dutta *et al.*, 1991). Indian workers (Chauhan *et al.*, 1993) reported the resurgence of disease in 1981 after several decades of eradication. They also reported 12 minor outbreaks in Haryana State during a period of 3 years commencing from January, 1985 with a morbidity of 7% and mortality 2.8%. According to Nanda (1993), the disease has now become endemic in most parts of the country. It is only from a small part of India that the disease has been successfully eradicated. This area has been declared as "Rinderpest free zone".

As regards Pakistan, there has been two epidemics of rinderpest since 1947. The first pandemic was recorded from 1947 to 1951 which caused a death toll of about 500,000 bovines. This outbreak was controlled by employing wet Goat Tissue Vaccine (GTV). The second pandemic continued from 1959 to 1962 and killed over 150,000 heads of bovines. This outbreak was again controlled by vaccination using GTV and lapinized rinderpest vaccines. Thereafter the disease occurred only sporadically and up until now, 18 outbreaks have been recorded. According to Durrani (1988), collective losses due to rinderpest, mucosal and foot and mouth diseases were estimated at Rs. 21467/- million. Rinderpest remains endemic in Landhi Cattle Colony near Karachi and possibly other cattle colonies (Raja, 1995; Raja, 1996). For some years it was considered that it did not occur in Pakistan, possibly because of confusion in diagnosis between rinderpest and other conditions such as mucosal disease, BVD, and FMD. Nevertheless, it is now certain that much of what was reported as "rinderpest-like disease" was in fact classical rinderpest. It is probable that rinderpest is endemic at very low level over much of the country. Lack of field disease investigation and reporting and change in the epidemiology of rinderpest in Pakistan following earlier vaccination probably led to this notion. Recently, between April to August 1994, a major epidemic has been reported from Northern areas in Gilgit and Hunza valleys where about 40,000 cattle and yaks succumbed to rinderpest (Rossiter *et al.*, 1998). Strategic ring vaccination of animals at risk and movement control is in place. Vaccination is encouraged by the animal health authorities. European Union has planned to eradicate this menace from many countries including Pakistan, Afghanistan and Iran by 2010 (Anonymous, 1996). Another closely associated disease i.e., peste des petits ruminantum (PPR; Kata) has become rife among small ruminants in Pakistan since last few years (Pervez *et al.*, 1993; Athar *et al.*, 1995; Ayaz *et al.*, 1997). As the causative virus is antigenically similar to that of rinderpest, it is apprehended that the PPR virus may cross the species barrier and establish itself in cattle and buffaloes.

Proposed rinderpest eradication programme drawn from Indian and African perspectives

Eradication requires the complete elimination of virus from the potentially susceptible animal population

in the country. Maintenance of a rinderpest-free status requires:

1. Eradication of rinderpest from all contiguous countries;
2. Absolute quarantine measures; and
3. Very deep zones on either side of all international frontiers in which all bovines are immunised through vaccination or transfer of maternal immunity, and subject to strict movement control.

Unfortunately, rinderpest virus recognises no geographical and political boundaries (Anonymous, 1996). It has an 'unrestricted passport' to enter any country and affects millions of cattle and buffaloes without discrimination if they are not immunized (Ali, 1995).

In the past eradication campaign was not successful because all the countries which adopted the vaccination and field monitoring programmes relaxed as soon as the outbreaks subsided and animals apparently stopped suffering from the disease. However, 4–5 years later when a majority of bovine population lost the immune resistance against the disease, the outbreak flared up from the residual foci, or due to infected animals brought in from virus contaminated countries. The cycle will continue forever unless the total eradication of rinderpest be attained at the country, regional and eventually global levels. In this context, following campaigns have been launched to eradicate rinderpest in different parts of the world:

- Pan-African Rinderpest Campaign (PARC)
- West-Asia Rinderpest Eradication Campaign (WAREC)
- South-Asia Rinderpest Eradication Campaign (SAREC)
- National Rinderpest Eradication Project, India (NREP)
- Emergency Assistance for Rinderpest Control (EARC)
- Global Rinderpest Eradication Programme (GREP)

Drawing from the Indian and African perspectives, rinderpest can be eradicated successfully if the following measures are adopted stringently:

1. Active Surveillance of the Disease

All cattle and buffalo population in the country should be monitored for the presence of rinderpest disease virus (Sobhanan *et al.*, 1988; Anderson *et al.*, 1991). Based on their status, different geographic territories in Pakistan should be divided into three zones:

Zone A = Rinderpest free zone; no reports for more than 10 years.

Zone B = Having no reports of rinderpest for more than 24 months. Since there is no ongoing serosurveillance programme and since there is unhindered movement of animals in the country, in theory at least no part of Pakistan qualifies for these status.

Zone C = Where the disease is endemic like Landhi and Northern areas.

For a better control and effective disease eradication, every province can be divided into these three zones.

In zone A, mandatory vaccination of all susceptible animals should be carried out and once this is accomplished a *"provisional freedom"* should be declared after 1 year while active surveillance should be continued. By the end of another year, *"freedom from the disease"* and after two more years *"infection free zone"* should be declared.

In zone B, vaccination should be continued on state border areas and trade routes upto 3 years to be followed by the declaration of *"provisional freedom"*. Later on after two years *"freedom from disease"* and after another year *"infection free zone"* should be achieved.

In zone C, two years mass vaccination should be implemented including all sheep and goats in campaign. Two years later *"provisional freedom"* status will be sought. *"Freedom from disease"* will be attained after 2 more years and after another 2 years *"freedom from infection"* should be sought. All the animals showing signs of rinderpest should be slaughtered for salvage and the in-contacts should be vaccinated immediately.

2. Animal Movement Control

Animals belonging to different zones should be restricted in their movements till the achievement of goals. Movement should be made possible only after ensuring the immune status of that animal. All the incoming animals to a zone should be quarantined and vaccinated. Clover-leaf ear notch system should be implemented to differentiate the vaccinated animals from non-vaccinated ones.

3. National Disease Reporting System

A nation-wide disease reporting system (National Disease Reporting Cell; NDRC) should be evolved so that prompt measures be adopted in the face of an outbreak or immunity break down. Its head office will be situated at the Department of Clinical Medicine and Surgery, University of Agriculture, Faisalabad who will administer the entire programme. Simultaneously, this cell will keep the veterinarians, farmers and other field staff abreast about the day to day development in this programme. This cell will also take help of television and radio to discourse on the benefits and progress of this programme. The authorities will also keep close

contact with SAREC, WAREC, PARC and GREP for rinderpest situation in other neighbouring countries.

4. Establishment of a National Reference Laboratory

A national reference laboratory should be established at the Department of Clinical Medicine and Surgery, University of Agriculture, Faisalabad with its branches at all provincial headquarters. Luckily, we already have well-reputed veterinary research institutes at Lahore, Peshawar, Karachi and Quetta. They should be upgraded and equipped to fulfil the requirements of this campaign. The laboratories should be able to provide antigens for diagnostic purpose, antisera for treatment of some animals, sufficient doses of TCRV (approximately 4 millions/annum) and if possible the genetically engineered DNA-recombinant vaccine (JP15 for one). The laboratory should also try to develop a field test based on monoclonal antibodies and latex agglutination for field diagnosis of rinderpest. The laboratory should also be provided ELISA facilities for prompt diagnosis of rinderpest.

5. Training of Veterinary and Field Staff

Veterinary and field staff especially in the areas where rinderpest is endemic should be trained for prompt recognition of the disease, proper vaccination, and disposal of dead carcasses. They should also be trained for the collection of morbid and post-mortem samples for despatching to laboratory. A pictorial handbook written specifically to this end will address this need.

6. Sero-monitoring of the Vaccinated Animals

For this purpose, 0.1% of the total bovine, bubaline, ovine, and caprine population should be monitored for sero-conversion of TCRV or other vaccines (to test their efficacy). Its record should be maintained by the Central Administration, National Reference Laboratory and National Disease Reporting Cell.

7. Establishment - of an Independent Central Quality Control Laboratory

This should be established for the testing of every batch of rinderpest vaccine(s) produced before being released for field use.

8. Development of a Cocktail Vaccine (African Perspective)

In a bid to control and eradicate rinderpest from Africa, a number of vaccines were developed and used: a bile vaccine, a serum-virus vaccine, a formalized spleen vaccine, a goat tissue vaccine, and tissue culture rinderpest vaccine. Each met with some degree of success but each had serious handicaps. An ideal vaccine for the control of rinderpest in developing countries should have the following characteristics (Pritchard, 1988):

- It should be inexpensive and easy to make in the country where its use is intended.
- The vaccine should be stable at ambient temperatures so there would be no requirement for a "cold chain" as it is almost impossible to maintain needed refrigeration in most developing countries.
- It should have a convenient mode of administration (skin scratch inoculation for one).
- A single dose should confer lifetime protection.
- The vaccine should be highly effective, so that the confidence and cooperation of owners is maintained.
- It should be particularly useful if young cattle could be vaccinated as many infections are acquired at an early age.

A single injection for several diseases e.g., rinderpest, foot and mouth disease, haemorrhagic septicaemia) would have many advantages over separate vaccines for each disease. Separate visits to farmers for vaccination against each disease are very time and labour intensive.

It would be desirable if the vaccine had the ability to terminate infections as well as to prevent them.

The goal should be to develop a vaccine technology to fit these needs. With DNA-recombinant technology, it is possible to insert genes from viral, bacterial, and other antigens and proteins into viruses such as herpes virus, retroviruses, and vaccinia or cowpox virus. Animals infected with these viruses would be expected to develop an immune response to these antigens. The use of vaccinia is particularly promising as a virus-vectored vaccine. Of the extreme importance is the fact that vaccinia virus is highly stable, maintain its potency for months at ambient temperatures in the tropics, and its convenient administration i.e., by scarification (Pritchard, 1988). As vaccinia genome may carry upto 25 kilobases of foreign DNA successfully, enough to code for a considerable number of proteins, one can envision the production of a "vaccine cocktail" incorporating protective genes for other important diseases in the area like foot and mouth disease, haemorrhagic septicaemia, black quarter, etc.

9. Research Programmes

Under this sub-component, emphasis will be given to develop research programme on (Krishnan, 1995):

- Epidemiological studies on rinderpest infection in small ruminants;
- Improvement of rinderpest vaccine production using vero cells;

- Development of field tests for rinderpest diagnosis; and
- Other conceivable problem(s) which surface during the execution of eradication programme.

Like many other developing countries, rinderpest eradication in Pakistan seems difficult (not impossible though), due to:

1) Fragmentary and non-commercial nature of dairy industry. A common practice in rural household is for each family to keep 3–5 heads primarily for house use (Chaudhry, 1984).
2) Inadequate diagnostic facilities.
3) Inadequate vaccines and vaccination campaigns.
4) Lack of control on animals' movement within country and transboundary movement.
5) Control on wild animals, stray dogs, rodents, etc.
6) Improper hygienic disposal.
7) Socio-economic constraints.

Epilogue

Rinderpest, though endemic, is amenable to eradication provided there is a professional determination and a firm will on the part of Government to carry it out. Without eradicating rinderpest, it would be naïve to expect development of an export-oriented livestock industry in Pakistan.

REFERENCES

Al-Anbari, A., and F.A. Jassim. 1992. Country report rinderpest eradication, 1991. Republic of Iraq. Operation Rinderpest, (10-11):13–15.

Ali, S. 1995. Current situation of rinderpest and its eradication. Modern Agriculture, 6(7):40–44.

Anderson, J., E.C. Anderson, F. Chiduo, G.E. Joshua, K. Loretu, T.F. Mpelumbe, and T.E. Kavishe. 1991. Field evaluation of the indirect ELISA for sero-monitoring during the rinderpest eradication campaign in Tanzania. The Sero-monitoring of Rinderpest Throughout Africa. Phase I. In: Proc. Final Research Co-ordination Meeting of the FAO-IAEA-SIDA-OAU-IBAR=PARC Co-ordinated Research Programme, Bingerville, Cote d'Ivoire. Pp.87–101.

Anderson, J., T. Barrett and G.R. Scott, 1996. Manual on the Diagnosis of Rinderpest, 2nd Ed. FAO Animal Health Manual, No. 1. FAO, Rome, Itally.

Anonymous, 1996. Prevention and control of transboundary animal diseases. FAO Animal Production and Health Paper 133. Report of the FAO Expert Consultation on the Emergency Preventive System (EMPRES) for Transboundary Animal and Plant Pests and Diseases, Rome, Italy, July 24–26, 1996.

Athar, M., G. Muhammad, F. Azim, A. Shakoor, A. Maqbool, and N.I. Chaudhry. 1995. An outbreak of peste des petits ruminants-like disease among goats in Punjab (Pakistan). Pakistan Vet. J., 15(3):140–143.

Ayaz, M.M., G. Muhammad, and M.S. Rehman, 1997. Pneumo-enteritis syndrome among goats in Dera Ghazi Khan. Pakistan Vet. J., 17:97–99.

Chakrabarti, A. (ed.). 1997. Rinderpest. In: A Textbook of Preventive Veterinary Medicine, 2nd Ed. Kalyani Publishers, Ludhiana, India. Pp.29–43.

Chaudhry, A.R., 1984. Livestock development in Pakistan. Science Technology and Development, 3:29-38.

Chauhan, R.S., N.K. Mahajan, and R.K. Kaushik. 1993. Emergence of rinderpest epidemics in buffaloes in Haryana (India). Indian Vet. J., 70:695–698.

Durrani, N.U., 1988. Research on animal health in Pakistan. Proc. Meeting of Counterpart Scientists on Livestock under SAARC (South Asian Association for Regional Cooperation), held on May 22-25, 1988 at NARC, Islamabad, Paksitan. Pp.21–25.

Dutta, J., B.S. Rathore, and S.G. Mallick. 1991. Status of rinderpest in India – An epidemiological survey. Indian Vet. J., 68:99–103.

Hall, H.T.B. 1977. *Diseases and Parasites of Livestock in the Tropics.* Longman, London.

Kingsbury, D.W., M.A. Bratt, P.W. Choppin, R.P. Hanson, Y. Hosaka, V. ter Meulen, E. Norrby, W. Plowright, R. Rott, and W.H. Wunner. 1978. Paramyxoviridae. Inter-virology, 10:137–152.

Krishnan, D., 1995. Rinderpest eradication in India. Asian Livestock, 20(4):42–45.

Maurer, F.D., 1970. Rinderpest. In Gibbons, W.J., E.J. Catcott, and J.F. Smithcors (eds.): Bovine Medicine and Surgery 1st Ed.. Am. Vet. Publications Inc., Illinois, USA. Pp.75–85.

Nanda, Y.P. 1993. National project for rinderpest eradication progress report for 1992. Asian Livestock, 18(5):54–60.

Nawathe, D.R. and M.M. Shittu. 1990. Rinderpest in Nigeria. Vet. Rec., 127:46.

Nawathe, D.R., and A.G. Lamorde, 1984. Socio-economic impact of rinderpest in Nigeria. Revue Scientifique et Technique, Office International des Epizooties, 3(3):575–581.

Nicolle, M., and A. Bay. 1902. Etudes sur la peste bovine. III. Experiences sur la filtration du virus. Annls Inst. Pasteur, Paris, 16:56–64.

Pervez, K., M. Ashraf, M.S. Khan, M.A. Khan, M.M. Hussain, and F. Azim. 1993. A rinderpest-like disease in goats in Punjab, Pakistan. Pakistan J. Livestock Res., 1:1–4.

Plowright, W., 1972. The production and use of rinderpest cell culture vaccine in developing countries. World Anim. Rev., 1:14–18.

Plowright, W., and R.D. Ferris. 1957. Cytopathogenicity of rinderpest virus in tissue culture. Nature, 179:316.

Pritchard, W.R. 1988. Ways that veterinary medicine can help alleviate hunger in Africa. Special commentary. J. Am. Vet. Med. Assoc., 192(12): 1701–1705.

Radostits, O.M., D.C. Blood, and C.C. Gay, 1994. Veterinary Medicine, 8th Ed. Bailliere Tindall, London.

Raja, R.H. 1995. Rinderpest situation in Pakistan. Strategies for its eradication by the year 2000. Asian Livestock, 20(4):37–41.

Raja, R.H. 1996. Current status of rinderpest in Pakistan and Afghanistan. Proc. FAO Technical Consultation on the Global Rinderpest Eradication Programme, Rome, Italy. Pp.22–24.

Reid, H.W. 1981. Diseases of Cattle in Tropics. Martinas Nijhoff Pub. London.

Rossiter, P.B., M. Hussain, R.H. Raja; W. Moghul, Z. Khan, and D.W. Broadbent. 1998. Cattle plague in Shangri-La: Observations on a severe outbreak of rinderpest in northerrn Pakistan 1994-1995. Vet. Rec., 143(2):39–42.

Roustai, M.H., 1985. Eradiation of rinderpest in Asia–Iran. In: *14th* Conf. Of the O.I.E. Regional Commission for Asia, the Far East and Oceania, held at Columbo. July 29 to Aug. 1, 1985.

Scott, G.R. 1985. Rinderpest in the 1980s. Prog. Vet. Microbiol. Immun., 1:145–174.

Scott, G.R., W.P. Taylor, and P.B. Rossiter, 1986. Manual on the Diagnosis of Rinderpest. F.A.O. Publications, Rome. P.5.

Sobhanan, T.S., A. Sreekumar, and T.K. Ravindran. 1988. Detection of serum antibodies to rinderpest in bovines by counter immunoelectrophoresis. Kerala J. Vet. Sci., 19:77–79.

Yilma, T.D. 1989. Prospects for the total eradication of rinderpest. Vaccine, 7:484–485.

Yilma, T.D., L. Jones, C. Mebus, and L. Giavedoni, 1991. A non-pock forming vaccinia virus double recombinant expressing F and H genes protects cattle against rinderpest. Proc. Annual Meeting of the United States Animal Health Assoc., 95:50–58.