1 Introduction

Smallholder farmers cultivating in West African cities may lack appropriate knowledge on the safe application of agrochemicals and may also lack access to sufficient and clean irrigation water, particularly in the dry season. Thus, many urban farmers in West African cities rely on the use of wastewater in agricultural production. Wastewater includes pathogens, such as bacteria or viruses, which may cause human health risks (e.g. diarrhoea or typhoid). Consequently, West African consumers are likely exposed to health risks, especially when eating fresh produce. According to the World Health Organization (WHO, 2019), 550 million people worldwide get sick of diarrhoea annually of which 230 000 people die due to the intake of contaminated food.

Wastewater filtration systems treat wastewater prior use. This may reduce the pathogen load to a level where the consumption of agricultural produce is safe, that is, not harmful to human health,[1] according to the WHO standards. A farmer will only have an incentive to invest in such a filtration system if he knows that consumers are willing to pay higher prices for safe vegetables. If the price premium consumers are willing to pay is high enough, then the farmer could cover his additional production costs by passing them to the consumers.

Currently, we do not know whether consumers value food safety since under the present local market conditions, safe products cannot be differentiated from unsafe ones prior purchase. This is because safety is an attribute of food, which is not observable by the consumer prior purchase. The farmer who produces food or the trader who sells food can be expected to be better informed about the safety of food than the consumer. We have a situation where the information on food safety is asymmetrically distributed with an information deficit on the consumers' side. Food providers can improve the information environment for consumers by signalling them that the food they sell is safe. The two signalling

[1] The term "safe" food in this thesis means that the use of agrochemicals or wastewater in agricultural production is still allowed but to a level which is – according to the WHO standards – safe for human consumption. This understanding of "safe" vegetables is similar to the one which is applied by Yu, Gao and Zeng (2014, p. 80). The enforcement of production methods to produce "safe" vegetables is – considering the developing country context − easier than the enforcement of organic production. Organic production is – with few exceptions – characterised by the complete absence of synthetic inputs. In addition, farmers often have to implement further environmental protection measures to receive an organic certificate (Food and Agriculture Organization of the United Nations [FAO], 2008, p. 11). This would deprive many smallholder farmers of their livelihood.

methods that are of relevance in this thesis are (i) repeated purchase experience and (ii) certification.

The aim of this thesis is …

- …to assess consumers' maximum willingness to pay (WTP) a higher price for vegetables that are safe and for vegetables that are certified to be safe and
- …to identify the determinants that are shaping consumers' WTP.

The WTP-influential determinants we focus on are, among others, the effects that different levels of trust in food providers and trust in certifying institutions bring about for WTP. Trust is a precondition for reducing information deficits on the consumers' side, through repeated purchases on the one hand and certification on the other hand.

The influence of trust in traders, trust in farmers and trust in certifying institutions on consumers' WTP for safe and certified safe vegetables is analysed in a Hicksian framework and verified empirically with household data collected in Tamale (Ghana), Ouagadougou (Burkina Faso), Bamenda (Cameroon) and Bamako (Mali). Consumers' WTP was elicited with the double-bounded dichotomous choice (DBDC) approach of the contingent valuation method (CVM). Two standardised surveys, that is, one for eliciting WTP for uncertified safe vegetables, and one for eliciting WTP for certified safe vegetables were conducted in each of the four research locations within the Urban Food Plus (UFP) project.

The UFP project is an international and interdisciplinary research project that aims at investigating and test-implementing technical innovations to enhance agricultural production, food safety and value chains in urban and peri-urban agriculture in Tamale, Ouagadougou, Bamenda and Bamako (see Figure 1-1). One of the technical innovations developed in the context of the UFP project is a low-cost wastewater filtration system to reduce the pathogen load in vegetables to a level that, according to the WHO standards, is not harmful to human health. The contingent valuation (CV) surveys encompassed by this thesis will give insights into the potential adoption of such a wastewater filtration system from the perspective of local farmers by eliciting costumers' WTP for safe and certified safe vegetables.

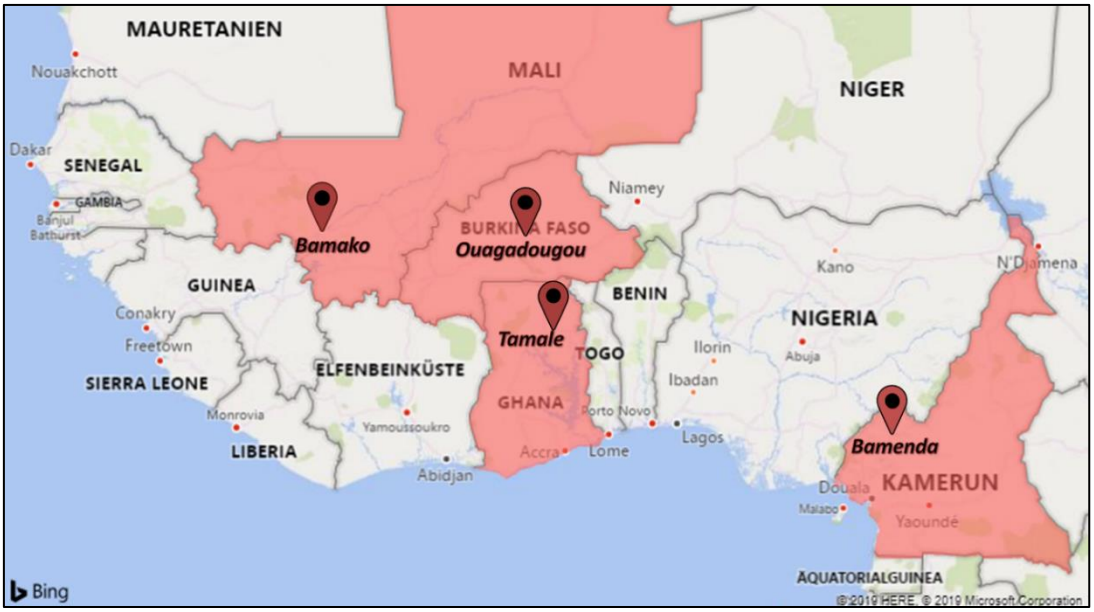

Figure 1-1: Research locations in West Africa (modified from Bing maps, 2019).

In Chapter 2, the key concepts that are relevant in this thesis are discussed. We first define food safety, present food safety hazards and relate them to adverse health effects in general and with regard to wastewater irrigation in particular. We then identify safety as a food quality attribute, introduce additional food quality attributes, and classify them as either search attribute, experience attribute or credence attribute. These three kinds of quality attributes differ in their observability before and after purchase and, consequently, in their costs associated with searching for information on the good's quality. Information costs for experience and credence goods are likely to be high, so that consumers are not expected to search all relevant information. This indicates that information asymmetries for specific food quality attributes are likely to remain. Informational asymmetries and their impact on high-quality products traded are illustrated next based on Akerlof's (1970) market for lemons (Section 2.3). Afterwards, we present certification and repeated purchase experience as two market signals to overcome the problem of asymmetrical information (Section 2.4). The effectiveness of both market signals is closely linked to trust which is elaborated in Section 2.5.

Chapter 3 comprises the theoretical and empirical framework for the economic valuation of food quality improvements. We first set the theoretical framework by categorising food safety according to the concepts presented in the preceding chapters, based on a public-private good discussion, and embedded in a discussion on food markets in developing countries and their differences in dynamics

compared to Akerlof's (1970) market for lemons (Section 3.1). Based on this discussion, we then show using Hicksian measures how trust in traders, trust in farmers and trust in certifying institutions influence consumers' WTP for two different kinds of safety improved vegetables, namely, safe vegetables and certified safe vegetables (Section 3.2).
We then move on to the CVM that provides the empirical framework for the CV surveys (Section 3.3). This section contains literature-based discussions on the construction of the valuation scenario, WTP elicitation techniques, biases that might arise in CV surveys, strategies to mitigate them and econometric approaches to the analysis of CV data.

Chapter 4 outlines the research design and the methodology. We first provide background information on the four countries in which the CV surveys were implemented with a particular focus on food safety problems (Section 4.1). We then show how sampling was conducted, CV surveys were designed and data were collected (Section 4.2). Section 4.3 contains a detailed description of how we applied the DBDC format to elicit consumers' WTP for a range of safety improved vegetables. This chapter ends with a comprehensive description of how we operationalised the variables used in the empirical analysis (Section 4.4).

Chapter 5 presents the empirical results of the eight CV surveys which are interpreted in accordance with the concepts and theories discussed in the Sections 2.1–3.2 and which answer the two research questions of this thesis. Firstly, some descriptives on household characteristics, food quality awareness, food safety perception and trust (Sections 5.1–5.5) are provided. Afterwards, in Section 5.6, the first research question which asks for consumers' WTP for safe and certified safe vegetables is answered by presenting mean WTP values and price premia which are cross-checked for similarities and differences. Research question 2 which asks for determinants influencing consumers' WTP is answered next through a comparative analysis of regression results. Each regression is checked for its construct validity from which we draw conclusions on the validity of respondents' WTP statements. As the characteristics of safe and certified safe vegetables potentially require new marketing channels if introduced in West African cities, consumers' preferences in this regard are assessed in Section 5.7.

This thesis ends with a summary of the main results and gives a conclusion in Chapter 6.

2 Food safety, informational asymmetries, repeated purchase experience and food certification

The aim of this chapter is to explain what food safety means, to distinguish different food safety hazards and to show how these food safety hazards may contaminate food along the food value chain. Food contamination and resulting illnesses are often linked to unsafe water used in agriculture (Section 2.1.1). Wastewater is unsafe water but an important alternative to fresh water, particularly in areas where fresh water is a scarce resource (Section 2.1.2). Based on this background information, food safety is then categorised as food quality attribute, which is not observable by the consumer prior purchase (Section 2.2). As the food provider is most likely better informed on the product's quality than the consumer, the food market is characterised by asymmetrical information (Section 2.3). Informational asymmetries can be mitigated by market signals (Section 2.4), such as certification (Section 2.4.1) or repeated purchase experience (Section 2.4.2). Both signals are available to the consumer prior purchase and, under certain circumstances, may convey information related to the unobservable food quality attribute "safety". Trust in the persons and institutions providing information on food safety is required in order for repeated purchase experience and certification to be effective (Section 2.5).

2.1 Food safety

Health risks associated with the consumption of unsafe food increase globally. Some of the major drivers include the growing consumption of fresh produce, an increase in the international trade of fresh produce and the increasing number of people, particularly in developing countries, moving to urban areas (Unnevehr, 2003). We will elaborate the interrelation of urbanisation and food-borne health risks further. Urbanisation increases the demand for food in urban areas, particularly the demand for fresh produce. Urban food markets used to get the fresh produce they offered from rural areas (FAO, 2011, p. 3). However, the transportation of agricultural products from rural to urban areas faces many challenges, including the lack of cold storage facilities, bad transport conditions and long distances (FAO, 2011, p. 9). This negatively affects the quality of food (FAO, 2011, p. 3) and even results in high losses of food (FAO, 2011, p. 9). Urban agriculture (UA) is considered to mitigate these problems as it supplies food there where it is consumed (FAO, 2011, p. 3). In the absence of reliable

means of transport, UA is the only source to provide the city with fresh vegetables including leafy vegetables as they lose their freshness one day after harvesting (Moustier and Renting, 2015, pp. 124–125). Leafy vegetables are vegetables from which the leaves are eaten, for example, cabbage and lettuce (FAO and WHO, 2008a, p. 9). These are two of the most frequently consumed vegetables in African countries (Moustier and Renting, 2015, p. 125). Although UA brings benefits to the urban population and increases the food security, it also creates new challenges, especially with regard to water demand and, related to that, to food safety. Agriculture is already the largest consumer of fresh water worldwide,[2] and it will increase the water demand even further as the rise in food demand requires a rise in agricultural production. This poses challenges to water-scarce urban areas as the agricultural sector competes with private households and the industry sector for fresh water. To mitigate this problem, wastewater is increasingly used as an alternative irrigation source in agriculture (Mateo-Sagasta et al., 2013, pp. 13–14). However, wastewater is likely to carry food safety hazards and can, therefore, cause adverse health effects if the households consume wastewater-irrigated vegetables (see Section 2.1.1).

2.1.1 Definition, hazards and adverse health effects

Food safety concerns hazards that may cause negative health effects (FAO and WHO, 2003, p. 3). Food hazards can be differentiated into physical,[3] biological or chemical hazards (Moy and Todd, 2014, p. 243). As the causes for foodborne diseases, chemical hazards and particularly biological hazards, are of special importance for this thesis, they are described in more detail.

Chemical hazards can contaminate food when food is produced, harvested or processed. During the production of food, chemical hazards can be introduced through the inappropriate application of pesticides leaving residues on food. Furthermore, food can become contaminated through heavy metals included in the soil or water (FAO and WHO, 2003, p. 27) that farmers use for agricultural purposes. When the food is harvested, contamination may happen through detergents used to clean farm equipment or food itself. When the food is processed, it can become contaminated through acrylamide (Grace, 2017, p. 15),

[2] It is estimated that 70% of freshwater worldwide is used for irrigation in agriculture (World Water Assessment Programme [WWAP], 2012, p. 46).

[3] Physical hazards are, for example, stones, wood, metal or insects (Aladjadjiyan, 2006, p. 211). They can enter food at any point in the food chain (Aladjadjiyan, 2006, p. 209).