

Measuring gaps and weighing benefits

Analysis of Quality Infrastructure Services along the maize and pineapple value chains in Ghana with a focus on smallholder farmers

Thomas Pfeiffer, David Bexte, Erik Dolch, Milica Sandalj, Edda Treiber, Nico Wilms-Posen



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Seminar für Ländliche Entwicklung | Centre for Rural Development

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Foreword

For 53 years, the Centre for Rural Development (Seminar für Ländliche Entwicklung, SLE) at the Humboldt Universität zu Berlin has trained young professionals in the field of German and international development cooperation.

Three-month practical projects conducted on behalf of German and international organisations in development cooperation form an integral component of the one-year postgraduate course. In interdisciplinary teams and with the guidance of experienced team leaders, young professionals carry out assignments on innovative future-oriented topics, providing consultant support to the commissioning organisations. Involving a diverse range of actors in the process is of great importance here, i.e. surveys from the household level to decision-makers and experts at national level.

The studies are mostly linked to rural development (including the management of natural resources, climate change, food security or agriculture), the cooperation with fragile or less developed countries (including disaster prevention, peace building, and relief), or the development of methods (evaluation, impact analysis, participatory planning, process consulting and support). Over the years, SLE has carried out over two hundred consulting projects in more than ninety countries, and regularly publishes the results in this series. In 2015, SLE teams completed studies in Ghana, the Philippines, Mozambique and Namibia.

The present study is the synthesis of the development and testing of a methodology on the systematic field research in two of Ghana's rural provinces to what degree quality infrastructure (QI) is utilized by smallholders. The two value chains maize and pineapple were studied with a focus on QI providers, their QI services and what obstacles lay in smallholders' way to increase utilization of QI.

The study was commissioned by the Federal German agency for standardization and metrology *Physikalisch-Technische Bundesanstalt (PTB)*. In the field, PTB's implementing partner the Ghana Standards Authority was supporting and involved in the detailed performance of this study.

The full report is available from the SLE and downloadable from the SLE website.

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In Ghana, we were warmly received and welcomed by so many people, organizations and companies that we can only mention a few. The Ghana Standards Authority (GSA) is not only PTB’s main implementing partner, but was also our host. In particular, the GSA’s Metrology Department managed by P. Date provided us with a steady counterpart. GIZ’s MOAP program was so kind to provide us with a vehicle, partially finance two drivers and contribute to our study – through its countrywide staff – with extremely helpful insights in their work and the situation of Ghanaian smallholders. The University of Ghana in Legon not only hosted us, but also made a crucial contribution to the study by offering their agricultural expertise. In addition, the university facilitated our contact with five of their graduates who helped us understanding the smallholder farmers. In particular, we are thankful to the crop science department managed by Dr. C. Amoatey who discussed practical details with us throughout the project. The German Embassy kindly gave this project clout by opening the recommendation workshop.

Our gratitude also goes to members of Ghanaian Ministries such as the MoTI and MoFA at the national and regional levels and the GSA’s executive management and staff, who we had the privilege to meet and interact with.



Photo: T. Pfeiffer

We encountered a great deal of interest for and commitment to the topic and an earnest wish to make progress in this rather complex topic of QI utilization. We hope that this report is found helpful by its most important users: PTB and the GSA. From the outset, this research was intended to be an

open research with many more stakeholders.

In order to be accessible to as many stakeholders as possible, this report is written in English.

Executive summary

Background and task

This report – summarized here – marks the end of a six-month research project commissioned by the Physikalisch-Technische Bundesanstalt (PTB) in May 2015. The terms of reference reflected PTB's interest in rural areas of Ghana, after operating mostly on the national level since 2007. This study aims at identifying existing quality infrastructure (QI) services in the maize and pineapple value chains, as well as the need and potential for their improvement and upscaling to reach smallholders through its in-country partners.

The objective of PTB's technical cooperation with developing and emerging countries is to strengthen the five technical components of QI that this research also focused on:

- Metrology;
- Standardization;
- Testing;
- Certification;
- Accreditation.

These five components of QI form a network that ensures that products and processes meet predefined specifications, thus guaranteeing quality assurance and consumer protection. PTB's cooperation with Ghana focuses on the agri-food sector.

One of PTB's main implementing partners in Ghana is the Ghana Standards Authority (GSA). Its mission is, among others, to promote standardization for the improvement of the quality of goods, services and management practices. In addition to the GSA, PTB also cooperates with the Food and Drugs Authority (FDA), other Quality Infrastructure Service Providers (QISPs) and other Ghanaian authorities. PTB's political counterpart in Ghana is the Plant Protection and Regulatory Services Directorate (PPRSD) within the Ministry of Food and Agriculture (MoFA).

This research studies the agricultural sector, where 22 percent of Ghana's GDP is produced. The sector currently employs 45 percent of the country's total labor force. It is characterized by a smallholder production base and low productivity. Rural smallholders are often living in poverty, thus making the sector relevant to poverty reduction. Even though parts of the farming population seem to be on a migratory route to Ghana's cities, the aspect of rural poverty cannot be underes-

timated. While migration to towns might initially seem opportune, many people fail to find work and maintain a partial presence in rural areas. The rural population is within focus of this study and BMZ's strategies and programs, which tackle its underlying poverty.

Agriculture plays an essential role – not only for peasants, but also for the growing middle class in Ghana's cities who demand agricultural products from rural areas. In this exchange from rural to urban areas, Ghanaian trade is being stretched over much greater distances, requiring, in theory, a transparent and universal communication about quality. The earlier quality is measured in this sequence "farm-to-fork", the more efficiently and sustainably farmers reach higher quality. At the smallholder level, services to analyze product quality therefore need to be applied at the beginning of value chains. For example, maize needs to be free of toxic mycotoxins and pineapples shouldn't contain levels of residual chemicals that pose health risks.

This research looked at smallholders who cultivate approximately 2 to 8 acres of land and who sell their produce on local markets, national markets or even for export. The research questions from the terms of reference included numerous aspects that were bundled and focused on five outputs:

1. Mapping of QI services and their providers at local level in two regions;
2. Analysis of the utilization of QI services by smallholders and potential obstacles;
3. Assessment of perceptions of quality among smallholders, traders / consumers;
4. Assessment of case studies on costs and benefits of QI service utilization;
5. Identification of recommendations on improving framework conditions as well as institutional interactions and on the question of how QI can be promoted among smallholders.

The concept of this research had less to do with the location of quality infrastructure service providers (QISPs) and how precise testing results are achieved, and more to do with the conditions under which QI is utilized in rural areas by smallholders.

Methodology

The three-month long field research was prepared during a two-month inception phase in Berlin. During this phase, the methodology and data collection tools were drafted and expert interviews were prepared. Study sites were chosen in

consultation with experts, based on a preliminary mission of the team leader. Since Accra hosts most QISPs and laboratories, the distance to the production sites and smallholders was considered. For maize, the Brong-Ahafo region was selected as a highly commercialized production area, hosting the most important supranational maize market in Techiman. For pineapple, a less commercialized but interesting border area was chosen: the Volta region. The region is located only half the distance from Accra as compared to Brong-Ahafo.

Given the exploratory purpose of the study, a multiple methods approach was chosen, focusing on different qualitative methods. Selected data collection methods included focus group discussions, semi-structured interviews and a workshop. In consultation with PTB and the GSA, interview questions were developed such as: "Do smallholders know about QI services? What are their traditional methods in order to measure quality? Can farmers afford the complicated tests?" In total, 144 interviews were conducted, recorded and qualitatively analyzed with the help of ATLAS.ti. Additionally, soil tests were performed in four locations in order to determine soil quality and fertilizer requirements. The Knowledge-Attitude-Practice (KAP) approach was used in order to identify needs, problems and barriers to QI utilization by smallholders.

Findings in the maize and pineapple value chains as well as the national QI

Ghana produces 1.9 million Mt of maize annually. The staple crop is utilized for the following: a) as whole grain for human consumption, b) in processed maize products (such as cornflakes or Banku flour), and c) as feed. This project researched maize in the Brong-Ahafo region, where most maize is produced and partly consumed by the poultry industry. Maize feed for chickens is relevant since poisonous maize reduces the productivity of chickens and has a direct impact on their health.

Aflatoxin¹ found in moldy maize has attracted this study's attention due to its public health and food safety aspect and the consequence for QI use. Mold is caused by insufficient drying and storage, in combination with humid, warm conditions. QI already assists in the detection of the highly poisonous mycotoxin, including QISPs such as the Accra-based laboratories of the GSA and the Food and Research Institute (FRI). The maize standard GS 211 sets the national threshold value at 15 parts per billion. However, more than half of the maize samples tested in the laboratories of the GSA are above this limit. No farmer was found to per-

1 Aflatoxins are toxic carcinogenic by-products of the molds *Aspergillus flavus* and *Aspergillus parasiticus*.

form aflatoxin tests in the observed regions. This is problematic: if aflatoxin remains undetected at the farm level, the poison trickles further down the value chain with detrimental results.

Aflatoxin can be prevented by drying maize timely to the moisture level of 13 percent which is prescribed in the national maize standard GS211. In order to safely determine the moisture level of maize, handheld moisture meters can be used outside laboratories. This is another measuring device leading to a QI service that requires calibration. However, smallholders were found to be unaware of the link between aflatoxin and the moisture content. None of the smallholders interviewed actually used a moisture meter. Experiments that the research team carried out with 44 farmers indicate that traditional methods used to determine the moisture content, e.g. biting on maize grains, report the maize being on average over 3 percent dryer than it actually is, thus rendering the maize vulnerable to mold.

Quality awareness could trigger the use of QI services. However, quality does not seem to play a major role in the view of maize farmers and traders. This can partly be explained with the absence of the consumers' quality exigencies. Therefore, there are no incentives for smallholders to invest in aflatoxin tests or moisture meters. Further obstacles include cash constraints of smallholders, as well as insufficient drying and storage facilities that restrict their ability to respond to test results. In contrast to smallholders, poultry farmers and processors check for moisture levels before storing maize and perform aflatoxin tests since they would otherwise be afflicted by high economic losses.

With respect to weighing, utilization of balances –understood as QI utilization in this research- among smallholders and traders is equally low as compared to aflatoxin testing or the use of moisture meters. The bulk-good maize is traded in bags of various sizes. Instead of weighing the mass, the maize bags are arbitrarily filled and traded with different prices according to perceived moisture. Up to now, authorities haven't used their power to rule trading maize only in kilograms as neighboring Francophone countries do. At the same time, the GSA has only been partially successful in convincing Ghanaians to trade by weight.

Given these circumstances, this study concludes that the use of QI services could be promoted by raising the public awareness of aflatoxin. Once a continuous nationwide mapping of aflatoxin contaminations has been conducted, public awareness of the potential of aflatoxin analyses can be expected. This in turn is also likely promoting the quality infrastructure's reputation. This study recom-

mends rendering the already proved aflatoxin contamination of maize products a national priority.

Pineapple, which differs from maize in its nature as cash crop and piece good, was studied among farmers in the Volta region. Fresh pineapples and juices were considered, both for the domestic and export market.

In the pineapple value chain, a low level of QI service utilization was observed at the smallholder level. Only in the context of export services is quality infrastructure utilized for pineapple products (testing and metrology), mostly because of certifications that require the services. Large-scale pineapple farmers who certify their pineapple for the lucrative export business invest a lot of time and money in the related processes of obtaining the certification. Without financial support, it is practically impossible for smallholders to obtain certificates for export. Only out-grower schemes allow smallholders to take part in group certification. GLOB-ALG.A.P.-certified farmers are required to utilize some QI services, such as soil analysis or the testing of pesticide residuals or sugar levels of the fruits. Interestingly, many exporters test in recipient countries and not in Ghana. One reason might be that Ghanaian labs can only test 36 out of 452 residuals for which the EU prescribes maximum residue levels.

A considerable portion of the 40-50 percent of harvested pineapples gets sorted out –mainly for optical reasons– before export so that quality demands of the international customers are fulfilled. The second grade pineapples are traded on the domestic market, but without recovering the costs invested in export. On the domestic market, the quality demands of consumers of fresh pineapples are limited to shape, taste and juiciness of fruits. This lack of pineapple value on the domestic market does not encourage smallholders to use QI services.

Fruit processors have higher quality demands for the domestic market than consumers of fresh pineapples and give high attention to the sugar content and color of fruits. Here, the FDA prescribes the full range of tests on the juice products before allowing juice production. For example, refractometers – handheld devices that determine the sugar content in pineapples – are commonly used by exporters, large producers and most processors since the sugar level directly affects the quality of the products. In contrast to juice makers, refractometer utilization among smallholders is absent.

The use of soil testing was studied where pineapple production takes place. Interviews revealed that benefits from soil testing are largely unknown amongst smallholders. Even if the potential is known, farmers don't know how to understand the test results and there are only few developing agencies to help interpret

the findings. Besides high costs for soil tests, another obstacle for smallholders is the lack of available specific fertilizer needed for a given soil fertility. Soil testing is regularly performed by larger producers, particularly when required for certification. While soil analysis laboratories are concentrated in Kumasi and Accra, eight agricultural colleges and farm institutes across the country have been found with the ability to offer commercial soil testing. These institutions also provide vocational training for extension officers.

In the example of the pineapple piece good, weighing was studied. The study found that pineapples on the local market are traded by piece. In contrast, the more transparent trade by weight is practiced by large producers and processors, and when exporting pineapple. A few smallholders use scales and a growing trend was observed. Smallholders who use scales find weighing to be beneficial for them because there is no need for the time and labor intensive sorting and grading of pineapples. The research concludes that an increase in the use of scales might contribute to paving the way to behavior change towards further QI utilization of more sophisticated services, potentially even beyond metrology.

In three cost-benefit² analyses, this study found concrete potential cases where economic benefits would occur if QI were actually used. The observed case of a maize processor testing and measuring its products contributed to a reduction of input losses and costs due to over drying. The costs of purchasing a moisture meter were recovered because the savings are five times higher. This study further confirmed the losses that farmers incur due to the limited use of QI services. For example, it was found that pineapple farmers measuring fertilizers with matchboxes instead of scales overdose the fertilizers by 77 percent, thus wasting money and potentially harming the environment.

Discussion and recommendations

In an attempt to generalize the specific findings in the maize and pineapple value chains, this report contains four general variables to increase QI utilization. A smart management of both, voluntary and obligatory measures is needed to increase the demand for QI. In particular, consumers haven't used their power to improve quality through consumer protection mechanisms. Centrality of quality infrastructure services seems to be a hindering factor for smallholders that the Ghanaian QI, which has its laboratories in Accra and Kumasi, has yet to overcome. The observed inconsistent and unorganized maize and pineapple value chains do

2 More precisely known as „partial budgeting“.

not contribute to the desired utilization of QI services. Instead, this report finds organization of and a trust in value chains to contribute more to an increase in quality. Looking at pineapple and maize products as well as the export business, the value of agricultural production is a determining parameter for the use of QI services in rural areas.

Besides the four variables that influence QI use, development cooperation can render quality infrastructure attractive for smallholders. Development programs should therefore continue refining their approaches towards higher quality of agricultural products and QI use. Complementing particularly FDA's, GSA's and MoFA's countrywide mandates, development programs are needed to support rural districts to foster quality through an increased use of QI.

Recommendations of this research project comprise 29 aspects, out of which 6 recommendations shall be highlighted in this summary. Observed interventions in the QI sector appear more effective and sustainable the longer they run. Due to the need for significant behaviour changes, the SLE study recommends PTB continuing designing and implementing interventions targeting smallholders even longer with durations of at least two years. Based on observations, QI rarely is an independent problem or issue. Instead, QI needs to be seen in the context of agricultural practices and processing. Since such topics are only touching upon the GSA's and PTB's expertise, partnering makes a lot of sense. In this way, PTB's cooperation with e.g. Ghana Grains Council is a step in the right direction, but a more systematic approach would be desirable. A cooperation with the MoFA and district agricultural offices for the agricultural sector could also be beneficial. Given the large number of districts and the vast number of locations where QI is required for rural areas, together with the limited resources available to invest in QI, it is important to have a very focused use of resources. For example, since Techiman district harbours the largest market for maize, this district or the capital of the Brong-Ahafo region, Sunyani, would be good locations for QISPs to set up their laboratory capacity. Similarly, each commodity has main hubs where QI services should be offered. Such "rural QI hubs" could also serve to influence good agricultural practices of smallholders. Concretely, the MoFA and the districts' agriculture departments could learn from a specifically built up QI expertise and capacity in the regions and help to share the expertise accordingly. Besides a number of concrete recommendations, this report sees the need to complement producer and legally driven approaches with consumer driven approaches. While the FDA is in charge of food safety from the governmental side, many more private initiatives would be necessary to gain sufficient momentum for consumer protec-

X Executive summary

tion. This should lead to higher quality demands of customers and subsequent QI use, thus ensuring higher quality demands of agricultural products.

The annex of this report contains sketches of five project ideas on how QI could be promoted. The SLE research team elaborated clusters of recommendations into these concepts:

- Facilitate the use of QI on the level of small-scale entrepreneurs in order to familiarize smallholders with QI and effectively tackle quality issues in the maize value chain.
- Facilitate a systematic data collection on aflatoxin contamination of maize and maize products in Ghana to assist in creating awareness and emphasizing the relevance of QI.
- Bringing soil testing down to the ground, i.e. to rural areas.
- Bringing quality infrastructure to the field – integrating quality infrastructure into the vocational training for future agricultural extension agents.
- Animal health and food safety: establishment of an animal feed testing laboratory in Dormaa Ahenkro town, Brong-Ahafo region.

Zusammenfassung

Hintergrund und Auftrag

Das Auslandsprojekt „Measuring gaps and weighing benefits“ bezieht sich auf die ländliche Bevölkerung Ghanas und soll deren Einkommenssituation verbessern bzw. zur Armutsreduktion beitragen.

Die Physikalisch technische Bundesanstalt (PTB) ist in Ghana seit 2007 präsent und dort hauptsächlich auf nationaler Ebene aktiv.³ Die Terms of Reference dieser Studie spiegeln das Interesse der PTB wider, sich zukünftig stärker auf die ländlichen Regionen zu konzentrieren. Dieses AP setzte sich zum Ziel, bestehende Qualitätsinfrastruktur (QI)-Dienstleistungen in Mais- und Ananas-Wertschöpfungsketten sowie den Bedarf, die Nutzung und das Potential für eine Verbesserung und Ausweitung dieser Dienstleistungen zu identifizieren, um Kleinbäuerinnen und Kleinbauern zukünftig besser erreichen zu können. Damit leistet dieses AP auch einen Beitrag zur Konkretisierung des BMZ-Sektorkonzepts „Qualitätsinfrastruktur und Konformitätsbewertung – Messen, Normen, Prüfen.“

Die Internationale Zusammenarbeit der PTB hat das Ziel, die fünf Elemente der QI zu stärken, die auch im Fokus dieser Studie stehen: Metrologie, Normung, Prüfwesen, Zertifizierung und Akkreditierung. Sie stellen sicher, dass Waren und Prozesse definierte Kriterien erfüllen. QI trägt somit sowohl zur Qualitätssicherung als auch zum Verbraucherschutz bei. In Ghana konzentriert sich die Zusammenarbeit der PTB auf den land- und ernährungswirtschaftlichen Sektor.⁴

Der landwirtschaftliche Sektor, der aktuell zu rd. 22% zum Bruttoinlandsprodukt (BIP) Ghanas beiträgt, beschäftigt gegenwärtig 45% der erwerbstätigen Bevölkerung. Er ist kleinbäuerlich geprägt und durch eine geringe Produktivität gekennzeichnet. Die Landwirtschaft stellt nicht nur für Kleinbäuerinnen und Kleinbauern, die im Durchschnitt 2-6 Acres bewirtschaften, das wirtschaftliche Rückgrat dar, sondern sie ist auch für die wachsende urbane Mittelschicht zentral, die Agrarprodukte aus den ländlichen Regionen nachfragt. Als Folge des Handels mit Nahrungsmitteln zwischen städtischen und ländlichen Regionen wachsen die

3 Die PTB gehört neben der GIZ, der KfW-Entwicklungsbank und der Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) zu den vier offiziellen Durchführungsorganisationen der deutschen Entwicklungszusammenarbeit.

4 Einer der wichtigsten Projektpartner dort ist die Ghana Standards Authority (GSA). Sie hat den Auftrag, Normung zu fördern, um die Qualität von Waren, Dienstleistungen und Managementsystemen zu verbessern. Neben der GSA kooperiert die PTB mit der Food and Drugs Authority (FDA), weiteren QI-Institutionen und Ghanaischen Behörden. Auf politischer Ebene ist das Plant Protection and Regulatory Services Directorate (PPRSD) innerhalb des Landwirtschaftsministeriums Partner der PTB.

Handelsdistanzen über die traditionellen dörflichen Grenzen hinaus. Dies erfordert eine transparente Kommunikation über die Qualität von Produkten. Um diese vom Erzeuger zum Verbraucher sicherzustellen, sollten Dienstleistungen, die die Qualität von Produkten analysieren, nicht nur zum Ende, sondern auch am Beginn der Wertschöpfungsketten genutzt werden. So können Verluste nachhaltig reduziert werden. Für Mais bedeutet dies z.B., dass dieser bereits auf Produktionsebene frei von giftigen Mykotoxinen sein sollte und bei Ananas sollten Grenzwerte chemischer Rückstände nicht überschritten werden.

Die Idee dieser Studie ist es, die Determinanten für Kleinbäuerinnen und Kleinbauern zur Nutzung von QI in ländlichen Gebieten zu identifizieren.

Untersuchungsregion und Methodik

Als Untersuchungsregion für die Mais-Wertschöpfungskette wurde ein kommerzialisiertes Maisproduktionsgebiet, die Brong-Ahafo Region ausgewählt, für die Untersuchung der Ananas- Wertschöpfungskette wegen der Grenzlage die Volta Region.

Die Datenerhebung beinhaltete Fokusgruppendifkussionen, halbstandardisierte Interviews und einen Workshop. Insgesamt wurden 144 Interviews durchgeführt und mit Hilfe des professionellen Software ATLAS.ti qualitativ ausgewertet. Zusätzlich wurden an vier Standorten Bodenuntersuchungen durchgeführt.

Ergebnisse

Wertschöpfungskette Mais: Ghana produziert jährlich 1,9 Millionen Tonnen des Grundnahrungsmittels Mais, der als Ganzes oder verarbeitet für den menschlichen Verzehr verwendet wird oder als Futtermittel, insb. in der Geflügelindustrie dient.

Qualitätsprobleme: Hier haben die immer wieder im Mais zu findenden hochgiftigen Aflatoxine⁵ die höchste Bedeutung. Schimmelpilze, die *Aflatoxine* absondern, werden durch mangelhafte Trocknung und Lagerung in Kombination mit feuchtwarmen Bedingungen hervorgerufen und gelangen so in die Wertschöpfungskette. Mithilfe von Laboren, wie beispielsweise der Ghana Standards Authority (GSA) oder des Food and Research Institute (FRI), können die hochgiftigen Mykotoxin nachgewiesen werden. Der staatlich Ghanaische Maisstandard GS211 legt den unbedenklichen Schwellenwert für Aflatoxin bei 15 ppm fest. Jedoch liegen mehr als die Hälfte der Proben über diesem Schwellenwert. In den Unter-

5 Aflatoxine sind toxische und krebserregende Nebenprodukte der Schimmelpilze *Aspergillus flavus* und *Aspergillus parasiticus*.

suchungsregionen konnte kein kleinbäuerlicher Betrieb gefunden werden, der seinen Mais auf Aflatoxine testen lässt. Wird der Mais rechtzeitig auf einen Restfeuchtegehalt von 13 Prozent getrocknet, kann die Entstehung von Aflatoxinen verhindert werden. Dieser Feuchtigkeitsgehalt wird im nationalen Maisstandard GS211 festgelegt. Tragbare Feuchtemesser können außerhalb von Laboren genutzt werden, um die Feuchtigkeit von Mais zuverlässig zu bestimmen.

Die Studie zeigt jedoch, dass den Kleinbäuerinnen und Kleinbauern der Zusammenhang zwischen Aflatoxin und dem Feuchtigkeitsgehalt des Mais unbekannt ist und keiner der befragten kleinbäuerlichen Produzenten nutzte einen Feuchtemesser. Eine Befragung von 44 Kleinbäuerinnen und Kleinbauern zeigt, dass auf der Grundlage von traditionellen Methoden, die von ihnen eingesetzt werden, um den Feuchtigkeitsgehalt des Mais zu bestimmen, der Mais durchschnittlich 3 Prozent trockener eingeschätzt wird, als er tatsächlich ist. Dieser Unterschied ist relevant und stellt daher keine sichere Methode zur Vermeidung von Gesundheitsschäden dar.

Ein *Qualitätsbewusstsein* ist weder bei den Produzenten noch bei den Händler/innen oder Konsumenten vorhanden. Dadurch fehlen für die Produzenten Anreize, in solche Tests oder Feuchtemesser zu investieren. Weitere Determinanten stellen die finanziellen Begrenzungen der Kleinproduzenten sowie mangelhafte Trocknungs- und Lagerungsmöglichkeiten dar. Somit könnten sie auf Testergebnisse kaum reagieren. Für Geflügelproduzenten und Verarbeiter ist die Situation anders. Da sie bei der Entdeckung einer Aflatoxinbelastung mit großen Vermögenseinbußen konfrontiert wären, überprüfen sie den Feuchtigkeitsgehalt des Mais, bevor sie diesen einlagern und führen zusätzlich Aflatoxintests durch.

Hinsichtlich des *Wiegens* lässt sich eine ähnlich geringe Nutzung der QI-Dienstleistung feststellen. Gleichzeitig sind vor allem die Konsumenten unzufrieden mit willkürlichen Kaufgebinden und auch die Kleinbauern sehen sich durch Händler ungerecht behandelt. So wird das Schüttgut Mais in Säcken verschiedener Größe gehandelt und entlang der subjektiven Einschätzung des jeweiligen Feuchtigkeitsgehalts gehandelt. Durch Wiegen könnte man das Problem lösen. Da aber mit dem Trocknen ein Gewichtsverlust einhergeht, der nur durch ein Nominalgewicht gerecht ausgeglichen werden kann und der dem Standardtrocknungsgrad von 13% entspricht, muss der Verkaufspreis auf dieses Nominalgewicht bezogen werden. Dies ist nicht leicht lösbar, weil sich die Wagen für die Bauern nicht unbedingt lohnen und mangels Interesse bei Händlern. Entsprechend war die GSA nur teilweise erfolgreich, die Ghanaische Bevölkerung entgegen deren Traditionen und Einzelinteressen von einem Handel nach Gewicht zu überzeugen.

In der Studie werden kontinuierliche und landesweite Messungen von Aflatoxingehalten und Feuchtegraden zur Aufzeichnung von Aflatoxinwerten und Maßnahmen zur öffentlichen Bewusstseinssteigerung vorgeschlagen. Die Aflatoxinbelastungen von Maisprodukten sind real und sollten daher zur nationalen Priorität erhoben werden. Mit der nationalen Priorität wird dabei erhofft, dass neben dem bewussteren Produzieren und Konsumieren auch technische Mittel zur Trocknung von Mais mobilisiert werden.

Wertschöpfungskette Ananas: Sie wird in Ghana als Ganzes und als Stückgut sowohl frisch als auch als Saft auf heimischen und auf Exportmärkten verkauft.

In der Ananas-Wertschöpfungskette konnte ebenfalls nur eine geringe Nutzung von QI-Dienstleistungen durch kleibäuerliche Betriebe beobachtet werden. Nur im Rahmen von Exporten werden QI-Dienstleistungen genutzt, hauptsächlich wegen der Zertifizierungen, die eine Nutzung dieser Dienstleistung vorschreiben.

Für kleine Produzenten ist es ohne finanzielle Unterstützung so gut wie ausgeschlossen, Exportzertifikate zu erhalten. Nur Vertragsanbauer, von denen es nur wenige gibt, können an Gruppensertifizierungen teilnehmen. Produzenten, die nach GLOBAL.G.A.P. Richtlinien zertifiziert sind, müssen eine Vielzahl der QI-Dienstleistungen annehmen und bezahlen, beispielsweise Bodenuntersuchungen, Prüfung auf Pestizidrückstände oder Prüfung des Zuckergehalts der Früchte. Viele Ananasexporteure führen die vorgeschriebenen Untersuchungen jedoch in den Empfängerländern und nicht in Ghana durch. Dies lässt sich darauf zurückführen, dass Labore in Ghana – beispielsweise – nur auf 36 der 452 Rückstände testen können, für welche die EU maximale Rückstandswerte vorschreibt. Aus diesem Grund umgehen nicht wenige der Interviewten Exporteure Ghanaische Labore bzw. die nationale Qualitätsinfrastruktur.

Knapp die Hälfte der geernteten Ananas wird wegen Nichterfüllung optischer Qualitätsanforderungen vom Export ausgeschlossen. Diese zweite Klasse gelangt auf dem heimischen Markt, ohne dass die für den Export investierten Kosten zurückgewonnen werden. Auf dem heimischen Markt beschränken sich die Qualitätsanforderungen der Verbraucher/innen frischer Ananas auf die Form, den Geschmack und die Saftigkeit der Früchte. Der – im Vergleich zu Exportware – mangelnde Wert der Ananas auf dem heimischen Markt schafft keine Anreize für Kleinbäuerinnen und Kleinbauern, QI-Dienstleistungen zu nutzen.

Saftverarbeiter für den heimischen Markt haben dagegen höhere Qualitätsanforderungen als die Endverbraucher von frischer Ananas, z.B. hinsichtlich des Zuckergehalts und der Farbe. Die Food and Drug Authority (FDA) schreibt vor, welche Tests durchgeführt werden müssen, damit eine Saftproduktion zugelassen

werden kann. Zur Messung des Zuckergehalts verwenden Exporteure, Großproduzenten und viele Saftverarbeiter Refraktometer. Dies sind tragbare Geräte, die während des Ananaswachstums den ansteigenden Zuckergehalt messen. Solche Geräte mit Preisen um fünfhundert US Dollar können sich Kleinbäuerinnen und Kleinbauern wenn überhaupt, dann nur im Rahmen von Kooperativen leisten.

Bodenanalysen: Den meisten Ananas anbauenden Kleinbäuerinnen und Kleinbauern ist der mögliche Nutzen aus Bodenuntersuchungen unbekannt oder sie wissen nicht mit den Testergebnissen umzugehen. Bodenuntersuchungen würden sich für die meisten kleinbäuerlichen Betriebe zudem nicht auszahlen, da spezifische Düngemittel kaum verfügbar sind, um zielgerichtet auf mögliche Testergebnisse zu reagieren. Für größere Produzenten ist die Situation anders. Sie führen regelmäßig Bodenuntersuchungen durch, insbesondere wenn die Untersuchungen für eine Zertifizierung benötigt werden. Labore für Bodenanalysen konzentrieren sich derzeit noch auf Accra und Kumasi. Jedoch konnten acht Landwirtschaftsschulen und Farminstitute identifiziert werden, die Bodenanalysen kommerziell anbieten könnten. Die im ganzen Land verteilten Schulen und Institute bilden auch Fachleute für den landwirtschaftlichen Beratungsdienst aus.

Wiegen: Ananas wird auf dem lokalen Markt zumeist stückweise nach Augenschein gehandelt. Von Großproduzenten, Verarbeitern und Exporteuren wird die transparentere Form des Handelns nach Gewicht verwendet. Nur wenige Kleinbäuerinnen und Kleinbauern nutzen Waagen, jedoch lässt sich feststellen, dass diese Wenigen das Wiegen als nützlich ansehen, da so das zeit- und arbeitsaufwändige Sortieren und Klassifizieren der Ananas entfällt. Hier kommt die Studie zu dem Schluss, dass dieser positive Trend hin zu mehr Nutzung von Waagen den Weg für eine Verhaltensänderung hin zu einer erhöhten Nutzung von komplexeren metrologischen und sonstigen QI Dienstleistungen ebnen könnte. Einige gebräuchliche Anleitungen zum Düngen schlagen angesichts des Mangels an Waagen für das Dosieren Streichholzschachteln vor. Ananasproduzenten, die Düngemittel so abwiegen, messen nach Beobachtung im Rahmen dieser Studie nach rd. 77 Prozent zu viel Dünger ab.

Feuchtemessung: Durch eine solche Messung kann verhindert werden, dass Mais zu kurz oder zu lange getrocknet wird. Letzteres kann Kosten durch Übertrocknung sparen. Die Kosten für die Anschaffung eines Feuchtemessers wurden durch diesen Nutzen in knapp 3 Monaten zurückgewonnen, wie eine Kosten-Nutzen-Rechnung zeigte. Kleinbauern könnten im Rahmen von Genossenschaften solche Kosten amortisieren. Die Berechnungen zeigten zudem, dass durch die

Nichtnutzung von QI-Dienstleistungen Verluste entstehen, die größer sind als die eingesparten Kosten.

Diskussion und Empfehlungen

Die Nachfrage von QI-Dienstleistungen wird von einer Mischung aus freiwilligen und verpflichtenden Maßnahmen durch unterschiedliche Akteure vorangetrieben. Bisher haben insbesondere Konsumenten ihre Macht nicht genutzt, um über Mechanismen des Verbraucherschutzes die Qualität von Produkten zu verbessern. Die Zentralität der QI-Dienstleistungen, die sich als Hindernis für Kleinbäuerinnen und Kleinbauern erweist, kann dagegen nur durch die Ghanaischen QI-Dienstleister selbst überwunden werden. Der geringe Organisationsgrad bei allen Akteuren der untersuchten Mais- und Ananas-Wertschöpfungsketten ist der Nutzung von QI Dienstleistungen zudem abträglich, denn höhere Organisationsgrade sowie Vertrauen zwischen den Wertschöpfungskettengliedern erhöhen die Qualität von Produkten.

Von den 29 Empfehlungen werden hier fünf hervorgehoben.

1. Beobachtete EZ-Projekte im QI-Sektor waren umso nachhaltiger und wirksamer, je länger sie andauerten. Da ein Übergang hin zu mehr QI-Nutzung Verhaltensänderungen von Akteuren erfordert, wird empfohlen, die Laufzeit auf mehr als zwei Jahre, d.h. erheblich zu verlängern.
Solche Projekte würden erlauben, Informationslücken zu schließen, die Haltung zur Zahlungsbereitschaft für QI-Dienste zu erhöhen und langfristig die Nutzung von QI-Diensten derart zu verstärken, dass sie auch erschwinglicher für Kleinbauern werden (Skaleneffekt).
2. QI hat oft unklare Systemgrenzen und sollte stärker im landwirtschaftlichen Kontext betrachtet werden. Da die Fachkompetenz der PTB und GSA eher bei den QI-Themen selbst liegt, empfiehlt es sich, stärker als bisher mit den anderen landwirtschaftlichen Partnern zusammenzuarbeiten (Ghana Grains Council, Landwirtschaftsministerium und den landwirtschaftlichen Bezirksstellen).
3. Aufgrund der Vielzahl an Bezirken und Orten, an denen QI in ländlichen Regionen benötigt wird bei gleichzeitig beschränkten Ressourcen wäre zudem eine Fokussierung sinnvoll. Im Hinblick auf Mais beispielsweise sollten Laborkapazitäten in Techiman, der Bezirk mit dem größten supranationalen Maismarkt oder in Sunyani, der Hauptstadt Brong-Ahafos, aufgebaut werden. Man muss also beides machen: Zentral sollten die teureren Labortests, wie beispielsweise Aflatoxinmessungen angeboten werden, während

gleichzeitig dezentralisiert Feuchtemessungen durchgeführt werden sollten. Beides dient zusammen einer Reduktion der derzeit aflatoxinhaltigen Nahrungsmittel in Ghana.

4. Ähnlich wie bei Mais besitzt jedes Erzeugnis Hauptproduktionszentren, in denen QI-Dienstleistungen angeboten werden sollten. Solche „ländlichen QI-Zentren“ könnten auch genutzt werden, um gute landwirtschaftliche Praktiken der Kleinbäuerinnen und Kleinbauern zu fördern. Konkret bedeutet dies, Kompetenzen und Kapazitäten im Bereich QI in ländlichen Regionen aufzubauen. Das Landwirtschaftsministerium und die landwirtschaftlichen Bezirksstellen sind hier angesprochen, die landwirtschaftliche Schulen effektiver nutzen könnten.
5. Produzenten- und gesetzlich orientierte Ansätze müssen durch verbraucherorientierte Ansätze ergänzt werden. Während die FDA auf Regierungsebene für die Lebensmittelsicherheit verantwortlich ist, müsste es viel mehr private Initiativen geben, um den Verbraucherschutz zu gewährleisten. Erhöhte Qualitätsanforderungen der Verbraucher würden die Nutzung von QI erhöhen und so wiederum zu einer verbesserten Qualität landwirtschaftlicher Produkte beitragen.

Table of contents

Foreword	i
Acknowledgements	ii
Executive summary	iii
Zusammenfassung.....	xi
Table of contents	xix
List of tables	xxiii
List of figures	xxiv
Abbreviations.....	xxv
1 Introduction	1
1.1 Problem statement	1
1.2 Occasion and objectives of the study	2
1.3 Structure of the report.....	3
2 Study background	5
2.1 Quality infrastructure and its contribution to rural development	5
2.2 Country context	8
2.3 Selected commodities	9
3 Study approaches and definitions	13
3.1 Value Chain approach.....	13
3.2 Knowledge-Attitude-Practice approach.....	14
3.3 Working definitions	14
3.3.1 Smallholder	14
3.3.2 Quality infrastructure service provider and potential candidates	15
4 Methodology	17
4.1 Study regions	17
4.2 Selection of quality infrastructure services	20

XX Table of contents

4.3	Data collection	22
4.3.1	Selection of interview partners	22
4.3.2	Data collection methods	24
4.4	Data analysis	29
5	National quality infrastructure in Ghana	31
5.1	Institutional responsibilities and quality infrastructure	31
5.1.1	Key public institutions and their responsibilities	31
5.1.2	Interventions, initiatives and networks	35
5.1.3	Current challenges	36
5.2	Mapping of quality infrastructure service providers	37
5.2.1	Location and type of quality infrastructure service providers	37
5.2.2	Capacity, clients and market demand	39
5.2.3	Accessibility	41
5.2.4	Cooperation between quality infrastructure service providers	43
5.3	Potential quality infrastructure service providers.....	44
6	Maize value chain.....	47
6.1	Contextual findings in the maize value chain	47
6.1.1	Value chain actors and marketing channels	47
6.1.2	Maize production and utilization	48
6.2	Quality perception and demand.....	50
6.3	Status quo of quality infrastructure in the maize value chain	52
6.3.1	Laboratory testing	53
6.3.2	Metrology	55
6.3.3	Standardization	62
6.4	Cost benefit.....	63

7	Pineapple value chain	67
7.1	Contextual findings in the pineapple value chain	67
7.1.1	Pineapple production	67
7.1.2	Value chain actors and marketing channels	70
7.2	Quality perception and demand.....	72
7.3	Status quo of quality infrastructure in the pineapple value chain	74
7.3.1	Testing	75
7.3.2	Metrology	81
7.3.3	Certification	83
7.4	Cost benefit.....	85
7.4.1	Soil testing	85
7.4.2	Utilization of weighing scales	91
8	General discussion.....	95
8.1	Drivers of quality infrastructure demands	96
8.2	Centrality of quality infrastructure services	98
8.3	Organization and trust in value chains	100
8.4	Value of agricultural production.....	102
8.5	Development cooperation and quality infrastructure for smallholders.....	103
9	Recommendations	105
9.1	Commodity specific recommendations.....	105
9.1.1	Maize value chain	105
9.1.2	Pineapple value chain	106
9.2	General recommendations	107
9.2.1	PTB	107
9.2.2	QI institutions in Ghana	108
9.2.3	Other stakeholders	109
	Bibliography.....	111

Annexes 115

- Annex 1: Interview reference list..... 115
- Annex 2: Interview guideline maize farmers.....120
- Annex 3: Interview guideline pineapple farmers122
- Annex 4: Categorization of QI users according to KAP124
- Annex 5: Providers of quality infrastructure125
- Annex 6: Organigram of Decentralized MoFA 127
- Annex 7: Maize Grades128
- Annex 8: Detailed results of soil analysis129
- Annex 9: Quantities and types of recommended fertilizers
(case-study soil testing)..... 130
- Annex 10: Required yield increases to cover increased fertilization costs
(case-study soil testing)..... 131
- Annex 11: Project short description – small-scale entrepreneurs 132
- Annex 12: Project short description – data collection 133
- Annex 13: Project short description – soil testing 134
- Annex 14: Project short description – extension officers..... 137
- Annex 15: Project short description – rural laboratory 139
- Annex 16: Estimated and measured maize moisture levels140

List of tables

Table 1: Selected data collection methods and the corresponding approaches	25
Table 2: Goals of semi-structured interviews	26
Table 3: Overview of authorities relevant to QI	34
Table 4: Maize weight in the drying process.....	64
Table 5: Economic valuation of costs and benefits	65
Table 6: Definition and characteristics of interviewed pineapple producer types	69
Table 7: Overview of farmers.....	85
Table 8: Results of soil analyses	86
Table 9: Applied and recommended fertilization.....	87
Table 10: Cost of fertilization scenarios	88
Table 11: Subsequent costs of soil analysis	90
Table 12: Required yield increases to cover analysis and fertilization cost	90
Table 13: Annual costs and benefits, in GHS	93
Table 14: Fruit weights and margins	94
Table 15: Typology/categorization of smallholders regarding QI use.....	124
Table 16: Quantities and types of recommended fertilizers.....	130
Table 17: Required yield increases to cover increased fertilization costs.....	131

List of figures

Figure 1: Possible impacts of QI in the context of rural development.....	7
Figure 2: Selected study sites	18
Figure 3: Selected QI services in the maize value chain	21
Figure 4: Selected QI services in the pineapple value chain.....	21
Figure 5: Information sources on local, regional and national levels.....	23
Figure 6: Sampling strategy to identify primary sources of information.....	24
Figure 7: Interviews with different stakeholders.....	28
Figure 8: Level or location of quality infrastructure service provider	38
Figure 9: Value chain actors in processing market channels in Brong-Ahafo (simplified).....	48
Figure 10: Maize utilization in Ghana compared to Brong-Ahafo.....	50
Figure 11: Differences between moisture content determination by traditional methods and moisture meter application	56
Figure 12: Production site of St. Bassa.....	63
Figure 13: Pineapple value chain actors in the three market channels and the quality demand by domestic and international consumers.....	73
Figure 14: Simple soil test with pH strip in the Volta Region	76
Figure 15: Weight of fertilizer in a matchbox	82
Figure 16: Revenues of different price structures according to equations (1) and (2).....	92
Figure 17: Smallholder using a weighing scale	93
Figure 18: Observed variables / continua relevant to QI utilized by smallholders.....	95

Abbreviations

ADB	African Development Bank
ADF	African Development Fund
AEA	Agricultural Extension Agent
ATVET	Agricultural Technical and Vocational Education and Training
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung
BNARI	Biotechnology and Nuclear Agriculture Research Institute
CSIR-FRI	Food Research Institute of the Council for Scientific and Industrial Research
CSIR-SRI	Soil Research Institute of the Council for Scientific and Industrial research
EMQAP	Export Marketing Quality Awareness Project
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization
FBO	Farmer based organization
FDA	Food and Drugs Authority
FGD	Focus Group Discussion
FPMAG	Fruit Processors and Marketers Association of Ghana
GASIP	Ghana Agriculture Sector Investment Programme
GDP	Gross domestic product
GHS	Ghanaian Cedi
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoG	Government of Ghana
GSA	Ghana Standards Authority
GSS	Ghana Statistical Service
ha	Hectare
IFPRI	International Food Policy Research Institute
ILAC	International Laboratory Accreditation Cooperation
ISO	International Organization for Standardization
KAP	Knowledge-Attitude-Practice Approach
KfW	Kreditanstalt für Wiederaufbau
KNUST	Kwame Nkrumah University of Science and Technology
MESTI	Ministry of Science, Technology and Innovation
METASIP	Medium Term Agriculture Sector Investment Programme
MOAP	Market-Oriented Agriculture Programme
MoFA	Ministry of Food and Agriculture

XXVI Abbreviations

MoH	Ministry of Health
MoTI	Ministry of Trade and Industries
MRL	Maximum residue level
Mt	Metric tons
NAFCO	National Food Buffer Stock Co.
NGO	Non-governmental organization
NQI	National quality infrastructure
PPRSD	Plant Protection and Regulatory Services Department
pQISP	Potential quality infrastructure service provider
PTB	Physikalisch-Technische Bundesanstalt
QI	Quality infrastructure
QISP	Quality infrastructure service provider
SLE	Centre for Rural Development
SPEG	Sea-Freight Pineapple Exporters of Ghana
SPS standard	Sanitary and phytosanitary standard
SRID	Statistics, Research and Information Directorate – Government of Ghana
SSI	Semi-structured interview
TRAQUE	Trade Related Assistance & Quality Enabling Programme
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
VC	Value chain
WAQP	West Africa Quality Programme
WFP	World Food Programme
WHO	World Health Organization
WTO	World Trade Organization

1 Introduction

Agriculture plays a crucial role in the economy of Ghana and the development of its rural areas. Forty-five percent of the total work force is employed in the agricultural sector, which makes up 22 percent of the national GDP (World Bank Database, 2015; Ghana Statistical Service, 2014). A smallholder production base characterizes the sector: 90 percent of the farms in Ghana are smaller than two hectares (Ministry of Food and Agriculture, 2011). Despite losing its importance as a driver of macroeconomic growth in the country, the agricultural sector bears a large potential to create opportunities for income generation in rural areas. An economically viable inclusion of smallholder farmers and small- and medium-sized agri-food enterprises into market driven agricultural growth is therefore crucial.

To tap into this development potential, opportunities in international agricultural markets could be seized. With low shares in the international fruit market, Ghana needs to focus on high quality products to develop competitive advantages (Wolter, n.d.; Kleemann, 2011). Opportunities to develop economically viable agri-food enterprises also exist in the domestic market; average per capita income growth rates of around 5 percent over the last ten years and a projected urban population of 70 percent by 2040 point towards a growing Ghanaian urban middle class. Thus, both national and international markets underscore the increasing demand and preferences for high quality agricultural products.

1.1 Problem statement

In this context, the assessment and assurance of quality becomes increasingly important. Several challenges related to quality persist in different agri-food value chains in Ghana. These become particularly noticeable when it comes to the export of agricultural products; an audit undertaken by the European Commission in 2015 revealed continued interceptions of consignments of fruits and vegetables exported from Ghana to the European Union, due to the presence of harmful organisms. The number of interceptions has increased steadily from 2012 to 2014, with 341 consignments intercepted in 2014 (European Commission, 2015). As a response to this development, the Ministry of Food and Agriculture (MoFA) of Ghana placed a temporary ban on the export of certain vegetables to the EU market in September 2015. Interceptions of consignments lead to significant economic losses for exporters and, in turn, for producers. They further affect Ghana's international reputation and carry the potential for World Trade Organization (WTO) sanctions. Despite its relevance

2 Introduction

for the export market, quality issues in fresh and processed agricultural products also have implications to food safety on local markets and to the health of Ghanaian consumers.

A sound and appropriate national quality infrastructure (QI) must be in place to prove the compliance of goods and services with compulsory regulations and voluntary standards that outline quality requirements. Within an existing national QI system, the application of quality control measures and practices can elicit increased farm incomes, e.g. through increased market value, access to new markets, or savings in required inputs. However, measures and services to ensure high quality of products and proof quality characteristics to buyers require investments and know-how. Codified quality requirements may therefore put certain groups of farmers at a disadvantage. In light of smallholder based agricultural production in Ghana, it is crucial that QI is accessible not only for agri-food industries, but also on a local level, serving the needs of smallholder farmers. Smallholders' access to a national QI, however, remains a significant challenge.

1.2 Occasion and objectives of the study

In order to improve QI in the agricultural sector in Ghana, the "Physikalisch-Technische Bundesanstalt" (PTB), the German National Metrology Institute, is currently implementing the project "Quality assurance of agricultural products through metrological and testing services" in cooperation with the Ghanaian Ministry of Food and Agriculture (MoFA) and the Ghana Standards Authority (GSA). The project is funded by the Federal Ministry for Economic Cooperation and Development (BMZ).

Building on these experiences, PTB selected Ghana as a country for project implementation under the BMZ initiative "One World, No Hunger". Within this initiative, PTB intends to expand its programmatic focus to rural areas of Ghana and to focus on smallholder farmers as direct beneficiaries of interventions. The development and dissemination of suitable technologies, as well as access to institutions at the local level, is essential if smallholder farmers are to be included in upgraded agricultural value chains. The improvement of quality infrastructure in agri-food value chains in Ghana is also important to promote food safety and contribute to poverty reduction. PTB's expertise in QI can therefore be used to complement the Green Innovation Centres being implemented within the BMZ initiative.

PTB has commissioned the Centre for Rural Development (SLE) to conduct this study, which analyzes QI along the maize and pineapple value chains with a focus on smallholder farmers. In an inception phase of two months, the SLE team decided to

focus on the utilization of QI services rather than only mapping the locations of QI service providers. Therefore, the team agreed with PTB to study the following specific objectives:

1. Identification of existent and potential QI service providers for the local level based on selected characteristics (i.e. location of service provider, offered services, clients and organizational capacity).
2. Analysis of the status quo of QI service utilization by smallholders in maize and pineapple value chains regarding (a) the utilization of QI services, (b) obstacles to QI service utilization and (c) QI framework conditions (standards and technical regulations).
3. Assessment of the perceptions regarding quality among smallholders, traders, and consumers and the subsequent QI needs of smallholders.
4. Assessment of the costs and benefits of QI service utilization through a case study approach.
5. Identification of recommendations on improving framework conditions as well as institutional interaction and the dissemination of good practices on quality management.

The present report is the central output of the inception phase and three months of field work in Ghana. The established objectives aim at providing PTB, its counterparts and other Ghanaian QI providers with a better understanding of smallholders' utilization of QI services and the potential impacts of QI improvements. The results of this study can be used for future interventions of PTB and their counterparts to improve and upscale existing QI services according to the needs of smallholders. In the longer term the study aims at making QI accessible for smallholders by adapting the strategy, scope and quality of QI services offered by QI service providers to the needs of smallholders, thereby contributing to economic growth and the avoidance of environmental as well as health risks.

1.3 Structure of the report

The report is comprised of nine parts. The problem statement as well as the occasion and objectives of this study were presented in the previous section. The study background summarizes the concept of QI and its contribution to rural development, the country context and the selected commodities. Part three describes the approaches that form the basis for the selected methods, i.e. the value chain approach and the Knowledge-Attitude-Practice approach. Moreover, it provides the working

4 Introduction

definitions for smallholders and (potential) QI service providers that are used in the context of this study. Part four gives an overview of the study methods. The results of this study are presented in parts five, six and seven. While part five summarizes the findings concerning the national QI in Ghana, the commodity specific findings are presented in chapters six and seven. These chapters give a brief overview of contextual findings in the maize and pineapple value chains and then focus on describing the need for and utilization of selected QI services and identifying obstacles with a particular focus at the level of producers.

The findings of the two value chains and the national QI are discussed and synthesized in part eight of this report. The chapter draws general conclusions on the degree of relevance of QI services and their potential benefit for smallholders. Thereby it builds the foundation for the general recommendations that are presented in part nine. Recommendations are divided into commodity specific recommendations and general recommendations for PTB, QI institutions in Ghana and other stakeholders. Annex 1 includes, among others, an overview of all interviews that are referenced throughout this report.

2 Study background

The concept of QI and its contribution to rural development represents the basis of this study. It is therefore outlined in the following study background as well as the country context with a focus on the agricultural sector and the selected commodities of this study: maize and pineapple.

2.1 Quality infrastructure and its contribution to rural development

Quality infrastructure refers to “all aspects of metrology, standardization, testing, and quality management with its components certification and accreditation. This includes both public and private institutions and the regulatory framework within which they operate” (Sanetra, Marbán, 2007: 15). Hereby, regulations serve customers in the fulfilment of quality requirements. QI is necessary in order to ensure that products and processes meet predefined specifications demanded by authorities or the market place (Kellermann, 2011).

QI is based on a number of components that are closely interrelated and form a network whose logical links are based on a technical hierarchy. Five components can be identified which have been described by Sanetra and Marbán (2007):

- Standardization originally aims at compatibility and interchangeability. It provides a reference framework or a common language between suppliers and their customers containing the requirements that a product, process or service should comply with. While the term standard is exclusively used for voluntary application, the term technical regulation is used for compulsory implementation.
- Testing is the determination of characteristics, contents and/or quality-determining parameters of products, components, substances, etc. against specifications/standards. Depending on the respective testing field (e.g. chemical or microbiological testing) different methods of analysis, testing and/or inspection are used.
- Metrology is the science of exact and reliable measurements. QI services such as testing, inspection, certification and accreditation therefore rely on metrology. Metrology is based on the international system of units (SI), which defines the fundamental units of measurements (e.g. length, mass, time). For example, metrology includes the calibration of scales, the type specific ap-

6 Study background

proval of thermometers and meters, and the correct measurement of the kilogram in trade.

- Certification ensures that a product and its related production process, a service, organization or individual complies with the requirements defined in written standards.
- Accreditation is the procedure by which an independent third party gives formal recognition that a body or person has the technical competence to perform specific QI related tasks. Accreditation creates trust and reliability, thus facilitating international trade and competitiveness. It is based on international standards.

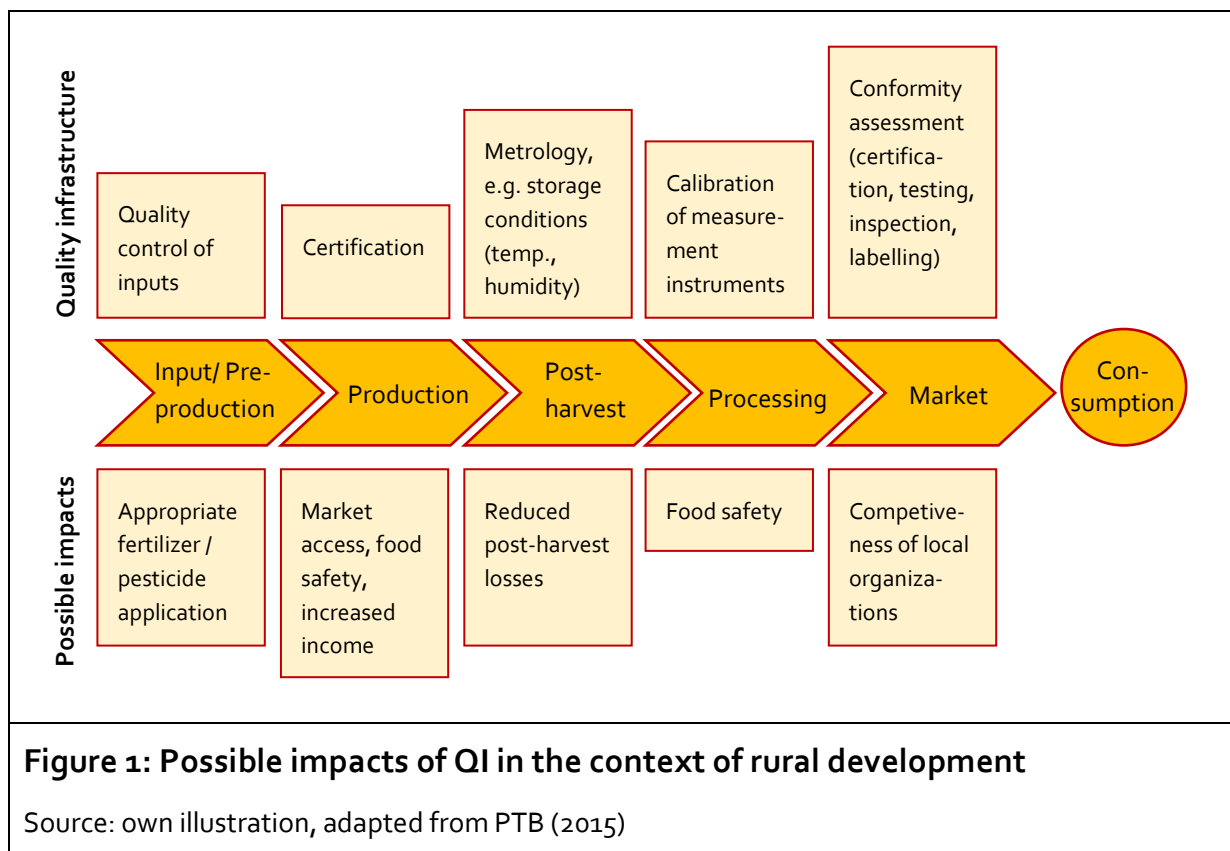
These five components comprise a national QI (NQI). Its fundamental institutions are the metrology institutes as well as the standards- and the accreditation-body (Sanetra, Marbán, 2007). A NQI, however, cannot be seen as an isolated system. In order to get access to world markets and enhance international competitiveness, a national QI system must be oriented according to international framework conditions (Stoldt, 2014). Laboratories, for example, must be accredited by internationally recognized bodies signatory to the International Laboratory Accreditation Cooperation (ILAC) mutual recognition agreement in order to prove their credibility and to establish and maintain their reputation. In order to unfold its full potential for the development of a country, a NQI further needs to be integrated in the framework of regional policies (Stoldt, 2011). The West Africa Quality Programme (WAQP) (now West African Quality System Programme, WAQSP-3) is an example of a regional QI approach that aims at strengthening the NQI in the ECOWAS region (WAQSP, 2015).

QI can play an important role in the development of agricultural innovation and the promotion of agricultural value chains. Its positive impacts could contribute to rural development and poverty reduction in the following ways (Stoldt, 2014):

- Quality assurance throughout value chains improves the quality of food products and reduces post-harvest losses (e.g. through better storage conditions as per humidity and temperature), thus increasing both the availability of food and its nutritious value.
- Local access to affordable and suitable laboratory analyses of soils, plants or residues in products prevents the misapplication of substances (e.g. fertilizers, pesticides, additives). QI thereby contributes to the health of the population and the conservation of their environment.
- The conformity with national and international guidelines and standards increases competitiveness of local organizations.

- Potential higher productivity, reduced losses and improved marketability of crops can have a positive impact on the income of farmers.

Some possible impacts of QI in the context of rural development are illustrated in Figure 1. The potential contribution of QI to sustainable economic development and improved social and ecological market economy is part of the Sectoral Concept “Quality Infrastructure, Conformity Assessment – Metrology, Standardization, Testing (MSTQ, 2004)” of the BMZ. The concept defines actions for promoting QI in developing countries.



Access to QI services, particularly in rural areas, is suspected to be limited. But even where it is accessible, and despite its potential positive impacts on rural development, the required investments to benefit from QI are often too high for certain groups of people, thus excluding them from participating in the national QI. QI may also impose a trade barrier to these groups, for example if testing is expensive or standards are not accessible or difficult to understand (Gonçalez, Peuckert, 2011).

2.2 Country context

Ghana is a low-middle income country with a total population of 26.79 million inhabitants (World Bank, 2015). 49.1 percent of the total population lives in rural areas (SRID, 2013). Gross Domestic Product (GDP) grew by 9.7 percent per annum from 2010-2013 (GoG GASIP, 2014). Although GDP growth was projected to fall to 3.4 percent in 2015, Ghana's long-term growth prospects are positive (World Bank, 2015). The country is divided into ten administrative regions and 170 districts. Despite its diverse and rich natural resources, a quarter of the population lives below the poverty line. However, the country has made considerable progress in reducing poverty and met the Millennium Development Goal of halving poverty rates by 2015 (GSS, 2013; World Bank, 2015).

Ghana's economic growth in recent years was driven by agriculture, which remains the primary livelihood for the majority of the population, currently employing 45 percent of the country's total labour force (World Bank Database, 2015). The major agricultural crops produced in Ghana include industrial crops, starchy staples, cereals, legumes, fruits and vegetables (ADB, ADF 2012). The major export crop is cocoa. Over the years, Ghana has also encouraged the export of other agricultural commodities, including pineapple, banana and mango (GoG METASIP, 2010). Agricultural production activities in Ghana are predominantly rain-fed and vary with the amount and distribution of rainfall and soil characteristics. Farming systems are characterized by smallholder production. The majority of smallholders practice a combination of subsistence farming and cash-cropping. Farming is largely carried out by traditional practices that employ hand and simple working tools (SRID, 2013).

Agricultural production is compromised by several factors, including limited access to markets and processing facilities, high post harvest losses as a result of poor post harvest management, a low level of mechanization in production and processing as well as low level and ineffective agricultural finance (GoG METASIP, 2010). This results in low productivity of land, poverty, low investment capacity and lack of economic opportunities as well as opportunities for young people. As a consequence, rural areas are characterized by an ageing and generally less dynamic rural population (GoG GASIP, 2014).

In order to improve agricultural performance and enhance incomes of smallholders, the Government of Ghana has implemented the Medium Term Agriculture Sector Investment Programme (GoG METASIP, 2010). The five year investment plan (2011-2015) has six programmes that address constraints on productivity, market access, sustainable production and institutional coordination. Maize, cassava, rice, yam and cowpea have been identified as priority staple crops for support (GoG

METASIP, 2010). Under programme three (“increased competitiveness and enhanced integration into domestic and international markets”) different development issues have been identified, including poor grading and standardization system, inadequate volumes with the required specifications and quality to supply the international markets and limited capacity to fully comply with international Sanitary and Phytosanitary (SPS) standards (GoG METASIP, 2010). This emphasizes the importance of QI in contributing to Ghana’s vision for its agricultural sector of a modernised agriculture, transformed economy, food security, employment creation and poverty reduction.

2.3 Selected commodities

For the scope of this study, PTB suggested an assessment of QI related issues along the rice and pineapple value chains. Those two commodities, as well as maize, will be the focus of new projects in Ghana. However, during the inception phase the study team chose to focus on maize instead of rice because of its higher production volume (1.9 million Mt in comparison to 0.5 million Mt of paddy rice in 2012 (MoFA SRID, 2013)), its health related problems and more QI relevance.

Maize (*Zea mays*) is the most important cereal crop on the domestic market in Ghana, accounting for 55 percent of the country’s total cereal production (FAO, 2012; IFPRI, 2014). In 2012, 1.9 million Mt of maize were produced (FAOSTAT, 2012). Maize is grown throughout Ghana. The leading producing areas are mainly in the middle-southern part (Brong-Ahafo, Eastern and Ashanti provinces) where 84 percent of the maize is grown (FAO, 2012). Around 70 percent of the maize grown in the country is grown by smallholders (FAO, 2012). The majority of farmers grow maize for home consumption as well as for a cash crop. Cultivated maize is mainly of the white type. Yellow maize is also imported and is mainly used in the poultry feed industry (FAO, 2012; IFPRI, 2014). According to FAO (2012), 89,000 Mt of maize were imported in 2010. Maize is also exported, but often through informal channels, for example to neighboring Burkina Faso and Ivory Coast.

Maize consumption has grown in the past and is projected to increase further due to population growth, increasing per capita income, urbanization and a growing poultry sector (FAO, 2012; IFPRI, 2014). Average maize yields of 1.9 Mt/ha, however, lag behind its estimated achievable yield of around 2.5 to 4 Mt/ha (SRID, 2011). Besides low yields, poor or non-existent post-harvest management infrastructure reduces production volumes and contributes to post-harvest losses from molds, insects and rodents, as well as inadequate handling and transport. Grain spoilage, mycotoxin contamination, quality loss and market value loss are resulting problems.

10 Study background

Aflatoxins, toxic carcinogenic by-products of the molds *Aspergillus flavus* and *Aspergillus parasiticus*, have been commonly found in maize and maize products in Ghana. A survey of the Council for Scientific and Industrial Research Ghana (2013) suggests that 66 out of 202 maize samples analyzed between 2010 and 2013 were above the national permissible levels of 15µg/kg. The lowest and the highest amounts reported were 0.05 µg/kg and 462.07 µg/kg respectively. The uptake of high-level aflatoxin contaminated food produces an acute hepatic necrosis, resulting later in cirrhosis or carcinoma of the liver. Children are particularly affected, since even small doses can lead to stunted growth and delayed development. Besides its high relevance for human health, other animal species that feed of aflatoxin contaminated maize are also vulnerable to the acute toxic effects of aflatoxin. Particularly the poultry industry is affected (Williams et al., 2004).

The prevalence of aflatoxins is strongly influenced by humid warm conditions, as well as insufficient drying and storage of grains. It is estimated that approximately 90 percent of the harvested maize in Ghana's humid regions could be contaminated with aflatoxins (pers. comm. Paul Schütz 17.06.15). This figure underlines the need for QI services available for smallholders to address this issue through testing and quality management in order to ensure food safety.

The pineapple (*Ananas comosus*) industry is the most developed horticultural sector in Ghana (Kleemann, 2011). Two percent of all households in Ghana grow pineapple on a total of 10,300 ha of land (SRID, 2013), but not all of them on a commercial basis (Kleemann, 2011). Ghana's pineapple production is estimated between 120,000-150,000 tons annually (Kleemann, 2011). Production is predominant in the Greater Accra, Eastern, Central, Western and Volta regions (Zottorgloh, 2014). There are four varieties grown in Ghana – Sugar Loaf, MD2, Smooth Cayenne and Queen Victoria.

In the mid 1980s, Ghanaian firms began exporting Smooth Cayenne (FAO, 2013). Pineapple exports peaked in 2004 at 71,805 Mt (MoFA SRID, 2013). Exports, however, have decreased since 2004 due to a shift in market demand away from the Smooth Cayenne variety to the MD2 variety produced primarily in Costa Rica. MD2 is costly to grow in Ghana and as a consequence producers (mainly smallholders) were unable to successfully shift to MD2 production (FAO, 2013; Zottorgloh, 2014). Today, the main private pineapple exporters are large-scale plantations that, in some cases, are collaborating directly with smallholders through contract farming (so called out-grower schemes). Thirty-nine percent of pineapple exports are produced by small-

holders⁶ (Kleemann, 2011). With 41,212 Mt being exported in 2012, Ghana's pineapple exports are currently at the 26th position on the international market (ATVET, GIZ 2014; MoFA SRID, 2013). Exports from Ghana are almost entirely transported to European countries (Kleemann, 2011).

One of the major challenges for Ghana's pineapple production is low productivity of pineapple producers with an average yield of 60 t/ha compared to a potential yield of 100 t/ha (FAO, 2013). Challenges related to the quality of pineapple are less obvious as compared to maize. This is particularly true for pineapples that are destined for the local market where the quality of a fruit is usually determined through shape, size and color. With respect to international markets, however, pineapple production in Ghana is not effective in supplying the right quality to meet the demands of those markets (FAO, 2013).

6 The author of the article does not indicate how she defines a smallholder. It should therefore be noted that the total land size cultivated by a smallholder may be defined differently as compared to this study.

3 Study approaches and definitions

This research is based on two study approaches in order to analyze QI services along the maize and pineapple value chains with a focus on smallholders – namely a value chain approach and a Knowledge-Attitude-Practice (KAP) approach. These approaches are presented in the following section, together with working definitions for smallholders and (potential) QI service providers.

3.1 Value Chain approach

In the Value Chain (VC) approach economic activities are characterized by the consecutive addition of value to a product. This value is added within the segments of a chain, such as production, processing, distribution and consumption. A set of autonomous but interdependent actors is involved in adding value to the product along the segments of the value chain. This process is supported by value chain operators such as information providers and enabled in a political environment, for example through laws.

In the context of this study of QI, the VC approach is used to analyze quality requirements of different value chain actors and analyze and evaluate the services provided by the national QI. The goal here is to identify the need for QI in order to strengthen QI services needed within a value chain and adapt the services to the respective demand (Sanetra, Marbán, 2007; Stoldt, 2014). PTB introduced the CALIDENA method, which is a “participative learning process of quality and chain analysis” (PTB, 2009: 10).

Quality is an important concept within this context of VC analysis as it influences the demands towards value addition of actors upstream the value chain. The concept of quality is “a set of properties inherent to an object that enables it to satisfy implicit or explicit needs” (PTB, 2009: 18). Quality is determined through the perception that a VC actor has of a certain product. Nevertheless, inherent characteristics of a product can be defined through requirements that need to be fulfilled, thus making quality objectively measurable (PTB, 2009).

In order to understand what motivates or prevents smallholders from utilizing QI services, this study used a partial value chain analysis that focused on smallholders, i.e. the segments of input provision, production, post-harvest and trade. Issues of quality in the maize and pineapple value chains were addressed as well as the perception of and demand for quality.

14 Study approaches and definitions

3.2 Knowledge-Attitude-Practice approach

Characteristics in knowledge, attitude and final behaviour or practice about QI service utilization among smallholders were suspected as relevant criteria to describe smallholders' practice in QI use. This is best reflected in the Knowledge-Attitude-Practice approach (KAP) that has been used in research of service utilization, for example in the health sectors (WHO, 2008; Médecins sans Frontières, 2011). A KAP survey aims at gathering information about knowledge and attitudes in order to determine obstacles and possible actions. Interviews determine what respondents know about a certain topic, what they think about it and what they actually do with regard to taking action (WHO, 2008).

In the context of this research, knowledge refers to the awareness of existing QI services. Attitude describes appreciation or refusal of QI and captures the motivation to use QI and possible incentives/sanctions. The term practice describes the degree to which a smallholder effectively uses QI services. The relation between KAP and QI utilization can be used to determine different categories of smallholders, i.e. QI non-users who are ignorant, informed or interested and QI users. A detailed overview of the categorization of smallholders regarding their QI use can be found in annex 4.

The major goal of using the KAP approach was to identify needs, problems and barriers to QI utilization by smallholders; problems and barriers in service delivery; and solutions for improving quality and accessibility of services. The KAP approach was not entirely verified in quantitative terms, but enabled the study team to distinguish between lack of knowledge that can be overcome by training and the welcoming and refusing attitudes of farmers.

3.3 Working definitions

3.3.1 Smallholder

There is no universal definition of smallholders applicable to this research. Although various indicators can be used to define smallholders, farm size is often understood as the main determinant. In Ghana, average landholding size is 8 acres; two thirds of all farms are below 7.5 acres (IFPRI, 2007). Further key characteristics of farmers that are commonly defined as smallholders in Ghana are (a) lower agricultural income per capita, (b) predominance of food crop marketing, (c) weak engagement with input and credit markets and (d) high importance of family labor on the farm (Chamberlin, 2008).

For the purpose of this study, smallholders were indicatively defined as farmers who cultivate on less than 5 acres of land, thereby following the smallholder definition given by the African Development Bank (aidenvironment, 2013). When field surveys started, however, it was realized that a too stringent selection of smallholders excludes farmers who use QI or have the potential to use QI in the future. For example, maize farmers who have larger landholdings (>5 acres) were observed to store maize for a longer period than farmers with smaller landholdings (<5 acres), thus increasing the risk of aflatoxin contaminations and the need for QI. In order to give a complete picture about (potential) QI utilization among farmers, the smallholder definition was adapted, using the average landholding size in Ghana given by IFPRI (2007). According to the new definition, smallholders are farmers who cultivate on 8 acres of land or less. Further socio-economic characteristics that define smallholders are disregarded for the same reason. The terms smallholder and small-scale farmer are used interchangeably.

3.3.2 Quality infrastructure service provider and potential candidates

In the context of this research, the term QI service provider (abbreviated QISP) encompasses all public and private institutions as well as regulatory bodies that contribute to quality demands of value chain actors being verified in production and trade of products. This encompasses quality control of inputs and goods as well as the documentation of quality requirements. A QISP can provide services in metrology, testing, standardization, certification and accreditation.

Potential QI service providers (pQISP) are institutions that have the capacity to become QI service providers in the future. The potential capacity includes that an institution has the human and technical resources, the infrastructure and/or the competences and the ability to develop economically viable QI services in the future, thereby improving availability of and access to quality infrastructure services in rural areas. Potential QISPs may be government departments, public institutions, NGOs or for-profit private organizations.

4 Methodology

Given the exploratory purpose of this study, a multiple methods approach was chosen, focusing on different qualitative methods. Selected qualitative methods generated in-depth as well as background information on QI utilization by smallholders in the selected value chains. This section describes the selected study regions as well as the selection of QI services and interview partners, data collection methods and data analysis.

4.1 Study regions

Due to different growing conditions of maize and pineapple, one study region was selected per commodity according to the following criteria:

- Production and local trading of maize/pineapple and commercial character;
- Amount of smallholders engaged in maize/pineapple production;
- Existence of problems that require QI;
- Distance to national QI centers, mostly Accra;
- Partner infrastructure (GIZ, Export Promotion council);
- Budget and time.

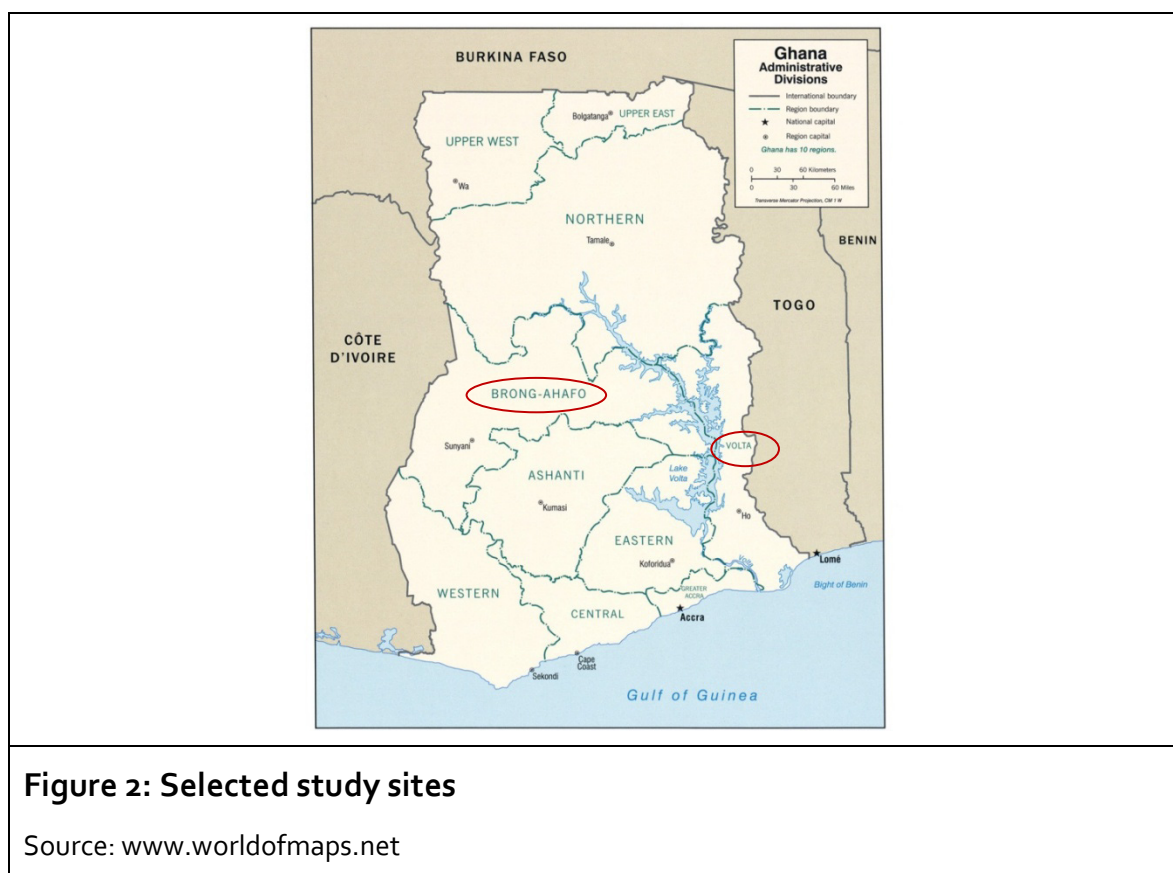
A further aspect to select the study regions was the presence of interventions of the Market Oriented Agriculture Program of GIZ (MOAP⁷) in the study region. MOAP supports producers and processors in the maize and pineapple VCs. It was hypothesized that a participation of smallholders in the national QI system may be facilitated by their participation in QI specific interventions by development actors or public authorities and/or support from donors that externally trigger motivation of smallholders. It was further hypothesized that QI service use may be influenced by the affiliation of smallholders to farmer based organizations (FBOs) or outgrower schemes.

The Brong-Ahafo region was selected to study QI utilization by smallholders in the maize value chain, mostly because maize production and rainfall coincide during the major maize season, thus risking post harvest losses and increasing the need for QI. Brong-Ahafo further is the leading maize producing region (466.208 Mt

7 MOAP is a collaboration between MoFA and GIZ. It started in 2004. Present priority intervention regions are the Greater Accra, Volta, Central and Brong-Ahafo Region. Activities in the maize VC focus on post-harvest management while activities in the pineapple VC focus on organizing farmers in associations so that export and quality aspects can be easier communicated to a greater number of farmers.

in 2012/2013) (SRID, 2014). It is therefore commonly referred to as the “Bread Basket” of Ghana. Thirty-five percent of the cultivated land is under maize production (Interview 37). The majority of maize farmers are smallholders.

The region with its capital Sunyani is located in the west central part of Ghana (Figure 2). Agriculture employs 69.1 percent of the region’s labor force (MoFA a, n.d.). Average land holding size in Brong-Ahafo is 8.7 acres (IFPRI, 2007). 30.2 percent of the population of the region, aged 11 years and older, are not literate (GSS Brong-Ahafo, 2013).



Brong-Ahafo has varied vegetation, ranging from forest and transitional vegetation to savanna. It has a bi-modal rainfall, ranging from an average of 1000mm in the northern parts to 1400mm in the southern parts. Major rains occur between April and July and minor rains between September and October (MoFA b, n.d.), which is the major season when maize is harvested. The region is divided into two major climatic zones – the southwest sector is situated in the rain belt, while the northeast sector lies in the savanna belt. Molds and the related development of aflatoxins are of significant relevance in the southwest sector where rainfall is

high. The prevalence of molds decreases to the northeast of the district. A local GSA office is located in Sunyani.

With respect to the distribution of quality related problems, in particular molds and aflatoxins, targeted sampling was used to identify four districts in the south-west sector for data collection. The districts were selected according to (a) their relevance in maize production, (b) the existence of FBOs, (c) the presence of MOAP interventions, and (d) the amount of farms that use maize as poultry feed. The following four districts were selected: Nkoranza, Techiman, Dormaa and Sunyani. Selection of districts was verified and coordinated with the regional MoFA.

Maize production in all four districts is above the regions average maize production of 21.191 Mt (SRID, 2014). Techiman hosts the most important supranational maize market. Another important maize market is located in Nkoranza district. Both districts moreover have benefitted of MOAP interventions in the maize value chain that have organized farmers into FBOs. Dormaa district was selected due to its relevance in the poultry sector. The district has the largest poultry concentration in the region (Anang et al., 2013). The short distance to the regional capital where (potential) QI service providers and maize processors are located was the criterion to select Sunyani district.

The Volta region was chosen in order to study QI utilization by small-scale pineapple farmers with less commercial attitudes and in some distance to QI service providers located in Accra. The region with its capital Ho is located in the southeast of the country bordering Togo (Figure 2). Agriculture plays a vital role in the socio-economic development of the region and employs about 74 percent of the economically active population. Average landholding size is 5.44 acres (IFPRI, 2007). Of the population aged 15 years or older 29.3 percent are illiterate (GSS Volta, 2013).

The rainfall of the region is bi-modal with rainfalls occurring from March to July and mid-August to October. The annual rainfall ranges from 513.9 mm and 1099.88 mm. Rainfall figures vary greatly throughout the region (MoFA c, n.d.).

Common crops cultivated in the region include cereals such as maize, legumes, vegetables, oil trees, roots and tubers, pulses and plantation crops. The cultivation of non-traditional crops like pineapple, however, is on the rise. All four pineapple varieties are cultivated. In contrast to the Central region, where commercial pineapple farming takes place, the Volta region bears a significant production by smallholders who sell their produce to the local market (Zottorgloh, 2014). Moreover, a cross-border trade with neighboring Togo can be observed. Although

pineapple production of the Eastern and Central region exceeds the volumes produced in the Volta region, this region was selected based on the information of an increasing number of smallholders in the region and its potential importance for the sector in the future. Furthermore, it represents an area that is located further away from the QI service providers in Accra. Notable districts for pineapple production are Akatsi North and South, Kpando and South and North Tongu (MoFA c, n.d.). A number of smallholders are supported by MOAP to improve production and quality management of pineapple. MOAP established a number of FBOs as well as the Volta Value Chain Cooperative as an umbrella organization for pineapple and mango VC actors in the Volta region. A regional GSA office is located in Ho.

Targeted sampling was used to identify four districts within the region for data collection according to (a) their relevance in pineapple production, (b) the existence of farmer based organizations, (c) the presence of MOAP interventions, and (d) the markets that are supplied by smallholders (local/regional). The selected districts were Akatsi North, Akatsi South, Kpando and Jasikan districts. Selection of districts was verified and coordinated with the regional MoFA. Since pineapple production in the Volta region is characterized by small-scale production for the local market, two districts in the Eastern and Central region were additionally selected to complement interviews from the Volta region. This was in Akuapim South Municipal District in the Eastern region and Gamoia East district in the Central region. There, pineapple farmers who are in outgrower schemes were interviewed in order to analyze influences of organizational structure.

4.2 Selection of quality infrastructure services

In order to identify the existence and need of QI services in the maize and pineapple value chains as well as the obstacles for service utilization, the study focused on selected QI services that were identified prior to data collection in the field. Services were selected according to their potential relevance for smallholders, i.e. their point of relevance in the value chain. Selection was based on expert recommendations and literature review. Figures 3 and 4 display the selected services and the value chain segments for which they were analyzed.⁸

In the maize VC (Figure 3), most quality related issues occur on the post-harvest level, thus compromising the economic benefits for smallholders. There-

8 The displayed VCs are simplified. A more precise illustration of the VCs of the respective commodities is presented in chapter 6.1 and 7.1.

fore a major focus of investigation was on the utilization of QI services at the post-harvest level, e.g. the testing of the moisture content, as well as the use of weighing scales and the maize standard GS211.

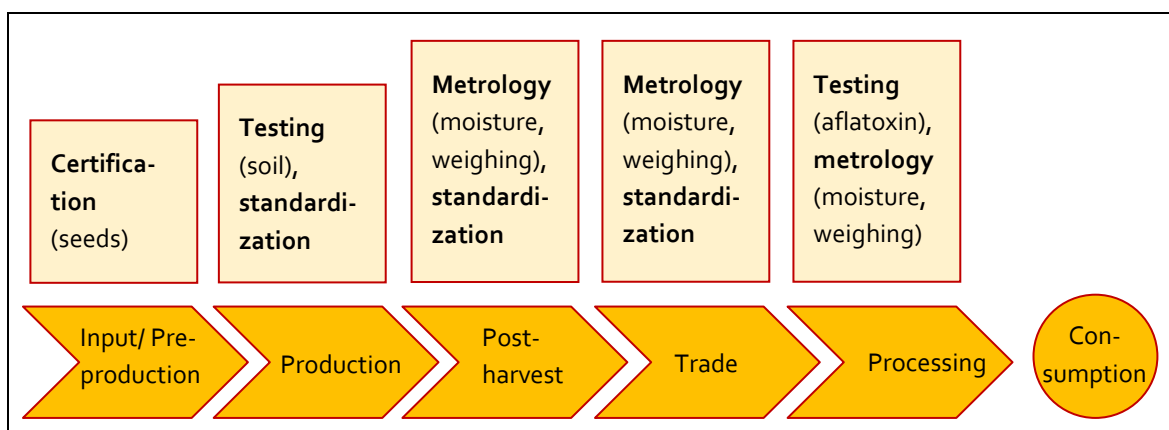


Figure 3: Selected QI services in the maize value chain

Source: own illustration

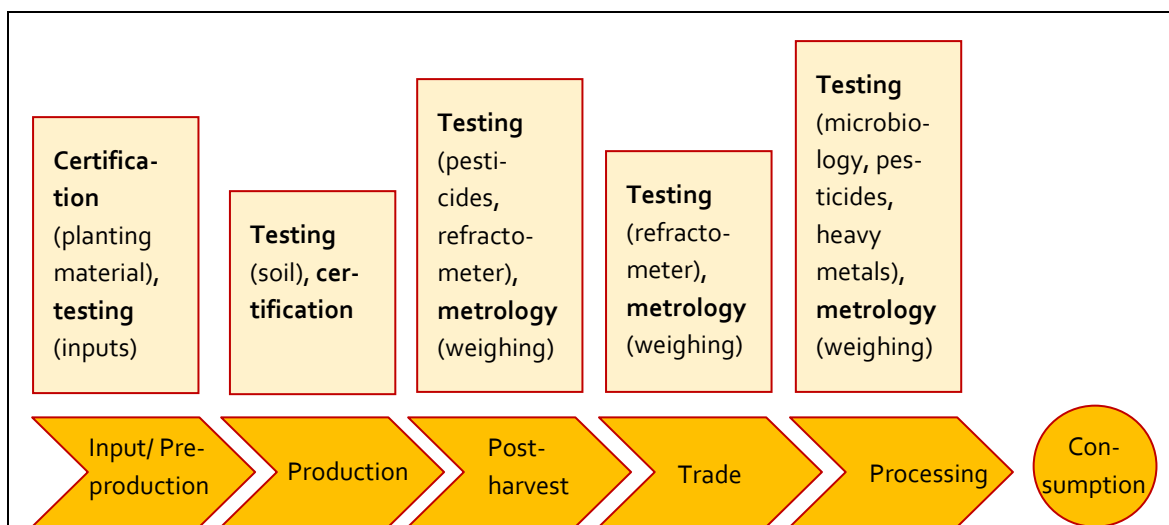


Figure 4: Selected QI services in the pineapple value chain

Source: own illustration

22 Methodology

In the pineapple VC (Figure 4), the analysis of QI services focused on the production, post-harvest and trade level. The utilization of weighing scales when trading pineapple, testing services including the measurement of pesticide residues in pineapples as well as the measurement of the sugar contents were analyzed. A further focus was soil testing due to the high, intense and continuous fertilization needed by the MD2 variety.

4.3 Data collection

Field surveys were conducted over a period of 2 ½ months – from August 3 to October 13, 2015. Data collection was supported by five Ghanaian research assistants from the University of Ghana who translated interviews with smallholders and supported the interpretation of results.

4.3.1 Selection of interview partners

Primary and secondary sources were used to draw conclusions on the levels of smallholders, traders, consumers and (potential) QI service providers (investigation units). Smallholders and (p)QISPs have already been defined in Chapter 3. The research unit trader describes all aggregators, market women and middlemen that deal with smallholders. The research unit consumer refers to supermarkets and market customers. Interviews were conducted on local, regional and national levels (Figure 5).

Secondary sources of information were selected according to their expertise and knowledge about the value chains and/or QI related topics. Targeted sampling was used to identify primary sources according to criteria defined for the district, regional and individual levels. The criteria for selecting the study regions and districts were already described in the previous chapter.

The following criteria were used to identify individual respondents:

- Smallholders: age, sex, farm size and market orientation;
- Traders: trade of selected commodity, trade with smallholder products and operating level;
- Consumers: frequency of consumption, amount of consumption and operating level;
- (potential) QI service providers: existing/potential provision of QI services, capacity for QI service provision, relevance of QI service for selected commodity, operating level.

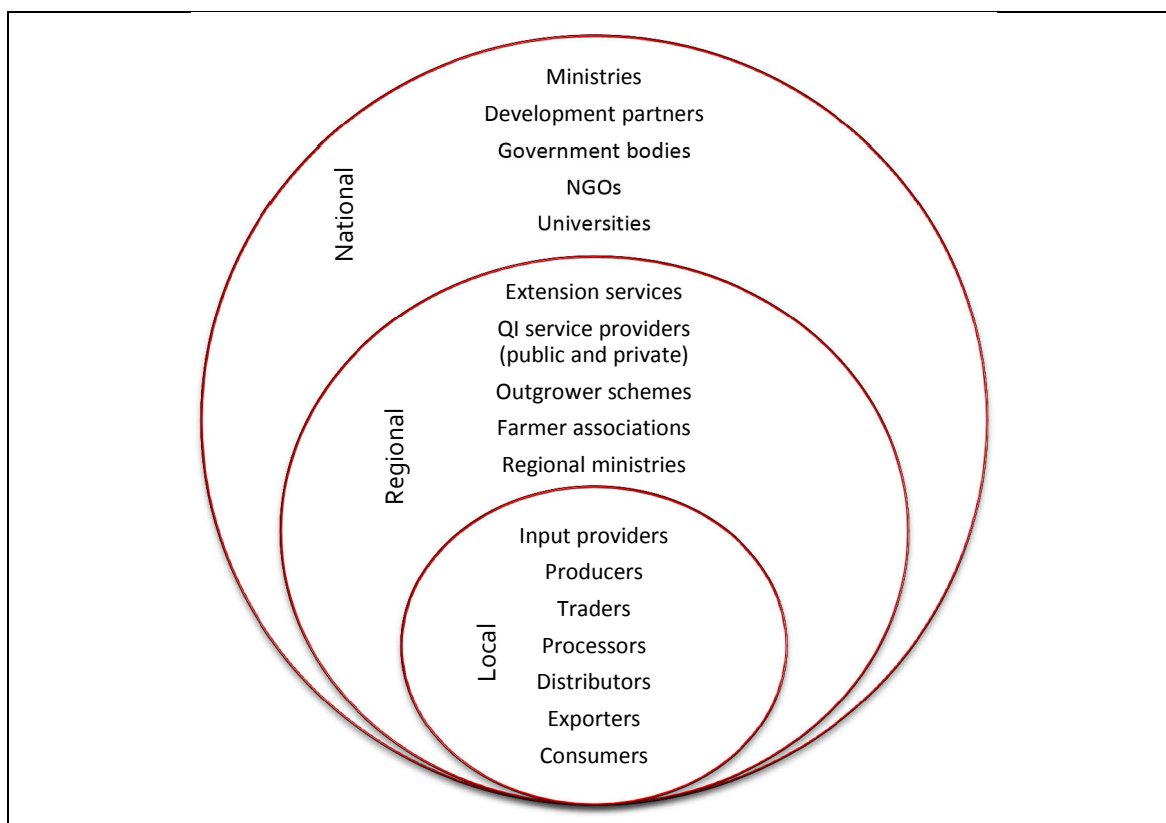
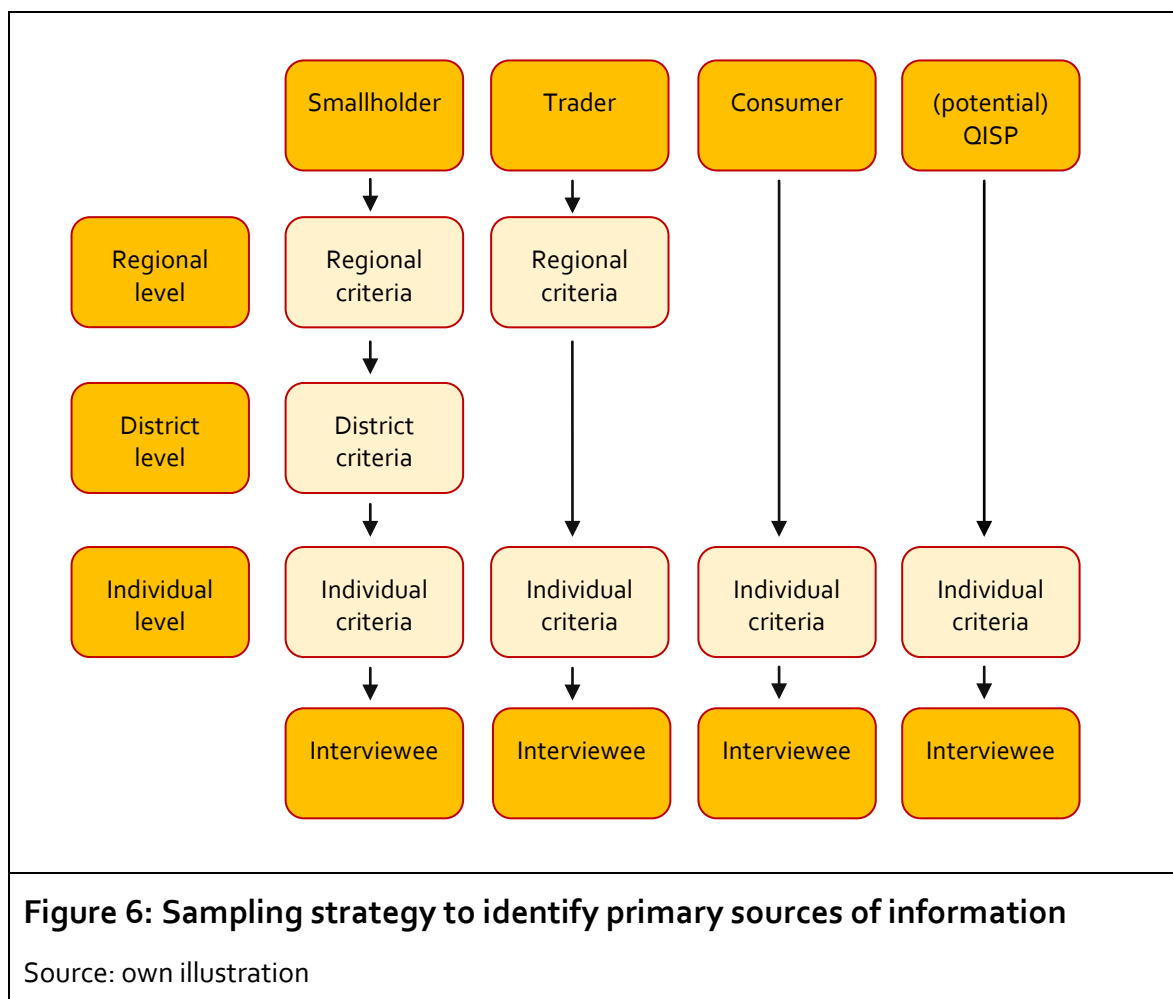


Figure 5: Information sources on local, regional and national levels

PTB's definition of the micro level corresponds with the regional level in this figure; the meso level corresponds with the national level. PTB's definition of the macro level, meaning international QI networks, was looked at by this study to a lesser extent.

Source: own illustration

Figure 6 displays the sampling strategy. In order to sample smallholders, first, two regions were sampled then districts within each region and finally smallholders according to individual criteria. Traders were selected by sampling the regions and, in a second step, individual traders (no district criteria were applied). Consumers and (potential) QISPs were sampled across the country according to individual criteria (no regional or district criteria were applied).



4.3.2 Data collection methods

Principal data collection methods were semi-structured interviews and focus group discussions. In total, 137 semi-structured interviews and 7 focus group discussions were conducted. Fifty-five maize farmers and 50 pineapple farmers were interviewed. Data collection started with semi-structured interviews in Accra, particularly with QI service providers and representatives of ministries, NGOs and further relevant experts. Field surveys in Brong-Ahafo and Volta included focus group discussions with smallholders, followed by semi-structured interviews with smallholders, traders, processors, consumers, QI service providers as well as agricultural departments of the districts. In addition, four soil analyses were conducted. At the end of field surveys, debriefing sessions were held in both regions with the regional MoFA and MOAP. The data collection period was finalized with a recommendation workshop in Accra. Selected methods as well as the corresponding approaches are summarized in Table 1.

Table 1: Selected data collection methods and the corresponding approaches

Objective	Investigation unit	Approach	Data collection methods
1	QI service providers	Stakeholder mapping	Semi-structured interviews
2	QI service providers, smallholders	Partial value chain analysis , KAP	Literature review, semi-structured interviews, focus group discussions, workshops
3	Smallholders, traders and consumers	Perception analysis	Semi-structured interviews, focus group discussions
4	Smallholders	Cost-benefit analysis based on case studies	Semi-structured interviews, Soil analysis
5	QI service providers, smallholders	-	Literature review, semi-structured interviews, workshop

Source: own illustration

Semi-structured interviews

Semi-structured interviews were based on a prepared interview guide with open-ended questions. They were designed to gather individual attitudes of different stakeholders towards QI. Different interview guides were developed for each stakeholder.

Interviews were conducted with:

- Existing and potential QI service providers;
- Experts from ministries, development programs, research, NGOs;
- Relevant value chain actors (input providers, producers, traders, processors, distributors, exporters and consumers).

A detailed list of interviewed stakeholders as well as an exemplary interview guide conducted with maize and pineapple farmers can be found in annex 1-3. The goals of different semi-structured interviews with the selected stakeholders are presented in Table 2.

Stakeholder	Goals
(potential) QI service providers	<ul style="list-style-type: none"> • Validate data collected through literature review • Discuss relevant issues of current and potential QI services • Identify bottlenecks regarding QI along maize and pineapple value chains • Identify QI relevance for smallholders • Identify driving factors for QI utilization by smallholders
Experts	<ul style="list-style-type: none"> • Validate data collected through literature review • Discuss relevant issues of current and potential QI services • Identify bottlenecks regarding QI along maize and pineapple value chains • Identify QI relevance for smallholders
Input providers	<ul style="list-style-type: none"> • Discuss relevant issues of current and potential QI services • Identify QI relevance for smallholders • Identify costs and availability of pesticides and fertilizers • Provide data for the cost benefit analysis
Traders, processors, distributors, exporters, consumers	<ul style="list-style-type: none"> • Discuss the demands of traders, processors, distributors, exporters and consumers regarding the quality of products • Discuss relevant issues of current and potential QI services • Identify QI relevance for smallholders
Producers	<ul style="list-style-type: none"> • Deepen information gathered in the earlier process through focus group discussions • Verify specific issues which could not be discussed in depth or which remained controversial • Provide data for the cost benefit analysis

Source: own illustration

Focus group discussions

Focus group discussions were conducted with maize and pineapple small-scale farmers (Figure 7). They are an appropriate method for swiftly generating ideas and opinions and for revealing the reasoning behind these. For the purpose of this study the method was selected in order to obtain information about the opinions of smallholders regarding QI. In particular, the goals of focus group discussions were to:

- Identify the perception of smallholders regarding the quality of maize/pineapple;
- Identify awareness about QI, attitude towards QI, the use of QI services, motivating factors and obstacles for QI service utilization, as well as needs

and demands of smallholders with respect to QI services along maize and pineapple value chains;

- Identify differences in QI utilization between organized and unorganized farmers;
- Validate data collected from semi-structured interviews with experts.

Four focus group discussions were conducted with maize farmers and three with pineapple farmers. Discussions had anywhere between 5 and 12 participants, whereby they attracted more people from the villages than planned, since they found the discussions interesting. Participants of discussions were either unorganized farmers, members of FBOs with or without intervention of MOAP, or farmers in outgrower schemes. Participants were invited 1-3 days in advance. Discussions followed an interview guide with leading questions. They lasted 1-2 hours.

Soil analysis

In two districts of the Volta region (Jasikan and Akatsi South) four soil samples were collected and analyzed for different physico-chemical properties. Soil analyses were conducted with the purpose of identifying the potential contribution of soil testing to optimized fertilizer application and increased pineapple yields. The costs and economic benefits of soil testing were calculated through a partial budgeting exercise that is described in the following chapter (Chapter 4.4).

Soil samples were taken from unfertilized pineapple fields by following the instructions given in the soil-testing guide of MOAP (2013). The samples were analyzed by the Soil Science Department of the University of Ghana. The following parameters were analyzed: particle size distribution of sand, silt and clay, texture, pH, extractable bases (Ca, Mg, K), org. C, total N, avail. P, Cd and Pd.⁹

9 Calcium (Ca), Magnesium (Mg), Potassium (K), organic Carbon (C), total Nitrogen (N), available Phosphorus (P), Cadmium (Cd) and Palladium (Pd).



Figure 7: Interviews with different stakeholders

Top left: Group discussion with maize farmers; top right: group discussion with pineapple farmers. Bottom left: interview with a pineapple farmer; bottom right: recommendation workshop.

Photos: T. Pfeiffer

Recommendation workshop

A recommendation workshop was organized and held on the 13th of October at the premises of GSA in Accra (Figure 7). The goal of the workshop was to bring stakeholders of the local, regional and national levels together in order to:

- Validate the data collected;
- Discuss recommendations on information and technology, institutional interaction of actors in QI service provision, framework conditions and dissemination of good QI service practices.

Forty-three stakeholders attended the workshop. Representatives of the national, provincial and district levels were present. After a general discussion with all participants the group was splint into maize and pineapple working groups in order to discuss more specific recommendations for each value chain.

4.4 Data analysis

All interviews were recorded throughout the data collection period. Qualitative data analysis was performed using open coding of the interview protocols. The software ATLAS.ti was applied in this process. Codes were defined as the collection and review of data started. In a first step, a structure of the report was developed according to the research objectives and preliminary findings. In a second step, 76 detailed codes were developed in line with the structure of the report. Every code was precisely defined in order to ensure inter-coder reliability.

Data triangulation of primary and secondary data was carried out to strengthen and validate data and research findings from the various data sources. Triangulation further allowed reducing bias and developing a comprehensive understanding of the findings.

Quantitative results on the costs and economic benefits of QI service utilization were analyzed through a case-study approach and calculations on smallholder, processor and trader levels. The analysis follows the logic of a partial budgeting exercise with the objective of identifying financial impacts of past and potential changes within business operations. Thus, changes in costs and returns through QI service utilization were identified.

5 National quality infrastructure in Ghana

One main expectation of this research is to map QI providers in Ghana, particularly at the local level. Chapter 5 addresses these findings in narrative form; Annex 5 provides an overview in table form. Chapter 5.2.2 summarizes findings related to national QI and forms the basis for the general discussion in Chapter 8.

5.1 Institutional responsibilities and quality infrastructure

5.1.1 Key public institutions and their responsibilities

In the previous discussion on the concept of quality infrastructure, its complex nature was emphasized. A key characteristic of a national quality infrastructure (NQI) is the multiplicity of organizations it involves. Understanding the various responsibilities of these organizations and their interaction is therefore an important starting point for improving a NQI and fundamental for the discussions in the following chapters focusing on small-scale farmers and QI.

The key public institutions of Ghana's NQI are the Ghana Standards Authority (GSA) and the Food and Drugs Authority (FDA). The Plant Protection and Regulatory Services Department (PPRSD) of the Ministry of Food and Agriculture is a key public institution of Ghana's agri-food related NQI.

The Ghana Standards Authority is the leading Ghanaian institute concerning standardization as well as metrology. The GSA reports to the Ministry of Trade and Industries (MoTI). Activities related to metrology include the calibration of laboratory, medical and other equipment, as well as industrial weights and measures, and the verification of weights and measures. Furthermore, the GSA is mandated to establish and promulgate standards with the objective of ensuring high quality of goods produced in Ghana, both for domestic consumption and for export. Furthermore, the GSA is in charge of promoting (a) standardisation in industry and commerce, as well as industrial efficiency and (b) standards in public and industrial welfare, health and safety (Standards Authority Act, 1973). The GSA has published six standards relevant to pineapple (raw material (GS 101), planting material (GS 966), juice (GS 1091), packaging (GSA 136-2), inspection manual for pineapple planting materials (GS IM 11), and dried pineapple (GS 1035)), and four standards for maize (raw material (GS 211), maize grits (GS 729) and maize meal (GS 735), and roasted maize flour (GS 883)).

32 National quality infrastructure in Ghana

The working process for developing and maintaining a standard is as follows:

- A draft of a new standard is sent to the technical coordination service committee, which consists of GSA staff, commodity-specific experts and private as well as public associations and entities;
- After reviewing and editing the draft standard, it is sent out for public review, where, theoretically, smallholders have an opportunity to give feedback;
- Finally, the standard is published and ready for utilization.
- After 5 years, a standard must be reviewed and revised. In addition, the revision can be requested by anybody, at any time.

In addition to standards, the GSA has also been responsible for enforcing export certificates since May 2015. The purpose of export certificates is to ensure that Ghanaian export products fulfil the quality demands of the exporting country, i.e. Ghana. With the exception of raw fruits and vegetables, the GSA's export certificate procedure is legally binding for every product that is to be exported. Depending on the nature of the product and the status of the producer, different procedures for obtaining the export certificate apply. All cereal- and nut-based products need to be tested for toxins, and the company needs to be certified. For other products, testing is only mandatory if the company is not certified (Interview 42).

In 2014, the GSA issued 700 export certificates. Between January and October 2015, the number of certificates grew to 1800. Eight hundred samples were sent to the laboratory during the same period – compared to just 75 in 2014 (pers. comm. Felicia Adams). Therefore, the amount of export certificates and samples sent to the laboratory has increased since the introduction of mandatory export certificates. This should contribute to ensuring the quality and the competitiveness of Ghanaian export products. Subsequently, it would be expected that the number of Ghanaian products being rejected at the borders of importing markets should decrease.

The Food and Drugs Authority was established in 2012, replacing the previous Food and Drugs Board. It is the most important public agency related to food safety and health. The FDA reports to the Ministry of Health (MoH) and its mandate is defined in the Public Health Act of 2012 (Act 851). According to this act, the main responsibility of the FDA is to “provide and enforce standards for the sale of food, herbal medicinal products, cosmetics, drugs, medical devices and household chemical substances” (Public Health Act, 2012: 43). Two main functions of the

FDA are (a) to secure adequate and effective standards for food and (b) to provide advice on measures for the protection of consumers. Any processed product to be sold on the domestic market has to be registered with the FDA. The process of registration includes conformity testing for products.

The Plant Protection and Regulatory Services Department (PPRSD) plays a crucial role for quality assurance with regard to agricultural production. The Plants and Fertilizer Act lays down the responsibilities of PPRSD, which include the import and export of agricultural inputs, seed certification and fertilizer analysis (Plants and Fertilizer Act, 2010). Furthermore, PPRSD is responsible for delivering the Phytosanitary Certificate. The certificate assures the buyer that products are free from quarantine pests and conform to the phytosanitary requirements of the importing country (Interview 89). However, in the period from 2013 to 2014, 488 out of the 494 consignments that were intercepted by the EU due to the presence of quarantine harmful organisms had a phytosanitary certificate.

Other QI-relevant organizations of the NQI include the Food Research Institute (CSIR-FRI) and the Soil Research Institute (CSIR-SRI). Both are supervised by the Council for Scientific and Industrial Research (CSIR) and report to the Ministry for Environment, Science, Technology and Innovation (MESTI). The Biotechnology and Nuclear Agriculture Research Institute (BNARI) is an important institute for research on agriculture and food. The Environmental Protection Agency (EPA) is a major institution concerning agricultural inputs; the EPA registers chemicals and monitors their application. The key stakeholders and their responsibilities are summarized in Table 3. As the table clearly shows, four ministries oversee the governmental QISPs. The question arises here, whether this number is sufficiently justified by the diverse responsibilities given the consequent coordination efforts.

Since this research aims at establishing the utilization of quality infrastructure in rural areas, it is useful to briefly describe political responsibilities at the regional and district levels. At the regional level, the regional directorate of food and agriculture (RADU) reports to the capital. Districts are the smallest administrative unit in Ghana. The Local Government Law implemented in 1993 and subsequent legislative acts entrust the district assembly with the planning authority, including development planning, political and administrative authority and responsibility for public health, environmental protection, roads, forestry, agricultural extension and sanitation (FES, 2010). District assemblies, for instance, are responsible for the regulation of markets in their districts, as is the case with major maize markets in Techiman and Nkoranza districts. Any law passed by a given district assembly is legally binding for that district. The Local Government Law foresaw the major re-

sponsibility being assumed at the district level, while policy planning, coordination, technical backstopping, monitoring and evaluation would be located at the regional level (Asuming-Brempong et al., 2005). In 1997, as part of the decentralization process, the previous district MoFA office was replaced with an agricultural department as part of the district assembly (Asuming-Brempong et al., 2005: see annex 6). Agricultural departments are supposed to report to the district assembly first. The regional MoFA director of agriculture advises – but does not manage – a district director of agriculture. The District Director of Agriculture supervises the District Development Officer (DDO). The DDOs are responsible for the Agricultural Extension Agents, which work directly with farmers and are responsible for training them.

Table 3: Overview of authorities relevant to QI			
Institution	Ministry	Responsibility	Mandated by
Food and Drugs Authority (FDA)	Ministry of Health	Food Safety Public Health Domestic product certification Regulation	Health Law, 2012
Ghana Standards Authority (GSA)	Ministry of Trade and Industries	Standardization Metrology Certification (export, product) Testing	Standards Authority Act, 1973 (N.R.C.D.175)
Biotechnology and Nuclear Agriculture Research Institute (BNARI) Environmental Protection Agency (EPA) Soil Research Institute (CSIR-SRI) Food Research Institute (CSIR-FRI)	Ministry of Environment, Science, Technology and Innovation	Research on soil (SRI) Research on food (FRI) Testing (FRI, SRI, BNARI) Registration of Agricultural Inputs (EPA) Environmental Education (EPA)	-
Plant Protection and Regulatory Services Department (PPRSD)	Ministry of Food and Agriculture	Seed Certification Import and Export of Fertilizers Export Certification	Plant and Fertilizer Act, 2010
Source: own illustration			

5.1.2 Interventions, initiatives and networks

Presently, there seem to be a lot of national and regional efforts in order to improve quality and safety of domestic products. Currently, MoTI is drafting a National Quality Policy in collaboration with the European Union's "Trade Related Assistance & Quality Enabling Programme" (TRAQUE) and with PTB. In addition, the establishment of a National Accreditation Body is planned (Interview 131).

Furthermore, Ghana is in the process of adopting a new policy in the area of food safety and health, which is a first step towards new food safety and health legislation. Based on the FDA's draft, the new National Food Safety Policy was adopted on April 27, 2015, with the theme "Food Safety from Farm to Plate" (WHO, n.d.). The main goal of the policy is "to bring coordination into the regulation of food safety and define the role of stakeholders to ensure public health and trade in food" (Ministry of Health, 2013: 27).

In 2012, the Forum for Agricultural Research in Africa (FARA) established the Partnership for Aflatoxin Control in Africa (PACA). The core element of PACA is its innovation platform on aflatoxin control, as requested by farmers. PACA's main purpose is to spread innovations to the field level and to promote links between farmers and research. For the Ghanaian PACA initiative, Brong-Ahafo and Central regions were selected as pilot sites (Interview 17).

Interestingly, an intervention established so called One-Stop-Centres through the MoFa and the NGO Africare (2011-2014) and funded by Alliance for Green Revolution in Africa (AGRA). The project's aim was enhancing the scope of extension services for smallholders and as an aggregation point for crops. A warehouse, input shop and training centre are already in place in the Jasikan, Kadjebi and Hohoe districts of the Volta region.

One of the major interventions in the past was the U.S. Agency for International Development (USAID)-sponsored "Trade and Investment Program for a Competitive Export Economy" (TIPCEE), which ended in 2009. "Agricultural Development and Value Chain Enhancement" (ADVANCE) is the follow-on programme of TIPCEE.

PTB has been supporting QI in Ghana since 2005. Since 2009, the PTB-supported laboratory network has been assisting testing institutions in Ghana. Members of the lab network are the GSA, FDA, FRI, BNARI and the customs lab. Recently, PPRSD and the police forensic lab were also added to the network. In addition to joint trainings, activities include the provision of joint equipment. A website enabling clients to inform themselves which lab is most relevant for their

requirement was established by the network (Interview 64). From 2012-2015, PTB, together with the GSA, organized more than a dozen CALIDENA-workshops in Accra and also within the regions (Sunyani, Ho, Tamale, Kumasi) to increase awareness of quality infrastructure and the maize, the rice and fertilizer standards.

5.1.3 Current challenges

Although QI-relevant responsibilities are assigned to different organizations at the national, regional and district level, there seems to be a confusion about which organization is providing which particular services. For instance, distinguishing between the GSA and FDA was reported as a challenge for customers (Interview 50).

Further, there is a perceived lack of regulation. On the formal domestic market and for processed products as well as for exports, there are mandatory quality checks in place such as the FDA's certificate. However, for the local market – particularly in rural areas – the division of labor and an understanding of who takes which responsibility is not clear. Between PPRSD being responsible for agricultural raw products and the GSA as well as the FDA concentrating on industry and processed products there is a gap (Interview 64, 11). This affects data collection on agricultural production and marketing of agricultural products as well as on health-related implications of agricultural products. If no one is responsible for it – or the responsibility is disputed – no systematic data collection takes place. However, sufficient and reliable data for policy making and information campaigns would be necessary in order to develop standards and technical regulations.

Furthermore, the institutional relationship between the different stakeholders in the agricultural sector at the district-, regional- and national-level seems to be an issue of concern. Points raised included the identification with procedural requirements, communication among the stakeholders and the relevance of agricultural interventions at the district level. It was mentioned that agricultural departments still report to the MoFA first, perhaps because agricultural departments tend to see themselves belonging to the MoFA rather than to the district assembly. Furthermore, stakeholders expressed dissatisfaction over the quantity and the quality of information exchange between them, including the exchange of relevant data. For instance, it was mentioned, that district data generated at the national level is not shared with district authorities (Interview 9). Interviewees criticized that agriculture is of minor importance to the district assembly compared to other district-related responsibilities. They complained about a lack of recognition of the agricultural department by the municipal assemblies. Consequently, finance for agriculture-related interventions in rural areas is lacking (Interview 122).

Further, the collaboration between the national and district levels seems weak. For instance, a representative of Nkoranza district mentioned that they have a committee on weighing, but currently no exchange with the GSA takes place (Interview 9). National interventions mostly end at the regional level (Interview 141).

5.2 Mapping of quality infrastructure service providers

The QI definition presented in Chapter 2.1 provides the framework for the following mapping of existing QI service providers. QISPs can provide services in metrology, testing, standardization, quality management, and accreditation and are therefore important players in the NQI that supplements the legislative framework laid out in the NQI. QISPs were mapped according to their location, the type of institution, as well as their capacity and accessibility. Furthermore, the cooperation between different QISPs was analyzed.

5.2.1 Location and type of quality infrastructure service providers

The location of service provision in relation to the location where the service is needed is a crucial factor for QI utilization by smallholders. It was therefore selected as criterion for mapping QISPs. It was assumed that if service providers are distant from potential customers the QI customers have to undertake greater efforts to get in contact with QISPs. As a consequence, timeliness, information exchange and transaction costs of QI services become unattractive for smallholders. Limited financial resources of smallholders, time constraints and weak access to ICT technologies might further aggravate the situation.

Based on their location, QISPs can be grouped on three levels: a) capital/national, b) regional and c) district. The results are illustrated in Figure 8.

In Accra and Kumasi, potential customers can choose between various QISPs. However, at the sub-national level, the presence of QISPs is significantly reduced. Apart from the GSA and FDA offices at Sunyani and Ho, no other QISP is present at the regional level, let alone in the districts.

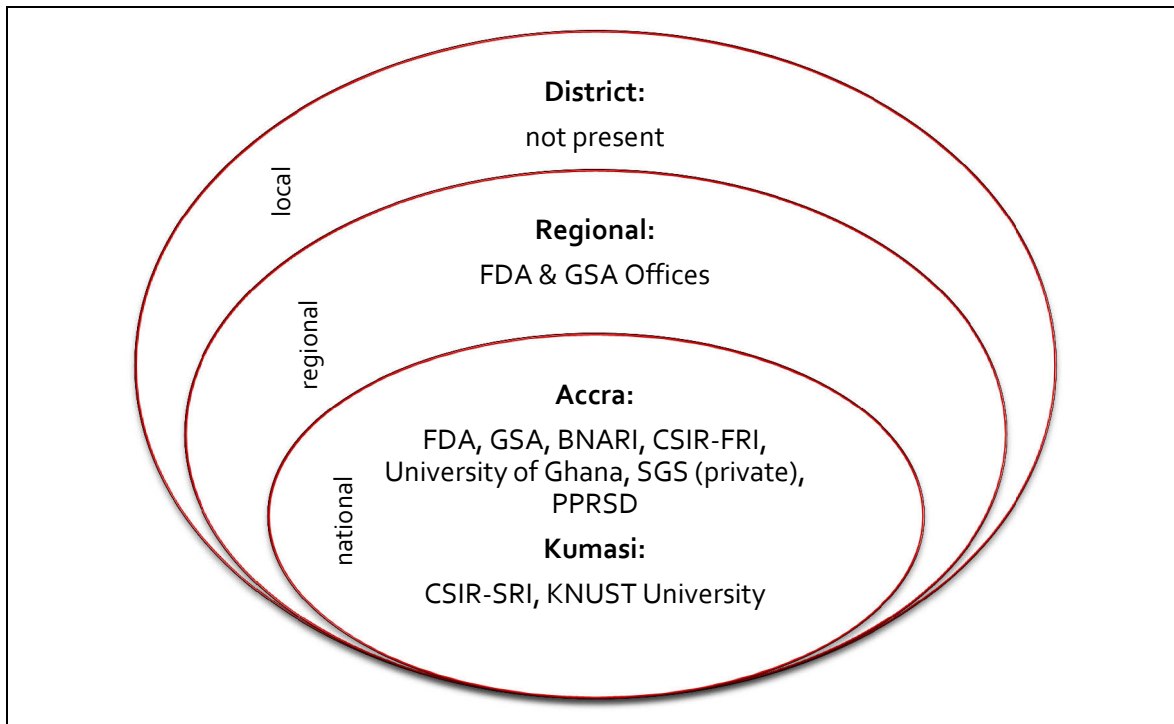


Figure 8: Level or location of quality infrastructure service provider

The term level is mostly utilized in a geographical sense.

Source: own illustration

The figure further reveals that the public sector dominates the market for testing services. However, the Government of Ghana is currently reducing its financial contribution to public organizations. The question is whether this will trigger increased competition between public and private QISPs in Accra, where QISPs enjoy good infrastructure and lower costs than in rural areas. The question is furthermore, whether keeping the QI services governmental doesn't suit Ghanaian product's quality better. Particularly given the 2015 EU import bans the Ghanaian government appears to seek a tool how to augment quality.

Some private actors, e.g. companies, run laboratories. However, the use of the laboratories is mostly restricted to the company itself. No case of a company offering commercial testing services for external customers could be observed. In addition, no private independent laboratory was found at our field sites. The study team observed only one attempt to establish a private laboratory with the potential to offer testing services for external clients. The laboratory is owned by the private company Yedent and is located in Sunyani (see Chapter 5.3.).

The limited availability of QISPs and in particular the lack of laboratory services at the regional and district level was mentioned by several interviewees as a major

bottleneck for the utilization of QI services by smallholders (Interview 7, 62). Also among QI providers in the capital, there is some awareness that more laboratories are needed at the sub-national level. The regional presence of the GSA and FDA will be described in Chapter 5.2.2. Worth mentioning, the GSA already acquired land in regional capitals in order to establish regional laboratories (Interview 44). BNARI plans to set up facilities in other regions in the future (Interview 2). Apart from a veterinary MoFA laboratory (see Chapter 5.3.), the research team did not observe any other efforts to establish laboratories at the district-level. In fact, at the moment, it seems doubtful that laboratories at the district level would be profitable (Interview 33), because demand must first be solicited.

5.2.2 Capacity, clients and market demand

The capacity of QISPs is the second mapping criterion. While being easily reachable is a first precondition for QIS utilization, it is not sufficient. Capacity refers to the time needed for service provision, the scope of services offered, and the equipment available. It further includes the number as well as qualification of staff and trainings they received, including trainings on maintenance of equipment. The capacity of QISPs is also analyzed in relation to market demands and the economic efficiency of testing services.

Building up capacity is a very challenging process. Change will happen slowly and overall it takes a long time to establish a well-functioning laboratory. In the view of a German laboratory that performs QI trainings in Ghana and other African countries, it “easily takes a decade” to reach a culture of precision and laboratory etiquette (pers. Comm. GFL 8.July 2015).

Notwithstanding this argument, most of the testing laboratories that were visited rely on modern equipment. For instance, several laboratories were equipped with HPLCs (Interview 6, 44) by UNIDO. Worth mentioning is the fact that a maintenance program was not implemented, so that PTB now supports such recipients. Several efforts to strengthen the technical infrastructure of the laboratories were noted during the research. For instance, the FDA plans to open an aflatoxin laboratory at the beginning of 2016 and PPRSD is in the process of establishing a fertilizer and pesticides laboratory (Interview 20, 89). Both the FDA and GSA laboratories expressed that increasing the scope of testing is a major objective (Interview 19, 48). There is an awareness of the key importance of training of staff. The interviewees mentioned regular training activities (Interview 6, 48). Since 2012, through the PTB-supported laboratory network, members receive three

trainings per year (Interview 64). The laboratories at the GSA and FRI are either DAkkS or SANAS¹⁰ accredited. The FDA plans to obtain accreditation in the near future (Interview 6, 20, 46, 48). More details are available in Annex III: Table of QISP characteristics.

According to the interviewees, individual small-scale farmers are not clients of QI services at the moment (Interview 2, 44). If farmers were mentioned, it applied to large-scale farmers (Interview 3). In the case of pesticide testing, farmers associations were mentioned as regular customers (Interview 48). Other main users of testing services are students, as well as processing and mining companies (Interview 3, 6, 7).

The regional GSA and FDA offices are not equipped with agri-food testing facilities. Major services of the regional GSA offices are calibration of fuel stations and medical devices. The current capacity of GSA offices is low. The offices lack equipment to access rural areas, e.g. cars and technical staff. During the research, the GSA office in Sunyani was equipped with a moisture meter. Standards can be bought or ordered at the regional offices. Compared to GSA offices, the number of staff in FDA offices is significantly higher. For instance, at the FDA office in Sunyani the total number of staff is 24 compared to 4 at GSA regional offices, including a driver and secretary. In addition, there are cars available at the FDA office (Interview 22, 51).

Several bottlenecks still exist. For instance, the scope of many laboratories is limited compared to requirements of international markets. The European import regulation, for example, has determined 452 maximum residue levels (MRL) that limit the level of pesticides in pineapples (European Commission, 2015). However, only 36 MRLs of these residues can be tested by the current Ghanaian national quality infrastructure (Interview 48). Interviewees confirmed that the limited scope of testing services is an obstacle for using QI services (Interview 129).

There is no “hub” for QI services in rural areas. Instead, it is common practice among laboratories to collect a critical mass of samples until the actual testing takes place in order to save costs for buying reference material (Interview 6, 44, 51). This, however, affects the time it takes for performing a test because customers have to wait longer for their results. It was mentioned that results could be delivered quicker if each samples were tested immediately and separately (Interview 44). Express test are already available, but are more expensive (Interview 6, 44).

¹⁰ South African National Accreditation System – SANAS

Prolonged test duration is a major disincentive for customers, particularly exporters. As a consequence, many exporters prefer to test abroad where tests can be done overnight (Interview 48, 132).

Both challenges mentioned – limited scope and time for delivery of testing results – constrain the market demand for commercial testing services. In addition, as mentioned above, major large-scale producers, such as Nestlé, have their own labs and utilize public testing services, such as those offered by the GSA, only if testing is mandatory. The limited scope further constrains the market for testing services because customers tend to send samples to Europe instead of testing in Ghana. In the case of the market for soil testing, an interviewee doubted that there is even a market for soil testing services (Interview 3). However, the study team also observed promising signs. For instance, just recently the cassava industry requested more soil testing services (Interview 56).

The currently limited utilization of commercial testing services has another serious implication. During the research, the study team observed that capacities of existing laboratories often are not utilized to their full potential. Four out of nine organizations that run laboratories mentioned that they could handle more tests (Interview 3, 7, 8, 44).

Finally, it could be observed that public research institutes, e.g. BNARI, are now trying to reposition themselves. In addition to their public mandate, they aim to transform themselves into a commercial QI service provider (Interview 2). This is a consequence of the government pulling out of the market for testing services mentioned above. This further adds to the market capacities for commercial testing services and increases the risk of creating overcapacities if market demand remains low.

5.2.3 Accessibility

The accessibility of quality infrastructure services is the third criterion used for mapping QISPs. Accessibility refers to the pricing and clarity of QI services, as well as the dissemination of standards. For instance, if prices are too high or the standard is designed in a way that customers cannot understand it, an increased use of QI services cannot be achieved.

Several interviewees mentioned high costs as the major obstacle for small-scale farmers to use QI, concerning both testing services and standards (Interview 41; 48, 62, 126). Other obstacles mentioned by interviewees were low awareness of the benefits from analysis (foremost economically) and interpretation of testing results (Interview 62).

4.2 National quality infrastructure in Ghana

Regarding testing, there is a price incentive based on the group size. Small-scale farmers have to pay less for using the GSA's testing services if they come as a group (Interview 11). However, the pricing structure for individual customers does not recognize the individual asset base and accordingly the financial strength of the individual smallholder. For instance, the pricing structure does not consider the size of land and offers a price deduction for less endowed farmers.

The price for a GSA standard depends on the amount of pages. The cheapest standard costs 30 GHS (≤ 10 pages; 11-20 pages: 50 GHS; 21-30 pages: 70) (GSA standard catalogue¹¹). Such prices are affordable for a small processor and indeed standards were observed in companies during the study. Considering that small-scale farmers are often financially constrained, 30 GHS for a standard is expensive. Concerning the sale of standards, this research did not observe any price mechanism that effectively increases the purchase of standards by taking into consideration the different financial means of groups. On top of that, due to the lack of presence in rural areas, additional expenses for transport or delivery of samples by post/courier have to be added. The previously described low demand for testing services affects the pricing structure of laboratories. An interviewee mentioned that if the laboratory received more samples they would be able to offer cheaper tests (Interview 48).

Language was mentioned as another obstacle for utilization of standards by small-scale farmers, who might struggle to understand technical documents written in English (Interview 49). However, the standards are not available in local languages such as Twi, Ga or Ewe. In addition, GSA customers complained that standards, in addition to being too expensive, are also too technical (Interview 53). In the same way, interpretation of standards was mentioned as a major challenge for small-scale farmers. The GSA has developed pictorials in order to provide support in interpreting a standard. However, when the pictorials for the pineapple and maize standards were requested by the research team, they were difficult to obtain or even unavailable. In order to increase knowledge on standards, the GSA offers trainings upon request, both for users of standards and agricultural extension agents (AEA). The number of trainings is limited. In 2014, a total of 10 trainings were held (Interview 53). The last training of agricultural extension agents on standards took place in 2011 (Interview 52). Further workshops and trainings are only conducted upon request and with support of other institutions or programs (e.g. CALIDENA method by PTB). The GSA organised five workshops in the maize

11 <http://www.gsa.gov.gh/standards/index.php>

value chain. Participants were processors, members of trader associations and warehouse operators, but no smallholders. Information campaigns in rural areas on standards happen only rarely and collaborating with a partner, e.g. the Information Service Department and their vehicles, is difficult due to limited funds (Interview 49). There is no follow-up mechanism to monitor if – and how – stakeholders utilize standards (Interview 53).

5.2.4 Cooperation between quality infrastructure service providers

This study observed a low degree of specialization of QISP. There is a tendency to expand the services offered instead of building capacity in one particular field. A specialization of laboratories that would allow a clear division of labor could not be observed. In several interviews, the dissatisfaction over the division of labour and/or the strategy of other QISP was clearly articulated (Interview 7, 42, 53). This not only prevents the laboratories from building up strong capacities in a special field. It also raises the risk of overlap, but includes the risk of interfering with other laboratories and taking away customers in an already slim market for commercial testing services. The finding also highlights the need for coordination among QISPs. Currently, and despite apparent numerous contacts, laboratories are not obliged to share information with each other (Interview 44). As mentioned above, PTB set up the laboratory network that has started to increase and improve collaboration among laboratories.

At the regional level, an institutionalized system of cooperation and information exchange between QI service providers could not be observed (Interview 50). The significance of regional cooperation needs to be stressed, since some services offered, e.g. the inspection of processing plants, performed by the GSA and FDA are similar. For a customer of these two organizations, it might be not economic to spend money twice for the same service.

In recent years, it seems like donors have increasingly made efforts to provide equipment. While this in itself is not problematic, it becomes problematic if there is no coordination because it contributes to creating overlapping capacities with all the consequences mentioned above. Unfortunately, the study team could not observe an institutionalized information exchange and coordination among donors and implementing organizations (Interview 131, 133). Furthermore, it was mentioned that implementing organizations delivered equipment without sufficient training. There is supposed to be a donor coordination desk located at the MoFA (Interview 35). In addition, efforts are currently underway to harmonize the development assistance financed by Germany, the Netherlands and the European Union, and establish a central coordination point (Interview 10).

Mapping of QISP in brief

- Besides one potential company, QISPs are hardly represented in rural areas and the number of offered services is very limited.
- In Accra, there are numerous well-equipped laboratories that have trained staff. The limited amount of samples delivered to the laboratories does not match with current testing capacities.
- Smallholders currently do not utilize the NQI.
- The access to and the applicability of offered services and QI-related products for smallholders is low.
- With shrinking governmental financing of QI, lowering costs of services might be a big challenge, but sufficient QI customers and economy of scale would repay.

5.3 Potential quality infrastructure service providers

Notwithstanding the mapping of QISPs that are already operating, a number of organizations were identified that have the potential to provide QI services to smallholders in the future. Six of these entry points are mentioned here:

Regional FDA and GSA testing services

As mentioned in Chapter 5.2.2., the current capacity of both FDA and GSA regional offices is limited. However, a new moisture meter delivered to GSA Sunyani (by the research team) is a first step into the right direction. Similarly recommendable, the GSA has already acquired land to build regional labs, e.g. in Ho and Kumasi. The transaction costs (time, money) to deliver samples compared to Accra would be significantly lower for customers living in rural regions. Therefore, QI services would become much more attractive. If well equipped with cars, the outreach of information dissemination into rural areas could be significantly increased.

Public farm institutes and agricultural colleges

The farm institute in Adidome is a public educational institution in the Central region, close to the Volta region. The mandate of the farm institute is to teach agricultural skills to youth. The farm institute belongs to a consortium of farm institutes and agricultural colleges supervised by the Human Resource Development and Management Directorate of the MoFA. There are two other farm institutes

(Esuansi (Central region), Wenchi (Brong-Ahafo region)) and five agricultural colleges (Ohawu, Ejura, Damongo, Kwadaso and Pong-Tamale). All eight institutes and colleges have been equipped with soil labs by the global initiative "Alliance for a Green Revolution in Africa" (AGRA). Since 2013, the GIZ-MOAP program "Agricultural Technical and Vocational Education and Training" (ATVET) supports the Adidome farm institute in improving the quality of education. For instance, it developed a pineapple tutorial consisting of 14 different leaflets. The staff of the Adidome farm institute received trainings and has the capacity to do soil analyses. The scope of testing includes pH, soil organic matter content, percentage of sand clay, phosphorus, potassium and trace elements (e.g. boron). Tests they are not able to perform themselves are sent to the CSIR-SRI in Kumasi. So far the tests are only performed as part of the training for students. However, the head of the farm institute stated that the institute has the capacity to offer tests to the public in the future (Interview 144). Simple tests – such as pH – could be taught by such agricultural schools.

Planned veterinary laboratory

When conducting research on maize in poultry farming in Dormaa, the study team came across a planned laboratory that was never finished. Currently, the building exists, but there is no equipment and the building is abandoned. Its initial purpose was to serve as a public veterinary laboratory for microbiology and pathology. The Government of Ghana was planning and overseeing the construction of the building. In the future, the laboratory could serve as an important entry point for interventions focusing on health-related risks of agricultural production in rural areas. Veterinarians regularly visit poultry farmers. If equipped with a functioning laboratory, samples could be analyzed on the spot and risks are detected quickly. Moldy maize or even worse toxic maize affects the productivity of the poultry. Therefore, the earlier health risks are detected, the earlier it is possible to take appropriate measures and to prevent/reduce productivity losses.

Small-scale processor Yedent

The planned laboratory of the private company Yedent was one of the few attempts observed to implement a laboratory in rural areas. The company is located in Sunyani in the Brong-Ahafo region. It produces maize fortified blended food (e.g. TomBrown), and food supplements for the domestic market and export to Nigeria. Clients are public institutions, e.g. Ghana Health Centre and World Food Programme (WFP). At the moment, Yedent has in-house testing facilities for microbiological elements and substances. The small company tests moisture levels

and fat content with a moisture meter and a moisture analyzer. There aren't any aflatoxin testing facilities as of yet, but the company plans to have in-house testing for aflatoxin. In the future, Yedent could play an important role as an entry point for testing on aflatoxin for smallholders and traders in rural areas, particularly since there are no other providers. Due to its location in Sunyani, Yedent is close to major maize trading areas and the transaction costs (time, money) for farmers to reach the laboratory are significantly lower compared to Accra.

Universities

Universities play an important role for innovation, knowledge dissemination and training. Universities are often the origin of scientific / technological spin offs (Interview 56). Agricultural research at Ghanaian universities made a solid impression during this project. Many inventions might be beneficial for QI issues and, inversely, QI might easily influence agricultural research. Furthermore, universities often offer laboratory services for students at reasonable prices. Therefore, in theory, accessibility for finance-constrained groups, such as small-scale farmers, should be higher. In addition, there is a direct link between students and farmers. Agricultural extension officers undergo their training at universities. In return, farmers can access basic testing services much closer to their farms than to the capital. This is especially true for colleges in rural areas, which focus on agriculture. Last but not least, students of agriculture are likely to work as AEAs later.

Warehouses

Warehouses are an important point of aggregation of agricultural raw material – such as shelled maize – prior to the production phase. Major warehouse operators in Ghana include National Food Buffer Stock Company (NAFCO), the Ghana Grains and Legumes Board and the Ghana Grains Council (GGC). The grains stored in these warehouses are sold to schools, processors, stock farmers and/or retailers. The 12 USAID-sponsored warehouses managed by GGC are part of the Ghanaian warehouse receipt system. The warehouses' customers can take advantage of moisture measurement services offered at these warehouses. In this project, the GSA is responsible for calibration of the applications. Other project partners are the FDA and the Ghana commodity exchange (GCX) (Interview 33). The TRAQUE programme also equips small- and medium-sized warehouses among them other maize specific devices like grain cleaners with moisture meter connecting their supported warehouses with the warehouse receipt system (Interview 131). Therefore, such warehouses are entry points for the promotion of QI services. Warehouses can easily be equipped with weighing scales and moisture meters.

6 Maize value chain

Chapter 6 describes quality infrastructure where it concerns the maize commodity. Furthermore, the findings from context, perceptions and demands of quality, as well as QI service utilization by producers, are described in this chapter.

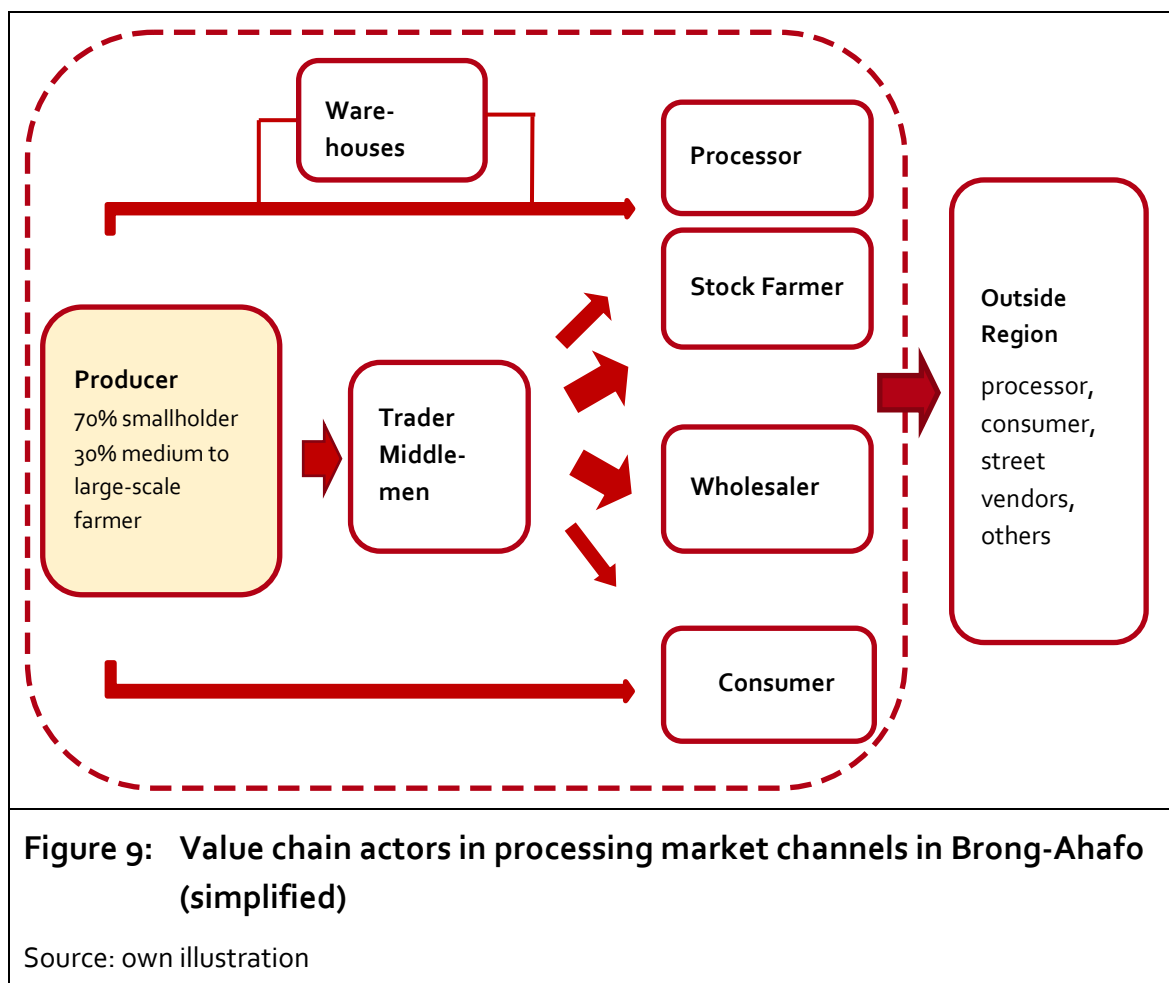
6.1 Contextual findings in the maize value chain

Before describing quality infrastructure in the maize value chain, a general overview of important procedures and stakeholders is presented. Therefore, the context is introduced in this chapter, including where QI is not involved but nonetheless relevant to this study. Aspects include descriptions of value chain actors, marketing channels, farming and trading conditions, as well as maize utilization.

6.1.1 Value chain actors and marketing channels

Maize is a major staple crop for personal consumption and an important source of income for Ghanaian small-scale farmers. In Brong-Ahafo, the majority of maize produced is sold, with only a minor proportion used for subsistence. Small-scale farmers sell maize as bulk good to (a) traders, (b) middlemen, (c) processors and (d) stock farmers (mainly poultry farmers). Interviewed smallholders lack means of transport or the financial resources to pay for transport to the market place and/or storage facilities. Therefore most of the maize is sold to traders at the farm gate rather than at local/regional markets. Middlemen buy only at the farm gate and sell the maize to producers, traders or wholesalers within the country. In contrast to middlemen, traders are rather to be found at formal markets, organized in associations and sell on the official market premise. Major maize markets of Brong-Ahafo are located in Techiman, Nkoranza, Wenchi and Odumasi; with the exception of Wenchi, all markets were visited.

Some privately-owned warehouses store maize and sell it onwards to processors or wholesalers. These warehouses are typically used by large-scale farmers. A fee has to be paid to gain warehouse membership, which then allows for the storage of maize. Processors and poultry farmers either source directly from small-scale farmers at the farm gate, from the market, or – if necessary – directly from middlemen. If processors and poultry farmers buy directly from small-scale farmers, there is a tendency to organize the farmers they source from in associations. Wholesalers sell outside the region to markets, processors, restaurants and direct consumers. Figure 9 depicts these stakeholders.



6.1.2 Maize production and utilization

Most farmers use their own seeds and reproduce local varieties. However, certified seed, open-pollinated varieties (OPV) and hybrid-maize are available. The most common improved maize variety used is Obatanpa. Due to higher investment costs, which include seed and increased input requirements, the percentage of smallholders using certified seeds remains low. Most interviewed farmers use compound fertilizer (NPK) but mostly below the recommended application. The same could be observed with pesticides during the growing process. In contrast, pesticide application is common during the drying and storage process to avoid infestation.

In Brong-Ahafo, the majority of maize is harvested in August/September (major season) and February/March (minor season). On average, maize is harvested 120 days after seeding. After harvesting, maize needs to be dried. Smallholders dry unshelled maize in the sun or in a small shed, barn or crib, which is constructed on the field. With the exception of these shelters, most small-scale farmers have

no adequate storage facilities. Farmers interviewed said they have extra expenses like school fees, inputs for replanting and debts at this part of the season. The lack of storage facilities and the need for cash are the main reasons smallholders sell most of their grain right after the harvest. Those with the smallest-sized land are most likely to sell right away. As a consequence, they miss out on higher prices for maize offered by the market in periods before harvest, such as the first quarter of a year. In 2014, the lowest price paid to maize farmers was GHS 80 for a so-called “bush weight” bag, which measures 130-160 kg; the highest price was GHS 160. The standard price for freshly harvested maize is GHS 100.

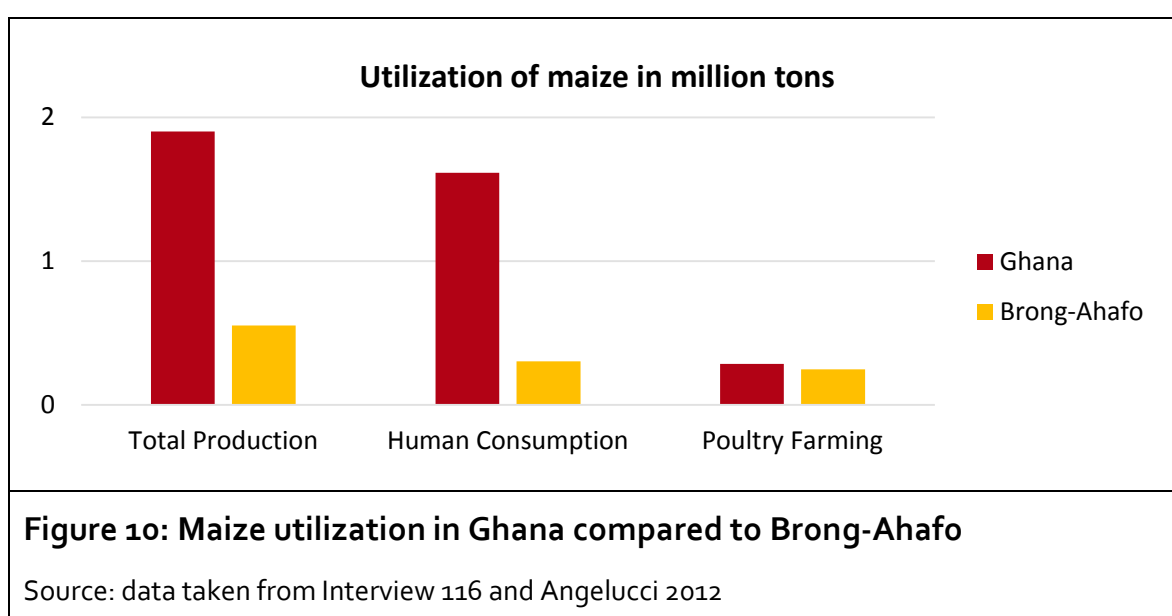
Before selling, maize needs to be shelled. Maize is shelled by hand or with the help of shelling machines. The latter usually belong to traders or shelling service providers who offer the services for 7-10 GHS per bush weight bag. After shelling, maize is purchased from smallholders at the above-mentioned prices. If traders are transporting maize from the farm to the market, they charge a transportation fee of approximately 1 GHS/km. Most commonly, the grain is not sufficiently dried by farmers. As a result of high moisture content, traders demand price deductions to compensate for further drying expenses and the resulting loss of weight. Traders subsequently dry maize on tarpaulins. If this becomes challenging due to increased precipitation, mechanical drying is also used. Afterwards, purchased maize is either stored in private or rented storage rooms at warehouses. On the market, maize is sold to different stakeholders. Thereby every client is charged 7-8 GHS per bag for packaging, loading and taxpaying. Taxpaying is mandatory to transport maize outside of districts and region – even for grain purchased at informal markets.

The following three methods of maize utilization have been observed (Figure 10):

1. Within Brong-Ahafo, experts assume that about 45 percent of the maize produced is used by poultry farmers (Interview 116) in contrast to a 15 percent average nationwide (MAFAP, FAO, 2012). Poultry feed consists about 60 percent of maize (Interview 110). Large poultry farmers usually have their own feed mills for producing high quality feed. They also sell their feed to medium-sized poultry farmers. Small-scale poultry farmers usually cannot afford the premium feed and mix feed on their own and send it to a miller (Interview 109,111,112). Maize is also sold to pig and tilapia farms.
2. A large amount of maize is used for direct human consumption, about 45 percent in Brong-Ahafo in contrast to 85 percent nationwide (MAFAP, FAO, 2012). Next to self-consumption, the majority of maize in Brong-Ahafo is purchased by wholesalers who retail outside the region, especially in areas with low agri-

cultural production and high population density, like Accra, Kumasi or Takoradi (Interview 82, 84). Trade usually takes place at informal markets. Stakeholders for direct consumption are mostly restaurants, street vendors called “chop bars”, schools or customers for home requirements.

3. Food processing companies process maize into cornflakes, Banku- and maize flour. In the Brong-Ahafo region, there are currently only a few small-scale companies processing maize. The two companies mentioned by experts were both interviewed by the research team. Wholesale traders deliver most of the maize to food processing companies outside Brong-Ahafo.



6.2 Quality perception and demand

The GS 211 prescribes a clear quality definition for maize. Next to the maximum moisture content of 13 percent, parameters like diseases, discoloring, deformation of grains, or insect infestation are also important. The standard distinguishes between five grades of quality; thresholds are shown in annex 7.

Despite the existence of a national standard, farmers interviewed usually only distinguished between good and bad maize instead of several grades of quality. The most crucial factors for determining the quality of maize are mold, followed by insect infestation. Other less important criteria include discoloured grains, foreign material, germination, as well as unusual size and shape. If maize is free of the mentioned factors it is perceived as good maize, especially if it is properly dried.

Interviewed traders mentioned similar crucial factors for determining the quality of maize. However, traders on the Techiman maize market, and also a few in Nkroanza, distinguish between three grades of quality. For instance, Grade A is maize without any observable failures; Grade B represents discoloured and infested grains that are sold for a lower price; and Grade C is moldy maize that is still sold, but at a larger discount (Interview 83, 84). In general, traders seem to be more concerned about mold than smallholders and invest more effort to prevent it. Although farmers and traders are aware of mold and insect infestation, their awareness of other quality criteria is low. This is underlined by the way maize is treated while drying and storing it. It was frequently observed that people drive over maize that is drying in the sun. Maize is further exposed to chickens, goats and other animals that both feed and defecate on it. Further organic and inorganic matter, as well as insects, can easily contaminate the grains.

The perception of quality appears mainly related to economic gain and losses and rarely to other factors like health risks or flavor (Interview 114). Statements like “quality ensures that buyer returns” or “if the grain is moldy traders will not buy it or only on a price deduction” (Interview 28) underline this observation. Contamination with toxins like aflatoxin was not a quality criterion for any interviewee. Although some interviewed farmers and traders knew that moldy maize can be toxic (FGD Sunyani), grains that have been sorted out are frequently used for personal consumption or sold through other marketing channels, for instance as feed or substrates for alcoholic beverages.

Poultry farmers and processors revealed a more complex perception of quality. Commercial poultry farmers have a large interest in avoiding disease among their stock due to the direct economic losses incurred. Their quality demands and criteria for purchased maize are comparable with grade 1 of the maize standard (Interview 39, 115). Interviewed processors even use quantifiable parameters according to the maize standard to purchase maize. For instance, foreign objects are not allowed to make up more than 1 percent of the total weight (Interview 129). Another example is the processor Yedent: to reduce the risk of purchasing aflatoxin-infested maize, Yedent buys maize in the 125 km remote Kintampo district, which is known to produce very dry and less aflatoxin contaminated maize (Interview 144). The high awareness of quality among interviewed processors is remarkable, vis-a-vis other buyers, e.g. wholesalers and retailers on the informal market.

International companies have even higher quality demands than the interviewed processors. Nestlé, for instance, only purchases from its own outgrower schemes, which are part of a strict quality management system.

Considering the Knowledge-Attitude-Practice (KAP) approach, it seems that stakeholders of the maize value chain that only interact on the informal market have lower and fewer quality demands and perceptions. In contrast, the stakeholders on formal markets are more aware of several quality criteria as well as product safety to reduce potential economic loss.

Quality perception in brief

- Smallholders define quality of maize based on sensual characteristics;
- Smallholders and most traders distinguish between two grades of quality;
- Most important parameters are mold and insect infestation;
- Quality appears mainly related to economic gains and losses;
- Poultry farmers and processors apply quality demands that are sufficiently high for QI use.

6.3 Status quo of quality infrastructure in the maize value chain

The research conducted in the maize value chain explored several QI services and their utilization by value chain actors with a particular focus on producers and smallholders respectively. Preliminary results by various experts revealed the urgent topic of aflatoxin. Checking maize for this poison would therefore be an interesting utilization of QI, with the effect of reducing health risks in the maize value chain. Therefore, the focus in this chapter will be on aflatoxin and moisture content testing.

In addition, weighing services and the utilization of standards will be explained in detail in the following subchapters. Findings on testing of soil and pesticide residues are not covered in the following but in the pineapple chapters: the need and potential for accurate soil testing for maize is comparatively low. Maize farmers have a low profit margin per acre to pay for additional soil tests and availability of specific fertilizers is low. Maize farmers usually use one type of compound fertilizer, which was originally designed for cocoa (Interview 37). The research did not focus on pesticide residue testing in maize since it was more crucial in the pineapple value chain, due to strict export thresholds and exclusions from markets. Nevertheless several interviewees mentioned a potential health risk caused by the

misapplication of pesticides. In addition to the introduction of testing services, the focus in the future to target the problem should be on better education regarding the accurate application of pesticides at the producer level.

6.3.1 Laboratory testing

This subchapter presents findings about laboratory testing for aflatoxin. This study chose aflatoxin levels as an indicator of the need, utilization, availability and obstacles for QI services in rural areas.

Aflatoxin

Need for aflatoxin testing

In Ghana, there is a low general awareness of aflatoxin and its effects. One of the reasons is the lack of reliable data on actual levels of aflatoxins in maize. Neither national statistics about the level and percentage of contaminated maize on markets, nor the traceability of carcinosis is available. Interviewed experts assume a high level of aflatoxin in most consumed maize. Whereas the Ghanaian threshold value, set in the GS 211, is 15 parts per billion (ppb), 60-70 percent of the samples tested in GSA laboratories are above this limit (Interview 44). In addition, a recently conducted survey commissioned by GIZ-MOAP on different major maize markets in Brong-Ahafo revealed that 9 out of 14 samples were above the limit (15ppb) – 5 of them even in the range of 235 to 454 ppb (pers. comm. Prof. Pa Nii Johnson 15.10.2015).

In addition to low awareness levels, most interviewees blame insufficient infrastructure – foremost drying and storage – as the main reason for the high contamination of maize with aflatoxins. During this research, quality infrastructure was found to assist in the detection of aflatoxin in improved post-harvest facilities. In poultry farming, high aflatoxin levels are directly visible through reduced meat and egg production (Interview 138). For humans, the effects usually become visible only years later, for instance when victims contract liver cancer. At that stage, the cause can hardly be traced back to the contaminated maize they ate (Interview 37).

Availability of aflatoxin testing

International threshold values of aflatoxin vary between 2 and 30 parts per billion (ppb), e.g. Ghana 15 ppb and the EU 4 ppb. Because of the toxic effect of small amounts of aflatoxin, sophisticated testing methods such as High Performance Liquid Chromatography (HPLC) are required. Accurate testing with HPLC

can be done, without accreditation, in laboratories of official institutions in Accra, namely the GSA, FRI, and the University of Ghana (UG), or in Kumasi at the Kwame Nkrumah University of Science and Technology (KNUST). Within Brong-Ahafo, aflatoxin testing is not available. The regional offices of the GSA and FDA are only able to transfer given samples to the laboratories in Accra. In contrast to sophisticated tests, rapid testing strips, such as AgraStrip® Aflatoxin or Fluoro-Quant® Afla, are easy to handle and can also be used to detect aflatoxin if levels are above a critical value. Nevertheless, the use of rapid testing strips was not observed during the research.

Utilization of aflatoxin testing

Several interviewed experts stated that the vast majority of maize produced in Ghana is neither tested for aflatoxin at the level of producer nor trader (Interview 37, 44, pers. comm. Schütz). Utilization of aflatoxin testing starts at the processor level. According to Ghanaian law, it is mandatory to sample and test maize for aflatoxin, and to register at the FDA to obtain the certification to sell maize products on the market (also see Chapter 5). Nevertheless, most maize is sold at informal markets that do not require FDA registration and is subsequently processed into food (Interview 129). Other users of aflatoxin tests are poultry farmers in Brong-Ahafo who use maize in feed mixes. Those who produce feed as a business or who have a large stock are most likely to check purchased maize regularly for aflatoxin. Distance to laboratories and the price of the test are the most crucial factors in deciding which lab is chosen (Interview 87, 109). Further customers of aflatoxin testing services are donor funded maize aggregation centres, such as of WFP. WFP commissions a private company, Intertec, to control the quality of the maize, which includes tests for aflatoxin at the FRI, Accra (Interview 140).

Obstacles in the utilization of aflatoxin testing

The utilization of aflatoxin testing is only conducted if there is a mandatory legislation, such as the one for food processors, or an economic need, such as the poultry farmer that targets high yields of their chickens through aflatoxin safe food. As outlined in chapter 6.2, health issues do not seem to be playing a sufficiently important role in the consideration of testing. Due to the lack of awareness of the health hazard posed by aflatoxin, and therefore low demand for aflatoxin-free maize, the need for testing is not comprehensible to the majority of the maize value chain stakeholders.

Neither sanctions for contaminated maize nor premiums for verifiable aflatoxin-free maize could be observed. Therefore, no economic pressure forces small-

holders, traders or processors using informal markets to test their products and goods. A lack of institutional regulations of markets is another constraint. Laws to regulate mandatory thresholds of aflatoxin within the maize trade do not exist at the national or regional level. Despite the increased responsibility of district assemblies, no rules have been established so far to control the problem at the local level either. The low availability and high prices of aflatoxin testing services are also considered to be limitations. The testing of a single sample at FRI costs GHS140, and at the GSA even GHS250. In contrast, smallholder maize farmer have an average profit margin of 200 GHS/acre (Interview 6, 31, 44). Sending samples to Accra and Kumasi also costs time and money. Moreover, interviewed clients already complain about long waiting times for test results. Rapid tests could be a possible solution to test aflatoxin in rural areas, since they are less expensive, around 25 GHS at the time of research. However, they are not available at the regional level.

Aflatoxin testing in brief

- Low general awareness of aflatoxin and its effects;
- Majority of maize is not being tested;
- Testing is only available in Accra and Kumasi and costs of tests are too high for smallholders;
- ~60 to 70% of tested samples are above threshold values;
- Main users are processors and large-scale poultry farmers;
- No incentives for aflatoxin testing on smallholder and trader level.

6.3.2 Metrology

This subchapter presents findings about metrology. The focus will be on moisture measurement and weighing. It reflects on the need, utilization, availability and obstacles to utilization of selected QI services.

Moisture Measurement

Need for moisture measurement

One of the measures to prevent post-harvest aflatoxin formation is to dry maize within 48 hours to 13 percent of its original moisture content, as high moisture content is an important precondition for the growth of mold. Next to the pro-

motion of better drying and storage infrastructure to reduce and keep the moisture at a low level, it is therefore also essential to determine the moisture content to verify if there is a need for further drying, or if the maize has reached a safe level for storage. Indeed, most interviewed farmers and traders see properly dried maize as the most important parameter for good quality. However, the actual understanding of dryness at the level of smallholder and traders remains vague, and is not verified by objective and precise testing applications, like moisture meters.

In order to compare perception and actual state of moisture content, the research team conducted practical experiments with 44 farmers, traders and poultry farmers. The participants of the experiments were asked to estimate the moisture level through “traditional” methods. The results were compared with the data determined with a moisture meter and showed an underestimating of the actual moist by an average of 3.4 percent (Figure 11).

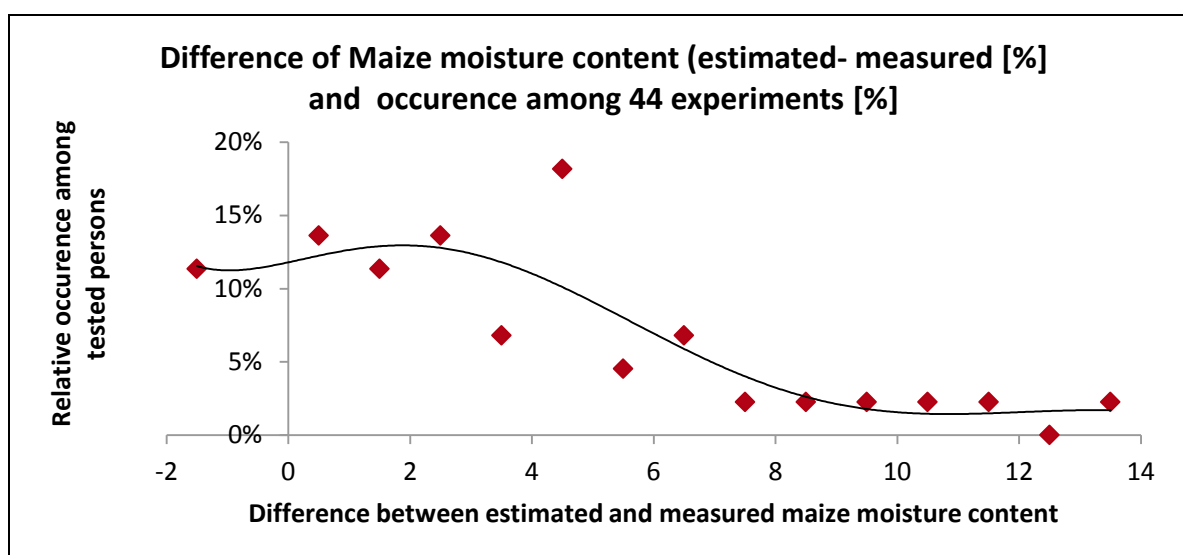


Figure 11: Differences between moisture content determination by traditional methods and moisture meter application

Besides one test person, 43 participants estimated the maize being dryer than it actually was. While the error ranged from 0,5 to 14%, the average amounted to 3,4%. (All data can be found in Annex 16).

Source: own illustration

Next to reduced post-harvest losses, another reason to promote accurate moisture measurement is potential financial benefit. At the time of research, maize from the previous season is labelled as “old maize” and can be sold for a premium of 60 to 80 percent (Interview 110, 130). Buyers with high quality de-

mands decide to pay the additional charge for the old maize under the assumption that maize that was stored more than three months and is still free of infestation was properly dried and matches their requirements. "New maize" can reach the requested moisture level of the GS 211 within four days of sun drying. However, even properly dried "new maize" cannot be sold for the same premium as "old maize" because of missing verification (Interview 86). Accurate moisture measurement could provide this missing verification and help to establish quality parameters that are more transparent and verifiable.

Knowing the exact moisture content of maize during trade could increase trust between different value chain actors. It was found that out of 55 interviewed farmers, 27 complained about incomprehensible reasons for price deductions or rejections by traders. Traders most commonly reference insufficiently low moisture level, which, according to the interviews, leads to disagreement because objectively verifiable methods are not applied (Interview 25). Interviewed buyers also complained about improperly dried or moldy maize, which was only discovered long after purchase (Interview 82, 83).

Availability of moisture meters

The availability of moisture meters within Brong-Ahafo is low. Out of 55 smallholder farmers and 17 traders interviewed, only one farmer possessed a dysfunctional moisture meter that had been provided through a GIZ project intervention (Interview 25). Generally, the use of moisture meters seems to be the result of intervention programmes. Supported FBOs, markets or warehouses were supplied with moisture meters by USAID, GIZ, TRAQUE or WFP (Interview 37, 140).

No moisture meters were available at the maize markets studied during this research, including in Nkoranza, as well as Odumase I and II. Only at the largest national maize market, a single non-calibrated moisture meter is available and in the responsibility of the Techiman Trader Association. The use of the moisture meter is free of charge for anyone on the market, whether trader or buyer. Warehouses that are part of the warehouse receipt system or being supported by TRAQUE provide moisture measurement services to their stakeholders. Other moisture meters can be found among processors, e.g. St. Bassa, and poultry farmers. The interviewed poultry farmers in Dormaa either possess their own moisture meters or can borrow one for GHS 5 per day from Green Bank Ltd., a wholesaler for maize (Interview 109,113).

The availability of moisture meters within the agricultural departments of the districts and the regional MoFA is rare. Exceptions are the district assemblies in

Wenchi and Tain, which have moisture meters due to their responsibility for maize silos, as well as in Drobo. In these locations, high levels of aflatoxin were detected in traded maize during 2012. As a consequence, the regional MoFA in Brong-Ahafo supplied one moisture meter. Farmers were officially informed via radio that the moisture meter is available for everybody (Interview 119).

Utilization of moisture meters

The observed utilization of moisture meters can be analyzed by distinguishing between two different groups. The first group can be described as general non-users of “technical” moisture meters. Representatives are all stakeholders of informal marketing channels. Properly dried maize is perceived as an important quality parameter by this group (also see Chapter 6.2). However, these stakeholders choose inaccurate methods to determine moisture levels. Even freely available moisture meters, e.g. at the district assembly in Drobo, are not utilized (Interview 119). To test whether consumed or stored maize meets the particular quality/moisture requirements, traditional methods are applied and generally accepted. Most of the interviewees check the moisture level by biting on the grain or shaking several maize kernels in their hand. Different sounds, tactile and visual as well as sensible perceptions between wet and dry maize, offers a judgement on the maize’s moisture. Some farmers determine the dryness by looking „if grains come out easily out of the shelling machine” (Interview 25) or if the grain is separating easily from the crop” (Interview 73), both of which are highly subjective assessment methods.

The second group can be described as partial users of moisture meters. Representatives of this group are especially processors (including feed millers and large-scale poultry farmers) with economic interest to meet quality standards for selling products on the formal national or even export market. These users apply the devices in order to avoid economic loss and complaints by their customers. For instance, poultry farmers determine the moisture content to reduce the likelihood of developed mold and toxins. Consequently, moisture is measured and, if necessary, maize is dried further as risk management (Interview 87, 129). Further partial users are stakeholders that have participated in intervention programmes. WFP stated that there is no proof of moisture meter utilization, but the decreased amount of aflatoxin indicates higher awareness of the significance of moisture content (Interview 140). Other interventions, such as providing moisture meters to the Techiman maize market, clearly failed their objectives and available meters are hardly used. Only processors are requesting the market moisture meter from

time to time, but traders still rely on their experience and traditional methods (Interview 130).

Obstacles to moisture measurement

The reasons for the low utilization of moisture meters seem mostly based on the lack of understanding and responsibility for accurate moisture measurement. Most interviewed smallholders and traders knew about necessity of moisture reduction, but had difficulties understanding the concept of the moisture content as a percentage. Furthermore, the GS 211 threshold of 13 percent was unknown, as was the correlation between aflatoxin and moisture content. In addition, “no buyer is asking for percentages or other verification for properly dried maize” (Interview 86). Therefore, farmers and traders see no need to conduct further testing beyond their usual, traditional methods.

The training of farmers on the concept of moisture content and the strong correlation to post harvest losses and health risks are the responsibility of regional institutions, like MoFA, or agricultural departments at the district level. However, AEAs that have direct access to farmers have not yet been provided with moisture meters and have similar low levels of understanding of sophisticated moisture measurement as farmers (Interview 119).

Another constraint preventing smallholders from operating moisture meters is the purchase and running costs of the devices. The average interviewed smallholder farmer needs to invest about GHS 800/acre maize for input and labour. The raw profit is around 200 GHS/acre. Prices for moisture meters, on the other hand, vary from 600 to 2000 GHS (40, 44, 129).

Traders even see a disadvantage in accurate measurements. At the moment, traders can sell a wider range of maize because it is assumed to be properly dried. From their perspective, buyers have to prove reasons to claim for recourse, like unacceptable moisture content by themselves (Interview 86). In addition, most traders are buying and selling so quickly that the majority of the maize is not stored for longer than a week. Consequently, they hardly suffer from further post-harvest losses through mold and are less motivated to use a moisture meter (Interview 130). Instead, the customer bears the risk for maize that becomes moldy.

Moisture measurement in brief

- No utilization among smallholders probably due to lack of understanding, responsibility as well as financial ability;
- Lack of understanding of concept of moisture content as a percentage;
- Underestimation of the actual moisture by traditional methods;
- Low awareness of link between high moisture content and aflatoxin;
- Disagreements and loss of trust on trading level;
- Poultry farmers, processors and warehouses are frequent users.

Weighing

Despite the national weights and measures act from 1973, the utilization of weighing scales could hardly be observed in maize trading. Measurement is rather done by various sizes of bags. The transactions between interviewed smallholder farmers and traders are usually traded in jute bags, called “bush weight”. However, if the moisture level of purchased maize does not meet the trader’s requirements, a top up is requested. The reason is decreasing volume, due to further drying. Therefore the weight of the bags bought from the farmer often varies between 130 and 160 kg. Smallholders themselves use smaller units to measure the amount of maize that is traded within the community. For instance a “rubber bucket” is used, which contains about 10kg; 10 such buckets are supposed to make up a bag.

When the maize is bought on the market, it is first refilled out of bush weight sacks into standardized cocoa bags to agree about the volume, which is about 100kg. After that the maize is again refilled into the bag of the buyer. During the described process of an average maize trade from producer to client, at least four different kinds of bags are used, none of which determine the precise weight.

The use of weighing scales was observed, however, but at different levels. Interviewed processors purchase maize in bush weight directly from farmers or as “cocoa-bag weight” from the market. However, they utilize weighing scales after buying the maize as a part of the further processing, for example to determine exact amounts for different products. Poultry farmers and feed millers are the only group of buyers who demand accurate weighing at the market. They usually prefer precisely weighted 50kg bags. A warehouse operator assumes that 80 percent of poultry farmers rely upon weight and have access to scales. They either

possess their own scales or their supplier does (Interview 40). Scales are used to verify the weight of 50 kg bags but also to guarantee accurate feed composition.

AT the Techiman maize market, scales are currently rented from cashew traders for GHS 50/day. At the Nkoranza maize market, one trader offers weighing services for GHS 0.5/50 kg bag. The weighing scale was provided by the Ghana National Association of Poultry Farmers (GNAPF). Calibration of scales is done in different ways. Scales in warehouses that are part of the warehouse receipt system are calibrated by the GSA once a year. The scale at Nkoranza maize market is calibrated by the operator of a warehouse that is located close to the market by comparing it with the warehouse scale. Weighing scales of poultry farmers or processors are mostly not calibrated. To verify if a scale is working properly, a “pre-weight” is used, for instance a 50 kg bag of commercial feed additive. Others use already packaged and labelled 50 kg bags for crosschecking.

Several programmes already focus on the provision and/or use of weighing scales. For instance, the D-MAPS project financed by AGRA and implemented by NGOs like CONCERN is providing several FBOs in Brong-Ahafo with scales. GIZ MOAP also intends to support the large maize markets in Brong-Ahafo with weighing scales, like they are already doing in the cashew initiative. The value chain committee (VCC) for maize in Brong-Ahafo has already developed a plan to introduce scales. Some districts, e.g. Nkroanza, even established a weighing committee in 2014. First steps are the introduction of harmonized bags within the various maize markets of the region. If the VCC/assemblies plan is followed, the authorities expect fairer pricing, transparent taxation and more competitive conditions in their accessing of other markets (Interview 9, 37). One current major constraint is apparently that non-utilization of scales is a source of profit for traders, and weighing is therefore not in their interest.

Weighing in brief

- Maize is traded by volume and not by kg at markets and farms;
- Minimal availability of scales at markets and farms;
- Non-utilization of scales is a source of profit for traders;
- Utilization of scales only by poultry farmers and processors.

6.3.3 Standardization

The utilization and understanding of maize-relevant standards have been examined. The focus in this study is on the Ghana standard 211: Cereals and Pulses – Specification for Maize (Corn). The objective of GS 211 is to improve the quality of traded maize. Intended benefits are reduced health risk and increased customer loyalty/trust, which leads to higher volume of trade on domestic markets. In the foreseeable future this could form the basis for entrance into export markets (Interview 54).

The maize standard is disseminated by publications and trainings (also see Chapter 5.2.3). Sales of the standard are low. In 2014 only eleven standards were sold. The main customers of the maize standard are NGOs that are consulting maize farmers or processing companies on quality standards. The last official GSA training for AEAs regarding the GS 211 was held in 2011 (Interview 54). Since then, five workshops and trainings were conducted upon request and support of other institutions, such as PTB or GGC. Participants were processors, members of trader associations, AEAs and warehouse operators, but not smallholders. The GGC further developed pictorials for the maize standard that simplify the GS 211 and shall be more applicable for farmers and traders in their daily transactions.

The utilization and awareness about the GS 211 is low among stakeholders of the maize value chain. Out of 55 interviewed smallholders, none has heard of the maize standard. On the trading level, only 2 out of 17 interviewed traders were aware of the standard. An agreement on individual quality assessments was observable, but grading and moisture measurement is not examined according to the GS 211. Additionally, none of the markets visited in Brong-Ahafo label bags with basic information on weight, grade, trademark, date of harvest or origin. The only maize bags that were labelled originated from Ivory Coast.

Interviewed processors utilize major parts of the maize standard, even if some prescriptions are used as rather a suggestion and adapted to their specific needs. In their opinion, following the standard is helpful to meet the requirements of export certification and FDA registration (Interview 144). Other frequent users are warehouses. If participating in the warehouse receipt system, they have to be managed according to GS 211.

The major constraint for an increased utilization of GS 211 is the very low awareness about an existing standard for maize. Reasons are mainly general obstacles for standard dissemination as described in Chapter 5.3. However, even with improved dissemination, the maize standard still excludes smallholders. The current version is not sufficiently applicable and comprehensible, e.g. the division

in 5 grades does not reflect the practices of smallholders. Furthermore, the determination of individual properties in percentages, e.g. the percent of discoloured grains in order to determine a grade, does not fit with current practices. Other experts criticise the voluntary character of the standard (Interview 53). In their opinion, some elements of a standard, for instance the ones addressing health issues, should be obligatory.

Standardization in brief

- Sales of and trainings on maize standards are very seldom;
- Awareness and utilization is low among most maize stakeholders;
- Processors and warehouse operators are frequently using standards;
- The maize standard is hard to apply and comprehend for smallholders;
- No monitoring or evaluation of standard utilization has been conducted so far.

6.4 Cost benefit

The benefits of a moisture meter at a small-scale processing site

The small-scale maize processor St. Bassa in Chiraaa in Brong-Ahafo is producing banku flour, corn flour and houssa coco for its customers in Accra, the UK and Australia, and plans to expand its product portfolio in the future. Established five years ago, the company now employs a total of 30 staff members.

In total, 160MT of maize are procured through the company annually. Most of the maize is purchased from approximately 500 smallholder farmers around the processing site. The majority of those farmers supply two to three bags per year. Additional maize is procured from the Techiman maize market. Maize is currently not being stored through St Bassa, but is processed immediately.



Figure 12: Production site of St. Bassa

Photo: T. Pfeiffer

Visual quality checks are performed upon pick-up of the produce from the farm through the truck that is owned by the company. Price premiums are paid for maize that is perceived as good quality. Weight and moisture content are controlled at the processing site, but do not affect the price at the farm gate. Maize that has not been dried sufficiently by the farmer or the trader is dried further through a mechanical drier in the processing facility. A problem with Aflatoxin levels of 30ppb was detected two years ago. Consequently, St Bassa traced the farmer that supplied the maize and stopped purchasing from this farmer.

Maize dryness is controlled with a moisture meter before it is processed. The device was supposed to be calibrated by the GSA, but the person in charge never came. The reliability of St Bassa's moisture meter was checked through a comparison with a GSA calibrated moisture meter and showed identical results. Despite the control of maize inputs, the moisture meter is also used to control moisture levels of maize when it is dried in the mechanical drier of St Bassa.

St Bassa purchased the moisture meter for 2000 GHS. Recurring costs for 220V electricity are neglected here. Due to the introduction of a moisture meter in the production process, the management realized that maize was being dried to 9 percent moisture content, instead of the required 13 percent. Drying maize beyond the required moisture levels implies a loss in the weight of inputs. Assuming that 50 percent of the maize has been dried through the mechanical drier in the processing facility, the annual loss due to overdrying amounts to 3.517 metric tons (Table 4).

Table 4: Maize weight in the drying process						
Initial weight	Required moisture content	Achieved moisture content	Over-drying	Water shrink factor at 9%¹²	Weight loss (% overdrying x water shrink factor)	Final weight at 9%
80 MT	13%	9%	4%	1.099	4.396%	76.483 MT
Source: own illustration						

Handling losses are omitted in the calculation as they are already occurring during the drying process and are much smaller than moisture shrink.

¹² The water shrink factor equals $100/(100-\% \text{ final moisture})$
(<http://corn.agronomy.wisc.edu/Management/pdfs/NCH61.pdf>)

Despite the costs of lost maize weight as input for the production, also the operational costs of the dryer need to be considered in the economic valuation of the benefit of the moisture meter. According to information from St. Bassa, it takes 11.25kg of gas to dry one metric ton of maize from 18 to 13 percent moisture content. Conservatively assuming proportionality in the drying process, the additional costs for drying the maize to 9 percent moisture content amounted to 70GHS per metric ton.

The economic valuation of the overdrying of maize and subsequently reduced input weight, operational costs of the dryer and the costs of detection through the moisture meter shows that the investment in QI paid off after implementing moisture meter measurements in the drying process after just 2.4 months of production (Table 5).

Table 5: Economic valuation of costs and benefits			
	Benefit of QI use		Cost of QI use
	Loss in maize weight (annually)	Cost of overdrying (annually)	Moisture meter
Quantity	3'517 MT	80 MT	1
Unit cost	1'208 GHS / MT	70 GHS / MT	2'000 GHS
Total cost	4'247.45 GHS	5'800 GHS	2'000 GHS
	Benefit		Cost
Balance	10'047.45 GHS		2'000 GHS
Source: own illustration			

The results of this case study are especially relevant in the context of the results presented earlier on the precision of traditional assessment of the moisture contents in maize through various VC actors. This case study shows that on a processor level, the exact measurement of quality characteristics in the production chain can yield economic benefits.

7 Pineapple value chain

Chapter 7 describes quality infrastructure where it is relevant to the pineapple value chain. Furthermore, the findings from context, perception and demands of quality as well as QI service utilization by producers are described in this chapter.

7.1 Contextual findings in the pineapple value chain

The degree of quality infrastructure utilization in the pineapple value chain will be more easily understandable after discussing its agricultural production and context. Aspects include the types of pineapple producers, what their farming conditions and market channels are, to whom pineapple is delivered and finally the influence of interventions in the pineapple sector and its quality infrastructure.

7.1.1 Pineapple production

Pineapple reproduction is vegetative by using suckers and, to a lesser extent, crowns and slips of pineapple. When using suckers as planting material the growing period until the harvest is the shortest, at a minimum of 12 months. In Ghana, plants are commonly sprayed with Calcium Carbide (CaC_2) to force them to flower at a desired production period. The availability of planting material with good productivity was often stated to be a problem in Ghana (Interviews 25, 113).

Regarding varieties typically grown in Ghana, all four varieties were observed among the interviewed farmers, whereby Sugar Loaf and MD2 were most common.

Sugar Loaf cultivation is largely observed among smallholders and is considered a local variety. It is said to be more resistant to weeds and insects than the MD2. According to the majority of interviewed farmers, Sugar Loaf needs half as many inputs as the MD2 variety (Interview 28). Farmers mostly do not use chemicals to de-green Sugar Loaf either (Interviews 89, 90). Due to low use of fertilizers and chemicals, its production is often considered organic (Interview 113). Sugar Loaf was also said to prosper on all soils (Interview 22), even without fertilizer. This variety is largely sold at local markets. Sugar Loaf can be processed, but is not preferred as component by juice producers due to its white – not yellow – flesh and unsatisfactory sugar/acidity ratio. This ratio leads to short expiry periods (Interview 88). The fresh Sugar Loaf is also less suitable for export because it is less robust for transport.

The MD2 variety is often called “agric” pineapple in Ghana. The shift in demand during the years 2005 to 2010 from Smooth Cayenne to the MD2 on the international market also affected Ghana. Today, most exported fresh pineapple to Europe is from this extra sweet MD2 variety (Kleemann et al., 2014), which was confirmed by this study. In contrast to Sugar Loaf, its cultivation requires good soils and high amounts of inputs in order to grow well. Nevertheless, the variety is becoming more favored among all farmers as it can be sold on all markets (Interview 22). However, high inputs and technical competence are quoted as major reasons that prevent more smallholders from engaging in the MD2 cultivation (Interview 126).

Smooth Cayenne production was not observed in the Volta region, but it is cultivated in the Eastern and Central regions, where it is grown by $\frac{1}{4}$ and $\frac{3}{4}$ of farmers, respectively (Zottorgloh, 2014). It is not easily found in local markets and has been replaced in the export market by MD2. It is hard to multiply suckers of Smooth Cayenne (Interview 113); however, it is still favored by processors since it yields more juice than MD2 (Interview 59). Blue Skies Ghana, a processor from the Eastern region, still encourages its suppliers to grow this variety (Interview 100). Before the shift in variety in 2005, 30-40 percent of Smooth Cayenne suppliers were smallholders (Interview 128).

During this study, the least commonly observed variety was the Queen Victoria, also known as baby pineapple. A large farm TropiGha Farms Limited from the Volta region is farming Queen Victoria under organic farming conditions and is entirely exporting to Europe (Interview 130).

This study differentiated between three types of producers in Ghanaian pineapple production, presented in Table 6. Large-scale farmers were found to have access to transportation means, storing, washing, packing and cooling facilities. Interviewed smallholders do not have access to any of the aforementioned benefits. Spoilages that occur through improper post-harvest handling and lack of transport were generally said to pose a problem (Interview 19). A pack and cooling house visited in Vakpo district in the Volta region could offer post-harvest services, but is currently not widely accessible to farmers, nor used to its full potential.

All interviewed producers sell their pineapple since they cultivate it as a cash crop. Smallholder farmers farm three or more other crops in addition. Larger producers specialized additionally in other cash crops, such as papaya or mango. On average, interviewed smallholders started cultivation 4 years ago, middle scale farmers 9 years and large farmers 15 years ago. The fact that smallholders have

not been in pineapple cultivation for as many years corresponds well with the fact that many smallholders abandoned pineapple cultivation after the shift in variety (Interview 126), and are restarting just now. At the present time, however, a growing trend has been observed through two planned outgrower schemes in the Volta region initiated by Kingdom Premium Fruits and the Catholic Church in the Jasikan district (Interviews 27, 28, 99).

Table 6: Definition and characteristics of interviewed pineapple producer types

Producer type (# and %)	Definition	Farming system
Smallholder farmer 34 (~66%) 31 FBO farmers	Farmers who farm on 8 or less acres of total land and not working under a farming contract. They may or may not be organized in FBOs.	Average total/pineapple land size: 5 acres / 1 acre; Variety planted: Sugar Loaf and MD2; Fertilizer: 31 compound mineral/1 straight mineral / 1 organic; Pesticides: 31 use / 2 no pesticides.
Middle scale farmer 6 (~12%) 3 FBO	Farmers who cultivate on 9-100 acres. They may or may not be in an FBO.	Average total land size/pineapple land size (acre): 39 / 2,4; Varieties: Sugar Loaf, MD2 and Smooth Cayenne; Fertilizer: 3 compound mineral / 2 straight mineral / 1 organic; Pesticides: used by all.
Outgrower 8 (~16%)	Small-scale or medium-scale farmers who are contracted to grow products following the rules and agricultural practices of the contractor.	Average total land size/pineapple land size (acre): 12 / 8.5; Varieties: MD2, Sugar Loaf and Smooth Cayenne; Fertilizer: 4 compound mineral / 2 straight mineral; Pesticides: used by all.
Large scale farmer 3 (~6%)	Farmers who cultivate on more than 100 acres of land.	Average total land size/pineapple land size (acre): 913 / 246; Varieties: MD2, Sugar Loaf and Queen Victoria; Fertilizer: straight / 1 organic; Pesticides: used by all (and organic treatment)

Source: own illustration

Pineapple seems to be an adequate choice of farming in Ghana for income generation, but investment is very costly at the same time. For example, if a smallholder farmer wants to cultivate pineapple on one acre of land, they need to invest 110 GHS/acre to pay for a tractor to do the necessary field preparation (In-

interview 28). Furthermore, an acre would require buying approximately 22,000 suckers/acre for a price of 0.1GHS/sucker (Interview 130) and to hire a laborer for planting and harvesting for a price on average 12.5 GHS/day/worker (Interviews 28, 94). These minimum investments amount to 2,335GHS per one acre (~550 EUR on 28.10.2015), which smallholders often do not have available. High initial costs hinder smallholders, especially considering that pineapple need 12-13 months until they can be harvested and sold. The lack of cash is compounded by banks being reluctant to give credits to the farmers due to high risks. Even if smallholders obtain loans, the very high interest rates of up to 30 percent annually render loans unaffordable (Interview 60, 122).

7.1.2 Value chain actors and marketing channels

Pineapple is traded as a piece good through three different market channels. It is sold to local markets in Ghana, to international consumers and finally to fruit processors who deliver the domestic or export market with their produce.

Through the local market channel farmers sell fresh pineapples to middle-women who then sell to town/city markets in Ghana or along the roadsides. In the Volta region, the Sugar Loaf variety is traded most commonly, followed by MD2. Farmers perceived a growing demand for MD2 among local consumers due to its golden color and less sour taste (Interviews 92, 93). In contrast to Ho, consumers in Kpando and Hohoe districts preferred the MD2 variety over others. In the Central region, however, the preferred variety at markets was Sugar Loaf. It is assumed that the various tastes have grown diversely with the offered varieties in the respective regions and districts, possibly because of the introduction of the MD2 variety.

Cultivation and harvesting of pineapple is generally done by men, while trading of fruits through the local market channel is exclusively done by women. The reason stated was because women care more about fruit quality and hygiene as the traders would sometimes sell pineapple freshly cut on local markets (Interview 94). Furthermore, fruits that don't meet export requirements end up in the local market as well. Around 40-50 percent of all fruits are rejected for export, mostly due to unsuitable size and shape of the fruit and crown (Interview 126).

In this market channel, trading per piece at the farm gate price of 0.7 GHS was the common practice. The price sometimes varied according to the size, in which case bigger fruits cost more (0.5 HS-1.25 GHS/piece). When selling to end consumers, one pineapple costs on average of 2 GHS. At larger markets in Accra, the price can range between 3-5 GHS. In a few cases, farmers were observed selling

their fruits per kilogram (kg) to middlewomen. The price was 12GHS/20 kg crate. Despite traders purchasing by the kilogram, they sold pineapple in pieces to end consumers (see also weighing in 7.3.2 Metrology). In general, the price did not vary between MD2 and Sugar Loaf varieties in the Volta region. On the contrary, middlewomen in the Central region paid 50 percent more for Sugar Loaf.

Export market channels for Ghana's pineapple are dominated by large-scale farmers who may subcontract other farmers. Compliance to high international quality standards requires high investments, technical know-how and good connections to national and international value chain actors. Farmers contracted by such large-scale producers fulfill all the requirements mentioned as they obtain constant assistance from such large producers. Pineapple is exported and sold to international buyers who thereafter sell to consumers. Pineapple that does not fulfill export requirements ends up at the local or processing markets in Ghana (Interview 130).

On average, export outgrower farmers receive 0.85 GHS/kg for selling the MD2 variety to their contractor (Interview 28). The higher price on this market might reflect stricter quality requirements by international consumers. Such international requirements induce higher production costs for the farmer, which can be more easily fulfilled by large-scale farmers or outgrowers than by individual smallholders.

Processing market channels of pineapple will be analyzed next. Processors like PEELCO Limited, Kingdom Premium fruits, Blue Skies and FPMAG members operate their own pineapple farms or have suppliers. Observed suppliers were medium-scale, large-scale or outgrowers. Processed varieties are MD2, Smooth Cayenne and, to a lesser extent, Sugar Loaf. Pineapple are processed both for domestic and international markets.

Processed produce for export market requires many quality checks starting at the farm level. Those farmers are advised about farming practices by the processors and their products undergo various tests before offtake for processing. Processors for the domestic market need to have an FDA licence for processing (Chapter 5.1.1). The requirements, however, are not as strict as for exported products (Chapter 7.3).

Price paid for pineapple varies between export and local processors. Export processors pay 0.8 GHS/kg (Interview 100), whereas local processors pay 0.4 GHS/kg to farmers.

The SLE research had the impression that there is a growing demand for pineapple juice. This juice demand is perceived to be even higher than the demand for

fresh fruit on the domestic market (Interviews 59). A low price paid by local processors, however, is not encouraging farmers. After providing processors with fruits, farmers often have to wait for payments from processors. Export processors offer more money per kg, but also demand higher quality from farmers.

7.2 Quality perception and demand

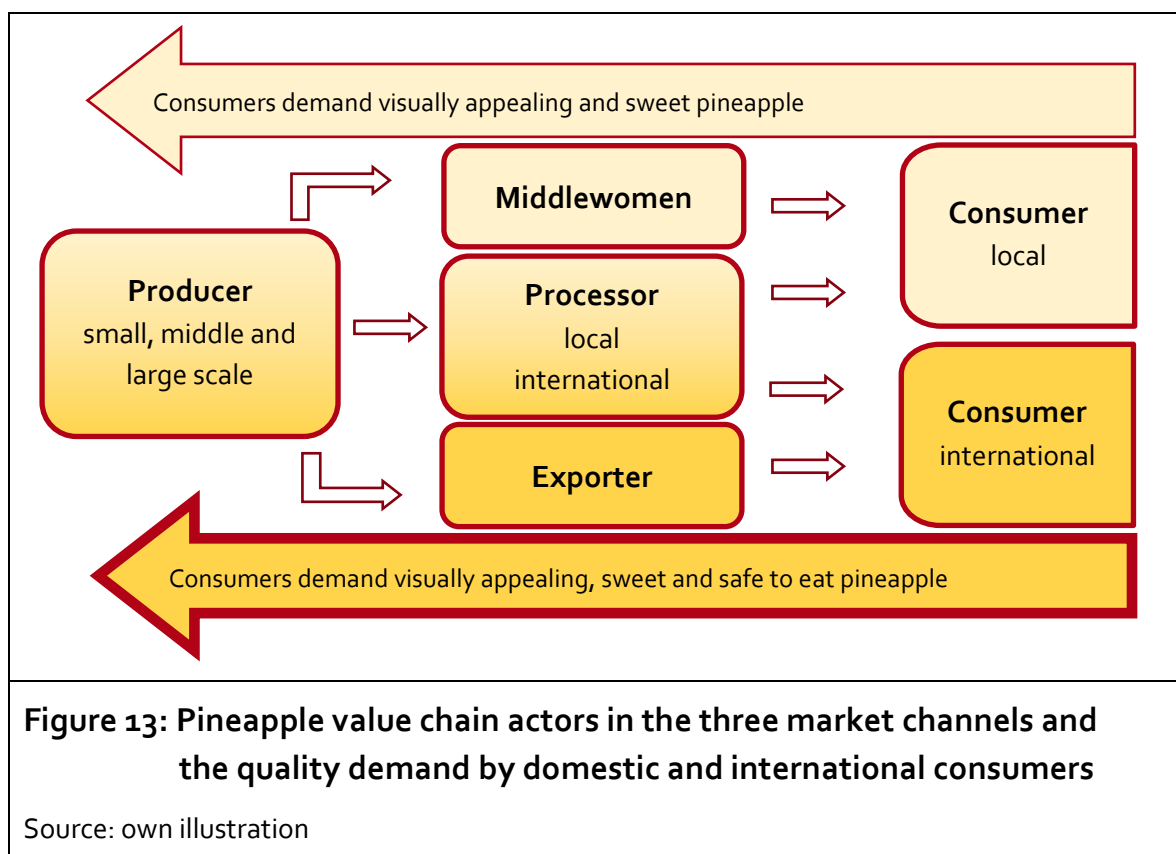
Smallholders who supply local markets indicated visual characteristics such as color, shape, size, disease-free appearance, and taste of pineapple as important quality characteristics. All problems mentioned by farmers in pineapple production were linked to those quality demands on local markets. These included, for example, the crown being bigger than the fruit, a brown or wilted crown, abnormal fruit shape, rotten pineapple, and insect holes. Post-harvest damages such as rodent attacks were also brought up.

When buying from those farmers, interviewed local buyers confirmed that appearance and taste were determining criteria. One market seller stated that freshness of fruits is the most important criterion (Interview 102). Middlewomen would always reject rotten and damaged fruits. Among consumers on the local market, the only real quality requirement was sweetness of fruits. When asked whether pineapple were tested for excessive residuals, for example, a pineapple exporter stated: "No test is necessary at the moment for the local market" (Interview 126). As a consequence, there are few visible quality requirements applied and communicated to producers for the pineapple value chain on the domestic market (Figure 13). According to the umbrella organization of juice processors, domestic consumers are already satisfied when processed juice is to their taste and do not ask for a specifying label on the bottle (Interview 30). None of the listed quality requirements are a demand for QI.

Regardless of farm size, higher quality awareness was observed if pineapples were cultivated for the export market. "When we talk about quality, do we talk about appearance and taste or about food safety?" indicated one contract farmer (Interview 100). Small-scale farmers under outgrower schemes were also aware that, in addition to physical characteristics, products need to be hygienic and free from pesticide residues (Interview 28). Large-scale farmers and juice processors for the export market indicated sugar level and yellow color as important quality criteria in addition to having clean and pesticide residue safe products as a response to quality demands of the international consumers (Figure 13). Local processors are aware that microbiological results should indicate hygienic juice but

they do not see residue free products as a necessary quality requirement explaining that “Testing of pesticide residuals is not needed for the FDA certification” (Interview 32). The FDA certification is based on the rules defined in the Ghana Standard 101:2008 for fresh fruits and vegetables – specification for pineapple, among others.

GS101 requires that pineapples are intact and clean, the crown and fruit have a good shape and are without pest infestation. GS 101 also specifies that the fruits should be microbiologically acceptable and free from heavy metals and pesticide residues. The same standard asks for the weight of fruits when packaging and labeling them. None of the interviewed producers, however, handles pineapple according to the GS standard. Hence, the farmers’ knowledge about those defined quality requirements is missing. Figure 13 aims at expressing this lacking communication of quality requirements from consumer to producer.



However, there were some indications observed that the demand for safer or organic products might be present on the domestic market. A farmer from the north of the Volta region said that two out of ten consumers ask for organic-like products (Interview 99). According to some respondents, there is a demand for

quality and organic products by Ghanaian retailers and hotels (e.g. Interviews 46, 59, 94). At the same time, some retailers are mistrustful as to whether smallholders can deliver products of high quality (Interview 125).

Following the KAP approach, domestic producers and consumers are aware of only a few quality demands. Both are less knowledgeable about the possible spectrum of quality requirements. In contrast, the producers and consumers on the international market are more aware about product safety requirements in addition to taste and appearance.

Quality perception in brief

- Smallholder who supply local markets define quality of pineapple based on visual characteristics and taste;
- Fruit processors perceive good quality through satisfactory sugar content and yellow color in fruits;
- In addition to appearance and taste, large producers, fruit processors and outgrower farmers who export their produce characterize a good pineapple as clean, safe, residue-free fruit.

7.3 Status quo of quality infrastructure in the pineapple value chain

The study about the pineapple value chain explored which of the QI services are utilized by producers and other value chain actors, and to what extent. Utilization of microbiological contamination tests is only relevant when producing juice and will be briefly described together with the pesticide testing subchapter.

Theoretically, contamination with lead due to illegally disposed lead batteries or mercury due to gold mining with the amalgam method is conceivable. However, heavy metal testing of pineapple and pineapple produce showed not to pose a big concern in today's pineapple production in Ghana. One exporter of pineapple requested testing on heavy metals but the suspicion proved to be unfounded and there was no single case during the data collection indicating otherwise. In addition, the SLE team conducted four soil analyses and no traces of heavy metals were found (see Annex 8 for results of soil testing). For this reason, a description of heavy metals testing is not included in this report.

The utilization of pineapple relevant national standards is also not described in detail. This is partly due to the fact that there was no stakeholder observed handling the fruits according to national standards and additionally because the Pineapple Standard is currently under revision. Quality requirements specified in the current standard were briefly described in Chapter 7.2. In contrast, soil testing, voluntary certification of farming system, weighing, testing on pesticide residues and refractometer utilization will be explained in more detail below.

7.3.1 Testing

This subchapter presents findings about soil testing, pesticide residues and microbiology testing and refractometer use. It reflects on the need, utilization, availability and obstacles to utilization of selected QI services.

Soil testing

Investigation on soil testing looked into use, knowledge and acceptance of two modes of quality assessment: laboratory soil testing and soil quick tests.

Interviewed experts described an increasing need for soil testing, in particular in the future, when shifting agriculture¹³ will no longer be an option due to growing land pressure. Furthermore, continuous mono-cropping was stated to be a farming system that depletes the soils, already perceivable now by some larger producers. “Production is now more difficult because soils are depleted and because of climate change. Yields are dropping” (Interview 88). Soil analysis is not only relevant for pineapple, but mostly for horticultural crops. The reason is probably the fertile forest soil losing its strength over time. Hence, there is a necessity to know the soil profile and its quality, and respond thereafter with proper inputs and choice of a crop or variety. Farmers who wish to export their produce, e.g. to Europe, need to conduct regular soil analyses because annual soil analysis is a prerequisite for Global GAP certification. However, not only when it is an obligatory requirement, many experts stated that knowing the soil profile would help farmers in understanding nutrient levels and soil pests, input demands, such as suitable fertilizer applications, needs for liming of acidic soils or other adjustments of agricultural practices. This would in turn have a positive impact on the productivity, as farmers would be able to add the appropriate amount of inputs. The costs and benefits of soil testing utilization are discussed in the Chapter 7.4.

13 In shifting agriculture system a field is cultivated for a short time and then abandoned to recover its soil fertility while moving to a new plot of land (<https://stats.oecd.org/glossary/detail.asp?ID=2452>)

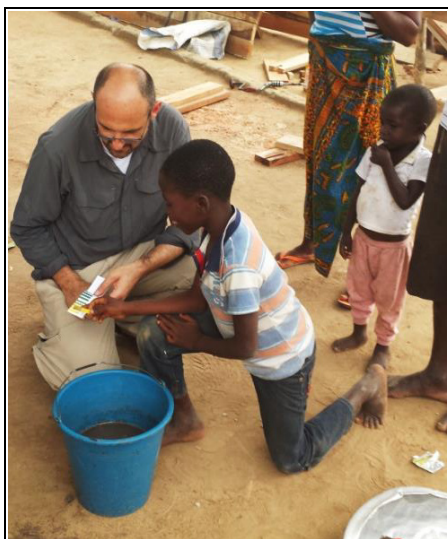


Figure 14: Simple soil test with pH strip in the Volta Region

A ten year old reads results.

Photo: T. Pfeiffer

Laboratory soil analysis in Ghana can be conducted in public institutions, such as the CSIR-SRI in Kumasi. This study utilized the lab at the soil science department of the University of Ghana in Accra, which does not perform these tasks on a commercially developed basis. Within the private sector, a company SGS situated in Accra performs various soil analyses.

No commercial soil testing was observed in the Volta region. However, the Farm Institute in the Volta region is one of the 8 educational centers in the country that has the ability to perform simple test analyses (see Chapter 5.3 for laboratory descriptions). The utilization of simple tests, such as pH strips, could be taught by such agricultural schools. However, neither use nor availability of rapid soil field test kits was observed

during data collection within the Volta region. Both GIZ and CSIR-SIR report that test strips can be imported.

Among the 50 interviewed pineapple farmers, all large-scale farmers test their soils in laboratories regularly, motivated by export market demands (Interviews 59, 88, 130). Four medium-scale farmers, two individually interviewed smallholders and a few more smallholders from two focus group discussions had tested their soils on one occasion. The test utilization was stimulated and paid by GIZ interventions with selected farmers' associations, by the Catholic Church in Jasikan or through an outgrower contract. The majority of smallholders perceive the cost of the testing as high. However, when asking further, almost none of them knew what the price was.

All farmers interviewed within this research who have done the testing, had assistance when interpreting soil results. Without assistance by an expert, it would be very difficult to understand results and apply inputs such as fertilizers accordingly (Interview 126). A limited utilization of soil testing on a broader scale was furthermore observed as a consequence of a limited awareness of the benefits a soil analysis can offer. Even some agriculture extension officers often are not aware themselves what the benefits of soil testing are and hence, recommend doing traditional assessment methods. "Sometimes looking at control plants is sufficient, instead of sending in a sample" (Interview 25).

Some farmers perceive their soils as rich and fertile. In addition, they believe that traditional quality assessment methods suffice to estimate soil fertility. Farmers look whether certain indicator weeds are growing on fields; search for earthworms in the soil; observe if yields are declining; or throw a handful of soil to see how it disperses when it hits the ground. Neither do these methods cost anything, nor do they require help in understanding quality infrastructure services. Finally, no commercial testing facilities are located in the region.

In addition, for those farmers who wish to perform the analysis, there is a limited possibility to respond to test results with specific inputs, such as straight fertilizers¹⁴. Every producer stated that input dealers are reachable within a short time; nevertheless, none of the input dealers in the Volta region offer pineapple specific fertilizers. Apart from a few medium- and large-scale producers, many farmers use a compound fertilizer designed for cocoa production¹⁵ and the mode of input application is following a blanket recommendation¹⁶ approach for the entire country. Given the differing results from the soil samples analyzed during the study (see Chapter 7.4 Costs and benefits of soil testing), blanket recommendations might not be an adequate approach. Finally, many smallholders expect that the costs will be born by someone other than themselves, as their economic situation is already dire.

Soil testing utilization in brief

- Benefits from soil testing are largely unknown among small-scale producers;
- Farmers need assistance in interpretation of test results;
- The limited possibility responding to soil test results due to cost of lab analysis is perceived as high by smallholders;
- Large-scale producers tend to test regularly for soil properties; Several medium- and small-scale farmers have tested it once due to a project or foreign intervention;
- No commercial soil testing in rural areas (decentralized service) has been observed, but capacity to test in 5 agricultural colleges and 3 farm institutes across the country exists and bears potential.

14 Straight or single-nutrient fertilizers supply only one nutrient to a crop (IFA, 2013)

15 NPK fertilizer: 15%N 15%P₂O₅ 15%K

16 Blanket recommendation approach suggests applying same fertilizers to all crops, irrespective of the plant characteristics and need or agroecological zones.

Pesticide residues and microbiological testing

Among interviewed experts and academics from Ghana (e.g. Interviews 54, 59, 63, 88, 130), there appears to be a widespread belief that smallholder farmers may use pesticides incorrectly by applying them at the wrong time or using pesticides in excess. Out of all pineapple farmers interviewed, only two are not using pesticides in pineapple cultivation. Bempah et al. (2011) reported that in Kumasi, in the Ashanti region, pineapple had pesticide residues above the MRL set by the European Commission in 75 percent of the cases. Therefore, the risk of input misapplication is indeed present.

The testing on pesticide residues in laboratories is linked to the export market channel. Large-scale producers and processors test pineapple products when exporting to Europe. They seem to always test exported pineapple in European laboratories, as customers from Europe do not accept test results from Ghana (Interviews 59, 88, 130). Occasionally, some of those producers would pretest their fruits in Ghana for their own records.

The GSA pesticide residue laboratory located in Accra is one of the labs in Ghana that can perform these analyses. The scope of the laboratory is nonetheless much lower with 36 out of 452 chemical compounds (see Chapter 5.2.2). According to a GSA expert, no individual smallholder has ever tested their produce for residues. This has been confirmed in interviews with farmers. Besides, the majority of the interviewed smallholder farmers were not aware of the relevant QISP and their services in Ghana.

The juice processors who are supplying solely to the domestic market test their juice samples for microbiological contamination and some physical juice properties (pH (total acidity), soluble solids, Faecal coliform, total APC (aerobic plate count), yeasts, molds) but not for pesticide residue level (Interview 30). According to the director of the fruit processors association FPMAG, microbiological analysis is necessary for the annual renewal of the FDA certificate, but there is no requirement for residual analysis.

Some respondents argued that decentralized laboratories, possibly in every region and closer to producers, would encourage utilization of pesticide residues tests. Other experts argued that these would be too costly to run, as there must be a sufficient number of samples being tested regularly in order for a lab to be profitable. Furthermore, as stated by many, the price of the analysis is too high for smallholder farmers.

One interviewed exporter expects that all producers should be able to communicate to the consumers about chemicals and other specifics of their pineapples (Interview 126) but there is no incentive in form of a demand for residue free products among the wider general public. There is a general belief among interviewees that if people were more aware of quality problems, there would be a demand for quality assurance. A few hotels and retailers ask for residual analyses in order to maintain their own quality requirements. It was also reported that retailers who test on residues deduct the cost of testing from the price paid to the producer (Interview 46). One farmer said that he would have an incentive to test under certain conditions: "If a customer would now like to see his pineapples tested, I would suggest sharing the costs" (Interview 92). This would mean that farmers need incentives to make additional investments or, in other words, the willingness to pay for more quality by the consumers might lead to more QI use.

It was observed that fruit processors supplying to the domestic market do not test for pesticide residues, but also do not face any sanctions in practice if the microbiological test results have not been satisfactory. According to FPMAG, fruit processors do not need to receive lab results before selling their produce to restaurants, hotels and stores. In the event that lab results are unsatisfactory, a processor would simply inform those retailers and advise them to halve the expiry date of juice that is sold to their consumers.

Pesticide residues testing in brief

- Large-scale producers and fruit processors who export their products test for pesticide residues and they let products be tested outside of Ghana;
- Juice processors supplying the domestic markets test for microbiological contaminants and some physical properties;
- Smallholders were not observed to utilize pesticide residues or microbiological testing.

Refractometer

As mentioned, taste or sweetness of a pineapple seems to be important to pineapple consumers. To test this objectively, a refractometer is used. A refractometer is a handheld device that helps determine the sugar – or BRIX level in pineapple, i.e. it reliably shows sugar content of a fruit (Agrisolutions, n.d.). This is a sign for producers that the pineapple is ripe and should be harvested because

the more mature a fruit is, the sweeter it becomes. According to the GSA standard for fruit juices (GS 1092:2014), the minimum BRIX level of fruits for processing should be °BX=12.8°.

Among the interviewed farmers, only attendants of GIZ trainings that had introduced the device knew about refractometers. The majority of smallholder farmers said they can accurately tell when pineapple is ripe and ready for harvesting by counting 130 days after forcing. Others would visually examine the color of fruits to determine ripeness. Traders, who buy from those farmers sacrifice one fruit, then cut, try and taste pineapple to check for sweetness. In contrast, large-scale producers and processors use refractometers to check the sugar or °BX level and influence the harvest time.

Using BRIX level as a sanction was observed in a case where one export processor reduced the price paid to the farmers based on the shown sugar level (Interview 100). In another two cases, a processor and a trader supplying the domestic market were observed to arbitrarily judge the sweetness and sanction their producers. In one case, purchased pineapples were not ripe enough and therefore the quality of juice was bad. As a consequence, this processor stopped buying from those farmers (Interview 137). In the other case relevant for the domestic market, a middlewoman reported paying different prices to two different pineapple producers. To one producer she paid less money (8GHS/20kg of pineapple) for fruits rejected for export that are harvested earlier and apparently less sweet than to another producer whose pineapple are claimed to be sweeter (12GHS/20kg). This trader has based her judgment on the experience in trading and is not aware how the testing for sweetness could be done differently (Interview 105).

Refractometers are useful where there is a demand for fruits with a minimum sugar content, such as export, where BRIX must be higher than °BX>12.8°. The demand currently comes from large export producers or processing companies. These stakeholders presently have an incentive to utilize refractometers, whereas smallholder farmers do not. The consumers on the local market prefer sweet pineapple, but are not asking for a transparent proof of sweetness.

In this study, locations to purchase refractometer on the market were not observed. Big input shops don't offer this device, and interviewed input dealer have never seen it, or did not know the purpose of this device (Interviews 55, 56, 57). A refractometer is claimed to be too expensive for the interviewed farmers. Local processors complain that the required annual calibration for a refractometer is expensive (70GHS) and that this poses another obstacle for QI use (Interview 30).

Refractometer utilization in brief

- None of the smallholder farmers has ever used a refractometer despite it being a handheld device that can be used locally;
- Traders on the local market taste fruits to check for sweetness rather than testing with a refractometer;
- Exporters, large producers and most processors use refractometers as sugar level directly affects the quality of juice.

7.3.2 Metrology

Under metrology the utilization of scales by pineapple producers, relevance of scales and of QI in general, as well as the availability of scale was studied.

Weighing

There are two different modes of pineapple trade in Ghana. Pineapples are sold per piece or weighed and sold by kilogram.

Trading per piece is also the most common trading mode between smallholder farmers and middlewomen. Farmers mostly sort pineapple into three different sizes arbitrarily (big, medium and small), which is quite labor intensive. For each size or category, they fix prices like “3 fruits for 5GHS”. Bigger fruits always cost more and are preferred by middlewomen. Another trading system is selling all fruits per one fixed price (flat-rate for all sizes) without sorting and grading them.

A grading system is practiced among large export farmers. However, they classify their pineapples into different systems arranged with their international buyers. Fruit processors normally do not grade purchased fruits, but require pineapple above or of a certain weight, depending on the type of produce they make (juice, dried fruits or fresh cut).

Among interviewed smallholder farmers and medium-scale farmers, there were some observed who sell pineapple per kg and some farmers who want to do so in the future (Interviews 94, 99, 100, 134). Farmers understand and can easily use scales. Stated reasons for farmers to weigh pineapple were multiple. Farmers could calculate exact costs of production. It is easier to sell per kg as no sorting by size has to be done beforehand. In this way, farmers can mix sizes and sell all fruits. Since weighing is seen as an objective measure, farmers avoid the risk of being cheated when selling their pineapple to traders. Higher revenues through selling by kilograms were been brought forward by farmers and this will be dis-

cussed in Chapter 7.4. Traders accept buying in kg, but prefer selling their fruits per piece on the local market. Selling by the kg would not allow traders to earn a lot for big fruits, as the profit margin is always higher for big fruits when sold per piece.

Scales were available in the Volta region. Smallholders purchase hanging scales for 25 GHS in shops where building material is sold. However, sometimes the quality and duration of such scales is questionable. Therefore, farmers who use those scales always have a second one at hand in case the first one stops functioning (Interview 94).

Large-scale, export-oriented producers always weigh their fruits before selling them and have weighing scales on their farms (Interviews 59, 130). Large export farmers who contract out-growers use weighing platforms upon the arrival of pineapple to their farms (Interview 28).



Figure 15: Weight of fertilizer in a matchbox

Photo: T. Pfeiffer

In the processing industry, processors who export their juices and other fruit products always weigh when purchasing fresh fruits. Local processors, however, do not use weighing scales as a rule. They often buy pineapple with a unit price. Nevertheless, the interviewed processors expressed the intention to use weighing systems in the future, as it would help them better estimate their production costs (Interview 137).

Finally, some interviewees suggested that weighing should not only be restricted to pineapples, but also when fertilizers and pesticides are used to calculate the exact amount necessary before mixing them with water (Interviews 59, 100). There were indications observed that current traditional practices of input measurements are inconsistent with what the application requirements should be.

One example of wrong input measurement: an instruction of a 20/20/20 MPK compound fertilizer instructs to “use 5-10 matchboxes corresponding to 50-100 gram of fertiliser per 15 litres at 7-14 days interval”. However, when measuring at the Ghana University how much of that fertilizer fits into a matchbox, nearly double fits in (Figure 15). The farmer would dose 77 percent more than instructed and appropriate. This costs money that farmers seldom possess.

Weighing in brief

- Pineapples are mostly weighed by large producers and processors when exporting them;
- Some smallholders use scales when selling in the local market and a growing trend is observed;
- Smallholders and medium-scale farmers who use scales perceive weighing as beneficial for them.

7.3.3 Certification

Voluntary certifications communicate transparently to consumers a certain product's higher quality in contrast to non-certified products. Being certified against a certain standard also means a strict compliance to predefined rules of the standard (FAO, 2014). During the period of this study, three types of certifications were found to be relevant for pineapple production: GLOBALG.A.P.¹⁷, organic and Fairtrade certification. These schemes require inspections and often analyses of produce and farming system.

GLOBALG.A.P. requires soil and water analyses and, when necessary, residue analysis of products. European retailers demand that imported products are compliant to GLOBALG.A.P standards (Interviews 32, 34, 126).

There was a fairly low share of smallholder farmers observed in this study whose farming complies with one of the mentioned quality standards. Among those small-scale farmers, only outgrowers whose produce is destined for exports complied with GLOBALG.A.P. Nonetheless, 20 other smallholder farmers are actively preparing for GLOBALG.A.P. certification in the hope of entering international markets (Interviews 22, 95, 97). "When farmers know that they will export their products, they undertake an extra step e.g. GLOBALG.A.P., organic, Fairtrade" (Interview 32). All large-scale export producers, on the other hand, cultivate at least under GLOBALG.A.P or organically.

¹⁷ GLOBALG.A.P. certification is an independent certification system that established responding to growing consumers' concerns on food safety, welfare and environmental health. The organization defines standards and conformity of a farming system and its products are audited (GLOBALGAP, 2015). GLOBALG.A.P. have four different certification schemes, out of which two were observed in Ghana (option 1 for individual farmers and option 2 for group certification).

For most of the smallholder farmers, high certification costs pose a big constraint and more often than not, farmers don't have access to cash or credits. There were attempts of organized smallholder farmers to produce organic products for the export market. However, they failed due to their inability to bear the costs (Interviews 27, 34). Also, the German development bank (KfW) aims at providing funds that include investments into quality tests and certification (Interview 58).

Additionally, GLOBALG.A.P. certification did not yield expected benefits for smallholders, as the market to absorb the produce after harvest was missing. The same interviewed expert perceives it as impossible for smallholders to financially carry out this certification regime without donor support (Interview 11). One way of reducing costs can be through joining a group certification program under GLOBALG.A.P. option 2 scheme (Will, 2010). However, mutual trust among farmers who comply with the requirements and those who don't is an issue. Additionally, acceptance of products under group certification by some European retailers, such as EDEKA, have been questioned as it is harder to control groups than having only one responsible farmer (Interview 130).

Even though certified products are destined for Europe, a certain quantity of pineapple always ends up on the domestic market. Pineapples that do not meet preferred shape or size or have multiple crowns, etc. are sold in Ghana together with other non-certified products (Interview 130). But then the export certification becomes useless and is an economic loss.

Certification utilization in brief

- Smallholders in the Volta region are currently not supplying markets that demand certification;
- A willingness of smallholders was observed to sell to high value markets that require certification;
- It is very difficult to undergo a strict certification program without external (financial) support;
- Around 40-50% fruits are rejected for export, which reduces attractiveness of investment in certification.

7.4 Cost benefit

7.4.1 Soil testing

Economic benefits through a soil analysis can materialize on the farm level in two ways. First, a soil analysis can identify the overapplication of fertilizers. Here, an economic benefit can be realized based on the reduction of input costs through subsequent reduced levels of fertilization. Secondly, if a soil analysis reveals underfertilization, an adopted improved fertilization can result in increased yields, which translate into an economic benefit if the yield increases surmount the costs of additional fertilizers.

Whether such benefits materialize has been assessed through case studies of three different farmers. All farmers are currently supplying to the local market. Two samples have been taken from the farm of Mr B, as one of his fields had been fertilized. Table 7 provides further details.

Farmer	District	Cultivated area	Experience in pineapple farming	Support through
Mr Y	Akatsi South	5 acres	3 years	District Agricultural Department
Mr S	Akatsi South	3 acres	9 years	District Agricultural Department
Mr B	Jassikan	2.4 acres	1 year	Catholic church

Source: own illustration

This case study is based on the soil testing guide that has been issued and promoted by GIZ. Calculations and recommendations follow the advice of this document, which has been designed for farmers and extension agents.

This cost-benefit analysis follows the following steps:

1. General interpretation of soil testing results;
2. Comparison of current and recommended nutrient application;
3. Two scenarios of adjusted fertilizer applications based on test results;
4. Overfertilization: Cost saving potential through detection of overfertilization;
5. Underfertilization: Calculation of required yields to cover costs of improved fertilization.

1. General interpretation of soil testing results

The four analyzed samples from the districts of Jasikan (Northern Volta region) and Akatsi South (Southern Volta region) showed that the soils differ in fertility, depending from which specific part of the Volta region the sample is taken (Table 8). Soil acidity showed an adequate range for growing pineapple in both regions, although at the upper limit for the recommended conditions for pineapple (FAO, 2015). The samples in Jasikan district revealed relatively fertile soils with adequate values of organic C, N and Mg, but very low amounts of K and Ca. Levels of phosphorus were high in one field site. In the samples taken in Akatsi district, on the other hand, all values of macro and micronutrients, apart from Mg, were low. Detailed results for all tested parameters can be found in annex 8.

Location	Last fertilization	pH	Extractable Bases			Total	Available
			Ca	Mg	K	N	P
			cmol / kg			%	mg/kg
Akatsi: Mr Y	Unfertilized	6.4	2.66	0.77	0.08	0.06	2.41
Akatsi: Mr S	Unfertilized	6.3	0.31	0.11	0.03	0.04	1.88
Jasikan: Mr B (1)	Unfertilized	6.0	2.12	0.89	0.23	0.1	23.22
Jasikan: Mr B (2)	July 2014	5.8	1.81	0.78	0.28	0.15	32.38

Colours indicate the nutrient levels based on the GIZ soil guide: High Adequate Low

Source: own illustration

2. Comparison of current and recommended nutrient application

In a second step, the required amounts of nutrients that need to be added to replace nutrient removal through the harvesting of crops were calculated. If the amount of nutrients measured in the soil are too high or too low, the soil testing guide recommends an adjustment of the amounts of nutrients to be added through a multiplication factor in order to adjust the fertilization according to the soil characteristics. The results of this calculation are depicted in Table 9.

Farmer	Area (acre)	Recommended fertilizer application per growing cycle (kg/acre)			Currently applied fertilization per growing cycle (kg/acre)			Current cost of fertilization (GHS/acre)
		N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	
Mr Y	5	120	20	300	31.5	13.1	0	376.25
Mr S	3	120	30	300	38.25	22.5	0	502.5
Mr B (1)	2.4	120	20	300	57	15	0	620
Mr B (2)	2.4	120	10	300	57	15	0	620
		Underfertilization >50% of recommendation		Underfertilization >25% of recommendation		Underfertilization <25% below recommendation		Overfertilization
Source: own illustration								

Table 9 reveals that none of the farmers sampled are currently applying the recommended amounts of nutrients. Nitrogen fertilization did not even cover half of the recommended amounts of fertilizer in all cases. Phosphorus fertilization was also insufficient in most cases and did not cover the nutrient removal of the pineapples. However, one soil sample revealed high phosphorus levels in the soil, so that phosphorus seems to be overfertilized. The biggest gap between the recommended levels of fertilization and applied fertilization is observed for potassium, where no fertilizer is applied at all.

3. Two scenarios of adjusted fertilizer applications based on test results

Based on the nutrients that need to be replaced and the nutrient contents of different types of fertilizers, fertilizer recommendations can be made in a next step. Due to the fact that not all types of suggested fertilizers for pineapple farming are available on the Ghanaian market, only fertilizers that were at least available at fertilizer retailers in Accra have been taken into consideration. Prices have been extrapolated from the retailers' prices to obtain realistic price levels at shops in Ho in case these fertilizers were currently not available there.

Two scenarios of potential fertilizer recommendations have been developed. The first scenario is based on the recommendations in the soil testing guide and aims to replace all required levels of N, P and K. As it was found that the cost of potassium nitrate to replace K increases the total cost of fertilization excessively,

a second scenario that applies NPK (15-15-15) and allows for a lack of K_2O replenishment has been developed. It takes into account empirical evidence that shows that yield increases have been mainly associated with the availability of nitrogen, and to a lesser extent with K_2O in Smooth Cayenne cultivation on tropical soils (Obiefuna, 1987; Spironello et al., 2004). Table 10 reveals the costs of fertilization in the different scenarios. Based on the similar soil conditions, the same fertilization is recommended for Mr Y and Mr S. A table describing quantities and types of fertilizers can be found in annex 9.

Scenario	Farmer	Cost of fertilization (GHS per acre)
S ₁	Mr Y / Mr S	5168.22
S ₂	Mr Y / Mr S	960
S ₁	Mr B (1)	5092.15
S ₂	Mr B (1)	853.33
S ₁	Mr B (2)	5016.08
S ₂	Mr B (2)	746.64

Source: own illustration

4. Overfertilization: Cost saving potential through reduced input costs

As mentioned earlier, an economic benefit through a soil analysis can evolve either through the detection of overfertilization or through yield increases based on an improved fertilization that was triggered through a soil analysis.

To detect differences in soil characteristics, expenditures are necessary; the present soil analysis that quantified levels of six macronutrient, pH, soil texture and two heavy metals cost 130 GHS per sample. A soil test at the Soil Research Institution in Kumasi to determine pH and the macronutrients N, P and K would have cost 40 GHS.

Overfertilization has only been detected in one fertilizer component in one of the four cases: Mr B overfertilized 5kg of P_2O_5 per acre. This result is interesting as it suggested a slightly different fertilization on adjacent fields. Two options for adjustment shall be depicted here:

a) When hypothetically optimizing the allocation of his current fertilizer budget of 620 GHS between NPK and Ammonium sulphate fertilizers according to the results of the soil test, the loss of required nitrogen could be reduced from 68 kg to 59.18 kg. However, this adjustment would also go ahead with a 5 kg reduction in K_2O fertilization.

b) When fertilizing N and P_2O_5 according to the suggested levels with the fertilizers that are currently in use by the farmer and allowing for a reduction of K_2O fertilization of 5kg, input costs could be reduced by 35.36 GHS per acre. If the results of the soil test are assumed to be representative for the 2.4 acres of the farmer, the farmer could realize a net benefit of 44.86 GHS if the soil test and its interpretation would have cost him 40 GHS.

For the other three soil samples, the soil analysis did not point to overfertilization and could therefore not have realized an economic benefit for farmers in this way. Further calculations are therefore made in step five to assess potential economic benefits by increased levels of fertilization.

However, it can already be concluded that farm management practices need to be adopted to potentially realize an economic benefit of the soil test. As the most basic soil test costs between 6.5 and 10.5 percent of the fertilizer input costs under consideration, this ratio seems currently unfavourable to incentivize the use of this QI-service. If input costs are increasing, the ratio of costs for soil tests and fertilizers becomes more favourable with regards to the use the particular QI-service.

5. Underfertilization: Calculation of required yields to cover costs of improved fertilization

As shown in Table 10 in step three, all suggested adoptions would increase the costs of fertilization as the current application rates do not provide sufficient nutrients. When fertilization is adopted according to the guidelines of the soil testing guide and the taking into account the availability of fertilizers in the market, a complete replenishment of the soil (S_1) would increase the cost of fertilization between 821 and 1870 percent. An alternative adoption that neglects the nutrient replenishment of K_2O increases costs between 137 and 255 percent. To evaluate the benefit of this increase in input costs against the increase in revenues through higher yields, field trials would need to be conducted.

This fifth step of the analysis therefore calculates the required increases in yields to cover the additional input costs at current market prices.

Table 11: Subsequent costs of soil analysis	
Cost of soil analysis	40 GHS
Increased cost of fertilization per acre	
Mr Y	583.75 GHS
Mr S	505 GHS
Mr B (1)	233.33 GHS
Mr B (2)	126.64 GHS
Source: own illustration	

Taking into consideration the most favourable costs of soil analysis and adopted fertilization, the QI utilization would result in an average cost of 480.70 GHS per farmer. Table 11 shows the costs that would need to be covered through yield increases.

The required yield increases have been calculated based on the current prices that can be obtained by the farmers in the market. It is assumed that the planting density remains constant. If sales would occur per kg, the observed market price of 0.6 GHS / kg has been applied for the calculations in Table 12. For the calculation of the required numbers of fruits in increased size, the average price difference between three size categories has been applied. A detailed calculation can be found in annex 10.

Table 12: Required yield increases to cover analysis and fertilization cost				
Farmer	Y	S	B (1)	B (2)
Required increase in revenue (GHS)	623.75	545	273.33	166.64
Required number of fruits of increased size	3118.75	641.17	1656.54	1009.93
Required increase in yield per fruit if sold by kg	0.047	0.041	0.021	0.012
Source: own illustration				

The calculation in the table above of required yield increases shows that the applied pricing structure has a high impact on the amounts of fruits that would need to increase in size. The increases in yields – both when sold per piece and per weight – seem to be attainable.

Three main conclusions can be drawn based on this case study:

1. Currently, levels of fertilization are too low to detect high amounts of fertilizers that have been overapplied. Cost saving potentials through soil tests are therefore low.
2. To reach economic benefits from soil tests, fertilization needs to be adopted according to the result.
3. The adoption of fertilization according to the soil testing guide faces the constraints of availability of straight fertilizers, high costs of specific fertilizers and financial constraints of smallholders.

7.4.2 Utilization of weighing scales

As outlined in Chapter.7.3.2, both the sale per unit and per weight has been observed in the pineapple value chain on smallholder levels. This case study therefore aims at comparing the economic aspects of the use of scales in transactions on smallholder level from the perspective of the farmer and the trader.

The farmer's perspective

If prices were paid per piece, it has been observed that prices are either tiered based on the size of the fruits or paid independently of fruit sizes. The prices within the stepped pricing structure varied among farmers studied by this research. Where price agreements have been made based on an average price or per kilogram, it appeared here that 0.7 GHS are paid per piece and 12 GHS per 20kg (~0.6 GHS / kg).

Assuming the common fruit density of 22'000 fruits per acre, a comparison between the kilo- and piece-based pricing structures was made. It shows that the use of weighing scales becomes more profitable to the producer than selling at 0.7 GHS per piece, if his average fruit weight exceeds 1.16 kg/piece. Under these conditions, revenue of 15,400 GHS can be achieved per acre (Figure 16). A sale according to equation (3) provides farmers with a revenue of 18'695 GHS per acre, independently of the average fruit weight. The same amount of revenue can be realized through a sale per kg if average fruit sizes exceed 1.42 kg.

(1)	$R = 0.7 \text{ GHS} \times 22000$	(price per piece)
(2)	$R = 0.6 \times W_p$	(price per kg)
(3) ¹⁸	$R = 2500 \times 1.1 \text{ GHS} + 16500 \times 0.83 \text{ GHS} + 3000 \times 0.75 \text{ GHS}$	(tiered pricing)

R = Revenue ; W_p = Average pineapple weight



Figure 16: Revenues of different price structures according to equations (1) and (2)

Source: own illustration

The cost of equipment that is required to sell per kg includes the purchase of a weighing scale (this research project found prices down to GHS25), a crate to place the fruits (estimated at GHS10) and a structure to hang a scale (estimated at GHS50). Furthermore, a scale needs to be calibrated regularly. Although none of the interviewed farmers calibrated their scales, annual costs of 30 GHS for calibration are included in this calculation.

Table 13 depicts the annual costs and benefits of an emerging smallholder farmer in the Volta region (Figure 17) that cultivates 5 acres of pineapple and is currently selling her pineapple at 12GHS per 20kg crate. The farmer is cultivating

¹⁸ The prices for the different price categories are based on the average price mentioned for the categories big / middle / small. Due to the fact that different geographical locations have been mixed, it might therefore not represent an accurate pricing structure.

24,000 fruits per acre and is currently only producing for the local market. The calculation assumes an average fruit weight of 1.4 kg and 22,000 fruits per acre.

At current market prices, the farmer would achieve a net benefit of GHS3297.5 through the utilization of QI. The net income at the point of research nearly two years before this research through pineapple farming has been assessed by Zottergloh (2014) and amounted to 3560 GHS per acre. However, given annual inflation of 15 percent, the growing prizes need to be considered. It can thus be estimated that the additional revenue through the utilization of weighing scales accounts for about 16 percent of the net income of the pineapple farmer.



Figure 17: Smallholder using a weighing scale

Photo: T. Pfeiffer

Table 13: Annual costs and benefits, in GHS

Costs		Benefits	
Scale (2 year linear depreciation)	12.5	Additional revenue as compared to sales per piece ¹⁹	3,360
Crate (2 year linear depreciation)	5		
Structure (2 years depreciation)	25		
Calibration of Scale	30		
TOTAL costs	62.5	TOTAL benefits	3,360
Balance: 3297.5			
Source: own illustration			

¹⁹ Equation (2) with 24,000 fruits – Equation (1) = Additional revenue

The trader's perspective

Interviewed traders that sell to customers on the market in Hohoe purchase their produce in kilogram, but sell to their customers per piece. Table 14 illustrates the observed pricing structure and deducted margins for the trader.

Fruit weight	Market price per piece (GHS)	Farm gate price per piece	Traders' margin by sale per piece	Hypothetical margin sale by kg (30% mark-up)
0.9	1	0.54	0.46	0.702
1.0	1	0.6	0.4	0.78
1.1	1	0.66	0.34	0.858
1.2	1	0.72	0.28	0.936
1.3	2	0.78	1.22	1.014
1.4	2	0.84	1.16	1.092
1.5	2	0.90	1.1	1.17
1.6	2	0.96	1.04	1.248
1.7	3	1.02	1.98	1.326
1.8	3	1.08	1.92	1.404
1.9	3	1.14	1.86	1.482
2.0	4	1.2	2.8	1.56
2.1	4	1.26	2.74	1.638
2.2	4	1.32	2.68	1.716

Source: own illustration

When applying a linear extrapolation to the margins, it appears that selling fruits by piece is more profitable to the traders if the average fruit weight starts to exceed 1.37 kg.

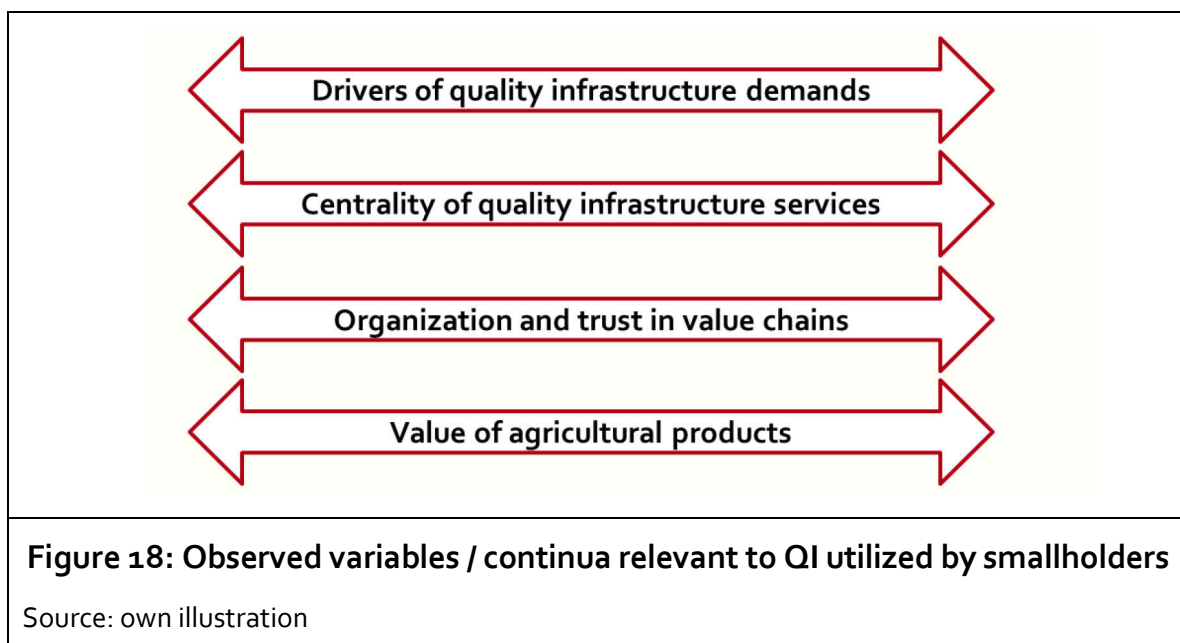
This case study shows that the utilization of weighing scales is incentivized through the applied pricing structures in the value chains. Traders and farmers are currently facing different economic incentives towards the application of a unified and objective measuring system to determine prices

8 General discussion

The preceding chapters provided evidence on the conditions and obstacles that smallholder farmers face in their decision to utilize QI services. It has been observed that services along the value chains relating to the concept of QI can support smallholders on different levels. These services have certain relevance at the level of input supply, production, post-harvest handling and trade of agricultural produce no matter what the smallholder's farm size is. The applied Knowledge-Attitude-Practice approach has been found useful for conceptualizing different levels of decision-making towards the utilization of QI during the design of the questionnaire.

The structure of this chapter does not reflect the KAP approach, as it has been found that knowledge and attitude only partially explain the farmer's practices. Beyond knowledge and attitudes, the degree of relevance of QI services and their potential benefit for smallholder farmers is also dependent on a range of variables outside the farmer's decisions and practices.

By discussing findings of both VCs together, this chapter aims to outline common factors relevant to an assessment of QI for smallholder farmers in other contexts. Four observed variables, or continua, in which QI for smallholder farmers operate are outlined below (Figure 18). The role of development cooperation is discussed afterwards.



8.1 Drivers of quality infrastructure demands

Should farmers be forced to follow standards and quality requirements or should they be convinced to provide high quality voluntarily? This question arose from several interviews with regards to the observation of low QI utilization. There is a general belief among interviewees that if consumers and farmers were aware of quality problems, there would be a demand for quality assurance, and, as a consequence, more quality infrastructure would be required. However, awareness does not seem to suffice in all cases: well-informed farmers were found who still continued selling moldy maize. This study concludes that knowledge that generates a sense of responsibility must still be complemented with obligatory measures.

With regard to smallholders in agricultural value chains, the first variable that affects the degree of QI utilization by smallholders is the driving force for QI services. In this regard, objectives of QI utilization can vary between addressing issues of food safety, on the one hand, to meeting customers' quality demands that are not necessarily related to public health.

In the context of the alarming levels of aflatoxin contamination in the local market, legally binding quality demands can provide QI institutions and other stakeholders in the maize VC with the opportunity to promote QI to contribute to national food safety. Increased levels of legally rooted quality demands might also be expected to emerge in other VCs. When considering decisions of the Ghanaian government to enforce requirements for export certification and the recent ban of exports of various vegetables to the EU, legally binding quality requirements can also induce more QI utilization in this sector in the future. However, such legally binding quality requirements might not be effective given the particularities of certain markets. While the reputation of Ghanaian agricultural exports could potentially be promoted through strict quality controls, the effective regulation of a highly decentralized and informal national maize market will face several implementation barriers. Given these challenges, the role of the consumer has to be underlined. Beyond that, many domestic informal markets in small communities allow bypassing legally binding quality requirements. They would also be practically impossible to police and enforce.

In the national market, defined quality demands by VC actors and consumers are generally on a low level in Ghana. The study, for example, observed maize buyers that seem to purchase maize from the same source that previously supplied them with moldy maize (Interview 53). On the other hand, there seem to be some VC actors that show awareness towards quality related problems, such as

small processing companies that exclude farmers from their list of suppliers if they supplied maize that was affected by aflatoxins (Interview 76). Technical regulations and public health legislation should go hand in hand with measures to increase consumer awareness. In light of the seemingly alarming scope of aflatoxin contamination in maize, measures to increase consumer demand for aflatoxin-free products are only a necessary first step in tackling the problem. Awareness-raising among consumers needs to be accompanied by QI that addresses the problem on various aggregation levels in the VC. A regulation of the informal market could trigger QI utilization.

In the pineapple VC, international consumer driven quality demands induce testing and certification requirements that impose entry barriers for smallholders into high-value markets. High investment costs for pineapple production, fierce competition from other international suppliers, and the lack of opportunities to develop outgrower schemes all inhibit smallholders from participating in higher value markets. Nonetheless, customer quality demands will be central in changing smallholder practices to improve quality. Legally binding regulations, such as maximum residue levels, originate in consumers' demands. On the national market, however, quality demands are currently constraining QI utilization by smallholders, since so few quality criteria are demanded. In the future, the Green Label certification scheme and organic niche markets might increase the necessity of QI services for quality assessment. This will depend on both consumer demand and willingness to pay for certified and/or organic pineapple.

The implications of increasing quality demands through consumers or regulation authorities need to be assessed with regards to smallholders' ability to meet them. If already outlined quality criteria cannot be fulfilled by smallholders, further increasing and enforcing them can lead to the exclusion of small producers. Here, political will is needed to ensure that QI services are accessible and standards and regulations applicable to smallholders. The participation of producers in decision-making processes regarding both the operationalization of quality demands and their enforcement are important.

In addition to QI utilization that is triggered by legislation or quality requirements by consumers and other VC actors, the motivation of smallholder farmers themselves needs to be considered. Soil tests, for example, may neither be required by law, nor by consumers or processors. Still, smallholder farmers can have an interest in utilizing QI to know the status of their soils and subsequently increase productivity. Also, increasing the sense of responsibility for food safety at the smallholder level could create an intrinsic motivation for more QI utilization. In

the past, the MoFA was already successful in increasing environmental responsibility through radio announcements on the consequences of slash-and-burn practices.

In conclusion, the analysis of this study shows that there are different rationales for promoting QI in the different contexts of agricultural value chains. The set of technical regulations or standards relevant to the commodity and target markets is a major parameter influencing the role that QI services play for smallholders. Additionally, all measures that promote quality on a voluntary basis don't require enforcement and are cheaper. Food safety and the involved QI should be promoted using a concerted approach that incorporates both consumer driven demands and legally binding regulations to improve quality of pineapple and maize products. This coexistence of approaches requires well-coordinated efforts of different institutions at different levels. The design of the national QI and its ability to reach out to rural areas and coordinate will therefore be discussed in the following chapter.

8.2 Centrality of quality infrastructure services

A second continuum emerges when looking at the geographical distribution of QI services that are offered across a country. Within a system of QI for smallholder farmers, QI services and service providers differ in their level of decentralized service provision. A decentralized utilization of weighing scales or pH strips at the farm level is, for example, distinct from the testing of pesticide residues in a laboratory in the capital.

The centrality of QI services is not only dependent on the characteristics of the QI service offered, but also on the geographical setup of national QI institutions. Here, as described in Chapter 5, a strong focus of national QI institutions and testing facilities in the capital Accra has been observed. This is partly unavoidable, since laboratories require infrastructure, trained staff and a certain number of clients and samples for operations to be economically viable.

The low level of activity at the regional offices of national QI institutions in the agricultural sector point to the need to increase attention towards QI service provision at the regional and – where appropriate – district level. A decentralization of QI structures needs to be accompanied by sufficient financial and human resources. Shortfalls of a decentralization process that has been observed in the MoFA (Chapter 5) have to be avoided. Regional QI institutions should have incen-

tives to perceive smallholder farmers as their target groups to avoid neglect of the agricultural sector.

The decentralization of QISP and related institutions can increase their ability to disseminate QI related information and practices in rural areas. Pictorials of standards or radio shows could in this way be promoted more effectively. A decentralized QI service provision might not only increase the dissemination of QI services and their utilization by smallholder farmers. It can also contribute to facilitating a process in which QI institutions better adapt their services to the needs of smallholder farmers based on an improved understanding of their situation. Here, an increased integration of smallholder practices and needs into standards for agricultural products is especially desirable to increase outreach to these farmers.

It is important to reiterate that decentralization does not mean countrywide. Running costs of laboratories are high and today's laboratories already face difficulties in obtaining a sufficient number of customers to offer their services in an economically sustainable way. However, serving particular target groups, including for maize in Brong-Ahafo and for fruits, including pineapple, in the Eastern or Central region would allow a targeted and yet effective approach. This research names such QISP concentrations close to farmers "rural QI hubs". QI service providers for smallholders need to take into consideration their economic capacities and adopt their pricing structures accordingly.

Despite the availability of some QI services outside the capital, the poor interaction and coordination of QI institutions with relevant authorities in the agricultural sector is currently further limiting the role that QI could play for smallholder farmers. Such interaction is necessary to compensate for certain levels of centralization within QI institutions. Improved interaction between the GSA, FDA, MoFA and District Assemblies could contribute to the promotion of standards and implementation of technical regulations at the local level. An exchange between QI institutions and stakeholders relevant to smallholder farmers is also crucial to ensure that QI helps address the needs of smallholder farmers. Agricultural extension workers should play a crucial role here and contribute to the dissemination and sensitization of smallholders regarding QI. These field workers currently represent the most effective way to reach out to smallholder farmers, given the centralized structure of national QI.

On higher levels too, the GSA, FDA and PPRSD and their superior ministries, the MoTI, MoH and MoFA, would achieve more through greater coordination and cooperation. The current lack of leadership within the management of aflatoxin, for example, has led to incoherent activities in the past. Initiatives like the aflatox-

in task force headed by the MoTI or workshops conducted on the behalf of the MoFA have failed their aims in recent years and did not generate observable aflatoxin awareness among all value chain stakeholders. Coordination and cooperation is especially relevant if efforts towards a farm-to-fork approach to food safety are to be implemented effectively and if yet unregulated informal markets are to be covered. The laboratory network established by PTB and the recent initiative by Partnership for Aflatoxin Control in Africa (PACA), provide good examples of how an improved coordination and cooperation could be initiated.

Coordination is also important beyond state institutions and currently available QISP. To achieve the objective of a QI service provision that is more applicable and accessible to smallholder farmers, potential QISPs have to be integrated in the national structures that are already supporting smallholder farmers, such as the Agricultural Departments at the district level. The inclusion of private sector actors, such as input providers and small-scale enterprises, into a decentralized system of QI service provision can facilitate the process of decentralizing QI services for smallholders' benefit. Especially when looking at decentralized measurement and testing services such as moisture meters or refractometers that are currently too expensive for smallholders to purchase, these private sector actors could play an important role. Also when considering testing services, e.g. for aflatoxin, these actors or markets and warehouses are strategic (both thematic and institutional) entry points.

The study concludes that, on the one hand, a range of QI services can be useful for smallholders, but at present they are offered far from the location where farmers need them. On the other hand, labs too thinly spread do not encounter sufficient workload to operate economically. A compromise between the two opposed requirements could involve the installation of specific QI services in select locations. Additionally, cooperation and coordination are needed to the reduce consequences arising from this trade off.

8.3 Organization and trust in value chains

A third continuum that proved to be of relevance for the utilization of various QI services is the degree of organization among smallholders in the value chains. QI is thus operating in a continuum of value chains that range from fragmented to highly organized chains. Organizational structures in value chains can reduce entry barriers for QI utilization.

Furthermore, a relationship between trust among VC actors and the role that QI plays – or could play in the future – has been observed in this study. First, QI utilization could reduce disagreements and mutual mistrust through objective measurements and definition of quality characteristics. Second – in contrast – more powerful parties could utilize testing services that are not applied correctly or do not use calibrated instruments in the trade of agricultural products to cheat and exacerbate already existing mistrust. To reduce this risk, the utilization of QI has to go hand in hand with an understanding of the purpose, measurement units and their interpretation, and the credibility of quality assessment of all parties involved. As suggested by the KAP approach, knowledge and awareness are therefore key. Third, QI utilization can also be impeded by high levels of trust between VC actors, as trade partners rely on their partners in supplying good quality products and do not perceive a need to control the quality of products through QI.

Trust has not only to be established between VC actors, but also between these actors and the national QI. A high service quality, a wide scope of testing and credibility of national QI institutions are key elements in establishing relationships between VC and QI service providers. Confidence into the QI of developing countries from international buyers is important to further develop services offered by a national QI and create the basis for sustainable operations of QI service providers.

A variety of institutional structures in the analyzed VCs can facilitate both the levels of organization and trust that are required for an increased QI utilization by smallholders. Producer and trader associations, as well as VC committees, play a key role here. Given that such structures in the VC have often faced difficulties in maintaining their institutional sustainability, due attention should be paid towards the establishment of such institutions. Experiences from the Ghanaian mango VC show that such efforts pay off in the long run (Osei, 2007). Improved coordination between VC actors is also important to ensure producers that investments in quality and its demonstration will pay off. They can furthermore facilitate the exchange of quality demands articulated from traders, processors, and consumers towards smallholder farmers. Furthermore, the vertical integration of smallholders through a committed private sector has been observed to lead to an increased utilization of QI in the maize and pineapple VCs. Firms governing VCs are key stakeholders to facilitate QI utilization at the production level.

Next to these organizational structures within the VCs, the role of public institutions also needs to be considered. Ghana has been successful in maintaining its role as one of the world's leading producers of high quality cocoa over decades

(Baffes, Larson, Varangis, 2001; Larsen, Kim, Theus, 2009). During this time, the national cocoa board COCOBOD maintained its role as a strong facilitator in the VC and runs an extensive quality control system (Laven, Boomsma, 2012). The national Producer Price Review Committee (PPRC) recommended in 2011/12 that 77 percent of the net FOB cocoa price be paid to the producer, while 1.5 percent is dedicated for grading and quality control (Kolavalli et al., 2012). The Ghanaian cocoa sector thus exemplifies that the country can export high quality agricultural products if entire sectors and related public institutions commit to quality production and control. This commitment towards quality production as a main goal of all VC actors has been argued to be crucial by various interviewees. Consequently, lead firms and private sector value chain actors committed to working with small-scale farmers are an important group of actors to address when considering trust and organization. Managers in firms with the right attitude towards QI might therefore play a key role its promotion.

8.4 Value of agricultural production

It can be concluded from observations in the maize and pineapple VCs that the value of an agricultural product influences the degree of QI utilization. As the value of a commodity grows, so, too, does the probability that QI services will be used. Contributing to the value of production are the value of the crop, the market channel and land size.

Concerning the value of the crop, a distinction between staple and cash crops should be made. Necessary investments into QI by smallholders need to be seen in relation to other costs and revenues. Both the input costs and the revenues from pineapple far exceed those for maize. While gross income from one acre of pineapple has been shown to amount up to 2000 GHS per acre in the Volta region, an acre of maize creates a gross income of about 200 GHS in the Brong-Ahafo region. High quality awareness and QI utilization in the cocoa VC as outlined above, supports this argument.

When looking at different market channels, this argumentation can be extended to variations within VCs. As QI utilization has been observed to increase with the value that products can achieve in certain markets, e.g. the domestic fresh cut versus the international pineapple market, it appears that the utilization of QI is partly triggered by the economic value that agricultural products achieve in these markets. As outlined in Chapter 8.1, the willingness of consumers to pay for a certain product quality plays a crucial role here. At the moment, the utiliza-

tion of a variety of QI services seems currently to be viable at the level of small-scale processors or warehouses.

8.5 Development cooperation and quality infrastructure for smallholders

The Ghanaian QI system has received support from various donors and development cooperation agencies in the past. Such interventions have, in some cases, been embedded in programs relating to issues beyond QI. Some interventions focused on specific VCs, while others had a clear focus on export markets. This research gained the insight that many non-QI challenges are more important to smallholders than the simple accessibility to QI services. Hence, this study concludes that effective QI interventions require cooperation with other agricultural projects in rural areas. Embedding projects that address QI-specific challenges of smallholders into programs that also address underlying issues in input provision, production, post-harvest handling, trade, and processing is therefore crucial.

Coordination of international development cooperation actors is especially relevant in QI-specific interventions on the national and regional levels. It has been shown that a network of QI institutions needs to grow according to the demand for QI services. Support to centralized laboratories with capacities exceeding the actual national demands may exacerbate a situation of unsustainable competition between QI providers. A clear division of labor between donors has to be negotiated with the Ghanaian authorities.

Outside the national QI, the regional context of QI promotion should be considered: cross-border trade has been observed for both maize and pineapple in the study areas. While there is evidence that the trade by kg is much more common in French-speaking neighboring countries of Ghana, trade in different measurements seems to be more common in the studied VCs. QI measures and interventions should therefore also include Ghana's neighboring countries in West Africa. The West African Agricultural Productivity Program is a good example, as it aims at harmonizing standards across the region.

The aflatoxin problem and increasing numbers of rejections of Ghanaian agricultural products at the European borders reiterates the need to focus not only on increasing production volumes, but also on the quality of products and the related QI. The economic situation of smallholders provides a justification for development cooperation to engage in facilitating smallholders' integration in an increasingly commercialized and competitive agricultural sector. The ability of small-

holders to meet legal and market driven quality requirements is inevitable for this integration. To support this process, the interface of smallholder agriculture and QI has been found to be relevant on various levels. Case studies also provided evidence on the potential economic benefit of QI utilization among smallholders and small-scale processors. Availability and accessibility of relevant QI services and quality awareness of VC actors from consumer to producer are necessary to assure quality of Ghanaian agricultural products in the domestic market and internationally.

9 Recommendations

Following the discussion in Chapter 8, this recommendations chapter is structured for the various user groups of this research project in 1) maize, 2) pineapple and 3) general recommendations.

9.1 Commodity specific recommendations

9.1.1 Maize value chain

- The topic of aflatoxin in maize products should be treated as a national priority. As QI is relevant to tackling aflatoxin, the problem can be beneficial as a thematic entry point to demonstrate its usefulness and enhance its utilization along the VC:
 - At the policy level, stakeholders including the GSA, FDA and MoFA should focus on the topic.
 - In addition, a public campaign to raise awareness of aflatoxin among consumers, traders and processors should be initiated.
- To effectively tackle quality issues and familiarize smallholders with QI, its use should be facilitated first on the level of small-scale entrepreneurs, traders and warehouses. Ways to operationalize this recommendation are described in Annex 11.
- Trainings for farmers on good agricultural practices should include QI relevant topics. Trainings should raise awareness of the opportunities that the national QI and its service providers hold for smallholders, with a specific focus on local and regional areas.
- Promotion of QI must be complemented by interventions to improve post-harvest infrastructure. Improving drying and storage facilities, as well as the quality of feeder roads, is a necessary precondition to tackle the problem of aflatoxin. This would necessitate QI use, more specifically moisture meters that verify the maize moisture content.
- Improved and increased systematic data collection on aflatoxin and moisture levels of maize and maize products should be conducted to facilitate awareness creation. Such a database would serve as a basis for argumentation for the relevance of QI, as well as the identification of the most problematic areas. Annex 12 suggests one way to operationalize this recommendation.

- The introduction of weighing scales for smallholders should be accompanied by moisture meters, since weight depends on moisture content.

9.1.2 Pineapple value chain

- Agricultural colleges should be promoted as QI service providers for soil testing closer to farmers than the capital based labs. This could be promoted by encouraging the colleges' use of services and attractive pricing for students. In practice, students analyze soil samples of smallholders at the agricultural colleges as part of their training.
- To increase the availability of forward placed soil testing services, input dealers should be engaged as service providers. They would provide assistance in linking farmers to soil labs; offer simple soil toolkits; and consult farmers according to test results. Annex 13 shows one possible way how input dealers would facilitate soil testing before selling fertilizers based on the soil quality.
- In order to increase incentives for adequate and environmentally adapted fertilization, the shifting of fertilizer subsidies to soil testing subsidies should be considered. In this way, a shift from blanket to site-specific fertilizer recommendations would be enabled and overfertilization could be avoided. Framework conditions should facilitate the availability of required fertilizers so that users of soil tests can adopt their farm management according to the results.
- Awareness of the various benefits of selling pineapple by kg to traders should be increased through the extension system and role model farmers. Sensitization for the use of scales could also be based on the argument that the use of scales is necessary to know the exact nutrient removal from the soil. This recommendation can form a synergy with the recommendation, encouraging the soils analysis.
- Certification that is currently only relevant for higher value markets should be made economically valuable for the domestic market. This would reduce the risk of the investment into expensive certification, because pineapple producers can sell on the domestic market more profitably, even if access to international markets is constrained. The establishment of national certification schemes, such as the Green Label scheme – observed at GIZ – should therefore be linked to existing export certification schemes for pineapple. At the same time, consumer awareness for pineapple quality, including organic production, should be mobilized in the domestic market to incentivize certification and QI utilization in general.

- In order to include smallholders and to engage them in promising pineapple production, costs for certification and testing should not increase the already high investment costs involved in pineapple cultivation. Opportunities for financing certifications for the domestic and international market should be assessed through a complementary study that takes into account financing options through smallholders, consumers, the reduction of certification costs, development cooperation and national authorities.

9.2 General recommendations

9.2.1 PTB

- Interventions to increase QI utilization by smallholders should be linked to projects that address underlying non-QI obstacles, such as drying facilities. Here, enhancing exchange and collaboration with other German and European development cooperation agencies is recommended. Together with the Ghanaian authorities, the EU and the German Embassy, PTB could facilitate this process of coordination.
- As an increased utilization of QI by smallholders in selected value chains also requires structural and behaviour changes along the value chains, the longer durations of interventions in value chains are, the more effective and sustainable they become, as observations in the field confirmed. Given PTB's engagement of many projects over nearly a decade, the study recommends continuing planning and implementing even longer projects exceeding a minimum timeframe of two years.
- Measures to promote QI on smallholder level should take into consideration the role of key VC actors governing the chain as levers to induce QI utilization by smallholders. Considering the most promising levers, it is recommended to implement projects in close collaboration with small-scale enterprises or producers and processor associations as a means to efficiently reach smallholder farmers.
- Project planning to increase QI utilization in agricultural value chains should take into account both producer- and consumer-driven approaches to create incentives for QI utilization. Complementary approaches addressing QI related problems from the perspective of food safety related regulations and market driven consumer demands should be pursued.

9.2.2 QI institutions in Ghana

- Capacities of quality infrastructure service providers (FDA, GSA) and potential QI service providers (e.g. universities, colleges) should be strengthened in the regions, in order to increase the outreach of the national QI to rural farmers. Such “rural QI hubs” would require more qualified staff, vehicles and office equipment. Laboratory capacities should be strengthened in the regions, or accelerated in their timely delivery of results according to regional needs and demands.
- Cooperation among QISP as well as between QISP and MoFA/local government are necessary to increase outreach and effectiveness of interventions in rural areas. Pilot activities and cooperation between QI service providers and agricultural institutions could provide examples for fruitful cooperation. They should be focused on specific areas and target specific agricultural VCs.
- QI service utilization should be promoted through dynamic / customer specific pricing structures based on farm sizes in order to make testing services attractive for smallholders.
- QI services should also be offered with the objective to sensitize smallholders for the potential and importance of testing and QI’s role for product quality. Awareness about the benefits of testing services in production, trade and consumer safety could be created in this way. In the long run, this awareness can increase the customer base of QISPs.
- The utilization of standards by smallholders should be increased by ensuring availability, access and relevance of standards to smallholders’ farming systems and transactions.
- Dialogue between smallholder farmers, QI institutions and consumers should be strengthened so that technical regulations, standards and certification schemes become more relevant and take into account opportunities and challenges of smallholder farmers and the national QI. Multi-stakeholder platforms, such as the Customer Forum initiated by the laboratory network, are a good example.
- Due attention should be paid to the risk that powerful VC actors misuse QI services opportunistically against smallholder farmers. Calibration and awareness raising for the interpretation of measurements is therefore required.
- Increase national testing service capacity (with sufficient scope and speed), in order to compete with international laboratory services testing Ghanaian products abroad. However, duplication of laboratory services and overcapaci-

ties have to be avoided. Together with Ghanaian labs enhancing their capacity, confidence among international buyers in Ghanaian national QI should be promoted aiming for more QI use in country.

- Agricultural extension officers work directly with farmers and can close the present gap between the national quality infrastructure institutions and the rural farming population. The extension officers should therefore be trained on market demands, quality assurance and the national QI potentials for smallholders. The functionality of the extension system needs to be guaranteed by local, regional and national government. A suggested approach for the operationalization of this recommendation can be found in Annex 14.

9.2.3 Other stakeholders

- Donors and implementing agencies should align their activities in order to support a network of QI institutions, particularly in rural areas, that grows according to the demand for QI services. Such coordination should go hand in hand with a facilitation of an improved coordination of national QI institutions. Development partners external to the national QI system can monitor and create opportunities for dialogue and coordination in a fragmented landscape of the national QI in Ghana.
- As GIZ is already doing, the organization of smallholders and VC actors should be supported continuously in order to create sustainable entry points for QI promotion and QI related interventions.
- QI Projects initiated by national actors deserve higher priority for support, given their degree of ownership and the greater potential for sustainability. An example would be investing in an unfurnished laboratory building in Dormaa Ahenkro town, Brong-Ahafo region. This recommendation is further described in Annex 15.

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Annexes

Annex 1: Interview reference list

Inter-view Number	Name of institution	Department	Date	Location
1	AfriCare	-	18.09.2015	Hohoe
2	BNARI	Radiation Technology Centre	13.08.2015	Accra
3	BNARI	Soil and Environmental Lab	13.08.2015	Accra
4	CARE International	-	14.08.2015	Accra
5	Concern Universal Ghana	-	17.08.2015	Sunyani
6	CSIR-FRI	Chemistry Lab	05.08.2015	Accra
7	CSIR-SRI	-	04.09.2015	Kumasi
8	Customs	Customs at Kotoka Airport	13.08.2015	Accra
9	District Assembly Nkoranza	-	02.09.2015	Nkoranza
10	EU Delegation	-	30.10.2015	Accra
11	GSA	Debriefing GSA	04.08.2015	Accra
12	MoFA, GIZ MOAP	Discussion MoFA and GIZ MOAP	23.09.2015	Ho
13	Regional MoFA	FGD Regional MoFA	18.09.2015	Hohoe
14	MoFA, GIZ MOAP	Feedback Presentation	17.08.2015	Sunyani
15	University of Ghana	University of Ghana, GIZ MOAP	18.08.2015	Nkoranza, Techiman
16	MoFA	Debriefing MoFA Sunyani	02.09.2015	Sunyani
17	FARA	Integrated Capacity Development	10.08.2015	Accra
18	Farm Institute	-	23.09.2015	Adidome
19	FDA	Food Microbiology Laboratory, Imported Food Products	06.08.2015	Accra
20	FDA	Microbiology Lab, Quality Ass. Unit	13.08.2015	Accra
21	FDA	Regional Office Ho	14.09.2015	Ho
22	FDA	Regional Office Sunyani	19.08.2015	Sunyani
23	FGD Sunyani	-	01.09.2015	Sunyani
24	FGD Akatsi-North	-	10.09.2015	Akatsi-North, Wortu
25	FGD Brahofo	-	21.08.2015	Brahofo
26	FGD Dormaa	-	28.08.2015	Dormaa

Inter-view Number	Name of institution	Department	Date	Location
27	FGD Extension Officers	-	10.09.2015	Afiadenyigba Ave
28	FGD Fetenta	-	19.08.2015	Fetenta
29	FGD Kpandu	-	16.09.2015	Kpandu Distr. Gbefi Village
30	FGD Ojobi	-	24.09.2015	Ojobi
31	FGD Salam-krum	-	24.08.2015	Salam-krum
32	FPMAG	-	06.08.2015	Accra
33	GGC	-	07.08.2015	Accra
34	GIZ MOAP	-	03.08.2015	Accra
35	GIZ MOAP	-	07.08.2015	Accra
36	GIZ MOAP	-	12.08.2015	Accra
37	GIZ MOAP	-	17.08.2015	Sunyani
38	GIZ MOAP	-	04.09.2015	Ho
39	GIZ MOAP/ Regional MoFA	-	31.08.2015	Sunyani
40	Grain Leaders	-	25.08.2015	Nkoranza
41	GSA	Export Certification	03.08.2015	Accra
42	GSA	Export Certification	12.08.2015	Accra
43	GSA	Histamin and Mycotoxin Lab	04.08.2015	Accra
44	GSA	Histamin and Mycotoxin Lab	05.08.2015	Accra
45	GSA	Metallic Contamination Lab	06.08.2015	Accra
46	GSA	Microbiology Lab	06.08.2015	Accra
47	GSA	National Codex Committee	05.08.2015	Accra
48	GSA	Pesticide Residue Lab	05.08.2015	Accra
49	GSA	Public Relations	13.08.2015	Accra
50	GSA	Regional Office	18.09.2015	Ho
51	GSA	Regional Office Sunyani	18.08.2015	Sunyani
52	GSA	Standards	03.08.2015	Accra
53	GSA	Standards	07.08.2015	Accra
54	GSA	Food, Chemical and Mat. Standards	07.08.2015	Accra
55	GSA	Standards	10.08.2015	Accra
56	University of Ghana	Institute of Applied Science & Techn.	07.08.2015	Accra
57	Input Dealer	-	22.09.2015	Ho
58	Input Dealer Doelyne	-	14.09.2015	Ho
59	Input Dealer Doelyne	-	14.09.2015	Ho

Inter-view Number	Name of institution	Department	Date	Location
60	KfW	-	21.10.2015	Accra
61	Kingdom Fruits	-	17.09.2015	Vakpo
62	KNUST Kumasi	Soil Lab	04.09.2015	Kumasi
63	Koala	-	12.08.2015	Accra
64	GSA, PTB	Mycotoxin Lab, Lab Network	04.08.2015	Accra
65	Lab Network	-	12.08.2015	Accra
66	Lab Network	-	22.09.2015	Accra
67	Maize Farmer	-	21.08.2015	Brahoho
68	Maize Farmer	-	21.08.2015	Brahoho
69	Maize Farmer	-	21.08.2015	Brahoho
70	Maize Farmer	-	21.08.2015	Brahoho
71	Maize Farmer	-	21.08.2015	Brahoho
72	Maize Farmer	-	24.08.2015	Salam-krum
73	Maize Farmer	-	24.08.2015	Salam-krum
74	Maize Farmer	-	24.08.2015	Salam-krum
75	Maize Farmer	-	24.08.2015	Salam-krum
76	Maize Farmer	-	24.08.2015	Salam-krum
77	Maize Farmer	-	24.08.2015	Salam-krum
78	Maize Farmer	-	28.08.2015	Nsuhia, Dormaa District
79	Maize Farmer	-	28.08.2015	Nsuhia, Dormaa District
80	Maize Farmer	-	28.08.2015	Nsuhia, Dormaa District
81	Maize Farmer	-	28.08.2015	Nsuhia, Dormaa District
82	Maize Trader 1 Nkoranza	-	21.08.2015	Nkoranza
83	Maize Trader 2 Nkoranza	-	21.08.2015	Nkoranza
84	Maize Trader 3 Nkoranza	-	21.08.2015	Nkoranza
85	Maize Trader 4 Nkoranza	-	21.08.2015	Nkoranza
86	Maize Trader 5 Nkoranza	-	02.09.2015	Nkoranza
87	MoFA	Maize and Poultry Farming	06.08.2015	Accra
88	MoFA	NAFCO	02.09.2015	Sunyani

Inter-view Number	Name of institution	Department	Date	Location
89	MoFA	PPRSD	13.08.2015	Accra
90	Bomarts Farms Ltd.	Production and Quality	12.08.2015	Nsawam
91	Pineapple Farmer	-	10.09.2015	Akatsi-North, Ave
92	Pineapple Farmer	-	10.09.2015	Akatsi-North, Ave
93	Pineapple Farmer	-	10.09.2015	Akatsi-North, Wortu
94	Pineapple Farmer	-	15.09.2015	Golokwati
95	Pineapple Farmer	-	15.09.2015	Golokwati
96	Pineapple Farmer	-	16.09.2015	Gbefi
97	Pineapple Farmer	-	15.09.2015	Golokwati
98	Pineapple Farmer	-	23.09.2015	Akatsi-South, Akatsi
99	Pineapple Farmer	-	23.09.2015	Akatsi-South, Akatsi
100	Pineapple Farmer	-	10.09.2015	Akatsi-North, Wortu
101	Pineapple Farmer	-	18.09.2015	Jasikan
102	Pineapple Farmer	Blue Skies	24.09.2015	Nsawam
103	Pineapple Farmer	-	23.09.2015	Akatsi-South, Akatsi
104	Pineapple Trader	-	09.09.2015	Ho
105	Pineapple Trader	-	10.09.2015	Akatsi-North, Ave
106	Pineapple Trader	-	10.09.2015	Akatsi-North, Ave
107	Pineapple Trader	-	17.09.2015	Kpandu
108	Pineapple Trader	-	18.09.2015	Hohoe
109	Poultry Farmer 1	-	27.08.2015	Dormaa
110	Poultry Farmer 2	-	27.08.2015	Dormaa
111	Poultry Farmer 3	-	27.08.2015	Dormaa
112	Poultry Farmer 4	-	27.08.2015	Dormaa
113	Poultry Farmer 5	-	27.08.2015	Dormaa
114	Prof Ag Ltd.	-	26.08.2015	Sunyani
115	Regional MoFA	Ghana Export Promotion Council	16.10.2015	Ho
116	Regional MoFA	Crop	25.08.2015	Sunyani
117	Regional MoFA	Extension	26.08.2015	Sunyani

Inter-view Number	Name of institution	Department	Date	Location
118	Regional MoFA	Extension officers	01.09.2015	Sunyani
119	Regional MoFA	Extension Officers	03.09.2015	Sunyani
120	Regional MoFA	Extension Officer Supervisor	23.09.2015	Akatsi-South
121	Regional MoFA	Ghana Export Promotion Council	08.09.2015	Ho
122	Regional MoFA	-	17.09.2015	Kpando
123	Regional MoFA	M&E	14.09.2015	Ho
124	Regional MoFA	PPRSD	25.08.2015	Sunyani
125	Regional MoFA	-	15.09.2015	South Dayi
126	SGS	-	12.08.2015	Accra
127	Shoprite	Freshmark	06.08.2015	Accra
128	SPEG	-	13.08.2015	Accra
129	St. Baasa Gh Ltd.	-	25.08.2015	Sunyani
130	Techiman Traders Assc.	-	25.08.2015	Techiman
131	TRAQUE	-	06.08.2015	Accra
132	TropiGha	-	16.09.2015	Kpandu Distr. Gbefi Village
133	UNIDO	-	06.08.2015	Accra
134	University of Ghana	Food Science	04.08.2015	Accra
135	University of Ghana	Agricultural Extension	10.08.2015	Accra
136	Vakpo pineapple association, Volta Value Chain Cooperative	-	18.09.2015	Kpandu
137	Vet service Dormaa Ahenkro	-	27.08.2015	Dormaa
138	Vet Service Dormaa	-	16.10.2015	Dormaa
139	Wecap Agro Proc. Ltd.	-	17.09.2015	Have, Nyagbo Anyigbe
140	WFP	P4P Programme	09.10.2015	Accra
141	Recomm. Workshop	-	13.10.2015	Accra
142	Recomm. Workshop	-	13.10.2015	Accra
143	Recomm. Workshop	-	13.10.2015	Accra
144	Yedent	-	25.08.2015	Sunyani

Annex 2: Interview guideline maize farmers

General Information

Name

Education level

Total area of land cultivated (acres)

Total are of land cultivated with maize (acres)

Yield per acre in the last year (major / minor season)

Membership in FBO

Additional income source in the family?

1. How much maize do you keep for your own consumption and how much do you sell?
2. Where / to whom do you sell your maize?
3. What are the major quality problems for maize you face?
[If dryness: ask how do you store and dry your maize?]
4. What is your motivation to reduce these quality issues?
Do any of these problems have an impact on the price?
5. In which season do you make most money out of your maize sales and why?
6. Are quality issues an important loss factor?
(no, negligible, concern, intolerable, total loss)
7. Do you store your maize and where? How long do you store it?
8. Before you sell or consume your maize, how do you check that the maize is dry?
9. How do your customers check if the maize is dry?
10. Have you ever used any device (moisture meter) to check how dry your maize is?
Why/ why not?
11. Do you sort your maize at home into different categories/classes?
How? → grading
12. Which quality of maize do you sell to whom?
13. How do you measure how much maize you sell (or How do you know how much maize you sold)? (e.g. do you measure it in coco bags?)
14. What do you know about aflatoxin? How do you make sure that your maize is aflatoxin-free?
15. Who would you ask for advice if you identify quality problems?
16. Is there any person or organization that helps you or other farmers in the community to determine the quality of maize? If yes, who is it?
Follow up – Do you know about GSA, FDA, GGC?

17. Have you ever heard about Maize standard GS211 (from GSA)? Have you ever seen something similar to the following (show them Standard pictorial for maize)? If yes, where do you know it from?
18. Do you make price arrangements before you plant/harvest your maize? With whom?
19. How do you know at what price you can sell your maize?
20. How do you check if your land is fertile?
21. Have you ever used any soil testing on your land? Why/ why not?
22. Have you or anyone in the community attended any training related to the quality of maize? [training could have taken place within or outside the community.] When was this training / who performed it / what was it about?
23. Did you or any of your neighbors adopt new practices/technologies related to the quality of maize you were trained on? Why? Why not?
24. Do you have access to loans? Did you receive any loan within the last five years that contributed to your agricultural production? What other possibilities are there to borrow money?
25. If anything happens (for example a disease outbreak) or if there are any news (for example about agricultural innovations), who informs you?
26. Do you have access to radio/mobile phone/television (Where there is access, ask if they receive agricultural information via these channels. If yes, is it relevant to your situation?)

Annex 3: Interview guideline pineapple farmers

General Information

Name

Education level

Total area of land cultivated (acres)

Total area of land cultivated with pineapple (acres)

Type of variety grown, since when?

Yield per acre in the last year

Membership in FBO

Additional Non-farming income sources in the family?

1. Where / to whom do you sell your pineapple?
Do you sell to juice producing companies?
2. Who in your household is responsible for selling the pineapples?
3. Do you sell your pineapples across the border?
4. How do you transport your pineapples to your customers?
5. What are the major quality problems for pineapple that you face?
6. What is your motivation to reduce these quality issues?
Do any of these problems have an impact on the price?
7. Are quality issues an important loss factor?
(no, negligible, concern, intolerable, total loss)
8. Do you store your pineapple and where? How long do you store it?
9. Before you sell your pineapple, how do you check that your pineapple is ready to be sold?
10. Do you know about any device (refractometer) to check the quality of your pineapple?
Have you ever used a refractometer? Why/why not?
11. Have you ever used a swimming test?
12. Do you sort your pineapple at home into different categories/classes?
How? (→ grading)
13. Who would you ask for advice if you identify quality problems?

14. Is there any person or organization that helps you or other farmers in the community to determine the quality of pineapples? If yes, who is it? Follow up: Do you know about GSA, FDA?
15. Are you satisfied with the services of MoFA extension officers?
16. Have you perceived any yield changes throughout the last years? If yes, what do you think are the causes?
17. How do you check if your land is fertile?
18. Have you ever used any soil testing on your land? Why/ why not?
19. Do you apply any fertilizers? What kind of fertilizers do you apply? (inorganic/organic, compound/single chart)
20. Do you apply any pesticides? If yes, when? How often? What kind of pesticides?
21. Where is the nearest input dealer where you access your fertilizers/pesticides?
22. Do you degreen your pineapples?
23. Have you or anyone in the community attended any training related to the quality of pineapple? [training could have taken place within or outside the community.]
When was this training / who performed it / what was it about?
24. Did you or any of your neighbors adopt new practices/technologies related to the quality of pineapple you were trained on? Why? Why not?
25. Do you have access to loans? Did you receive any loan within the last five years that contributed to your agricultural production? What other possibilities are there to borrow money?
26. If anything happens (for example a disease outbreak) or if there are any news (for example about agricultural innovations), who informs you?
27. Do you have access to radio/mobile phone/television? (Where there is access, ask if they receive agricultural information via these channels. If yes, is it relevant to your situation?)

Annex 4: Categorization of QI users according to KAP

Table 15: Typology/categorization of smallholders regarding QI use		
QI usage	Name	Typology description in relation to QI usage
QI Non-user	Ignorant	Smallholder is not using QI services, does not have a positive attitude to improve the quality of the product nor has the smallholder knowledge of available QI services
	Informed	The smallholder is aware of QI services, but lacks motivation and the ability to actually utilize QI services
	Interested	Smallholder is not using QI services and has no knowledge of available QI services, but has a positive attitude towards improving the quality of the product.
	Unknown other	Reasons other than awareness, attitude and ability prevent a smallholder to use QI
QI user	User	Good QI practice: Smallholder is using QI services and would potentially use more QI services
	QI user ⁺	Smallholder is using QI service and has expressed its motivation to use it more.
Source: own illustration		

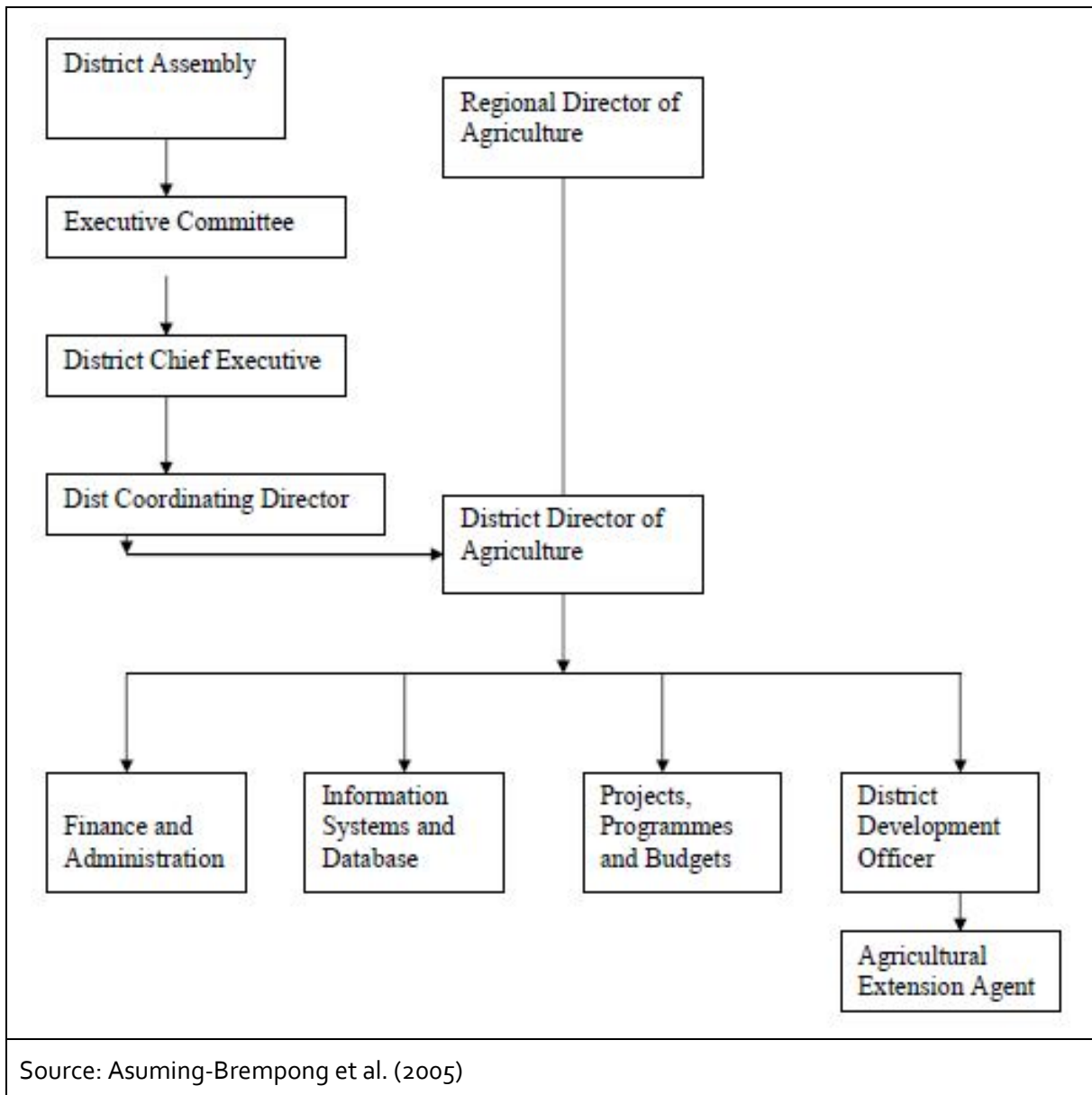
Annex 5: Providers of quality infrastructure

Org.	Location	Relevant Laboratories Visited	Services Offered (examples)	Price per Service/ sample (in GHS)	Staff of Laboratory	Type of Client	Laboratory Accreditation?
GSA	Capital Accra 9 Regions	Pesticide residue; Microbiology; Metallic contamination; Histamine and Mycotoxins laboratory	Microtoxology: Aflatoxin (B ₁ , B ₂ , G ₁ , G ₂); Ochratoxin; Fumonisin Microbiology: e. coli, staphylococcus and Salmonella Pesticides: Pesticides registered with EPA, chemicals (e.g. DDT, organochlorins)	Pesticide: GHS300 (Express GHS600) Aflatoxin: GHS250 (for Export Cert. GHS200) Histamin: GHS500 (for 9 samples) Heavy metal: GHS50 (per element)	Pesticide: 6 + 1 (head of dept.); 4 Master degree Mycrotoxin: 5; 1 Master degree Microbiology: 10; 3 Master degree	Small companies Associations; Domestic producers; Exporters rarely farmers	Yes (Pesticide, Microbiology)
FDA	Capital Accra 10 Regions	Microbiology, physiochemical; heavy metal	Product Certification; Microbiological testing: autoclaves, Incubators, freezers Aerobic plate E Coli, Staphylokkoen, Salmonella, Clostridium Perfrensis	Registration Fee: GHS650	Microbiology: 6	Processors	Currently applying for accreditation (Microbiology)
FRI	Capital Accra	Chemistry lab and Microbiology laboratory	Aflatoxin testing (b ₁ , b ₂ , G ₁ , M ₁ , M ₂), Ochratoxin testing, fat, ash and protein analysis and atomic absorption for heavy metals, fertilizer analysis	GHS140 (210 express)	Chemistry: 13 Microbiology: 16	large international companies (e.g. Cadbury), national companies, students, researchers, processors	Yes (SANAS)

Annex 5: Providers of quality infrastructure (cont.)

Org.	Location	Relevant Laboratories Visited	Services Offered (examples)	Price per Service/sample (in GHS)	Staff of Laboratory	Type of Client	Laboratory Accreditation?
BNARI	Capital Accra	Soil and Environmental laboratory; Radiation Technology Centre	Testing on Microorganisms, for example for bacteria and fungi; disinfestation; control of insects in processed maize products	Microorganisms, disinfestation, control of insects: GHS60; Organic soil analysis: GHS80; Inorganic soil analysis: GHS25	Radiation Centre: 31 (15 scientists + 16 technicians)	Students, commercial farmers, companies	No
SRI	Kumasi	Soil laboratory	Soil testing; fertilizer testing	Commercial: 50 US\$; farmers = 15 US\$; students = 10 US\$	Soil: 15	Mining companies, commercial farmers	No data
SGS	Accra, Tema (for other purposes Takoradi)	Soil analysis laboratory (5 chemical labs; 2 environmental labs)	GlobalGAP Certification; Fertilizer Analysis; Pesticide Residual Testing (via GSA Lab); Water Quality Analysis; Soil analysis: metals, nutrients, pH, physical examinations, cation /anion exchange capacity	2000 US\$ (Global GAP Option 1); >2000 US\$ (Global GAP Option 2)		Large-scale agricultural producers	No data
KNUST	Kumasi	Soil laboratory	Soil testing	GHS10 per parameter and sample	Soil: 2	Students	No
PPRSD	Capital Accra 9 Regional Ministries MoFA, border posts	Visual Inspection; basic chemical analysis	Basic laboratory services; Phytosanitary Certificate	price / certificate: 50 GHS + fee for weight <1000kg: GHS10; <5000kg: 50 Gc)		Producers	No
Source: own illustration							

Annex 6: Organigram of Decentralized MoFA



Annex 7: Maize Grades

Characteristic (%)	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Disease	0.5	0.5	0.5	0.5	0.5
Discoloured	2.0	3.0	3.0	4.0	4.0
Broken / Chipped	5.0	6.0	10.0	14.0	20.0
Insect damaged	2.0	4.0	5.0	5.0	5.0
Stained	0.0	0.5	0.5	1.0	1.0
Germinated	0.0	0.5	0.5	0.5	0.5
Shrivelled	1.0	2.0	3.0	4.0	5.0
Other grains	0.5	0.5	1.0	1.0	2.0
Total Defective	11.0	17.0	24.0	30.0	38.0
Inorganic	0.0	1.0	2.0	2.0	2.0
Organic	1.0	2.0	5.0	5.0	5.0

Source: Maize standard GS211

Annex 8: Detailed results of soil analysis

Location Farmer	Particle size distribution			Texture (USDA)	pHw 1:1	EC dS/m	Extracable bases			Organic	Total	Available	Cd	Pd
	Sand	Silt	Clay				Ca	Mg	K	C	N	P		
	%			cmol/kg			%		mg/kg					
Akatsi														
Mr Y	21.0	64.0	15.0	Silt loam	6.4	0.08	2.66	0.77	0.08	0.92	0.06	2.41	nd	nd
Mr S	31.0	59.0	10.0	Silt loam	6.3	0.03	0.31	0.11	0.03	0.32	0.04	1.88	nd	nd
Jasikan														
Mr K(1)	11.2	66.3	22.5	Silt loam	6.0	0.07	2.12	0.89	0.23	2.20	0.10	23.22	nd	nd
Mr K(2)	27.0	45.0	28.0	Silt clay	5.8	0.08	1.81	0.78	0.28	2.51	0.15	32.38	nd	nd
Nd=not detected														
Source: own illustration														

Annex 9: Quantities and types of recommended fertilizers (case-study soil testing)

Table 16: Quantities and types of recommended fertilizers						
Scenario	Farmer/ field	Fertilizer	Current quantity (kg/acre)	Recom- mended quantity (kg/acre)	Cost of rec- ommended quantity (GHS)	Total cost (GHS / acre)
S ₁	Mr Yao / Mr Samson	NPK (15-15-15)	87.5	0	0	5168.22
		Ammonium sulphate	87.5	0	0	
		Urea	0	69.69	167.25	
		Potassium nitrate	0	681.82	4772.73	
		Triple Superphosphate	0	65.21	228.26	
S ₂		NPK (15-15-15)	87.5	200	480	960
		Ammonium sulphate	87.5	0	0	
		Urea	0	200	480	
		Potassium nitrate	0	0	0	
		Triple Superphosphate	0	0	0	
S ₁	Mr Blaze (1)	NPK (15-15-15)	100	0	0	5092.15
		Ammonium sulphate	200	0	0	
		Urea	0	69.69	167.25	
		Potassium nitrate	0	681.82	4772.73	
		Triple Superphosphate	0	43.48	152.17	
S ₂		NPK (15-15-15)	100	133.33	320	853.33
		Ammonium sulphate	200	0	0	
		Urea	0	222.22	533.33	
		Potassium nitrate	0	0	0	
		Triple Superphosphate	0	0	0	
S ₁	Mr Blaze (2)	NPK (15-15-15)	100	0	0	5016.08
		Ammonium sulphate	200	0	0	
		Urea	0	69.69	167.25	
		Potassium nitrate	0	681.82	4772.73	
		Triple Superphosphate	0	21.74	76.09	
S ₂		NPK (15-15-15)	100	66.66	159.87	746.64
		Ammonium sulphate	200	0	0	
		Urea	0	244.44	586.66	
		Potassium nitrate	0	0	0	
		Triple Superphosphate	0	0	0	

Source: own illustration

Annex 10: Required yield increases to cover increased fertilization costs (case-study soil testing)

Table 17: Required yield increases to cover increased fertilization costs								
Farmer	Mr Y		Mr S		Mr B (1)		Mr B (2)	
	Price (GHS)	Required increase in revenue (GHS)	Price (GHS)	Required increase in revenue (GHS)	Price (GHS)	Required increase in revenue (GHS)	Price (GHS)	Required increase in revenue (GHS)
Small fruit	0.8	623.75	0.8	545	0.5	273.33	0.5	166.64
Medium fruit	1		1.5		0.55			
Large fruit	1.2		2.5		0.83			
Average price difference	0.2		0.85		0.165			
Required number of fruits of increased size	3118.75		641.17		1656.54		1009.93	
Required increase in yield per fruit if sold by kg	0.047 kg		0.041 kg		0.021 kg		0.012 kg	
Source: own illustration								

Annex 11: Project short description – small-scale entrepreneurs

Project management: Implementing partner in Ghana:

PTB

GSA

Project title:

Facilitate the use of QI on the level of small-scale entrepreneurs in order to familiarize smallholders with QI and effectively tackle quality issues in the maize value chain.

Target group: Small-scale maize producers in the Ashanti and Brong-Ahafo regions

Short description – objectives and activities

The aim of the project is to familiarize smallholders with QI through facilitated QI use on the level of small-scale entrepreneurs that are supplied with maize of smallholders. In the longer run and after the smallholder's familiarization with QI, an increase of their QI service use is expected, leading to reduced quality issues in the maize value chain.

Currently there are small-scale entrepreneurs that purchase maize directly from smallholders. By equipping entrepreneurs with moisture meters and the maize standard GS211, they would be obliged to offer at least 3 workshops per year to their supplying smallholders. During the workshops, entrepreneurs train smallholders on the use of moisture meters and the maize standard. Workshops are conducted with heads of farmer groups. In this process, entrepreneurs receive technical guidance of GSA staff. In order to motivate entrepreneurs to participate in the project, they are offered reduced prices for testing services (e.g. aflatoxin tests) that are undertaken at selected laboratories. Price reductions offered by QI service providers are adapted to the amount of workshops offered by a small-scale entrepreneur. In an initial phase PTBS's role would be to compensate QI service providers for their economic losses due to reduced prices. This financial support would end after a 2-3 year period as soon as the expected demand for QI services increases.

It would be recommended that benefiting entrepreneurs purchase 50 percent of the raw maize directly from smallholders. Their smallholders should be organized in farmer groups. The entrepreneurs must be clients of testing laboratories in order to ensure their familiarity with QI. They are identified by asking for a list of clients of testing laboratories that receive samples of small-scale entrepreneurs (e.g. BNARI).

The proposed project shall be implemented in the Ashanti and Brong-Ahafo regions. At the end of a 2-3 year long project, the impact of the project should be evaluated concerning the familiarization of smallholders with QI and their QI use.

Annex 12: Project short description – data collection

Project management: Implementing partner in Ghana:

PTB

GSA

Project title:

Facilitate a systematic data collection on aflatoxin contamination of maize and maize products in Ghana to assist awareness creation and emphasize the relevance of QI

Target group: Graduate students, research assistants who work in agriculture later on as intermediaries to QI

Short description – objectives and activities

The aim of the project is to tackle the lack of statistical relevant and published data on aflatoxin contamination in maize or maize products. Currently, results of laboratories are confidential, area-wide surveys are rare and because of missing quality infrastructure within the regions no data is generated for rural areas. Therefore an improved systematic data collection on aflatoxin levels of maize and maize products shall be conducted. Surveys on aflatoxin contamination at markets and other maize aggregation points as well as profound research of cases of illness or fatalities should be the major part of the dissertations to identify most problematic areas. In the longer run, generated statistical data shall facilitate awareness creation and provide a basis for argumentation for the relevance of QI.

By strengthening the cooperation with research institutes, for instance the Food Research Institute and the University of Ghana, studies can be tendered and commissioned by GSA. Especially graduate students and research assistants shall be addressed. Bachelor and Master Theses as well as PhD dissertations could be a suitable scope to generate profound data. Research tasks should be tendered and financed over a period of three years. PTB can assist in financing these studies, for instance in providing scholarships and third-party funds for participating institutions.

Gained data shall be collected and further analyzed by GSA to develop strategies for publications and awareness creation as well as identifying relevant areas for QI utilization. Thereby a strong cooperation with related ministries, for instance Ministry of Trade and Industry and Ministry of Health is crucial.

Annex 13: Project short description – soil testing

Project management:	Implementing partner in Ghana:
PTB	GSA

Project title:

Bringing soil testing down to the ground

Target group: Small-scale horticultural producers in the Volta region
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Short description – objectives and activities

Horticultural producers in Ghana are required to compete on national and fierce international markets. To increase agricultural production and maintain soil fertility, the application of good agricultural practices is necessary. Yet, most small-scale farmers do not test their soils to determine nutrient levels for adequate fertilization.

This pilot project therefore proposes to determine potentials of innovative decentralized soil testing facilities and modalities for offering the service to producers of horticultural products in rural areas. Potentials of public-private partnerships and decentralized testing shall be evaluated. The pilot project focuses on horticultural producers as fertilization for these crops is already taking place and farmers have been sensitized for the relevance of soil testing through a GIZ programme (MOAP). Although awareness for the opportunities and benefits for soil testing arose, beneficiaries did not yet test their soils after the intervention on their own. In the longer run, activities of this pilot project can contribute to the increased availability of soil testing facilities on district and regional level by using existing structures. In order to smoothen the introduction, MoFA could consider SLE's recommendation to shift the fertilizer subsidies to soil-testing subsidies.

To achieve the output of the proposed pilot activity, three modalities shall be tested to increase the outreach of soil testing facilities and enhance their utilization by smallscale farmers. Modalities one and two imply a public-private partnership between soil testing laboratories, input dealers, and the Ministry of Food and Agriculture.

A1: Input dealers as facilitators

Input dealers are visited directly by farmers. Currently, input shops are selling fertilizers, pesticides and herbicides, but are not offering any other services to the farmers. In order to connect farmers with soil testing laboratories in Accra or Kumasi and in agricultural colleges, input dealers could in the future serve as brokers between farmers and laboratories. Once the test results are available, the input

dealer can consult the farmer on fertilizer recommendation and adopted farm management practices. A fee for advice on soil sampling, forwarding soil samples and interpretation of results can be an additional benefit for the input dealer. Technical staff of QISPs and the Ministry of Food and Agriculture should prepare this intervention by providing training and advice to input dealers.

- A1.1 Facilitate the interaction between MoFA, input dealers and soil testing laboratories through three workshops on regional level.
- A1.2 Develop an easily understandable and concise template for the presentation of soil testing results through laboratories.
- A1.3 Develop and print posters for input providers that depict rationale, benefits, risks and costs of soil testing. These posters will be handed out to input dealers for display at their shops.

A2: Input dealers for quick tests

To increase the availability of soil tests input dealers will be encouraged to sell pH strips and test strips for macronutrients. After the purchase of tests, farmers could conduct the tests on their farm and retrieve subsequent advice on interpretation of results through the input provider. The availability and purpose of test strips should be advertised through the input dealer. The interpretation provides the input dealer with better sales arguments for required amounts of fertilizers. Input dealers can develop parallels between measured soil qualities and traditional methods of soil quality measurement. The results of these parallels could subsequently be developed in curricula for agricultural extension officers.

- A2.1 Establish business linkages between QISPs, manufacturers of test strips, importers and input dealers as well as farmers.
- A2.2 Assist Ministry of Food and Agriculture in developing interpretation guidelines for input providers.
- A2.3 Document parallels between assumptions of farmers on soil qualities and tested soil properties and their recommendations.

Mobile soil laboratories

Input dealers are selling only inorganic fertilizers, they have no incentive to advise the utilization of available organic fertilizers that can be cheaper and reduce nutrient loss within the farming system. Ideally, input dealers could also facilitate the availability of organic fertilizers in the region. However, to offer independent consultation to farmers it should be tested within this project if a mobile soil laboratory can be managed by input dealers and is used by smallholders. The mobile soil lab should be operated in coordination with MoFA by a public institution, such as SRI or, within conjunction of the Green Innovation Centres agricultural college.

Mobile soil laboratories are already operated in Kenya by a private foundation. A vehicle, lab equipment and trained staff are required. The vehicle will visit different villages and farmers can bring their soil samples for testing after having received consultations on how to sample. Testing and recommendations will be performed on site.

The different outlined models shall be implemented in different regions in order to not create competition between the modalities, as demands for soil testing on smallholder level is currently low. The pilot project should be evaluated on district, regional and national level identifying shortfalls and the potential of different modalities for upscaling. All activities should be implemented in close collaboration and coordination with the regional offices of the Ghana Standards Authority and ongoing GIZ programs.

Annex 14: Project short description – extension officers

Project management:	Implementing partner in Ghana:
PTB	Ghana Standards Authority, Food and Drugs Administration, Regional Ministry of Food and Agriculture, District Directors of Agriculture

Project title:

Bringing quality infrastructure to the field – integrating quality infrastructure into the vocational training for future agricultural extension agents

Target group: Agricultural students at agricultural colleges and farm institutes

Short description – objectives and activities

Agricultural Extension Agents (AEAs) are quality infrastructure's closest link to the smallholders. They directly interact with smallholders due to the AEAs responsibility to assist farmers, to identify problems and to advice solutions. However, vocational training of agricultural students and potential AEAs focuses on good agricultural practices and quality infrastructure-related aspects are hardly mentioned. Presently, quality infrastructure is not a central element of the vocational training of potential AEAs. This makes it difficult to educate farmers on quality infrastructure in agricultural production, when starting to work as an AEA.

The vocational training of potential AEAs takes place at designated public-owned agricultural colleges and farm institutes. 8 of those institutions are located in 5 regions (Ashanti, Volta, Northern, Central and Brong-Ahafo). Agricultural colleges and farm institutes have been identified by the SLE study as important entry points for capacity development in quality infrastructure for AEAs.

The objective of a pilot project would be to increase the capacity of potential agricultural extension officers in the quality infrastructure sector. It will enable graduates to respond to any requests related to quality infrastructure related aspects made by smallholders, after taking the job as an AEA. In addition, AEAs would be able to providing advice on quality requirements and quality enhancement of agricultural production. In the long run, if the demand for quality infrastructure grows, smallholders will be better prepared and can rely on competent advice.

The project has three components. The first component is the integration of quality-infrastructure aspects into the curricula of agricultural colleges and farm institutes. The second component is the development of a practical handbook on quality infrastructures and agriculture. It should include case studies, lessons learned and recommendations for the application of quality infrastructure in agricultural production. The handbook should be utilized during the course program and every student should be provided with a copy. The third component is the collaboration

with selected quality infrastructure service providers. While GSA would influence the AEA's curricula concerning technical expertise and testing the FDA would be responsible concerning food safety. In addition, GSA should provide technical equipment for educational purposes, e.g. moisture meters and testing strips.

Further opportunities include the application of the acquired knowledge at the agricultural colleges. For instance, if agricultural colleges equipped with basic laboratories, knowledge on testing services can be applied immediately.

In order to successfully enhance the effectiveness of the project, the regional agricultural office needs to be involved in the planning and implementation of the project activities. It can transfer information from the national level to the agricultural colleges and vice versa. In addition, district directors of agriculture should be invited, since they are responsible for designing and implementing staff development trainings and programmes, including AEAs.

It is recommended that the project lasts three years. The objective of the first year would be the finalizing and piloting the AEA's curricula and the development of the handbook. For the remaining time the renewed curricula and the handbook need to be applied in practice. A final evaluation establishing the quality and general impacts of the new curricula and the handbook is necessary, in order to adapt the curricula. Follow-up workshops after the end of the project for the AEAs on quality infrastructure, e.g. by GSA, are desirable. In those workshops the experiences of the AEAs together with the challenges of smallholders observed by AEAs should be central. Representatives of the smallholders should be invited as well.

Annex 15: Project short description – rural laboratory

Project management: Implementing partner in Ghana:

PTB

MoFA, GSA, FDA, MoLG

Project title:

Animal health and food safety: Establishment of an animal feed testing laboratory in Dormaa Ahenkro town, Brong-Ahafo region

Target group: Poultry farmers and maize smallholders, feed millers, aggregators

Short description – objectives and activities

The objective of the project is to increase food and feed safety as well as the efficiency and productivity of the poultry sector. This shall be enhanced by equipping an already existing empty laboratory building in Dormaa district, the most important poultry hub in Ghana. This project involves the following QI services: testing of feed characteristics, testing of aflatoxin and other pathological contaminants, weighing and calibration services and moisture measurement.

Components and activities of the project should include: a) record keeping on occurrence of aflatoxin prevalence with feedback for smallholders, b) communication of good agriculture and quality practices to their maize producers/ smallholders by poultry farmers, c) availability of moisture meters with “rent out” possibilities and d) calibration of weighing scales. Small-scale maize farmers and small poultry farmers should pay a smaller fee for the offered services than large poultry farmers.

The Ministry of Food and Agriculture with its veterinarian service in cooperation with the District Agriculture office should be in charge of operating the lab and channeling information between the target groups and public bodies. The Ghana Standards Authority would support the project with the lab technology and the Food and Drugs Authority concerning food safety. The Faculty of Environmental and Natural Resources in Sunyani/Dormaa could execute QI services and in addition train extension officers on good agriculture and quality practices.

The need for the lab was deduced from occasional testing practices observed among poultry farmers. Those poultry farmers from Dormaa district in Brong-Ahafo send their samples to laboratories in other regions. Their intrinsic motivation to test combined with having testing facilities in their proximity would offer those stakeholders a possibility to test quicker, cheaper and possibly more often. By collecting data and monitoring aflatoxin occurrences, the laboratory would further contribute to a decline of aflatoxin contaminations.

Annex 16: Estimated and measured maize moisture levels

Forty-four farmers, traders and poultry farmers were asked in an experiment with real maize to estimate the moisture level with a traditional method of their choice. They estimated it by driving their hands into a maize bag, biting on the corn, or skidding over the surface of the maize bulk. Afterwards, SLE measured the real maize moisture with a moisture meter and compared it with the estimation. Eleven percent – or 5 people – estimated higher moisture levels than were actually present. In contrast, 89 percent of the participants thought the maize was drier than it really was.

On average over all, the participants estimated 3,38 percent too dry.

Comparison between estimated and measured maize moisture levels		
Difference moisture estimated-measured [%]	Occurrence among 44 estimations [absolute numb. of cases]	Occurrence among 44 estimations [proportion of 44 cases, %]
-1,5	5	11
0,5	6	14
1,5	5	11
2,5	6	14
3,5	3	7
4,5	8	18
5,5	2	5
6,5	3	7
7,5	1	2
8,5	1	2
9,5	1	2
10,5	1	2
11,5	1	2
12,5	0	0
13,5	1	2
	44	100
Source: own illustration		

Results

1. On average farmers / traders underestimated maize moisture by about 3,4%
2. Only 11% of the test persons estimated the maize being moister than the actual maize was measured. 89% of the test persons estimated the maize being dryer than it actually was.

List of SLE publications since 2000

All studies are available for download at www.sle-berlin.de.

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