Institution:
Bangor University, 10007857

Unit of Assessment:
UoA 7 - Earth Systems and Environmental Science

Title of case study:
The options by context paradigm shift builds resilience of agricultural systems through agroecological transitions.

Period when the underpinning research was undertaken:
2009 - 2019

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:
1. Dr Fergus Sinclair	1. Senior Lecturer Agroforestry	1. September 1989 - present
2. Dr Tim Pagella	2. Lecturer in Forestry (Teaching and Scholarship)	2. October 2003 - present
3. Dr Emilie Smith-Dumont	3. Research Officer	3. June 2017 - present

Period when the claimed impact occurred:
2013 - 31 July 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact

Bangor University's research partnership with World Agroforestry produced a paradigm shift in agronomy, supporting agroecological transitions across 3 continents. Applying Bangor's **options by context (OxC)** approach profoundly changed international, national and private sector policy and practice across 15 countries in Africa, Asia and Latin America. Diverse and inclusive agroecological options that result from applying this approach, include increasing food security, farm income and environmental resilience for 2,250,316 people, restoring 2,611,902ha of land, with 422,968 households and 428,599ha already reached, through investment of GBP101,631,640 in projects using OxC. Global initiatives target improving access to agroecological practices for over 60,000,000 smallholder farmers and OxC features in national and sub-national policies in Rwanda, Peru and Vietnam.

2. Underpinning research

For many smallholder farmers (there are 500 million globally feeding 80% of the population in Africa and Asia), conventional agricultural improvement based on the use of fossil-fuel derived chemical fertilisers and pesticides to increase yield of monocultural crops has often either: i) led to debt, reduced dietary diversity and increased environmental degradation where it has been widely adopted (across many contexts in Asia and Latin America); or ii) left rural communities in poverty and food insecurity because improvements have not been adopted, yields and income remain low and environmental degradation has occurred because of a lack of investment in sustainable agricultural practice (across much of sub-Saharan Africa). The fundamental problem in both cases is the lack of locally suitable agricultural practices that regenerate rather than degrade the environment **[3.1]**.

To address these problems Bangor University entered an innovative research partnership with World Agroforestry (ICRAF) in 2009 which resulted in the development of the novel **options by context (OxC)** approach. This approach supports local innovation by farmers by fostering transition to more agroecological farming methods, including agroforestry. These involve maximizing use of natural processes, such as biological nitrogen fixation, rather than forcing

agricultural systems with external inputs **[3.1]**. Sinclair led an ICRAF-Bangor joint systems research group, based at ICRAF and funded by research grants from ICRAF to Bangor **[3.a]**. Since 2012, this Bangor / ICRAF partnership resulted in Dr Fergus Sinclair leading the Livelihood Systems Flagship of the CGIAR research programme on Forests, Trees and Agroforestry (FTA). The Consultative Group on International Agricultural Research (CGIAR) is part of the world's largest global agricultural innovation network.

Sinclair's research pioneered a global analysis of agroforestry adoption that identified how fine-scale variation in farmer context constrained the spread of agroecological farming methods **[3.2]**. National analysis of the performance of four agroforestry options across Malawi, revealed large variation in crop yield for each option across smallholder contexts, with different options performing well in different contexts **[3.3]**; thus average performance was not a useful basis for making recommendations for farmers. Research in Kenya **[3.4]** and Ethiopia **[3.5]** revealed how contextual factors (e.g. household wealth, land tenure and topography) determined adoption of different agroforestry practices by farmers; moreover they were using a far greater diversity of tree species than previously recognised. These key research findings established the need to take **option by context (OxC)** interactions into account in generating locally appropriate agronomic innovations.

To enable this, the OxC approach comprises three key departures from conventional agronomic research: 1) The use of structured stakeholder engagement and attendant local knowledge to determine what is known about the suitability of existing options for the range of extant contexts **[3.6]**; 2) The use of planned comparisons across large numbers of farmers, where variation in the performance of options in real-farm conditions is evaluated in terms of how context determines performance, rather than using conventional controlled experiments to estimate mean differences in performance of different options **[3.7]**; 3) Iterative co-learning in partnership with farmers who participate in evaluating performance, resulting in locally appropriate knowledge that farmers trust and adopt **[3.2]**. The outcome is a new agronomic paradigm that supports local innovation and reveals which options work where and for whom, rather than attempting to generate and promote silver bullet technologies that work well on average but not necessarily for particular farmers **[3.7]**. Locally appropriate use of agroecological approaches supported by OxC is particularly relevant to ensuring post-COVID recovery where resilience of food systems is of paramount importance. Given the nature of this research, key benefits to the farmer are realised at the research-in-development phase.

3. References to the research

Research outputs

3.1 **Sinclair, F.**, Wezel, A., Mbow, C., Chomba, S., Robiglio, V. and Harrison, R. (2019) The contribution of agroecological approaches to realizing climate-resilient agriculture. *Background Paper. Global Commission on Adaptation* (Rotterdam and Washington DC) Link (Peer-reviewed scientific report)

3.2 Coe, R., **Sinclair. F.** and Barrios, E. (2014) Scaling up agroforestry requires research 'in' rather than 'for' development. *Current Opinion in Environmental Sustainability*, **6**, 73–77. DOI (Peer-reviewed journal article)

3.3 Coe, R., Njoloma, J., and **Sinclair, F.** (2019) Loading the dice in favour of the farmer: Reducing the risk of adopting agronomic innovations. *Experimental Agriculture*, **55**(SI), 67–83. DOI (Peer-reviewed journal article).

3.4 Nyaga, J., Barrios, E., Muthuri, C. W., Öborn, I., Matiru, V. and **Sinclair, F. L.** (2015) Evaluating factors influencing heterogeneity in agroforestry adoption and practices within smallholder farms in Rift Valley, Kenya. *Agriculture, Ecosystems & Environment*, **212**, 106–118. DOI (Peer-reviewed journal article)

3.5 Iiyama, M., Derero, A., Kelemu, K., Muthuri, C., Kinuthia, R., Ayenkulu, E., Kiptot, E., Hadgu, K., Mowo, J. and **Sinclair, F. L.** (2017) Understanding patterns of tree adoption on farms in semi-arid and sub-humid Ethiopia. *Agroforestry Systems*, **91**(2), 271–293. DOI (Peer-reviewed journal article)

3.6 **Smith-Dumont, E.**, Bonhomme, S., **Pagella,T. F.** and **Sinclair, F.** (2019) Structured stakeholder engagement leads to development of more diverse and inclusive agroforestry options. *Experimental Agriculture*, **55**(S1), 252–274. DOI (Peer-reviewed journal article)
3.7 **Sinclair, F. L.** and Coe, R. (2019) The options by context approach: a paradigm shift in agronomy. *Experimental Agriculture*, **55**(SI), 1–13. DOI (Peer-reviewed journal article)

Grants
3.a **Sinclair, F.** (2009 - 2020) *ICRAF research fellowship,* World Agroforestry Centre (ICRAF), GBP633,113 (Bangor University: R37812, R27P10, R37P15)

4. Details of the impact

International policy and development action

Promotion of agroecological approaches using the **options by context (OxC)** approach, developed through Bangor's research, has been adopted internationally by the UN Committee on World Food Security (CFS) High Level Panel of Experts (HLPE) in the context of food security and nutrition in 2019 **[5.1]** and by the Global Commission on Adaptation (GCA) with respect to climate resilience of agricultural and food systems in 2019 **[5.2]**. Both bodies recommend promotion of agroecological practices, citing Bangor's underpinning research. The HLPE report forms the basis of an international policy convergence process initiated at the 46th Session of CFS at the UN Food and Agricultural Organisation (FAO) in Rome in October 2019. The GCA report launched in September 2019 sets out a programme for governments and businesses to take urgent action to advance climate adaptation solutions in the light of Bangor's research findings, including a commitment to improve access for at least 60,000,000 small-scale producers to agroecological practices. By adopting the OxC principles, enhanced policy and practice has occurred at an international scale for securing poverty alleviation, increasing food security and enhancing environmental restoration.

National and sub-national policy

Application of the OxC approach directly associated with Bangor's underpinning research has led to development of new national and sub-national policies and incentives to promote agroecological options in Vietnam **[5.3]**, Peru in **[5.4]** and Rwanda **[5.5]**. In the private sector, Barry Callebaut, one of the largest buyers of cocoa in the world, has adopted the OxC approach for cocoa agroforestry, explicitly derived from Bangor's underpinning research **[5.6]**. In Vietnam, OxC trials of agroforestry options to increase farm income and control soil erosion on slopes, have led to implementation of new provincial level policies to promote agroecological transitions **[5.3]**. In 2015, Yen Bai provincial Resolution (15/2015/NQ-HDND) and Decisions (27/2015/QD-UBND and 2412/QD-UBND) provided financial support for households to establish fruit tree agroforestry practices and agroecological soil and water conservation measures to sustain maize production on sloping land. The Ministry of Agricultural and Rural Development (MARD) Decision (2477/QD-BNN-HTQT) created MARD's Agroforestry Working Group set up to review, improve, and propose agroforestry-related policies in Vietnam **[5.3]**. In Peru, regional implementation of a national agroforestry concession policy incorporates the OxC approach explicitly based on Bangor's underpinning research **[5.4]**. This policy grants formal land-title to farmers, provided that they commit to maintain, or establish agroforestry on 20% or more of the land. With the OxC approach thus adopted in national policies, it is estimated that up to 120,000 households in the Peruvian Amazon are benefiting from the OxC rollout affecting over 1,000,000ha **[5.4]**.

Reach of development projects promoting grassroots agroecological practices using OxC

Several major development initiatives have adopted the OxC approach as a direct outcome of the underpinning Bangor research. The Global Climate Fund, together with the Government of Sri Lanka, have invested approximately USD49,000,000 (03-2020) **[5.7]**. The development work aims to strengthen the adaptive capacity of smallholder farmers to address climate-induced irrigation and drinking water shortages by improving the resilience of farm- and land-management practices using the OxC approach, targeting at least 1,343,216 beneficiaries and protecting approximately 346,000ha of land **[5.8]**. The Netherlands invested USD49,461,485 (06-2015) in the Dryland Development project (2014 to 2019) **[5.9]** in Kenya, Ethiopia, Mali, Niger and Burkina Faso

(DryDev), which had the OxC approach at its core. Success was validated by associated planned comparisons funded through the International Fund for Agricultural Development (IFAD) Dryland Restoration project EUR3,845,630 (04-2015) and USD1,500,000 (04-2015) **[5.10]** with key impacts for individual farmers being realised at the project delivery and evaluation stages. They showed DryDev reached 219,694 farmers who rehabilitated 122,850ha of common land, practiced improved soil and water conservation on 90,058ha and other climate smart practices on 52,994ha; household resilience was higher in all 5 countries as a result, with dietary diversity of women in Kenyan project sites increased by 15% **[5.9]**. External mid-term evaluation of this IFAD development project stated that "*upscaling of best options by voluntary farmers on their farms and by other farmers (especially neighbours) is very impressive…. the project is currently reaching the impressive number of about 10,000 households, or more than 50,000 beneficiaries in the four action countries which are directly benefiting for their livelihoods from the land restoration project". Main findings report that "the project may significantly contribute to the achievement of [United Nations Development Goals] SDGs, especially 'no poverty' and 'zero hunger'*" **[5.10]**. The EU and partners have invested EUR21,379,310 (09-2017) in the Regreening Africa project (2017 to 2022), which operates the OxC approach developed from Bangor research across 8 African countries, including Ghana, Rwanda and Senegal in addition to those in DryDev. It targets at least 500,000 households and restoration of at least 1,000,000ha with 145,274 households already actively engaged in restoring 162,697ha by 2019 **[5.11]**. The Australian Centre for International Agricultural Research (ACIAR) have invested AUD10,390,000 (01-2017) in two phases of the Trees4FoodSecurity (T4FS) project (2012 to 2020) in Burundi, Ethiopia, Rwanda and Uganda that uses OxC to scale-up agroforestry. A 2019 evaluation of the impacts of the ACIAR projects identified the first phase (FSC/2012/014) as 1 of only 3 projects out of 15 evaluated that had contributed to transformational development impacting over 30,000 farmers in 2019 reaching over 48,000 in phase 2 **[5.12]**.

5. Sources to corroborate the impact

5.1. **HLPE (2019) Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security**, Rome. 162 p. http://www.fao.org/3/ca5602en/ca5602en.pdf. The need for context-specific agroecological transitions is stated (p26) citing the underpinning research **[3.7]**. OxC is outlined in Section 2.1 (p52 – articles 2, 3 and 7) and Section 4.1.1. (p94-95 article 7) and frames all recommendations around the need for such context-specific transitions (p.21), which are now the basis of an international policy convergence process. Sinclair was selected from over 250 nominations to lead an HLPE project team on agroecological approaches for food security and nutrition on this basis (p3).

5.2. **GCA (2019) Adapt Now: A Global Call for Leadership on Climate Resilience.** https://gca.org/report-category/flagship-reports/ This high-level report states on p66 that it bases its content in Chapter 2 explicitly on the underpinning research **[3.1]**. It is also explicit on use of OxC in Section 5.2 p31 and Fig. 7 p33).

5.3. **Patton (2017) Profiting from well-chosen tree species: improving the productivity of farming systems in Northwestern Vietnam.** Sinclair is a lead scientist on the AFLi project that falls within the remit of the FTA Livelihood Systems Flagship that he leads. The blog details the AFLi OxC trials in Vietnam and how they influenced provincial and national policy. http://blog.worldagroforestry.org/index.php/2017/04/11/profiting-well-chosen-tree-species-improving-productivity-farming-systems-northwestern-vietnam/

5.4. **PARA (2018) German Federal Ministry of Economic Cooperation and Development (BMZ)** report which funded project for planned comparison of OxC implementation of agroforestry concessions in Peru. https://www.dropbox.com/s/6mxey8b82i3xrah/ICRAF_PARA.docx?dl=0 This project uses OxC as its organising framework (p6), explicitly citing the underpinning research **[3.2]** and has it as the basis of a planned comparison to evaluate effectiveness of regional policy implementation in Peru (p7) following a successful pilot also funded by BMZ.

5.5. **Ministry of Environment, Republic of Rwanda (2018) National Agroforestry Strategy and Action Plan (2018-2027).** 48 pp. The strategy incorporates the OxC approach as a basic

principle (item 2 on p15) and acknowledges Sinclair's contribution to the development of the strategy (p iii). (Copy available on request)

5.6. **Testimonial from the Barry Callebaut Group position on agroforestry** as a result of Sinclair's advice and input at their conference in June 2019 (participant in the impact process). The Carbon and Forest Advisor and the Global Head of Agronomy of the Barry Callebaut Group (the largest global buyer of cocoa) explicitly thanked Sinclair for input on OxC, which they incorporated into the *position* following Sinclair's presentation to a science-policy dialogue on the role of agroforestry in the cocoa industry.

5.7. **Development project website for the Green Climate Fund (2020) Strengthening Climate Resilience of Subsistence Farmers and Agricultural Plantation Communities residing in the vulnerable river basins, watershed areas and downstream of the Knuckles Mountain Range Catchment of Sri Lanka** confirming the development investment of approximately USD49,000,000 (03-2020) https://www.greenclimate.fund/project/fp124#investment

5.8 **Project Proposal for the Green Climate Fund (2020) Strengthening Climate Resilience of Subsistence Farmers and Agricultural Plantation Communities residing in the vulnerable river basins, watershed areas and downstream of the Knuckles Mountain Range Catchment of Sri Lanka.** https://www.greenclimate.fund/sites/default/files/document/funding-proposal-fp124.pdf Sinclair led the design of this development project and leads the implementation of the ICRAF (Bangor) component of the project that provides scientific guidance to the whole development project. The nature of this development work ensures benefits are realised at the project delivery stage. Use of the OxC approach is explicit (paragraphs 143-145, p49) and the targeted number of beneficiaries (p74) and area of land protected (p75).

5.9 **The Drylands Development Programme (DryDev). Final Report. Ministry of Foreign Affairs, the Netherlands (2020).** This reports on activities up to July 2019, evidencing investment, farmers reached, and area of land affected by the programme as well as early indications of some impacts. The programme implemented by ICRAF explicitly uses the OxC approach (p8 and Annex 1, p55) citing the underpinning Bangor research (footnote 6, p51). Sinclair advised the project on use of OxC and it was linked via planned comparisons to the EU-IFAD grant. (Copy available on request)

5.10 **Bloesch, U. (2019) Mid-term Evaluation of EU-IFAD Grant: Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale.** http://repo.mel.cgiar.org:8080/handle/20.500.11766/10177 External mid-term evaluation of this development project, which Sinclair is Principal Investigator of at ICRAF, that evidences use of the OxC approach, the investment, number of farmers engaged and the efficacy of the approach. Report quotes documenting the impacts are cited in section 4 are available on p7 and p22.

5.11 **Regreening Africa Annual Report (2019) European Commission: Directorate General for International Cooperation and Development.** Annual report of project implemented by ICRAF using the Bangor / ICRAF OxC approach evidencing the level of investment as well as targeted and reached numbers of farmers and area of land restoration. (Copy available on request)

5.12. **Bartlett, A.G. (2020). Exploring transformational outcomes from donor investments in agroforestry research for development. Agroforestry Systems.** https://doi.org/10.1007/s10457-020-00516-3 This article includes evaluation of the first phase of the Trees for Food Security project that promoted trees on farms in Ethiopia, Rwanda, Uganda and Burundi. It evidences the efficacy of the OxC approach (explicitly citing the underpinning Bangor research), level of investment and farmers reached.