

Institution: Cranfield University		
Unit of Assessment: UoA 6		
Title of case study: Improved opium crop monitoring with applied remote sensing		
Period when the underpinning research was undertaken: 2003-2015		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Dr Toby Waine	Senior Lecturer	2004-present
Dr Dan Simms	Lecturer	2005-present
Dr Tim Brewer	Senior Lecturer	1987-present
Prof John Taylor	Emeritus Professor	1985-2010
Dr Gavin Wood	Senior Research Fellow	1994-2009
Period when the claimed impact occurred: August 2013-present		
Is this case study continued from a case study submitted in 2014? Y/N No		
1. Summary of the impact (indicative maximum 100 words)		
<p>Opium production in Afghanistan is the source of almost all the heroin trafficked into the UK, leading to social issues of drug addiction and drug crime, and security threats from the flow of funding to terrorist groups internationally.</p> <p>Cranfield's development of refined remote sensing approaches has become the basis for the United Nations Office on Drugs and Crime (UNODC) and Government of Afghanistan campaign of poppy eradication: increasing accuracy of estimates of crop production; saving lives by reducing the need for field surveys; exposing misreporting of poppy eradication; and informing international drug policy decisions</p>		
2. Underpinning research (indicative maximum 500 words)		
<p>The remote sensing group at Cranfield has a heritage of developing techniques using data from multiple sources to study agriculture. Wood et al. (2003) [R1] combined ground-based measurements of leaf area index and remote sensed reflectance data to improve yield predictions with better spatial, temporal, and spectral resolutions. This led to the development of improved tools for variable rate nitrogen application to cereal crops (Welsh et al., 2003) [R2].</p> <p>Building on this, Cranfield's opium poppy research programme investigated the discrepancies in annual estimates of opium production to better understand poppy cultivation in Afghanistan. Assessment of the remote sensing-based survey methodologies of the US Government and UNODC (United Nations Office on Drugs and Crime) identified sources of bias responsible for quantitative differences in cultivation estimates [R2]. Based on this analysis, Cranfield developed improved remote sensing approaches that use the newly available medium resolution imagery from the UK-DMC satellites, for full country coverage. This was integrated with very-high-resolution satellite imagery as surrogate ground data in limited sample areas, to improve poppy cultivation estimates and deliver results months earlier in the growing season than previously possible (Taylor et al., 2010) [R3].</p>		

Field-trials on opium crops were designed to assess the **effectiveness and efficiency of eradication** methods and to measure **opium yield potential from imagery** [R4], leading to image-based approaches for eradication verification and yield methodology with **minimal ground data requirements** [R3].

Wide area monitoring of agriculture throughout the growing season was developed using high frequency imagery covering the whole of Afghanistan [R5]. This information was used for characterising agricultural practice, crop rotations, the exploitation of new land, localised variation in crop management, water availability and outbreaks of disease. This enabled the:

- 1) **tracking of crop phenology** in near-real time for planning survey activities such as image data collection,
- 2) the **optimal timing for poppy eradication**,
- 3) the identification of areas of high production to **target counter-narcotics operations**, and
- 4) provide information across **remote and inaccessible areas** for the first time [R3, R6].

3. References to the research (indicative maximum of six references)

- R1 Wood, G.A., Taylor, J.C. and Godwin, R.J., 2003. Calibration methodology for mapping within-field crop variability using remote sensing. *Biosystems Engineering*, 84, 409–423.
<http://www.sciencedirect.com/science/article/pii/S1537511002002817>
- R2 Welsh, J. P., Wood, G. A., Godwin, R. J., Taylor, J. C., Earl, R., Blackmore, S. and Knight, S. M., 2003. Developing Strategies for Spatially Variable Nitrogen Application in Cereals, Part I: Winter Barley, *Biosystems Engineering*, 84, 481-494
<http://www.sciencedirect.com/science/article/pii/S1537511003000023>
- R3 Taylor, J. C., Waive, T. W., Juniper, G. R., Simms, D. M., and Brewer, T. R., 2010. Survey and monitoring of opium poppy and wheat in Afghanistan: 2003-2009. *Remote Sensing Letters*, 1(3), pp 179-185.
<https://doi.org/10.1080/01431161003713028>
- R4 Waive, T. W., Simms, D. M., Taylor, J. C. and Juniper, G. R., 2014. Towards improving the accuracy of opium yield estimates using remote sensing. *International Journal of Remote Sensing* 35, pp 6292-6309.
<https://doi.org/10.1080/01431161.2014.951743>
- R5 Simms, D. M., Waive, T. W., Taylor, J. C., and Juniper, G. R., 2014. The application of time-series MODIS NDVI profiles for the acquisition of crop information across Afghanistan. *International Journal of Remote Sensing* 35, pp 6234-6254.
<https://doi.org/10.1080/01431161.2014.951099>
- R6 Simms, D. M., Waive, T. W., & Taylor, J. C. (2017). Improved estimates of opium cultivation in Afghanistan using imagery-based stratification. *International Journal of Remote Sensing*, 38(13), 3785–3799.
<https://doi.org/10.1080/01431161.2017.1303219>

4. Details of the impact (indicative maximum 750 words)

The annual cultivation of opium in Afghanistan exceeds 95% of the world production, supplying almost all the heroin used in the United Kingdom. The heroin leads to drug addiction, drug-related

crime, and funds terrorism globally. Accurate cultivation figures for poppy and cereal crops are essential for effective counter narcotics policy. The Government of Afghanistan (GoA) and United Nations Office on Drugs and Crime (UNODC) produce the annual opium survey and report the levels of poppy eradication. GoA's National Drug Control Strategy includes action to physically destroy the opium crop in the fields, by hand and/or mechanised means, and offers a compensation scheme for provincial governors based on the area of crop eradicated.

Cranfield's research between 2003 and 2015 informed the development of remote-sensing based methodologies for improving information on illicit drug production and verification of eradication, which has reduced the number of field workers killed, informed international counter-narcotics policy, and built the capacity of the GoA to conduct its own survey of illicit opium production. These impacts are detailed below.

Saving lives by reducing the need for ground surveys

The methodologies... *"continue to reduce the risk to ground surveyors through the use of satellite imagery as surrogate ground data in the cultivation estimate and for the verification of eradication"* [S1, UNODC]. The use of satellite imagery has reduced the number of deaths and serious injuries to UNODC, MCN and Afghanistan National Police staff at a time of deteriorating security. In 2008, 78 people were killed; 21 in 2009; 28 in 2010, and 20 in 2011 (UNODC annual opium survey) and continues to reduce the risk to surveyors to this day [S1].

Informing international and high-level national policy decisions on counter narcotics in Afghanistan

Opium cultivation information allows international stakeholders to make timely decisions on future counter-narcotic activities such as alternative livelihoods, anti-planting campaigns, education, and incentive payments to 'zero cultivation' provinces. Cranfield led the Survey, Monitoring, Targeting and Verification project for the UK's Foreign & Commonwealth Office (UK-FCO). This... *"delivered timely and accurate data on poppy cultivation and eradication in Afghanistan for use by HMG to support the Government of Afghanistan's implementation of their National Drug Control Strategy"* [S2, Miliband].

Cranfield's remote-sensing was used to independently verify reported areas which *"confirmed the UN's assessment of the significant impact of the food zone project in Helmand. The Cranfield study assessed that poppy cultivation fell by 37% within the food zone"* [S3, S4].

Ongoing impact is being achieved through assessing changes in poppy cultivation in response to intervention projects aimed at transitioning to a licit agricultural economy: counter narcotic activities and alternative livelihood programmes such as the Helmand food Zone. The UNODC published our earlier results in a 'Quick-impact Case Study on the Food Zone in Helmand Province' in their World Drugs Report, 2015. [S5].

Uncovering the misreporting of poppy eradication

During the UK-FCO analysis, Cranfield uncovered significant discrepancies in the areas reported as destroyed by the US-led Poppy Eradication Force (PEF). The US Government's 'Counternarcotics: Lessons Learned Report', June 2018, said: *"Imagery collected by the UK revealed gross over-reporting. Researchers at Cranfield University who were doing imagery analysis concluded that some areas eradicated by the PEF were "considerably over-estimated."* [S6]

INL (US State Department, Bureau of International Narcotics and Law Enforcement Affairs) disputed the claims, causing a further review of the data. A joint US and UK review ultimately supported Cranfield's analysis, finding that where the PEF had reported 7,000 hectares destroyed, *"not more than 3,000 hectares"* had actually been eradicated. [S6]. Ultimately, this... *"was instrumental to the closure of the Poppy Eradication Force that had cost the US taxpayer almost*

USD300,000,000 (10-2020) over 6 years - and led to the subsequent refocusing of policy towards rural development and interdiction” [S7].

Capacity building

The legacy of Cranfield’s work with UNODC and MCN, along with the capacity building and mentoring of Afghan nationals, has enabled them to successfully undertake key remote sensing techniques themselves. *“UNODC and MCN use the science-based method developed by Cranfield to verify and measure eradication. The approach is open and is used to assess the success of eradication and determine the size of the payments. Cranfield authored the ‘Guidelines for illicit crop interpretation in Afghanistan, 2015’ which is used operationally by the UNODC and Ministry of Counter-Narcotics in Kabul to produce the annual opium and cannabis production figures for Afghanistan” [S1].*

5. Sources to corroborate the impact (indicative maximum of 10 references)

- [S1] Letter from UNODC Vienna on impact of RS approach and eradication (saving lives)
- [S2] Miliband, 2008. Parliamentary Questions, 15 Sep 2008: (Column 2172W, *FCO Afghanistan – Drugs*, Paragraph 2)
- [S3] UNODC, 2009. United Nations Office on Drugs and Crime and Government of Afghanistan Ministry of Counter Narcotics Afghanistan opium survey 2009 – Summary Findings, UNODC, Vienna. Highlighted text on page 8 and map on page 9 (document numbering)
http://www.unodc.org/documents/crop-monitoring/Afghanistan/Afghanistan_opium_survey_2009_summary.pdf
- [S4] The National Archives, 2009. Afghan opium production drops by 10 per cent.
<http://webarchive.nationalarchives.gov.uk/20100511092211/http://www.number10.gov.uk/news/latest-news/2009/09/afghan-opium-production-drops-by-10-20477>
- [S5] UNODC World drug report 2015, Quick-Impact Project Case Study: the Food Zone in Helmand Province, Afghanistan. Cranfield’s project results are the basis of this case. Pp100. (document numbering)
http://www.unodc.org/documents/wdr2015/World_Drug_Report_2015.pdf
- [S6] Special Inspector General for Afghanistan Reconstruction, 2018. Counternarcotics: Lessons from the US Experience in Afghanistan. 2530 Crystal Drive, Arlington, Virginia 22202. Pp 89.
<https://www.sigar.mil/pdf/lessonslearned/SIGAR-18-52-LL.pdf>
- [S7] Letter from UK-FCO advisor – World expert on poppy policy