

Impact case study (REF3b)

<p>Institution: University of Greenwich</p>
<p>Unit of Assessment: (UoA 6) – Agriculture, Veterinary and Food Science</p>
<p>Title of case study: Ecologically-based rat management for increased food security and improved livelihoods in Africa and Asia</p>
<p>1. Summary of the impact</p> <p>Rats are responsible for massive damage through crop destruction, stored food consumption and disease transmission. Steven Belmain’s research on ecology and management of rodents has increased understanding in a neglected field. He has helped mitigate a regional famine and save lives during a rodent population outbreak in South Asia, and changed national policy and practice in South Africa. He has demonstrated how an African city can reduce zoonoses, and how damage to crops can be dramatically reduced. He has shown how communities can transform health and livelihoods if they work together and that rat-damage can be managed sustainably without using poisons.</p> <p>2. Underpinning research</p> <p>Global research on rats as pests continues to be neglected. While rodents are a problem in many environments, their impact is more severe in developing economies because their proximity to people is higher. Poor agricultural practices and sanitation encourage rodents, impacting on people and farming systems through pre- and post-harvest crop losses, contamination of food and water and zoonosis transmission. Farmers and householders, when conscious of the problem, have tended to rely on poisons which contaminate the environment, are ineffective unless the whole community acts together to eradicate a rodent population, and can be lethal if sold and used without knowledge and care.</p> <p>Dr Steven Belmain, Principal Scientist in Ecology, 1998 to present, has researched the ecology and management of rodents and developed technologies which reduce the multiple impacts on people’s health and livelihoods and are relevant to the agro-ecological and sociological contexts found within African and Asian societies. Belmain, acting as Principal Investigator, has collaborated with scientific teams from Europe (Belgium, Netherlands, France, Germany, Denmark), Africa (Sierra Leone, Tanzania, South Africa, Namibia, Zimbabwe, Mozambique, Swaziland), Asia (China, Vietnam, Bangladesh, India) and Australia. He has led competitively-won projects involving multidisciplinary research encompassing rodent population dynamics, systematics and taxonomy, habitat utilisation, rodent behaviour, outbreak ecology, social anthropology, economics, damage assessment methodologies, and the development of non-chemical rodent population control and impact mitigation strategies. The research has been undertaken in Africa and Asia in relation to a range of agricultural and human health problems caused by rodents on cropping systems and post-harvest food storage, as well as in non-agricultural ecologies.</p> <p>Belmain’s main finding is that rodents can be sustainably managed without using poisons. This can be done by strengthening communities to deal with shared problems, the introduction of intensive trapping and trap barrier systems, and environmental management to reduce the proximity of rodents and people. Treatment-control studies of Belmain’s research show that crop damage can be reduced by more than 75% in ways that are environmentally sustainable and cost-beneficial to subsistence farming communities [3.6].</p> <p>In Bangladesh, Belmain’s research included the causes and effects of rodent population outbreaks, an infrequent 50-year phenomenon driven by semelparous bamboo flowering. The most recent cycle started in 2004 in India, reaching Bangladesh in 2007. Historical outbreaks 50 and 100 years ago led to regional famine and civil war across India, Bangladesh and Myanmar [3.2]. Despite this devastation, the science of the outbreaks remained poorly understood, conflated by legend and anecdote, with little consensus and much scepticism about the scale and impact of the events. Belmain’s research confirmed the baseline ecology of bamboo seed production (this fuels exponential rodent breeding within forests, producing up to seven generations in six months) and its linkage to rodent outbreaks, to explain the scale of the regional famine occurring. As the seed is depleted and germinates, rodents migrate out of forests and swarm into crop fields, causing nearly 100% crop failure. Belmain was able to combine this knowledge with research on how to reduce</p>

the damage to agriculture and health.

3. References to the research (REF1 submitted staff in **bold**, **REF2 Output)

- **3.1 Bastos, A. D. S., Nair, D., Taylor, P. J., Brettschneider, H., Kirsten, F., Mostert, E., Maltitz, von E., Lamb, J. M., Hooft, van P., **Belmain, S. R.**, Contrafatto, G., Downs, S., & Chimimba, C.T. (2011). Genetic monitoring detects an overlooked cryptic species and reveals the diversity and distribution of three invasive *Rattus* congeners in South Africa. *BMC Genetics*. 12, 26. <http://dx.doi.org/10.1186/1471-2156-12-26>. One of the journal's "most highly accessed" publications and has been cited 15+ times and accessed +4600 times. IF 2.48
- 3.2 Singleton, G. R., **Belmain, S. R.**, & Brown, P. R. (Eds.) (2010). *Rodent Outbreaks: Ecology and Impacts*. International Rice Research Institute Press, Los Banos, Philippines. 289 pages. <http://books.google.co.uk/books?id=yal0NFQb36UC&lpq=PP1&ots=VOGhvQiwFe&dq=rodent%20outbreaks&pg=PP1#v=onepage&q&f=false> Article cited +13 times, +2000 full text downloads
- 3.3 Singleton, G. R., **Belmain, S. R.**, Brown, P. R., Aplin, K. and Htwe, N. M. (2010). Impacts of rodent outbreaks on food security in Asia. *Wildlife Research*. 37, 355-359. <http://dx.doi.org/10.1071/WR10084> Article cited +16 times. IF 1.32
- 3.4 Stenseth, N. C., Aikimbayev, A., Atshabar, B. B., Begon, M., **Belmain, S. R.**, Bertherat, B., Carniel, E., Gage, K. L., Leirs, H., & Rahalison, L. (2008). Plague: Past, Present and Future. *PLoS Medicine*. 5(1), e3. 9-13. <http://dx.doi.org/10.1371/journal.pmed.0050003> Article cited +109 times with + 30,000 views/downloads and 57 academic bookmarks. IF 16.27
- **3.5 Taylor, P. J., Arntzen, L., Hayter, M. Iles, M., Frean, J., & **Belmain, S. R.** (2008). Understanding and managing sanitary risks due to rodent zoonoses in an African city: beyond the Boston Model. *Integrative Zoology*. 3, 38-50. <http://dx.doi.org/10.1111/j.1749-4877.2008.00072.x> +18 citations
- 3.6 Taylor, P. J., Downs, S., Monadjem, A., Eiseb, S. J., Mulungu, L. S., Massawe, A. W., Mahlaba, T. A., Kirsten, F., Maltitz von, E., Malebane, P., Makundi, R. H., Lamb, J., & **Belmain, S. R.** (2012). Experimental treatment-control studies of ecologically based rodent management in Africa: balancing conservation and pest management. *Wildlife Research*. 39(1), 51-61. <http://dx.doi.org/10.1071/WR11111> +2 citations

Key grants about rodents

- 3a S. R. Belmain. *StopRats: Sustainable technology to overcome pest rodents in Africa through science (Sierra Leone, Tanzania, Swaziland, Namibia, South Africa, Madagascar)*. EU ACP Science and Technology. 2013-2016. €1,168,000.
- 3b S. R. Belmain. *Rat Management for Rural Communities in Bangladesh*. DFID Asian Innovation Challenge Fund of Research Into Use Programme Project CRD ITT 001. 2008-2011. £594,000. www.nri.org/bandicoot
- 3c S. R. Belmain. *Ecology of rat floods and bamboo masting*. Krishi Gobeshona Foundation of the World Bank . 2008-2011. \$25,000.
- 3d S. R. Belmain. *Scientific Assessment of Bamboo Flowering, Rodent Outbreaks and Food Security in the Chittagong Hill Tracts*. United Nations Development Programme CHTDF-SSA-D04-2008. 2007-2008. \$75,000.
- 3e S. R. Belmain. *The EcoRat Project, (Namibia, Swaziland, Tanzania, South Africa)*. EuropeAID 9th EDF research project 9 ACP SAD 1-12. 2007-2010. €650,000. www.nri.org/ecorat
- 3f S. R. Belmain (PI/Technical Coordinator). *Prevention of sanitary risks linked to rodents at the rural/peri-urban interface: ratzooman, ICA4-2001-10125, (Belgium, Denmark, Netherlands, Mozambique, South Africa, Tanzania, Zimbabwe)*. EC FP5 INCO-DEV funded research project ICA4-CT-2002-10056. 2003-2006. €1.45 million. www.nri.org/ratzooman
- 3g S.R. Belmain. *Ecologically-based rodent management for diversified rice-based cropping systems in Bangladesh*. DFID funded research project R8184. 2002-2005. £294,000.

Impact case study (REF3b)

3h S. R. Belmain. *Technology transfer and promotion of ecologically-based and sustainable rodent control strategies in southern Africa, (South Africa, Mozambique)*. DFID funded research project ZA0506. 2002-2005. £75,000.

4. Details of the impact

Rats are responsible for massive damage across the globe. Sometimes it's dramatic, like the rodent swarms in South Asia leading to widespread famine and civil war. Often it is more hidden and chronic, like nibbling away 20% of a family's grain store or spreading disease – part of daily life in developing countries. In each case, mystery has shrouded both causes and effects of rodent damage, leading either to wildly inappropriate treatment or no treatment. Against a background of neglect in global research on rats as pests, Steven Belmain's work is arguably more notable. He has helped mitigate a regional famine and save lives in the most recent bamboo-related population outbreak in Bangladesh, and changed national policy and prompted regular plague surveillance in South Africa. He has demonstrated how an African city can reduce rat-transmitted disease, and how rodent damage to crops can be reduced by over 75%. He has shown how communities can transform health and livelihoods if they work together and that rat-damage can be dealt with sustainably without using poisons. Finally he has raised awareness through extensive media work.

When the food security disaster struck Bangladesh, the UNDP, WFP, Save the Children and Helen Keller International (2008-2009) consulted Belmain extensively to inform their international relief efforts to avert a regional catastrophe [3b]. In 2008 Belmain was commissioned through the UN to lead a team of scientific experts to apply his methods, first to confirm the scale of the problem and second to provide evidence-based policy intervention recommendations [3c]. Dr Belmain informed Government of Bangladesh ministers with facts on the phenomenon at several high-profile meetings to enable them to respond appropriately. The adoption of his recommendations on how to reduce damage to agriculture and health helped mitigate a regional famine and undoubtedly assisted in saving many people's lives and livelihoods [3d, 3.2, 3.3]. When the bamboo masting ended in 2010 there were no confirmed fatalities directly attributed to food insecurity, a considerable improvement on the 10,000+ documented deaths that occurred in the region 50 years ago [5.7]. Many food security assessments carried out by NGOs and UN agencies showed that the famine caused severe food shortages, underweight children and mothers, miscarriage and many other health and socio-economic problems including no money for school fees and selling children. However, use of Belmain's research helped mitigate the growing crisis by ensuring regional relief efforts and funding for emergency food continued in a targeted fashion at the appropriate scale and timing [5.6].

Dr Belmain's research in South Africa, which started in 2002 [3h, 3f, 3e, 3a], has led to changes in national and regional policies [5.8]. For example, his discovery and highlighting of the absence of dedicated qualifications in rodent pest management led the National Pesticide Regulation Authority of South Africa to change its regulations: anyone wishing to commercially engage in rodent management must now pass specific examinations. Presently (2008-2013), all new qualifying pest control operators who want to deal with rodents have a component on control of rodents. In the city of Durban, Dr Belmain's research in the Ratzooman project [3f] raised awareness of rodent diseases found in squatter camps and informal settlements; it led to a clean-up campaign and institutionalised rodent trapping programme by city authorities that continues to be operated under the 'Ratzooman' banner [3.5, 5.9]. Furthermore, Dr Belmain's research prompted the South African Department of Health to establish a plague surveillance expert panel. It has operated every year since 2006 and now routinely surveys "at risk" areas for plague outbreaks [3.4, 5.8]. Belmain's research directly led to the development of a new design rat trap by a commercial company in South Africa which has been part of its sales portfolio every year since 2008, as part of its pest control services. The trap is sold through existing marketing chains nationally and for export throughout the member countries of the Southern African Development Community [5.10].

Belmain's research has had considerable impact on society by raising public awareness about rodents and the impact they have on people's livelihoods in developing countries. Discovery Channel commissioned a nature documentary featuring Dr Belmain in 2009, following his research on rat swarms [5.3]. Other examples of media work include international radio and internet programmes [5.2, 5.4, 5.5] as well as magazine articles in journals such as *Science* [5.1]. Belmain's research on the Bangladesh rat population outbreak has been incorporated into a book

Impact case study (REF3b)

[3.2], which will help inform future generations when the event happens again and ensure better preparedness to avert famine.

5. Sources to corroborate the impact

- 5.1 Normile D. (2010) Holding back a torrent of rats. *Science*. 327: 806-807.
<http://www.sciencemag.org/cgi/content/summary/327/5967/806>
- 5.2 CBCRadio (2010) Falling Flowers Rising Rats. Quirks and Quarks.
<http://www.cbc.ca/quirks/episode/2010/12/11/december-11-2010/>
- 5.3 Discovery Channel (2011) Swarmchasers: Rats!. 45 minute documentary film broadcast on Animal Planet. The programme was originally released in North America and subsequently translated into 25 languages for broadcast to over 50 countries across Europe, Asia and Africa. <http://www.nri.org/projects/bandicoot/docs/swarmchasers%20rats.wmv>
- 5.4 BBC World Service (2010) Rat Attack Science in Action.
<http://www.bbc.co.uk/programmes/p00bwg89>
- 5.5 BBC Earth News (2010) Attack of the Rats.
http://news.bbc.co.uk/earth/hi/earth_news/newsid_9198000/9198744.stm
- 5.6 Executive Director, Association for Integrated Development.
- 5.7 Programme Director, Chittagong Hill Tracts Development Facility.
- 5.8 Director, Plant Protection Research Institute, Agricultural Research Council.
- 5.9 Director, Manager (Vector Control), Communicable Diseases, eThekweni Municipality.
- 5.10 Managing Director, Scientific Supakill, 8 Derrick Road, Spartan, Kempton Park, South Africa.
Email: lee@supa-kill.com Tel: +27 11 394 3941/2