

# Molecular anthropology of cassava – a cultural ecology of plant varietal preferences

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**”People like Hans Rosling face the criticism of being too superficial, it’s the dilemma of the public intellectual, academics who bridge several disciplines rather than excel at one”**

*Peter Baylor, Baylor College of Medicine, USA on Hans Rosling, Nature 540, 330–333 (15 December 2016) doi:10.1038/540330a.*

Molecular genetics has provided science with innovative tools for increasing food production. One of the legacies that Hans Rosling has left behind is understanding of cassava cyanogenesis and how molecular plant genetics could better contribute to the reversal of the “poverty, population and environment spiral” (PPE-spiral). This requires incorporating appropriate methods and tools for routine use in breeding programmes; with breeders in collaboration with interdisciplinary teams, farmers and more specifically female farmers. In other words, molecular anthropology, the combining of anthropological methods from the social sciences with biochemical methods in surveys. The combination of biological sciences with social sciences, in the understanding of cassava cyanogenesis could rapidly advance and be a cost effective way for understanding farmer varietal preferences and their needs for food security. While funding has improved somewhat, evidence shows that despite the central role that women play in provisioning household food security there remains a severe lack of integration of a critical gendered approach.

Molekylär genetik har försett vetenskapen med innovativa verktyg för att öka matproduktionen. Något Hans Rosling lämnat efter sig är förståelse för hur kassavacyanogenes och molekylär växtgenetik bättre kan bidra till att stoppa den negativa fattigdoms-, befolknings- och miljöspiralen. Det kräver att man inför rutinmässig användning av lämpliga metoder och verktyg i avelsprogram, där uppfödare samarbetar med tvärvetenskapliga team och bönder, mer specifikt kvinnliga bönder. Molekylär antropologi är en kombination av antropologiska metoder från samhällsvetenskapen och biokemiska undersökningsmetoder. Denna kombinationen kan, när det gäller förståelsen av kassavacyanogenesen, snabbt utvecklas och vara ett kostnadseffektivt sätt att förstå lantbrukarnas sortpreferenser och deras behov av livsmedelssäkerhet. Även om fi nansieringen har förbättrats något råder rådet alltså en allvarlig brist när det gäller att se det hela ur ett kritiskt könsperspektiv. Detta trots den centrala roll som kvinnor spelar för att säkra hushållens livsmedelsförsörjning.

## Introduction

Several studies continue to show that there are differences in how men and women select cassava varieties based on their various needs and preferences (Chiwona-Karlton et al., 2015, Masamha et al., 2017, Christinck et al., 2017). Furthermore, evidence shows that despite the central role that women play in provisioning household food security there remains a severe lack of integration of a critical gendered analysis in the total accumulated research. This is particularly glaringly absent from commodity or value chains research (Andersson et al., 2016, Dunaway, 2014). In his seminal work on molecular anthropology, Hans Rosling stated the following:

*“the mostly female farmer in the poorest communities can identify problems and possible solutions for farming systems researchers with downstream researchers. She can also contribute to upstream research with a wealth of accumulated knowledge of the biological system she operates if the visiting researcher possess methods for collection of this biological knowledge. My limited experience of poor agricultural communities in Africa indicates that there, in addition to the research stream continuum is a place for some rain-research” (Sobral 1996:316).*

In my many years of research on and with cassava, I have come across few studies dedicated to identifying problems and possible solutions for mostly female farmers. Overwhelming evidence shows that patriarchal, social, and cultural stereotypes

continue to determine what roles women can play in crop production and other functions (Quisumbing et al., 2014). This is further compounded by lack of participation as influenced by differential access to chain functions, services and resources, and by gender-related power disparities in agro-commodities (Nakazibwe and Pelupessy, 2014). In this paper, I revisit the earlier work that I conducted together with Hans Rosling on cassava varietal plant preferences in Malawi to contribute to the ongoing debate on how gender determines the relative importance of varietal traits and the selection of cultivars particularly for household food security. While much work has been conducted on cassava since then, clearly there remains much work to be done when it comes to cassava, household food security and women’s participation as well as decision-influencing in cassava value chains (Masamha et al., 2017).

A recent review on gender differential farmer varietal preferences, showed that men tend to focus more on production and market-related traits while women focus more on production and end-use related traits (Christinck et al., 2017). It is surprising that almost two decades later, these findings are no different from our earlier work on farmer cassava preferences (Chiwona-Karlton et al., 1998). In the conclusions of the review by Christinck et al., the authors emphasize the importance of deepening our understanding of gender-specific differences and that such insights would aid to assist plant breeders towards addressing gender-



While much work has been conducted on cassava there remains much work to be done when it comes to household food security and women's participation as well as decision-influencing in cassava value chains. *Field photography*

specific preferences for varietal traits. The authors end by stating that this would require appropriate methods and tools for routine use in breeding programmes; breeders in collaboration with interdisciplinary teams and farmers. In other words, molecular anthropology.

### **The origins of molecular anthropology**

In his chapter in the book edited by Bruno Sobral in 1992 titled "the impact of plant molecular genetics" (Rosling, 1996), Hans Rosling persuasively outlines how molecular genetics had provided science with innovative tools for increasing food production. The story that Hans Rosling tells is that of cassava cyanogenesis and how molecular plant genetics could better contribute to the reversal of the "poverty, population and environ-

ment spiral (PPE-spiral).

In his earlier studies on konzo, Rosling and colleagues, (Rosling et al., 1993) describe the causal mechanisms behind human diseases induced by dietary cyanide exposure from consumption of cassava. It is during these studies that Rosling realizes that the combination of clinical observations with biological phenomena would reveal deeper understanding of contextual problems such as konzo. Rosling was a pioneer in his time, combining anthropological methods from the social sciences with biochemical methods in surveys, best described as molecular anthropology. Molecular anthropology is a concept that was first defined by Zukerland (1963). The term was used to determine amino acid sequence of serum proteins in prehistoric human evolution. A medical doctor by training, Rosling was intrigued by the onset



Removal of bitterness and toxicity in cassava roots soaking and fermentation in earthenware pots in Nkhata-Bay, Malawi. *Field photography*

of the disease konzo that had causal links with the food crop cassava. Rosling's encounter with cassava in Mozambique is what led Rosling into the field of ethnobotany. Other authors in this special issue have described the Mozambique story. According to the Oxford dictionary, ethnobotany is the scientific study of the traditional knowledge and customs of a people concerning plants and their medical, religious, and other uses (<https://en.oxforddictionaries.com/definition/ethnobotany>). Rosling had figured out that the combination of biological sciences with social sciences, in the understanding of cassava cyanogenesis could rapidly advance and be a cost effective way for understanding poor farming communities and their pressing needs for food security. The underlying premise being to sort out

knowledge or evidence from fallacy. When Hans Rosling first introduced the concept of molecular anthropology in understanding cassava cyanogenesis he dared to term it a marketing trick.

*"a marketing trick to convey old wisdom already conveyed by Louis Pasteur, in the field of observation, chance favours the prepared mind" (Sobral, 1992:317)*

However, history was to show that, it was the beginning of a long-term building of human capacities of African scientists at doctoral education level as well as post-doctoral level in the field of cassava research and development. The ground breaking work by one of the leading cassava geneticist in the world, Martin Fregene, would culminate in the mapping of the cassava genome (Fregene et al., 1997,



Nursery discussion.

*Field photography*

Farmer to farmer varietal selection discussions Domasi CMRTE farmers visiting Mulanje farmers 2002.

*Field photography*

Fregene et al., 2001). While the application of molecular anthropology methodology would firstly result in explaining in-depth why farmers, especially women, preferred bitter cassava cultivars. Secondly, application of molecular anthropology showed that farmers ethno-classification of varieties into bitter and cool cassava cultivars corresponded to a genetic sub-division of the typical genotypes of the most common cultivars, with four-fold higher cyanogenic glucoside levels in the bitter cultivars. We clearly showed that women farmers grasp sufficiently the genetic diversity of cassava with regard to cyanogenesis to simultaneously benefit from it and avoid its dangers.

### **Cassava Toxicity and Food Security**

Historically, it has been found that in areas where cassava constitutes a main staple crop, farmers preferentially grow varieties that are both bitter and toxic (Jones, 1959, Nweke and Bokanga, 1994, Purseglove, 1968). There is ample documentation showing that processing not only

improves shelf-life but also that bitterness and toxicity in cassava roots can be removed through processing (Coursey, 1973, Dufour, 1989, Hahn, 1989, Nweke, 1994, Chiwona-Karltun et al., 2000). Any shortcuts or interruptions in of the processing sequence due to extreme poverty, food shortages may result in high residuals of cyanogenic glucosides in consumed products leading to dietary cyanogen exposure. It is these types of exposures that may cause acute poisonings and have been implicated as a causative factor in neurological disorders (Tylleskär et al., 1992).

Thus to get an indepth understanding of the rationale for why farmers in Malawi, particularly women, preferred to grow cultivars with bitter and toxic roots we used a combination of explorative survey methods (Chiwona-Karltun et al., 1998). The findings were extremely revealing, emphasizing for the first time that while advances in molecular genetics had advanced and acyanogenic cassava, that is toxic free cassava could be bred, this scientific achievement was neither perceived as a prio-



Above: Farmer varietal selection discussions.  
Right: Irrigation, intercropping, Domasi.



Tasting the tip of a cassava root to determine bitterness and ethnobotany classification  
*Field photography*



rity or benefit by the farmers. They were three main categories of findings for the farmers rationale and preference for bitter cassava namely: 1) protection from human theft and vermin; 2) yield explained by the bitterness and 3) end-product quality both of the roots as well as the cassava leaves (Chiwona-Karlton et al., 1998). Cassava leaves is something that grossly have been marginalized in the scientific literature as well as research

and development agenda. However, of all the findings, the most important finding was the fact that farmers, men and women regarded the crop cassava to be two different types of crops, the bitter and toxic and the cool and non-toxic. The richness of the local language that farmers, especially women, used to describe minute differences between very bitter, bitter to slightly bitter was fascinating. Not least because in much of the discussions



Interviewing farmers.

*Field photography*

with key-informants, that is scientists, farmers were regarded as sometimes, “confusing” issues. How could one be certain that farmers knew for sure what they were talking about, that is separating knowledge from superstition as Rosling had described in his seminal paper on molecular anthropology (Rosling, 1996).

### **Molecular anthropology in practice**

Studies had successfully been undertaken to examine the detoxification of cassava as described above, but hitherto, there were no studies combining survey social science qualitative interviews with biochemical studies on the same specimen. In an unparalleled study, interviews were conducted with women farmers to ascertain the name of each cultivar, the predicted taste and the actual taste of the root as per

local custom. The very same cassava root that the farmer tasted were taken to the laboratory where a trained taste panel and chemical analysis was undertaken to determine the cyanogenic glucoside equivalent. This study entailed 492 cassava roots, classified as bitter and toxic or cool and non-toxic. Farmer’s distinction of the roots into these categories predicted cyanogenic glucoside levels and tasting of the root greatly enhanced this prediction. The scoring of bitterness by the trained taste panel correlated strongly with glucoside levels suggesting that cyanogenic glucoside confer the bitter taste (Chiwona-Karltun et al., 2004). In order to verify how well women farmers comprehended cassava genetics in dealing with cassava cyanogenesis in this complex system, we enlisted molecular markers to show that farmers knowledge about



Cassava sold at the market.

*Field photography*

a specific named cultivar had a typical genotype of that cultivar (Mkumbira et al., 2003). Furthermore, the farmer's ethno-classification of their cassava cultivars into bitter or cool was not random but based on in-depth morphological and cyanogenic experience. Clearly, the combination of taking into account women farmers' knowledge, the environmental context and advances in molecular genetics could contribute towards improving household food security and even other indirect benefits. In so doing, a more nuanced understanding of the what, how and why could better inform scientists, particularly breeders on what preferences farmers are likely to regard as important and thus increase adoption of improved bred cassava materials (Kizito et al., 2007, Chiwona-Karlun et al., 2015).

### **Consequences for future cassava research – a cultural ecology of food preference**

It is unequivocal, as reflected in the quote at the beginning, that Hans Rosling's contribution to cassava research, particularly in the novel field of combining the use of social science survey methods with biochemical and molecular genetic studies, has contributed significantly to a better understanding of how resource poor African women farmers try to ensure household food security. This was way before funding for "orphan crops" like cassava were identified as target crops for funding by major donors. While funding has improved somewhat, it is nevertheless disconcerting that evidence shows that despite the central role that women play in provisioning household food security there is a severe lack of integra-



tion of a critical gendered approach in the total accumulated research (Dunaway, 2014, Masamha et al., 2017). The recent review showing that men tend to focus more on production and market-related traits while women focus more on production and use-related traits (Christinck et al., 2017), findings much similar to our earlier work on reasons for use of bitter cassava (Chiwona-Karlton et al., 1998) informs that there is a sense of urgency in doing things differently. Enlisting a broader understanding of the cultural ecology of food preferences i.e. taking into account environmental and cultural issues, with specific reference to cassava varietal traits and end-use preference with gender in mind is paramount. Today more than ever before, there is the need to apply molecular anthropology methodology in deepening our understanding as well as embracing trans-disciplinary research to find evidence-based solutions for food security.

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