

Green food value chain development: Learning from the bottom of the pyramid

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ABSTRACT

The green food value chain development approach was designed to allow for adaptability, flexibility and morphing in the most diverse local circumstances and contexts that are found globally. As such, the approach considers and attempts to learn from the over four billion people, who live and work in the bottom of the economic pyramid: a bottom-up perspective to developing green food value chains. Consequently, in the approach, and as prescribed in this article, a large emphasis is placed on the importance of learning from green innovations that can be commonly found in bottom of the pyramid (BOP) contexts in terms of the (informal) food sector. The approach considers that innovations in the BOP are not just about technologies, but are also related to activities, processes, systems, knowledge, know-how and behavior. The article's main aims are to emphasize learning from the BOP to develop green food value chains and what methods can be used to learn from the BOP. The article covers the context and characteristics of the BOP: poverty, the natural environment, the informal food sector and consumer characteristics. It then looks at BOP innovations, how the BOP can be researched in seeking for insights on green innovations and how such learning can be of critical importance to developing green food value chains. Overall such learning is based on field realities and hence can enable a far more realistic picture of what needs to be done and more importantly what can be done to develop green food value chains.

Keywords: green food, economic pyramid, food value chains

Introduction

The United Nations Development Programme (UNDP), in 2017, reports that biodiversity is disappearing at an unprecedented rate, soils are being irreversibly damaged, freshwater is increasingly in short supply and climate is changing at an increasing rate. It has been well documented that commercial activities and processes along the food value chain can have considerable negative environmental impacts at pre-production, production and post-production stages, and that environmental impacts result from differing practices carried out at each stage (Reynolds *et al.*, 2015). For example, more waste is generated downstream, at retail and consumer level in the food value chain in industrialized countries and upstream, at farm, post-harvesting and processing level in developing countries (WEF, 2009).

The reduction of environmental impacts of food value chain activities has been widely studied in industrialized countries, but relatively less so in developing and emerging economies: the subject matter is relatively new (Stucki & Blignaut, 2018). Most of these economies rely on fossil fuels, on energy intensive irrigation and refrigerated storage and have considerable issues in terms of food governance (Stucki & Blignaut, 2018). For example, in such contexts, attempts and efforts to reduce food loss and waste can generate a "triple win." It can save money for farmers, companies, and households, help feed more people, and it can alleviate pressure on water, land, and climate (WRI, 2017). However, it takes financial resources to grow, harvest, store, process, transport, market, and purchase food and when food exits the food value chain before reaching its intended use, consumption by people, some organization is not recouping a return on the investment made (WRI, 2017). But steps to reduce food loss and waste often requires financial expenditures as it takes money to conduct an inventory to identify where and how much food is being lost and wasted, to determine what actions to take, and to implement those actions (WRI, 2017). These costs can include expenditures on staff, consultants, new equipment, process redesigns, awareness campaigns, or other activities. Therefore, in order for there to be a financial

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business case for taking action to reduce food loss and waste, the financial benefits of taking action need to outweigh the financial costs (WRI,2017).

A main driver for preventing, reducing, and attempting to eliminate the environmental impacts of food value chains activities is to focus on the planet (natural environment) aspect of the sustainability “triple bottom line” of people, profits and planet. The logic is fairly simple: without planet there can be no people, let alone profits. But important considerations need to be given to the fact that the vast majority of the people on the planet live in poverty and obtain their livelihoods from working in dire contexts, commonly referred to as the Bottom of the Pyramid (BOP) (see Figure 1). Those who live and work at the bottom of the economic pyramid represent circa 4 billion individuals of the world population and earn between US\$1 and US\$5 per day (Rangan *et al.*, 2011), and about 1 billion of these live in urban slums (GIZ, 2012). However, the bottom of the pyramid can be easily extended to those who live on less than US\$10 per day, which equates to about US\$3,000 per person per year in purchasing power parity (PPP) (GIZ,2013) and thus it is estimated that about 80 per cent of humanity works and lives in BOP settings (Pansera & Owen, 2014).

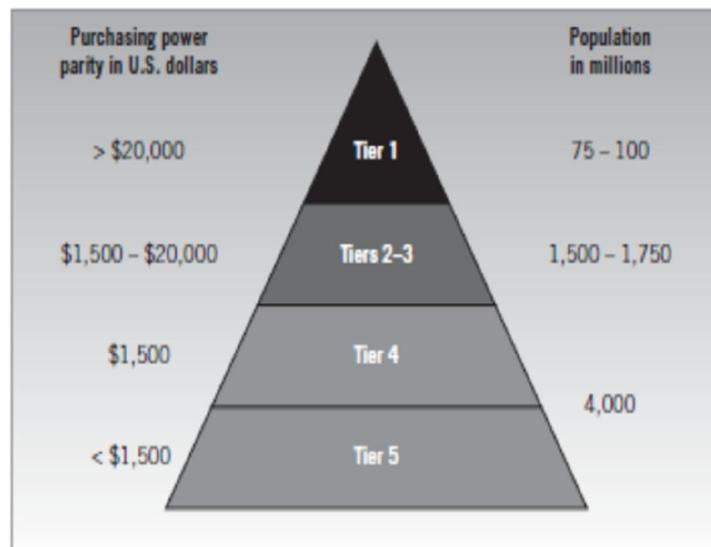


Fig. 1: The economic pyramid (Source: Prahalad, 2010)

This vast number of the global population who live and work in BOP contexts, operating prevalently in the informal economy, are far too big to ignore and may have, as is commonly thought, considerable negative impacts on the natural environment. But, this is not necessarily the case, as local communities have an innovative capacity to find effective solutions to solve the problems they face on a daily basis, and to seek processes that are socially inclusive. Many communities have proven track records of being resilient to environmental challenges, as local knowledge has been co-evolving with nature for centuries (Hilmi, 2018), and such knowledge and ingenuity is inevitably going to be rooted in the traditions and specific localities of such communities (Cozzens & Sutz, 2014). Local knowledge relies on raw materials and capabilities that are affordable and socially acceptable, such as, for example, organic farming and related sustainable land and water management practices (Pansera & Owen, 2014).

More often than not BOP food production, postharvest operations, trading, and retailing occur in the informal food sector. The informal food sector relates to activities of food production, transport, and retailing, for example, that are not under the direct purview of national governments (FAO, 2003). The main characteristics of the informal food sector are that it targets households with very small budgets, and usually, but not always, provides food with low safety, hygiene, and quality standards. It also provides for strong relationships between production and consumption, with consequent local sourcing of food. It is vulnerable to seasonal changes and seemingly has a poor environmental track record (FAO, 2003).

It is within this background and context that the green food value chain development approach is based (see Hilmi, 2018). The approach has a primary concern with the environmental aspects of food value chains, and places a large emphasis on attempting to learn from greening practices that derive from the billions of people who tender with poverty on a daily basis, but also have to tender with the natural environment. The approach attempts to capture, understand and importantly comprehend “green innovations” in terms of technologies, activities, processes, systems, knowledge, know-how and behavior that are provided by the billions who live, and have to contend with poverty every day. Simply put, the BOP is a vast rich learning environment that cannot be ignored and may be considered as a vast research and development hub. For example, consumption and income generation in poverty contexts can provide considerable insights into green innovations and on how these can contribute to making food value chains more environmental sound, in others words, contribute to green food value chain development. Critically the green food value chain development approach attempts to capture, better understand and importantly comprehend reality: identifying and defining green innovations at the grass-root level, verifying the greenness, the appropriateness of up-scaling them and then replicating them in different localities to wider populations.

The articles main objective is to primarily emphasize further, and better explain, the importance of learning from the BOP for green food value chain development. The article starts with explaining how the approach to green food value chain development was developed, it defines what is green food value chain development and provides the conceptual framework to the approach. It then covers the context and characteristics of the BOP: poverty, the natural environment, the informal food sector and consumer characteristics. It then considers BOP innovations, how the BOP can be researched in looking for insights on green innovations and how such learning can be of critical importance to developing green food value chains on a wider scale.

The research process followed to develop the green food value chain approach

The green food value chain approach was first published in 2018 (see Hilmi, 2018). Such an approach was developed based mainly on empirical research: embedded (immersion) research, observational (pictographic) and case study methodologies in country, with a principle focus on BOP agri-food markets and agri-food value chains. In 2012 an initial in-country appraisal was conducted in Tanzania and the results of such research provided guidelines, in the period 2012 and 2013, to carry out an extensive and in-depth literature research and review. Concurrently to this, still in 2012, country-based case study researches were conducted in Africa (Cameroon, Ghana, Kenya, Liberia, Uganda) the Caribbean (Belize, Grenada, Haiti, Jamaica) and the Pacific (Fiji, Solomon Islands, Vanuatu,) (see Westlake, 2014a, Westlake 2014b). This was then followed by other in-country researches conducted in Africa (Tanzania, Kenya, the Gambia) and the Middle East (Egypt, Iran, Tunisia). The findings from such initial research provided a concept note and conceptual framework (see Hilmi, 2014) that provided the basis to organize a knowledge exchange forum in 2014 to review, contribute too and validate the concept and conceptual framework (see FAO, 2015). In 2015 further in-country case study researches were conducted in Latin America (Peru), Caribbean (Trinidad and Tobago), North Africa (Tunisia) and the Middle East (Iran). This was followed by a series of unstructured one-to-one e-interviews with a panel of global experts on the subject matter of green food value chain development, and a number of conference and e-conference participations were also implemented to present findings and importantly receive feedback. This was then followed in 2016 and 2017 by another extensive literature review and further field work conducted in Algeria, Chad and Zambia.

This drawn out period of research, seven plus years, enabled a good deal of “full immersion research” to be implemented in BOP food markets and related food value chains. This was done so as to enable learning, with a bottom-up perspective, of the realities of how people work and earn their livelihoods in such harsh and frugal contexts: Their ways of perceiving, thinking and tendering to daily challenges with the natural environment and not only. The intent was to better understand and importantly comprehend, from a grass-roots perspective, the “greening” technologies, activities, processes, systems, knowledge, know-how and importantly behaviors of those who operate and work in such contexts as related to food markets and food value chains.

Consequently, the intended main outcome of such a research process was to design and build an approach that was based on empirical realities. The approach would not only enable learning to occur from BOP agri-food markets, agri-food value chains and contexts, but also have the flexibility,

adaptability and could morph to attempt to fit in to the most diverse of contexts, that are commonly found in the BOP, to develop green food value chains. This was dictated not only by the diversities found in local contexts in terms of the natural environment, but also and importantly of the extreme diversity of poverty, as the BOP is far from homogeneous: it represents multiple cultures, ethnicity, literacy, capabilities, and needs (Prahalad, 2011).

This long research, and gestation period, in fact only provided for a first article to appear in 2016 (see Hilmi, 2016a) followed by a second article, still in 2016 (see Hilmi, 2016b). This was followed by a book chapter (see FAO & CIHEAM, 2016) and a third article, (see Hilmi, 2018), that delineated the green food value chain development approach. This was followed in 2019 by another article which outlines one of the three main strategies of the green food value chain approach (see Box 1), that of recapturing value from waste (see Hilmi, 2019). The research outcomes and the number of publications on the subject matter provide evidence that the approach involves direct interaction, listening and learning from people and their contexts and their living environments, in other words ground-truthing: the participatory rigor of realism (Chambers, 2017). Consequently, as an approach, green food value chain development is primarily based on learning from the realities of the BOP.

Box 1 The main strategies for green food value chain development

Preventive strategies

This considers understanding how preventive strategies for averting inappropriate use of the natural environment can be defined and importantly implemented all along the food value chain or in defined sections (stages) of it. This will not only pertain to purely functional aspects, but also look at how institutional and behavioral aspects can be geared to the prevention of the inappropriate use of the natural environment. Importantly, such strategies will need to build on and learn from existing greening competencies found within such food value chains and not introduce practices that are not part of the cultural context, are not economically and socially viable, and are convenient to implement. Examples of common preventive strategies include: in Tanzania a cassava grater was made from locally available materials (UNEP, 2006), thus preventing the import of materials with its related and extensive carbon footprint; also in Tanzania energy for processing grains for small processing enterprises was sourced from self-made water mills (Lubinza & Hilmi, 2013), thus averting the use of fuel. All of these strategies were based on local technology, know-how, and knowledge and thus enabled a good uptake and usage.

Reduction strategies

Such strategies seek to reduce the inappropriate use of the natural environment where preventive measures are not feasible and/or applicable. In very much the same way as preventive strategies, reduction strategies require local adaptation and acceptance by food network stakeholders and blend in well with cultural, social, and economic contexts, and importantly need to be convenient to implement. Commonly reduction strategies relate to products, for example reducing packing materials in food products. However, there are also other strategies: for example, in Ghana a transport trailer was designed so as to increase its loading capacity for farm crops (UNEP, 2006) thus reducing the number of trips required for crop collection; in pistachio processing in Iran, pistachio shells were used as fuel for powering processing machinery (Hokmabadi, 2015), reducing the need for using other energy sources.

Recapturing strategies

This looks at strategies that can recapture any value to be found in waste derived from food chain operations. In food value chains, more often than not food losses and waste may be inevitable because of the biological nature of food, for example, and thus such strategies for recapturing value from losses and waste need to be in tune not only with environmental priorities, but also and importantly social and economic priorities of stakeholders. Many networks for recapturing value from waste operate efficiently in recapturing residual value found in food losses and waste, but the efficiencies may be social as well as economic. For example, in pistachio processing in Iran, pistachio hulls, which can be considered waste, are used to make essential oils, jams, and animal feed (Hokmabadi, 2015); in Malaysia palm biomass waste is re-used to produce plywood for furniture, palm fibers, pellets, high value chemicals, and soil mulching (Ng *et al.*, 2012).

(Source: Hilmi, 2018)

Green food value chain development defined

A green food value chain can be defined as one that needs to provide value at each stage by proactively reducing the usage of the natural environment (natural resources, ecosystem services, and biodiversity), to diminish or mitigate adverse impacts, or even have positive impacts, while at the same time considering disposal and recycling patterns of generated waste, to recapture value at every stage

of the food value chain and thus further reduce environmental impact (Hilmi, 2014, FAO, 2015, Hilmi 2016a, 2016b; FAO & CIHEAM, 2016; Hilmi, 2018; Hilmi 2019).

This definition provides a basis on which to define a conceptual framework for developing green food value chains. The framework, shown in Figure 2, provides for a circular (and open-ended) non-linear flow of forward and reverse food values that progress from the natural environment to final markets. The forward flows increase not only food economic value, but importantly food environmental, social, and cultural values; the food value that is wasted is recaptured with reverse flows that reset such food value from an economic, environmental, social, and cultural point of view. The intent is to provide for a holistic, circular, and open-ended framework that inherently mitigates effects on the natural environment, attempts to adapt to changes, and at the same time attempts to replenish what has been used/consumed from the natural environment (Hilmi, 2014).

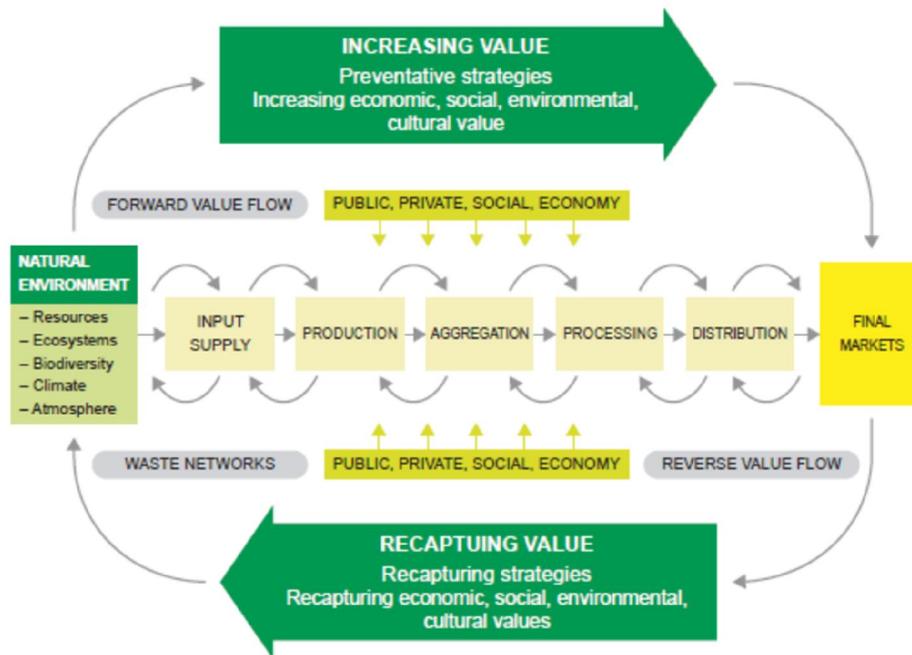


Fig. 2: The green food value chain development framework Source: (Hilmi, 2014)

The step by step process

As provided in Hilmi (2018) the green food value chain development approach is a step by step guideline (see Box 1).

Box 1: The steps in the green food value chain development approach

- Step 1: Form a multi-stakeholder working group
- Step 2: Identify one or more food value chains that need green upgrading
- Step 3: Select one or more specific food value chains for green upgrading
- Step 4: Map one or more food value chains, provide for an environmental hotspot analysis and a stakeholder analysis
- Step 5: Set specific objectives and strategies
- Step 6: Plan and action plan
- Step 7: Set up a monitoring and evaluation system
- Step 8: Hold regular multi-stakeholder working group meetings
- Step 9: Attempt to contribute to and foster the development of a policy action plan

Source: (Hilmi, 2018)

The guideline was purposely designed in this manner so as to allow for adaptability, flexibility and morphing in the most diverse of local circumstances and contexts that can be found in BOPs

globally. Some Steps are provided with “tools” that have been field tested time and time again, for example in Step 2 *Identify one or more food value chains that need green upgrading*, suggested tools to be used are rapid market appraisal (see CRS, 2009), market research, (see Miehlabradt & Jones, 2007), and end-market analysis (see USAID, 2008). In Step 4: *Map one or more food value chains, provide for an environmental hotspot analysis and a stakeholder analysis*, one of the tools provided is hotspot analysis (see GIZ, 2015). Step 5 of the green food value chain development approach provides for three generic strategies that are adaptable to the most diverse circumstances (see Box 1). In other Steps, for example, suggestions are provided in text boxes on how to go about managing and importantly implementing such Steps. The suggestion text boxes derived from extensive field work and experience, both from the research process of developing the approach, but also from other organizations, such as for example UNEP (see UNEP, 2016).

In the step by step process, a large emphasis in the green food value chain development approach needs to be based on learning from the BOP in terms of grass root (green/frugal) innovation technologies, activities, processes, systems, knowledge, know-how and behaviors. Some of the findings of the research have already been published (see Hilmi 2016a, 2016b, 2019) and some of the findings were instrumental when up-scaled to be provided as inputs to each step of developing green food value chains. Hence one of the major thrusts of the approach is to learn with a bottom-up perspective. But how can this learning occur and how does this learning transition into the green food value chain development approach.

Poverty and the Bottom of the Pyramid (BOP)

Sen (2000) sees poverty not merely as low income, but as a deprivation of basic capabilities. The relationship between capability and income is affected by location, gender, age, social roles and other variables. Hence the relationship makes it harder to convert income into capability, as since for example an older person who may be disabled may need more income to achieve the same capabilities of another person (Sen,2000). Consequently, poverty in terms of capability deprivation is more intense than what appears by considering only income levels (Sen,2000), but income is still an important means to capabilities. The capability perspective on poverty moves attention from the means, income, to ends, what people would like to satisfy in terms of these ends (Sen, 2000).

Poverty also places burdens on decision making. Poverty, usually but not always, creates a mindset that focuses on the present, in other words, how to survive the day. This intense focus on the present influences heavily the determinants of the future: when poor individuals must direct their mental resources toward daily poverty concerns they can devote less mental resources, for example cognitive thinking, to making investments for the future (World Bank, 2015). Poverty can also make aspirations oblivious and taking advantage of opportunities that may arise far less evident to an individual as well as reduced capacity to aspire (World Bank 2015). The context of poverty also imposes daily demands on individuals that deplete mental resources, for example the daily quest for potable water (World Bank 2015). All these factors impinge on poor people’s decision making abilities and all that such requires, hence can perpetuate poverty as a result of such decisions.

The BOP perspective regards poor people not as victims but rather as economic actors, potential entrepreneurs and value-demanding consumers (Angot & Ple’, 2015). This is especially true about food, food markets and food distribution systems. For example, at retail level, the diversities of food, how food is prepared, sold and consumed as well as the types of distribution networks used, all fit in to the high diversity of BOP markets and settings (FAO, 2012).

GIZ (2013) reports that out of the total BOP population, roughly 1.4 billion people live on US\$3-5 a day and are considered low-income, with some education and job skills, and a semi-regular income. Around 1.6 billion people live on US\$ 1-3 a day and are typically poorly educated and low-skilled. They have unsteady incomes (such as subsistence farming or temporary work) and interact in informal markets. The last billion people live in extreme poverty: their basic needs of food, shelter and clean water are not met and they are excluded from participating in the formal economy. Technically, you are poor if you live on US\$2 a day or less and if you live on less than US\$1.25, as more than a billion people do, you are extremely poor (Giugale, 2014).

Consequently, in BOP markets, many goods and services are either unaffordable or unavailable, for example, people in the BOP typically do not have a bank account or insurance, a fridge, TV or vehicle of any kind, and they typically lack access to basic utilities such as water and electricity (GiZ,

2013). But people in the BOP do have purchasing power, in other words they have money to spend. It may be a very small amount per capita, but it is still spending power. Most of the money of low-income people is spent on food, clothing and fuel, leaving very little for anything else. Because they only buy in small quantities, have little experience as customers and are rarely able to choose between providers, they pay particularly high prices – a situation referred to as the ‘poverty penalty’ (GiZ, 2013).

Lack of knowledge of what it is to be a “consumer” refers to consumer illiteracy, while consumer literacy includes the ability to manage one’s identity, as well as the knowledge and ability to use personal, situational, and social coping skills to get one’s needs met in the marketplace (Adkins & Ozanne, 2014). Consumer literacy is reading labels, but it is also understanding consumer rights and labeling practices and being able to manage a service encounter or lodge a complaint (Adkins & Ozanne, 2014). In this regard in the BOP, consumers are brand conscious, are well connected not only among themselves in terms of relational networks, but also thanks to the access of, for example, mobile communication. Such environments, although resource-poor with respect to income and literacy, are typically network-rich, with social ties among people that facilitate information sharing and the consequent development of consumer and entrepreneurial skills (Viswanthan *et al.*, 2010). The BOP is prone to adopt new technologies, but apart from these common trends, the BOP is far from homogeneous: it represents multiple cultures, ethnicity, literacy, capabilities, and needs (Pralhad, 2011).

Consumers in the BOP have very specific, but not necessarily basic needs to fulfill, seeking out for very low prices, precise and useful features in products or services. These goods and services are commonly provided within their communities, for the communities, are commonly customized, either in product features or related services, and can be highly innovative. Consequently, innovation or more precisely frugal innovation, that is to say the process of designing and producing simple goods or services that benefit many people with limited resources, has been seen as a possible and potential solution (Radjou *et al.*, 2012). For example in South India, (see Viswanathan *et al.*, 2012), for consumers in the BOP there is a strong mutual interdependence, not just between buyers and sellers, but between friends, neighbors and others involved in their social networks, a reliance on oral tradition, empathy among buyer and sellers beyond the simple economic transaction (interactional empathy), a focus on long term and enduring relationships, high seller responsiveness to customer demands and high demanded customization. In a case from Brazil (see Barki & Parente, 2010) for consumers in the BOP there is a different configuration of the perception of value not solely determined by lower prices; a stronger need to compensate for a dignity deficit and low self-esteem; a stronger preference for personalized relationships; a high level of aspiration to feel socially included in society; and a preference for abundance.

It was found in The Gambia, for example, that consumers relied very much on their relational networks, in their community area, and if ventured outside the community area, they would rely on community referrals and rarely buy from non-referred sellers. Commonly, food was bought daily, and the meal numbers would vary from one to two. Often food was bought on credit. Moreover, in yet another case example, in Zambia, food was bought from informal street sellers hawking traffic lights, but there was a strong trust connotation, as commonly women would buy meager quantities of food from male sellers on credit, and often failed to pay when the credit was due. Further, in another case in Chad, street sellers were found to be the main source of daily nourishment for many of the poorest. There were strong bonds between buyers and sellers as for buyers it represented the only meal of the day and hence were looking for food that was safe and satisfying, while for sellers the buyers represented not only a meager assured daily income, but the possibility of remaining in business and earning a livelihood. Hence this highly relational and interdependent bond, assured not only a focus on enduring food quality, but also mutual reinforcing ties. Moreover, it was found in Tunisia, that there were very strong social ties between sellers and buyers at the street food level, where the buyer would provide traditionally grown foods to customers who were sick, at no price difference. Traditional foods were (are) cultivated and grown without modern farming inputs such as hybrid seeds, chemical pesticides and fertilizers, and could be considered as “organic food without formal certification”. Consumers valued such traditional foods as they traditionally evaluated them as being healthy foods, to be consumed when one was not well. Sellers would supply such traditional foods to consumers who were not well, but did not charge a premium for such foods, as sellers were considering the social good of such foods and the social courtesy around such foods for those who were not well.

The poor, as has been amply documented, are typically more dependent on environmental capital and climate for their economic activities, not least as most of the poor still live in rural areas, dependent on agriculture (Dercon, 2012). The poor are also more vulnerable to extreme events affecting economic productivity, health and security of livelihood, and may also find it harder to adapt their livelihoods to changing environmental conditions, as they lack the resources to invest in more appropriate profitable economic activities (Dercon, 2012). Hence the BOP, as commonly thought, is more vulnerable to environmental concerns such as climate change and pollution, for example, and individuals and communities have less capacity to adapt (Vermeulen *et al.*, 2012).

Food value chains that operate in BOP settings seemingly do not have a good natural environmental track record according to the common adage of the interface between poverty and the misuse of natural environmental assets. However, this is not always the case as demonstrated in some studies (see Benson, 2014; Brown *et al.*, 2014, Hilmi, 2016a, 2016b). For example, small-scale farmers and micro-scale traders are far more embedded within the natural environment (and its degradation) in many BOP settings, especially within peri-urban and urban areas, and consequently seem to be far more sensitive to environmental concerns. This seemingly creates a greater awareness for the natural environment and thus more motivation (and concern) to use natural environmental assets in a way that attempts to avert further degradation and harm to their work and livelihoods. Many practices that are carried out in such BOP settings are undoubtedly carried out and motivated as a matter of need (poverty) and to earn whatever meagre living can be made. However, such practices can also potentially reduce the environmental impact of food chain operations. For example, the reintroduction of recycled materials into food value chain activities, which many food value chain actors are involved in, causes a reduction in the emissions of pollutants generated during the production and marketing of food. These recycling activities reduce the quantity of waste that is destined for landfills and consequently reduces greenhouse gas emissions because a lower content of organic material goes into landfills (GIZ, 2011).

Poverty measurements

Identifying poverty, and importantly its various segments, at field level may seem to be a fairly easy task. For example, based on macro (aggregate level) data and information, gross domestic product (GDP) per capita may seemingly be sufficient. But GDP per capita, for example, is being more and more recognized as not sufficient to account for the well-being of individuals. As provided by Berik (2018), GDP only captures market-sourced goods and services and underestimates non-market contributors to well-being, such as for example detraction from well-being, that can be environmental degradation. Increasingly it is being recognized that poverty is not just a question of low income and consumption.

The Global Multidimensional Poverty Index (MPI), provided by the United Nations Development programme (UNDP), along with the Oxford Poverty and Human Development Initiative, covers education, living standards and health for over 100 countries, complementing income based poverty measures. It has ten weighted indicators: nutrition; child mortality; years of schooling; school attendance; access to cooking fuel; sanitation; potable water; electricity; quality of flooring; and household ownership of basic assets. If someone is deprived in more than one-third of these ten basic needs indicators, they are identified as MPI poor (Lawson *et al.*, 2017). More recently, the World Bank (2018) has also provided a multidimensional global poverty measurement. These multidimensional poverty measurements (MPMs) do not exclude income and consumption, as these are very important in measuring poverty, but include other aspects of human well-being also, for example community safety, access to infrastructure services, etc. However, one important point about these multidimensional poverty measures is that not all goods and services that matter are obtained exclusively through markets (World Bank, 2018). An example of goods and services which cannot be bought, but are important, is a clean environment. The MPMs recognize that many dimensions of well-being are not all readily available through markets. Considering poverty under the lens of MPMs, for example in the case of the World Bank (2018), alters the share of the poor by 50 percent. Currently, for example, the extreme poverty line is set at those living with less than int\$1.90 per day (Roser & Ortiz-Ospina, 2017).

Other measures also exist. There is the Human Development index, provided by the United Nations Development programme, (see UNDP, 2018), there is the OECD's Better Life Initiative (see OECD, 2018), there is also the Happy Planet Index (HPI) (see Jeffrey *et al.*, 2016), the Genuine Progress

Indicator (GPI), etc. However not all these indicators provide for the natural environment (Berik, 2018). Thus aggregate indicators need to include environmental and non-market contributors to well-being, in other words, there is a need to aggregate economic indicators of well-being that are cognizant of the problems of ecological disaster and inequality (Berik, 2018). For example, Managi and Kumar (2018), consider for well-being a stock of assets that equal what is defined as “inclusive wealth”. The assets are manufactured capital (roads, buildings, machines, equipment), human capital (knowledge, skills, education) and natural capital (forests, agricultural lands, atmosphere). Interestingly they find that using inclusive wealth per capita, since 1998, 44 out of 140 countries have experienced a decline in inclusive wealth.

The duration of poverty is also another measure used. It considers, for example US\$1 per day, and for how long individuals have been in this situation as well as the intergenerational transmission of poverty. Yet another method used is that ‘an indicator’ is identified in the field that can be easily assessed and it can provide measurement of individual and household poverty. For example, one of the indicators is access to food. Yet another method to identify poverty is participatory: for example, the participatory rural appraisal method involves individuals from a community conducting and recording such matters as focus groups, social mapping, wealth ranking and community mapping (see FAO, 1997).

Poverty also derives from wealth inequality. As reported by WIB (2018), income inequality has increased in nearly all countries, the highest income inequality is found in the Middle East, and wealth inequality among individuals increased across countries. The WIB (2018) also finds that there has been a rise between inequality of ownership of capital between private and public, in other words governments have become poorer.

We have seen some of the measures that can be used to measure and identify poverty, and have seen that income and consumption data and information are the most common. These are based on the poverty-line to meet calorie needs of an individual, currently set at int\$1.90 per day. It is a useful indicator, but as per Lawson *et al.*, (2017), a particular disadvantage of this is that it cannot be used in the field to practically identify poor people or the poorest people, as collecting accurate data on the income of very poor people is costly, time-consuming, and beyond the capacity (and the cost structures) of most service delivery agencies.

From the above it is clear that as a starting point identifying poverty, and its various segments, is not an easy task at field level. This initial identification, using the above mentioned reports that are provided from various organizations, along with tools to actually carry out more specific in the field poverty identification and assessments, for example see FAO, 1997, are a necessary first step in the approach of green food value chain development.

Learning from the bottom of the pyramid

Poverty does not occur all at once, it is a long lasting, daily-routine experience, over cast by vulnerability, destitution, physical pain, and easily preventable death. Daily survival is a struggle and is primarily based on “personal efforts”: casual laboring, recycling waste, begging, using common property resources and the support that is offered by relatives and neighbors. It is in this context of “survival” that the green food value chain development approach attempts to learn from and attempts to understand and assess “innovations” that have environmentally sensitive connotations in terms of technologies, activities, processes, systems, knowledge, know-how and behaviors. Some of these green innovations have already been documented, for example by Hilmi 2016a, 2016b, 2019, as well as by others, for example see Pansera & Owen 2014b.

Despite the importance of innovation, there are many misconceptions about it. A major one is the mistaken assumption that it must involve “high technology”, requiring advanced scientific and technological resources (Botta *et al.*, 2015). But in the BOP, learning to be innovative is a daily necessity of trial and error and in most instances means doing more with the same and more often than not, doing more with less. Learning from the BOP is not just about technology, but also about activities, processes, systems, knowledge, know-how and behavior (Hilmi, 2016b). Most of these are considered “innovations” and are commonly referred to as grass-roots, frugal and/or green innovations. Each type of innovation has been defined separately, see for example Radjou & Prabhu, 2013; Pansera, 2013; Hilmi, 2012 and Díaz-García *et al.*, 2015, but commonly such innovations are interrelated and interlinked as they are born and provided at the grass root level, mostly intended for the grass root level,

are based on frugal use of resources and as per their frugality also have green connotations, as per the savings in the usage of natural resources, for example.

Grass root innovations are innovative skills, activities, processes, systems and products found in the BOP commonly deriving from challenges, hardship and necessities (Hilmi, 2012). The innovations derive from the distinctive nature of BOP markets, that are characterized by acute social-economic, institutional and financial resource constraints and are born out of local knowledge of specific community needs and a commitment to the local community (Sarkar, 2018). Grass root innovators, commonly have little formal education—but often possess a rich heritage of traditional knowledge (Pansera & Sarkar, 2016). Grass root innovators and their innovations arising from within the BOP can have a tremendous impact not only in terms of serving unmet and ignored consumer needs, but also longer term impacts through enhanced productivity, sustainability, poverty reduction and promoting entrepreneurship behind the regional borders in which they originally emerge (Kaplinsky, 2011).

The importance of these innovations, for example frugal Innovations, lies partly in their ability to be economically efficient under conditions of severe scarcity and develop sustainable solutions that address immediate needs while integrating a long-term outlook (Basu *et al.*, 2013). Frugal innovation provides solutions, employing scarce resources, that are affordable, sustainable, easy-to-use and provide to solve urgent local problems (Hossain *et al.*, 2016). Frugal innovation is the ability to generate considerably more business and social value while significantly reducing the use of scarce resources. More than a strategy, frugal innovation is a whole new mindset, a flexible approach that perceives resource constraints not as a debilitating challenge but as a growth opportunity (Radjou & Prabhu, 2013). Frugal innovation means re-thinking how resources will be used and implementing such know how, to generate trade, that has environmental as well as social value. Frugal innovation conducted in BOP markets, not only has the potential to tackle large and untapped markets with innovations born and bred in such contexts, but importantly such innovations have strong environmental values inherent in the outcomes and can contribute, actively to improved quality of life for BOP populations (Angot & Ple', 2015). As per Angot & Ple' (2015), the outcomes of frugal innovation processes usually present four main characteristics: affordability, good performance, usability and importantly sustainability.

Working to reach the poorest involves considering multiple layers of exclusion and deprivation as well as trade-offs between competing groups (Lawson *et al.*, 2017). Critically individuals, researchers and organizations involved in development have to overcome a high level of unfamiliarity they typically have with these contexts (Viswanathan *et al.*, 2016). The complexity and uncertainty involved in such contexts exacerbate the difficulty of gaining insights. These contexts are plagued by inadequacies in physical and informational infrastructure, operate in formal-institutional voids, are characterized by low levels of literacy and the distinctiveness of each setting calls for methods that help researchers and organizations overcome such barriers (Viswanathan *et al.*, 2016). The distinctiveness of each setting calls for methods that help researchers and organizations overcome such barriers.

Further in researching BOP contexts there may be a set of biases on behalf of the researcher. These are well exposed by Chambers (2017). Personal bias is the tendency by researchers for example, to perceive reality in ways that are closest to personal cultural, social and intellectual backgrounds; spatial bias is the tendency to choose research locations that are easily accessible from urban areas, can be reached by road and are safe; project bias is the tendency to visit project locations where outside intervention has occurred and hence distorting what reality really is all about on the ground; person bias is to meet people who are commonly most accessible, for example such as government officials, etc. and enquire about non-sensitive matters; seasonal bias is to commonly visit locations when the weather is favorable and roads can be traveled on; and gender bias is where commonly men are sought for research far more than women.

Viswanathan *et al.*, (2016) provide for the following research methods to better understand such contexts: (a) organizing a short research immersion for effectiveness *and* efficiency; (b) combining verbal communication with sensory observation; (c) trying out action-oriented approaches involving researcher/educator–participant interaction; (d) covering different units of analysis in terms of individuals, households, communities, village-level leadership, and the outside ecosystem of organizations; and (e) combining natural science analytical testing with social science methods, and substantive issues: focusing on specific substantive domains in subsistence to understand the intersection of poverty and the environment.

In another case, researching and better understanding BOP contexts requires, for example as in the case of Chikweche & Fletcher (2012), the researchers living in the BOP respondents' community for a continuous period of time and using such qualitative data collection methods as in-depth one to one consumer interviews, focus groups, ethnographic observations and case studies.

In such BOP contexts it is good to (a) acknowledging one's own ignorance and (b) actively seek the voices of the marginalized: This approach is, thus, starting at the micro-level. In other words, 'lived experience' is the starting point for knowledge: (a) anchored in premises that accurately describe the realities in poverty, (b) parsimoniously explain the empirical regularities observed in contexts of poverty and (c) predict interventions or programs that enhance well-being in contexts of poverty (Venugopal & Viswanathan, 2017).

However, just listening is far from an easy task: It takes time, energy, demands attention, receptiveness, and requires choices (Anderson *et al.*, 2012). Listening is a discipline that involves setting aside expectations of what someone will say and opening up, instead, to the multiple levels at which humans communicate with each other. At the interpersonal level, one needs first to be quiet long enough to let the other person talk (Anderson *et al.*, 2012). Then one needs to ask questions and probe the ideas offered rather than interject one's own opinions and analyses or jump to quick conclusions about what the other person means. A listening conversation is distinct from an interview. It opens space for dialogue on issues of importance to both parties. The act of listening is a way of showing respect (Anderson *et al.*, 2012).

Hence it is not only identifying poverty that can be challenging. What is also challenging is researching BOPs and interacting on a daily basis with those who earn a livelihood within such a context, in attempting to access and gain insights, for documenting green innovation technologies, activities, processes, systems, knowledge, know-how and behaviors. For example, in Tanzania it took well over two weeks to be able to "embed" or "immerse" in a local community, gain the respect and importantly trust of the people, prior to being able to have an in-depth insight into the community, in an attempt to find and ascertain any green innovations. Commonly in this local context, small-scale actors in the food value chain, such as for example farmers, traders, processors, retailers, consumers and waste pickers, were very diffident initially "to speak their minds", but with group discussion techniques derived from the participatory rural appraisal method (see FAO, 1997), participants felt far more confident. Critical to this was follow-up one-to-one informal unstructured interviews, well camouflaged in (listening) conversations, to obtain in-depth insights. This wealth of information from such green innovative approaches was documented, up-scaled, shared with other local communities, and integrated into projects devoted to green food value chain development. For example, incorporating such knowledge into training that was conducted with public and private organizations in country, in attempts to institutionalize such green innovations.

In this regard of institutionalizing and spreading to wider audiences such innovations a promising, and well documented, proposition are green innovation centers. Via innovations and multi-stakeholder partnerships (private sector, civil society, research and associations) these centers, provided by German Federal Ministry for Economic Cooperation and Development, are present in over 14 countries and focus on four main areas: training, extension coaching, networking and access to finance. This knowledge sharing is critical to greening activities and innovation has many facets, that run all along the food value chain: from improved production practices, to reduced post-harvest losses to more effective and efficient marketing. Such innovations can become well established as for example target training of smallholders is set at 1, 110,000 (BMZ, 2017). Such centers are a good example of institutionalization of green innovations and hence could possibly become conduits of such green innovations found in BOPs and diffused and adapted more broadly to augment further green food value chain development.

Foreign consultants commonly dominate knowledge supply to government, industry and aid donors. Small firms and farms are not used to articulate their demand for knowledge. Such weak demand and timid articulation are typical signs of emerging innovations systems (Trojer *et al.*, 2014). An intriguing perspective is represented by the possibility to adopt, hybridize with, or scale up the sustainable solutions coming from the South (Pansera & Sarkar, 2016). Such learning from the BOP can be "building upon what disadvantaged people are rich in: (the) *inability to live with problems unsolved*" (Gupta).

Conclusions

There is evidence to suggest that BOP contexts can be seen as R & D hubs for green innovations and from which technologies, activities, processes, systems, knowledge, know-how and behavior can be captured and fed into making food value chains greener. Such an approach to greening food value chains enables a far more and better understanding of not only what needs be done, but realistically what *can* be done. It also enables that green innovations found in the BOP context can be more readily implementable as they derive directly from the local BOP context and are provided, on a larger scale, back to the local context. This is not only very much in line with the green food value chain development approach that was designed to allow for adaptability, flexibility and morphing in the most diverse of local circumstances and contexts that can be found globally, but is critically focused on “*what is real in the field*”.

Further and as provided by UNDP (2017) cost benefit analyses (CBAs) proves that investments in greening activities can be highly profitable, especially in the long run. Various value chain actors be they public and/or private, have indeed shown considerable innovation and drive to make the shift towards environmentally sustainable and resilient food value chains. But multiple constraints impede the expansion of good practices. A holistic, systemic approach is needed to connect production and consumption, to bridge different policy domains and to create action-oriented partnerships throughout food value chains (UNDP, 2017).

If governments are not explicit about the importance of agriculture and do not make large expenditure and rapidly build key government institutions to foster agricultural growth, (that is environmentally sensitive), the sector will not grow rapidly and rural poverty levels will decline slightly or not at all (Mellor, 2017). Of course agriculture is preeminently private sector—farmers are private sector as is the bulk of input and output marketing firms. However, they become more motivated in the context of clear government emphasis on their role in reaching national objectives and they require essential, constantly improving, complementary government services including rural roads, electrification, education and major government institutions always including research and extension, and many modest services such as statistics provision and market analysis (Mellor, 2017).

Small commercial farmers, for example, dominate agricultural production in most low- and middle-income countries and spend a substantial portion of their incremental income from farming on labor-intensive non-tradable goods and services from the large, rural, non-farm sector. This is central to poverty reduction (Mellor, 2017). The rural poor are concentrated in the rural non-farm sector and their employment and income increase comes from increased local demand for non-farming activities. That demand comes from the small commercial farmer and is the dominant means of reducing poverty in both low- and middle-income countries (Mellor, 2017). Many households in the rural non-farm sector also do some farming, earning a portion of their income from that source. Because small commercial farmers dominate agricultural growth and foster rapid growth in the rural non-farm sector this plays an important role in economic transformation (Mellor, 2017). That not only speeds up economic transformation but disbursts urbanization from the major central city to a geographically dispersed set of smaller towns and cities. That in turn influences the path of growth as upper-middle-income and high-income status is achieved (Mellor, 2017).

Moreover, policies that foster growth, like for example green growth policies, cannot ignore the informal economy. Most of the world’s poorest and most vulnerable people live and work in the informal economy (IIED, 2016). The informal economy is closely tied to the state of the environment and the informal economy will not vanish any time soon, as millions of people live and work in the informal economy. In many developing countries, the informal economy employs more than half the workforce, one billion people live on agriculture, and most arrangements are informal and the informal economy is worth US\$10 trillion, 13 percent of the world’s GDP (IIED, 2016). Many poor people depend on natural resources to support their informal economic activities, this means they are particularly vulnerable to the impacts of climate change and environmental degradation, which exacerbate the poverty cycle. The link between deterioration in natural resources and drop in incomes is direct. Informal activities that depend on natural resources can be environmentally damaging, charcoal production, for example, is associated with environmental pollution and degradation (IIED, 2016), however there are lots of other examples of how informal activities can and do support a green economy, for example see Benson, 2014; Brown *et al.*, 2014; and Hilmi, 2016a, 2016b, 2019.

The way forward

More research needs to be conducted in the BOP in terms of green innovations that can further enable, enhance and augment green food value chain development. There is also a need for far more research on how such green innovation learning from the BOP can be institutionalized and importantly shared with wider audiences. Further more research is undoubtedly needed in the field of researching and learning from BOP settings. True that many research methods already exist that help and support research in BOPs contexts, for example see Venugopal & Viswanathan (2017), Shah (2018), Reason & Bradbury (2008), Anderson *et al.*, (2012), FAO (1997), but far more diffusion of such knowledge is required for people involved in development. This calls for more research in participatory and experiential training methods that can be used to support the training of field practitioners in how to learn from the BOP.

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