



ATSAF - CGIAR++ Junior Scientists Program Final Report

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Country: Kenya

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Start and end date of stay at IARC: 15 Jan 2020 - 17 Jul 2020

Start and end date of remotely supervised project: -

Title: Integrating Climate Change Adaptation Measures into Tree Crop Diversification Recommendations for Food and Nutrition Security

Funded by the German Federal Ministry for Economic Cooperation and Development (BMZ)





The World Agroforestry Centre (ICRAF)

The International Council for Research in Agroforestry (ICRAF) was founded in 1978 to promote agroforestry, particularly in the developing world. In 1991, ICRAF joined the Consultative Group on International Agricultural Research (CGIAR), a consortium of independent research institutes in the fields of agriculture and forestry. Thereafter, ICRAF's mission and goals aligned with that of the CGIARs to promote food security, reduce poverty and enhance the environment. In 2002, ICRAF acquired the brand name 'World Agroforestry' to reflect its global leadership in the arena of agroforestry research, but retained ICRAF as its legal name. To this day, ICRAF engages in strategic partnerships with public and private institutions to deliver top-tier quality research, inform evidence-based policies and contribute to restoration and development projects.

The Georg-August University of Göttingen and the University of Kassel

The Georg-August University is an internationally renowned university, founded in the Age of Enlightenment in 1737. Historically, it was a centre for great philosophers, writers and mathematicians. Today, it is a leader in education and research across its 13 faculties, ranging from the natural to social sciences, with over 30,000 students following over 212 different academic programs. The Master of Sustainable International Agriculture (SIA) is a joint program between the agricultural faculties of the Georg-August University of Göttingen and the University of Kassel to add international and sustainability dimensions to the study of agriculture. The SIA program offers three specialisations: i) International Agribusiness and Rural Development Economics, ii) International Organic Agriculture, and iii) Tropical Agricultural and Agroecosystems Science.

ATSAF++ Junior Scientist Program

The ATSAF++ Junior Scientist Program (JSP) grants students enrolled in agricultural and forestry programs at German universities the opportunity to conduct their master's thesis research at a CGIAR centre within the scope of an internship and research fellowship. As a JSP recipient in 2020, I was awarded the opportunity to work with the team of Dr. Todd S. Rosenstock in ICRAF's soils unit in the research division. Our joint proposal was to expand on the methodology of ICRAF's trees unit on the development of 'Fruit Tree Portfolios' to integrate climate change adaptation measures.

The Fruit Tree Portfolios

ICRAF's Fruit Tree Portfolios (FTP) identify seasonal nutrient gaps in a given study site using a methodology that combines household survey data and on-farm tree inventories. The FTP methodology identifies the times of year households and their communities experience shortages of Vitamin A, C and iron intake. They then compile tree planting recommendations to diversify production systems for sustainable nutrition. For instance, if there is a Vitamin C shortage at a given time of year that coincides with the fruiting of *Adansonia digitata*, a species suitable for that area, then the FTPs could recommend the integration of *A. digitata* into the production system. The recommended species are socio-ecologically suitable and nutritionally important and aim to meet local consumption and nutritional needs. Though the FTPs tackle one of the most pressing issues facing humanity (undernutrition), they do not yet account for climate change. The aim of this research project was to integrate climate change adaptation measures into the FTP methodology to provide climate smart and nutrition sensitive recommendations to stakeholders.



Roles and Responsibilities

The research project was designed to bridge the climate change and nutrition work of ICRAF's soils and trees units. The project was subdivided into three work packages: i) identifying recommendation zones for the FTPs, ii) identifying priority areas for future FTP interventions based on pre-selected criteria, and iii) modelling recommended fruit tree species' shifting suitability under future climate change scenarios. My role was to complete the aforementioned work packages to deliver the following outputs within the given six month time frame: i) maps of FTP recommendation zones under current and future conditions, ii) maps of priority areas for future FTP interventions that target either malnutrition or land degradation, iii) population estimates of potential beneficiaries from future interventions, iv) maps of recommended species' shifting suitability under future climate change scenarios, and v) suitable area change from baseline estimates for each species under each climate change scenario. In addition, my responsibilities included preparing communication materials, including a publication to submit to a scientific journal and an infographic summarising the shifting suitability for each species to be included in final FTPs in the future.

Performance Evaluation

I consider the internship and research fellowship a success, since I was able to deliver all aforementioned outputs as planned. The true measure of success will be a publication in a scientific journal. We are currently reviewing the first publication draft internally at ICRAF and following more revision will submit the manuscript to the target journals. When reviewing my own performance in the process of developing the outputs, I must be transparent in recognizing my own inefficiencies. Since I had no prior knowledge of cluster analysis, priority analysis, principal component analysis of raster data, species suitability modelling, population estimates, recommendation zone mapping or any of the other items outlined in the work packages, I had to painstakingly figure out what I was doing each step of the way. To confound matters, my knowledge of RStudio was extremely limited when I first arrived at ICRAF. I was very fortunate to have the technical support and guidance of ICRAF colleagues, who I could turn to whenever I got stuck, as well as receive feedback on the ongoing process. Nevertheless, my progress was highly inefficient, having to spend days googling and reading R package vignettes, whilst someone familiar with the methods could have programmed the R code without a second thought in less than half the time. However, my aim, first and foremost, was to learn new skills. If I measure my performance in terms of learning outcomes, I must say that this internship was a great success. I became familiar with many different R packages and working with raster data in R. I acquired skills for a variety of methods involved in recommendation zone mapping, prioritisation analyses and species suitability modelling.

Skill Development and Capacity Building for Future Career Goals

The skills required to complete the three work packages and deliver the planned outputs mainly involved working in RStudio and to a lesser extent QGIS. Prior to this internship, my work in RStudio was limited to ANOVAs (Analysis of Variance) and PCAs (Principle Component Analysis). My university courses teaching R skills had been based primarily on copying and pasting code and not learning the foundations of the R language. This internship demanded species modelling skills and working with complex social and demographic datasets, such as the Demographic Health Survey, none of which I had ever done before. It was a steep learning curve, but with the guidance of an excellent colleague, Peter Steward, and with a lot of time spent on online R forums, like github and stack exchange, I managed to develop the necessary skills in RStudio to complete all three work packages and deliver all the outputs as planned. I certainly developed more technical skills in these last six months than I have in my last six years at university. There is much truth to the saying:



‘Learning by doing.’ These technical skills will serve me well in the future. R is the language of science and these last six months have made me, if not fluent, then at least conversationally competent.

These last six months at ICRAF have convinced me that independent applied research is the niche in society where I want to carve out my career. I have worked for NGOs that cherry pick science to further their own agenda and I have worked at vertically structured organizations where the hierarchy is so entrenched, everyone is too busy clawing upwards to ever be appreciative of where they already are. I have worked at universities where some, to excuse the cliché metaphor, dwell in the ivory tower and have lost touch with ground level realities. I found that ICRAF as a research institute has managed to blend the best of all those worlds and bypass their pitfalls. ICRAF has retained the development agenda and ground-level project implementation shared with so many great NGOs, but keeps the work evidence-based and founded in the scientific method, as academia does. ICRAF shares the policy focus of many vertically structured institutions, but the ICRAF organization feels more horizontal, with the Director General stopping to chat with interns at coffee breaks, and even the student research fellows feeling valued by senior scientists in the team. It is this healthy work environment that I cherish at ICRAF. ICRAF is a workplace where you feel valued, no matter your rank in the hierarchy, and where you are surrounded by inspirational scientists and bold projects, that further the sustainable development goals through applied research and promoting evidence-based policy. Combining science, evidence and policy to help people and the environment on the ground level is what I want to dedicate my life to doing. I have yet to come across a healthier, more inspirational workplace than ICRAF where that can be accomplished.

The JSP opened my eyes to this career pathway and steered my future goals towards applied research. As a next step towards reaching this goal, I will start a PhD in January 2021 in the geography department of Penn State University. My PhD supervisor, Dr. Bronwen Powell, and I are in discussion to collaborate with my current team at ICRAF on this 4 year long research journey. I hope to continue working on the landscape – nutrition - climate change interface and explore local resiliency and adaptation to climate change for nutrition security in the face of landscape level impacts. My work and technical skill development under the JSP will no doubt prove to be a valuable foundation for the next four years of PhD research.

Ongoing Considerations

My internship at the IARC not only helped build my technical capacity and skill development, but also shone a critical light on the areas where I still need to improve. During the internship, I struggled for several weeks with interpolating Demographic Health Survey (DHS) household point data into a smooth raster surface. The DHS recommends Bayesian hierarchical geostatistical modelling in which a model based on several submodels of pre-selected DHS variables can be used to interpolate point DHS data into smooth surfaces. More classic interpolation methods, such as Inverse Distance Weighted and Kriging, only made my interpolated surface look like they had chicken pox. Ultimately, I failed to figure out how to conduct the Bayesian hierarchical geostatistical modelling. While I understood the concept and theory, online tutorials and tips on how to implement such models in R were scarce. Developing the technical skill of Bayesian hierarchical geostatistical modelling will be a priority for me, as I enter Penn State’s geography department and start my PhD. I have already communicated this to my PhD supervisor and she has pointed me in the direction of geostatistical experts in our department. Once I develop this skill in the future, I will be able to interpolate DHS data properly, which will open up the doors to all kinds of geospatial analysis of the DHS dataset.



As an example, my PhD supervisor, Bronwen Powell, and my colleague Stepha McMullin, who developed the FTP methodology at ICRAF, and Amy Ickowitz at CIFOR, frequently collaborate on research looking at nutrition from the landscape level. They are currently working on a policy info brief about the potential of fruit trees to alleviate micronutrient deficiencies. Once I am able to interpolate DHS data, I will be able to contribute to their work by producing interpolated raster maps of children's fruit intake across sub-Saharan Africa. This is only one simple example, but interpolating DHS data using geostatistics will be a fundamental skill that will open up many opportunities for future research, data presentation and collaboration with other researchers whose work I greatly admire. It was through the JSP that I identified this priority area for future technical skill development.

Concluding Summary

The JSP program was much more than a convenient means to collect data and produce a master's research thesis. The program raised my level of technical competency, setting a strong foundation of technical skills for my upcoming PhD. The program also paved the way for a five-year long collaboration between ICRAF, myself and various academic institutions through the research fellowship, now a consultancy and a future PhD. It gave me the opportunity to work in a team of dedicated and passionate scientists, striving to improve the world. The program also helped clarify my own future career goals and steered me firmly on a course towards applied independent research. I hope this future will hold many more collaborations with CG centres, also within the context of a Post Doc following the PhD. In discussing my future career goals, I have to admit that I was disillusioned about building my career in the past. I believed the corporate world was guilty of greenwashing, NGOs were too biased and academia was too cut off from harsh ground-level realities. It comes as a relief to find this sweet spot of applied independent research, and though riddled with its own set of imperfections, such as the constant pressures to obtain funding and deliver outputs, applied research at the IARC blends the best of all those worlds by forging public-private partnerships and implementing projects on the ground to improve livelihoods and the environment through agriculture and forestry.

We all know the mounting pressures facing humanity. Feeding 9.2 billion people by 2050 in the face of oncoming climate change and overshoot planetary boundaries, will be a challenge to say the least. But this challenge is not insurmountable. Trees offer solutions to the intersecting challenges of food and nutrition security, climate change adaptation and mitigation, gender equity, income diversification and livelihood resiliency, soil health and land degradation, freshwater scarcity, nitrogen cycling, among many others. The IARCs, and among them ICRAF scientists, are on the forefront of tackling these challenges and I hope to join their ranks as we work together to overcome these challenges in the future.