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WOAH Regional Workshop on Vector Borne diseases in Asia and the Pacific

19-20 September 2024

LUMPY SKIN DISEASE

WOAH MANUAL: CHAPTER 3.4.12.

Antoinette van Schalkwyk

Agricultural Research Council – Onderstepoort Veterinary Institute

Lumpy skin disease: Introduction

Causative agent: [Poxvirus] – {*Capripoxvirus*}
- Lumpy skin disease virus

Type strain: Neethling strain (Western Cape, RSA, 1957)

Ruminants: Cattle and water buffalo.

Wildlife:. Springbok, impala, eland, giraffe, camel, gazelle, oryx, Arabian oryx, banteng and Mainland searow

Notifiable disease: WOAH

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Lumpy skin disease: Transmission

Highly contagious viral infection

Direct contact: Skin nodules, nasal discharge or saliva from infected animals

In-direct: Contaminated food, water and milk

Vertically: Intrauterine route

Vector-borne, non-zoonotic and transboundary disease

Long-distance dispersal of LSDV seems to occur via the movement of infected animals

NOT an arbovirus

Seasonal patterns indicate that arthropod-borne transmission (Mechanical):
Blood-sucking or biting arthropods:
Stable flies (*Stomoxys calcitrans*), Mosquitoes (*Aedes aegypti*),
Hard ticks (*Rhipicephalus* and *Amblyomma* species)
House fly (*Musca domestica*)

Require more investigations

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Lumpy skin disease: Role of wildlife species

In 2022, isolation and characterisation of LSDV from a giraffe in a zoo was reported in Vietnam (Dao et al., 2022).

Namibia: an eland antelope (Taurotragus oryx), which was asymptomatic for LSD, but LSDV DNA isolated (Molini et al., 2021)

India: Farmed camels (Kumar et al., 2023)

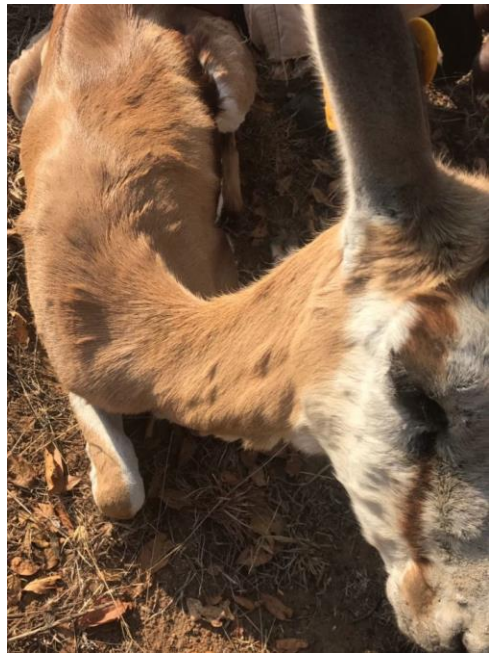
India: Free living gazelle (Sundhankar et al., 2023)

This evidence is supported by extensive serosurveys of wildlife in Africa which detected antibodies in very low numbers of samples (Davies, 1982; Hedger and Hamblin, 1983), leading the authors to conclude “wildlife in Africa probably does not play a very important part in the perpetuation and spread of LSDV”.

LSDV has spread rapidly in recent years into the Middle East and Asia, and the susceptibility of wildlife species in these regions to LSDV is unknown.

In South Africa:
Springbuck and giraffe - National parks and game reserves

Require more investigations



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Lumpy skin disease: Global spread

Zambia: 1929

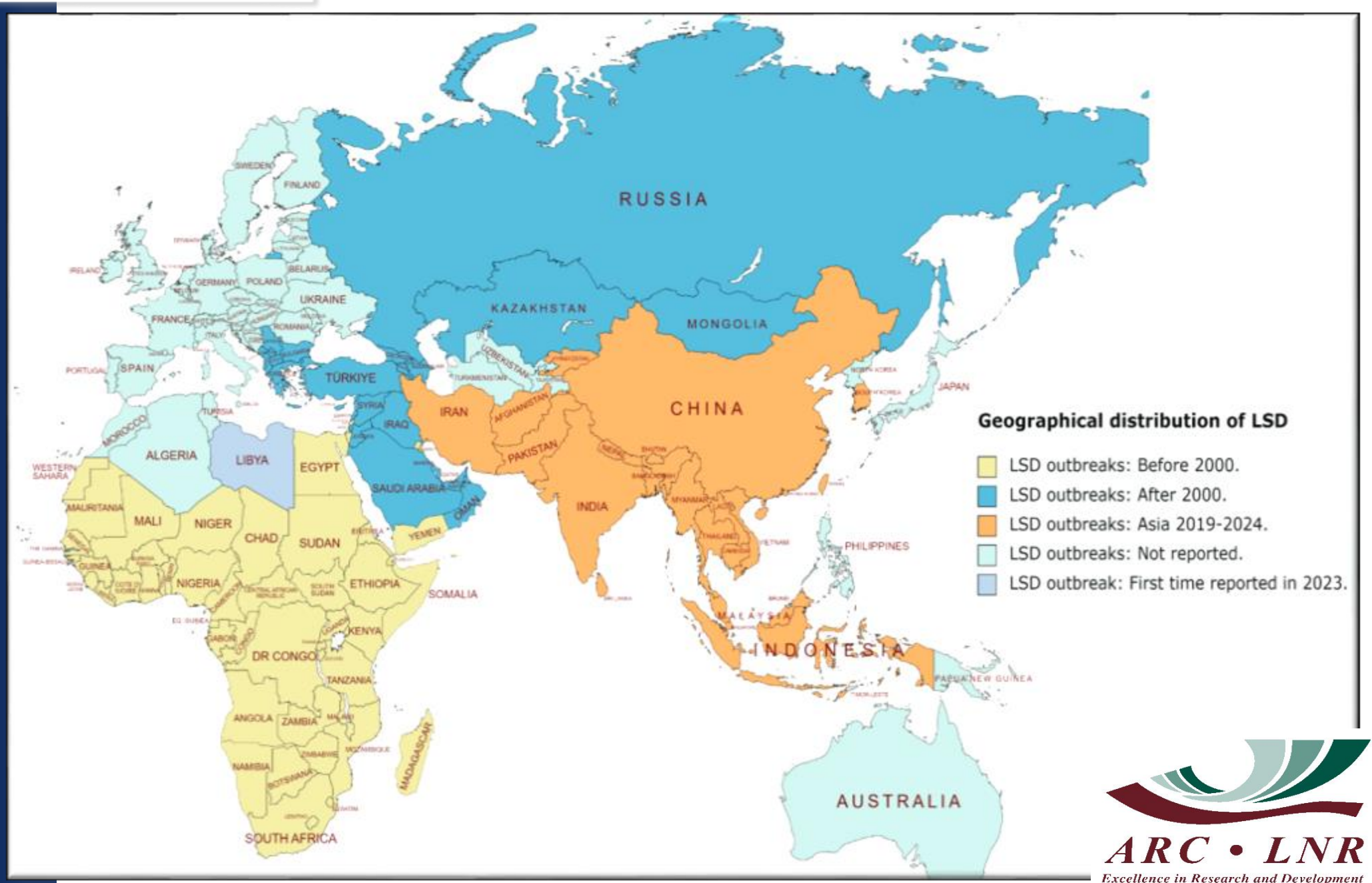
South Africa: 1944

Kenya: 1958

Middle East: 1988 and again in 2006

Europe, Caucus and Russia: 2015

China and India: 2019



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Lumpy skin disease: Epidemiology

Clusters based on Markers

- 1.2
- 1.2 -KSGP
- 1.1 & 1.2
- 1.2 & 2.3
- 2.5
- 1.1 & 1.2 & 2.1 & 2.2 & 2.4 & 2.5 & 2.6
- No sequence data

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Lumpy skin disease: Phylogenetics

Clusters 1.1 and 1.2

LSDVs representing sequences from both clusters were circulating in Africa in the 1950's.

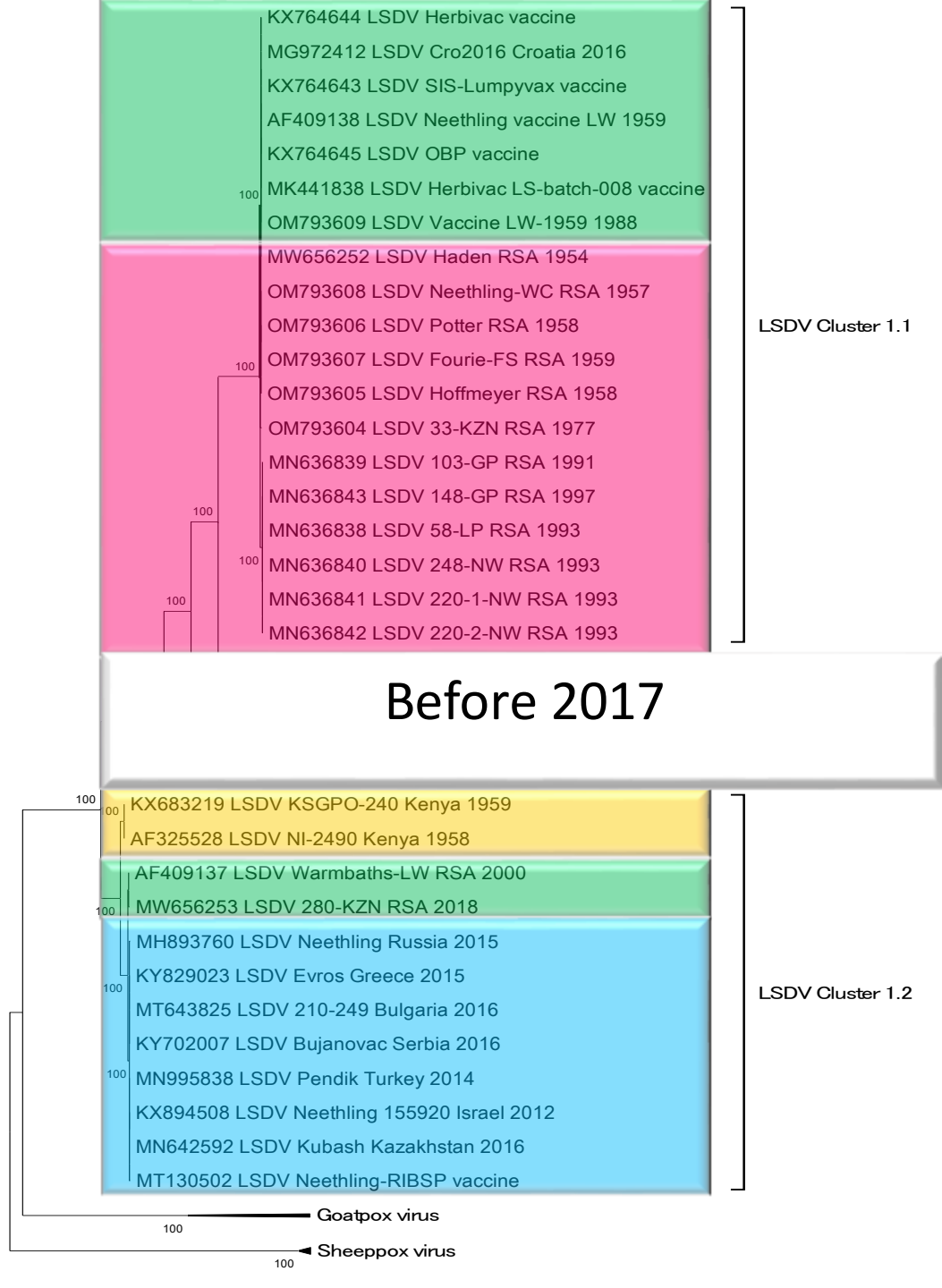
± 2,200 SNPs between cluster 1.1 and 1.2
(Kara et al., 2003; van Schalkwyk et al., 2021)

Majority of the DIVA assays are based on differentiation between cluster 1.1 and 1.2. Thus not suitable to detect the field isolates of cluster 1.1

- ± 1860 SNPs in 114 ORFs
- 57% Synonymous
- 26% Non-Synonymous

- ± 330 (15%) IGR

TMRCA: ± 500 years



Lumpy skin disease: Phylogenetics (Cluster 1.1)

Oldest isolate: Haden / 1954
(van Schalkwyk et al., 2021)

Prototype: Neethling-WC / 1957
(Alexander et al., 1957; van Schalkwyk et al., 2022)

- Vaccine: Neethling-LW1959 (van Rooyen et al., 1959; Kara et al., 2003)
- Vaccine: OBP, Herbivac, SIS-Lumpyvax (Mathijs et al., 2016; Douglass et al., 2019)

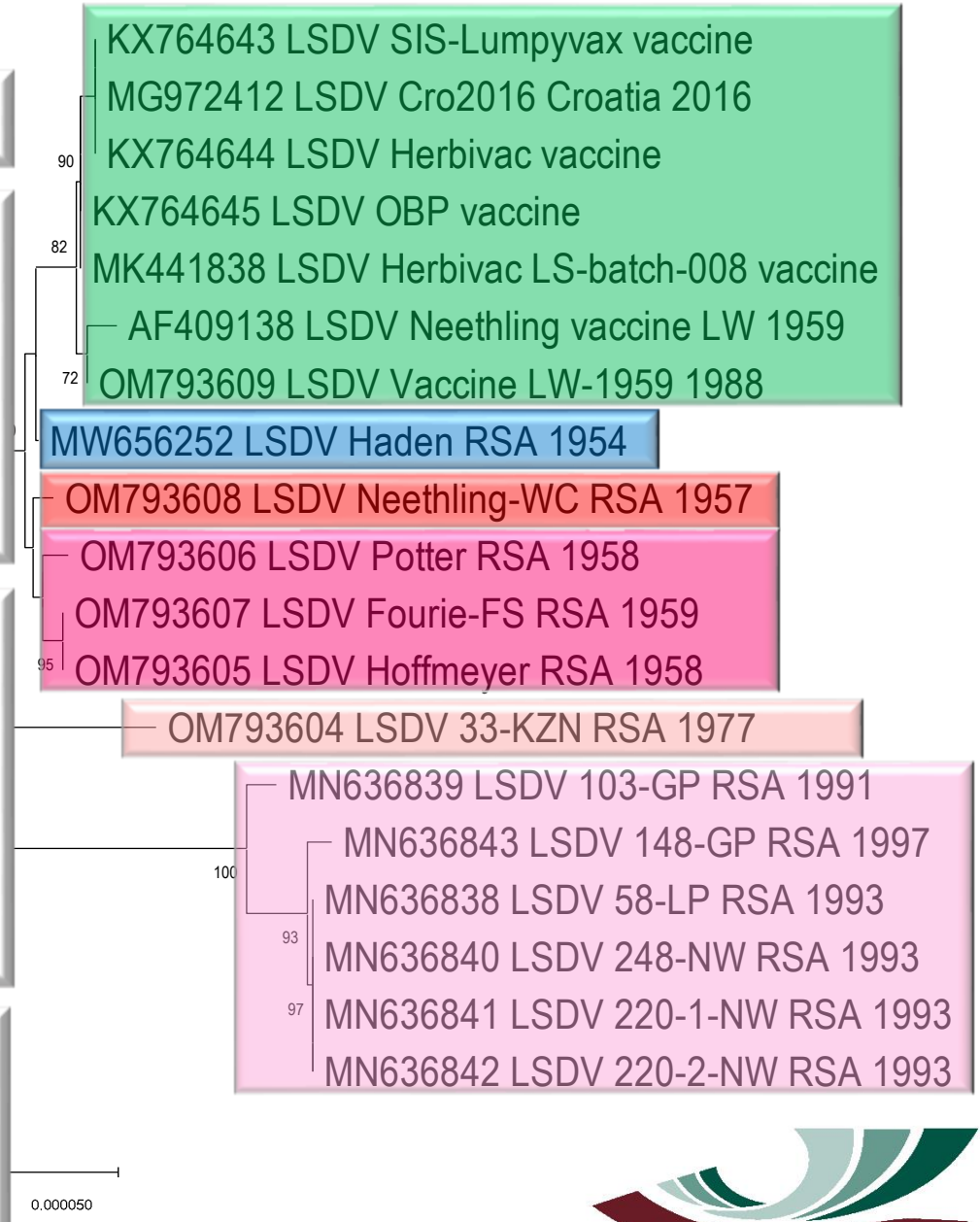
Wild type field isolates: South Africa
1950's, 1970's and 1990's
(van Schalkwyk et al., 2020 and 2022)

Cluster 1.1 - **Attenuation**

Seven SNPs between Neethling-WC/1957 and Neethling-LW1959 vaccine
(van Schalkwyk et al., 2022)

- Non-synonymous:
  - LW028 T135A
  - LW083: K663N
  - LW098: G553S
  - LW098: I625T

- Reading frame:
  - LW086: Termination
    LW131: Termination
    LW134: Termination



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Lumpy skin disease: Phylogenetics (Cluster 1.2)

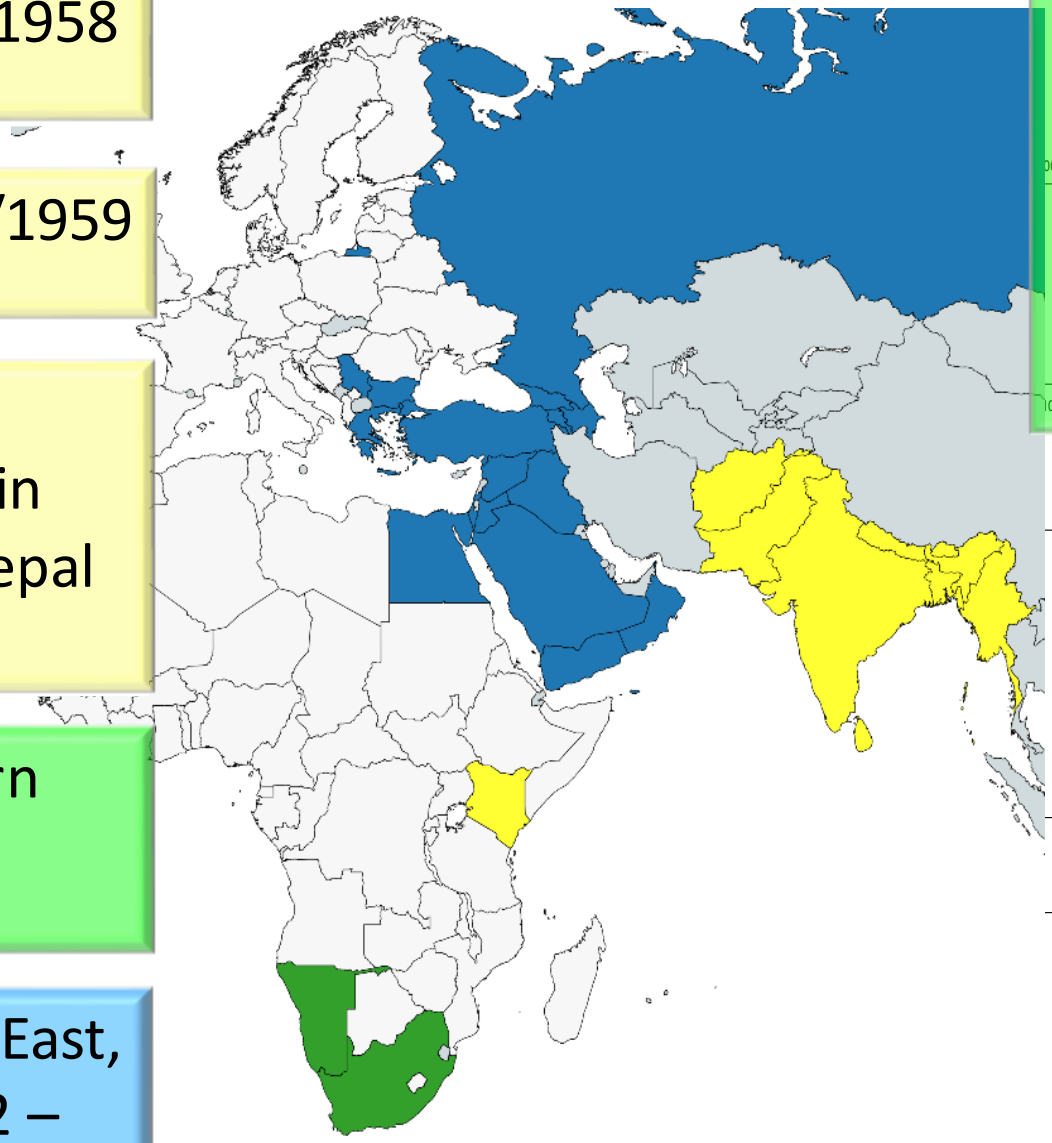
Isolate: 2490/Kenya/1958
(Tulman et al., 2000)

Vaccine: KSGPO-240/1959
(Vandenbussche et al., 2016)

Vaccine: KSGPO-240/1959. Outbreak in Bangladesh, India, Nepal and Pakistan

Isolates from southern Africa 2000 – 2022
(Kara et al., 2003)

Isolates from Middle East, Europe and Asia 2012 – 2016



LSDV LD008 MP GP RSA 2022
LSDV LD032 GP RSA 2022
LSDV LD028 GP RSA 2022
LSDV LD001 GP RSA 2021
LSDV LD004 GP RSA 2021
LSDV D2366 FS RSA 2011
LSDV LD260 NW 2017
MT007950 LSDV Neethling 9F Namibia 2016
MT007951 LSDV Neethling 10F Namibia 2016
MW656253 LSDV 280-KZN RSA 2018
AF409137 LSDV Warmbaths-LW RSA 2000

KY702007 LSDV Bujanovac Serbia 2016
KY829023 LSDV Evros Greece 2015
MT643825 LSDV 210-249 Bulgaria 2016
MH893760 LSDV Neethling Russia 2015
KX894508 LSDV Neethling 155920 Israel 2012
MN642592 LSDV Kubash Kazakhstan 2016
MN995838 LSDV Pendik Turkey 2014

OK318001 LSDV V281 Nigeria 2018

MW883897 LSDV Ranchi India 2019
MN072619 LSDV Kenya
AF325528 LSDV NI-2490 Kenya 1958
KX683219 LSDV KSGPO 240 Kenya 1959

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Lumpy skin disease

Parental sequences are both vaccines:
- Neethling-LW1959
- KSGPO-240

Recombinants

2.1: Saratov/Russia/2017
(Sprygin et al., 2018)

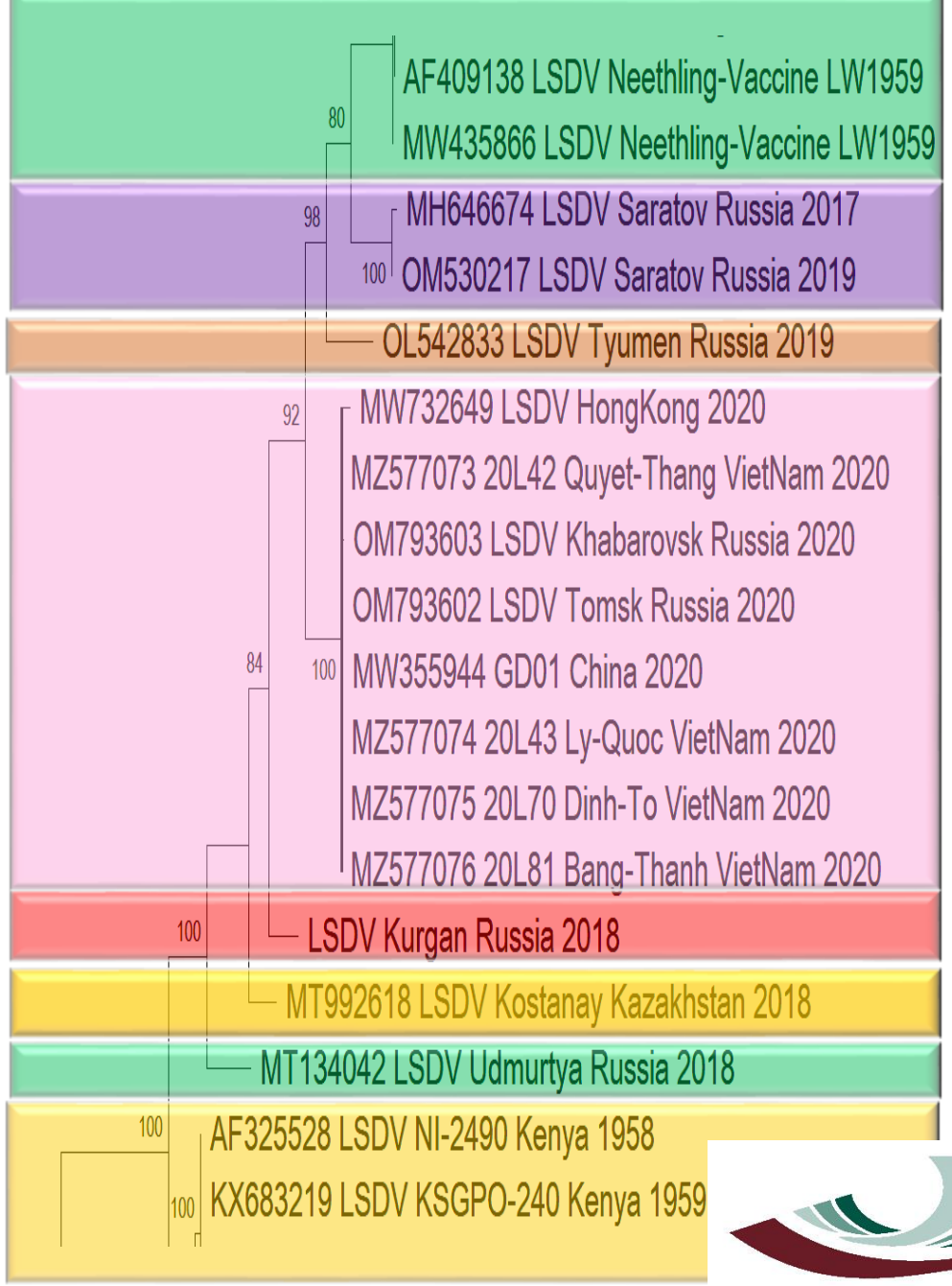
2.2: Udmurtya/Russia/2018
(Sprygin et al., 2018)

2.3: Kostanay/Kazakhstan/2018

2.4: Tyumen/Russia/2019
(Krotova et al., 2022)

2.5: GD01/China/2019
(Ma et al., 2021)

2.6: Kurgan/Russia/2018
(Sprygin et al., 2024)



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Lumpy skin disease

Recombinants

The Importance of Quality Control of LSDV Live Attenuated Vaccines for Its Safe Application in the Field

by Andy Haegeman [1,*], Ilse De Leeuw [1], Meruyert Saduakassova [2], Willem Van Campe [3], Laetitia Aerts [4], Wannes Philips [4], Akhmetzhan Sultanov [2], Laurent Mostin [3] and Kris De Clercq [1]

Recombinant LSDV Strains in Asia: Vaccine Spillover or Natural Emergence?

by Frank Vandenbussche [1,†], Elisabeth Mathijs [1,†], Wannes Philips [1], Meruyert Saduakassova [2], Ilse De Leeuw [3], Akhmetzhan Sultanov [2], Andy Haegeman [3] and Kris De Clercq [3,*]

Contaminated LSD vaccine = Neethling, KSPG vaccine and GTPV

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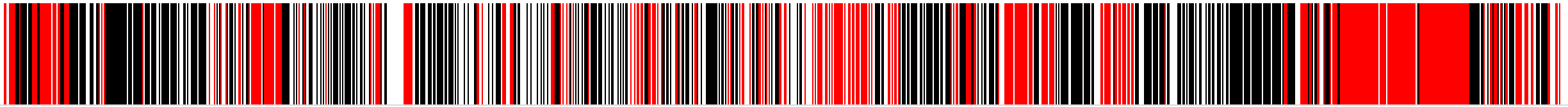
Saratov / 2017

Tuymen / 2019

China / 2019

Kurgan / 2018

Kazakhstan / 2018



Udmurtia / 2018

Lumpy skin disease

Russia: Saratov & Udmurtiya

Non-vector-borne transmission of lumpy skin disease virus

Kononov Aleksandr[1], Byadovskaya Olga[1], Wallace B. David[2,3], Prutnikov Pavel[1], Pestova Yana[1], Kononova Svetlana[1], Nesterov Alexander[1], Rusaleev Vladimir[1], Lozovoy Dmitriy[1] & Sprygin Alexander[1]

A lumpy skin disease virus which underwent a recombination event demonstrates more aggressive growth in primary cells and cattle than the classical field isolate

Svetlana Kononova[1] | Aleksandr Kononov[1] | Irina Shumilova[1] | Olga Byadovskaya[1] | Alexander Nesterov[1] | Pavel Prutnikov[1] | Shawn Babiuk[2] | Alexander Sprygin[1]

Experimentally controlled study indicates that the naturally occurring recombinant vaccine-like lumpy skin disease strain Udmurtiya/2019, detected during freezing winter in northern latitudes, is transmitted *via* indirect contact

Alexander Nesterov[1], Ali Mazloum[1], Olga Byadovskaya[1], Irina Shumilova[1], Antoinette Van Schalkwyk[2,3], Alena Krotova[1], Vladimir Kirpichenko[4], Irina Donnik[5], Ilya Chvala[1] and Alexander Sprygin[1*]

Overwintering of recombinant lumpy skin disease virus in northern latitudes, Russia

Irina Shumilova[1] | Alena Krotova[1] | Alexander Nesterov[1] | Olga Byadovskaya[1] | Antoinette van Schalkwyk[2] | Alexander Sprygin[1]

Recombinants: Novel phenotypes

- Transmission
- Overwintering
- Aggressive growth

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Lumpy skin disease: Phylogenetics

Phylogenetic analysis shows the majority of LSDV strains group into two monophyletic clusters (cluster 1.1 and 1.2) (Biswas et al., 2020; Van Schalkwyk et al., 2021).

Cluster 1.1: Neethling Prototype strain and vaccine

Cluster 1.1 consists of LSDV Neethling vaccine strains that are based on the LSDV/Neethling/WC-1957 type-strain (Kara et al., 2003; Van Rooyen et al., 1959; van Schalkwyk et al., 2020) and historic wild-type strains from South Africa.

Cluster 1.2: KSGP and "wild type"

Cluster 1.2 consists of wild-type strains from southern Africa, Kenya, the northern hemisphere, and the Kenyan KSGP O-240 commercial vaccine.

Cluster 2.1 -2.6: Six unique recombinant strains

In addition to these two clusters, there have recently been recombinant LSDV strains isolated from clinical cases of LSD in the field in Russia and central Asia (Flannery *et al.,* 2021; Sprygin *et al.,* 2018; 2020; Wang *et al.,* 2021). These recombinant viruses show unique patterns of accessory gene alleles, consisting of sections of both wild-type and "vaccine" LSDV strains.

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Lumpy skin disease: Laboratory confirmation

- Laboratory confirmation:

- "Gold standard" serological test: serum/virus neutralization test (SNT/VNT).

Not all animals either naturally infected or vaccinated develop LSDV neutralizing antibodies.

- Enzyme-linked immunosorbent assay (ELISA) by IDVet (France).
- Conventional and Real-Time Polymerase chain reaction (PCR) assays.
- Virus isolation on cell culture (Skin nodules).

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Lumpy skin disease: WOAH Manual: B. DIAGNOSTIC TECHNIQUES

Key:

+++ = recommended for this purpose

++ recommended but has limitations

+ = suitable in very limited circumstances

– = not appropriate for this purpose

Method	Purpose					
	Population freedom from infection	Individual animal freedom from infection prior to movement	Contribute to eradication policies	Confirmation of clinical cases	Prevalence of infection – surveillance	Immune status in individual animals or populations post-vaccination
Detection of the agent						
Virus isolation	+	++	+	+++	+	–
PCR	++	+++	++	+++	+	–
Transmission electron microscopy	–	–	–	+	–	–
Detection of immune response						
VNT	++	++	++	++	++	++
IFAT	+	+	+	+	+	+
ELISA	++	++	++	++	++	++

PCR = polymerase chain reaction; VNT = virus neutralisation test;
IFAT = indirect fluorescent antibody test; ELISA = enzyme-linked immunosorbent assay

Lumpy skin disease: Molecular test to differentiate vaccine and wild-type LSDV

DIVA: **D**ifferentiation of **I**nfected from **V**accinated **A**nimals

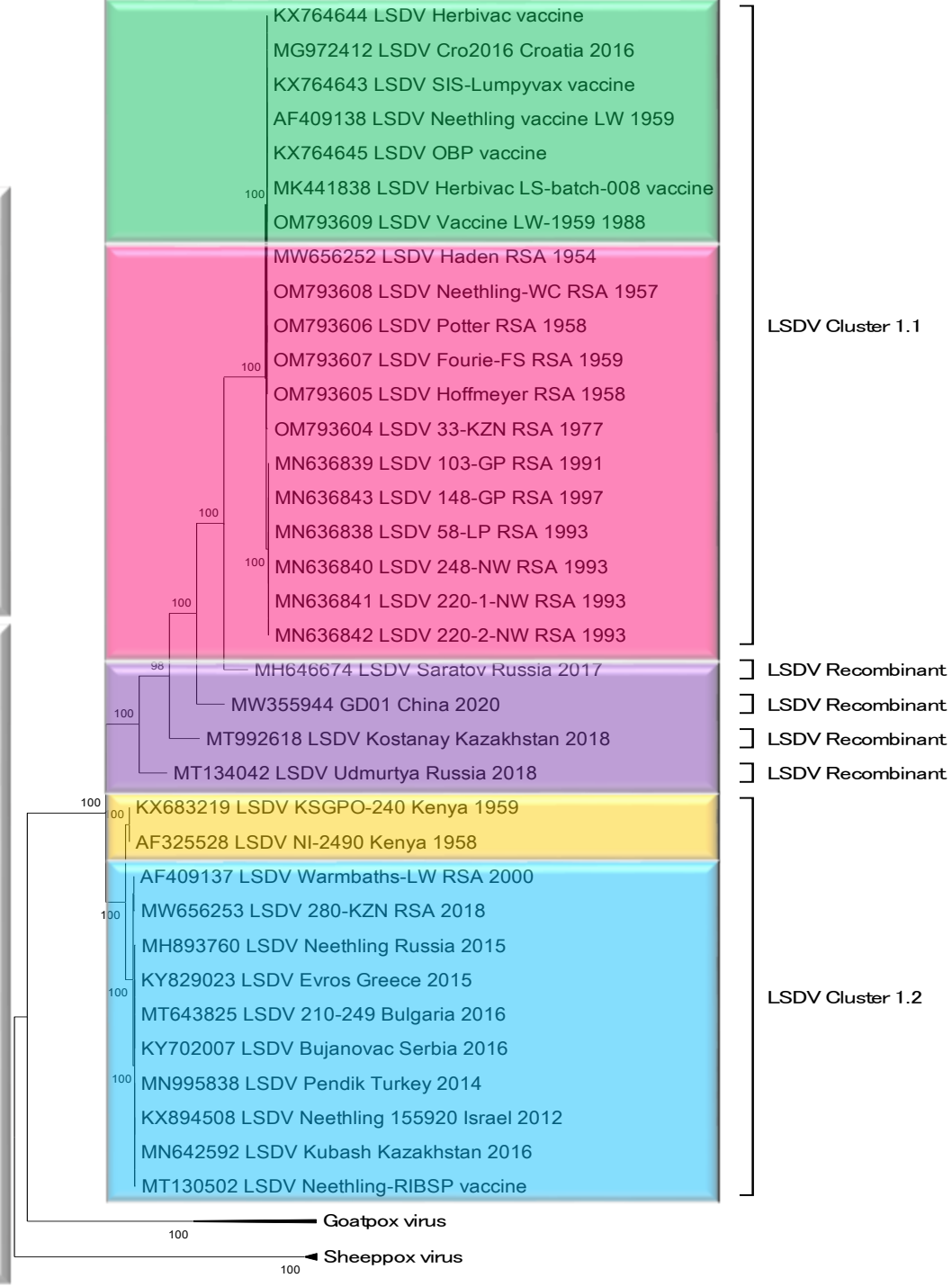
<u>CAN</u>
differentiate between cluster 1.1 and 1.2.

<u>CAN NOT</u> differentiate between vaccine and wild type isolates within
Cluster 1.1

<u>CAN NOT</u> differentiate between vaccines and novel recombinant strains (Cluster 2.1 – 2.5)

Quantitative real-time PCR assays have been designed to differentiate the "Neethling response" caused by vaccination with a Neethling-based LSDV strains and wild-type LSDV strains from cluster 1.2 (Agianniotaki et al., 2017; Pestova et al., 2018; Vidanovic et al., 2016).

However, they cannot distinguish between a LSDV Neethling vaccine strain and the novel recombinant LSDV strains recently isolated from disease outbreaks in Asia (Byadovskaya et al., 2021; Flannery et al., 2021). These DIVA assays are also not capable of discriminating between LSDV Neethling vaccine strains and recently characterised (historic) wild-type viruses from South Africa belonging within cluster 1.1 (Van Schalkwyk et al., 2020; 2021).



Lumpy skin disease: New Markers

Kumar et al., 2023	HRM-based gap-qRT-PCR: 801bp in terminal repeat region (ITR) • Vaccine: (Lumpi-ProVac^{Ind}) vs. Wild type: (LSDV/2019/India/Ranchi)
Haegeman et al., 2023	Duplex qRT-PCR: LW133 and LW144 • Vaccine (Neethling) vs. Wild type: Cluster 1.2 vs. Recombinant (Cluster 2.5)
Krotova et al., 2023	PCR and Sanger sequencing: 705bp in ORF LW134 • Vaccines (Neethling and KSGPO) vs. Wild type Cluster 1.2 vs. Recombinant (Cluster 2.1, 2.2, 2.3, 2.4 and 2.5)

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Lumpy skin disease: New Diagnostic tests

Nan et al., 2023	Triplex real-time PCR: • LSDV vs GTPV vs SPPV
Liao et al., 2023	CRISPR-Cas12a: • LSDV vs GTPV vs SPPV
Nandi et al., 2023	Isothermal PCR: 27bp in ORF LW126 • Vaccines (GTPV) vs. Wild type Cluster 1.2-KSGPO
Abdalhamed et al., 2022	Gold nanoparticle – lateral flow test
Sthitmatee et al., 2023	In-house ELISA using whole virus (LSD/THA/CMU/21/05)

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Lumpy skin disease: WOAH Manual: C. REQUIREMENTS FOR VACCINES

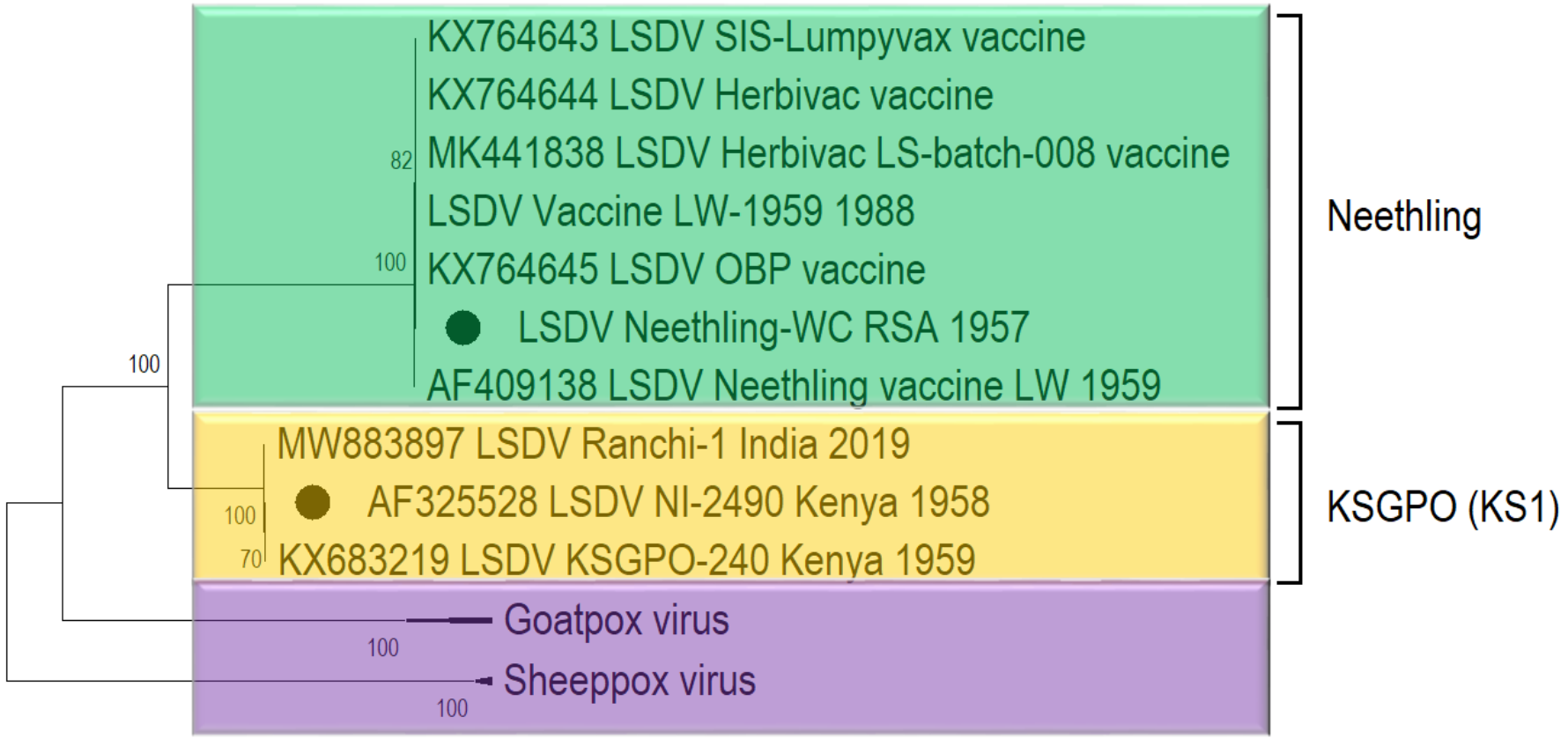
NO DIVA

Homologous vaccines:
Attenuated LSDV
(Neethling and KSGPO)

Heterologous vaccines:
Goatpox (Gorgan / Uttarkashi)
Sheeppox (NISHKI)

Haegeman et al., 2023;
Hamdi et al., 2020;
Wolf et al., 2022

DIVA



Homologous inactivated vaccines: Safe, regular boosters; <1 year immunity

New vaccines: vector-, subunit, mRNA vaccines

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Lumpy skin disease: Available vaccines

Manufacturer	Product Name and Virus Strain	Target Species	Titre, Dose, Administration
Onderstepoort Biological Products (OBP) South Africa	Lumpy Skin Disease (LSD Neethling strain)	Vaccine for Cattle	$10^{3.5}$TCID$_{50}$/dose 2 ml SC
Intervet (Pty) South Africa/MSD Animal Health	Lumpyvax™ (LSD SIS Neethling strain)	Vaccine for Cattle	$10^{4.0}$TCID$_{50}$/dose 2 ml SC
MCI Santé Animale Morocco	Bovivax-LSD™ (LSD Kenya strain)	Vaccine for Cattle	$10^{3.5}$TCID$_{50}$/dose 2 ml SC
Jordan Bio-Industries Center (JOVAC) Jordan	LumpyShield-N™ (LSD Neethling strain)	Vaccine for Cattle	$10^{4.0}$TCID$_{50}$/dose 2 ml SC
Jordan Bio-Industries Center (JOVAC) Jordan	Caprivac™ (Gorgan GTP strain)	Vaccine for Cattle	
Middle East for Vaccines (MEVAC) Egypt	MEVAC LSD (LSD Neethling strain)	Vaccine for Cattle	$10^{3.5}$TCID$_{50}$/dose 2 ml SC
National Veterinary Institute (NVI) Ethiopia	Lumpy Skin Disease vaccine (LSD Neethling strain)	Vaccine for Cattle	$10^{3.0}$TCID$_{50}$/dose 2 ml SC
Kenya Veterinary Vaccines Production Institute (KEVEVAPI)	Lumpivax™ (LSD Neethling strain)	Vaccine for Cattle	Not known TCID$_{50}$/dose 2 ml SC
Pendik Veterinary Control Institute/ Ministry of Agriculture, Turkey	Penpox-M™ Live SPPV (Bakirköy SPPV strain)	Vaccine for Cattle	$10^{2.5}$TCID$_{50}$/dose 2 ml SC
Vetal Company Turkey	Poxvac™ (Bakirköy SPPV strain)	Vaccine for Sheep and Cattle	$10^{2.5}$TCID$_{50}$/dose 2 ml SC
	Lumpyvac™ (LSD Neethling strain)	Vaccine for Cattle	$10^{3.5}$TCID$_{50}$/dose 2 ml SC
Dollvet Turkey	Poxdoll™ (Bakirköy SPPV strain)	Vaccine for Sheep, goats and Cattle	$10^{2.5}$TCID$_{50}$/dose 2 ml SC
	LSD-NDOLL (LSD Neethling strain)	Vaccine for Cattle	$10^{3.5}$TCID$_{50}$/dose 2 ml SC
FGBI-Federal Centre for Animal Health Russia	Sheep Pox Cultyral Dry™(Arriah (NISHKI) SPPV strain)	Vaccine for Sheep and Cattle	Not known TCID$_{50}$/dose
ABIC, Israel	RM 65 Sheeppox (Yugoslavia RM65)	Vaccine for Sheep and Cattle	

Tuppurainen et al., 2021

Lumpy skin disease: Vaccine testing (literature study by Pravesh Kara)

Breed Age Gender	Construct / Vaccine Dose Route & Volume	Number of animals	Fever (%)	Start of fever (Ave Days)	Inoculation site reaction (%)	>1 nodule (%)	Clinical reaction [other than fever] (%)	Shedding (PCR) (%)	Nodule (PCR) (%)	Viremia (PCR / VI) (%)	VNT 1 (%)	VNT 2 (%)	ELISA (%)	IPMA (%)	iFIT / IFAT (%)	Reference
Holstein - Friesen 6 months Male	LSD Neethling OBP [1.4x10^{7} $TCID_{50}$] SC Route: 2ml	5	0/5 (0%)	N/A	1/5 (20%)	0/5 (0%)	1/5 (20%)	Nd	0/1 (0%)	PCR 0/5 VI 0/5	0/5 (0%)	nd	nd	nd	nd	Kara et al., 2018
Holstein 6 months Male	LSD Neethling OBP [1x10$^{8.5}$ $TCID_{50}$] SC Route: 2ml	7	6/7 (86%)	1 dpv (4.2 days)	0/7 (0%)	0/7 (0%)	0/7 (0%)	Nd	0/7 (0%)	0/7 (0%)	1/7 (14%)	3/7 (43%)	nd	7/7 (100%)	nd	Haegeman et al., 2021a
	LSD Neethling Lumpyvax [1x104 TCID50] SC Route	7	7/7 (100%)	1 dpv (10.3days)	0/7 (0%)	0/7 (0%)	0/7 (0%)	Nd	0/7 (0%)	0/7 (0%)	1/7 (14%)	4/7 (57%)	nd	5/7 (72%)	nd	
	LSD Neethling HerbivacLS [1x102.5 TCID50] SC Route	7	4/7 (57%)	1 dpv (3 days)	0/7 (0%)	3/7 (43%)	3/7 (43%)	nd	3/7 (43%)	4/7 (57%)	3/7 (43%)	5/7 (71%)	nd	6/7 (86%)	nd	
	LSD Neethling (O variant) MCI [1x103 TCID50] SC Route	7	4/7 (57%)	1 dpv (3.8 days)	3/7 (43%)	2/7 (29%)	3/7 (43%)	nd	2/7 (29%)	2/7 (29%)	4/7 (57%)	3/7 (43%)	nd	7/7 (100%)	nd	
	LSD KSGP Kenyavac [1x102.5 TCID50] SC Route	7	5/7 (71%)	1 dpv (6.8 days)	0/7 (0%)	0/7 (0%)	0/7 (0%)	nd	0/7 (0%)	0/7 (0%)	0/7 (0%)	2/7 (29%)	nd	5/7 (72%)	nd	
Holstein-cross 4-6 months	LSD Neethling (LSD_Nt) [1x104 $TCID_{50}$] SC Route: 2ml	15	7/15 (47%)	2 dpv (2 days)	0/15 (0%)	1/15 (7%)	1/15 (7%)	1/15 (7%)	1/15 (7%)	nd	7/15 (47%)	nd	nd	nd	nd	Bamouh et al., 2021
	LSD Neethling (LSD_Nt) [1x105 $TCID_{50}$] SC Route: 2ml	30	13/30 (43%)	NI (4.3 days)	2/30 (7%)	2/30 (7%)	2/30 (7%)	2/30 (7%)	2/30 (7%)	nd	23/30 (73%)	nd	nd	nd	nd	
	LSD KSGP O-240 [1x104 TCID50] SC Route: 2ml	12	5/12 (42%)	NI (5.6 days)	0/12 (0%)	0/12 (0%)	0/12 (0%)	0/12 (0%)	0/12 (0%)	nd	12/12 (100%)	nd	nd	nd	nd	
	LSD KSGP O-240 [1x105 TCID50] SC Route: 2ml	12	9/12 (75%)	NI (3.8 days)	1/12 (8%)	3/12 (25%)	3/12 (25%)	3/12 (25%)	3/12 (25%)	nd	12/12 (100%)	nd	nd	nd	nd	
Morocco (Zebu) 6-8 months	LSD Neethling OBP 1x104 TCID50 SC Route	15	1/15 (7%)	1 dpv (1 day only)	0/15 (0%)	0/15 (0%)	0/15 (0%)	0/15 (0%)	0/15 (0%)	nd	7/15 (47%)	nd	nd	nd	nd	Hamdi et al., 2020
Holstein-Friesen 9-10 months	LSD Neethling (Nt_hd) [1x107 TCID50] IV Route: 3ml & SC Route: 1ml	6	0/6 (0%)	N/A	2/6 (33%)	0/6 (0%)	0/6 (0%)	2/6 (33%)	0/6 (0%)	4/6 (67%)	4/6 (67%)	nd	5/6 (83%)	nd	6/6 (100%)	Moller et al., 2019
Holstein-Friesen 4-6 months	LSD Neethling HerbivacLS [1x102.5 TCID50] SC Route: 2ml	6	3/6 (50%)	5-6 dpv. (4-6 days)	5/6 (83%)	0/6 (0%)	5/6 (83%)	0/6 (0%)	nd	4/6 (67%)	5/6 (83%)	nd	5/6 (83%)	nd	nd	Wolff et al., 2020
Borana (Zebu) 12 -24 months	LSD Neethling (NVI, Ethiopia) [1x104.5 TCID50] SC Route	5	0/5 (0%)	N/A	0/5 (0%)	0/5 (0%)	0/5 (0%)	nd	nd	nd	nd	nd	nd	nd	0/5 (0%)	Gari et al., 2015
	LSD Neethling (NVI, Ethiopia) [1x103.5 TCID50] SC Route	5	0/5 (0%)	N/A	0/5 (0%)	0/5 (0%)	0/5 (0%)	nd	nd	nd	nd	nd	nd	nd	0/5 (0%)	
	LSD KSGP O-180 [1x104.5 TCID50 SC Route	5	0/5 (0%)	N/A	0/5 (0%)	0/5 (0%)	0/5 (0%)	nd	nd	nd	nd	nd	nd	nd	0/5 (0%)	
	LSD KSGP O-180 [1x103.5 TCID50 SC Route	5	0/5 (0%)	N/A	0/5 (0%)	0/5 (0%)	0/5 (0%)	nd	nd	nd	nd	nd	nd	nd	0/5 (0%)	
Dexter 11-16 months Male	LSD Neethling OBP [1x103.5 TCID50] SC Route: Vaccination 1	6	0/6 (0%)	N/A	0/6 (0%)	0/6 (0%)	0/6 (0%)	nd	nd	0/6 (0%)	0/6 (0%)	nd	nd	nd	nd	Osuagwuh et al., 2007
	LSD Neethling OBP [1x103.5 TCID50] SC Route: Repeat Vaccination 21 dpv	6	0/6 (0%)	N/A	0/6 (0%)	0/6 (0%)	0/6 (0%)	nd	nd	0/6 (0%)	4/6 (67%)	nd	nd	nd	nd	
Holstein 6 months Male	LSD Lumpivax (KEVEVAPI, Kenya) [Dose: NI] SC Route: 2ml	7	7/7 (100%)	NI	7/7 (100%)	2/7 (29%)	7/7 (100%)	nd	3/3 (100%)	1/7 (14%)	nd	nd	1/7 (14%)	7/7 (100%)	nd	Haegeman et al., 2021b
Breed: NI 6-9 months Male	LSD Lumpi-ProVac Ind [1x103.5 TCID50] Route: NI	8	3/8 (37.5%)	NI	0/8 (0%)	0/8 (0%)	Viremia 5/8 (62.5%) 3dpv only	0/8 (0%)	0/8 (0%)	PCR 5/8 (62.5%) 3dpv only	7/8 (87.5%)	nd	nd	nd	nd	Kumar et al., 2022

Not all animals
naturally infected or vaccinated develop neutralizing antibodies against LSDV
or
they develop low levels of antibodies undetectable by current serological assays

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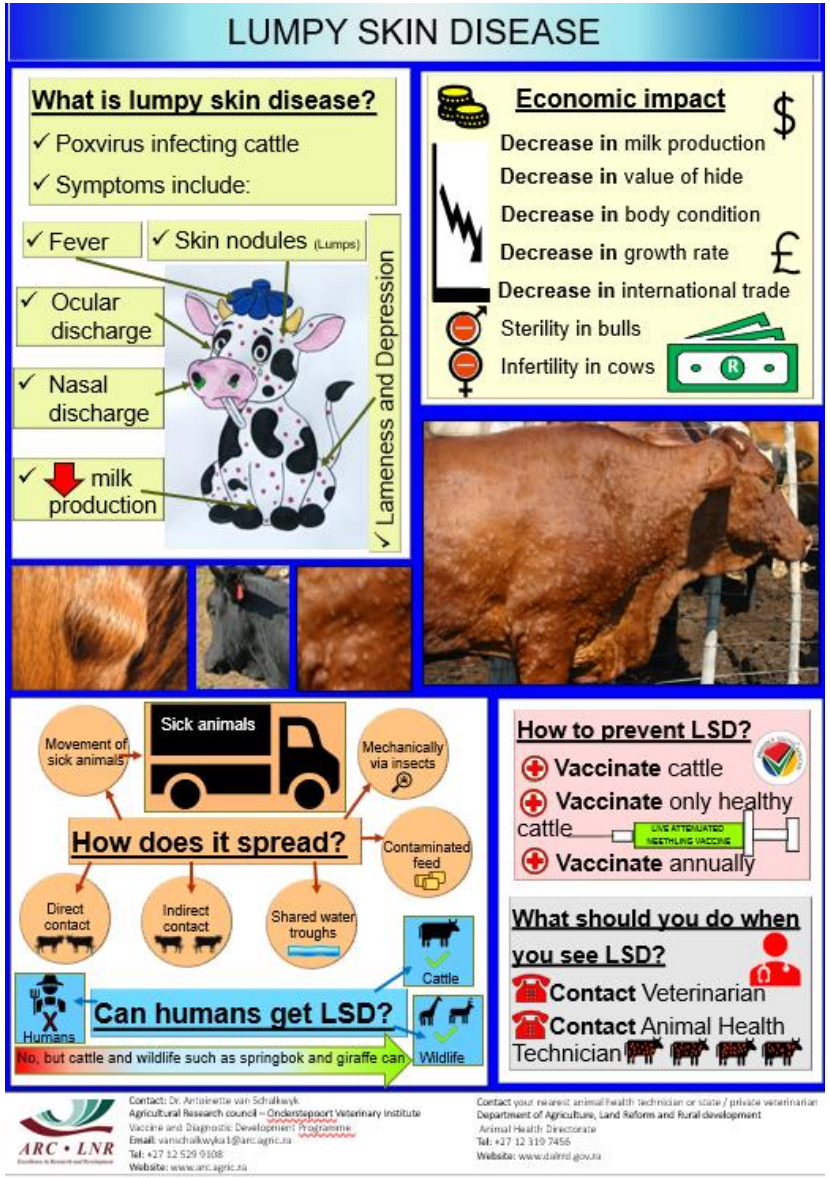
Lumpy skin disease: South Africa

Endemic since 1945
Annual outbreaks – Summer months

Diagnostic – Laboratory confirmation
- Molecular: Realtime PCR
- Serology: VNT
- Serology: IDVet ELISA
- Complete genome sequencing

Vaccination: Live attenuate Neethling vaccine:
- OBP vaccine Onderstepoort Biological Products, South Africa
- Herbivac - Deltamune, South Africa
- Lumpyvax - MSD Animal Health, South Africa
- Annual vaccination - encourage

Education and information: 5 Languages



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Questions?

Antoinette van Schalkwyk
Agricultural Research Council – Onderstepoort Veterinary Institute

vanschalkwyka1@arc.agric.za