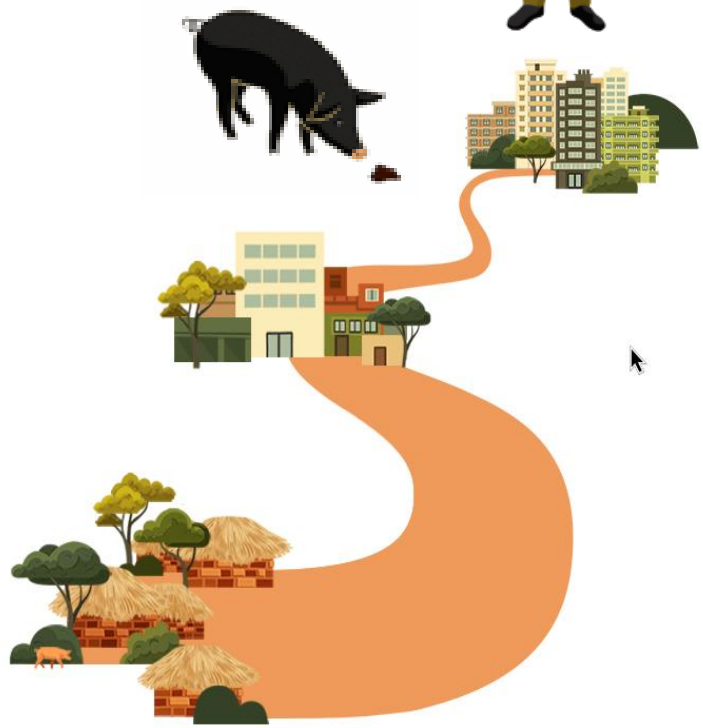
A One Health road to elimination of *Taenia solium* taeniosis/cysticercosis

Surveillance & Control



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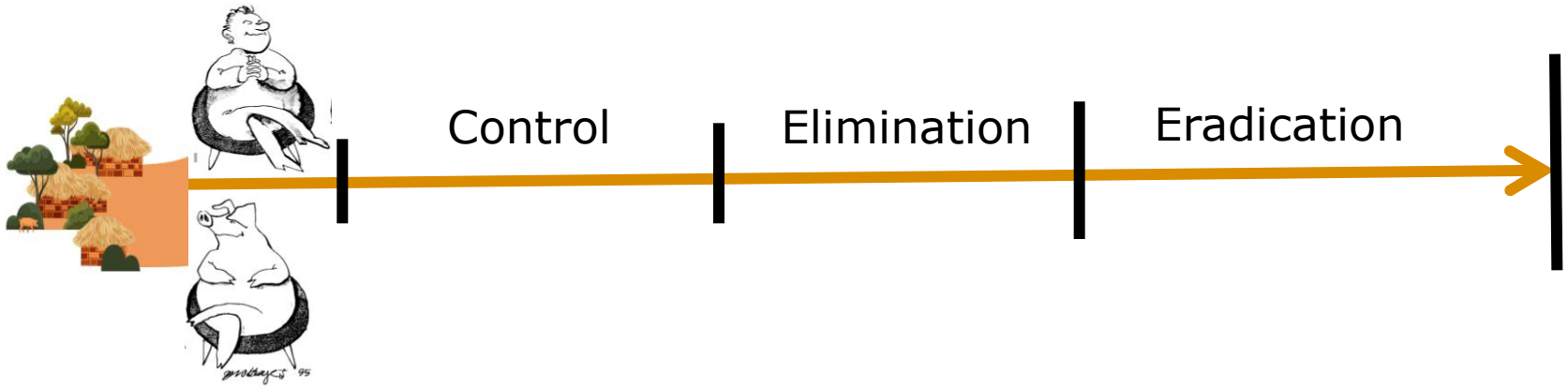
Learning outcomes

1. Become aware of the opportunities and challenges for developing a One Health algorithm and step-wise approach for control leading to elimination

2. Become familiar with available and needed diagnostic and surveillance tools



From endemicity to elimination – a long road

ONE HEALTH APPROACH

Roll-out & surveillance

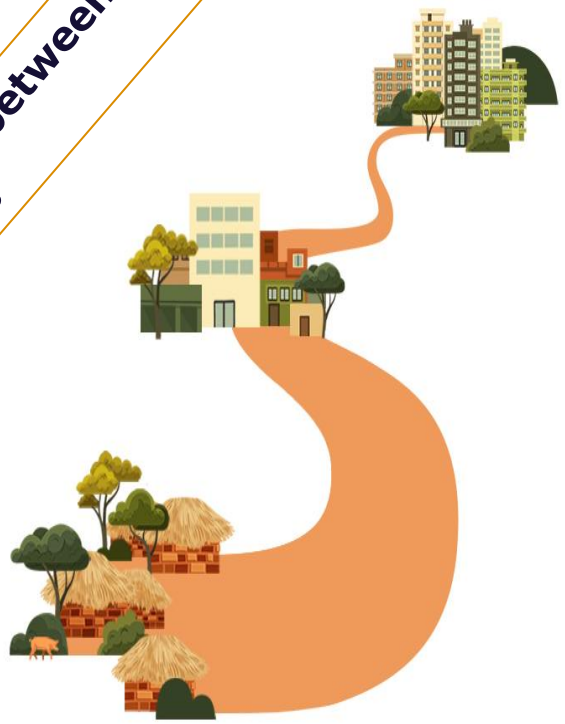
Programme planning

Country strategy

Political commitment

Awareness

Communication and collaboration between essential stakeholders



Endemicity

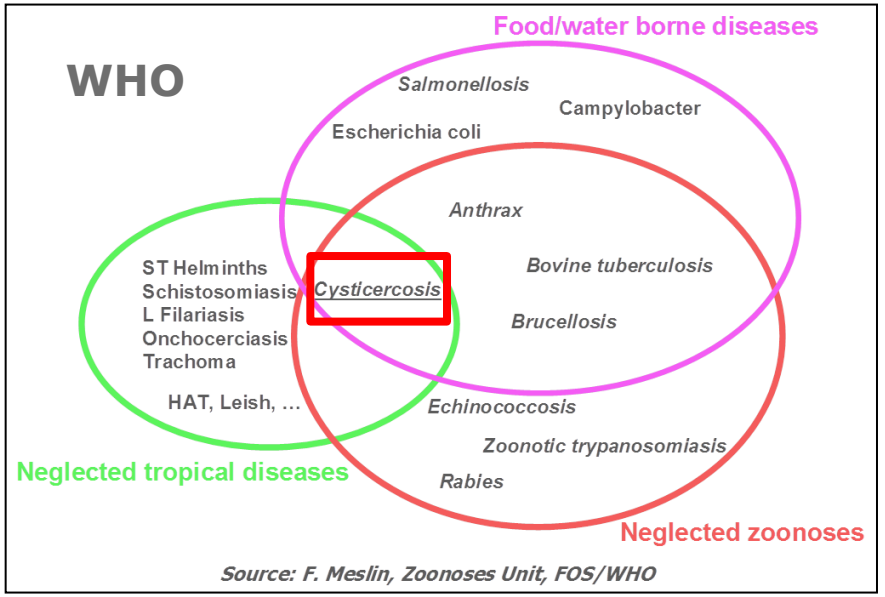
Elimination

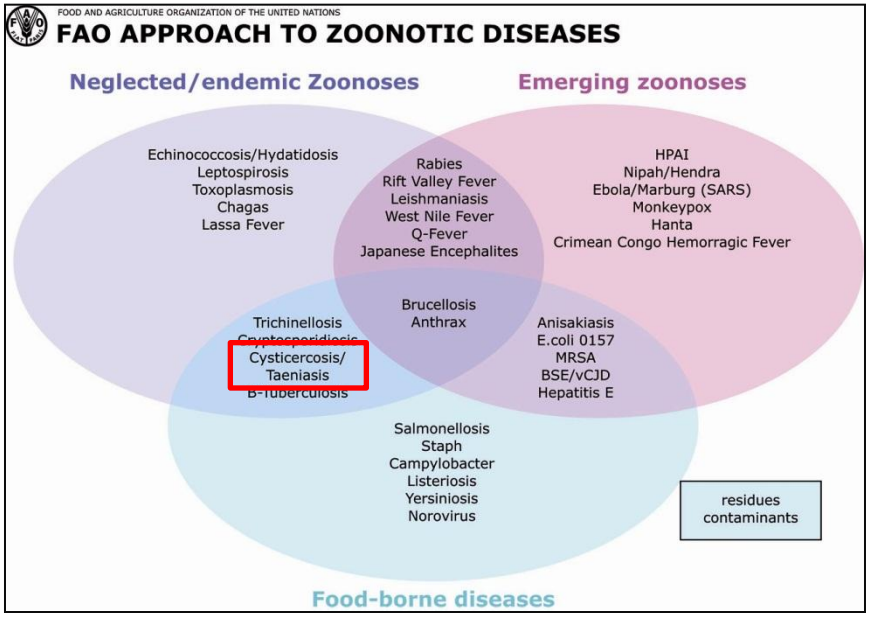
Awareness: International focus on *Taenia solium* taeniosis/ cysticercosis **(TSTC)**

In 1993: the International Task Force for Disease Eradication (Carter Centre) declared 6 diseases eradicable:

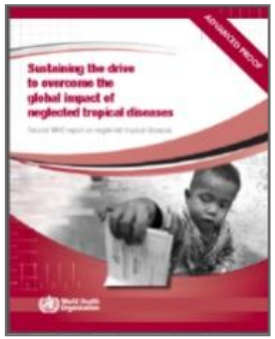
Poliomyelitis	Dracunculiasis
Rubella	Lymphatic filariasis
Mumps	**Cysticercosis**

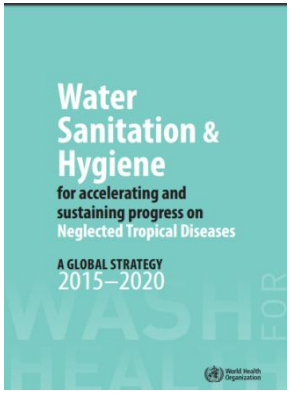
Neglected Tropical Disease (NTD) (WHO, 2010)

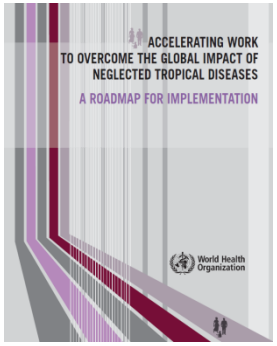




Tackling NTD: a pro-poor strategy on a grand scale





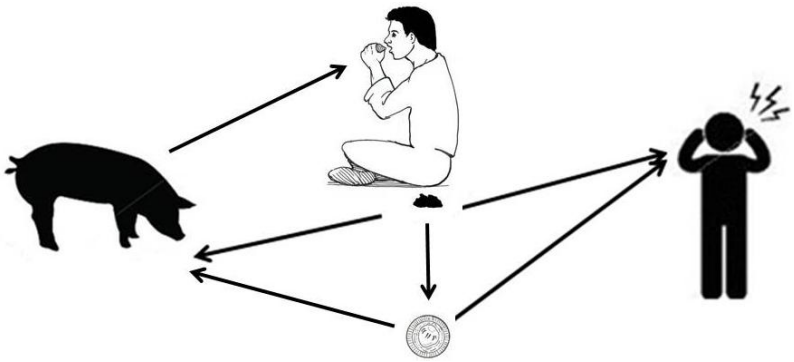


Five key interventions to combat NTDs

1. Preventive Chemotherapy
2. Innovative and intensified disease management
3. Vector control and pesticide management
4. Safe drinking-water, basic sanitation and hygiene services
5. Zoonotic-disease management

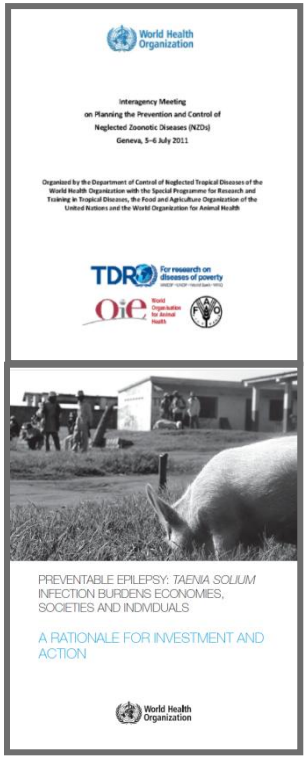
NTD Roadmap	2015	2020
TSTC	Validated strategy available	Interventions scaled up in selected countries

Awareness: Country specific information on TSTC prevalence, risks & burden



Political commitment: TSCT arenas and stakeholders

International arena



Tripartite

- WHO
- FAO
- OIE

Regional arena

National arena

- ✓ Ministries
- ✓ Private sector
- ✓ NGO's
- ✓ Civil societies

One World Health

Local arena

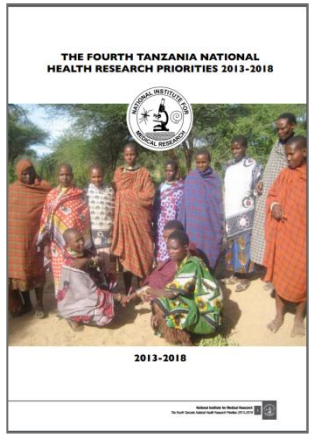


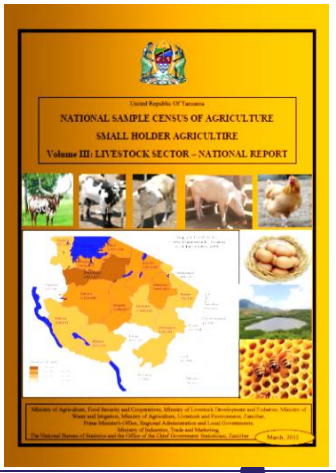



Political commitment for TSTC control & surveillance

TSCT control & surveillance endorsed at ministerial level including:

1. National priorities described and aligned
2. One-Health cross-sectoral unit established
3. Criteria for success defined
4. Control tools & algorithm selected
5. Surveillance tools & strategy in place
6. Institutional capacity locally available
7. Operational guidelines described
8. Control tools locally available
9. Communication strategy described





Country TSTC strategy – definition of success!

SMART country-specific goals

(Specific, Measurable, Achievable, Realistic, Time-bound)

”Neurocysticercosis eliminated as a public health problem (WH0, 2013)”

Ex.

No new porcine cysticercosis cases in country X for a consecutive 12 months

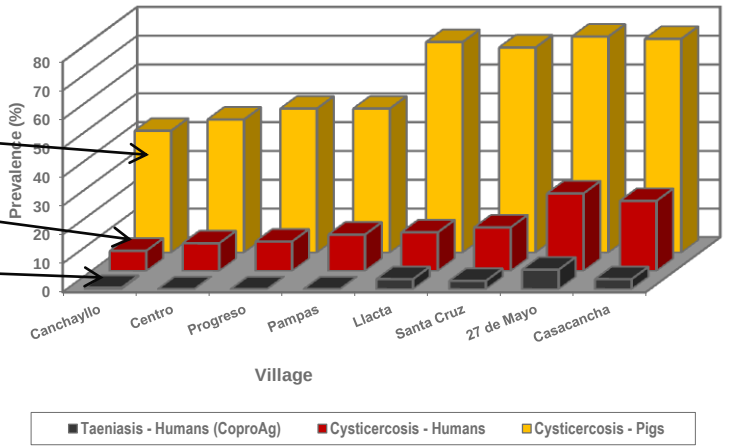
Relationship between:

porcine cysticercosis

human cysticercosis

human taeniosis

in 8 Peruvian villages (Garcia *et al*., 2002)



Treatment of *T. solium* infections

Human taeniosis

Praziquantel (5–10 mg/kg single dose)
Niclosamide (2 g single dose)
Herb medicine (e.g. pumpkin seeds)

Human cysticercosis

Praziquantel (50 mg/kg daily x 15-30 days)
Albendazole (15 mg/kg daily x 8-30 days)

Porcine cysticercosis

Oxfendazole (30 mg/kg P.O. single dose)

Which algorithm to chose for TSTC?

1. Control =???
2. Elimination = ???

→ ?

a. Treatment of taeniosis cases

b. Preventive chemotherapy - integrate with other programmes using praziquantel

c. Health education

d. Improved pig husbandry

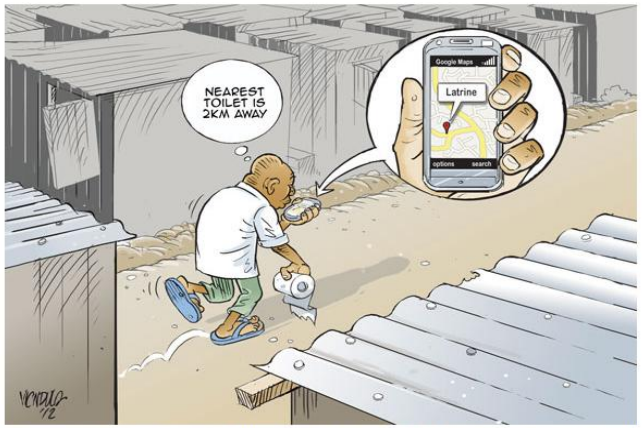
e. Improved meat inspection + processing

f. Improved sanitation- integrate with WASH,CLTS,..

g. Anthelmintic treatment of pigs

h. Vaccination of pigs

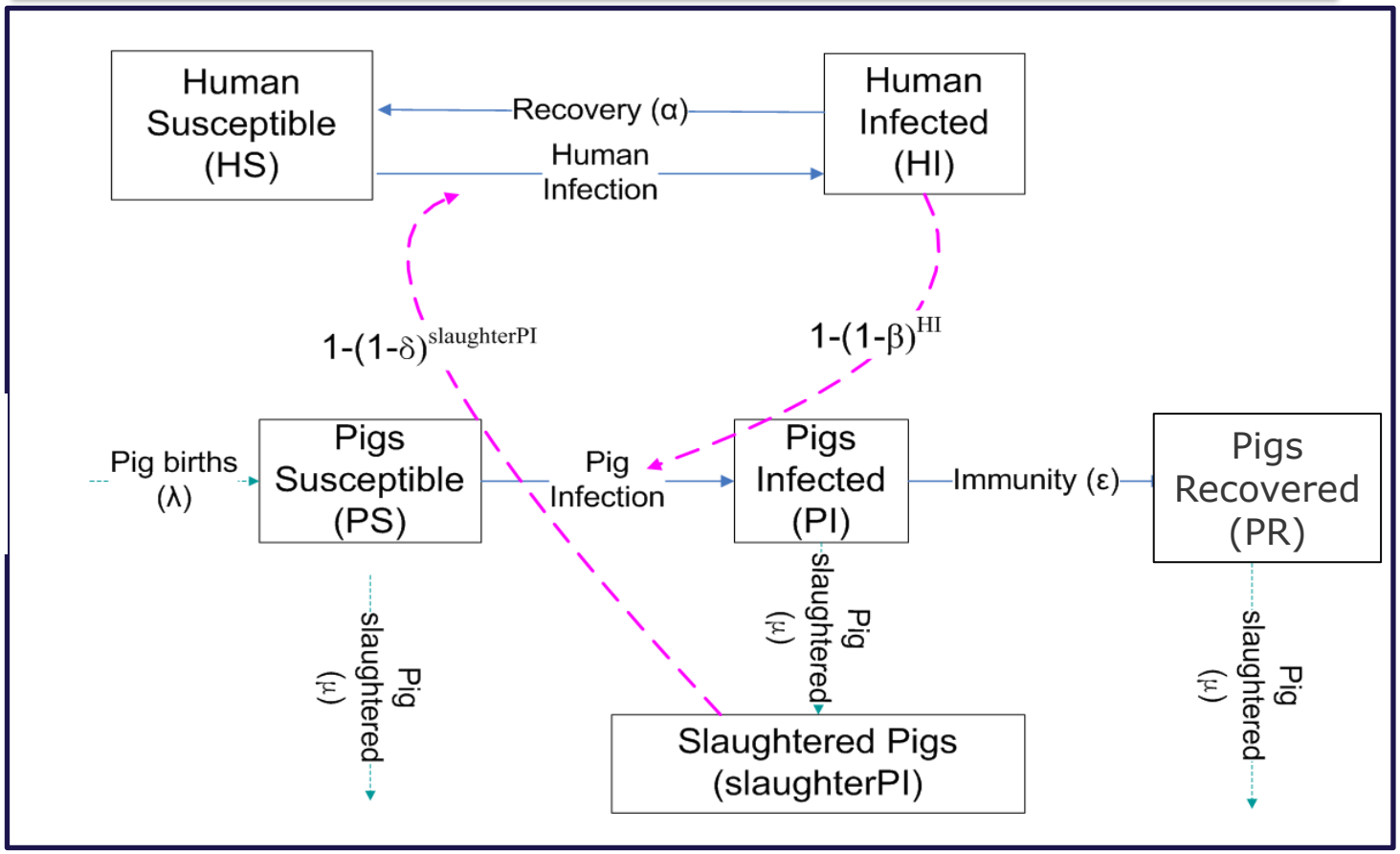
i. Treatment of CC/NCC cases



Africa has more than 500 million mobile devices — roughly one for every two people on the continent — and is partly credited with Africa's recent economic surge.

No tool will be effective on its own!

Theoretical approach to TSTC control

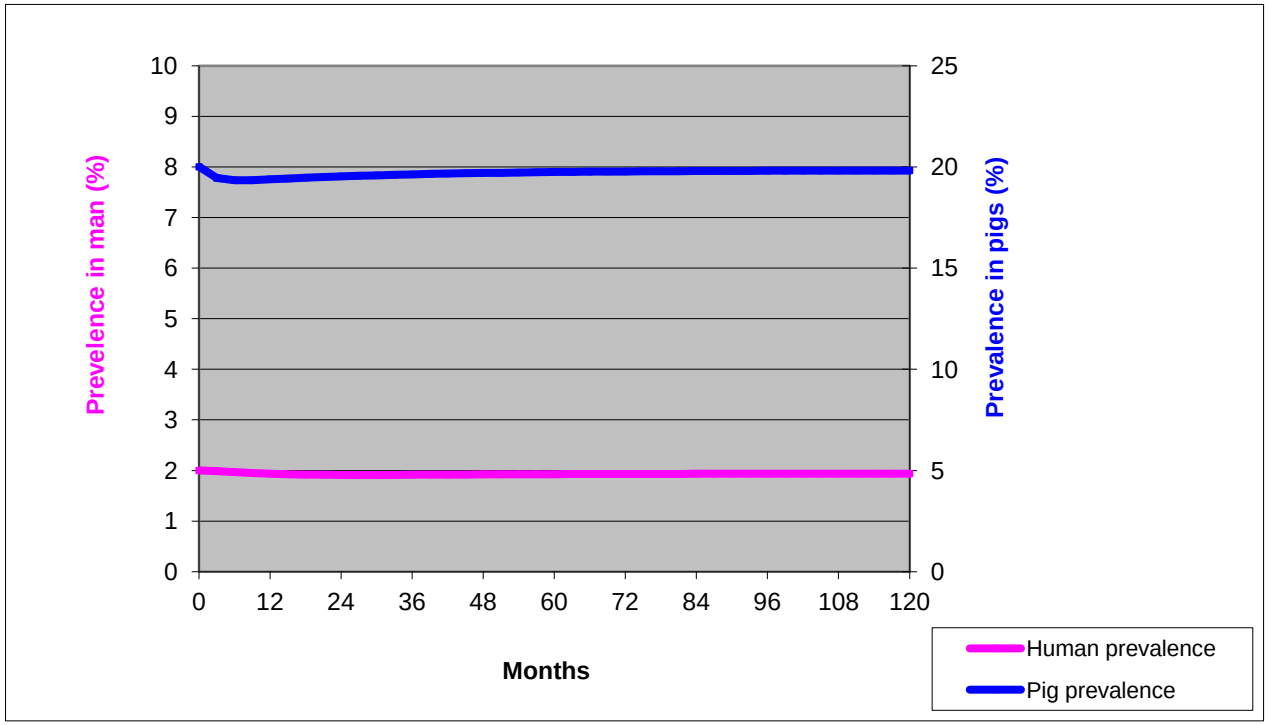


Simulating transmission and control of *Taenia solium* infections using a Reed-Frost stochastic model

Niels C. Kyvsgaard [a,c,*], Maria Vang Johansen [b,c], Hélène Carabin [d]

[a] *Department of Veterinary Pathobiology, Faculty of Life Sciences, University of Copenhagen, Stigbøjlen 4, DK-1870 Frederiksberg C, Denmark*

Kyvsgaard et al. 2007: A theoretical model with many assumptions



Theoretical village
1000 people – 2% (20 people with taeniosis)
200 pigs – 20% (40 pigs with cysticercosis)

ASSUMPTIONS

Transmission is by random contact

Pigs become infected by direct coprophagia

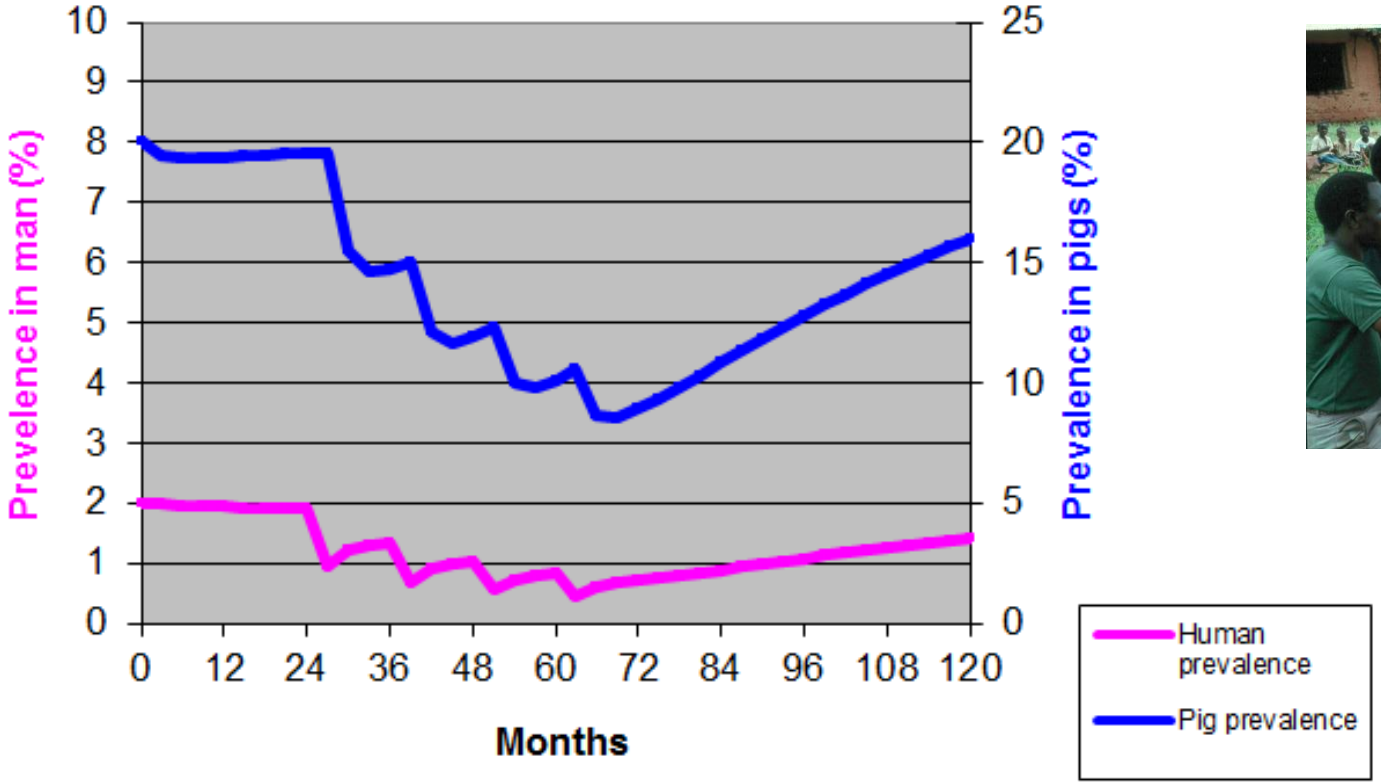
Pigs may recover and become immune

All infected pigs have equal risk of transmission to man after slaughter

The modelled community is closed

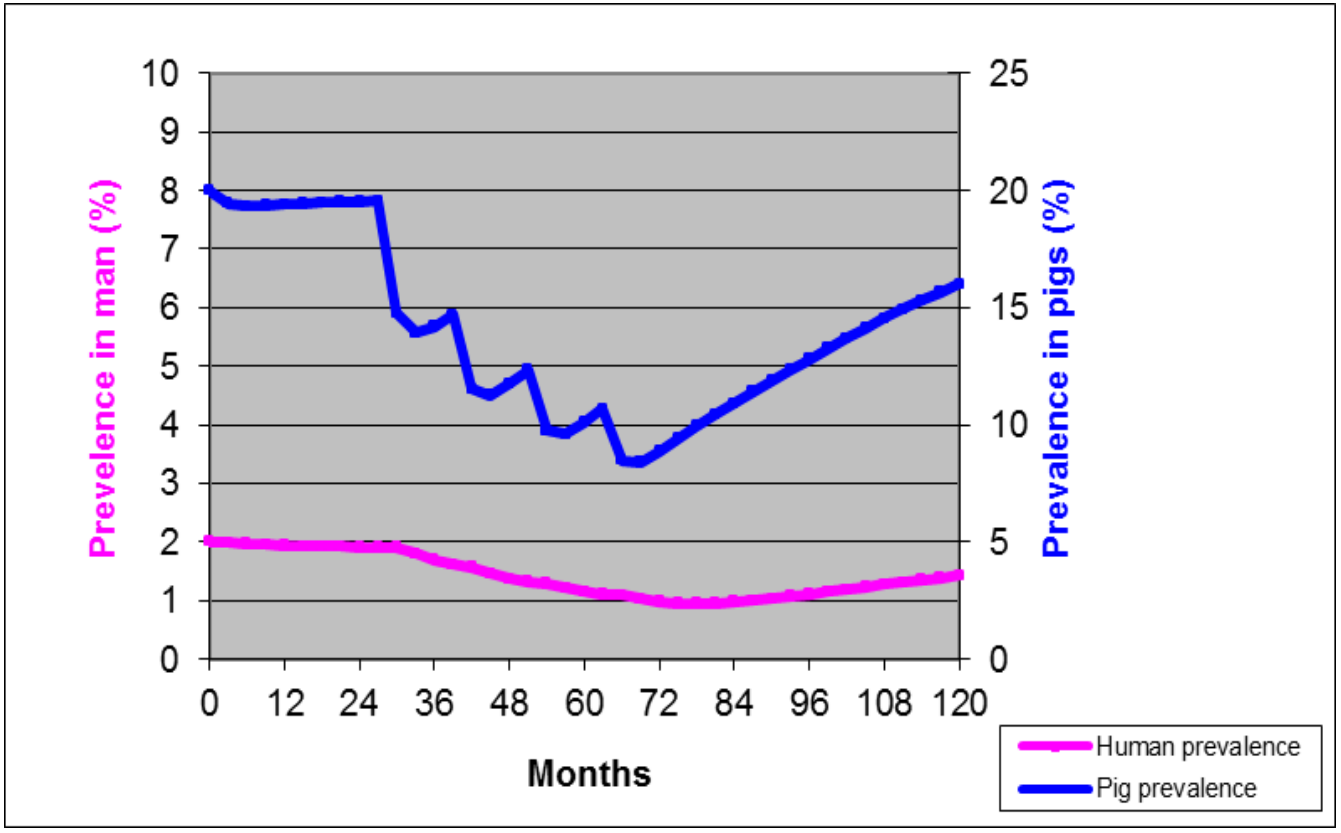
Short term control strategy: MDA (humans)

Mass treatment with praziquantel at month 24, 36, 48 and 60.
Efficacy 100 %, Coverage 75 % (Kyvsgaard et al, 2007)



Short term control strategy: Pig vaccination/oxfendazole

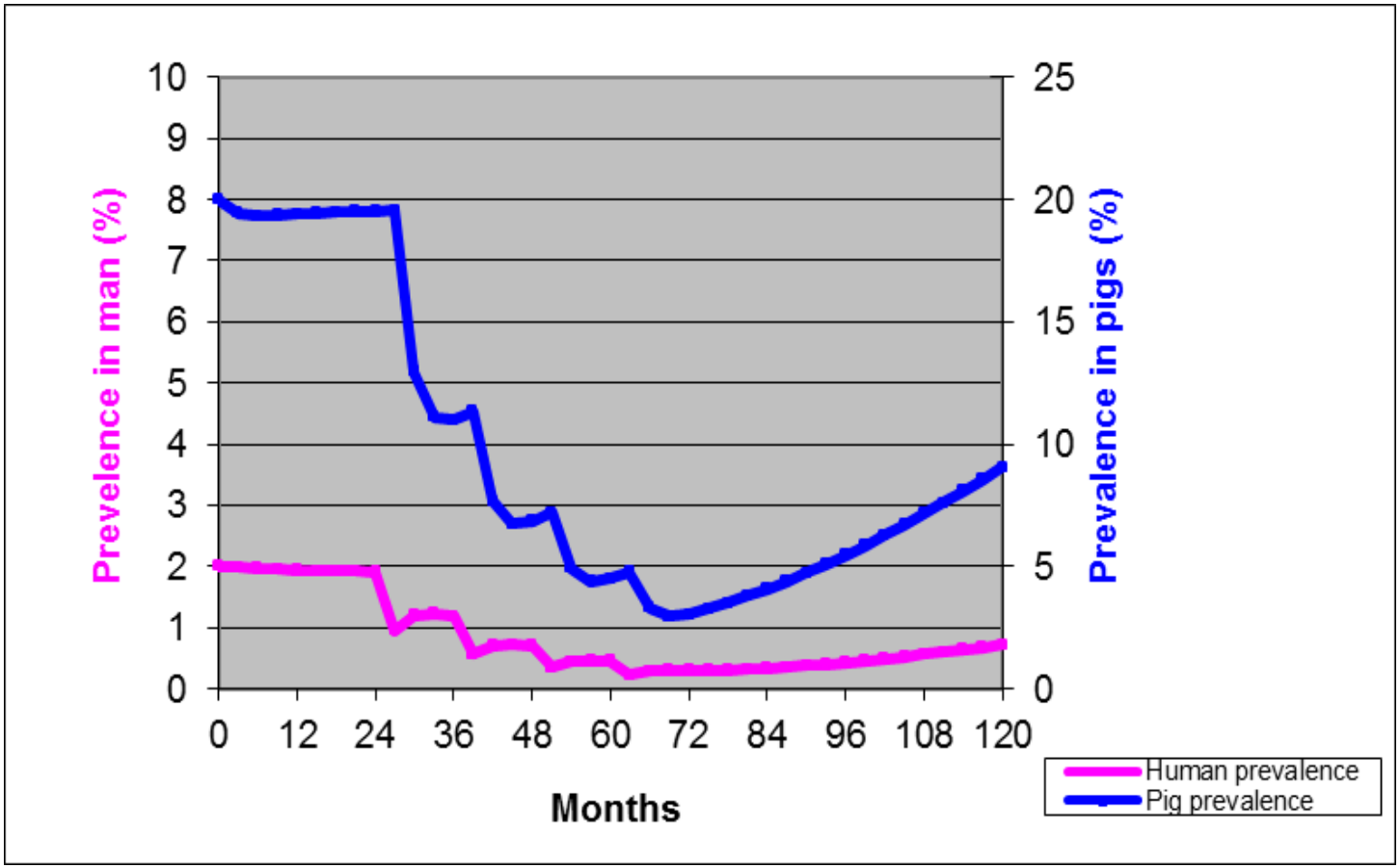
All pigs vaccinated from month 24, 36, 48 and 60
Protection 100 % Coverage 75% (Kyvsgaard et al., 2007)



Village prevalence:
20/1000 people
40/200 pigs

Short term control strategy: MDA (humans) + vaccination (pigs)

Mass treatment with praziquantel to humans and vaccination to pigs at month 24, 36, 48, 60. Efficacy 100 %, Coverage 75% (Kyvsgaard et al., 2007)



How do we define success?

Intervention tools for control of *T. solium* cysticercosis

i. Treatment of taeniosis cases

ii. Preventive chemotherapy (MDA)

iii. Health education

iv. Improved pig husbandry

v. Improved meat inspection and processing

vi. Improved sanitation

vii. Anthelmintic treatment of pigs

viii. Vaccination of pigs

ix. Treatment of CC/NCC patients

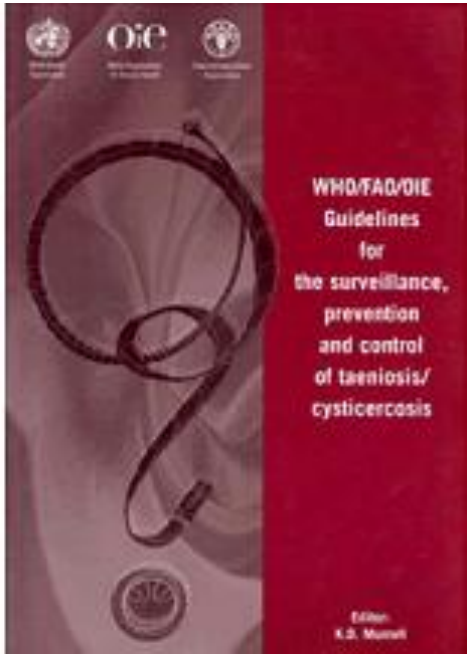
Specific health education in Northern Tanzania 2002 - 2005:
Reduce incidence of porcine cysticercosis in the intervention villages by **43%** compared to the controls one year after intervention (Ngowi et al., 2008).

Strategies for health education regarding *T. solium* taeniosis/cysticercosis

"Health education is the key factor in ensuring commitment to any control program"

Current WHO/FAO/OIE guidelines:

"In developing countries health education should be closely integrated with development of primary health care and not directed exclusively towards taeniosis and cysticercosis…"



Health education : Let's move it to a specific intervention tool!

THE VICIOUS WORM

A *Taenia solium* cysticercosis/taeniosis advocacy information tool

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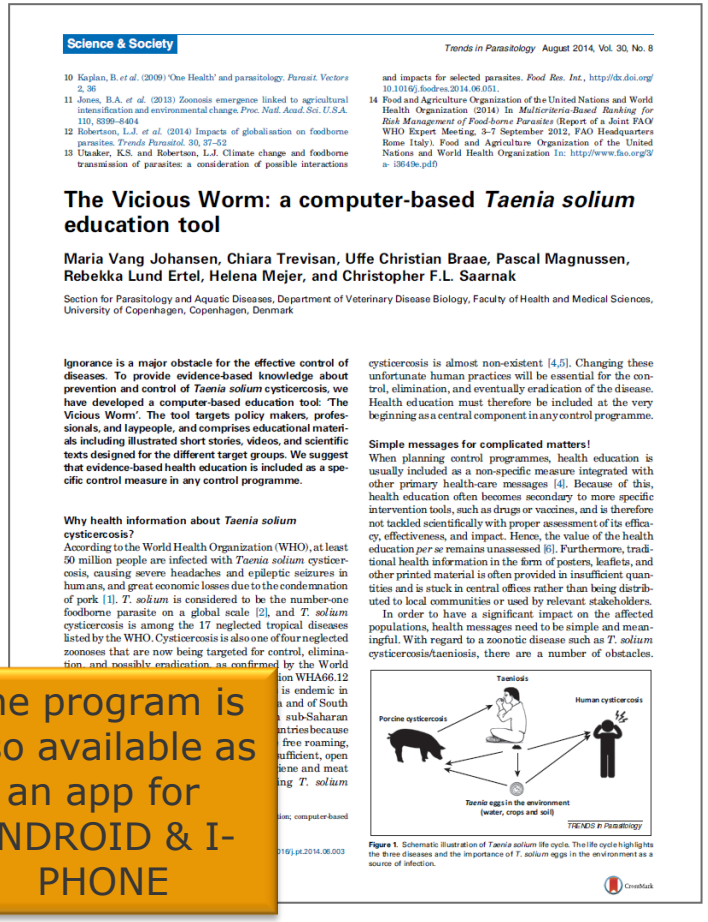
CREDITS | START | VIDEO

The Vicious Worm: www.theviciousworm.org

An electronic flexible distance learning course based on current knowledge for different target audiences



Science & Society

Trends in Parasitology August 2014, Vol. 30, No. 8

10 Kaplan, B. *et al.* (2009) 'One Health' and parasitology. *Parasit. Vectors* 2, 36

11 Jones, B.A. *et al.* (2013) Zoonosis emergence linked to agricultural intensification and environmental change. *Proc. Natl. Acad. Sci. U.S.A.* 110, 8399–8404

12 Robertson, L.J. *et al.* (2014) Impacts of globalisation on foodborne parasites. *Trends Parasitol.* 30, 37–52

13 Ubaaker, K.S. and Robertson, L.J. Climate change and foodborne transmission of parasites: a consideration of possible interactions and impacts for selected parasites. *Food Res. Int.*, http://dx.doi.org/10.1016/j.foodres.2014.06.051.

14 Food and Agriculture Organization of the United Nations and World Health Organization (2014) In *Multicriteria-Based Ranking for Risk Management of Food-borne Parasites* (Report of a Joint FAO/WHO Expert Meeting, 3–7 September 2012, FAO Headquarters Rome Italy). Food and Agriculture Organization of the United Nations and World Health Organization In: http://www.fao.org/3/a- i3649e.pdf)

The Vicious Worm: a computer-based *Taenia solium* education tool

Maria Vang Johansen, Chiara Trevisan, Uffe Christian Braae, Pascal Magnussen, Rebekka Lund Ertel, Helena Mejer, and Christopher F.L. Saarnak

Section for Parasitology and Aquatic Diseases, Department of Veterinary Disease Biology, Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark

Ignorance is a major obstacle for the effective control of diseases. To provide evidence-based knowledge about prevention and control of *Taenia solium* cysticercosis, we have developed a computer-based education tool: 'The Vicious Worm'. The tool targets policy makers, professionals, and laypeople, and comprises educational materials including illustrated short stories, videos, and scientific texts designed for the different target groups. We suggest that evidence-based health education is included as a specific control measure in any control programme.

Why health information about *Taenia solium* cysticercosis?

According to the World Health Organization (WHO), at least 50 million people are infected with *Taenia solium* cysticercosis, causing severe headaches and epileptic seizures in humans, and great economic losses due to the condemnation of pork [1]. *T. solium* is considered to be the number-one foodborne parasite on a global scale [2], and *T. solium* cysticercosis is among the 17 neglected tropical diseases listed by the WHO. Cysticercosis is also one of four neglected zoonoses that are now being targeted for control, elimination, and possibly eradication, as confirmed by the World ...ion WHA66.12 ...is endemic in ...a and of South ...a sub-Saharan ...ntries because ...free roaming, ...ufficient, open ...ene and meat ...ng *T. solium* ...ion; computer-based ...016/j.pt.2014.06.003

cysticercosis is almost non-existent [4,5]. Changing these unfortunate human practices will be essential for the control, elimination, and eventually eradication of the disease. Health education must therefore be included at the very beginning as a central component in any control programme.

Simple messages for complicated matters!

When planning control programmes, health education is usually included as a non-specific measure integrated with other primary health-care messages [4]. Because of this, health education often becomes secondary to more specific intervention tools, such as drugs or vaccines, and is therefore not tackled scientifically with proper assessment of its efficacy, effectiveness, and impact. Hence, the value of the health education *per se* remains unassessed [6]. Furthermore, traditional health information in the form of posters, leaflets, and other printed material is often provided in insufficient quantities and is stuck in central offices rather than being distributed to local communities or used by relevant stakeholders.

In order to have a significant impact on the affected populations, health messages need to be simple and meaningful. With regard to a zoonotic disease such as *T. solium* cysticercosis/taeniosis, there are a number of obstacles.

Figure 1. Schematic illustration of *Taenia solium* life cycle. The life cycle highlights the three diseases and the importance of *T. solium* eggs in the environment as a source of infection.

The program is also available as an app for ANDROID & I-PHONE

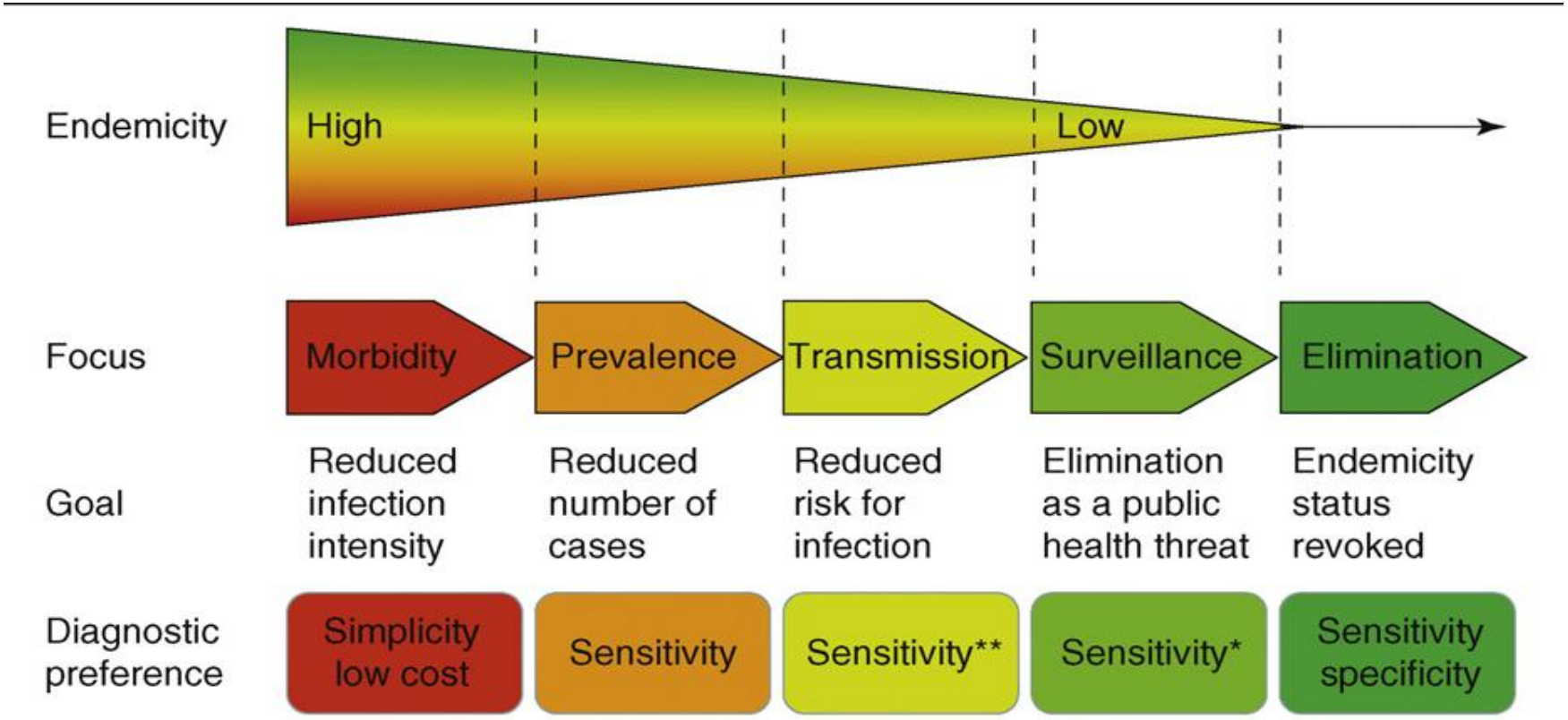
Provides information at three different levels regarding *T. solium* cysticercosis/ taeniosis:

1. Transmission
2. Diagnosis
3. Treatment
4. Prevention

Improved meat inspection and processing

Surveillance tools & strategy in place

No single tool fits it all!



Bergquist et al. 2009, Trends in Parasitology

Diagnosis of *T. solium* in pigs and man

Disease	Diagnostic tools	
	Ante-mortem	**Post-morten**
Porcine cysticercosis = metacestodes in e.g. muscles	Visible lingual cysts Serum Ab – ELISA / EITB Blood circulating Ag – ELISA	Muscular cysts (meat inspection)
Human taeniosis = intestinal adult taenids	Eggs/proglottids Serum Ab - ELISA Copro-DNA – PCR Copro-Ag – ELISA	Examination of intestine for adult tapeworm
Human cysticercosis = metacestodes in CNS and other places	Imaging (CT-scan etc.) Palpable cysts (biopsy) Serum Ab – ELISA / EITB CSF/blood circul. Ag – ELISA	Cysts

Diagnostic tools for porcine cysticercosis

Sensitivity & specificity of field tests

Method	Sensitivity	Specificity	Reference
Tongue palpation	10-50%	90-100%	Dorny et al, 2002
Pork inspection	20-25%	50-90%	Dorny et al. 2004
Ag-ELISA (B158/B60)	76-97%	71-84%	Deckers et al. 2010* & Pophyre et al. 2016

*: if no *T. hydatigena*

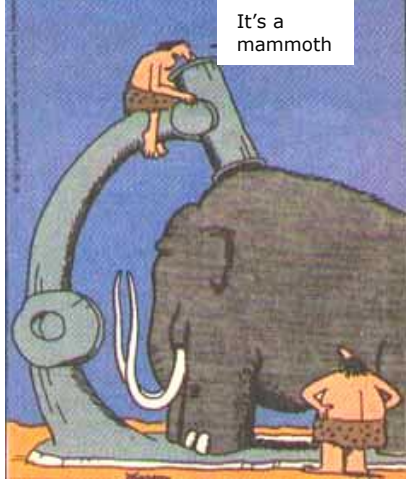
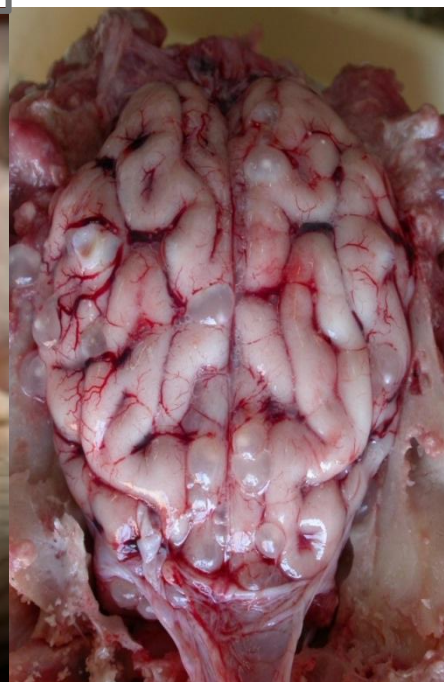
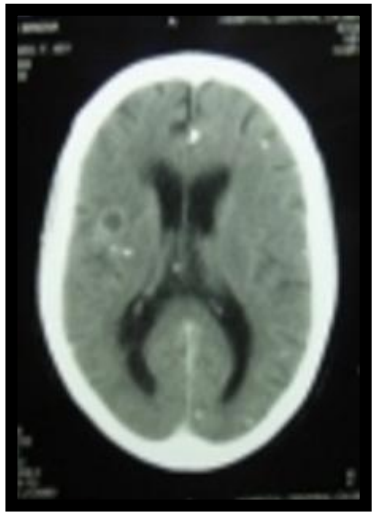



Photo: Mkupasi & Sikasunge

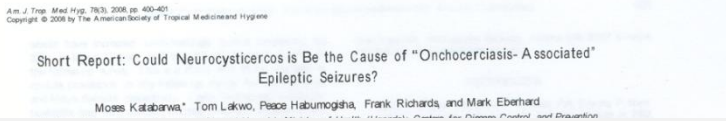


Diagnostic tools for human taeniosis/cysticercosis



Sensitivity & specificity of field tests

Method	Sensitivity	Specificity	Reference
EITB	> 97%	> 90%	Levine et al. 2007
Copro-Ag	> 96%	100%	Guezala et al. 2009



Short Report: Could Neurocysticercos is Be the Cause of "Onchocerciasis- Associated" Epileptic Seizures?

Could Neurocysticercosis be the cause of " Onchocerciasis-Associated Epileptic Seizures?
Am. J. Trop. Med. Hyg. 78, 400-401
(Katabarwa et al 2008)

Case report from Uganda

Moyo District
7 out of 21 persons with diagnosed "onchocerciasis" nodules were cysticercosis.

Kanungu District
4 out of 6 persons with diagnosed "onchocercoma" were cysticercosis.

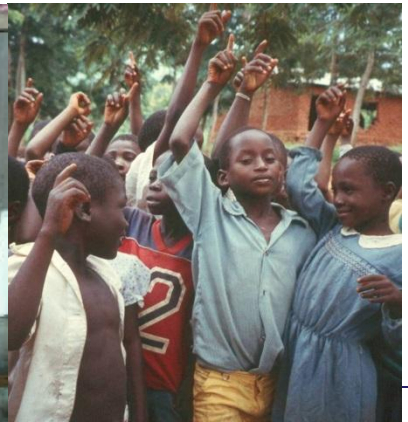
Diagnostic tools and algorithms

1. Screening tools + Validation tools (surveillance and control)
2. Indirect tools for hot-spot identification
3. Key informants (traders, meat inspectors)
4. Laboratories & Reference laboratories
5. Test validation (ring tests)

Point-of-care diagnostic tools for both humans and pigs

Simple, low cost, sensitive... → specific



Programme planning

Institutional capacity to implement TSTC control available including:

- ✓ human
- ✓ financial
- ✓ social
- ✓ tangible

} capitals

One World Health

Operational guidelines endorsed and communicated:

- ✓ who
- ✓ when
- ✓ where
- ✓ which tools
- ✓ how
- ✓ how many

Surveillance strategy in place

Passive -

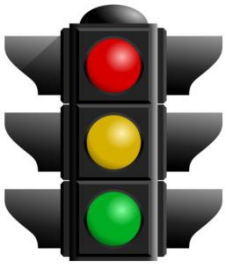
National notification of:

- ✓ Taeniosis
- ✓ Cysticercosis/NCC
- ✓ Porcine cysticercosis

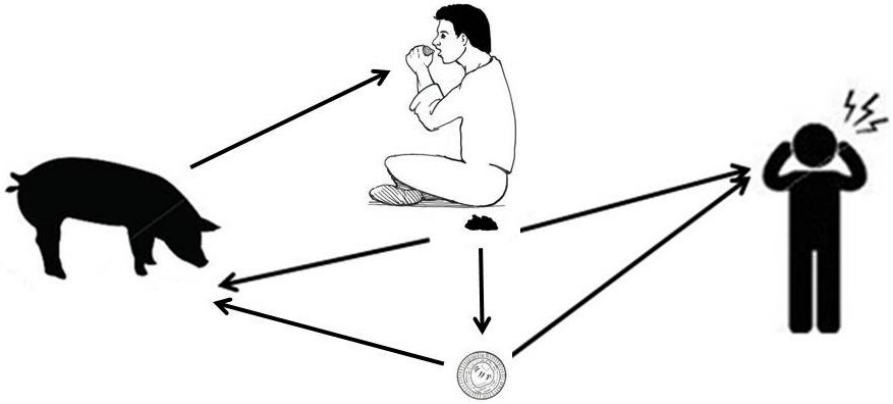
Collected at the One-Health Unit

Active –

- ✓ Track and treat positive cases (**T**/PC/NCC)
- ✓ Identification of hot-spots – and treat
- ✓ Intensified meat inspection
- ✓ Enforcement of meat regulations
- ✓ Pig trade regulations
- ✓ *T. solium* free zones
- ✓ Introduction of sentinel pigs



Key solutions to control of *Taenia solium* – Make it a One Health approach



1. Educate all stakeholders
2. Stop open defecation
3. Treat human taeniosis cases
4. Treat/vaccinate pigs
5. Confine all pigs at all times
6. Ensure proper meat inspection
7. Condemn/treat infected pork
8. Cook pork properly
9. Wash hands before preparing and eating food
10. Provide clean drinking water to pigs and people

One World Health


Photos provided by:
Assane, Trevisan, Braae,
Johansen, Laforet, Mejer,
Lauritsen
Thank you