

## Impact case study (REF3)

<b>Institution:</b> Lancaster University		
<b>Unit of Assessment:</b> 7, Earth Systems and Environmental Sciences		
<b>Title of case study:</b> Leading the United Nations in a safe and effective biopesticide policy and practice to combat fall armyworm, an invasive global crop pest.		
<b>Period when the underpinning research was undertaken:</b> 2004 to 2020		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Kenneth Wilson	Professor	01/02/2004–present
<b>Period when the claimed impact occurred:</b> August 2013-December 2020.		
<b>Is this case study continued from a case study submitted in 2014?</b> N		
<p><b>1. Summary of the impact</b></p> <p>Wilson has been researching the ecology and management of armyworms in Africa for more than 20 years, including the development of an environmentally-safe biopesticide against armyworms to be used as part of an Integrated Pest Management strategy. In 2016, a new threat to global food security emerged in the form of the Fall Armyworm (FAW, <i>Spodoptera frugiperda</i>), an invasive crop pest that has spread from the Americas to many areas of the world including Africa, Asia and Australasia, and will soon reach Europe. As much as 18 million tonnes of maize are lost annually in Africa now to FAW, enough to feed tens of millions of people and representing an economic loss of up to USD4.6 billion. Some chemical pesticides can be effective at reducing losses due to FAW and other crop pests, but can be extremely damaging to human health, beneficial insects, wildlife and the environment. Biopesticides (naturally occurring substances that control pests) are much safer alternatives to synthetic chemicals. The impacts of Wilson's work on armyworms and biopesticides fall into 3 main categories:</p> <p>(1) <b>POLICY:</b> working with the <i>United Nations Food and Agriculture Organisation</i> (UN-FAO) to develop a global Integrated Pest Management strategy for FAW, which is now being implemented in at least 45 countries;</p> <p>(2) <b>FORECASTS:</b> of FAW outbreaks published via the dedicated <i>Armyworm Network</i> website that provides information to farmers and other stakeholders, which has had more than 100,000 page views over the last 10 years; and</p> <p>(3) <b>COMMERCE:</b> the development of a commercial armyworm biopesticide production facility in Tanzania, realising benefits to hundreds of farmers.</p>		
<p><b>2. Underpinning research</b></p> <p><b>Insights into the ecology and management of armyworm</b></p> <p>Wilson's fundamental research focuses on the ecological and physiological interactions between insects and their diseases. His main research focus has been on the ecology and migration of native African armyworms (AAW, the caterpillar stage of a moth species) in sub-Saharan Africa (SSA), and how the natural diseases of armyworms can be harnessed as biopesticides within an Integrated Pest Management (IPM) setting with smallholder farmers [3.1-3.5]. Fall armyworm (FAW), from the Americas, was first reported as an invasive pest in West Africa in early 2016 and over the two following years it spread to nearly all countries in SSA, causing an estimated USD2,481 to USD6,187 million damage to maize production in the region. Wilson's intimate knowledge of armyworm ecology in Africa, and smallholder farming practices in relation to these insect crop pests [3.1-3.5], meant that he was uniquely placed to respond to the crisis that ensued following the invasion of FAW across SSA.</p> <p>Wilson and his collaborators have applied his research to develop a new biopesticide against armyworms [3.1-3.5]. This biopesticide is derived from a natural virus of the insects, and with funding from the <i>Department for International Development</i> and the <i>Global Challenges Research Fund</i>, he and his collaborators have constructed a purpose-built facility in Tanzania for mass-producing the biopesticide and to better understand the constraints on global biopesticides use,</p>		

especially by resource-poor smallholder farmers. This work recently resulted in the publication of a paper describing the biopesticide options currently available in Africa and highlighting constraints of their use, as well as the chemical pesticide resistance levels observed in this newly invasive crop pest [3.6-3.7].

### 3. References to the research

[3.1]. Grzywacz D, Mushobozi WL, Parnell M, Jolliffe F & **Wilson K** (2008) [Evaluation of \*Spodoptera exempta\* nucleopolyhedrovirus \(SpexNPV\) for the field control of African armyworm \(\*Spodoptera exempta\*\) in Tanzania](#). *Crop Protection* 27 (1): 17–24.

[3.2]. Vilaplana L, **Wilson K**, Redman EM & Cory JS (2010) [Pathogen persistence in migratory insects: high levels of vertically-transmitted virus infection in field populations of the African armyworm](#). *Evolutionary Ecology* 24 (1): 147-160. 71 citations

[3.3]. Graham RI, Grzywacz D, Mushobozi WL, **Wilson K** (2012) [Wolbachia in a major African crop pest increases susceptibility to viral disease rather than protects](#). *Ecology Letters* 15 (9): 993–1000. 114 citations (Google Scholar)

[3.4]. **Wilson K**, Benton T, Grzywacz D (2013) [Pest control: biopesticides' potential](#). *Science* 342 (6160): 799.

[3.5]. Grzywacz D, Stevenson P, Mushobozi WL, Belmain S, **Wilson K** (2014) [The use of indigenous ecological resources for pest control in Africa](#). *Food Security* 6 (1): 71–86. 93 citations (Google Scholar).

[3.6]. Zhang L, Liu B, Zheng Z, Liu C, Zhang D, Zhao S, Li Z, Xu P, **Wilson K**, et al. (2020) [Genetic structure and insecticide resistance characteristics of fall armyworm populations invading China](#); *Molecular Ecology Resources* 20 (6): 1682-1696.

[3.7]. Bateman, M., Day, R., Rwomushana, I., **Wilson, K.**, et al. (January 2021) [Updated assessment of potential biopesticide options for managing fall armyworm \(\*Spodoptera frugiperda\*\) in Africa](#). *Journal of Applied Entomology* [delayed output due to COVID-19, email from journal available on request]. Altmetrics score of 45 and in the top 5% of all research outputs scored by Altmetrics.

#### Additional Quality Indicators

BBSRC, UK Global Challenges Research Fund (GCRF), BB/P023444/1 (2017-2020), GBP637,000.

BBSRC-DFID Baculovirus Grant, Sustainable agricultural systems in sub-Saharan Africa (SASSA), BB/F004311/1, 2010-2013, GBP733,000

### 4. Details of the impact

#### Development of a global Integrated Pest Management strategy

As the world leader in armyworm research in Africa [3.1-3.5], Wilson was the only non-African scientist to be invited to a crisis summit in Harare, Zimbabwe, in February 2017 organized by the Food and Agriculture Organization of the United Nations (UN-FAO) [5.1]. Here, he presented his research to the attendees and provided expert opinion on the threat posed by Fall Armyworm (FAW) to the continent based on his extensive research into the ecology, migration and management of African armyworm and his previous experience of working on FAW in South America [3.1-3.5]. He also chaired three break-out groups and helped to draft the Final Meeting Report, including the recommendation that future management plans for FAW must have at its heart an Integrated Pest Management (IPM) strategy (a sustainable approach to managing pests that combines multiple practices, including the use of biopesticides, while minimising risks to human health and the environment) [5.1]. These recommendations built on Wilson's research

into the use of baculoviruses as biopesticides, exploring the commercial production of biopesticides [3.1], as well as the use of indigenous botanical and microbial resources [3.5]. Wilson was subsequently an invited keynote speaker and facilitator at further summits in Kenya, Ghana, Uganda and Thailand throughout 2017 to 2019, and was asked to contribute to the development of a long-term management plan for the new invasive pest in Africa and Asia; this has resulted in three further UN-FAO technical publications, targeting different stakeholders, but all of which have extensive recommendations for putting IPM into practice [5.2].

In response to the FAW invasion of SSA, the UN-FAO established eleven Technical Working Groups (TWGs) to develop a strategy for the management of FAW, and Wilson was asked to chair the *Biopesticides TWG* (2017 to 2019). As part of this, he presented his data on FAW susceptibility to pesticides and provided insights to regular UN-FAO international meetings and monthly teleconferences to develop the FAW management plan. This includes specific recommendations on which pesticides and biopesticides are suitable for FAW management, based on his research [3.6-3.7] [5.2]. Wilson has also been active in providing data and training on IPM via the UN's *Sustainable Development Solutions Network*, a free online platform providing expert advice to thousands of farmers, NGOs, governments, donors and other stakeholders globally [5.3].

Wilson's research and expertise has played a crucial role in developing UN-FAO's IPM strategy. This is corroborated by a statement from the Principal Technical Co-ordinator for Fall Armyworm at the UN-FAO in his testimonial of 2019, stating that Wilson's TWG "*has directly informed our Integrated Pest Management (IPM) strategy, which has now been implemented in 45 countries and benefited tens of thousands of farmers*" [5.4].

In early 2020, the TWGs were rationalised and Wilson was asked to co-chair the new *Biopesticides and Pesticides Technical Working Group* (2020 to 2022), tasked with delivering new educational materials, protocols, and long-term strategy documents for invasive pest management. This was motivated by FAW becoming an even greater global threat to food security as it spread from Africa into Asia, Indonesia and Australasia. As part of this, UN-FAO developed a new three-year plan called *Global Action for Fall Armyworm Control* to ensure a strong coordinated approach at country, regional and global levels, mobilising USD500 million "*to take radical, direct and coordinated measures to strengthen prevention and sustainable pest control capacities at a global level*" [5.5]. As co-Chair of one of the 7 new TWGs, Wilson was invited to deliver the first webinar to international stakeholders on the significant risks associated with chemical pesticides and the prospects for replacing these with biopesticides and other safer alternatives [5.6], based on his recent research [3.6,3.7]. This was watched live by more than 150 stakeholders at high government levels from more than 30 countries globally. His TWG was also the first of the new TWGs to be asked to deliver recommendations to the International Steering Committee of the *Global Action Plan for Fall Armyworm Control*, highlighting the influence that Wilson's work is having in shaping policy at an international level.

#### **Commercial production of a biopesticide**

Wilson has been working with an SME called Crop Bioscience Solutions (CBS) Ltd., the first bio-tech company to be established in Tanzania, to locally mass-produce a virus biopesticide in East Africa, based on his previous research [3.1, 3.5]. The CEO of CBS Ltd. states that the collaboration has included "*large-scale pre-registration field trials of the SpexNPV biopesticide in Africa, in collaboration with the Tanzanian Ministry of Agriculture*" [5.7].

As well as allowing CBS Ltd. to develop the capacity to mass produce the biopesticide, the collaboration has also allowed the company to diversify into tissue culture and the mass production of disease-free, vegetatively-propagated crops.

The CEO says: "*This expansion has led to Crop Bioscience Solutions Ltd. increasing its workforce and we now employ 15 staff. It has also impacted the lives of hundreds of farmers in Tanzania by providing them with clean planting materials.*" [5.7]

### Keeping stakeholders informed through a dedicated website detailing outbreaks and global press engagement

Wilson established, and has run, the [Armyworm Network](#) website for more than 10 years. It provides resources to stakeholders interested in the biology and control of armyworms in Africa, including farmers, NGOs, extension officers, government officials, the press and AID agencies. As well as providing information, press reports and publications, it also disseminates monthly forecasts for African and Fall Armyworm outbreaks throughout Africa. The website has generated approximately 100,000 page views and more than 40,000 unique visits over the last 10 years. The website has also had a significant amount of user interest in its bespoke graphics and movies based on his research [3.1, 3.5], such as the animation of the spread of Fall Armyworm in Africa on *YouTube* (more than 600 views across five drafts in 12 months).

Wilson has engaged with a wider pool of stakeholders by giving interviews to the media, including to TV channels such as *Al Jazeera* [5.1] and the *BBC*; newspapers including *The Guardian* [5.8]; radio, including *BBC World Service: Science in Action* (audience figures of 20 million globally), *BBC World Service: Africa Today*, and *Radio France Internationale*; and magazine interviews for *Science* and *Nature* [5.9]. Wilson also recorded an SDSN e-conference presentation on biopesticides for Fall Armyworm control, which is a lasting resource for farmers in Africa and other stakeholders and has been viewed nearly 400 times [5.3]. All of this outreach impact is possible only due to Wilson's extensive research and knowledge of armyworm biology, ecology, physiology, genetics and migration [3.1-3.7].

### 5. Sources to corroborate the impact

[5.1]. (a) [UN-FAO report on Harare meeting](#) (14<sup>th</sup> to 16<sup>th</sup> February 2017) on fall armyworm corroborating Wilson's contribution: and (b) [Video from Al Jazeera](#) including interview with Wilson from 04:10 (available online only). Dated February 2017.

[5.2]. UN-FAO documents to which Wilson has contributed (between 2017 and 2020): [Synthesis of the Fall Armyworm Expert Meeting in Accra](#) (25<sup>th</sup> September 2017), [UN-FAO Programme for Action on Sustainable Management of the Fall Armyworm in Africa](#) (6<sup>th</sup> October 2017), and [UN-FAO Integrated Management of Fall Armyworm on Maize booklet](#) (2018)

[5.3]. [SDSN 5-day e-conference on fall armyworm innovations in Africa](#). Includes a presentation by Wilson given on day 5 (available online only). Dated 26<sup>th</sup> October 2018.

[5.4]. Letter from the Principal Technical Coordinator-Fall Armyworm, Food and Agricultural Organisation of the United Nations, corroborating invitation to advise on spread of armyworm and development of Integrated Pest Management strategy. Dated 1<sup>st</sup> August 2019.

[5.5]. [Global Action for Fall Armyworm Control launch](#) corroborating to global level coordinated approach (dated December 2019)

[5.6]. Webinar to by Wilson to FAO stakeholders "[Pesticide and biopesticide in fall armyworm control: Protecting plants, people and the planet](#)" (Located on the right hand side bar. Available online only and can be accessed directly via this [Zoom link](#)).

[5.7]. Letter from the CEO of Crop Bioscience Solutions Ltd., Tanzania corroborating the identification, laboratory testing and production of a biological pest control agent. Dated 21<sup>st</sup> August 2019.

[5.8]. Newspaper article '[Armyworms: The hungry caterpillar threatening a global food crisis](#)', *The Guardian*, 16<sup>th</sup> May 2017. Highlights Wilson and his expertise on the Fall Armyworm.

[5.9]. (a) '[New crop pest takes Africa at lightning speed](#)' *Science*, 5<sup>th</sup> May 2017 and (b) '[African countries mobilize to battle invasive caterpillar](#)', *Nature*, 23<sup>rd</sup> February 2017. Both articles cite Wilson's work on armyworms.