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**Sustainable food systems and impacts on market participants in
global value chains**

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Abstract

Maintaining and improving global food security in the face of population growth and climate change is becoming one of the major challenges of this century. In order to tackle this global crisis, it is essential to increase agricultural productivity and reduce poverty in a sustainable way, without harming the environment. The Sustainable Development Goals (SDG) initiative recognizes the significance of sustainable consumption and production as a means to mitigate this challenge. Standards and labels that provide additional information aim to help consumers and processors make more sustainable choices, thereby reducing resource consumption. This study uses data from German consumers, Ghanaian small-scale palm oil farmers and palm oil-using food producers to create a holistic understanding of international palm oil food systems. The objective is to determine the potential of more sustainable palm oil cultivation systems.

First, preferences and willingness-to-pay (WTP) for sustainability indicators on products that contain palm oil as an ingredient as well as the effects of factual information about palm oil cultivation are analyzed. A hybrid latent variable model that allows to jointly examine the response to the stated choice component and the responses to attribute processing questions, thus capturing attribute non-attendance (ANA) to specific labels while controlling for heterogeneous preferences, is used to determine unbiased consumer preferences. The findings suggest that information tends to increase consumers' WTP and decreases their ANA for sustainability-indicating attributes, and that organic palm oil quality is ranked highest across all consumers, making it the most promising attribute for promoting sustainable palm oil. Second, building on the results of the consumer preferences section, the study analyzes the impact of the Roundtable on Sustainable Palm Oil (RSPO) and organic certification on farmers' welfare, food security, and the environment in Ghana's palm oil producing regions. The results of the analyses are particularly important as the potential of organic certification in the palm oil sector has been almost completely neglected. To account for selection bias due to observed and unobserved factors, a multinomial endogenous switching regression method is applied.

The empirical results show that certification has positive impacts on farmers' welfare and the environment, while both tend to benefit more from organic certification than from RSPO certification.

Further, the study addresses the issue that the palm oil sector, particularly in West Africa, faces significant problems with large yield gaps. It uses a stochastic frontier model with an endogenous treatment status and mediator to analyze the impact of organic and RSPO certifications on the production frontier and efficiency of Ghanaian smallholder farmers. The empirical results indicate that certification schemes exert negative overall impacts on crop yields, while generating economic benefits through improved net farm revenues for farm households. Most importantly, the findings suggest that appropriate extension services and learning improved management practices can efficiently help reduce yield losses for certified palm oil farmers.

Finally, the paper addresses the interconnectedness of the SDGs and thus the holistic achievability of sustainability goals. The research focuses on gender equality and reduced inequalities, as these two goals have been shown to be among the goals that least hinder or even promote the achievement of other goals. It emerges that the achievement of social and environmental sustainability goals is strongly related to the achievement of inequality reduction. Thereby, all forms of inequality play an important role, since, for example, global inequalities can lead to particularly climate-vulnerable developing countries having severely limited mitigation options. At socio-cultural levels, for example, gender inequalities can lead to reduced crop yields for women due to limited access to resources, resulting in lost potential for food security.

Zusammenfassung

Eine wachsende Weltbevölkerung und der sich beschleunigende Klimawandel bedrohen die globale Ernährungssicherheit. Die Steigerung der landwirtschaftlichen Produktivität und die Verringerung der Armut ohne dabei die Umwelt weiter zu schädigen gehören daher zu größten Entwicklungs Herausforderungen dieses Jahrhunderts. Die Vereinten Nationen erkennen dabei in ihren Zielen für Nachhaltige Entwicklung die Bedeutung von nachhaltigem Konsum und nachhaltiger Produktion als Mittel zur Erreichung von vermehrt nachhaltigen globalen Ernährungssystemen an. Standards und Labels, die zusätzliche Informationen über Produkte und Rohstoffe bereitstellen, sollen Konsumierenden und verarbeitendem Gewerbe helfen, nachhaltigere Entscheidungen zu treffen und so den Ressourcenverbrauch zu reduzieren. Diese Studie verwendet Daten von deutschen Verbraucher*Innen, ghanaischen Palmöl Kleinbäuer*Innen und Palmöl verwendenden Unternehmen, um ein ganzheitliches Verständnis von internationalen Palmöl Lebensmittelsystemen zu bilden. Ziel ist es, das Potenzial nachhaltigerer Palmölanbausysteme zu identifizieren.

Zunächst werden die Präferenzen und die Zahlungsbereitschaft (willingness-to-pay, WTP) für Nachhaltigkeitsindikatoren auf palmölhaltigen Produkten sowie die Auswirkungen von sachlichen Informationen über den Palmölanbau auf die Präferenzen analysiert. Zur Ermittlung unverzerrter Verbraucherpräferenzen wird ein hybrides Modell mit latenten Variablen verwendet, welches es ermöglicht, die Antworten auf die Komponente der geäußerten Produktwahl und die Antworten auf die Fragen zur Nichtbeachtung von Attributen (attribute non-attendance, ANA) zu erfassen, während gleichzeitig für heterogene Präferenzen kontrolliert wird. Die Ergebnisse deuten darauf hin, dass Sachinformationen die WTP von Konsument*Innen erhöhen und ihre ANA für Nachhaltigkeitsattribute verringern. Die Qualität von Bio Palmöl wird dabei als am höchsten eingestuft, was die Ausweisung als Bio Produkt zum vielversprechendsten Attribut für die Förderung von nachhaltigem Palmöl macht. Zweitens analysiert die Studie, aufbauend auf den Ergebnissen des Abschnitts über die Verbraucherpräferenzen, die Auswirkungen der Roundtable on Sustainable Palm Oil (RSPO) und der Bio Zertifizierung auf die Wohlfahrt von Kleinbäuer*Innen, die Ernährungssicherheit und die Umwelt in Palmöl produzierenden Regionen Ghanas. Die Ergebnisse der Analysen sind besonders wichtig, da

das Potenzial von Bio Zertifizierung im Palmölsektor bisher weitestgehend vernachlässigt worden ist. Um Selektionsverzerrungen aufgrund von beobachteten und unbeobachteten Faktoren zu berücksichtigen, wird eine multinomiale endogene Switching-Regressionsmethode angewandt. Die empirischen Ergebnisse zeigen, dass Zertifizierungen positive Auswirkungen auf das Wohlergehen der Landwirte und die Umwelt haben, wobei Kleinbauern, als auch die Umwelt tendenziell stärker von der Bio Zertifizierung als von der RSPO-Zertifizierung profitieren. Darüber hinaus befasst sich die Studie mit dem Problem, dass der Palmölsektor, insbesondere in Westafrika, mit großen Ertragslücken zu kämpfen hat. In einem stochastic frontier Modell mit endogenem treatment Status und Mediator, werden die Auswirkungen von Bio und RSPO Zertifizierungen auf die Produktionsgrenze und die Effizienz ghanaischer Kleinbäuer*Innen analysiert. Die empirischen Ergebnisse belegen, dass die Zertifizierungssysteme insgesamt negative Auswirkungen auf die Ernteerträge haben, während sie den landwirtschaftlichen Haushalten durch verbesserte Nettoeinkünfte wirtschaftliche Vorteile bringen. Vor allem aber deuten die Ergebnisse darauf hin, dass geeignete Beratungsdienste (Extension Service) und das Erlernen verbesserter Managementpraktiken wirksam dazu beitragen können, Ertragsverluste bei zertifizierten Palmölbauern zu verringern.

Abschließend befasst sich diese Dissertation mit der Verflechtung der SDGs und damit mit der ganzheitlichen Erreichbarkeit der Nachhaltigkeitsziele. Die Untersuchung rückt die Gleichstellung der Geschlechter und die Verringerung von Ungleichheiten in den Fokus, da diese beiden Ziele erwiesenermaßen zu den Zielen gehören, die die Erreichung anderer Ziele am wenigsten behindern oder sogar fördern. Es zeigt sich, dass das Erreichen sozialer und ökologischer Nachhaltigkeitsziele eng mit dem Erreichen der Verringerung von Ungleichheit verknüpft ist. Dabei spielen alle Formen der Ungleichheit eine wichtige Rolle, da z.B. globale Ungleichheiten dazu führen können, dass besonders vom Klimawandel negativ betroffene Entwicklungsländer nur sehr eingeschränkte Möglichkeiten des Klimaschutzes und der Anpassung an den Klimawandel haben. Auf soziokultureller Ebene können beispielsweise geschlechtsspezifische Ungleichheiten dazu führen, dass Frauen aufgrund des eingeschränkten Zugangs zu Ressourcen geringere Ernteerträge erzielen, was zu einem Verlust an Potenzial für die Erhaltung und Verbesserung Ernährungssicherheit führt.

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Chapter 1

General Introduction

1.1 Introduction

The declared objective of the Sustainable Development Goals (SDGs) is to transform our global economy and economic behavior in such a way that humanity uses natural resources responsibly and respectfully, and that the quality of life of all people worldwide is not only maintained but significantly improved (United Nations 2016). It is evident that the 17 target categories of the SDGs are defined in a way that calls for action by and in both industrialized and developing countries. At the same time, it is important to recognize that all of the goals have a reciprocal influence and thus can each reinforce or counteract one another (Pham-Truffert et al. 2020). Goals can thus serve as catalysts for, or obstacles to, other goals.

In relation to smallholders in developing countries, this issue is particularly relevant, as sub-goals are especially interwoven here. Labor, i.e., agricultural activity, poverty, hunger, health care, education, consumption and production, inequalities or the impact on environment and climate are much more interdependent than, for example, in industrialized welfare states with strong, democratic institutions. Nevertheless, the behavior in these states, for example of producers and consumers via global demand systems, directly influences the well-being and behavior of people in less privileged regions of the world as well as the environment in these parts of the world (Kleemann et al. 2014; Chiputwa and Qaim 2016; Blackman and Naranjo 2012). Consequently, the development of sustainable production and consumption systems in the food and agricultural sectors is of paramount importance, as it can have a profound impact on the achievement of numerous interrelated SDGs with global impacts. In developing countries, a large share of the population is employed in the agricultural sector. The fact that on the African continent in 2021 on average 48.4 percent of the population was engaged in agriculture, which on the one hand includes subsistence farming, and on the other hand is part of global food systems, underlines the importance of examining international agricultural supply chains in particular (FAO 2022).

This dissertation seeks to examine palm oil supply chains in a global context. Only by considering as many parties of global food systems as possible, targeted recommendations for action can be given, which can have a relevant impact on the development of more sustainable production processes and consumption patterns. It is crucial to stress the importance of this work, which uses primary data from different points within global palm oil supply chains to provide a more accurate, holistic picture of the potential for the development of sustainable palm oil supply chains. This includes consumer data from the industrialized country Germany, producer data from companies operating in Europe that rely on palm oil to produce their goods, and data from smallholder palm oil growers in Ghana. By using this unique combination of primary data, this dissertation is able to provide an exceptionally comprehensive holistic picture of international palm oil supply chains.

Creating a holistic picture is of particular importance since without capturing the opinions, behaviors, and impacts of different players in global food systems, the intersections and potential entry points for developing more sustainable processes may be overseen, and a unilateral approach to only one group of supply chain participants may miss its mark due to non-compatibility with other supply chain participants. This fact underlines the importance of this research, which is hence enabled to provide integrated recommendations for more sustainable development pathways in the palm oil sector, taking into account the interdependency of different actors and SDGs.

1.2 The palm oil sector

Palm oil is one of the most produced, consumed, and traded vegetable oils, with a production volume of approximately 75.45 million metric tons. Indonesia and Malaysia are the world's largest palm oil producers, accounting for 58% and 26% of worldwide production, respectively. India (17%), China (14%), and the European Union (14%), are the three leading importers (USDA 2020). The oil palm is the most productive oil crop, with a current global average production of around 3.5 tons per hectare and maximum yields of up to 16 tons per hectare (Byerlee et al. 2017; Barcelos et al. 2015). The oil palm is a perennial, evergreen tree, and as displayed in Figure 1.1, cultivated in equatorial areas which are rich in biodiversity (Barcelos et al. 2015). With a few exceptions in West and Central Africa, where

palm oil production may also be found as part of agroforest systems and is more typically utilized for home consumption, cultivation is primarily done as a monocrop for commercial purposes. (Byerlee et al. 2017; Corley and Tinker 2003). One of the main conflicts in the global palm oil sector is the fact that, on the one hand, cultivation is associated with considerable negative environmental and social impacts, on the other hand, due to the highest yields per hectare compared to all other oil crops, the oil plant offers the potential to meet a large part of the global demand for vegetable oils with relatively low land consumption (Foster et al. 2011; Koh and Wilcove 2008; Qaim et al. 2020; Okoro et al. 2016). However, even with increased yields the amount of land devoted to growing palm oil has increased a lot, due to a massive increase in worldwide demand. The area of land used to grow palm oil has more than quadrupled since 1980 (Ritchie and Roser 2021). Over the same period, Ghana's share of palm oil production as a percentage of world market production has fallen from 27% to less than 1%, highlighting the huge expansion of production in the Southeast Asian region (MASDAR 2011). It is beyond any question that the expansion of production causes an equally strong increase in negative social and environmental effects.

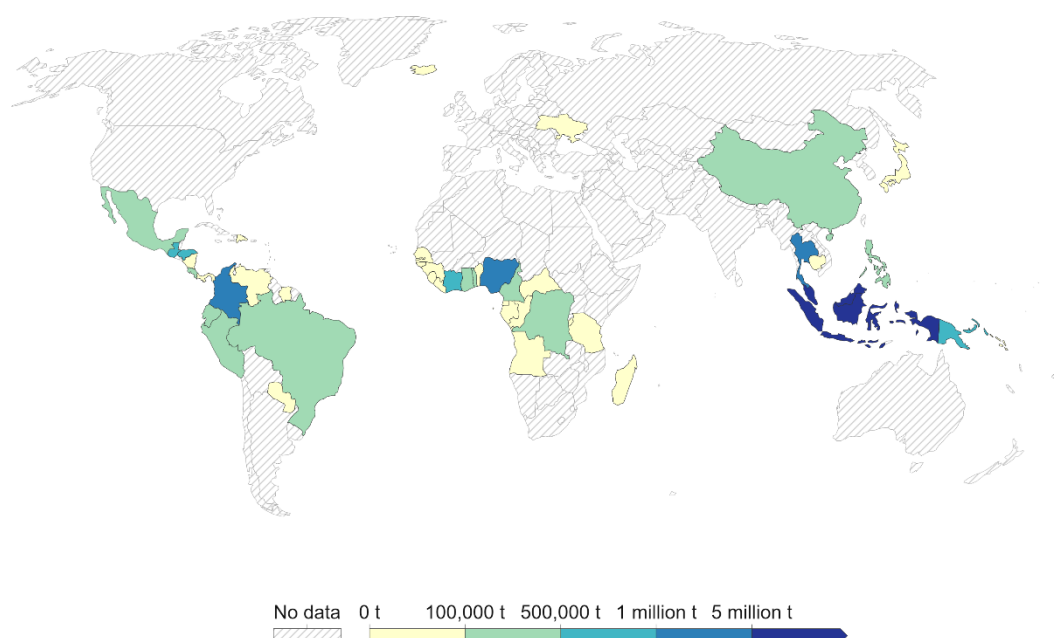


Figure 1.1 Oil palm production in metric tons, 2019

Source: Calculated by Our World in Data based on data from the UN Food and Agriculture Organization (FAO), 2019, adapted from Ritchie and Roser (2021)

However, when comparing the land use of oil palm with other crops, it immediately becomes apparent that promoting more sustainable palm oil is an important way to meet the world's demand for edible oil, as an increased switch to other oils would increase pressure on land (Ritchie and Roser 2021). This suggests that when compared to other oil plants, the negative image of palm oil is not entirely justified. Nevertheless, it is important to emphasize at this point that the negative consequences of palm oil cultivation are in no way intended to be questioned in this work.

Figures 1.2 and 1.3 present the relationship between land use of different oil crops and their yields per hectare. It becomes evident that palm has a relatively similar share of global land use as sunflower and a significantly smaller share than rapeseed or soybean, while in contrast it produces by far the largest yields per hectare. With only about 8.6% of global land use for vegetable oils palm oil accounts for about 36% of global vegetable oil (Ritchie and Roser 2021). In summary, therefore, a global boycott of palm oil would not solve associated problems, but only displace them, and on a greater scale, as more land is needed to meet global demand. The implementation of more sustainable land management practices in the palm oil sector is thus an important factor in making the global vegetable oil sector more environmentally sustainable and future-proof, and thereby contributing to global food security and the achievement of the SDGs. As an exemplary market within industrialized importing countries this dissertation uses data of the German palm oil market, where it is estimated that 48% of all palm oil imports are not certified, to analyze consumer preferences. Certified palm oil is divided into different types, such as *segregated* (27%), *mass balance* (21%), or *organic* (1%) oil. About 85% of the palm oil in food products is certified and 5% *organic* certified (Basili et al. 2018). More information on the palm oil sector and certification definitions is presented in Chapter 2.2 The Market of Sustainable Palm Oil and Chapter 3.2 Palm Oil Cultivation.

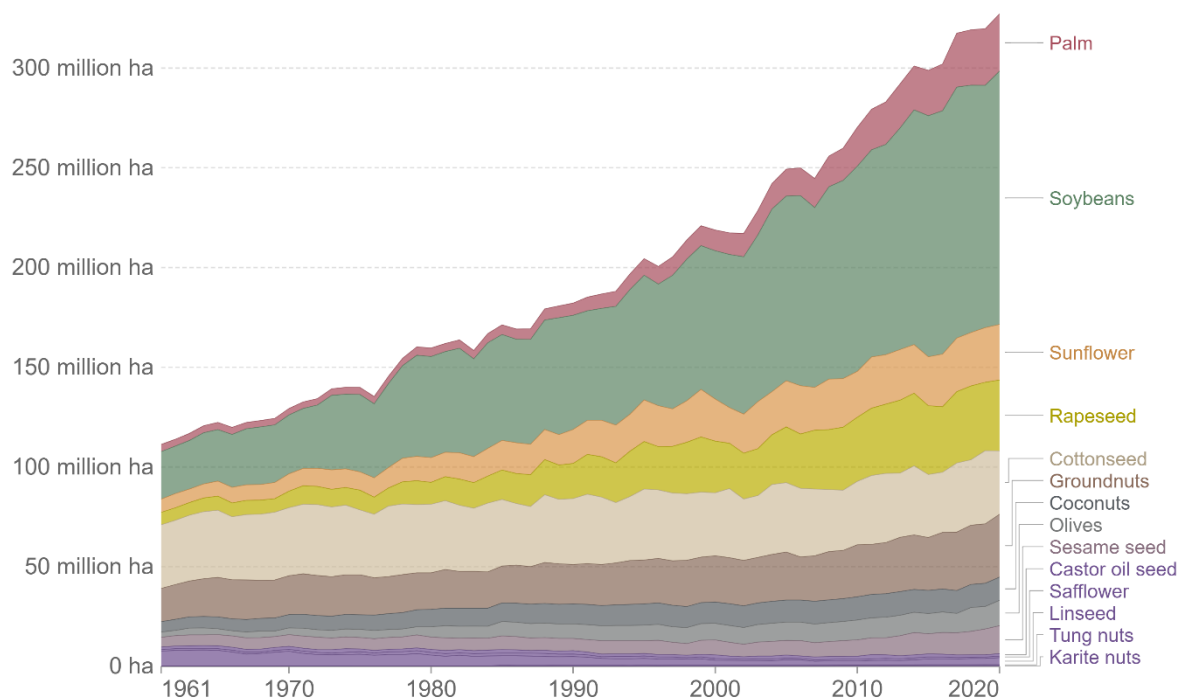


Figure 1.2 Land use for vegetable oil crops, world

Source: Calculated by Our World in Data based on data from the UN Food and Agriculture Organization (FAO), 2020, adapted from Ritchie and Roser (2021)

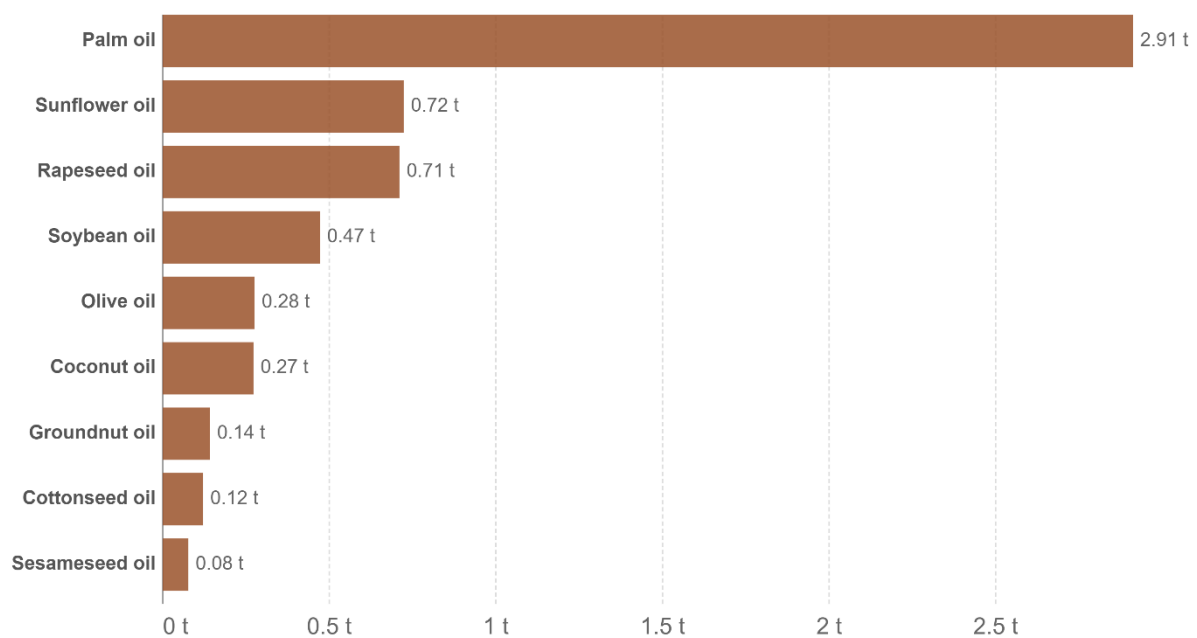


Figure 1.3 Oil yield per hectare of land by crop type, world, 2019

Source: Calculated by Our World in Data based on data from the UN Food and Agriculture Organization (FAO), 2020, adapted from Ritchie and Roser (2021)

As this dissertation puts a specific emphasis on organic certification which is still very rare in the palm oil sector, data from smallholder farmers in the Ghanaian palm oil sector are used for further analysis. In Ghana, smallholder palm oil farms certified according to EU and USDA organic standards have been established, which represents a special, globally almost unique situation. This provides the opportunity to analyze different types of certifications and to assess their impact on both the people and the environment.

Like other West African countries, Ghana is a rather small producer, with a production volume of less than 1% of the world market. Eastern, Western, Ashanti, and Brong Ahafo Regions account for 42%, 21%, 12%, and 10% of total production, respectively (USDA 2022b). As in many other agricultural sectors, the palm oil sector in sub-Saharan Africa is subject to the issue of low crop yields. The Food and Agriculture Organization of the United Nations (FAO) states that the reduced adoption of improved varieties is partly due to chemical properties, such as excessive solidification of the oil, or to the fact that the taste is unfavorable for traditional dishes (Poku 2002). The aspect that local production is insufficient to meet the growing domestic demand in Africa is problematic. Most African countries are therefore net importers of palm oil (MASDAR 2011). This fact highlights the problem of insufficient yields.

For example, average yields in Côte d'Ivoire and Ghana range from 1 to 3 tons per hectare, although large industrial estates can produce up to 10 tons per hectare. In contrast, yields on large private estates and state plantations in Indonesia can reach up to 16 tons of fresh fruit bunches (FFB) per hectare, with a projected maximum yield of 30 tons of FFB per hectare (USDA 2022a; Ofosu-Budu and Sarpong 2013; Rhebergen et al. 2018) (Herdiansyah et al. 2020). In West African countries, however, large-scale plantations are not yet the norm, and smallholders make up the majority of producers, often accounting for more than 80 percent of production, which stresses the importance of the participation of smallholder farmers in sustainable development of the sector (Barcelos et al. 2015; MASDAR 2011). The Ghanaian Ministry of Food and Agriculture (MOFA) states that the palm oil sector in Ghana has not experienced the same rapid expansion as the global palm oil industry. While most of

the main palm oil producing countries have increased output significantly, in some cases up to 12-fold, Ghana has not even been able to double output over the last decade. Even the typically well-organized industrial plantation industry has mostly failed to experience any kind of robust expansion, whether through extensification or intensification (MASDAR 2011). Nevertheless, as argued earlier, increased output of, ideally sustainably grown, palm oil is becoming crucial to not supporting more land-consuming crops or an unsustainable development pathway. Reduced yield gaps in the palm oil sector are critical to meeting the growing global demand for vegetable oil, which is especially important in terms of sustainable development, as increased output via improved practices would have a significantly lower impact on both land and environment than an expansive approach, as has been the case in Southeast Asia in recent decades (Varkkey et al. 2018).

Despite the substantial yield disparities between Western Africa and Southeast Asia, it is apparent that boosting productivity has the ability to reduce poverty and food insecurity while also promoting rural growth in growing regions (Gatto et al. 2017; Chrisendo et al. 2022). Additionally, palm oil cultivation in Ghana is an important employer for the local population and contributes to the food security of an estimated 119,724 people directly and more than two million people indirectly through the supply chain (GSS 2019; MASDAR 2011). By improving production capacity, palm oil producing countries in Africa could achieve significant economic and welfare gains, driven by growing demand for palm oil within the continent and on the global market (Asante 2021).

1.3 Certifications in food systems

Agricultural certifications aim to provide a precisely defined framework of requirements and specifications for production methods, appropriate inputs, management practices, and the general treatment of people and the environment, enabling every participant in a supply chain to rely on certain defined qualities. They thus represent classic signaling instruments that producers, for example, can use to communicate certain characteristics and qualities which are not accessible to all market participants in the same way due to information asymmetries. Certifications are designed to improve certain parameters in a production system and to communicate these improvements to the

processing or consuming side of the supply chain. Frequently applied objectives are fair compensation, for example for farmers in developing countries, or a reduced negative impact on nature and the environment. Certification is therefore an instrument for the direct promotion of SDG 12, responsible consumption and production, with profound overlapping effects on many other SDGs.

However, certifications are subject to various problems which can arise at all stages of the food production system. It is important, for example, that consumers are aware of a certification communicated by a particular label, that they understand and trust it, that they include it in their purchasing decisions, and that they exhibit an increased willingness to pay for it. All of these characteristics are not necessarily naturally given and depend to a greater extent on the individual characteristics of the products, the labels or even the consumers themselves. Hence, there is a risk of great heterogeneity with regard to the product or certification characteristics, and consumer preferences. Therefore, a core element of this dissertation is to capture consumer preferences for certified palm oil. After all, promoting or using a particular certification will only develop an economic rationale if individuals are generally interested in, i.e., have preferences and willingness-to-pay, for a particular certification. Since the latter depends on various factors, such as trust in the label-giving institution, and is difficult to transfer between products and consumer groups, an analysis in relation to the agricultural commodity palm oil remains indispensable. The preferences, opinions and interests of consumers must therefore be taken into account in order to guarantee the general economic viability of the signaling tool.

Regarding agricultural commodities, traders and manufacturers have to consider both ends of the supply chain in their production decisions. Consumer preferences as well as cost structures and availability must be included in the calculation. This presents industrial users of palm oil with the particular challenge of harmonizing both sides and adapting their production to the world market situation. The particular problem that producers face is the fact that they themselves, as clients, have to trust the signaling tools of the raw material producers and have to be willing to pay more for certified raw materials. At the same time, as producers, e.g., of end consumer products, they have to

communicate the increased quality of the products or raw materials in a credible way in order to benefit from the increased WTP of end consumers, and to maintain their own profitability.

An increased WTP is one of the central requirements for an increased sustainable product, since this increased WTP is required to finance the goals of the certification. Accordingly, achieving the goals of a certification represents another potential source of problems for certifications. Clearly, certification only serves a useful purpose if it actually contributes to the achievement of the objectives it communicates. Therefore, another central research focus of this dissertation is the impact assessment of different certifications in the palm oil sector. It is widely recognized in the literature that certifications of more sustainable agricultural practices with an environmental focus, in particular, can impose problems with respect to yield. Reduced crop yields in the context of sustainable agricultural practices or organic certifications are well documented in the research literature. Nevertheless, participation in certification programs for palm oil farmers in developing countries have to provide benefits that compensate for the potential disadvantages of reduced yields. In order to assess the usefulness of a certification, the assessment of its effectiveness is one of the most important elements, and thus also one of the most important aspects of this research work. Because only if a certification works in its intended purpose, a promotion is reasonable. Environmental benefits and social opportunities that arise from certifications are also well documented in the scientific literature, but do not necessarily have to occur, which makes an assessment in the palm oil context particularly important.

It becomes clear that a certification must meet various requirements in order to be considered useful. Hence, the holistic examination approach is of utmost relevance. After all, a certification for which there are no preferences, which is not economically sound, or which has no effects on social or environmental goals, can have its legitimacy for existence put into question. Consequently, allegations of so-called greenwashing or simply economic problems of users of the certification may arise.

Another interesting factor in the context of certification is the fact that such programs are often able to help overcome other problematic social structures and thus exert a positive impact on the

achievement of other SDGs. As farmers benefit from improved prices for their produce, there may be positive effects on poverty, hunger, well-being, education, life on land and below water, climate, economic growth, but also inequalities and gender equality. As access to international food supply systems is often organized by international corporations rather than by traditional social structures, positive effects on gender inequalities or general inequalities can also occur. In this context, women can also be explicitly included in certification structures to promote equality and strengthen regions and incomes. At the same time, inequalities, for example in terms of income, in end-product-consuming industrialized countries may prevent a large proportion of people from being able to afford an increased WTP for more sustainable products, so that inequalities in richer parts of the world may also have an indirect impact on the household welfare of farmers in developing countries.

It becomes quite apparent that certifications can make a contribution to the achievement of the SDGs. At the same time, the extreme complexity of the effects of certifications on international food systems also become evident. This dissertation therefore attempts to shed more light on these complex impacts by examining international palm oil supply chains from different perspectives. The contribution of each Chapter to this objective is presented in the following.

1.4 Structure of the thesis

Chapter 2 examines consumer preferences for organic and RSPO certified palm oil products using a discrete choice experiment, and analyzes the effect of factual information on consumers' food choice behavior and attribute non-attendance (ANA) patterns. A hybrid latent variable model that allows to jointly examine response to the stated choice component and to attribute-processing questions, i.e. stated ANA, while controlling for heterogeneous preferences is employed (Bello and Abdulai 2016). This approach aims at identifying consumer preferences and willingness-to-pay (WTP) for sustainability indicators, and at determining which labeling institution is best suited to promote sustainable palm oil consumption, given that consumers pay the most attention to a specific certification when making product choices.

The consumer data was collected between December 2019 and February 2020. A random sample of 460 respondents across Germany was recruited through personal, postal contact. In a cover letter, the individuals contacted were invited to participate in a survey on the topic of sustainability labeling of food products. The survey was then conducted on a browser-based platform. Participants were randomly assigned to different product and information intervention groups.

The results of the Chapter reveal that products with organic palm oil are ranked at the highest monetary value by consumers in the total sample as well as in the groups with and without information intervention. The results also show that providing additional information tends to change consumers' non-attendance patterns and WTP levels. Specifically, providing factual information on the topic of palm oil increases consumers' WTP scores and decreases their ANA scores for attributes indicative of improved sustainability. The results suggest that the attribute for organic quality has the potential to rank highest across the entire latent variable structure, making it the most promotable attribute for encouraging the use of sustainable palm oil across all consumer groups.

The third Chapter then examines the extent to which certifications have an impact on Ghanaian smallholder palm oil farmers. Primary survey data from 400 farmers is used to determine the drivers for the decision to participate in organic or Roundtable on Sustainable Palm Oil (RSPO) certification schemes. The study then examines how each certification scheme impacts different areas of sustainability, by analyzing the impacts on farm household welfare, food security, and environmental outcomes. To account for selection bias arising from observed and unobserved factors, a multinomial endogenous switching regression method is applied. The data was collected between March and May 2021 in palm oil producing regions Eastern, Western, and Central Ghana and include 133 non-certified, 158 RSPO certified and 109 organic certified farmers. The empirical results of Chapter 3 reveal that Farmers who engage in the RSPO certification process have higher net farm revenues and are more food secure than non-certified farmers, while their negative environmental effect from agrochemicals is decreased. By comparing organic certification to non-certification, the results reveal similar effects. Organic yields are significantly lower when compared to non-certified farmers. Additionally, and of

particular importance with respect to the assessment of the RSPO and organic certifications is the finding that both farmers and the environment benefit more from organic certification than from RSPO certification.

The fourth Chapter uses the same data to examine the impact of organic and RSPO certifications on the production frontier and efficiency of smallholder farmers in Ghana using a stochastic frontier model with an endogenous treatment status and mediator. The motivation for this methodology stems from the previously described problem associated with the risk of reduced yields due to sustainability certifications. The model enables a decomposition of the treatment effects into technology frontier and inefficiency components. Extension participation is used as mediation component in this Chapter. The mediation analysis allows to disentangle the direct effects obtained through other channels than extension participation from the indirect effects of learning good management techniques which are specific to RSPO or organic certification, mediated via extension participation. The rationale behind this approach is that certification, by means of its strict regulations, could also exert negative direct effects on the technology frontier and efficiency. As a result, certified farmers' yields could be significantly reduced. Since certification programs are often accompanied by tailored extension services, the objective of this study is to examine whether these can act as mediators to counteract the potentially negative direct effects of the regulations of the certifications. At the same time, strict regulations could also increase soil fertility, resulting in positive direct effects. Therefore, the directions of the effects cannot be predicted beforehand. In order for farmers to accept and participate in certification schemes, it is crucial that such schemes provide positive benefits in some way. Therefore, not only crop yield and yield gaps, but also effects on net farm revenue, i.e., economic productivity of the farm, are analyzed in this chapter.

The empirical results of this chapter indicate that both certification schemes have the negative potential to increase yield gaps in smallholder palm oil production systems. The negative impact on the total impact results mainly from the negative direct impact on the technology frontier. However, the indirect effects, i.e., the effects mediated through extension services, counteract this trend,

suggesting that both certification schemes are supported by the provision of adequate extension services that improve farmers' management skills. The results indicate that adequate extension services are an important and effective tool to counteract the effects of restrictive certification, although they do not yet appear to be sufficiently developed to prevent yield losses altogether. However, farmers under both certification schemes are able to generate considerable welfare gains from improved net farm incomes. This is an important finding, as without these benefits, farmers would have no incentive to join certification schemes, which in turn would eliminate any potential for environmental or social improvements.

The fifth chapter takes a closer look at the previously described interlinkages between the SDGs. It focuses in particular on SDGs 5, gender equality, and 6, reduced inequalities, as these goals have the potential to contribute to an increased extent to the achievement of other SDGs, and also because their achievement can be strongly supported by other goals, such as certified food supply chains, i.e., the achievement of holistic sustainable consumption and production patterns. In other words, this chapter discusses in more detail the extent to which modern food systems are interwoven with the achievement of the SDGs and vice versa. The chapter discusses the facets of global and gender inequalities and draws conclusions, also regarding the behavior of industrialized nations and consumer choice behavior in these countries, with respect to the achievement of the SDGs. Especially in the context of global agricultural supply chains and food systems, combating inequalities is particularly important, as they can, for example, hinder sustainable land management and thus further exacerbate negative effects on the environment and climate. Interrelationships like these demonstrate the vast complexity of the issue and further emphasize the interdependence of the SDGs, production and consumption patterns and individual as well as institutional behaviors. Finally, Chapter 6 summarizes key findings of this dissertation.

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Chapter 2

The role of information in consumer preferences for sustainable certified palm oil products in Germany

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Abstract

Food products are often subject to information asymmetries, which are commonly supposed to be reduced by labels and certifications. However, as the number of labels increases, consumers tend to get confused, bored or impatient and stop using them to make product choices. This study uses data from a discrete choice experiment, conducted in Germany, to analyze consumers' preferences and willingness-to-pay (WTP) for sustainability indicators on products that contain palm oil as an ingredient. Since information is crucial to the assessment and awareness of, or attendance to, labels on consumer products, this study assesses the effect of factual information on preferences as well as attribute-processing strategies. We use a hybrid latent variable model that allows us to jointly examine the response to the stated choice component and the responses to attribute processing questions, thus capturing attribute non-attendance (ANA) to specific labels while controlling for heterogeneous preferences. Our results reveal that the attribute 'organic' receives the highest monetary valuation in the overall sample as well as in the information intervention, and the no-information intervention groups. The results also show that providing additional information tends to change consumers' non-attendance patterns as well as WTP values. In particular, the information intervention tends to increase consumers' WTP and decreases their ANA for sustainability-indicating attributes. The findings suggest that the attribute 'organic' has the potential to be ranked highest across the entire latent variable structure, making it the most promising attribute for promoting sustainable palm oil use across consumer groups.

Keywords: attribute non-attendance, consumer behavior, palm oil, willingness-to-pay, consumer preferences

2.1 Introduction

Consumers normally face uncertainties, because various food product attributes are incomprehensible or intransparent credence type attributes. Credence characteristics are product characteristics for which utility cannot be exactly determined even after consumption (Benz 2007). Examples are sustainability properties indicated by sellers, which buyers cannot verify without very high pre- and post-buying costs. Information asymmetry can therefore lead to market failure, as the desire to match food choices with personal preferences may fail due to lack of information on the consumer side (Verbeke 2005). Since consumers need reliable information to help them in their consumption decisions to maximize utility, specific labels and certifications are normally used to provide effective information to them. The recent empirical literature shows that the concept of signaling tend to motivate consumers to increase their willingness-to-pay (WTP) for food products. For example, Van Loo et al. (2014) and Spiller et al. (2015) find increased WTP values or strong consumer preferences for certain quality indicating meat product attributes. Some studies also find increased WTP for fair trade and organic quality and other environmental sustainability indicators for regional agricultural products, as well as for products from tropical regions (e.g. Basu et al. 2016; Chen et al. 2018; Loureiro and Lotade 2005; Janssen and Hamm 2014).

The recent literature in the field of consumer preferences for palm oil suggests that consumers prefer certification measures that clearly reduce transparency problems within the supply chain (Gassler and Spiller 2018). Gasslers and Spillers' (2018) findings reveal that consumers are willing to pay a price premium of €0.85 for a Roundtable on Sustainable Palm Oil (RSPO) certified chocolate product. Results by Hinkes and Christoph-Schulz (2020) indicate that consumers on average prefer palm-oil-free products over certified products. The authors explain this choice behavior partly as a result of consumers' health concerns and a potential lack of trust in certification (Hinkes and Christoph-Schulz 2020). However, even though the authors of this study have integrated more labels into their choice tasks, they still neglect the fact that people do or do not pay specific attention to some product attributes. In other words, that people rely on heuristics. Not accounting for such heuristics may lead

to biased WTP estimates in the latent class model presented in Hinkes and Christoph-Schulz (2020). Our study extends the approaches used in previous studies and attempts to shed more light on precisely these behavioral structures, as multiple labels in the market can also become a problem for consumers. Since consumers are often faced with numerous labels, the notion of ‘bounded rationality’ (Simon 1957) raises the question of how and whether labels still facilitate consumers’ product choices today.

Some studies have revealed that as the number of labels increases, consumers tend to get confused, bored or impatient, with the probability of their ability to understand the individual labels and their informative value decreasing (Buxel 2018; Verbeke 2005). As a consequence, they no longer rely on labels when making choices or buying products. The use of heuristics refers to the application of simplistic decision-making rules, which may lead to biased estimates when not considered in statistical approaches (Hensher 2006). Consumers tend to use heuristics when situations are too complex to assess, when they are uncertain, or when motivation and potential personal consequences are low (Tversky and Kahneman 1974). This simplification can, for example, result in the non-attendance to certain attributes when choosing products, the so-called attribute non-attendance (ANA). We often find this concept in choices of low-involvement goods such as food products (Beharrell and Denison 1995), where consumers use routine purchasing patterns or heuristics that is, deliberately leaving out some attributes when evaluating products. As indicated above, recent literature shows that taking into account ANA sheds a more profound light on consumers’ decision-making behavior and that ignoring these heuristics can bias empirical estimates. More specifically, studies show changing WTP values for sustainability indicators on food products when ANA is included in the estimates (e.g. Bello and Abdulai 2016; Caputo et al. 2018; Richartz et al. 2020). Since the consideration of sustainability indicators in food choice situations is essential for products’ success, and thus the achievement of sustainability goals, it is necessary to examine whether and how ANA can be influenced, for example, through public information campaigns or by information imparted at the point of sale. Our study attempts to fill this gap in the literature by addressing this issue.

We use a discrete choice experiment to determine consumer preferences for certified palm oil, and explore the effect of factual information on consumers' food choice behavior and ANA patterns. Our study contributes to the literature by using a hybrid latent variable model that allows us to jointly examine the response to the stated choice component and to attribute-processing questions, thus also capturing stated ANA (Bello and Abdulai 2016). The objective of this approach is to identify consumer preferences and WTP for sustainability indicators and to identify which labeling institution is best suited to promoting sustainable palm oil consumption, as consumers pay the most attention to a specific certification when making product choices.

As part of the present study, an information treatment group received factual information on the topic of palm oil cultivation before continuing with an unlabeled Choice Experiment (CE), in which hypothetical purchasing decisions had to be made between palm oil-containing product alternatives. For example, respondents received information about global problems resulting from palm oil cultivation, information on yields or employment and livelihood opportunities for farmers in cultivation regions. Since our focus is on labels relating to environmental protection, no health claims were included in the information treatment. No organizations, certification bodies or other institutions were presented negatively or positively in this context, in order to prevent a biased attitude being formed by participants towards certain labels or regulatory mechanisms. This distinguishes our work from other studies, that often provide little information about the controversy of the topic or which strictly provide information about the labels themselves, such as the meaning of the label or the criteria of production conditions. One informational side (positive / negative) is often neglected, so that it can be assumed that respondents conduct the experiments in a biased manner (Hinkes and Christoph-Schulz 2020; Gassler and Spiller 2018; Lusk et al. 2004). We argue at this point that the linking of factual information that is, the fact that people have or do not have knowledge about certain topics is more in line with reality, and that consumers evaluate facts and thus products and labels with the help of their personal knowledge. This would be contrasted by a consumer who is strictly informed about certain labels. However, it is unclear how consumers evaluate products using a label without

having sufficient background knowledge. Here one can assume two scenarios. Either the person must have received the corresponding factual information in addition to the information about the label to be able to assess the product or he or she evaluates a label without knowing the background exactly. In the latter case, however, he or she would not know whether the label is even reasonable or trustworthy or not and the decision would be made on the basis of more, though not necessarily processable, information. We argue that providing information only about the label itself would not solve the previously mentioned problem of information overload.

When consumers are faced with product choice under many different labels, all of which they understand the meaning of, they would still have to decide which institution or label they trust the most to make a final product choice. However, it is unrealistic to expect every consumer to learn everything about every label. In contrast, it seems more realistic for the industry or official regulatory bodies to focus on labels that are understood, trusted and accepted by the consumer. Therefore, it is not only essential to determine preferences and WTP for product attributes, but it is just as important to understand which of these attributes are being paid attention to in the first place. Thus, we also contribute to scholarly knowledge by using the analysis of consumers' attribute-processing strategies, to identify the label to which consumers pay most attention to. Further, we contribute to the literature by presenting, to the best of our knowledge, the first study to examine the effect of factual information on ANA patterns related to attributes of food products. Finally, this study contributes to the literature by providing insight into both attitudes and expectations of palm oil using companies in the food sector and expectations of consumers through the use of primary data.

The rest of the paper is structured as follows. The next section discusses the background of oil palm cultivation and palm oil in food products, as well as the literature relating to this issue. Section three outlines the econometric framework used in the analysis, while section four presents the survey design. The empirical results are discussed in section five, and the final section presents conclusions and implications.

2.2 The Market of Sustainable Palm Oil

In 2015, the United Nations added sustainable consumption and production to the agenda of the Sustainable Development Goals (SDG). In particular, goal 12 of the SDGs aims to reduce future economic, environmental and social costs, strengthen economic competitiveness, increase incomes, reduce poverty and improve food security. The goal is to improve people's quality of life worldwide by reducing resource consumption, degradation and environmental pollution (United Nations 2020). Since these commitments affect global supply chains, action by both industrialized and developing countries is required. For consumers of products with ingredients from many parts of the world, it is therefore of paramount importance to be able to distinguish between more or less sustainable products and production processes. This requires consumer knowledge and education, i.e., information about sustainable consumption as well as interrelationships and consequences on a global scale. Knowledge and education are indispensable prerequisites for promoting sustainable development and improving people's ability to address environmental issues. They are necessities for bringing about a change in people's consciousness so that they are able to assess and address their concerns about sustainable development. They are also crucial for creating environmental and ethical awareness, as well as values and behaviors compatible with sustainable development, and for effective public participation in decision-making (e.g. Stoltenberg and Burandt 2014; Wals 2010).

The present study focuses on products that contain palm oil. Due to its prominent role in the world market for vegetable oils and with its global supply chains, palm oil is of particular importance. With a production volume of about 75.45 million metric tons, palm oil is one of the most produced, consumed, and globally traded vegetable oils. The world's major palm oil producers are Indonesia and Malaysia with 58% and 26% of global production, respectively. The main importers are India (17%), China (14%) and the European Union (14%) (USDA 2020). Compared to other oil crops, the oil palm is the most productive, with a current global average yield of around 3.5 tons per hectare and maximum yields of up to 6 tons per hectare (Byerlee et al. 2017; Barcelos et al. 2015). The oil palm is a perennial, evergreen tree, cultivated in equatorial areas rich in biodiversity (Barcelos et al. 2015), and the cultivation is

mostly done as a monocrop for commercial purposes, with some exceptions in West and Central Africa, where it can also be found as part of agroforest systems and more often used for domestic consumption (Byerlee et al. 2017; Corley and Tinker 2003). In this study, we focus on the German market, where it is estimated that 48% of all palm oil imports are not certified. Certified oil is divided into different types, such as *segregated* (27%), *mass balance* (21%), or *organic* (1%) oil. About 85% of the palm oil in food products is certified (i.e. *segregated*, *mass balance*, *book and claim*, and others) and 5% *organic* certified (Basili et al. 2018). Segregated refers to palm oil from different certified sources and is kept separate from ordinary palm oil throughout the supply chain. The category 'mass balance' implies that millers, refiners or retailers can acquire palm oil from both certified and non-certified sources and process them together, without the need for separate supply chains. The Roundtable on Sustainable Palm Oil (RSPO) 'book and claim' describes a system where the supply chain is not monitored for the actual presence of sustainable palm oil. Stakeholders in the supply chain are allowed to buy RSPO credits (RSPO 2020).

Negative impacts arising from palm oil production such as deforestation, habitat loss, decline in species populations and biodiversity have been very well documented (Foster et al. 2011; Koh and Wilcove 2008; Qaim et al. 2020; Okoro et al. 2016). Additionally, if slash and burn practices are used to clear the land for cultivation, smoke and toxic compounds with negative impacts on people and wildlife can occur (Crippa et al. 2016; Dislich et al. 2017). Other indirect effects are downstream water pollution from fertilizers or negative impacts on soils and waterbodies due to toxic compound-releasing palm oil mill effluents (Abrams et al. 2016; Khatun et al. 2017). However, manual weeding of plantations and harvesting of fresh fruit bunches is labor intensive, which makes cultivation an important livelihood option in growing regions (Byerlee et al. 2017). Moreover, due to its high yields per hectare, the oil palm has the potential to meet a large part of the global demand for vegetable oils with relatively low land use. These conflicting positions, on the one hand the resulting social and environmental problems, and on the other hand, the potential sustainability of the commodity, underline the importance for reliable guidelines governing sustainable consumer behavior. This importance is exacerbated by the

fact that palm oil is found in many products, which increases the demand for crude palm oil and thus the area under cultivation. It is estimated that close to 50% of products found in supermarkets contain palm oil, highlighting the importance of this commodity in terms of sustainable consumer choices (Oosterveer 2015). However, European consumers have become increasingly concerned about the adverse effects of palm oil production. Reactions to its use have been, for example, boycotts or campaigns led by non-governmental organizations (NGO) against plantation-funding institutions, retailers and processors (Teoh 2010).

To change consumption patterns and preferences in regions with high demand, such as the EU, consumers need reliable sources of information to address the problems associated with palm oil production. Although the RSPO aims to set a global sustainability standard for palm oil production, there are various uncertainties about this body. Founded in 2004, the RSPO is a voluntary membership association bringing together different private stakeholders, such as investors, processing firms, growers and NGOs, to promote economic, social and environmental sustainability in the production and use of palm oil. However, it has been referred to as pro-industry biased (Laurance et al. 2010), and criticized for not addressing the real problems of unsustainable cultivation (McCarthy 2012; Oosterveer 2015). The main reasons cited for this assessment include, for example, weak reporting, monitoring and enforcement mechanisms in the context of corporate sustainability or the lack of an effective system for monitoring and enforcing compliance at the micro level (Laurance et al. 2010; Reed and Reed 2009). Furthermore, there are different categories within the RSPO certification pathway such as 'mass balance' or 'book and claim'. For example, regarding the certification category 'mass balance', the RSPO states on its official website that a product can be RSPO-certified under the mass balance system and thus carry a label. Sustainable palm oil from certified sources can be physically included in the product, but may be mixed with conventional palm oil. In fact, in this case, the consumer does not have a full guarantee that the product actually contains sustainable palm oil (RSPO 2017). However, recent literature shows that consumers prefer segregated supply chains and uncertainty-reducing measures (Gassler and Spiller 2018). Therefore, the certification structure may

create transparency problems for less informed market participants. Nevertheless, this system also has advantages, as producers are not required to maintain separate supply chains, which can reduce transaction costs and allow for a gradual shift to more sustainable supply chains (Gassler and Spiller 2018). Another issue of great concern is the fact that many consumers are relatively unaware of the label. This raises the question of whether RSPO indeed represents an effective approach to sustainable oil palm cultivation. Thus, even though palm oil is no longer hidden in ingredient lists of food products (European Parliament 2011), considerable communication efforts will be required to increase consumer awareness and demand for sustainable palm oil (Gassler and Spiller 2018; Laurance et al. 2010). As indicated earlier, studies have shown an increased WTP or preferences for certified products. It can be concluded that clear preference structures with respect to particular certification bodies are generally not given across consumer groups or product types. Producers face the challenge of making the (right) decision for or against the use of certain labels, since investing in certification must be profitable and there are considerable differences regarding trust and acceptance of labels. Therefore, the next section focuses on the palm oil sector in Germany through the use of primary data. Both shared and conflicting opinions could provide stakeholders with important insights on how to maximize the utility of all market participants. We want to emphasize that only by identifying the most appropriate or accepted institution can an economically, environmentally and socially precise instrument for promoting sustainable consumption be developed and implemented efficiently.

In addition to consumer data, we collected data from companies in Germany that use palm oil to manufacture their confectionary and/ or chocolate products. The short survey was carried out in February 2020. About 87 (74%) companies that participated in our survey belong to the category of palm oil users. Appendix Chapter 2 Table 2.A1 shows an overview of the company sizes we surveyed. Within the category of oil palm users, only 4.6% stated that another agricultural commodity could *easily* serve as a substitute in their products, while 9.2% indicate that they could switch to another commodity with *little expenses*.

About 45% of the respondents indicated that palm oil can be replaced at *very high costs*, while 30% stated that it *cannot be replaced at all*. On the use of palm oil, 84% of the companies reported that they *exclusively* use certified oil, while 11% stated that they *mostly* use it. However, the certified commodities used by the companies differ. For example, 63% use RSPO-certified palm oil with segregated supply chains, 22% use palm oil from sources with other RSPO certification standards, such as book and claim. Organic certified palm oil is *sometimes* used by 11% of the companies. When asked whether the companies can imagine using only organic palm oil in the future, their responses differ, with 46% indicating that it is *likely* or *very likely*, while 54% stated that it is *unlikely* or *very unlikely*. 44% of the producers stated that they do not have any information on the region of origin of the commodity used for their products. When companies were asked about their future expectations of developments in the market and of sustainability aspects with regard to their own ability to adapt to more sustainable production methods, divided opinions also emerge. About 60% have *positive* or *extremely positive* expectations of the aforementioned, prospective transformations, while 40% of respondents already have concrete plans to adapt their company to more sustainable concepts and production methods. Nevertheless, the companies explained that they had used little or no organic palm oil so far due to high costs (53%), availability (19%) and uncertainties regarding secure supply chains (9%). However, most companies (67%) cannot imagine implementing a project initiative of their own, such as those that exist in West Africa, to ensure that their production requirements are met by means of a sustainable palm oil supply chain. Interestingly, 28% of the companies indicated that they could imagine participating in the implementation of a sustainable palm oil value chain project.

2.3 Econometric Framework

Our empirical analysis employs the framework by Hess and Hensher (Hess and Hensher 2013), where the link between the stated choice and the attribute-processing component in the model is made by a latent variable (LV) which relates to the unobserved respondent-specific importance measure for each attribute. Starting from the perspective of the traditional random utility model, we define the utility

of alternative i for respondent n in choice scenario t as $U_{int} = V_{int} + \varepsilon_{int}$. With J alternatives ($j = 1, \dots, J$), the probability of alternative i being chosen is given by:

$$P_{int} = P(V_{int} + \varepsilon_{int} > V_{jnt} + \varepsilon_{jnt}, \forall j \neq i) \quad (1)$$

where V_{int} represents the deterministic and ε_{int} the random component of the utility. The deterministic component of utility is given by a function of observed attributes x and estimated parameters β , $V_{int} = f(x_{int}, \beta)$, where a linear in parameters specification is employed. To account for preference heterogeneity, we employ a Mixed Multinomial Logit (MMNL) model, where we accommodate random variation across respondents in β with a type I extreme value distribution for the remaining error term ε . We define

$$P_{int}(\Omega) = \int_{\beta} \frac{e^{V_{int}(\beta)}}{\sum_{j=1}^J e^{V_{jnt}(\beta)}} h(\beta|\Omega) d\beta \quad (2)$$

where $\beta \sim h(\beta|\Omega)$, with Ω being a vector of parameters to be estimated. Since we work with repeated choice data, we follow Hess and Hensher (2013) with the assumption of intra-respondent homogeneity so that the likelihood of the actual observed sequence of choices for respondent n is then given by:

$$L_n(\Omega) = \int_{\beta} \left[\prod_{t=1}^T P_{i^*nt}(\beta) \right] h(\beta|\Omega) d\beta \quad (3)$$

where i^*nt refers to the alternative chosen by respondent n in choice situation t .

As indicated previously, in addition to capturing information on the choices, we also gathered information relating to respondents' attribute-processing strategies. The approach employed in this study uses the mutually exclusive, stated attribute rankings to determine the attribute non-attendance (ANA) indicators. We treat the answers to information processing as dependent variables that are a function of the true underlying processing strategies. We assume that for every attribute k , each respondent n has an underlying, latent rating of attribute importance. This underlying, unobserved rating is thus given by a latent variable:

$$\alpha_{nk} = \varphi_k z_n + \sigma_l \eta_{nk}^l \quad (4)$$

where z_n represents respondents' characteristics as well as answers to attitudinal questions relating to trust, consumption and environmental issues. η_{nk}^l is a random term assumed to follow a standard normal distribution across respondents and across the K different attributes. The vector φ_k explains the effect of z_n on the latent variable α_{nk} .

To model the probability for the response to the ranking question (ANA-indicators), we make use of a rank exploded MNL model, where the probability to fall between specific thresholds is influenced by the latent variable α_{nk} . The mutually exclusive rankings for the K attributes are given by R_k , $k=1, \dots, K$ where $1 \leq R_k \leq K$, $\forall k$. We specify:

$$\gamma_{nk} = \zeta_k + \tau_k \alpha_{nk}, \forall k \quad (5)$$

where ζ_1 is set to 0 for normalization purposes. The conditional probability is then given as:

$$v_{nr} = \sum_{k=1}^K \delta_{(R_k, r)} \gamma_{nk}, r = 1, \dots, K \quad (6)$$

where $\delta_{(R_k, r)}$ is equal to 1 if $R_k = r$, i.e., if attribute k has ranking r , and 0 otherwise. With ζ and τ grouping together the individual elements ζ_k and τ_k respectively, the probability for the response to the ranking question is specified as:

$$L_{Rn}(\zeta, \tau, \alpha_n) = \prod_{r=1}^{K-1} \frac{e^{v_{nr}}}{\sum_{s=r}^K e^{v_{ns}}} . \quad (7)$$

To link the latent variable α_{nk} which explains the answers to the non-attendance and ranking questions to the choice model, we use α_{nk} as shrinkage factors in the choice model component, thus allowing for a continuous measure of importance, i.e. using a latent variable scaling approach (Bello and Abdulai 2016). We replace the parameter β_k in the choice model component by $e^{\lambda_k \alpha_{nk}}$ by computing the attribute-specific scaling parameters $\lambda = \langle \lambda_1, \dots, \lambda_K \rangle$. We use two separate components to capture heterogeneity, α_{nk} and β_k , to allow for the absence of a strict relationship between attribute importance and sensitivities, thus capturing any unrelated random heterogeneity in β_k . Conditional on α_{nk} and β_k we specify:

$$P_{int}(\beta, \lambda | \alpha_n) = \frac{e^{\sum_{k=1}^K \lambda_k \alpha_{nk} \beta_k x_{k,int}}}{\sum_{j=1}^J e^{\sum_{k=1}^K \lambda_k \alpha_{nk} \beta_k x_{k,int}}} \quad (8)$$

where $x_{k,int}$ is the k th component in x_{int} . A positive estimate for λ_k here indicates that as the importance rating rises in value, so does the marginal sensitivity to attribute x_k (Bello and Abdulai 2016). Thus, the values of the attribute-processing component $L_{Rn}(\zeta, \tau, \alpha_n)$ are jointly modeled with the likelihood of the observed choice sequence $P_{int}(\beta, \lambda | \alpha_n)$.

Model- and group-specific WTP values for the different product attributes X are calculated as the rate of change in the attribute coefficient β divided by the rate of change of the price parameter y_{ps} (marginal rate of substitution). This is given as

$$WTP = - \left(\frac{\frac{\partial U}{\partial X}}{\frac{\partial U}{\partial P}} \right) = - \frac{\beta_{as}}{y_{ps}} \quad (10).$$

2.4 Survey Design and Data Description

To control for quantity effects, two different products, containing different amounts of palm oil were considered in the choice experiment (CE). In September 2019, we conducted face-to-face consumer pretests in front of a total of ten stores of the five leading German supermarket chains to determine relevant products as well as attributes of importance. Our pretest sample of 100 randomly selected respondents consisted of 52% women and had an average age of 41 years. The consumers were asked whether they regularly or at least occasionally buy the products of interest. They were then asked what attributes they pay most attention to when buying the products, i.e., which attributes are crucial to their product choice. Finally, the interviewers recorded basic socioeconomic data as well as the location of the purchase and store type. Based on the results, we selected chocolate cookies and chocolate spread, two common food products where people pay attention to and value different attributes such as ingredients or certifications, as the products to analyze. Other products, such as margarine, were eliminated by the pretest because consumers revealed a pronounced indifference regarding product alternatives or attributes. In contrast to other studies, our pretest clearly indicates

that consumers are mostly sensitive to the brand (36%) and chocolate type (28%) when buying chocolate cookies. In other choice experiments, however, the chocolate content of chocolate cookies was used as an attribute (Hinkes and Christoph-Schulz 2020), which was perceived as marginally important in our pretest (5%). The pretest data on the chocolate spread results in an even clearer picture. 64% of the total sample based their shopping decision mainly on the brand. Therefore, we have included brand as an attribute in the CE in addition to sustainability indicators.

During the survey period from December 2019 to February 2020, we randomly sampled 460 respondents across Germany via postal contact. The personally addressed individuals were invited to participate in a survey about sustainability labels on food products. The postal invitation to the study featured different ways and possibilities for accessing the questionnaire. The questionnaire was then carried out on a browser-based platform. The participants were randomly sampled into the two product groups. The final distribution of evaluable questionnaires consists of 46% and 54% of participants in the cookie and the spread groups, respectively. Furthermore, 50% of the participants were randomly assigned to the information intervention group, while the rest did not receive any information intervention. We would like to emphasize again that the information provided refers exclusively to facts concerning oil palm cultivation and to advantages and disadvantages resulting from it (Appendix Chapter 2 II). We also provided some very basic information on the displayed labels in both groups (Appendix Chapter 2 Table 2.A2). Furthermore, our questionnaire contained general questions on socio-demographic characteristics, on attitudes towards environment and sustainability, shopping behavior, risk and trust attitudes, the choice experiment, and questions on price expectations and perceptions as well as attribute processing strategies and importance.

We use the RSPO label because it was developed to communicate sustainability in the palm oil sector. We also include the German organic label, as it is one of the well-known sustainability indicators in Germany and one of the most helpful labels from a consumer's point of view (Buxel 2018). Along with concerns about chemical substances, environmental ethics and protection are among the most important considerations consumers make when choosing organic products (Baudry et al. 2017; Wulff

et al. 2021) Due to the aforementioned potential effect of consumers being overwhelmed by too many sustainability labels and in addition to the RSPO and the German 'Bio' (organic) label, we have integrated a hypothetical sustainability label into the experiment in order to test acceptance via familiarity and easy interpretability. The appearance of the label is identical to the appearance of the 'Haltungsform' label, which provides consumers with information about animal husbandry and transparency indicators in the food retail sector in Germany. Using a simple, ascending system of four levels (1, 2, 3, 4), the label was developed to be as informative as possible, quickly and easily. A visualization can be found in Appendix Chapter 2 Table 2.A2. The individual prices are calculated based on real prices across different supermarkets and quality categories. This means that we have included average prices from very low-priced private labels as well as average prices from the premium segment of products in the experiment. Based on our research, we decided on four price categories, as these realistically reflect the German market. We thus represent the lowest discount range, the more premium private label or low-priced brand range, the average brand range, and the average premium price range. The attribute brand simply describes whether or not the product is (in the participants' view) a well-known brand. Table 2.1 presents the attributes and their corresponding levels.

Table 2.1 Attributes and Attribute Level in the Choice Experiments.

Attributes	
RSPO Label / Certification	No / Mass Balance / Segregated
German organic (Bio) Label / Certification	No / Yes
4-Level Label / Certification	No / Level 2 / Level 4
Brand	No / Yes
Price (spread / cookies)	1.29€, 1.99€, 2.79€, 3.99€ / 0.99€, 1.29€, 1.99€, 2.79€

Participants had to take part in the unlabeled CE that is, they had to choose one of the presented products in each of the six choice scenarios. A *no-buy* option was always selectable. Participants could therefore choose between three alternatives in each choice scenario. The labels were presented graphically, as shown in Appendix Chapter 2 Table 2.A2. The participants were introduced to the

hypothetical shopping scenario, by being asked to imagine that they had an intention to purchase and were faced with the occurring choice situation in the supermarket. An example of a choice set can be found in Appendix Chapter 2 Table 2.A3. As in previous studies (Bechtold and Abdulai 2014; Ouma et al. 2007), we decided to use a D-optimal design to reduce the number of choice tasks while guaranteeing a balanced design. The resulting generic choice sets were divided into three blocks. For further information on the very well documented development of choice experiments and experimental designs, we would like to refer the interested reader to e.g. (Hensher et al. 2015, 2010). We could not determine strictly dominant alternatives and therefore did not remove any of the 18 choice situations from the experiment. The design was generated using Stata® 15.

Since it has been well documented in the literature (Bello and Abdulai 2016; Lusk 2003) that a hypothetical bias can be reduced using ex-ante hypothetical bias mitigation tools, and some studies reveal that cheap talk (CT) scripts work effectively in online surveys (Howard et al. 2017; Tonsor and Shupp 2011), a CT script was implemented right before the actual CE was carried out. A translated version can be found in Appendix Chapter 2 V.

Table 2.2 shows descriptive characteristics of our sample with comparative values of the German population. By comparing the descriptive values in Table 2.2, we find a relatively good match between our sample and the German population. For example, our dataset is characterized by 51% women, an average age of 46.5 years, a mean household income of €2000 - €3000, and an average household size of 2.35. However, there is a difference in the distribution with respect to university degrees. Since our postal distribution was randomized, it can be assumed that more highly educated population groups are more interested in participating in these kinds of study. As in Sandorf et al. (2017), a quiz-score (presented in Table 2.2) captured knowledge levels regarding information on palm oil cultivation and discussions within both the intervention and the non-intervention groups. Participants indicated whether they agreed or disagreed with six problem statements, each of which had correct or incorrect solutions. Thus, a maximum score of 6 could be achieved. We found a significant difference in test

scores between the intervention and the non-intervention group, with the former having a higher score. The questions from the knowledge quiz can be found in Appendix Chapter 2 VI.

As previously stated, one problem with the RSPO is that only few consumers are aware of the RSPO trademark, resulting in a weak market demand for it (Laurance et al. 2010). We can confirm this finding from our data. When asked “Are you familiar with the RSPO label?”, only 15% of participants in our sample answered in the affirmative. With regard to the German organic label, the situation is different. When asked “Are you familiar with the German Bio (organic) label?”, 65% of respondents answered “yes”. Images of the respective labels were attached to the questions. Further, we can confirm from our data that too many labels confront consumers with a situation of increased uncertainty (Buxel 2018). When participants were presented with the statement “There are too many labels: The number of labels does not give me an effective basis for decision-making.”, most agreed with the statement by choosing *agree* (42%) or *strongly agree* (30%) on a Likert scale. Only 12% disagreed or strongly disagreed.

As previously mentioned, we also captured respondents’ price expectations prior to the CE. To elicit uncertainty in this consumer reference price, we used the questioning technique presented in Caputo et al. (2020). In addition, we formulated the questions in both a future-oriented and past-oriented way (Appendix Chapter 2 VII). Table 2.3 presents summary statistics and mean comparisons of consumers’ reference prices by product and information status.

We find that consumers have a relatively accurate understanding of the prices of the products used in the experiment, which highlights the credibility of their subsequent product evaluation in the CE. Additionally, participants who received the information have significantly higher price expectations. Interestingly, a similar observation is made, even when the sample is split into product categories, although the result is not statistically significant.

Table 2.2 Descriptive Statistics: Sample compared to German population.

Dataset		Pooled Dataset	No Information Intervention	Information Intervention	Germany ²
female		0.51	0.51	0.51	0.51
age		46.5	46.2	46.8	44.4
income category (€)	mean	2001 - 3000			2008 - 3399
	median	2501 - 3000			2000 - 2500
household-size	mean	2.35			2
	median	2			
no. children		1.42	1.2***	1.7***	1.16 - 2.0
education	lower education	0.39	0.38	0.39	0.35
	prof. education	0.30	0.32	0.28	0.48
	university degree	0.31	0.30	0.33	0.18
test score ¹		3.8	3.5***	4.0***	
region	Germany				
N		460	231	229	

***, **, * Significance of difference between groups at the 1%, 5%, and 10% levels, respectively.

¹: Test score captured by knowledge quiz. The scale ranges from 0 (no correct answer), to a maximum of 6 (all questions answered correctly) points.

²: Sources: (Bundesinstitut für Bevölkerungsforschung 2020; Finanzen100 nach Statistisches Bundesamt 2016; Institut der deutschen Wirtschaft nach Statistisches Bundesamt 2020; Statistisches Bundesamt 2019a, 2018a, 2018b, 2019b, 2020; Stockhausen and Calderón 2020)

³: Prof. education refers to individuals who at least have completed vocational training under the dual system

Table 2.3 Price expectation by product and information status.

	Mean Price expectation in €	Forward oriented in €	Backward oriented in €
Full Sample	2.73	2.73	2.74
Chocolate Cookies	2.41	2.39	2.44
Chocolate Spread	3.11	3.22	3.03
	No-Information	Information	
Full Sample	2.66*	2.81*	
Chocolate Cookies	2.35	2.48	
Chocolate Spread	3.02	3.20	

***, **, * Significance of difference between groups at the 1%, 5%, and 10% levels, respectively.

The LV α_{nk} is described by each respondent's characteristics as well as answers to attitudinal questions related to trust, consumption and environmental issues which are included in the model as z_n variables. Table 2.4 presents the variables used for our model specification in the LV approach with their associated definitions.

Table 2.4 z_n Variable Definitions.

z_n Variable	Definition
age_45_more	respondent is 45 years or older
aware_po	whether respondents pay attention to palm oil in products or not. Scale: 1= always to 5= never
female	1 if respondent is female, 0 if respondent is male
greenvote	1 if respondent is a green party voter, 0 otherwise
children	1 if respondent has children, 0 otherwise
high_education	1 if respondent has university degree or master craftsman, 0 otherwise
inc_abv_av	1 if respondent has an above-average income
consinfluence	whether participants believe that reduction of environmental damage can be induced by consumer behavior and consumption choices. Scale: 1= 'not convinced at all' to 5= 'completely convinced'
pers_sacr	willingness to forgo products to ensure an intact environment. Factor ¹ . Scale: 1= low willingness to make sacrifices to 5= high willingness to make sacrifices
labeluse	respondents' frequency of label use. Scale: 1= 'never' to 5= 'always'
trust_organic	whether participants trust the sustainability label or not. Scale: 1= no top rank to 3= highest amount of distrust against the label
trust_4-level	whether participants trust the sustainability label or not. Scale: 1= no top rank to 3= highest amount of distrust against the label
trust_rspo	whether participants trust the sustainability label or not. Scale: 1= no top rank to 3= highest amount of distrust against the label
trust_ngo_sc	whether participants trust organizations such as NGOs or research and science. Factor ¹ . Scale: 1= 'no trust' to 5= 'a lot of trust'
trust_off	whether participants trust officials such as authorities, political parties or the media. Factor ¹ . Scale: 1= 'no trust' to 5= 'a lot of trust'
trust_impact	whether the participant trusts that labels really have an impact on what they are supposed to signal. Factor ¹ . Scale: 1= 'I do not agree at all' to 'I fully agree'
concern_futur_env	expresses concern about future development regarding the overall state of the environment. Factor ¹ . Scale: respondent 1= 'doesn't feel threatened at all' to 5= 'feels very threatened'.

¹: The variables and questions upon which the factor is based can be found in Appendix Chapter 2 Table 2.A4.

2.5 Empirical Results

Table 2.5 presents the empirical results of the hybrid latent variable analysis for the pooled sample, and both the intervention and non-intervention subsample. We present here a shortened version of the table. The complete table with all parameters of the estimation can be found in Appendix Chapter 2 Table 2.A5. All estimations are done using the Python package PandalBiogeme. The interested reader is referred to e.g. (Bierlaire 2018). The estimates for the choice experiment part of the model are presented in the upper third of Table 2.5. The second part of the table shows the parameters associated with the ANA part of the estimation, while the third part contains the estimates of the variables that contribute to the definition of the continuous LV, which in turn links the ANA to the choice model part.

By means of the associated variables, we can interpret the latent attitude of the respondents along the LV and subsequently its influence on the rest of the model. The signs of the estimates for the LV model suggest that a person with a high LV is more likely to be older than 45, to pay attention to palm oil, to be male, to have children, to have a lower education, to be confident that consumption decisions can have an impact on reducing environmental damage, is less likely to be a green party voter, and to use labels often.

The upper part of the table shows the coefficients of the choice part of the hybrid model. The λ -coefficients describe the influence of the latent variable on the sensitivity to the corresponding attribute. The remaining coefficients are the usual betas of the product attributes. With positive signs for the sustainability-indicating labels and a negative sign for the price attribute as well as for the alternative specific constant (ASC) for the no-buy option, we find the expected signs for all betas. It can be observed that the attribute 'organic' shows the largest coefficient, the 4-Level and the RSPO labels are rated quite similarly, and the brand shows the smallest coefficient. All beta coefficients are statistically significant at the 1% level. If we look at the λ -coefficients, we notice that all sustainability-indicating labels show negative signs. Price and brand show positive signs, indicating that individuals in the high range of the LV are more likely to have an increased sensitivity to price and brand and a

decreased sensitivity to the sustainability-indicating labels. This implies that with a high LV, the overall coefficient of e.g., RSPO decreases, while the overall coefficient of brand increases. It is interesting to note that the λ -coefficients of organic and price are not statistically significant in the pooled sample. This allows the assumption that the sensitivity directed to these two attributes is not influenced by the latent structure, suggesting that individuals across the range of LV assess these attributes relatively consistently, and are less driven by their own latent attitudes. This finding is consistent with the notion that most people are price-sensitive in their purchases of traditional consumer products, regardless of their personal beliefs.

We next turn to the model part for the responses to the non-attendance or rather ranking questions. With $\beta_{0_anaprice}^I$ normalized to 0, the β_0^I coefficients indicate a lower initial, stated ANA to the attribute 'organic' and a higher initial, stated ANA to 'brand' and 'RSPO'. The signs of the remaining β^I coefficients indicate that as the LV α_{nk} increases, the probability that respondent n ignored the attribute also increases. In other words, the higher the LV α_{nk} , the lower the attendance to all three sustainability-indicating attributes (or small LV value respondents have a higher probability of attending to sustainability labels). And the higher the LV α_{nk} , the greater the attendance to brand and price. These findings are in line with our previous findings regarding the choice model component, since people within the high range of the LV also seem to have a lower sensitivity to the sustainability indicating labels. Thus, the latent variable significantly scales the coefficient of the choice model part, while also influencing consumers' patterns of attribute non-attendance.

We next consider the results by information intervention group. We hypothesize that factual information influences choice behavior, latent structures, and the use of heuristics. Table 2.2 shows that individuals in the information intervention group achieved a significantly higher test score. It can thus be hypothesized that the information provided contributed, at least in part, to individuals' knowledge formation. We can confirm this relationship by presenting the results of an ordered probit model that controls for the explanatory variables used in explaining the LV, as well as the information intervention. The results of the ordered probit are presented in Appendix Chapter 2 Table 2.A7.

Table 2.5 Maximum Likelihood Estimates Pooled Sample, Information, and No Information Treatments.

Pooled Sample				No Information			Information		
Name	Est.	Rob. Std err	t-test	Est.	Rob. Std err	t-test	Est.	Rob. Std err	t-test
ASC_NOBUY_LA	0.0157	0.281	0.0557	-0.0969	0.308	-0.314	-0.334	0.246	-1.36
ASC_NOBUY_REF	-0.654***	0.239	-2.74	-1.88***	0.391	-4.8	-1.88***	0.584	-3.21
λ _ORGANIC_LA	-0.0658	0.0492	-1.34	-0.496***	0.0965	-5.15	-0.213*	0.122	-1.74
β _ORGANIC_REF	1.22***	0.0832	14.6	1.96***	0.186	10.5	2.47***	0.437	5.66
λ _BRAND_LA	0.651***	0.17	3.82	-0.213	0.185	-1.15	-0.0455	0.148	-0.308
β _BRAND_REF	0.0748**	0.0336	2.23	0.337**	0.137	2.45	0.134	0.0996	1.35
λ _4-Level_LA	-0.587***	0.124	-4.73	-0.71***	0.161	-4.4	-1.95*	1.15	-1.69
β _4-Level_REF	0.398***	0.067	5.94	0.556***	0.177	3.15	1.01***	0.155	6.53
λ _PRICE_LA	0.078	0.159	0.491	-0.186	0.182	-1.02	-0.483***	0.121	-3.99
β _PRICE_REF	-0.438***	0.0897	-4.88	-1.21***	0.107	-11.4	-1.12***	0.205	-5.46
λ _RSPO_LA	-0.418***	0.157	-2.66	-0.606***	0.135	-4.47	-2.86***	1.03	-2.79
β _RSPO_REF	0.324***	0.0711	4.56	0.568***	0.17	3.34	0.838***	0.052	16.1
β^I _anaorganic	0.278***	0.075	3.71	0.363***	0.104	3.5	0.28**	0.119	2.35
β^I _anabrand	-0.962**	0.395	-2.43	-0.679	0.427	-1.59	-1.12*	0.576	-1.95
β^I _ana4-Level	0.309***	0.0944	3.27	0.277***	0.0945	2.93	0.364***	0.137	2.65
β^I _anaprice	-0.242***	0.0133	-18.2	-0.466***	0.067	-6.96	-0.255***	0.048	-5.32
β^I _anarspo	0.308***	0.0798	3.86	0.282***	0.0887	3.18	0.393***	0.142	2.77
β_0^I _anaorganic	-0.974***	0.294	-3.32	-1.1***	0.29	-3.79	-1.2**	0.5	-2.4
β_0^I _anabrand	1.32**	0.603	2.19	0.926*	0.532	1.74	1.78*	0.97	1.83
β_0^I _ana4-Level	-0.105	0.0727	-1.45	0.00804	0.0835	0.0963	-0.154*	0.0915	-1.69
β_0^I _anaprice	0	-	-	0	-	-	0	-	-
β_0^I _anarspo	0.189***	0.0388	4.87	0.382***	0.062	6.16	0.151**	0.0626	2.42
φ _age_45_more	0.456***	0.0856	5.32	0.0128	0.448	0.0285	0.535***	0.111	4.84
φ _aware_po	0.0392***	0.0147	2.66	0.0488**	0.0244	2	0.0195	0.0187	1.05
φ _female	-0.133*	0.0704	-1.89	0.0486	0.231	0.21	-0.612***	0.0919	-6.66
φ _greenvote	-0.285***	0.0626	-4.55	-0.376**	0.169	-2.23	-0.185**	0.0766	-2.41
φ _children	0.632***	0.0914	6.92	0.615***	0.234	2.63	0.677***	0.148	4.58
φ _high_education	-0.273***	0.0711	-3.85	-0.667***	0.122	-5.46	-0.019	0.0752	-0.253
φ _inc_abv_av	0.052	0.0962	0.54	-0.413	0.276	-1.49	0.105	0.0864	1.21
φ _consinfluence	0.0392***	0.0147	2.66	0.0488**	0.0244	2	0.0195	0.0187	1.05
φ _pers_sacr	-0.00382	0.0294	-0.13	0.191*	0.11	1.74	0.0043	0.0435	0.0989
φ _labeluse	-0.445***	0.0768	-5.79	-0.791***	0.135	-5.86	-0.386***	0.0694	-5.56
φ _trust_oranic	0.202**	0.0831	2.43	0.745*	0.394	1.89	0.0368	0.0628	0.586
φ _trust_leh	0.104***	0.0286	3.63	0.201***	0.0605	3.32	0.103***	0.0383	2.69
φ _trust_ngo_sc	0.0801	0.062	1.29	-0.0821	0.0903	-0.909	0.227**	0.105	2.17
φ _trust_off	0.289***	0.0614	4.7	0.58***	0.11	5.26	0.171***	0.0614	2.78
φ _trust_rspo	-0.0185	0.0434	-0.426	-0.0685	0.0666	-1.03	-0.0837	0.0588	-1.42
φ _trust_impact	0.049	0.0333	1.47	-0.0106	0.079	-0.134	0.216***	0.0452	4.78
φ _concern_futur_env	0.0833	0.065	1.28	-0.18	0.208	-0.868	0.113*	0.0659	1.72
Respondents	460			229			231		
Observations	2760			1374			1386		
LL(0)	-29420.69			-10942.6			-10776.52		
LL	-21841.6			-10942.23			-10774.69		
Parameters	46			46			46		

***, **, * Significance at the 1%, 5%, and 10% levels, respectively. LA: latent attitude

Since most of the parameter estimates of the LV approach in Table 2.5 have the expected signs, we only focus on the major differences between the two subsamples.

We first focus on the LV part of the model comparing the 'No Information' and 'Information' columns of Table 2.5. We find that awareness of palm oil, high education, the belief in the influence of consumption choices and the willingness to make personal sacrifices are not statistically significant. In other words, for participants who received information, these characteristics no longer play a role in the latent structure that influences ANA and individuals' choice behavior. Using the example of the educational level, it implies that after an information intervention, someone's initial educational status may lose its influencing power when they are making complex food decisions. On the other hand, information also seems to trigger attitudinal characteristics which in turn interfere with ANA and choice structures. We find that trust in NGOs and science, the belief that consumption choices can have an impact, concern about future development regarding the overall state of the environment, as well as age and gender were statistically significant. These findings suggest that information can help trigger latent trust structures that are then used to resolve complex decision-making processes. Furthermore, information interventions appear to be perceived and processed differently by individuals with different socioeconomic characteristics. For example, we observe that with intervention, age takes on a significant role in forming the LV. We also note that gender is not only statistically significant in the information intervention group, but also shows a reversed sign. This indicates that in the no-intervention group, being female increases the value of LV, while in the intervention group, it decreases the value of LV. This is of particular interest, as women have a significantly higher knowledge score after the information intervention than men (Appendix Chapter 2 Table 2.A8), suggesting that women may have read the information more carefully or processed it more effectively, enabling them to incorporate the information into their decision-making processes.

Turning to the ANA part of the model, the results show that the coefficient for ANA-organic is smaller for individuals in the information intervention group. Also, the value of the negative ANA-brand coefficient is larger in this group. The value of the negative ANA-price coefficient is smaller in the

intervention group. These results indicate that, when consumers have information, the probability that they will consider organic and brand compared to when they do not have information increases, if the LV increases. Furthermore, the probability that price receives less attention in the information intervention group also increases. However, in the choice model part, we find that the λ -coefficient for brand is not statistically significant in both subsamples. In other words, while there are differences in the attention paid to the brand between the groups, the importance of the brand is generally not rated highly (or is only rated so by a small subset of people within the distribution of the LV) as that of other product attributes. In contrast to the non-information group, we find a significant λ -coefficient for the price, suggesting that individuals with different values of LV now evaluate the price differently. In particular, individuals with smaller LV now tend to have a smaller price coefficient, and there is no longer any consensus on the valuation of the price. We find a reverse pattern for the attribute 'brand'. Since the coefficients of the choice model part have the same expected signs in both groups, we now turn to the WTP estimates in the next section to better illustrate the intuition of the importance of the estimated coefficients using monetary values.

2.6 Willingness-to-pay Estimates

This section presents the monetary valuations calculated for the four attributes in Tables 6, 7, 8 and 9. The tables feature the mean WTP and the bounds at 95% confidence intervals (CI) for the full sample and both subsamples. Furthermore, we present the WTP estimates of the first and the fourth quartile of the predicted LV α_{nk} . As in Bello and Abdulai (2016), the means and 95% CIs represent empirical distributions computed using the parametric bootstrap procedure (Krinsky and Robb 1986) and based on 10,000 replications.

Table 2.6 presents the average WTP estimates for the full sample and subsamples. From the results, it is evident that the attribute 'organic' receives the highest monetary valuation in the full sample as well as in both subsamples. The estimates also reveal that with the exception of the brand, the WTP for the attributes are generally higher for the subsample that obtained information, compared to the no-information treatment. The WTP for the attribute 'brand' appears to be similar across the full sample

and subsamples. It is evident from the estimates that organic certification attracts the highest WTP among the respondents. Interestingly, the rating of the 4-Level label in the overall sample is higher than that of the RSPO label. In the subsample without information, the monetary valuation is virtually the same, suggesting that individuals rate the RSPO label almost the same, if not lower than a hypothetical label that they have only experienced within an experiment. This fact allows initial conclusions to be drawn about the significance of the RSPO label from the consumer's point of view.

Table 2.6 Average Willingness-to-pay Estimates.

Attribute	Full Sample		No Information Treatment		Information Treatment	
	WTP	CI	WTP	CI	WTP	CI
Organic	2.66	[2.09, 5.40]	1.38	[1.01, 2.19]	3.27	[2.39, 4.3]
Brand	0.27	[0.04, 0.51]	0.27	[0.08, 0.63]	0.24	[-0.01, 0.61]
4-Level	0.94	[0.55, 2.44]	0.39	[0.19, 0.73]	0.62	[0.33, 21.4]
RSPO	0.72	[0.38, 1.97]	0.40	[0.20, 0.74]	1.49	[0.36, 78.4]

Note: 95% confidence intervals (CI) are based on 10,000 replications.

Because consumers have heterogeneous preferences that are not attributable to the treatment groups, it is important to capture this heterogeneity (Boxall and Adamowicz 2002). The latent variable captures a changing structure among respondents, allowing us to use it to consider and reveal those heterogeneous preference and WTP structures. We thereby do not assume latent classes with class-specific, homogeneous preferences, but are able to estimate the WTP for any conceivable manifestation of the latent structure. Table 2.7 shows the WTP estimates of the first and fourth quartile of the predicted LV α_{nk} for the full sample to control for differences in the WTP along the LV. We consider the upper and lower quartiles to illustrate extreme values of α_{nk} .

Table 2.7 Willingness-to-pay Estimates first and fourth quartile of predicted LV, Full Sample.

Attribute	First Quartile (0.00 - 0.25)		Fourth Quartile (0.75 - 1.00)	
	WTP	CI	WTP	CI
Organic	2.97	[2.02, 7.79]	2.37	[2.03, 3.54]
Brand	0.16	[0.02, 0.38]	0.41	[0.08, 0.69]
4-Level	1.50	[0.77, 4.72]	0.53	[0.35, 0.94]
RSPO	1.03	[0.48, 3.55]	0.47	[0.28, 0.89]

Note: 95% confidence intervals (CI) are based on 10,000 replications.

The results in Table 2.7 reveal that individuals with a low LV tend to exhibit a higher monetary appreciation for all sustainability-indicating labels than individuals with high LV values. However, an individual with high LV is more likely to attribute a stronger WTP with respect to brand. The difference for 'organic' is only 20%, but the WTP for the other three attributes varies substantially. This observation already raises the question of whether the attribute 'organic' is given a more stable rating across the LV than the other product attributes.

Table 2.8 Willingness-to-pay Estimates first and fourth quartile of predicted LV, No Information Treatment.

Attribute	First Quartile (0.00 - 0.25)		Fourth Quartile (0.75 - 1.00)	
	WTP	CI	WTP	CI
Organic	1.96	[1.42, 3.52]	0.86	[0.52, 1.55]
Brand	0.28	[0.09, 0.71]	0.26	[0.07, 0.70]
4-Level	0.68	[0.35, 1.29]	0.17	[0.05, 0.43]
RSPO	0.62	[0.31, 1.27]	0.21	[0.09, 0.42]

Note: 95% confidence intervals (CI) are based on 10,000 replications.

Looking at the WTP in the first and fourth quartiles of predicted LV provides deeper insights into the effect of the information intervention. Tables 2.8 and 2.9 reveal the same pattern as before for both groups. As the LV increases, the WTP for the sustainability-indicating labels decreases, and the WTP for brand increases. However, it becomes evident that in the non-intervention group the brand is evaluated rather stably across the LV. Based on these findings, it can be assumed that, without further information, individuals of all LV values consider or evaluate the brand similarly strongly (or weakly) in their product choice processes.

The estimates in Table 2.9 reveal a higher monetary rating for 'organic' and 'brand' attributes in the fourth quartile than in the first quartile, while the other sustainability indicators play almost no role in the fourth quartile with information treatment. It should be noted that the WTP value of the RSPO attribute in the first quartile of Table 2.9 is not interpretable. Individuals in the first quartile of the LV reveal increased monetary appreciation of all sustainability indicators and significantly reduced monetary appreciation for the brand. These findings suggest that the attribute 'organic' has the potential to be ranked highest across the entire latent structure. First, we only observe a minor difference between the RSPO and the 4-Level label, and second, there is no clear consensus along

consumers' LV on how to rate these labels monetarily. In contrast to Hinkes and Christoph-Schulz (2020) whose estimates show a decreasing WTP for the EU organic label, our estimates show that the provision of information generates higher WTP among consumers, especially for the organic label. However, it can at the same time contribute to uncertainty, which is reflected in the differences in the monetary valuation of the labels throughout the LV landscape.

Table 2.9 Willingness-to-pay Estimates first and fourth quartile of predicted LV, Information Treatment.

Attribute	First Quartile (0.00 - 0.25)		Fourth Quartile (0.75 - 1.00)	
	WTP	CI	WTP	CI
Organic	2.59	[2.06, 3.23]	4.01	[2.63, 5.59]
Brand	0.16	[-0.01, 0.36]	0.33	[-0.01, 0.92]
4-Level	1.47	[0.68, 70.6]	0.13	[0.07, 3.26]
RSPO	4.59	[0.84, 302]	0.09	[0.04, 0.49]

Note: 95% confidence intervals (CI) are based on 10,000 replications.

To account for differences in the evaluation of different products, we also performed the analyses presented here for separate product groups. The results from the analyses are presented in Appendix Chapter 2 Tables 2.A5, 2.A9, 2.A10 and 2.A11. The estimates reveal comparable WTP patterns across product groups. However, for chocolate spread, brand seems to play a bigger role. At the same time, the RSPO label plays a rather negative role in product evaluation.

2.7 Conclusion

It is widely documented in the empirical literature that consumers face uncertainties in making product choices. Several studies have therefore shown that providing additional information that help consumers in their decision-making process contribute to reducing the bias in discrete choice experiments. In this study, we examined consumer preferences and willingness-to-pay (WTP) for certified palm oil, as well as the effect of information on consumers' food choice behavior and patterns of attribute non-attendance (ANA). We used a hybrid latent variable scaling approach to model consumer preferences, together with attribute processing-strategies in the context of palm oil-containing food products (Bello and Abdulai 2016). In particular, we addressed which sustainability label consumers pay most attention to, and which label at the same time elicits the greatest WTP. This

can be particularly important for manufacturing companies and listing retailers, as they can selectively focus on and invest in the certification that consumers prefer. The empirical results revealed increased WTP for sustainability-indicating product attributes, a finding that is consistent with results from previous studies (Bello and Abdulai 2016; Chen et al. 2018; Gassler and Spiller 2018).

Our results also showed that providing additional information tends to change consumers' non-attendance patterns as well as WTP values. In particular, the information intervention tends to increase consumers' WTP and reduces their ANA for sustainability-indicating attributes. Our estimates revealed that as information is provided, WTP tends to move toward sustainability indicators and away from other product attributes (Hinkes and Christoph-Schulz 2020). Our findings suggest that consumers of the various segments analyzed consistently showed the highest WTP values for the attribute 'organic quality', indicating that organic quality is one of the most important product attributes from the consumer's perspective. This is an important finding, as this specific product quality has had a very small market share to date. This finding also raises the question of whether producers should use the EU or German organic label when indicating organic quality.

We also found that consumer valuation of product attributes tends to vary widely across the sample, particularly within the information treatment subsample. Specifically, while with information provision some consumers have almost no WTP at all for brand, the WTP increases for other consumers. Our results further revealed that a hypothetical label that consumers are familiar with only by design, but not within the palm oil context, also exerts a positive influence on the valuation by a particular consumer group, resulting in increased WTP. However, this positive influence was not observed across other consumer segments, which contrasts with the findings for organic certified palm oil, which showed higher WTP across all consumer segments. This finding indicates that organic certified palm oil is more suitable as a sustainability indicator for influencing consumers' purchasing decisions. The findings also underscore the significance of providing factual information, as this increases the willingness to buy more sustainable products and at the same time shifts consumers' focus (ANA structures) away from price and towards sustainability indicators. However, there is no guarantee that

an organic certified product is in fact a more sustainable product, and organic certification appears to be the more important consideration purely from the point of view of German consumers.

Future research should examine this question more closely with regard to ecological and possibly social impacts. Our findings suggest that in order to set the palm oil sector on a more sustainable path, stakeholders should focus on sustainability labels that have already been accepted and valued by consumers. The organic label particularly appears to be important in this context. To the extent that some consumers value brands, producers could make use of brand names to attract some consumer groups. The RSPO which was founded to promote sustainable agricultural practices in the palm oil sector appears to play a relatively negligible role for consumers. Nevertheless, the importance of the RSPO label should not be underestimated. For producers, it is currently one of the few labels to indicate sustainability within their supply chain and represents a way to enhance a gradual shift towards more sustainable production methods. In line with recent literature, it is evident that consumers prefer segregated supply chains. Gassler and Spiller (2018) also indicate that consumers expect at least a guaranteed minimum of sustainable palm oil in a product if it carries a label. However, in their study they were only able to evaluate the RSPO label, which does not seem to receive wide acceptance from a consumer perspective. Implications based on this approach could lead to misleading conclusions, as the label in itself is accorded low importance. However, consistent with their findings, we find relatively similar WTP values for RSPO certification. Also, in line with findings by Hinkes and Christoph-Schulz (2020), we observe negative WTP values for the RSPO certification in some consumer groups. Our analysis thus helps shed more light on consumers' perceptions of these labels. From the consumer's point of view, oil palm cultivation systems should be converted to organic agriculture in the long run. At the same time, however, the indicator system could also be redesigned to give a more consistent look throughout all product categories, which would make it much easier for consumers to evaluate products of all kinds. Future research could also explore the extent to which a simple label design can holistically promote sustainability, in a simplified way, and for different product groups. It is significant to note that our results can only be interpreted on the basis of our survey sample. Although this sample

broadly reflects the German populace as a whole in terms of various characteristics, it is not representative. At the same time, we cannot be sure to what extent the treatment group actually read the information carefully. Furthermore, it is possible to provide information in such a visual and educational way that it has a greater educational effect. In order to develop highly effective information campaigns, it is essential that these aspects receive further attention. Our findings also suggest that producers are willing to use more organic certified palm oil if the market allows it suggesting that consumers and producers are not too far apart in their market and product expectations. However, there seems to be a market reluctance, among producers for example, to establish their own organic plantations or sustainable projects. We also suggest that it seems important that producers are given more information about the oil they use, as it appears that issues around transparency are already occurring in the wholesale sector. More information about the other side of the market – that is, improved information exchange and communication – could thus move the markets in a direction that would be more consistent with the expectations of both consumers and producers.

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Appendix Chapter 2

I. Information Intervention

Table 2.A1. Company Sizes

Company size (number of employees)	Percent
1 - 19	9.10
20 - 49	11.49
50 - 99	5.75
100 - 249	20.69
250 - 499	16.09
> 500	36.78
n = 87	100.00

II. Information Intervention

Some information presented here has changed in the meantime. To the best of our knowledge, all information was accurate at the time of the survey.

The following questionnaire will mainly discuss the topic of sustainable consumption within the context of palm oil as an agricultural commodity. Therefore, we would like to give you some general information on the topic of oil palm and palm oil cultivation.

- a) Palm oil is a vegetable oil that is used as an ingredient in food, cosmetics and also as biodiesel. Since 2014, it must be clearly labeled as an ingredient on food products.
- b) Statistically, palm oil is currently present as an ingredient in one out of every two food products available in supermarkets.
- c) Oil palms, like coconut palms, grow exclusively in the warm, humid tropics. They need high temperatures and rainfall all year round to thrive.
- d) Palm oil is the most produced, traded and consumed vegetable oil worldwide. Through employment opportunities in cultivation or the development of infrastructure in growing regions, the oil palm offers many people a way to earn their livelihood while the regions can develop economically.

- e) At the same time, palm oil cultivation on large plantations is also partly responsible for the displacement of indigenous populations from their lands in cultivation areas, either because property rights are not clearly regulated or because large corporations grab lands without obtaining permits or paying compensation. Such actions are sometimes made possible by corruption in cultivating countries. In the event that the originally resident population has to access new areas for agricultural use, the destruction of forest areas is thus further promoted.
- f) The European Union is the second largest importer of palm oil after India.
- g) The oil palm is the most productive oil plant in the world. Worldwide, the average yield per hectare is around 3.5 tons. Other oil plants, such as soy or rapeseed, however, only manage yields of 0.5 to 1.8 tons per hectare. This means that (compared to other plants) a lot of oil can be produced with a relatively low land consumption. For example, replacing palm oil with sunflower oil would require about four times more land to produce the same amount of oil.
- h) The world's largest share of palm oil is produced on large monoculture plantations in Indonesia and Malaysia. The clearing of primary rainforest areas leads to a decline in animal populations and to the loss of habitats for wild animals. A famous example is the orangutan. The loss of forests and peat bogs, which in contrast to the established plantations have an increased CO₂ storage potential, also has a direct impact on the global CO₂ balance and thus on man-made climate change. In order to gain new areas, slash-and-burn clearings are often practiced.
- i) Currently, about 38% less land is used for palm oil cultivation than for rapeseed cultivation.

III. Basic Information on labels and certifications used in the Choice Experiment

The products available for selection can carry three different labels (the labels always refer to the ingredient palm oil):

Table 2.A2 Basic Information

1. German Bio (organic) Label



The Federal Ministry of Food and Agriculture grants the German organic label. It is therefore a label with state-controlled requirements.

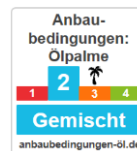
2. RSPO Label



The Roundtable on Sustainable Palm Oil was founded on the initiative of WWF and Unilever. Members of the Roundtable are environmental protection associations, non-governmental organizations, corporations, banks and other institutions involved in the production and processing of palm oil. It is therefore a label with a private character.

MIXED (or Mass Balance) means that there is partly RSPO certified and partly non-certified palm oil in the product. The exact proportions are not known.

3. 4-Level Label



The 4-level label refers to the cultivation conditions of the oil palm. As with the new animal husbandry label, the label shown here is established by retailers (e.g. Rewe, Lidl, Aldi, Edeka, etc.). The retailers are thus also responsible for the definition of the criteria, as well as the organization of the control. It marks a gradual improvement in individual social and ecological aspects through the stages. In the context of granting the label, all sustainability aspects (such as an overall footprint) of the respective product are included in the evaluation. In the experiment, you will find level 4 (Premium) or 2 (similar to the MIXED/ Mass Balance as described before).

IV. Choice Set Example

Table 2.A3 Choice Set 16

Attribute	Alternative 1	Alternative 2	Opt-Out
Brand	other product	well-known brand product	None of the products
Organic	-		
RSPO	-		
4-Level			
Price	0.99	1.29	
I choose:	☐	☐	☐

V. Cheap talk Script

After a general introduction to the experiment, we presented a cheap talk script directly before the first decision-making situation. In the following, we first provide an analogous translation and then the original German version.

“Previous experiments of this kind have shown that people often choose products that they would not choose in a real shopping situation. One reason for this behavior is that while they would like to buy the product, in reality they are not willing to pay the quoted price. Therefore, please think about which characteristics you personally value and to what extent your available budget for food affects your decision.”

„Vorangegangene Experimente dieser Art haben gezeigt, dass Menschen oftmals Produkte auswählen, für die sie sich in der Realität jedoch nicht entscheiden würden, da sie das Produkt zwar gerne kaufen möchten, in der Wirklichkeit jedoch gar nicht bereit sind, den angegebenen Preis zu zahlen. Überlegen

Sie sich deshalb bitte, auf welche Eigenschaften Sie persönlich Wert legen und inwieweit Ihr zur Verfügung stehendes Budget für Lebensmittel Ihre Entscheidung beeinflusst.“

VI. Knowledge Quiz: Statements to agree or disagree with

1. Due to the endangered tropical cultivation regions, producers should increase the use of coconut oil instead of palm oil as an ingredient in food to prevent further environmental damage.
2. Due to its efficient yield per unit area, oil palm has the potential to be a relatively sustainable oil crop.
3. In order to improve the living conditions of people in palm oil cultivation areas, the EU should impose a general ban on palm oil.
4. Palm oil is found in relatively few products, so it is not a major concern when choosing a food product.
5. Current oil palm cultivation practices are largely responsible for CO₂ emissions and biodiversity loss in Southeast Asia.
6. It is often not possible for consumers to identify palm oil as an ingredient in food products.

VII. Price expectation Questions

A) (Forward Looking Approach)

What price would you expect to pay for a [*standard unit*] of your favorite [*product*] in the supermarket during your next purchase? _____ €

I expect the price of my favorite [*product*] not to be HIGHER than _____ € in 90% of stores.

I expect the price of my favorite [*product*] not to be LOWER than _____ € in 90% of stores.

B) (Backward Looking Approach)

What price did you pay for a [*standard unit*] of your favorite [*product*] at the supermarket the last time you bought it? _____ €

I think that the price of my favorite [*product*] at the time of my last purchase was not HIGHER than _____ € in 90% of stores.

I think that the price of my favorite [*product*] at the time of my last purchase was not LOWER than _____ € in 90% of stores.

VIII. Factor variables

Table 2.A4 Factor Variables

pers_sacr	1. In order to preserve our natural livelihoods, I would be willing to completely abandon tropical food products from my diet. 2. In order to preserve our natural livelihoods, I would be willing to completely abandon animal-based food products from my diet.
Which people, groups or organizations do you trust more or less? How much trust do you place in...	
trust_NGO_sc	1. ... organizations (e.g. consumer or environmental organizations, other NGOs)?
trust_off	2. ... independent research institutes? 1. ... in media? 2. ... authorities? 3. ... political parties? 4. ... large commercial enterprises?
trust_impact	1. One can trust in the validity of labels on food products in German supermarkets, as producers and manufacturers are controlled in an effective way. 2. If a product carries a certain certification, then I don't question that assurance.
concern_futur_env	1. Please indicate how threatened you feel by the following issues in terms of preserving our natural livelihoods: Climate change. 2. It worries me to think of the environmental conditions our children and grandchildren are likely to have to live in. 3. Please indicate how threatened you feel by the following issues in terms of preserving our natural livelihoods: Consumption of food of animal origin in the future.

IX. Complete Result Tables

Table 2.A5 Maximum Likelihood Estimates Pooled Sample, Information, and No Information Treatments, Complete Estimation Table

Name	Pooled Sample			No Information			Information		
	Est.	Rob. Std err	t-test	Est.	Rob. Std err	t-test	Est.	Rob. Std err	t-test
ASC_NOBUY_LA	0.0157	0.281	0.0557	-0.0969	0.308	-0.314	-0.334	0.246	-1.36
ASC_NOBUY_REF	-0.654***	0.239	-2.74	-1.88***	0.391	-4.8	-1.88***	0.584	-3.21
λ _ORGANIC_LA	-0.0658	0.0492	-1.34	-0.496***	0.0965	-5.15	-0.213*	0.122	-1.74
β _ORGANIC_REF	1.22***	0.0832	14.6	1.96***	0.186	10.5	2.47***	0.437	5.66
λ _BRAND_LA	0.651***	0.17	3.82	-0.213	0.185	-1.15	-0.0455	0.148	-0.308
β _BRAND_REF	0.0748**	0.0336	2.23	0.337**	0.137	2.45	0.134	0.0996	1.35
λ _LEH_LA	-0.587***	0.124	-4.73	-0.71***	0.161	-4.4	-1.95*	1.15	-1.69
β _LEH_REF	0.398***	0.067	5.94	0.556***	0.177	3.15	1.01***	0.155	6.53
λ _PRICE_LA	0.078	0.159	0.491	-0.186	0.182	-1.02	-0.483***	0.121	-3.99
β _PRICE_REF	-0.438***	0.0897	-4.88	-1.21***	0.107	-11.4	-1.12***	0.205	-5.46
λ _RSPO_LA	-0.418***	0.157	-2.66	-0.606***	0.135	-4.47	-2.86***	1.03	-2.79
β _RSPO_REF	0.324***	0.0711	4.56	0.568***	0.17	3.34	0.838***	0.052	16.1
β^I _anaorganic_F1	0.278***	0.075	3.71	0.363***	0.104	3.5	0.28**	0.119	2.35
β^I _anabrand_F1	-0.962**	0.395	-2.43	-0.679	0.427	-1.59	-1.12*	0.576	-1.95
β^I _analeh_F1	0.309***	0.0944	3.27	0.277***	0.0945	2.93	0.364***	0.137	2.65
β^I _anaprice_F1	-0.242***	0.0133	-18.2	-0.466***	0.067	-6.96	-0.255***	0.048	-5.32
β^I _anarspo_F1	0.308***	0.0798	3.86	0.282***	0.0887	3.18	0.393***	0.142	2.77
β^I_0 _anaorganic	-0.974***	0.294	-3.32	-1.1***	0.29	-3.79	-1.2**	0.5	-2.4
β^I_0 _anabrand	1.32**	0.603	2.19	0.926*	0.532	1.74	1.78*	0.97	1.83
β^I_0 _analeh	-0.105	0.0727	-1.45	0.00804	0.0835	0.0963	-0.154*	0.0915	-1.69
β^I_0 _anaprice	0	-	-	0	-	-	0	-	-
β^I_0 _anarspo	0.189***	0.0388	4.87	0.382***	0.062	6.16	0.151**	0.0626	2.42
σ _anabio	0.757***	0.213	3.56	0.984***	0.198	4.96	0.819***	0.312	2.62
σ _anabrand	0.634***	0.0554	11.4	1.39***	0.17	8.13	0.67***	0.0856	7.83
σ _analeh	0.589***	0.162	3.64	0.795***	0.138	5.76	0.668**	0.266	2.51
σ _anaprice	0.91***	0.281	3.24	0.977***	0.328	2.98	1.07**	0.441	2.42
σ _anarspo	0.597***	0.176	3.4	0.717***	0.128	5.59	0.746**	0.303	2.46
φ _age_45_more	0.456***	0.0856	5.32	0.0128	0.448	0.0285	0.535***	0.111	4.84
φ _awarep	0.0392***	0.0147	2.66	0.0488**	0.0244	2	0.0195	0.0187	1.05
φ _female	-0.133*	0.0704	-1.89	0.0486	0.231	0.21	-0.612***	0.0919	-6.66
φ _greenvote	-0.285***	0.0626	-4.55	-0.376**	0.169	-2.23	-0.185**	0.0766	-2.41
φ _haveChildren	0.632***	0.0914	6.92	0.615***	0.234	2.63	0.677***	0.148	4.58
φ _highEducation	-0.273***	0.0711	-3.85	-0.667***	0.122	-5.46	-0.019	0.0752	-0.253
φ _incMoreAv	0.052	0.0962	0.54	-0.413	0.276	-1.49	0.105	0.0864	1.21
φ _consinfluence	0.0392***	0.0147	2.66	0.0488**	0.0244	2	0.0195	0.0187	1.05
φ _pers_sacr	-0.00382	0.0294	-0.13	0.191*	0.11	1.74	0.0043	0.0435	0.0989
φ _labeluse	-0.445***	0.0768	-5.79	-0.791***	0.135	-5.86	-0.386***	0.0694	-5.56
φ _trust_oranic	0.202**	0.0831	2.43	0.745*	0.394	1.89	0.0368	0.0628	0.586
φ _trust_leh	0.104***	0.0286	3.63	0.201***	0.0605	3.32	0.103***	0.0383	2.69
φ _trust_ngo_sc	0.0801	0.062	1.29	-0.0821	0.0903	-0.909	0.227**	0.105	2.17
φ _trust_off	0.289***	0.0614	4.7	0.58***	0.11	5.26	0.171***	0.0614	2.78
φ _trust_rspo	-0.0185	0.0434	-0.426	-0.0685	0.0666	-1.03	-0.0837	0.0588	-1.42
φ _trust_impact	0.049	0.0333	1.47	-0.0106	0.079	-0.134	0.216***	0.0452	4.78
φ _futur_env	0.0833	0.065	1.28	-0.18	0.208	-0.868	0.113*	0.0659	1.72
delta_1	0.26***	0.0706	3.68	0.323***	0.0607	5.32	0.314***	0.12	2.62
delta_2	0.583***	0.16	3.65	0.733***	0.139	5.28	0.689***	0.265	2.6
Respondents	460			229			231		
Observations	2760			1374			1386		
LL(0)	-29420.69			-10942.6			-10776.52		
LL	-21841.6			-10942.23			-10774.69		
Parameters	46			46			46		

***, **, * Significance at the 1%, 5%, and 10% levels, respectively.

LA = latent attitude

Table 2.A6 Maximum Likelihood Estimates by Product

Name	Cookies			Chocolate Spread		
	Est.	Std. err	t-test	Est.	Std. err	t-test
ASC_NOBUY_LA	-0.317	0.203	-1.57	0.747**	0.304	2.46
ASC_NOBUY_REF	-2.38***	0.577	-4.13	-1.08**	0.35	-3.07
λ _ORGANIC_LA	-0.15	0.102	-1.47	-0.988***	0.134	-7.36
β _ORGANIC_REF	1.78***	0.238	7.48	4.31***	0.399	10.8
λ _BRAND_LA	-0.0806	0.281	-0.287	-0.651***	0.204	-3.2
β _BRAND_REF	0.0747	0.102	0.731	0.427**	0.21	2.04
λ _LEH_LA	-1.2***	0.275	-4.38	-2.64***	0.332	-7.96
β _LEH_REF	1.07***	0.142	7.59	0.235***	0.0101	23.4
λ _PRICE_LA	-0.295***	0.0875	-3.37	-0.151	0.175	-0.861
β _PRICE_REF	-1.39***	0.163	-8.54	-1.07***	0.142	-7.52
λ _RSPO_LA	-1.15***	0.363	-3.18	-2.61***	0.345	-7.56
β _RSPO_REF	0.941***	0.214	4.4	-0.0475	0.0544	-0.873
β^I _anaorganic_F1	0.215***	0.0404	5.31	0.334**	0.156	2.15
β^I _anabrand_F1	-0.983***	0.245	-4.02	-0.06	0.0813	-0.738
β^I _analeh_F1	0.426***	0.0865	4.93	0.282**	0.135	2.08
β^I _anaprice_F1	-0.32***	0.0309	-10.3	-0.884**	0.408	-2.17
β^I _anarspo_F1	0.313***	0.0534	5.86	0.321**	0.147	2.19
β^I_0 _anaorganic	-1.03***	0.18	-5.74	-1.11**	0.504	-2.2
β^I_0 _anabrand	1.67***	0.471	3.54	0.503**	0.239	2.1
β^I_0 _analeh	-0.312***	0.109	-2.88	0.16**	0.0763	2.1
β^I_0 _anaprice	0	-	-	0	-	-
β^I_0 _anarspo	0.256***	0.0507	5.04	0.465**	0.215	2.16
σ _anabio	0.931***	0.156	5.96	1.02**	0.465	2.18
σ _anabrand	0.846***	0.0777	10.9	1.82**	0.833	2.19
σ _analeh	0.746***	0.118	6.32	0.715**	0.325	2.2
σ _anaprice	1.16***	0.204	5.69	0.322**	0.163	1.97
σ _anarspo	0.716***	0.123	5.82	0.823**	0.376	2.19
φ _age_45_more	0.698***	0.0882	7.91	-0.538***	0.0801	-6.72
φ _awarep	0.0861***	0.0215	4	0.0494***	0.0133	3.71
φ _female	-0.405***	0.106	-3.8	0.0274	0.0713	0.385
φ _greenvote	-0.245**	0.0985	-2.49	0.141**	0.0686	2.06
φ _haveChildren	1.22***	0.153	7.93	0.122	0.0953	1.29
φ _highEducation	-0.317***	0.096	-3.3	0.0286	0.081	0.353
φ _incMoreAv	0.0399	0.0978	0.408	-0.211***	0.0684	-3.08
φ _consinfluence	0.0861***	0.0215	4	0.0494***	0.0133	3.71
φ _pers_sacr	-0.0641	0.0469	-1.37	0.152***	0.0499	3.04
φ _labeluse	-0.582***	0.0617	-9.43	-0.383***	0.0472	-8.11
φ _trust_oranic	0.0633	0.0618	1.02	0.646***	0.0628	10.3
φ _trust_leh	0.0364	0.0422	0.863	-0.0114	0.0517	-0.221
φ _trust_ngo_sc	0.303***	0.0777	3.9	0.245***	0.0661	3.71
φ _trust_off	0.498***	0.0784	6.35	0.082	0.0961	0.854
φ _trust_rspo	-0.169***	0.0418	-4.05	-0.261***	0.0401	-6.52
φ _trust_impact	-0.0916*	0.05	-1.83	0.0564*	0.0338	1.67
φ _futur_env	0.235***	0.0677	3.47	-0.35***	0.0784	-4.46
delta_1	0.331***	0.053	6.25	0.317**	0.144	2.19
delta_2	0.718***	0.115	6.23	0.734**	0.334	2.2
Respondents	249			211		
Observations	1494			1266		
LL(0)	-15957.16			-13777.73		
LL	-11805.01			-9887.083		
Parameters	46			46		

***, **, * Significance at the 1%, 5%, and 10% levels, respectively.

LA = latent attitude

X. Quiz Score

Table 2.A7 Ordered Probit: Score

Variables	score	
age	-0.0221***	(0.00347)
children	-0.441***	(0.157)
education	0.0705**	(0.0336)
income	0.0168	(0.0254)
female	-0.0448	(0.116)
consinfluence	-0.0698	(0.0546)
labeluse	-0.0429	(0.0638)
trust_organic	-0.172	(0.127)
trust_rspo	-0.0299	(0.0658)
trust_4-levels	-0.0924	(0.0621)
awareness_po	0.0809*	(0.0466)
trust_impact	0.00144	(0.0665)
concern_futur_env	-0.105	(0.0930)
pers_sacr	-0.0376	(0.0631)
trust_off	-0.112	(0.0994)
trust_NGO_sc	0.193**	(0.0958)
information	0.414***	(0.103)
1. CDU / CSU	-0.386**	(0.158)
2. SPD	-0.343*	(0.203)
4. AFD	-0.570**	(0.246)
5. FDP	-0.210	(0.229)
6. DIE LINKE	0.0817	(0.197)
7. DIE PARTEI	-0.209	(0.355)
8. others	-0.400**	(0.186)
/cut1	-3.037***	(0.704)
/cut2	-1.850***	(0.696)
/cut3	-1.044	(0.695)
/cut4	-0.305	(0.693)
/cut5	0.372	(0.693)
Observations	460	

Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

This table presents the results of an ordered probit model which considers the quiz score as the dependent variable. We examine whether the determinants used in the latent variable model as well as the intervention have an influence on the score, that is, on participants' knowledge.

Table 2.A8 t-test: score by sex and subsample status

	obs	male mean	female mean	diff	st_err	t-value	Pr(T < t)
No Information Intervention	229	3.451	3.612	-0.161	0.178	-0.901	0.184
Information Intervention	231	3.821	4.252	-0.431	0.178	-2.419	0.008

XI. Willingness-to-pay estimates by Product

Table 2.A9 Willingness-to-pay Estimates by products

Cookies			Chocolate Spread	
Attribute	WTP	CI	WTP	CI
Organic	1.59	[1.18, 2.17]	5.12	[3.03, 10.70]
Brand	0.08	[-0.09, 0.53]	0.41	[0.02, 0.82]
4-Level	0.42	[0.25, 0.86]	7.40	[-1.15, 49.90]
RSPO	0.36	[0.18, 1.02]	-2.06	[-25.40, 20.20]

Note: 95% confidence intervals (CI) are based on 10,000 replications.

Table 2.A10 Willingness-to-pay Estimates first and fourth quartile of predicted LV, Cookie

First Quartile (0.00 - 0.25)			Fourth Quartile (0.75 - 1.00)	
Attribute	WTP	CI	WTP	CI
Organic	1.35	[1.10, 1.80]	1.82	[1.14, 2.68]
Brand	0.06	[-0.10, 0.25]	0.09	[-0.10, 0.90]
4-Level	0.94	[0.54, 2.04]	0.14	[0.07, 0.37]
RSPO	0.79	[0.41, 2.46]	0.13	[0.05, 0.53]

Note: 95% confidence intervals (CI) are based on 10,000 replications.

Table 2.A11. Willingness-to-pay Estimates first and fourth quartile of predicted LV, Chocolate Spread

First Quartile (0.00 - 0.25)			Fourth Quartile (0.75 - 1.00)	
Attribute	WTP	CI	WTP	CI
Organic	9.56	[4.61, 23.90]	2.31	[1.73, 3.48]
Brand	0.61	[0.04, 1.21]	0.26	[0.02, 0.59]
4-Level	25.90	[-5.72, 192]	0.35	[0.12, 0.92]
RSPO	-7.75	[-99.20, 78.70]	-0.06	[-0.35, 0.22]

Note: 95% confidence intervals (CI) are based on 10,000 replications.

Chapter 3

Does the certification type matter for smallholder farmers' welfare and the environment? Evidence from palm oil farmers in Ghana.

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Abstract

The empirical literature of the last decades has shown that certifications can have positive impacts on farm household welfare or the environment. However, most studies tend to focus on one dimension of sustainability, so that the impacts are usually not related to each other. At the same time, the potential of organic certification has been completely neglected in the palm oil sector. This study uses recent survey data from 400 smallholder farmers in Ghana to investigate the drivers for the decision to participate in organic or Roundtable on Sustainable Palm Oil (RSPO) certification schemes in the palm oil cultivation sector. In particular, we identify how each certification scheme impacts sustainability holistically, by considering farm household welfare, food security, and environmental outcomes in the analysis. To account for selection bias arising from observed and unobserved factors, a multinomial endogenous switching regression method is applied. The empirical results reveal that farmers who participate in the RSPO certification scheme obtain significantly higher net farm revenue, yields, and are more food secure than the counterfactual, non-certified farmers, while their negative environmental impact from agrochemicals is reduced. We observe similar results for organic certification, compared to non-certification. However, with reduced yield compared to non-certified farmers. Furthermore, farmers as well as the environment tend to benefit more from organic than from RSPO certification.

Keywords: certification schemes, impact assessment, food security, environmental impact, farm household welfare

3.1 Introduction

A growing world population combined with accelerating climate change threatens global food security, making increasing agricultural productivity and reducing poverty in a sustainable way without harming the environment, one of the major challenges of this century (Godfray and Garnett 2014; Gornall et al. 2010; Knickel et al. 2017; Beddington et al. 2011). Some approaches to improve agricultural production, however, pose a threat to many ecosystem services such as nitrogen fixation or soil regeneration (Lee 2005; Pretty et al. 2011; Pretty 2008). According to the FAO (2015), 33 percent of global soils and more than half of the 1.5 billion ha of productive lands are degraded due to unsustainable management practices (FAO 2015). Consequently, these practices can be related to a decline in productivity, farm revenues and increased food insecurity (Nkonya et al. 2016; MOFA 2017). These problems, in turn, are often addressed through the introduction of input subsidies, especially agrochemicals such as inorganic fertilizers or weed and pest control substances, which can also pose a risk on ecosystem services (Teklewold et al. 2013; MOFA 2017; Pretty et al. 2011; Lee 2005). However, if, as in many regions in Sub-Saharan Africa (SSA), the effectiveness of inorganic fertilizers is limited due to, for example, low soil organic matter, and less than 50% of the nitrogen is effectively used by the crop, the oversupply of fertilizer as well as chemical weedicides contribute significantly to the pollution of ecosystems such as water bodies as well as the atmospheric N_2O concentration (Liverpool-Tasie et al. 2017; Tilman and Clark 2015). Sustainable agriculture has emerged as an approach that can address challenges of household welfare, food security as well as degradation of the environment at the same time (Knickel et al. 2017; DeFries et al. 2017; Beddington et al. 2011).

Sustainable consumption and production are an essential part of the Sustainable Development Goals (SDG) agenda. Standards and labels are intended to provide more information at one end of the food system, helping consumers to make more sustainable purchasing decisions in order to minimize resource consumption (United Nations 2016). Since consumer decisions can have an impact on farmers' welfare as well as on ecosystems in cultivation regions, impact-efficient labeling is critical to sustainable management approaches of complex global production chains. At the same time,

consumers in economically developed regions are increasingly convinced that sustainably certified or organic products are healthier and that moving away from conventional agricultural practices is a key factor in feeding the world's growing population, protecting the environment, and fighting climate change (Klümper et al. 2013; Seufert et al. 2017). Recent studies show that consumers have increased willingness-to-pay (WTP) for sustainably certified palm oil products, with a clear preference for uncertainty reducing measures such as segregated supply chains and organic certified products (Gassler and Spiller 2018; Richartz and Abdulai 2022).

One essential benefit of verified sustainable production methods can be the access to international supply chains, which can achieve higher prices due to the sustainable quality of the product and may provide the rural population with higher household incomes and improved food security. However, the findings in the context of household welfare appear to be mixed or sometimes marginal (Oya et al. 2018). In particular, some studies argue that implementing certified practices can lead to increased yields (Brako et al. 2021; Fenger et al. 2017), while others indicate that certification schemes in agriculture do not generally result in positive impacts on food security, as they do not necessarily lead to higher yields or better environmental conditions. Some authors note that these schemes may even have negative effects (DeFries et al. 2017), meaning that farmers even see disincentives in adopting biodiversity-friendly practices (Waldron et al. 2012).

Some studies also indicate that certifications lead to improved living conditions. For example, Kleemann et al. (2014) find that organic and global GAP certifications achieve positive returns on investment (ROI), with organic certified farming leading to higher ROI for Ghanaian small-scale pineapple farmers and with relatively poorer farmers being more likely to adopt organic-certified production. Findings by Chiputwa and Qaim (2016) suggest that Fairtrade, Organic, and UTZ certifications increase food security and dietary quality, mainly through positive effects on incomes and gender equity. Other studies find positive effects of participation in organic smallholder contract farming schemes on net revenue through access to guaranteed price premiums and reduction of uncertainties through marketing guarantees and environmental benefits through reduction of

chemical input use and adoption of environmentally friendly practices (Blackman and Naranjo 2012; Bolwig et al. 2009). In this context Scialabba and Müller-Lindenlauf (2010) state that organic agricultural systems have an inherent potential to both reduce greenhouse gas emissions, through reduction of nitrous oxide emissions, and to enhance carbon sequestration in the soil, which highlights the importance of including organic certification when assessing the effects of certification schemes. The use of different agricultural practices, which are determined by certification systems can thus have an impact on the conservation of agricultural land, the welfare of local producers in developing countries, and the food security of future generations of a steadily growing population. However, the empirical literature on palm oil in this context is quite scarce. Due to its significant role in the global market for vegetable oils, with its worldwide supply chains and the production-related problems that we will discuss further in the next section, palm oil is of central importance when it comes to developing more sustainable supply chains, which also implies contributing to the achievement of the SDGs. Particularly in accordance with SDG 12, to put production and consumption on a sustainable path, reliable certifications, regulations and labels play an essential role. Effects that have the potential to be achieved through such labeling can have direct positive impacts on e.g., SDGs 1, 2, 3, or 13.

Recent evidence suggests that certification and certain types of contracts have positive impacts on the livelihoods of palm oil farmers in Ghana (Brako et al. 2021; Ruml and Qaim 2020; Ruml et al. 2022; Debela et al. 2021). Findings by Brako et al. (2021) show that palm oil certification has significant positive effects on farm yields, income and multidimensional poverty of Ghanaian smallholders. However, some of these studies neglect how certifications – which are quite common in the study and sourcing areas of the operating palm oil companies and which play a major role in pricing processes – could influence welfare and environmental outcomes, as farmers with different contract types may also have various types of certification (Debela et al. 2021; Ruml et al. 2022). Moreover, some studies have indicated that besides economic factors, non-economic factors such as moral and social concerns also guide farmers' participation decisions in certification schemes that tend to be ecologically friendly (e.g. Mzoughi 2011).

This paper contributes to the growing literature by examining the impact of different certification schemes of palm oil cultivation on the welfare of farmers and the environment in rural Ghana, using recent data of 400 palm oil farmers. The paper seeks to fill the research gap by examining different certification approaches in the palm oil context, as certifications are subject to different regulatory mechanisms and thus may have different effects on household welfare and environmental outcomes. Furthermore, to the best of our knowledge this paper is the first to analyze the impacts of different certification schemes, with the use of the multinomial endogenous switching regression (MESR) approach to control for potential selection bias from both observable and unobservable characteristics. The empirical approach is suitable for identifying the direction of the bias related to participation decisions, as well as the type of certification scheme which is the source of the bias.

Although oil palm cultivation is often associated with negative connotations in developed countries, it offers economic opportunities to many people in the growing regions. The manual cultivation and harvesting is labor intensive and access to global value chains provides people with valuable and lucrative sources of income and can significantly improve rural livelihoods as well as the economic situation of the region (Brandi et al. 2013; Byerlee et al. 2017). However, it is argued that the use of labor on smallholder farms is more than three times higher than on large-scale industrial plantations, highlighting the importance of smallholder structures for the welfare of many individuals in a growing region. At the same time, large-scale industrial structures create the risk that social and economic gains are not equally distributed among the various stakeholders (Obidzinski et al. 2012). We focus on Ghana, as extremely large, industrial plantations are not yet the norm for cultivation and, as in other West African countries, cultivation in the country can still follow a different development path than in the main cultivation regions in Asia. A crucial aspect in this context is the fact that Ghana is one of the few countries in the world where non-certified farming practices can be compared with practices under the regulation of the Roundtable on Sustainable Palm Oil (RSPO) as well as organic certified practices. This situation presents a unique opportunity to examine the effects of different certification schemes on farm household welfare and the environment, which is a major contribution of the current

study. We analyze the toxicity of chemical weedicides, and thus potential negative environmental impacts, by calculating the hazard quotient (HQ) (Sellare et al. 2020).

The rest of the paper is structured as follows: Section 3.2 gives an overview of palm oil production and certification worldwide and in Ghana. Section 3.3 captures data and summary statistics of the variables used in the analysis. Section 3.4 presents the empirical specification, followed by empirical results in Section 3.5. Section 3.6 concludes.

3.2 Palm Oil Cultivation

3.2.1 Background

With a production quantity of 75.45 million metric tons, palm oil is one of the most produced, consumed, and globally traded vegetable oils. Indonesia and Malaysia are the world's largest palm oil producers, accounting for 59 and 25 percent of production, respectively. The main importers are India (16%), China (14%), and the European Union (13%) (USDA 2022). The oil palm is the highest-yielding vegetable oil crop, with a current global average yield of about 3.5 tons per hectare, while rapeseed or soybeans achieve substantially lower yields in comparison, ranging from 0.5 to 1.8 tons per hectare (Meijaard et al. 2018; Byerlee et al. 2017; Barcelos et al. 2015). It is mostly grown as a monoculture for commercial purposes, with some exceptions in west and central Africa, where it is also found as part of agroforestry systems and often used for domestic purposes (Byerlee et al. 2017).

Extensive clearing of tropical forests as well as draining of peatlands are often used to expand the cultivation areas, as a result of which irreversible environmental damage occurs, local population groups are displaced, tropical biodiversity is lost and CO₂-equivalent amounts with effects on the global climate are released (Brandi et al. 2013; Rhein 2015; Dislich et al. 2015). Other negative impacts, besides massive deforestation include water pollution from fertilizers, soil erosion, and to some extent toxic smoke when slash-and-burn land clearing is used to expand plantations (Crippa et al. 2016; Meijaard et al. 2018).

Although large plantations of industrial producers can be found especially in the main growing countries, it is estimated that about 50% of the palm oil cultivation area worldwide is managed by smallholders, who dominate cultivation especially in Africa (Byerlee et al. 2017; Ordway et al. 2017). It seems that production in African countries did not participate in the strong, expanding development of the 20th century, or only to a much more limited extent. While Nigeria was still the main producer around 1960, no African country today accounts for a double-digit percentage of global production (Qaim et al. 2020; USDA 2022). However, even though multinational large-scale corporations appear to play a major role in Malaysia and Indonesia, farm structures do not necessarily seem to be a determinant of how much oil palm cultivation interferes with land use change. For example, the majority of deforestation for palm oil on the African continent is driven by a non-industrial oil palm production sector, with great heterogeneity among producers, often referred to as smallholders (Ordway et al. 2017). This fact stresses the importance of the participation of smallholder farmers in sustainable development of the sector. Like other West African countries, Ghana is a rather small producer, with a production volume of less than 1% of the world market (USDA 2022).

3.2.2 Certification Schemes

Certification systems can hold comparable characteristics as contract farming schemes. One might expect similar effects to traditional contract farming. However, one fundamental difference is the expectation imposed on farmers' agricultural practices. Although certification can give farmers access to markets, with better prices, non-compliance with specific environmental or social requirements, can cause farmers to lose this access, despite the investment in the conversion of the farms. Additionally, smallholders can also be certified in small groups and not have any contracts with buyers or oil mills. In contrast to conventional contracts, far more responsibility is thus transferred to the farmer. In this study, we consider the organic and RSPO certification types for palm oil cultivating smallholder farmers in rural Ghana.

Founded in 2004, the RSPO is a voluntary association of various private stakeholders such as investors, processors, producers, smallholders and non-governmental organizations to promote economic, social

and environmental sustainability in the production and use of palm oil (e.g. RSPO 2018). The original intention of the RSPO was to set the sustainability standard for palm oil production worldwide (Oosterveer 2015). Their principles and criteria (PC) are organized in three impact areas, which include prosperity, people, and planet. The first section relates to ethical behavior, compliance with the law, and economic efficiency. The second part addresses sustainable livelihoods and poverty reduction, while the third part focuses on environmental protection. In its PC, the RSPO specifies precise measures that must be complied with in order to obtain certification. For example, legal or approved boundaries must be clearly demarcated and visibly maintained. No planting shall occur outside of these legal or approved boundaries. For all directly sourced fresh fruit bunches (FFB), mills require information on geo-location of FFB origins, proof of the ownership status or the right to the land by the grower or smallholder. Pricing procedures should be transparent to smallholders, pesticides should not be used on a prophylactic basis and good agricultural practices should be followed to manage soil fertility and minimize environmental impacts (RSPO 2018)¹.

Farmers classified as organic in this study are officially USDA² and EU³ organic certified. Thus, the legal regulations of organic farming apply. The primary goal of the initiators of organic farming practices in the Ghanaian palm oil sector was to prioritize soil fertility, biodiversity, species conservation, and good agricultural practices, and thereby achieve increased yields and fair prices for farmers. The original initiators of organic farming provided smallholders with seedlings of more productive oil palm varieties at interest-free loans to replace low-yielding dura palms. To improve biodiversity, farmers also had to plant other tree species (Serendipalm 2022). Today, organic certified farmers no longer produce exclusively for the initiative company.

¹ For an overview of all principles and criteria, the interested reader is referred to RSPO (2018): Principles and Criteria. For the Production of Sustainable Palm Oil 2018. Revised 01 February 2020 with updated Supply Chain Requirements for Mills. Roundtable on Sustainable Palm Oil. Zürich, checked on 4/8/2022.

² For a detailed overview, the interested reader is referred to USDA: Organic Regulations. In *Code of Federal Regulations, Title 7, Part 205*.

³ For a detailed overview, the interested reader is referred to European Parliament: Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007, revised Current consolidated version: 1/1/2022 2022.

3.2.3 Outcome Variables

As described above, certifications can help farmers receive higher farm net returns. Organic certified farmers, for example, have to carry out more manual labor on their farms, as weed control is carried out strictly manually. RSPO certified farmers, on the other hand, invest in various inputs for chemical processing of the fields. Therefore, the different farming techniques impose different demands on hired labor, time and input investment, and environmental impact. Consequently, the different approaches to farming can have different impacts on crop yields, prices, and net farm revenue, as well as food security. Studies show mixed results of cash crop cultivation under certain contractual constraints on food security. Some studies argue that a strong obligation to cash crops or contractual partners – which in this case would be the buyer of certified FFB – can lead to certain cash crops, such as palm oil, replacing food crops (Wood et al. 2013). This could imply that even with increased incomes, farmers may be less able to cope with food crises, and thus become more food insecure, or regions may become dependent on more expensive food crops that have to be imported into the country or region (Kusters et al. 2021). Others find positive relationship between cash crop production and food security, with improved food security often associated with the ability to diversify income sources rather than with cash crops per se (Hashmiu et al. 2022).

This study uses net farm revenues, net household income, output, yield in metric tons, prices, and the Household Food Insecurity Access Scale (HFIAS) to analyze the effects of certifications on farmers' household welfare. Additionally, the use of chemical weedicides is used as an indicator for environmental impact. We measure the environmental impact by using the toxicity of applied weedicides with respect to mammalian species as an indicator. It is important to consider these environmental impacts when evaluating certifications, as different certification schemes have different requirements for the use of agrochemicals and may also have different levels of monitoring and training regarding these regulations, which implies that the actual behavior of farmers under a particular certification will determine the actual impact of the certification on the environment.

3.3 Data and Summary Statistics

3.3.1 Data

This study uses data from a survey conducted among Ghanaian smallholder oil palm farmers. The data was collected in the period from March to May 2021, using a multistage sampling procedure. First, palm oil producing regions Eastern, Western, and Central were purposively selected. The Ghana Oil Palm Development Company (GOPDC), Serendipalm, Twifo Oil Palm Plantations Limited (TOPP), and Benso Oil Palm Plantation Limited (BOPP) produce in these regions. Second, based on information from the Ministry of Food and Agriculture, extension officers, cooperatives and oil mills, the districts Kwaebibirem Municipal, Mpohor, Tarkwa-Nsuaem Municipal, and Twifo/Hemang/Lower Denkyira were chosen, as oil palm cultivation is particularly prevalent there. In the third stage, 18 communities were randomly chosen. In the last stage, certified and non-certified farmers were randomly selected from the communities.

The dataset contains 400 randomly selected farmers. These include 133 non-certified, 158 RSPO certified and 109 organic certified farmers. Farmers either produce FFB for the previously mentioned large-scale industrial oil mills or small mills. Farmers sell partly under contract and partly on the spot market. In the dataset, 32% of all farmers report being bound to a contract. Of the certified farmers, 30% report being committed to a contract as a result of their certification. Organic farmers are not allowed to use any kind of chemical weedicides or inorganic fertilizers. From the data, we can observe that non-certified and RSPO certified farmers use chemical inputs.

3.3.2 Summary Statistics

Table 3.1 presents descriptive statistics and definitions of the variables used in the analysis. Table 3.2 shows differences in characteristics between non-certified, RSPO, and organic certified farm households, and associated t values. The upper seven rows show differences in outcome variables. The descriptive statistics indicate that RSPO farmers produce the highest output, followed by organic certified farmers, and non-certified farmers, respectively. However, as RSPO farmers have the largest farms, they attain lower yields, while organic farmers achieve the highest yields. On Average, RSPO

farmers spend more money on hired labor and weedicides, resulting in the highest farming costs. They receive the lowest prices for their FFB, while organic farmers receive significantly higher prices and have significantly lower farming costs than RSPO and non-certified farmers. The descriptive statistics do not show any significant difference between the net farm revenue and net household income, which includes income from off-farm work, of RSPO and non-certified farmers, while organic certified farmers achieve higher net farm revenues as well as higher net household incomes. RSPO farmers have a statistically significant higher use of chemical weedicides, resulting in a higher average HQ. The data reveal lower level of landownership in this group of farmers, which is probably contributing to the more rigorous use of chemical substances on the land.

With respect to the HFIAS (Coates et al. 2007), organic certified farmers appear to show higher levels of food security, however not statistically significant. It should also be noted that organic farmers tend to have the lowest amount of off-farm income, an observation that is consistent with Ruml et al. (2020), who conclude that Ghanaian palm oil farmers who receive time savings on active farm work through certain contracts increasingly use the profits and time gained to transition out of agriculture. Conversely, this indicates that the behavior of organic certified farmers could be a result of the fact that the ban on the use of chemicals of any kind requires more presence and manual labor on the farm, which would also be in line with other studies, that have shown that certain types of contractual obligations make farmers spend less time on off-farm activities and more time on their farm work (Otsuka et al. 2016).

The data also reveal that in RSPO-certified farm households, women are more likely to be the household head than in organic certified households. It can be observed that the household head in RSPO certified households is older than in organic and non-certified households, respectively. Organic farmers show a significantly higher level of education than non-certified farmers. RSPO farmers have more experience in palm oil cultivation, are on average further away from local markets, and use more hired labor on their farms. RSPO and organic certified farm households are more often motorized and receive significantly more extension services than non-certified farm households.

Table 3.1 Variable definition and summary statistics

Variable	Description	Mean	Standard deviation
Yield	Quantity harvested in metric tons per hectare (FFB)	4.03	5.22
Output	Total quantity Harvested in metric tons (FFB)	21.3	27.08
Price	Price received per ton in GHS	469.22	93.19
Net Farm Revenue	Net Farm Revenue in GHS	9381.898	11807.74
Net HH Income	Net Household Income in GHS	12323.99	12995.36
Hazard Quotient	A higher Quotient indicates a more toxic combination of pesticides	0.33	0.94
HFIAS	Household Food Insecurity Access Scale	1.53	0.88
Farming costs	Total Farming Costs in GHS	3554.1	2839.66
Income off farm	Income off-farm work in GHS per year	3942.09	5683.37
Gender	1 if head of household is female, 0 otherwise	0.15	0.36
Age	Age of Household head (years)	57.15	12.26
Household Size	Number of household members	5.14	2.19
Education	Years of formal education of Household head	9.08	4.14
Motorized	1 if farmer owns any kind of motorized vehicle, 0 otherwise	0.22	0.41
Palm oil experience	Years of own experience in oil palm farming	21.83	8.84
Market Distance	Distance to local market in kilometers	1.98	1.51
Property Rights	1 if Owner of land, 0 otherwise	0.5	0.5
Hired Labor	Number of man days of paid labor	53.65	42.09
Extension	Extension Frequency	2.11	1.84
Off farm work	1 if farmer participates in any off-farm work, 0 otherwise	0.65	0.48
Credit constrained	1 if farmer is credit constrained, 0 otherwise	0.36	0.48
Farm age	Age of oil palm farm in years	19.65	7.04
Farm size	Land size of palm oil cultivation in hectare on household level	5.83	3.1
No Certified Farmers	Number of certified farmers within a 1.5 km radius of homestead	7.43	27.03
Extension Distance	Distance to extension contact possibility in kilometers	3.76	3.4
Knowledge of credit source	1 if farmer is aware of existing credit sources, 0 otherwise	0.39	0.49
Central Region	1 if farmer is located in central region, 0 otherwise	0.15	0.36
Eastern Region	1 if farmer is located in eastern region, 0 otherwise	0.59	0.49
Western Region	1 if farmer is located in western region, 0 otherwise	0.26	0.44

Note: GHS is Ghanaian currency (Ghanaian Cedi); US\$1 = GH¢ 5.74 in March / April 2021.

Table 3.2 Differences in characteristics among users of certification types

Variable	Non-certified		RSPO Certified		^a Diff. (t-stat.)	Organic Certified		^b Diff. (t-stat.)	^c Diff. (t-stat.)
	Mean	Standard deviation	Mean	Standard deviation		Mean	Standard deviation		
Yield	4.02	4.98	3.31	3.57	1.41*	5.09	7.08	-1.39*	-2.72***
Output	17.09	22.59	24.12	29.25	-2.26**	22.34	28.39	-1.60*	0.49
Price	476.87	82.79	407.31	77.22	7.41***	549.61	53.24	-7.93***	-16.69***
Net Farm Revenue	8659.44	10235.17	7972.21	10696.83	0.56	12306.85	14440.58	-2.29**	-2.82***
Net HH Income	12880.95	12095.78	12252.56	11922.74	0.45	15417.66	15234.93	-1.44*	-1.90**
Hazard Quotient	0.4	1.19	0.5	0.97	-0.72	0.00	0.00	3.48***	5.27***
HFIAS	1.62	0.99	1.5	0.82	1.09	1.47	0.81	1.25	0.32
Farming costs	3019.39	2377.91	4071.91	3236.57	-3.11***	3455.95	2626.33	-1.36*	1.65**
Income off-farm	4221.51	5628.45	4280.35	6300.25	-0.08	3110.82	4685.16	1.65*	1.65*
Gender	0.14	0.34	0.18	0.38	-0.97	0.12	0.32	0.37	1.29*
Age	53.41	13.64	59.88	10.39	-4.58***	57.72	11.93	-2.58***	1.57*
Household Size	5.32	2.16	4.87	2.06	1.81**	5.31	2.38	0.03	-1.60*
Education	8.76	3.94	9.05	4.76	-0.57	9.49	3.31	-1.55*	-0.83
Motorized	0.14	0.35	0.28	0.45	-2.83***	0.21	0.41	-1.39*	1.25
Palm oil experience	17.72	9.08	25.54	6.87	-8.35***	21.48	8.85	-3.24***	4.21***
Market Distance	1.65	1.51	2.36	1.59	-3.84***	1.81	1.29	-0.88	2.96***
Property Rights	0.62	0.49	0.25	0.44	6.85***	0.71	0.46	-1.35*	-8.18***
Hired Labor	47.15	39.39	61.29	46.86	-2.76***	50.48	36.15	-0.68	2.03**
Extension	1.53	1.93	2.38	1.81	-3.88***	2.44	1.61	-3.94***	-0.28
Off farm work	0.69	0.46	0.65	0.47	0.72	0.59	0.49	0.06	0.92
Credit constrained	0.37	0.48	0.34	0.48	0.47	0.39	0.49	-0.27	-0.73
Farm age	15.62	6.76	23.68	3.89	-12.69***	18.72	7.78	-3.32***	6.86***
Farm size	4.25	2.21	7.68	2.81	-11.43***	5.07	3.07	-2.42***	7.19***
No Certified Farmers	2.1	1.44	7.6	13.48	-4.68***	13.68	48.57	-2.75***	-1.5*
Extension Distance	3.29	3.05	4.49	3.74	-2.95***	3.26	3.13	0.06	2.79***
Knowledge of credit source	0.36	0.48	0.41	0.49	-0.88	0.39	0.49	-0.53	0.28
Sample size	133		158			109			

Note: *, **, and *** mean significant at 10%, 5%, and 1% levels, respectively.

^aDifferences in characteristics between non-certified and RSPO certified farmers.

^bDifferences in characteristics between non-certified and organic certified farmers.

^cDifferences in characteristics between RSPO certified and organic certified farmers.

3.4 Empirical Specification

3.4.1 Determinants of Participation

In the conceptual framework we present, we first describe the decision of farmers to enter one of the two certification schemes or to sell their product without certification. The conceptual framework we use in this study assumes that farmers choose a certification scheme or strategy to maximize their expected net benefits. Thus, farmers choose between the two certification schemes or no certification. Since the expected net benefits associated with each strategy cannot be directly observed, we assume R^* to be a latent variable that captures the expected net benefits from implementing one of the strategies j ($j = 1, 2, 3$) with respect to implementing any other strategy. In the framework of this paper, j takes the value 1 if a farmer is not certified, the value 2 if a farmer is RSPO certified, and the value 3 if a farmer is organic certified. Z_i is a vector of household and farm-level characteristics which are expected to influence farmers' decisions to choose a specific strategy. We define β_j as a vector of parameters to be estimated, and η_{ij} is an error term that captures relevant but unobservable variables, and which is assumed to be normally distributed with zero mean and constant variance. Given the definition of the latent variable R^* as a function of observable and unobservable elements, farmer i will choose strategy j if it provides greater net benefits than any other available strategy. For the participation in certification schemes, let R_i represent an index of the farmer's observed choice of certification schemes:

$$R_{ji}^* = Z_i \beta_j + \eta_{ij} \text{ with}$$

$$R_i = \begin{cases} 1 \text{ (Non - certified)} & \text{if } R_{i1}^* > \max(R_{i2}^*, R_{i3}^*) \\ 2 \text{ (RSPO certified)} & \text{if } R_{i2}^* > \max(R_{i1}^*, R_{i3}^*) \\ 3 \text{ (Organic certified)} & \text{if } R_{i3}^* > \max(R_{i1}^*, R_{i2}^*) \end{cases} \quad (1)$$

A multinomial logit (MNL) model is used to estimate equation (1), which constitutes the first-stage of the estimation procedure; η_{ij} is assumed to be independent across i and j . In the second-stage of the analysis, we estimate the impact of the different strategies on farmers' outcomes, taking into account the problem that farmers self-select into participating in one of the three different strategies.

3.4.2 Identification Strategy

In this paper, we hypothesize that the different strategies j (non-certified, RSPO certified, organic certified), affect the outcomes that we outlined earlier. Specifically, we consider yield, net household income, prices, HQ, and food security as outcomes in our analysis. To the extent that farmers self-select into participating in one of the three different strategies, depending on the expected net benefits arising from each of them, the decision to participate is not random, leading to potential selection bias problems. Selection bias arises if unobservable factors influence the error term η_{ij} in the first-stage equation (1) and the error term in the second-stage equation (2). In this case, the error terms of the participation choice model and the outcome equations are correlated, resulting in inconsistent estimates, if cross-sectional data is used. To address this issue, we use the method proposed by Bourguignon et al. (2007) (hereinafter BFG model), which has the advantage of estimating a selectivity correction parameter for each of the available certification alternatives. Thus, it provides insights into which coordination mechanism constitutes the source of the bias. Furthermore, it is considered in the literature to yield more robust estimates compared to Lee's (1983) initial model (Bourguignon et al. 2007; Abdul-Rahaman and Abdulai 2020). To estimate the impact of the certification schemes on the outcome variables in the second-stage, we specify three regimes of outcome equations:

$$\text{Regime 1 (Non – certified): } Y_{i1} = X_{i1}\gamma_1 + \mu_{i1} \text{ if } R = 1 \quad (2a)$$

$$\text{Regime 2 (RSPO certified): } Y_{i2} = X_{i2}\gamma_2 + \mu_{i2} \text{ if } R = 2 \quad (2b)$$

$$\text{Regime 3 (Organic certified): } Y_{i3} = X_{i3}\gamma_3 + \mu_{i3} \text{ if } R = 3 \quad (2c)$$

where Y_{i1} , Y_{i2} , and Y_{i3} are the defined outcome variables. X_i is a vector of explanatory variables, γ_j is a vector of parameters to be estimated, and μ_i is the error term. The model is identified because variables in X_i in equations 2a-2c are a subset of the variables in Z_i in equation 1. This implies that Z_i contains at least one additional variable, which serves as an instrument for identification. In our case, we use the instrument *certified farmers within a radius of 1.5 km*, which will be discussed in more detail in the next section.

By employing the BFG model, we first estimate the determinants of farmers' decision making, and then compute selection correction terms, which are later included in the second-stage to ensure consistent estimates in the outcome equations, as selectivity effects can still arise from unobservable factors.

Thus, we estimate the following regimes of selection bias corrected outcome equations:

$$\text{Regime 1: } Y_{i1} = X_{i1}\gamma_1 + \sigma_1 \left[\rho_1 m(P_{i1}) + \sum_j \rho_j m(P_{ij}) \frac{P_{ij}}{(P_{ij}-1)} \right] + v_{i1} \text{ if } R = 1 \quad (3a)$$

$$\text{Regime 2: } Y_{i2} = X_{i2}\gamma_2 + \sigma_2 \left[\rho_1 m(P_{i2}) + \sum_j \rho_j m(P_{ij}) \frac{P_{ij}}{(P_{ij}-1)} \right] + v_{i2} \text{ if } R = 2 \quad (3b)$$

$$\text{Regime 3: } Y_{i3} = X_{i3}\gamma_3 + \sigma_3 \left[\rho_1 m(P_{i3}) + \sum_j \rho_j m(P_{ij}) \frac{P_{ij}}{(P_{ij}-1)} \right] + v_{i3} \text{ if } R = 3 \quad (3c)$$

where P_{ij} is the probability that farmer i chooses certification strategy j , ρ_j represents the correlation between η_{ij} and μ_{ij} , and $m(P_{ij})$ is the conditional expectation of η_{ij} used to correct for selection bias, σ_j is the standard deviation of μ_{ij} , and v_{ij} is the error term. A significant correction term $m(P_{ij})$ associated with any strategy indicates the presence of selection bias (Bourguignon et al. 2007). For each outcome specification, a negative selectivity correction term related to any strategy indicates lower outcomes than those of randomly chosen farmers. This suggests that farmers with better unobserved attributes switch from using the given strategy into the alternative strategy (Dimova and Gang 2007).

3.4.3 Treatment effects of certification schemes

In the last step of the analysis, we compute the average treatment effects on the treated (ATT) to examine the causal effects of certification scheme choice on the outcome variables such as yield, net farm revenue, and food security. First, we consider farmers who are RSPO and those who are organic certified to be the treatment groups of our sample. Separate predictions of the treatment effects relative to the non-certified group are carried out. Second, we examine the different outcomes of the organic certified farmer group, relative to the RSPO group, to analyze the effects of switching from one certification to another. We calculate the ATTs by making use of the predictions of the counterfactual outcomes, that we obtain from the BFG model. We analyze the effects by specifying the expected

values of the outcome. The expected value of the outcome for a RSPO certified farmer is $E(Y_{i2} | R = 2)$. We can then define the expected value of the same farmer if he or she had not chosen to take part in the RSPO certification scheme to be $E(Y_{i1} | R = 2)$. The change in outcome due to the participation in the certification scheme can be specified as the difference between RSPO certification choice and non-certification choice. We specify the inverse mills ratios in the brackets of Equations 3a-3c by λ , and the ATTs for the RSPO (4a) and organic (4b) certification with respect to non-certification, and the organic certification with respect to RSPO certification (4c) as

$$ATT_{RSPO-non} = E(Y_{i2} | R = 2) - E(Y_{i1} | R = 2) = X_{i2}(\gamma_2 - \gamma_1) + \lambda_{i2}(\sigma_2 - \sigma_1) \quad (4a)$$

$$ATT_{Organic-non} = E(Y_{i3} | R = 3) - E(Y_{i1} | R = 3) = X_{i3}(\gamma_3 - \gamma_1) + \lambda_{i3}(\sigma_3 - \sigma_1) \quad (4b)$$

$$ATT_{Organic-RSPO} = E(Y_{i3} | R = 2) - E(Y_{i2} | R = 2) = X_{i3}(\gamma_3 - \gamma_2) + \lambda_{i3}(\sigma_3 - \sigma_2) \quad (4c)$$

3.4.4 Hazard Quotient

The Hazard Quotient (HQ) is an easily measurable and interpretable indicator as it considers the toxicity of the applied weedicide with respect to mammalian species. For the assessment of acute toxicity, we use the lethal dose of the active ingredient, which kills 50% of the test animals (LD_{50}). The HQ is calculated as follows:

$$HQ = \sum_{ai=1}^N \frac{Amount_{ai}}{Toxicity_{ai}} \quad (5)$$

where N is the total Number of pesticide active ingredients applied to the oil palm, $Amount_{ai}$ is the quantity of each active ingredient applied, and $Toxicity_{ai}$ is the acute rat LD_{50} via oral administration, expressed in mg per kg of animal weight (Sellare et al. 2020). A larger HQ indicates a more toxic combination of pesticides.

3.5 Empirical Results

This section first discusses the drivers of participation in a certification scheme. In Table 3.3, we present the results of the multinomial logit model (MNL) which represents the first stage of the estimation. We then examine the effects on the various outcome variables and the resulting impacts of certification (ATT).

3.5.1 Drivers of participation in certification scheme

The determinants of farmer's certification scheme choices are presented in Table 3.3. Farmers whose palm oil plantations are not certified constitute the base group for comparison in the analysis. For better interpretation the marginal effects of the coefficients of each group are displayed (Wooldridge 2010). As indicated previously, we include an instrument in the certification decision model as an identification strategy of the multinomial BFG model. The instrument has a statistically significant influence on the certification decision without being correlated with the outcomes (Wooldridge 2010).

We use the number of certified farmers in a 1.5 km radius around the farmer's homestead as the instrument variable. It is argued in the literature that high levels of clustering increase the likelihood that farmers will communicate with each other and information spillovers will occur (Michelson 2017). Farmers will thus exchange information about their certifications as well as their advantages and disadvantages with their neighbors. Nevertheless, it is important to mention that due to the context of sustainable cultivation methods and cultivation requirements, we use information exchange among neighbors around the farmer's homestead. This is important as neighboring certified and non-certified farmers in the communities share their experiences.

To examine the validity of the instrument, we present estimates in Table 3.A7 in the Appendix Chapter 3, which show that the χ^2 is significant in the participation decision specification, but not statistically significant in the outcome models. The estimate for instrument suggests that an increase in the number of certified farmers in the area contributes to farmers accessing the value chain through certification schemes.

Table 3.3 Determinants of farmers' certification scheme choices: First-stage MNL

Variable	Non-certified		RSPO certified		Organic certified	
	Marginal Effects	Std. err.	Marginal Effects	Std. err.	Marginal Effects	Std. err.
Age	-0.0469*	(0.0255)	0.0469*	(0.0256)	-2.33e-05	(0.000131)
Age ²	0.000436**	(0.000213)	-0.000436**	(0.000213)	3.70e-07	(1.06e-06)
Gender (female=1)	-0.127*	(0.0669)	0.128*	(0.0671)	-0.000466	(0.000466)
Household Size	0.0379**	(0.0168)	-0.0378**	(0.0169)	-8.51e-05	(0.000103)
Education	0.00218	(0.00891)	-0.00229	(0.00893)	0.000108**	(5.37e-05)
Experience palm oil farming	-0.00747	(0.00586)	0.00750	(0.00585)	-2.52e-05	(4.05e-05)
Market Distance	-0.0633**	(0.0273)	0.0636**	(0.0273)	-0.000236	(0.000147)
Farm size	-0.0282	(0.0198)	0.0279	(0.0199)	0.000270**	(0.000115)
Motorized	-0.136**	(0.0676)	0.137**	(0.0676)	-0.000920**	(0.000359)
Hired Labor	-0.00168	(0.00183)	0.00168	(0.00183)	1.15e-07	(1.11e-05)
Property Rights	0.277**	(0.115)	-0.279**	(0.115)	0.00289**	(0.00119)
Age of trees	-0.0255**	(0.00996)	0.0256**	(0.01000)	-0.000111**	(5.63e-05)
Off-farm work	-0.0819	(0.0684)	0.0830	(0.0685)	-0.00107**	(0.000542)
Extension Frequency	-0.0578**	(0.0249)	0.0578**	(0.0250)	4.07e-05	(0.000136)
Credit constraint	0.726	(0.505)	-0.729	(0.505)	0.00347	(0.00821)
Central	-0.0279	(0.130)	0.0281	(0.130)	-0.000224	(0.000623)
Eastern	-0.125	(0.0847)	-0.568***	(0.107)	0.693***	(0.0608)
No. certified farmers	-0.0516***	(0.00612)	0.0515***	(0.00611)	7.01e-05***	(1.93e-05)
Res_credit	-0.302	(0.280)	0.303	(0.281)	-0.00174	(0.00158)
Res_ext	-0.0505	(0.703)	0.0530	(0.704)	-0.00249	(0.00468)

Note: Base group is non-certified; ** and *** mean significant at 5% and 1% levels, respectively.

It is important to mention that in organizational structures such as certification or contractual schemes, access to credit as well as extension service may potentially be endogenous (Abdul-Rahaman and Abdulai 2020). Since certified farmers often receive guaranteed prices and sometimes also guaranteed purchase volumes, their creditworthiness may be improved. In addition, buyers of the certified output sometimes act as guarantors for the farmers, which again may increase the creditworthiness. The variable extension service could also be endogenous, as farmers may have better access to extension services due to their certification by some regulatory institutions, or product buyers to monitor a

specific product quality. At the same time, farmers who use extension services more often may be more likely to be selected by companies that want to engage farmers in certified production. As in Wooldridge (2015), we use a two-stage control function approach and include the generalized residuals of access to credit and extension in the analysis. The results in Table 3.3 show that the variables representing the residuals are not statistically significant, suggesting that they have been consistently estimated.

The estimates further reveal that female farmers are more likely to be RSPO certified and less likely to be non- or organic certified. A larger household is associated with an increased likelihood of selling without certification. We also observe that a higher educational level is associated with an increased likelihood of being organic certified, which is in line with the literature (Meemken and Qaim 2018).

The results further indicate that farmers with larger farms and longer distances to the local market are more likely to be part of the RSPO certification scheme. This relationship may be partly explained by the fact that large companies, which are dependent on RSPO certified commodities, also collect the FFB in large quantities from remote farms or collection points with company-owned transport vehicles. Therefore, for farmers in remote regions and with particularly large farms, it is reasonable to participate in the RSPO certification scheme in order to benefit from the industry's supply chains. However, we also see that more mobile farmers are more likely to participate in RSPO certification. This finding is consistent with the previously described effects, as these farmers presumably have an increased need for mobility due to their larger farm sizes and greater distances. It is interesting to note that farmers with property rights to the land they farm on are more likely to be non-certified or organic certified. Fewer RSPO farmers tend to have property rights to the land they cultivate. This is a rather plausible finding, as RSPO farmers often transfer land to large corporations and only hold the ownership to the trees on the land. Additionally, the age of the trees also plays an important role. The results indicate that farmers with older plantations are more likely to be RSPO certified and less likely to be organic or non-certified. This is not surprising, as organic certification in the palm oil sector is a recent development, and it was not until around the year 2009 that the first commercial production

of organic palm oil was initiated in the region. In line with Otsuka et al. (2016), we find that off-farm work has a significant and negative impact on organic certification choice. We recognize that an increase in extension contacts increases the likelihood of being RSPO certified, indicating that extension agents may raise the awareness about the potential benefits of certifications.

3.5.2 Impact of Certification Type on Outcomes

Table 3.4 presents the impact of certification schemes on net farm revenue. Tables 3.A1 to 3.A6 in the Appendix Chapter 3 show the results of the second stage of the estimation for the outcome variables output quantity, net household income, yield, prices, HFIAS, and HQ. The second stage of the BFG model allows us to determine the effects of RSPO and organic certification relative to non-certified farmers on the outcome variables. The advantage of the BFG model is that it provides a correlation term for each of the three strategies (non-certified, RSPO, organic), which control for selectivity effects resulting from unobserved heterogeneity. The estimates reveal a significant selectivity correction term for RSPO certification in the example provided in Table 3.4, the impact of certification on net farm revenue. The significance of the selection terms indicates the existence of selection bias, which supports the validity of the use of the BFG model. Without accounting for the selection bias, it is reasonable to assume that the impact of certification on farm and household outcomes would not have been estimated consistently. This indicates that farmers self-select into one of the groups based on observable and unobservable characteristics. In other words, the outcome variables are influenced by farmers who move to certain certification schemes (including non-certified), because they do not perform well under the other available schemes. Since the attributes which are linked to, for example, higher net farm revenues and which make farmers switch to a certain scheme are unobserved, our results reveal the source and direction of the selection bias.

The term for the selectivity correction related to non-certification in the specification for RSPO certification is found to be positive and statistically significant at the 10% level, suggesting that for farmers who are RSPO certified, switching to producing without certification would lead to a

significantly negative impact on their net farm revenue, compared to a randomly chosen farmer (Khanal and Mishra 2014).

The negative and significant estimates e.g., of $m1$ in Table 3.4 indicate that farmers with unobserved attributes that enhance net farm revenue in participating in the non-certified category have moved to RSPO certification. These farmers (non-certified farmers) appear to earn more in net farm revenue by opting instead to participate in RSPO certified farming. The same interpretation applies to RSPO farmers who would switch to organic production. These results reveal that selectivity bias is present, and that the estimated coefficients and ATT, which are presented in the next section would have been biased and inconsistent had we not included these terms in our model.

The positive and significant coefficients in the RSPO and organic certification specifications reveal that RSPO farmers with larger farms are able to achieve higher net farm revenue and that hiring labor increases net farm revenue in both certified categories. The results show that property rights lead to lower net farm revenue for RSPO farmers. This finding could be explained by the fact that palm oil processing mills give farmers incentives to sell off their land and only keep the trees on the land as their property. As a consequence, RSPO farmers are increasingly selling their land to multinational companies that are buyers of RSPO-licensed goods, and are being promoted and rewarded for doing so. The results further show that participation in off-farm work reduces net farm revenue in all groups, however, only statistically significant in the non-certified group. All results and coefficients in the outcome specifications in Tables 3.A1 to 3.A6 in the Appendix Chapter 3 are to be interpreted similarly. When farmers increasingly engage in off-farm work, the potential for improved net household income increases for non-certified and RSPO farmers. At the same time, output, yield, and net farm revenue tend to decline, results that are consistent with observations of Bolwig et al. (2009). Thus, we note that the transition to off-farm work seems to play a crucial role in farm household and environmental outcomes, depending on the certification obligation of the household. The results suggest that RSPO farmers in particular seek to compensate for the reduced outcomes due to off-farm work by using more hired labor.

Table 3.4 Determinants of net farm revenue by certification choice: Second-stage MESR

Variable	Non-certified		RSPO certified		Organic certified	
	Coefficients	Std. err.	Coefficients	Std. err.	Coefficients	Std. err.
Age	-0.0939	(-0.71)	0.0158	(0.17)	-0.0567	(-0.46)
Age ²	0.000798	(0.71)	-0.000188	(-0.24)	0.000373	(0.38)
Gender (female=1)	0.0676	(0.1)	-0.247	(-0.95)	0.553	(1.05)
Household Size	0.0322	(0.22)	-0.0237	(-0.43)	0.0133	(0.13)
Education	0.0191	(0.3)	0.0127	(0.64)	-0.0252	(-0.38)
Experience palm oil farming	0.0204	(0.55)	0.0149	(0.76)	0.0393	(1.38)
Market Distance	0.154	(0.85)	0.0394	(0.58)	0.064	(0.53)
Farm size	0.165	(0.92)	0.162*	(1.79)	-0.000659	(-0.01)
Motorized	0.404	(0.61)	0.402	(1.63)	0.296	(0.59)
Hired Labor	-0.00102	(-0.14)	0.0137***	(5.64)	0.00951*	(1.77)
Property Rights	0.00386	(0.01)	-0.613*	(-1.71)	-0.817	(-1.09)
Age of trees	-0.00684	(-0.12)	0.0423	(0.43)	-0.000177	(-0.00)
Off farm work	-0.759*	(-1.69)	-0.211	(-1.08)	-0.238	(-0.43)
Extension Frequency	-0.211	(-1.09)	-0.0825	(-1.10)	-0.0858	(-0.51)
Credit constraint	-0.17	(-0.39)	0.0675	(0.32)	0.179	(0.54)
Regional fx.	yes		yes		yes	
_m1	-0.766	(-0.69)	-3.560*	(-1.74)	-1.506	(-0.57)
_m2	-1.868	(-0.51)	-1.407*	(-1.86)	-0.206	(-0.07)
_m3	-2.218	(-0.73)	-3.006*	(-1.81)	-1.256	(-1.34)
_cons	9.205**	(2.08)	4.216	(0.94)	10.35**	(2.05)
ρ1	-0.407	(-0.87)	-1.766*	(-1.79)	-1.007	(-0.89)
ρ2	-0.992	(-0.76)	-0.698	(-1.62)	-0.138	(-0.11)
ρ3	-1.178	(-1.04)	-1.491	(-1.61)	-0.84	(-1.64)

*Note: Base group is non-certified; ** and *** mean significant at 5% and 1% levels, respectively.*

Positive and statistically significant coefficients of hired labor in Tables 3.A1 and 3.A3 in the Appendix Chapter 3 indicate that an increase in hired labor increases output, as well as yield among all farmers. Thus, reduced yield, output and net farm revenue from participation in the off-farm market may be compensated for by hiring labor. However, reallocating household resources may also result in other challenges, particularly for RSPO farmers. The findings reveal that more hired labor among RSPO farmers leads to lower prices, higher HQ, and increased food insecurity. These results suggest that RSPO farmers may have substantial allocation and management difficulties (Brandi et al. 2015). It

appears that farmers are not proficient at balancing the benefits of increased income from off-farm work against the economic disadvantages of additional labor and other opportunity costs. The results could be due to the fact that hired workers, for example, may be satisfied with lower prices and may have less bargaining power or less willingness to bargain. In addition, for RSPO farmers, larger farms, i.e., larger harvest volumes, also lead to lower unit prices. At the same time, hired laborers may be more rigorous in the use of chemical substances as they do not own the plantations and trees, and may not have long-term interests in sustainable land and tree management practices to ensure long-term soil quality and productivity. The latter aspect may also be explained on the basis of the allocation problem. If farmers are not able to improve their overall income, for example because they have to pay too many farm workers, their purchasing power for food may be reduced, which could potentially result in increased food insecurity.

3.5.3 Impact of participation in certification on farm performance and household welfare

In this section, we present the estimates on the impacts of certification schemes on household welfare and farm performance indicators. Table 3.5 presents the average treatment effects on the treated (ATT) of certification schemes on outcomes, such as net farm revenue, output in metric tons, prices, net household income, yield, food security (HFIAS), and hazard quotient (HQ). The estimates generally indicate that participation in certification schemes in most cases yields benefits for farmers in terms of economic, as well as social and environmental performance. In particular, under given observed and unobserved characteristics, RSPO farmers manage to achieve 15.39% more net farm revenue, 41.53% more output, and 33.86% more yields compared to the counterfactual mean of a non-certified farmer. However, a 13.26% reduction in the net household income of RSPO farmers compared to non-certified farmers suggests that non-certified farmers may achieve advantages in the overall economic performance of the household. One possible driver for this could be the additional expenses and time constraints required to comply with certification standards (Jaffee 2019).

Table 3.5 Average treatment effects of certification schemes on household welfare and environment

Outcome Variable	Mean Outcome	Mean Outcome (counterfactual)	ATT	t value	Change (%)
Net Farm Revenue (log)	RSPO	Non-certified			
	8.49	7.19	1.31	4.169***	15.39
	Organic	Non-certified			
	8.79	8.552	0.24	3.603***	2.7
Output in metric tons (log)	Organic	RSPO			
	8.79	7.52	1.275	12.87***	14.49
	RSPO	Non-certified			
	2.62	1.53	1.089	5.55***	41.53
Prices per metric ton (GHS)	Organic	Non-certified			
	2.47	2.45	0.015	0.31	0.61
	Organic	RSPO			
	2.47	1.99	0.47	6.59***	19.21
Net Household Income (log)	RSPO	Non-certified			
	415	647.94	-232.94	-5.999***	-56.13
	Organic	Non-certified			
	549.61	531.31	18.303	3.199***	3.33
Yield (log)	Organic	RSPO			
	549.61	499.08	50.533	10.479***	9.19
	RSPO	Non-certified			
	9.113	10.899	-1.786	-4.687***	-19.6
Food Insecurity (HFIAS)	Organic	Non-certified			
	9.267	9.345	-0.078	-1.101	-0.84
	Organic	RSPO			
	9.267	8.854	-0.413	7.366***	4.46
Hazard Quotient	RSPO	Non-certified			
	1.198	0.792	0.406	6.344***	33.86
	Organic	Non-certified			
	1.346	1.398	-0.052	-1.579*	-3.85
Food Insecurity (HFIAS)	Organic	RSPO			
	1.346	0.971	0.375	8.454***	27.83
	RSPO	Non-certified			
	1.528	2.429	-0.902	-4.329***	-59.04
Hazard Quotient	Organic	Non-certified			
	1.468	1.976	-0.508	-7.355***	-34.63
	Organic	RSPO			
	1.468	1.582	-0.114	-2.122**	-7.75
Hazard Quotient	RSPO	Non-certified			
	0.421	0.778	-0.357	-1.568*	-84.64
	Organic	Non-certified			
	-	-	-	-	-100
Hazard Quotient	Organic	RSPO			
	-	-	-	-	-100

Note: ATT is average treatment effect on the treated. Computation of ATT is based on the predictions. ** and *** mean significant at 5% and 1% levels, respectively. Household welfare is measured by net farm revenue, net household income, output, and food security status.

Furthermore, RSPO certified farmers receive on average and compared to the counterfactual mean 56.13% lower prices for their yields. This situation is one of the biggest challenges for the recipients of RSPO certified produce. Often, farmers do not fulfill the agreed delivery quantity and spontaneously sell their produce on non-certified spot markets, as higher than pre-agreed prices for RSPO certified produce are achieved there. Processors of RSPO certified goods refer to this problem as "*diversification*" to reflect the fact that farmers breach their agreements.

When considering organic versus non-certified farmers, our results reveal the same trends. Organic farmers are able to achieve 2.7% more net farm revenue, as well as 3.33% higher prices. However, organic farmers achieve slightly lower yields, which is in line with the literature on organic farming (Ponisio et al. 2015; Ponti et al. 2012; Seufert et al. 2012). Yet, with a value of 3.85%, the effective yield deficit is relatively moderate. In this context, Seufert et al. (2012) argue that perennial crops have better organic performance than annual crops, which could explain a small yield gap. Along with this argument, Ponti et al. (2012) state that the more productive the conventional comparison group, the larger the yield gaps. With regard to palm oil, this seems to be a valid argument, as average yields on the African continent are significantly lower than global maximum yields, for example, from Indonesia and Malaysia (Woittiez et al. 2017).

Since certifications tend to vary, it is equally important to examine the possible improvements or deteriorations in the event of a switch in certification. The results suggest that organic certification is preferable to RSPO certification in regard to the economic indicators considered here. In particular, participation in organic certification, compared to RSPO, results in a 14.49% increase in net farm revenue, a 19.21% increase in output, 9.19% higher prices, and even 27.83% higher yields for organic farmers. The latter aspect is particularly relevant, since under good, efficient production and management techniques, organic farming seems to be advantageous over conventional farming techniques and the use of agrochemicals. When comparing the certifications, it should be emphasized that organic farmers switching to RSPO certification have significantly lower net household income. It appears that these farmers may have household allocative advantages, which may in part be explained

by lower participation in off-farm work, and thus an increased allocation of household resources towards farm work. With stronger ties to farm activities, organic farmers seem to have more intense focus on the farm and the income from farm activities.

Next, we turn to the outcome variables in the lower section of Table 3.5, addressing food security as well as negative environmental impacts. From the descriptive statistics in Table 3.2, it appears that food security disparities are generally not excessively large. Nevertheless, they are present and, as presented in Table 3.5, certification schemes appear to influence the welfare, and thereby nutritional possibilities of farm households. We observe that a switch from RSPO to non-certified would increase the HFIAS by 59.04%, indicating improved food security of RSPO farmers compared to non-certified farmers. We find the same tendency when comparing organic and non-certified farms. Furthermore, Table 3.5 shows that food security is reduced by 7.75% when switching from organic to RSPO certification. The directions of the effects clearly indicate that organic farmers can potentially achieve the highest food security level.

The last section of Table 3.5 shows the impact on the environment caused by the use of chemical weedicides. Given that all organic farmers reported not to use any agrochemicals, we infer a potential 100% change in chemical substance discharge into the environment. Comparing RSPO certification, where agrochemicals are still being released into the environment, with non-certified farmers, we note that regulations and standards seem to be able to have a significant impact. Compared to the counterfactual situation, the results indicate an 84.64% reduction of the hazard quotient for RSPO certified farmers, suggesting that RSPO certification can significantly contribute to reducing the discharge of potentially environmentally harmful chemical substances.

3.6 Conclusions and implications

Over the last few decades, certification schemes have become increasingly popular in many countries as a means of promoting sustainable farm practices and also increasing farmers' welfare. This study employed farm-level data from Ghana to examine the drivers of smallholder palm oil farmers'

participation in certification schemes, as well as their impacts on farm performance, environmental indicators and household welfare. We used a multinomial endogenous switching regression (MESR) model to account for potential selection bias associated with observed and unobserved characteristics. The empirical results reveal that certification schemes have the potential to improve farmers' economic outcomes as well as food security. At the same time, environmental benefits arise as statistically significantly fewer harmful substances are used when farmers are certified. However, Roundtable on Sustainable Palm Oil (RSPO) farmers seem to face major challenges converting their advantages into increased household income. One of the main drivers of this trend seems to be the lower prices that are offered by oil mills using RSPO certified produce. The findings further indicate that organic certification has an advantage over RSPO certification, as farmers are able to generate higher net farm revenues, net household incomes, and higher food security status.

The results also reveal farmers' participation decisions in certification schemes depend on their age, gender, household size, education, market distance, farm size, motorization, property rights, age of oil palms, participation in off-farm work, extension frequency, and the number of certified farmers in the neighborhood. We conclude that certification tends to have a positive impact on farm households' welfare and the environment, but that whether and how certification pays off in overall household economic terms appears to depend first and foremost on received prices.

The findings from this study allow for policy recommendations to be made for the promotion and further development of certification schemes in the palm oil sector. The development of further certified cultivation areas is in accordance with the SDGs and could also prevent the cultivation of palm oil on the African continent from moving in an equally unsustainable direction as the cultivation in the Southeast Asian region. Policy recommendations include providing information, education and training regarding the benefits of certification, but also efficient resource management techniques if, farmers decide to transition into off-farm work or, focus more on farm activities, as certification requires them to increase their physical or management workload. In relation to recent literature on smallholder palm oil farmers, it should be noted that some of the effects we observed have also been

found in the context of contract farming (Ruml and Qaim 2020). This is not surprising, as certifications are, not always, but often directly related to marketing or production contracts. At the same time, compliance with the requirement for production must be recognized as a type of contract. However, this paper focused on certification, since farmers were often unsure whether their certification entailed a contractual obligation with respect to selling the commodity. It is therefore important for future research to try to disentangle the effects of contracts and certifications. There is already evidence in the literature that the use of sustainable practices, as well as participation in schemes yield beneficial effects for farmers (Bolwig et al. 2009).

As indicated in the Introduction, our results support the argument that certifications in the palm oil sector can have substantial impact on the achievement of the SDGs. The effects found in this study can be linked to SDGs one, two, three, twelve, thirteen, and fifteen. Precisely, we find that RSPO and organic certifications can contribute to increasing farm and household incomes and reducing food insecurity, which is a positive contribution to the achievement of SDGs one, two, and three. At the same time, by reducing the use of climate-impacting agrochemicals, negative impacts such as soil degradation are limited, which contributes positively to the achievement of SDGs 13 and 15. Organic certification appears to be more effective than RSPO certification in most segments that were analyzed in this paper. Despite the fact that our findings are limited to just one environmental indicator, they clearly indicate that certification in the palm oil sector can make a significant contribution to reducing negative environmental impacts, without causing farmers to incur economic losses. This is an extremely important finding, as it suggests that sustainable growth in line with the SDGs is indeed achievable, and can thus generate positive effects in all dimensions of sustainability.

References Chapter 3

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Appendix Chapter 3

Table 3.A1 Determinants of output quantity by certification choice: Second-stage MESR

Variable	Non-certified		RSPO certified		Organic certified	
	Marginal Effects	Std. err.	Marginal Effects	Std. err.	Marginal Effects	Std. err.
Age	-0.115**	(-1.96)	0.0363	(0.44)	-0.132	(-1.11)
Age ²	0.000894*	(1.79)	-0.000435	(-0.63)	0.000911	(0.93)
Gender (female=1)	0.302	(0.82)	-0.0427	(-0.16)	0.376	(0.63)
Household Size	-0.0481	(-0.75)	-0.153***	(-3.02)	-0.0394	(-0.45)
Education	0.00372	(0.13)	-0.0193	(-0.88)	-0.0547	(-0.85)
Experience palm oil farming	0.00803	(0.38)	0.0162	(0.86)	0.032	(1.07)
Market Distance	-0.0412	(-0.53)	0.0106	(0.15)	0.0268	(0.25)
Farm size	0.165**	(2.06)	0.204***	(2.64)	-0.0674	(-0.59)
Motorized	-0.0602	(-0.19)	0.31	(1.1)	0.246	(0.48)
Hired Labor	0.00965***	(2.64)	0.0159***	(8.89)	0.0110**	(2.29)
Property Rights	0.0776	(0.2)	-0.222	(-0.81)	-0.948	(-1.29)
Age of trees	0.0355	(1.06)	0.0405	(0.62)	-0.0255	(-0.78)
Off farm work	-0.476*	(-1.95)	-0.0135	(-0.07)	0.0742	(0.14)
Extension Frequency	-0.0495	(-0.67)	-0.0264	(-0.43)	-0.263*	(-1.79)
Credit constraint	-0.278	(-1.36)	-0.115	(-0.52)	0.153	(0.44)
Regional fx.	yes		yes		yes	
_m1	-0.863	(-1.50)	-2.654	(-1.47)	1.455	(0.6)
_m2	-1.034	(-0.64)	-0.43	(-0.64)	0.725	(0.23)
_m3	-2.717*	(-1.91)	-0.464	(-0.27)	-1.173	(-1.38)
_cons	4.093**	(2.1)	-1.598	(-0.44)	9.492**	(2.0)
p1	-0.59	(-1.33)	-1.932*	(-1.87)	1.047	(1.0)
p2	-0.707	(-0.65)	-0.313	(-0.63)	0.522	(0.39)
p3	-1.858**	(-2.01)	-0.338	(-0.26)	-0.844*	(-1.80)

Note: Base group is non-certified; ** and *** mean significant at 5% and 1% levels, respectively.

Table 3.A2 Determinants of prices by certification choice: Second-stage MESR

Variable	Non-certified		RSPO certified		Organic certified	
	Marginal Effects	Std. err.	Marginal Effects	Std. err.	Marginal Effects	Std. err.
Age	-0.128	(-1.14)	-0.00481	(-0.36)	-0.0144	(-0.49)
Age ²	0.00113	(1.14)	0.0000468	(0.42)	0.0000712	(0.31)
Gender (female=1)	0.0452	(0.09)	0.0343	(0.59)	0.32	(1.36)
Household Size	0.0683	(0.69)	0.0362***	(3.33)	-0.00231	(-0.08)
Education	-0.00224	(-0.04)	0.00357	(1.01)	-0.023	(-1.23)
Experience palm oil farming	-0.0413	(-1.00)	-0.00285	(-0.91)	0.0162	(1.31)
Market Distance	-0.0975	(-0.72)	0.00319	(0.26)	0.0448	(1.08)
Farm size	-0.0471	(-0.38)	-0.0223*	(-1.84)	-0.0263	(-0.80)
Motorized	-0.121	(-0.20)	-0.0233	(-0.55)	0.341	(1.64)
Hired Labor	-0.000134	(-0.04)	-0.00163***	(-3.85)	-0.00406	(-1.34)
Property Rights	0.127	(0.28)	0.0231	(0.42)	-0.497	(-1.50)
Age of trees	0.0638	(1.29)	-0.00821	(-0.78)	0.0109	(0.87)
Off farm work	-0.239	(-0.92)	-0.0388	(-1.36)	0.186	(1.13)
Extension Frequency	-0.00939	(-0.08)	-0.0185*	(-1.72)	-0.0269	(-0.57)
Credit constraint	0.308	(1.03)	0.0561	(1.51)	0.181	(1.11)
Regional fx.	yes		yes		yes	
_m1	-0.398	(-0.44)	0.22	(0.69)	0.91	(1.2)
_m2	-2.02	(-0.78)	-0.0951	(-0.62)	1.819	(1.36)
_m3	-1.769	(-0.73)	-0.590*	(-1.73)	0.0631	(0.25)
_cons	8.696***	(2.76)	6.510***	(10.53)	7.541***	(5.68)
p1	-0.269	(-0.49)	0.897	(0.86)	1.014	(1.21)
p2	-1.367	(-1.04)	-0.388	(-0.76)	2.028*	(1.72)
p3	-1.197	(-0.98)	-2.405**	(-2.24)	0.0704	(0.16)

Note: Base group is non-certified; ** and *** mean significant at 5% and 1% levels, respectively.

Table 3.A3 Determinants of yield by certification choice: Second-stage MESR

Variable	Non-certified		RSPO certified		Organic certified	
	Marginal Effects	Std. err.	Marginal Effects	Std. err.	Marginal Effects	Std. err.
Age	-0.0729	(-1.60)	0.024	(0.43)	-0.0757	(-0.88)
Age ²	0.000565	(1.48)	-0.000303	(-0.64)	0.000502	(0.71)
Gender (female=1)	0.268	(0.97)	-0.0129	(-0.07)	0.311	(0.73)
Household Size	-0.0329	(-0.68)	-0.102***	(-2.87)	-0.0499	(-0.78)
Education	-0.000623	(-0.03)	-0.0143	(-0.99)	-0.0301	(-0.66)
Experience palm oil farming	0.00831	(0.54)	0.011	(0.84)	0.0258	(1.21)
Market Distance	-0.0444	(-0.76)	0.00523	(0.11)	0.0263	(0.33)
Farm size	-0.0206	(-0.37)	0.0346	(0.63)	-0.112	(-1.38)
Motorized	-0.0938	(-0.40)	0.208	(1.11)	0.248	(0.66)
Hired Labor	0.00656**	(2.41)	0.0105***	(8.41)	0.00858**	(2.47)
Property Rights	0.136	(0.46)	-0.132	(-0.67)	-0.636	(-1.19)
Age of trees	0.016	(0.67)	0.0201	(0.46)	-0.0136	(-0.58)
Off farm work	-0.351**	(-1.98)	-0.0126	(-0.09)	-0.0101	(-0.03)
Extension Frequency	-0.036	(-0.65)	-0.0267	(-0.67)	-0.154	(-1.46)
Credit constraint	-0.216	(-1.34)	-0.094	(-0.62)	0.0663	(0.25)
Regional fx.	yes		yes		yes	
_m1	-0.262	(-0.59)	-1.799	(-1.43)	0.471	(0.26)
_m2	-0.254	(-0.21)	-0.305	(-0.63)	0.914	(0.39)
_m3	-1.215	(-1.13)	-0.346	(-0.28)	-0.587	(-0.92)
_cons	3.084**	(2.04)	-0.586	(-0.23)	5.657	(1.62)
p1	-0.332	(-0.69)	-1.922*	(-1.83)	0.5	(0.45)
p2	-0.321	(-0.28)	-0.326	(-0.64)	0.971	(0.71)
p3	-1.539	(-1.43)	-0.37	(-0.28)	-0.623	(-1.35)

Note: Base group is non-certified; ** and *** mean significant at 5% and 1% levels, respectively.

Table 3.A4 Determinants of net household income by certification choice: Second-stage MESR

Variable	Non-certified		RSPO certified		Organic certified	
	Marginal Effects	Std. err.	Marginal Effects	Std. err.	Marginal Effects	Std. err.
Age	0.00228	(0.03)	-0.032	(-0.49)	-0.0252	(-0.29)
Age ²	-0.0000249	(-0.04)	0.000145	(0.26)	0.000124	(0.18)
Gender (female=1)	-0.0288	(-0.07)	0.105	(0.58)	0.413	(1.08)
Household Size	-0.0471	(-0.64)	0.0607	(1.4)	-0.02	(-0.26)
Education	0.021	(0.56)	0.0189	(1.23)	-0.0188	(-0.38)
Experience palm oil farming	0.0284	(1.29)	0.000694	(0.04)	0.0295	(1.42)
Market Distance	0.0799	(0.74)	-0.0067	(-0.12)	0.018	(0.21)
Farm size	0.133	(1.35)	0.0605	(0.9)	-0.00653	(-0.08)
Motorized	0.234	(0.63)	0.181	(0.99)	0.113	(0.3)
Hired Labor	0.00184	(0.41)	0.00592***	(3.06)	0.00492	(1.36)
Property Rights	-0.152	(-0.37)	0.0414	(0.19)	-0.247	(-0.47)
Age of trees	0.0211	(0.66)	0.014	(0.2)	-0.0135	(-0.54)
Off farm work	0.528*	(1.71)	0.514***	(3.27)	0.378	(0.94)
Extension Frequency	0.0122	(0.13)	-0.0784	(-1.53)	-0.0417	(-0.38)
Credit constraint	-0.242	(-0.89)	-0.0729	(-0.47)	-0.0111	(-0.05)
Regional fx.	yes		yes		yes	
_m1	0.321	(0.43)	-0.886	(-0.68)	-0.956	(-0.54)
_m2	2.299	(1.06)	-0.806	(-1.41)	-0.7	(-0.35)
_m3	0.948	(0.46)	-2.409*	(-1.79)	-0.771	(-1.18)
_cons	7.895***	(3.7)	8.426***	(2.96)	9.868***	(2.8)
p1	0.255	(0.49)	-0.813	(-0.76)	-0.898	(-0.79)
p2	1.826	(1.48)	-0.74	(-1.64)	-0.657	(-0.51)
p3	0.753	(0.58)	-2.211**	(-2.45)	-0.724	(-1.41)

Note: Base group is non-certified; ** and *** mean significant at 5% and 1% levels, respectively.

Table 3.A5 Determinants of Household Food Insecurity Access Scale by certification choice: Second-stage MESR

Variable	Non-certified		RSPO certified		Organic certified	
	Marginal Effects	Std. err.	Marginal Effects	Std. err.	Marginal Effects	Std. err.
Age	-0.0665	(-0.86)	0.0324	(0.39)	-0.0314	(-0.38)
Age ²	0.000534	(0.81)	-0.00031	(-0.46)	0.000227	(0.32)
Gender (female=1)	0.145	(0.45)	0.336	(1.11)	0.474	(1.33)
Household Size	0.0125	(0.18)	-0.0349	(-0.67)	0.0133	(0.23)
Education	-0.0504	(-1.34)	-0.00303	(-0.16)	-0.0185	(-0.48)
Experience palm oil farming	-0.0125	(-0.58)	0.0267*	(1.69)	0.0135	(0.75)
Market Distance	-0.0388	(-0.47)	-0.00672	(-0.11)	0.0357	(0.4)
Farm size	-0.097	(-1.20)	-0.00137	(-0.02)	-0.0114	(-0.14)
Motorized	-0.535	(-1.29)	0.208	(0.92)	-0.106	(-0.34)
Hired Labor	0.00294	(1.0)	0.00682***	(3.31)	0.00429	(1.31)
Property Rights	0.28	(0.72)	-0.530*	(-1.94)	0.177	(0.42)
Age of trees	-0.0293	(-0.93)	-0.00983	(-0.13)	-0.00127	(-0.06)
Off farm work	-0.463	(-1.51)	0.00686	(0.04)	-0.137	(-0.45)
Extension Frequency	0.0307	(0.34)	-0.0171	(-0.30)	0.0521	(0.56)
Credit constraint	-0.0118	(-0.05)	0.178	(0.81)	-0.105	(-0.45)
Regional fx.	yes		yes		yes	
_m1	1.428**	(2.52)	-2.898	(-1.58)	-1.637	(-1.12)
_m2	1.094	(0.69)	-0.454	(-0.53)	-0.0139	(-0.01)
_m3	1.37	(0.83)	-2.482	(-1.27)	-0.23	(-0.44)
_cons	4.514*	(1.88)	-0.494	(-0.13)	1.531	(0.49)
ρ1	1.059**	(2.5)	-1.804*	(-1.78)	-1.607	(-1.53)
ρ2	0.811	(0.71)	-0.283	(-0.45)	-0.0136	(-0.01)
ρ3	1.016	(0.86)	-1.546	(-1.18)	-0.226	(-0.53)

Note: Base group is non-certified; ** and *** mean significant at 5% and 1% levels, respectively.

Table 3.A6 Determinants of Hazard Quotient by certification choice: Second-stage MESR

Variable	Non-certified		RSPO certified		Organic certified	
	Marginal Effects	Std. err.	Marginal Effects	Std. err.	Marginal Effects	Std. err.
Age	0.0342	(0.34)	0.0372	(0.39)	-	-
Age ²	-0.000298	(-0.36)	-0.000228	(-0.28)	-	-
Gender (female=1)	0.291	(0.45)	0.364	(1.04)	-	-
Household Size	-0.0135	(-0.16)	0.0156	(0.24)	-	-
Education	-0.0285	(-0.58)	-0.00636	(-0.29)	-	-
Experience palm oil farming	0.00855	(0.2)	0.0206	(0.79)	-	-
Market Distance	-0.037	(-0.45)	0.082	(1.31)	-	-
Farm size	0.165	(1.43)	0.0691	(0.72)	-	-
Motorized	0.0541	(0.14)	0.381	(0.97)	-	-
Hired Labor	-0.00317	(-0.79)	0.00740***	(2.58)	-	-
Property Rights	0.111	(0.28)	-0.244	(-0.63)	-	-
Age of trees	0.00594	(0.15)	0.215	(1.43)	-	-
Off farm work	0.491	(1.47)	0.431**	(2.03)	-	-
Extension Frequency	0.00669	(0.06)	0.116	(1.63)	-	-
Credit constraint	0.0229	(0.1)	0.0673	(0.27)	-	-
Regional fx.	yes		yes		-	
_m1	-0.321	(-0.42)	-2.842	(-1.53)	-	-
_m2	1.601	(0.81)	0.0149	(0.02)	-	-
_m3	-0.422	(-0.21)	-0.631	(-0.37)	-	-
_cons	-0.832	(-0.23)	-9.061	(-1.34)	-	-
ρ1	-0.248	(-0.53)	-1.998**	(-2.05)	-	-
ρ2	1.236	(1.23)	0.0105	(0.02)	-	-
ρ3	-0.326	(-0.27)	-0.444	(-0.39)	-	-

Note: Base group is non-certified; ** and *** mean significant at 5% and 1% levels, respectively.

Table 3.A7 Instrument validity and other diagnostic tests

BFG Impact specifications	χ^2	$p > \chi^2$
<i>First Stage</i>		
Certification schemes	23.68	0.0000
<i>Second Stage</i>		
Net farm revenue		
Non-certified	0.04	0.842
RSPO certified	1.02	0.313
Organic Certified	0.03	0.868
Output (Mt)		
Non-certified	0.01	0.925
RSPO certified	2.16	0.142
Organic Certified	0.36	0.551
Prices (GHS)		
Non-certified	2.10	0.148
RSPO certified	1.36	0.244
Organic Certified	0.01	0.924
Net household income		
Non-certified	0.01	0.987
RSPO certified	0.29	0.592
Organic Certified	0.14	0.712
Yield		
Non-certified	0.06	0.806
RSPO certified	2.26	0.133
Organic Certified	0.36	0.551
HFIAS		
Non-certified	0.19	0.667
RSPO certified	1.87	0.171
Organic Certified	0.01	0.923
Hazard Quotient		
Non-certified	0.03	0.872
RSPO certified	0.09	0.769
Organic Certified	-	-

Diagnostic test results

Wald tests for combining alternatives (N = 400)

Ho: All coefficients except intercepts associated with a given pair of alternatives are 0 (i.e., alternatives can be combined)

Choice alternative	χ^2	df	$p > \chi^2$
1 and 2	131.094	20	0.0000
1 and 3	2692.046	20	0.0000
2 and 3	5284.218	20	0.0000

Hausman tests of IIA assumption (N = 400)

H0: Difference in coefficients not systematic

Choice alternative	χ^2	df	$p > \chi^2$
1 and 2	3.61	20	1.0000
1 and 3	0.34	20	0.9871
2 and 3	2.50	20	0.8681

Table 3.A8 First stage estimates for addressing potential endogeneity

Variable	Extension Frequency		Credit Constraint	
	Coefficient	Std. err.	Coefficient	Std. err.
Age	0.0252	(0.82)	0.000585	(0.02)
Age ²	-0.000167	(-0.64)	-0.00011	(-0.33)
Gender (female=1)	-0.274	(-1.62)	0.0528	(0.25)
Household Size	0.0425	(1.62)	0.0278	(0.83)
Education	0.0151	(1.08)	-0.0206	(-1.15)
Experience palm oil farming	0.0103	(1.15)	-0.0266**	(-2.21)
Market Distance	0.0613	(1.6)	0.0472	(1.06)
Farm size	-0.0051	(-0.22)	-0.0715**	(-2.35)
Motorized	0.117	(0.84)	-0.16	(-0.91)
Hired Labor	-0.00372**	(-2.52)	0.00495***	(2.81)
Property Rights	-0.300***	(-2.60)	-0.250*	(-1.74)
Age of trees	0.00818	(0.79)	0.0352**	(2.55)
Off farm work	-0.0248	(-0.21)	-0.205	(-1.39)
Central	-0.297	(-1.55)	0.525**	(2.21)
Eastern	0.122	(0.77)	0.584***	(2.87)
Credit constraint	0.300**	(2.49)	-	-
Distance center	-0.0385**	(-2.10)	-	-
Extension Frequency	-	-	0.100**	(2.48)
Bank local	-	-	0.409***	(2.81)
Log likelihood	-593.42		-226.67	
Number of observations	400		400	

*Note: ** and *** mean significant at 5% and 1% levels, respectively.*

Chapter 4

Impact of certification and extension services on productivity and welfare of palm oil producers in Ghana

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Abstract

The palm oil sector, especially in West Africa, faces significant problems with large yield gaps. Certifications have been introduced to help identify sustainable agricultural products. However, these principles are often accompanied by reduced farm productivity. This study examines the impact of organic and Roundtable on Sustainable Palm Oil (RSPO) certifications on the production frontier and efficiency of smallholder farmers in Ghana using a stochastic frontier model with an endogenous treatment status and mediator. The empirical results show that both certification schemes had a negative overall impact on crop yield. However, the indirect effects associated with certification counteracted this trend, implying that both certification schemes provided relevant extension services that improved the managerial skills of farmers. The results also reveal considerable heterogeneity among farmers, highlighting the need for improved extension services aimed at reducing large heterogeneities within inefficiencies, which are major contributors to yield gaps. While farmers under both certification schemes enjoyed substantial economic benefits through improved net farm revenues for their households, increased demand for sustainably certified palm oil products may lead to environmental damage due to reduced yields and the expansion of cultivated land. Overall, the findings suggest that good extension and implementation of management practices can effectively help reduce yield losses.

Keywords: sustainable production, certification, mediation analysis, impact assessment, household welfare

4.1 Introduction

Food systems of the 21st century face the challenging task of feeding an increasing world population, while at the same time producing more sustainably to avoid damaging soils and ecosystems. For example, pesticides and mineral fertilizers in conventional agriculture often adversely affect the environment by reducing biodiversity, polluting and eutrophying water bodies, and degrading soil quality, thus threatening global long-term food security (Godfray and Garnett 2014).

Certifications represent a tool for communicating products and production processes that are designed to be more sustainable. The true impacts on the targeted goals and objectives of the tool are diverse and differ in their effectiveness. Studies have generally shown that consumers in developed countries are willing to pay for products carrying sustainability labels (Gassler and Spiller 2018; Richartz and Abdulai 2022). The objectives of certification are intended to be achieved through this increased willingness-to-pay (WTP) for certified products. Although many studies have documented the impacts of certification on rural farm households, the results remain mixed or inconclusive (Oya et al. 2018). Some studies argue that the use of certified practices can lead to higher yields (Fenger et al. 2017; Brako et al. 2021), while others emphasize that certification systems in agriculture do not lead to higher yields or better environmental conditions and therefore are generally not expected to have a positive impact on household welfare (DeFries et al. 2017; Meemken and Qaim 2018). Nevertheless, one of the most common arguments for sustainable practices, such as organic or conservation agriculture, is that, despite yield losses (Ponisio et al. 2015) and higher, negative yield variability (Knapp and van der Heijden 2018), they provide beneficial ecosystem services, which, in the overall global context, offset the benefits of yield losses (Tuck et al. 2014; Mäder et al. 2002). And there is increased interest in adopting agricultural systems that provide ecosystem values in addition to maximizing crop yields, as environmental impacts of agriculture have become a major concern and farmers get less dependent on expensive external inputs (Mäder et al. 2002; Schipanski et al. 2014).

It is often not explicitly clear or generalizable where precisely positive effects from different certification schemes arise from. For instance, studies find that positive effects on smallholder farmers'

net income result from access to guaranteed price premiums and reduction of uncertainty through marketing guarantees (Bolwig et al. 2009). Other studies find that certification can have positive impacts on food security and dietary quality, particularly through positive impacts on incomes and gender equality (Chiputwa and Qaim 2016). In the context of positive environmental impacts of certifications, evidence suggests that they promote environmental benefits by reducing the use of chemical inputs and encouraging the use of environmentally friendly practices (Blackman and Naranjo 2012). Organic farming systems have inherent potential to both reduce greenhouse gas emissions by reducing N₂O emissions and enhance soil carbon storage (Scialabba and Müller-Lindenlauf 2010). However, even when focusing on potentially positive impacts, the question remains which mechanisms exactly channel the resulting benefits. One can well imagine that advantages through, for example, price premiums are channeled directly as a result of the certification. At the same time, however, there are benefits based on the need for farmers to adopt new or different farming techniques to either meet certification requirements or to keep output levels stable as requirements change. Therefore, the farmer's behavior is as significant as the certification itself. Some studies argue that under certification, the implementation of different or new management practices on the farm can effectively reduce yield losses caused by the regulations of the certification, and that suitable farm management adjustments can be used to avoid large yield gaps (Ponisio et al. 2015; Knapp and van der Heijden 2018).

Agricultural programs that are supposed to have positive effects, e.g. on welfare or nature, often have dual goals of shifting the production frontier upward, i.e., inducing technological change, and promoting better farming management, i.e., narrowing the gap from the frontier, which incorporates two potentially endogenous treatments of one implementation (Bravo-Ureta 2014). These can be translated into new farming techniques or support for farmers, and the formation of human capital through learning about how to meet restrictions and changing production requirements, since both may affect the technology frontier as well as the inefficiency function (Kumbhakar et al. 2009).

Hence, this paper attempts to disentangle the direct effects of certification from the indirect effects, which arise from adjusted farming behavior. Certified farmers often, or usually receive specific extension services to learn about which techniques and adaptations are necessary to continue working efficiently or even more efficiently than prior to certification. The present study therefore uses the effects of extension services to analyze the indirect effects of certification, examining which of these effects play a dominant role in different outcomes. Thus, we investigate the impact of extension services as an indirect effect from certification on farm performance.

In the study, we examine the effects of the Roundtable on Sustainable Palm Oil (RSPO) and organic certifications among Ghanaian palm oil smallholder farmers. Palm oil is of particular importance in terms of production efficiency, as yields of the oil crop in the West African region, the region of origin of the oil palm tree, are significantly lower than in the main cultivation regions of Malaysia and Indonesia (Byerlee et al. 2017; Barcelos et al. 2015; USDA 2022b). More specifically, in Cote d'Ivoire and Ghana average yields range from 1 to 3 tons per hectare, although large-scale industrial estates can achieve yields of approximately 10 tons per hectare, with maximum observed yields of 20 tons per hectare (USDA 2022a; Ofosu-Budu and Sarpong 2013; Rhebergen et al. 2018). In contrast, average yields in Indonesian large private estates and state plantations are as high as 16 tons per hectare, with potential predicted maximum yields of 30 tons of fresh fruit bunches (FFB) per hectare (Herdiansyah et al. 2020).

A central key to meeting the growing global demand for vegetable oil is to reduce the yield gaps in the palm oil sector, which is particularly important in terms of sustainable development, as greater output via improved practices would have a significantly lower impact on both land and environment than an expansive approach, as has been the case in Southeast Asia in recent decades (Varkkey et al. 2018).

Studies conducted in the oil palm context do not provide consistent results on which type of palm oil cultivation and management methods are deemed most efficient for individual farmers. For example, Herdiansyah et al. (2020) find that farmers who receive the most support from the local government

and have the shortest cultivation period and farmers who are organized as core smallholders of large-scale producers generate the lowest yields. Other studies find that supported farmers perform better than independent farmers (Euler et al. 2016). Thus, it is not clear how various management types that involve support, subsidies or requirements actually affect farmers and their behavior, as farmers have to make considerable management efforts, for example, to operate in compliance with certification guidelines. Recent studies by Euler et al. (2016) and Hoffmann et al. (2017) used crop modeling analyses models to investigate yield gaps of oil palm in Southeast Asian production systems. They conclude that only about 50 percent of the potential yield is achieved over the life cycle of smallholder plantations. Among these, yield gaps are greatest during the most productive production phase of the oil palm plantations.

The rationale for separating certification per se from extension services is to decipher which effects on household and farm outcomes are due to the benefits and restrictions of certification and which effects are caused by the mediator extension services. In other words, the approach seeks to differentiate the extent to which certification and extension services shift farmers' production frontiers and technical efficiency. Certification schemes are associated with certain beneficial effects, that encourage farmers to participate in them. Extension services provide the potential for human capital formation, allowing learning and behavioral effects to positively (or negatively) influence farm or environmental performance (Chrisendo et al. 2022; Kumbhakar and Wang 2010). Thus, access to extension services can lead to increased adoption of new or improved technologies and management practices by farmers, improving farm performance and household incomes, irrespective of certification status (Shiferaw et al. 2014).

The present study employs a stochastic frontier model with endogenous treatment and mediator effects (Chen et al. 2020) and combines mediation analysis, treatment effect and stochastic frontier models in one single framework. Using this approach, we are able to disentangle the impact of certification into four components: The direct effect and indirect effect that go through the mediator on the technology frontier as well as the direct effect and indirect effect that go through the mediator

on the technical inefficiency. The advantage of this approach is that it estimates a treatment effects model using the stochastic frontier model framework, while addressing potential endogeneity from selection bias, endogenous treatment and mediator variables, distinguishing it from conventional approaches used in previous studies (De los Santos-Montero and Bravo-Ureta 2017; Abdulai and Abdulai 2016; Mohammed and Abdulai 2022c).

The rest of the paper is structured as follows: Sections 4.2, 4.3 and 4.4 present the conceptual and empirical framework, and identification strategy. Section 4.5 presents data and descriptive statistics. While the empirical results and discussion are presented in the last two sections.

4.2 Conceptual framework

Changing applied cultivation or management practices in the agricultural context can shift the production frontier or the efficiency of farmers. Agricultural technologies such as high-yielding varieties, conservation-oriented soil cultivation methods or complementary inputs, but also farmers' access to extension services, e.g., to provide information on improved varieties and cultivation practices, are designed to shift the production frontier upwards (Huang and Liu 1994). The use of new approaches or technologies, as well as human capital formation and associated adapted farm management, highlights the dual nature of implementing innovative transformations. Both, improvement in the production frontier and associated improved management practices are normally required for optimal or improved output (Bravo-Ureta 2014). Improved agricultural management, which can be mediated and taught through extension or training, has the potential to affect the production frontier as well as the inefficiency of farmers, as it exhibits characteristics of a technology and an input (Mohammed and Abdulai 2022a; Triebs and Kumbhakar 2018). In the context of certified and conventional production, it becomes evident that the intervention under examination, i.e., certification, may well exert negative effects, as strict requirements for certified products challenge farmers to continue to efficiently generate farm and household income under constraints, for example, regarding restrictions on the use of agrochemicals. Thus, Kumbhakar et al. (2009) argue that productivity differences result from technological differences - for example, that conventional

production technology produces the same output with fewer inputs or lower costs - or from differences in technical efficiency, or both. Since sustainably certified production, in this case organic or RSPO, is based on a more restricted use of certain inputs than conventional production, it is expected that certification could result in lower productivity. If RSPO or organic farms are less productive, their profitability will be lower, unless the difference in commodity prices is high enough to compensate for the lower productivity. Otherwise, certified farming will not be able to attract new farmers. However, there may be further benefits from access to sustainably certified supply chains and newly implemented management practices.

Consequently, we can expect two potentially shifts in farmers' production functions, induced by the type of management, the direction of which is not clear in advance. At the same time, these two shifts involve potentially endogenous treatments consisting of participation in certification schemes as well as participation in subsequent extension services (Mohammed and Abdulai 2022c). Thus, both channels of transformation may have an impact on the production frontier as well as the inefficiency function. Let Y denote the potential output under a given production technology and X , the vector of observed exogenous characteristics. We express the conventional stochastic frontier model (Kumbhakar and Lovell 2012) as:

$$Y = Y^* - \mu, \quad \mu \geq 0, \quad (1)$$

$$Y^* = h(X, \beta^h) + v, \quad (2)$$

where Y^* is the unobserved stochastic frontier that may be influenced directly by the restrictions or beneficial assets from the certification and indirectly via participation in associated extension services, $\mu \geq 0$ is the unobserved production inefficiency assumed to be random, $h(\cdot)$ is a frontier function with parameter vector β^h , and v is a pure random error. We express the conditional means of the random component as follows:

$$E[v | X] = 0 \quad (3)$$

$$E[Y^* | X] = h(X, \beta^h) \quad (4)$$

$$E[\mu | X] = g(X, \beta^g) \quad (5)$$

where $g(\cdot)$ is a non-negative inefficiency function with the parameter vector β^g . To relate the effect of the production frontier and the inefficiency to observed farmer-specific potential outcome, given observed characteristics and inputs, we express equation 1 in terms of the conditional mean representations in equation 4 and 5 as follows:

$$E[Y | X] = h(X, \beta^h) - g(X, \beta^g) \quad (6)$$

The impact of certification on farmers can be determined from the difference between the potential outcomes with certification (Y_1) and without certification (Y_0). The average treatment effect (ATE) can be expressed as:

$$ATE = E[Y_1 - Y_0 | D = 1] = E[Y_1 | D = 1] - E[Y_0 | D = 1] \quad (7)$$

where D is a binary participation indicator, with $D = 1$ if the farmer participates in a certification scheme and $D = 0$, otherwise. The stochastic frontier model is then extended by including treatment and mediator analysis as shown in Figure 4.1.

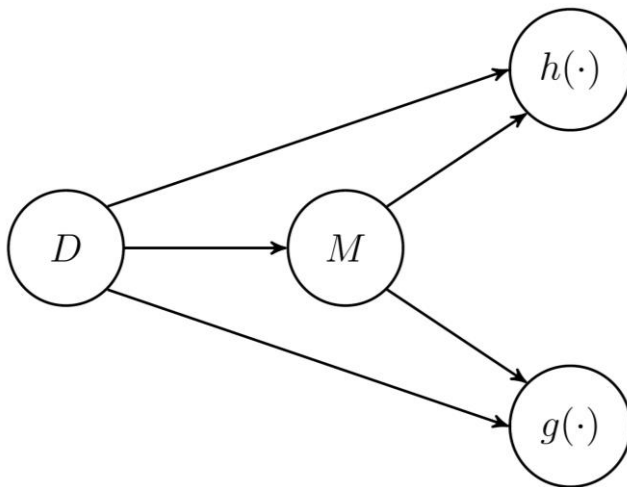


Figure 4.1 Causal model pathways

Note: D and M represent the treatment and mediator binary indicators, respectively. While $h(\cdot)$ and $g(\cdot)$ denote the technology frontier and inefficiency functions. Source: Adapted from Chen et al., 2022

As indicated above, the binary indicator D , as well as the binary mediation indicator M may not be randomly assigned, i.e., endogenous. M is a binary random variable, with $M = 1$ if the farmer participates in extension and $M = 0$, otherwise. It represents a mediator between D and Y . We use extension service as mediator, since farmers receive special extension services that is specific to their certification. This is important to highlight as agricultural practices and management techniques that better enable farmers to operate the farms under the new farming requirements and restrictions of certifications are taught through these extension services.

The methodological approach allows us to evaluate the impact of certification by examining the effectiveness of D on Y (i.e., $h(\cdot)$ and $g(\cdot)$), while disentangling how D directly influences Y and indirectly affects Y via M . Thus, the modeling framework allows us to combine treatment and mediation analysis for the sub-pathways of $(D; M; h(\cdot))$ and $(D; M; g(\cdot))$ and stochastic frontier analysis for the decomposition of the stochastic frontier and inefficiency functions, i.e., $(h(\cdot); g(\cdot); Y)$. The treatment and the mediator variables are allowed to be endogenously related to unobserved factors and identification is thus achieved through two separate instrumental variables.

4.3 Identification strategy

As the evaluation of the impact of the certification schemes on farm performance with observational data may suffer identification problems, this study employs instruments to categorize the population into mutually disjoint sub-populations of adopters who are compliers of the instrument. Specifically, ‘participation neighborhood’ is used as an instrument for identifying RSPO or organic certification participants. As indicated in the social networks literature, high levels of farmer clustering increases the likelihood of communication between farmers, resulting in information spillovers (Michelson 2017). In particular, farmers who live in communities where many certified farmers already operate will be more likely to participate in certification themselves, as information about opportunities or benefits from certification are easily available. In line with Michelson (2017), we argue that the likelihood of a farmer joining a certification scheme is higher if an above-average number of farmers in the neighborhood also participate in that specific certification scheme. It has been argued in the

literature that farmer-to-farmer information transmission promotes and accelerates adoption of new agricultural management strategies (e.g. Akter et al. 2023; Genius et al.). The dichotomous nature of the variable, i.e., a farmer participates or does not participate in a certification scheme, thereby derives from its employment in identifying the sub-populations of compliers of the instrument. Participation neighborhood is defined as a farmer neighborhood that has a greater than average number of farmers who participate in a specific certification scheme. We use the median value of the number of farmers participating in a specific certification in a farmer's neighborhood as the threshold for defining the neighborhoods. This means that a farmer who lives in a neighborhood that hosts more than the average number of adopters lives by definition in an adopter neighborhood.

Let Z_1 be an instrumental variable (IV) that takes the value of 1 if the farmer lives in a defined participation neighborhood and 0, otherwise. The propensity of a farmer joining a certification scheme can be specified in a latent variable participation decision model as:

$$D^* = \gamma_{z_1} Z_1 + \gamma_x X + U_D, \text{ with } D = \begin{cases} 1, & \text{if } D^* \geq 0 \\ 0, & \text{otherwise} \end{cases} \quad (8)$$

where D^* is the latent unobserved net benefit derived from certification participation, D is the discrete participation decision indicator, X is a vector of covariates, γ is the parameter of interest and U_D is the error term.

It is expected that the effect of extension service participation, which provides or improves managerial skills, is mainly observed after the farmer decides to participate in the certification scheme on which the extension is based. As indicated previously, the extension service functions as a post-adoption mediator and can be modeled as a function of adoption. The mediation effect is identified with a continuous exogenous variable with known distribution and whose level differs with participation status (Chen et al. 2020). We use distance to the nearest extension possibility as a possible exogenous continuous instrument. It has been shown in the literature that proximity, i.e., accessibility, to farmers by extension officers can contribute to whether farmers adopt agricultural management strategies

that sustainably change their farming practices (e.g. Akter et al. 2023), as farmers need to travel to extension offices or extension officers need to visit farmers.

Let Z_2 be a continuous IV that decreases as mediation takes the value of 1 and increases if mediation takes the value of 0. The propensity of a farmer to participate in extension services and also join the certification scheme can be expressed in a latent variable mediation model and specified as:

$$M^* = \alpha_d D + \alpha_{z_2} Z_2 + \alpha_x X + U_M, \text{ with } M = \begin{cases} 1, & \text{if } M^* \geq 0 \\ 0, & \text{otherwise} \end{cases} \quad (9)$$

where M^* is the latent unobserved net benefit derived from extension participation, M is the discrete extension participation decision indicator, X is a vector of covariates, D is the participation indicator, α is the parameter of interest, and U is the error term.

Following the causal pathway of the model framework in Figure 4.1, we define a new stochastic frontier function as follows (Chen et al. 2020):

$$Y(d, M(d')) = \tilde{h}(d, M(d'), X, \beta_{dj}^h) - \tilde{g}(d, M(d'), X, \beta_{dj}^g) + U_Y \left(v(d, M(d')) + \tilde{u}(d, M(d')) \right) \quad (10)$$

where $\tilde{h}(d, M(d'), X)$ and $\tilde{g}(d, M(d'), X)$ are potential frontier and non-negative inefficiency functions, respectively. X is a vector of covariates, β is a parameter of interest, while $v(d, M(d'))$ and $\tilde{u}(d, M(d'))$ are random error terms. The binary certification participation indicator is $D = d, d' \in \{0, 1\}$ and $j = M(d')$ is the mediator function whose distribution varies with adoption status.

Given a binary certification adoption indicator $D[D(1), D(0)]$ and a binary IV ($Z_1 \in \{0, 1\}$), four potential outcomes representing four mutually disjoint sub-populations of farmers can be identified (Imbens and Angrist 1994):

$$(D(1), D(0),) = \begin{cases} (1, 1), & \text{always takers,} \\ (1, 0), & \text{compliers (C),} \\ (0, 1), & \text{defiers,} \\ (0, 0), & \text{never takers.} \end{cases} \quad (11)$$

where C is an indicator of instrument compliers who are induced to adopt certification, based on the instrument. This implies that a randomly chosen farmer will always have the participation status based on the status of the instrument. By conditioning on the observed covariates X and the complier status C of the farmers, the conditional local average treatment effect ($CLATE$) on the treated can be identified as follows (Chen et al. 2020):

$$CLATE = E[Y(1, M(1)) | X = x, C] - E[Y(0, M(0)) | X = x, C] \quad (12).$$

Unconditional ATE can be derived by conditioning on only the subpopulation of Compliers:

$$LATE = E[Y(1, M(1)) | C] - E[Y(0, M(0)) | C] \quad (13)$$

where $LATE$ is the local average treatment effect which captures the total effect. The model allows for the decomposition of $LATE$ into direct and indirect effects for the mediation analysis:

$$DLATE = E[Y(1, M(1)) | C] - E[Y(0, M(1)) | C] \quad (14)$$

$$ILATE = E[Y(0, M(1)) | C] - E[Y(0, M(0)) | C] \quad (15)$$

where $DLATE$ is the direct local average treatment effect which captures the impact of certification participation and $ILATE$ is the indirect local average treatment effect which captures the role of the mediator, i.e., participation in extension services.

4.4 Empirical specification and estimation

A farmer's propensity to participate in extension, i.e., the mediation model, may correlate with the certification participation decision, i.e., the treatment model, due to observed or unobserved factors. The models error terms U_M and U_D are assumed to be independently and identically distributed (IID) and follow a normal distribution. The response model for the joint decision on certification participation and extension in equation (16) is specified as a bivariate probit model $P(M, D | Z_1, Z_2, X, \eta)$, with a bivariate normal distribution and cumulative distribution function $CDF F_{U_{M,D}}(\dots, \rho_{md})$.

$$\begin{bmatrix} U_M \\ U_D \end{bmatrix} | (Z_1, Z_2, X) \sim N \left(\begin{bmatrix} U_M \\ U_D \end{bmatrix}, \begin{bmatrix} 1 & \rho_{md} \\ \rho_{md} & 1 \end{bmatrix} \right) \quad (16)$$

where the estimates of the parameter vector $\eta \equiv (\alpha_d, \alpha_{z_2}, \alpha_x, y_{z_1}, y_{z_2}, \rho_{md})$ is obtained by a first-stage maximum likelihood estimation. Following the new stochastic frontier model in equation (10), we express the conditional mean representation as follows:

$$E[Y(d, M(d')) | X, C] = h_{d'}(X, \alpha_m, \beta_{d1}^h, \beta_{d0}^h) - g_{d'}(X, \alpha_m, \beta_{d1}^g, \beta_{d0}^g) \quad (17).$$

The parameters of vector β_d in Eq (17) are estimated using a second-stage weighted non-linear least squares estimator $\hat{\beta}_d = \hat{\beta}_{d1}^h, \hat{\beta}_{d0}^h, \hat{\beta}_{d1}^g, \hat{\beta}_{d0}^g$ for $d \in \{0, 1\}$ based on equation (18):

$$\beta_d \equiv \underset{b_d \in \beta_d}{\operatorname{argmin}} \sum_{d'=0,1} E \left[w(d, d', \alpha_w) \left(Y - h_{d'}(X, \alpha_m, \beta_{d1}^h, \beta_{d0}^h) - g_{d'}(X, \alpha_m, \beta_{d1}^g, \beta_{d0}^g) \right)^2 \right] \quad (18)$$

where $w(d, d', \alpha_w) \equiv w(1,1, \alpha_w), w(1,0, \alpha_w), w(0,1, \alpha_w), w(0,0, \alpha_w)$ is a weighted function of (D, Z_1, Z_2, X) with parameter vector α_w obtained from the first-stage maximum likelihood estimation. Given $\hat{\alpha}_m$ and $\hat{\beta}_d$, we obtain the *CLATE* component estimators.

4.5 Data and descriptive statistics

This study uses data from 400 Ghanaian palm oil farmers that operate in the Eastern, Western and Central regions. The data was collected in the period from March to May 2021. Information from the Ministry of Food and Agriculture, extension officers, cooperatives, and oil mills led to the selection of Kwaebibirem Municipal, Mpohor, Tarkwa-Nsuaem Municipal, and Twifo/Hemang/Lower Denkyira districts, where oil palm cultivation is particularly prevalent. After selecting 18 communities, certified and non-certified farmers were randomly sampled from the communities in the final phase of the multistage sampling approach. The sample consists of 133 non-certified, 158 RSPO-certified, and 109 organic-certified farmers producing FFB for either large industrial oil mills or smaller, local mills.

Table 4.1 presents descriptive statistics and definitions of the variables. Table 4.2 shows the differences in characteristics between non-certified, RSPO-certified, and organic certified farm households and the associated t-values.

The descriptive statistics show that organic farmers in the sample obtained the highest crop yields, of approximately 5 tons per hectare, while RSPO certified farmers achieve the highest output. It is worth noting that organic farmers receive the highest prices for their produce, followed by non-certified farmers, resulting in the lowest net farm revenue observed for RSPO certified farmers in the sample. The data show that most farmers across all groups use improved oil palm varieties, with more organic certified farmers (88 percent) using the improved varieties. It is also important to note that in the RSPO farmer group, only 25% have property rights to their farmland. This is not surprising, as large industrial producers who rely on RSPO certified products encourage farmers to sell their land during the certification process, and only hold title to the trees on the plots. It is also noteworthy that farmers with certification tend to have more access to extension service than non-certified farmers. On average, 16% of palm oil plantations are female managed. Interestingly, almost 50% of RSPO certified farms are jointly managed, while only 13% of organic farms follow this approach. It is worth highlighting that RSPO farmers consider their soils to be the most eroded, but are least likely to establish sustainable agricultural practices on their farms. It is also important to note that both groups of certified farmers report higher farming costs than non-certified farmers.

Table 4.1 Variable definition and summary statistics

Variable	Description	Mean	Standard deviation
Yield	Quantity harvested in metric tons per hectare (FFB)	4.03	5.22
Output	Total quantity Harvested in metric tons (FFB)	21.3	27.08
Price	Price received per ton in GHS	469.22	93.19
Net Farm Revenue	Net Farm Revenue in GHS	9381.898	11807.74
Net HH Income	Net Household Income in GHS	12323.99	12995.36
Hazard Quotient	A higher Quotient indicates a more toxic combination of pesticides	0.33	0.94
Farming costs	Total Farming Costs in GHS	3554.1	2839.66
Income off farm	Income off-farm work in GHS per year	3942.09	5683.37
Female	1 if head of household is female, 0 otherwise	0.15	0.36
Age	Age of Household head (years)	57.15	12.26
Household size	Number of household members	5.14	2.19
Education	Years of formal education of Household head	9.08	4.14
Improved variety	1 if farmer uses improved variety, 0 otherwise	0.82	0.38
Market Distance	Distance to local market in kilometers	1.98	1.51
Property Rights	1 if Owner of land, 0 otherwise	0.5	0.5
Hired Labor	Number of man days of paid labor	53.65	42.09
Extension	Extension Frequency	2.11	1.84
Credit constrained	1 if farmer is credit constrained, 0 otherwise	0.36	0.48
Farm age	Age of oil palm farm in years	19.65	7.04
Farm size	Land size of palm oil cultivation in hectare on household level	5.83	3.1
Female management	1 if plot is managed by female farmer, 0 otherwise	0.16	0.37
Joint management	1 if plot is managed by female and female farmer, 0 otherwise	0.31	0.46
Eroded soil	1 if farmer perceives soil as eroded, 0 otherwise	0.08	0.28
Low fertile soil	1 if farmer perceives soil as low fertile, 0 otherwise	0.08	0.28
Number of SAS	Number of sustainable agricultural practices employed by farmer	6.77	6.16
Distance extension	Distance to nearest extension contact possibility	2.72	1.42
Adoption Neighborhood	1 if more than 3 farmers in the neighborhood are certified, 0 otherwise	0.38	0.48
Central	1 if farmer is located in Central region, 0 otherwise	0.15	0.36
Western	1 if farmer is located in Western region, 0 otherwise	0.26	0.44
Eastern	1 if farmer is located in Eastern region, 0 otherwise	0.59	0.49

Note: GHS is Ghanaian currency (Ghanaian Cedi); US\$1 = GH¢ 5.74 in March / April 2021.

Table 4.2 Differences in characteristics among farmers

Variable	Non-certified		RSPO Certified		^a Diff. (t-stat.)	Organic Certified		^b Diff. (t-stat.)	^c Diff. (t-stat.)
	Mean	Standard deviation	Mean	Standard deviation		Mean	Standard deviation		
Yield	4.02	4.98	3.31	3.57	-1.41*	5.09	7.08	1.39*	2.72***
Output	17.09	22.59	24.12	29.25	2.26**	22.34	28.39	1.60*	-0.49
Price	476.87	82.79	407.31	77.22	-7.41***	549.61	53.24	7.93***	16.69***
Net Farm Revenue	8659.44	10235.17	7972.21	10696.83	-0.56	12306.85	14440.58	2.29**	2.82***
Net HH Income	12880.95	12095.78	12252.56	11922.74	-0.45	15417.66	15234.93	1.44*	1.90**
Hazard Quotient	0.4	1.19	0.5	0.97	0.72	0.00	0.00	-3.48***	-5.27***
Farming costs	3019.39	2377.91	4071.91	3236.57	3.11***	3455.95	2626.33	1.36*	-1.65**
Income off farm	4221.51	5628.45	4280.35	6300.25	0.08	3110.82	4685.16	-1.65*	-1.65*
Female	0.14	0.34	0.18	0.38	0.97	0.12	0.32	-0.37	-1.29*
Age	53.41	13.64	59.88	10.39	4.58***	57.72	11.93	2.58***	-1.57*
Household size	5.32	2.16	4.87	2.06	-1.81**	5.31	2.38	-0.03	1.60*
Education	8.76	3.94	9.05	4.76	0.57	9.49	3.31	1.55*	0.83
Improved variety	0.79	0.04	0.81	0.03	0.28	0.88	0.03	1.75**	1.54*
Market Distance	1.65	1.51	2.36	1.59	3.84***	1.81	1.29	0.88	-2.96***
Property Rights	0.62	0.49	0.25	0.44	-6.85***	0.71	0.46	1.35*	8.18***
Hired Labor	47.15	39.39	61.29	46.86	2.76***	50.48	36.15	0.68	-2.03**
Extension	1.53	1.93	2.38	1.81	3.88***	2.44	1.61	3.94***	0.28
Off-farm income	0.69	0.46	0.65	0.47	-0.72	0.59	0.49	-0.06	-0.92
Credit constrained	0.37	0.48	0.34	0.48	-0.47	0.39	0.49	0.27	0.73
Farm age	15.62	6.76	23.68	3.89	12.69***	18.72	7.78	3.32***	-6.86***
Farm size	4.25	2.21	7.68	2.81	11.43***	5.07	3.07	2.42***	-7.19***
Female management	0.18	0.37	0.16	0.37	-0.51	0.15	0.36	-0.67	-0.25
Joint management	0.27	0.04	0.47	0.04	3.53***	0.13	0.03	-2.75***	-6.19***
Eroded soil	0.08	0.02	0.09	0.02	0.18	0.07	0.03	-0.27	-0.44
Low fertile soil	0.08	0.02	0.06	0.02	-0.39	0.12	0.03	1.16	1.61*
Number of SAS	6.81	0.64	6.5	0.42	-0.41	7.11	0.53	0.36	0.99
Distance extension	2.52	0.11	2.95	0.12	2.58***	2.61	0.13	0.54	-1.86*
Adoption Neighborhood	0.20	0.03	0.46	0.04	4.85***	0.49	0.05	5.02***	0.49
Central	0.26	0.04	0.20	0.03	-0.61	0.00	0.00	-5.61***	-5.14***
Western	0.20	0.03	0.48	0.04	5.31***	0.00	0.00	-5.13***	-10.01***
Eastern	0.58	0.04	0.32	0.04	-4.52***	1.00	0.00	8.87***	15.07***
Sample size	133		158			109			

Note: *, **, and *** mean significant at 10%, 5%, and 1% levels, respectively.

^aDifferences in characteristics between non-certified and RSPO certified farmers.

^bDifferences in characteristics between non-certified and organic certified farmers.

^cDifferences in characteristics between RSPO certified and organic certified farmers.

4.6 Empirical results

In this section, we present the empirical results of the estimations. First, we present the factors that influence farmers' decision to participate in certification schemes and associated extension services. The effects on the outcome variables are reported in the following sections. Four different participation scenarios are presented for each certification status. The term "mediated adopters" describes farmers who participate in extension services and organic or RSPO farming, while the term "non-mediated adopters" describes farmers who do not participate in organic or RSPO farming, but participate in extension programs. The term "mediated non-adopters" describes farmers who do not participate in organic or RSPO farming, but participate in extension services, while the term "non-mediated non-adopters" describes farmers who do not participate in certification nor extension programs.

4.6.1 First-stage bivariate probit estimates: RSPO certification

Table 4.3 presents the results of the bivariate probit estimation for RSPO certification. The model is used to account for selection bias and for identification of the instrumental variable regression. Farmers with older farms, higher educational levels, further distance to local markets, and farmers without property rights tend to get RSPO certified. One reason why more farmers without property rights are participating in RSPO certification is due to the fact that international companies in the RSPO supply chain often provide farmers with an offer to buy their land, while the farmers only hold the property rights to the oil palms. As a result, the company owns the land after a cultivation period of about 25 years. If the farmers accept the offers, they effectively join the certification without ownership rights to the land.

The other relationships are expected, as large companies that rely on RSPO-certified palm fruit collect large volumes from remote farms or collection points using company-owned trucks. It therefore makes sense for farmers in more remote regions to participate in the RSPO certification scheme in order to benefit from the industry's supply chain. Additionally, the international RSPO supply chain provides the advantage of facilitating further services, such as access to labor or other inputs. It can be observed

that female farmers appear to be more likely to participate in RSPO certification than their male counterparts. The increased participation of female farmers is not an unexpected finding, as women in developing countries often have less access to inputs and can thus benefit from well-organized supply chains of the RSPO certification scheme and it is argued in the literature that accessibility of inputs, rather than propensity to use inputs, is a central issue for many female farmers (Peterman et al. 2011). The results further suggest that older farmers and farmers with larger farms are more likely to participate in the extension after RSPO certification. This may lead to the conclusion that factors that potentially limit farmers' productivity lead farmers to increase the use of extension to counteract this effect.

The lower part of the table shows instrumental variables and correlation. The D-variable, i.e., certification participation, indicates that farmers are more likely to participate in extension service if they are RSPO certified. The positive coefficient of Z1 (adoption neighborhood), which we use to identify the certification participation model, indicates that the probability of being certified increases if the farmer lives in an adoption neighborhood. Z2 (distance to nearest extension possibility), which is used to identify extension participation, is negative and significant at 1% level, suggesting that a decrease in distance to an extension possibility increases the probability of extension participation. The negative sign and statistical significance of ρ suggest that extension and certification adoption decisions are correlated due to unobserved heterogeneities, that farmers may have self-selected into the programs, and that farmers are likely to substitute adoption of certification with knowledge acquisition from extension participation (Mohammed and Abdulai 2022b, 2022c).

Table 4.3 Participation and Adoption Decisions (First-Stage Bivariate Probit Estimates), RSPO

Variables	Ext.-Participation (M)		Certification-Participation (D)	
	Coeff.	(S.E.)	Coeff.	(S.E.)
Const.	-1.501	(1.034)	-8.027***	(1.237)
Age	0.013*	(0.008)	0.013	(0.011)
Female	-0.080	(0.245)	0.467*	(0.266)
Education	0.005	(0.021)	0.012***	(0.024)
Farm size	-0.347*	(0.208)	1.257	(0.275)
Palm oil farm age	-0.066	(0.272)	1.303***	(0.334)
Labor	0.008**	(0.003)	-0.001	(0.003)
Credit constraint	0.047	(0.199)	0.368	(0.233)
Distance to market	-0.030	(0.058)	0.148**	(0.067)
Improved variety	0.223	(0.255)	-0.070	(0.326)
Erosion	0.018	(0.022)	0.028	(0.024)
Joint management	0.400	(0.388)	1.177**	(0.470)
Off-farm income	-0.011	(0.189)	0.247	(0.202)
Property rights	-0.108	(0.198)	-0.816***	(0.209)
Kwaebibirem_dist	0.201	(0.237)	-0.024	(0.308)
Mpohor_dist	0.010	(0.273)	0.329	(0.345)
Tarkwa_Nsuaem_dist	-0.123	(0.281)	0.129	(0.326)
Number of AMS	0.193*	(0.114)	-0.122	(0.099)
Certification Participation (D)	1.167***	(0.408)	-	
Adoption Neighborhood (Z1)	-		0.779***	(0.199)
Distextoff (Z2)	-0.149***	(0.071)	-	
ρ	-0.539*	(0.299)		
LR test of $\rho = 0$	chi ² = 19.073			
LL =	-215.801			
Wald chi ² =	256.51***			
Number of obs =	291			

Note: ***, **, and * are 1%, 5%, and 10% level of significance; Values in brackets are standard errors.

4.6.2 Determinants of technology and inefficiency frontiers: RSPO certification

Table 4.4 presents factors that affect the production technology and inefficiency frontiers of mediated adopters and non-mediated adopters with respect to yield. The scenarios, i.e., the columns in Table 4.4 describe farmers participating in the RSPO certification scheme and receiving (column one) or not receiving (column three) extension service. In Table 4.5, we present the effects of the factors contributing to production technology and inefficiency frontiers for mediated as well as non-mediated non-adopters. This corresponds to the first column showing the scenario where a farmer does not participate in the certification scheme but receives extension services, and the third column showing the scenario where the farmer does not participate in both the certification scheme and extension services. The estimated model is a weighted non-linear least squares model using the generalized method of moment procedure.

The results show that some observed farmer-specific characteristics such as credit constraint, improved variety, erosion level, property rights or joint management shift the production frontier in the same direction for all participation scenarios. The estimates indicate that poor land conditions, joint management, i.e., decision making under several interests, and being credit constraint negatively impact the production frontiers. Property rights and improved varieties tend to have a positive impact on production frontiers. The age of the farms seems to affect the frontiers differently, which seems plausible in the context of the characteristics of the farms of adopters and non-adopters. Since adopters of RSPO certification have on average the oldest farms, further aging of farms shifts productivity in a negative direction, as farms approaching 25 years of age become less productive and uneconomic. Of particular interest is the finding that increased off-farm income has a positive and statistically significant effect on mediated adopters and a statistically significant negative effect on non-mediated adopters. This suggests that a reallocation of household resources (e.g., time) to off-farm work may be less well managed by farmers who have not received extension service, and that trained farmers are more likely to be able, for example, to acquire additional or useful inputs through off-farm work, which have a positive impact on their crop yields.

Table 4.4 Adoption with Mediation – (Weighted Nonlinear Least-Squares) – Yield (lnKg/Ha), RSPO

Variables	Adopters ^M		Adopters ^N	
	(d, M(d')) = (1, 1)		(d, M(d')) = (1, 0)	
	Coeff.	(S.E.)	Coeff.	(S.E.)
Frontier function (<i>h</i>)				
Age	-0.001	(0.002)	-0.009***	(0.002)
Female	5.879***	(1.128)	1.100	(1.127)
Farm size	-0.007	(0.073)	-0.284***	(0.060)
Education	0.980***	(0.014)	0.893***	(0.024)
Palm oil farm age	0.020	(0.023)	-0.185***	(0.033)
Labor	0.001	(0.002)	-0.009	(0.007)
Credit constraint	-6.372***	(0.286)	-2.846*	(1.598)
Distance to market	-0.987***	(0.099)	-0.145	(0.115)
Improved variety	0.961***	(0.127)	0.327	(0.362)
Off-farm income	0.050*	(0.029)	-0.201***	(0.028)
Erosion	-5.088***	(0.099)	-3.203***	(0.121)
Joint management	-2.323***	(0.427)	-3.366***	(0.164)
Property rights	0.689*	(0.393)	1.980***	(0.357)
Kwaebibirem	-0.506	(0.566)	-2.515	(3.220)
Mpohor	0.455	(1.477)	-0.412	(0.711)
Tarkwa Nsuaem	-2.952***	(0.825)	-5.008***	(0.874)
Const.	-0.017	(0.102)	-0.580***	(0.104)
Inefficiency function (<i>g</i>)				
$\beta_{(AMS)}^g$	-1.319**	(0.748)	-2.949***	(0.362)
$\beta_{(0)}^g$	3.521***	(0.674)	1.472***	(0.379)
Number of obs.	158		158	

Note: ***, **, and * are 1%, 5%, and 10% level of significance; Values in brackets are bootstrapped robust standard errors. Columns one and two represent farmers who participate in the extension program and participate in RSPO certified farming (i.e. Adopters^M = Mediated-Adopters, abbreviated as (MA)) and farmers who participate in RSPO certified farming but not in extension programs (i.e. Adopters^N = Non-Mediated-Adopters, abbreviated as (NM-A)), respectively. $\beta_{(0)}^g$ represent estimates of the non-negative inefficiency parameter vector that did not control for the implementation of recommended agricultural management strategies and $\beta_{(AMS)}^g$ represent estimates of the non-negative inefficiency parameter vector that controlled for the implementation of recommended agricultural management strategies.

Table 4.5 Adoption with Mediation – (Weighted Nonlinear Least-Squares) – Yield (lnKg/Ha), RSPO

	Non-Adopters ^M		Non-Adopters ^N	
	(d, M(d')) = (0, 1)		(d, M(d')) = (0, 0)	
Variables	Coeff.	(S.E.)	Coeff.	(S.E.)
Frontier function (<i>h</i>)				
Age	-1.113***	(0.006)	2.509***	(0.005)
Female	-5.369	(3.875)	2.062	(6.348)
Farm size	1.318***	(0.229)	-2.546***	(0.179)
Education	4.129***	(0.027)	-1.679	(0.042)
Palm oil farm age	8.115***	(0.025)	3.984***	(0.089)
Labor	0.085***	(0.010)	-0.870***	(0.009)
Credit constraint	-3.593***	(1.006)	-3.927***	(1.099)
Distance to market	2.012***	(0.362)	0.850	(1.450)
Improved variety	0.856***	(0.198)	2.022***	(0.435)
Off-farm income	0.845	(0.700)	0.025	(0.040)
Erosion	-2.362***	(0.210)	-0.733***	(0.279)
Joint management	-4.450	(7.730)	-9.723***	(0.983)
Property rights	9.740***	(0.897)	4.500	(4.664)
Kwaebibirem	-3.282***	(0.026)	0.045	(1.240)
Mpohor	4.169	(4.552)	0.478	(0.882)
Tarkwa Nsuaem	2.013	(3.007)	-1.480	(2.600)
Const.	1.255***	(0.091)	1.170***	(0.278)
Inefficiency function (<i>g</i>)				
$\beta^g_{(AMS)}$	-0.490***	0.143	-11.070***	0.144
$\beta^g_{(0)}$	1.502***	0.333	13.622***	0.143
Number of obs.	133		133	

Note: ***, **, and * are 1%, 5%, and 10% level of significance; Values in brackets are bootstrapped robust standard errors. Columns one and two represent farmers who participate in the extension program and do not participate in RSPO certified farming (i.e. Non-Adopters^M = Mediated-Non-Adopters, abbreviated as (M-NA)) and farmers who neither participate in RSPO certified farming nor in extension programs (i.e. Non-Adopters^N = Non-Mediated-Non-Adopters, abbreviated as (NM-NA)), respectively. $\beta^g_{(0)}$ represent estimates of the non-negative inefficiency parameter vector that did not control for the implementation of recommended agricultural management strategies and $\beta^g_{(AMS)}$ represent estimates of the non-negative inefficiency parameter vector that controlled for the implementation of recommended agricultural management strategies.

The results also show that an increased educational level has a positive effect on the production frontier, however, only statistically significant in three scenarios. The statistically significant coefficients of the constant terms in Tables 4.4 and 4.5 capture the effect of unobserved farmer-specific characteristics. In Table 4.4 we observe negative effects, suggesting that unobserved characteristics, such as farmers' inherent abilities, may have played a role in reducing the production frontier of RSPO certified farmers. Conversely, the positive and statistically significant coefficients in Table 4.5 suggest that these abilities may have contributed to improving non-certified farmers' capacity to expand the production frontier, regardless of production technologies, certification, or extension status. These findings indicate that non-certified farmers in our sample may possess inherent farming abilities which may enable them to achieve higher yields, compared to RSPO certified farmers.

The bottom rows of Tables 4.4 and 4.5 present the estimates of post-mediation factors affecting farmers' inefficiency. We use the number of implemented agricultural management strategies (AMS) as a proxy for the post-mediation factors in the inefficiency frontier function. We consider AMS that are generally taught by extension officers and constitute a minimum requirement for good and advanced agricultural practice. The positive and statistically significant $\beta_{(0)}^g$ coefficients of a constant only inefficiency model indicate that certification without the implementation of recommended AMS does not have a positive impact on inefficiency. However, if recommended management strategies are implemented under certification, farmer productivity increases. The negative and statistically significant $\beta_{(AMS)}^g$ coefficients in all scenarios indicate that inefficiency is reduced. Tables 4.A1 and 4.A2 in the Appendix present the estimates of the different scenarios with respect to net farm revenue. The results in these two tables reveal similar effects to those described in Tables 4.4 and 4.5. Some of the key elements that particularly influence the production frontier are soil quality, credit constraints, education, improved variety, distance to local markets and off-farm labor.

4.6.3 Impact of mediation and certification participation on productivity, efficiency and welfare

The estimates of the treatment effects derived in equations 13 – 15 are reported in this section. Tables 4.6 and 4.7 in present the results for yields and net farm revenue, respectively. The results in the first column of Table 4.6 show that RSPO certification has a negative impact on smallholder farmers' yields per hectare. This finding is consistent with other studies that have found that one of the main drawbacks of certified sustainable agriculture is lower yields. Since certification programs are subject to restrictions on, for example, chemical inputs or land acquisition and preparation, farmers are limited in their range of farming and behavioral practices. We note that the direct effect is negative while the indirect effect reveals a positive influence on yield. This suggests that, as certifications are associated with constraints and obligations, negative effects on yields can arise, while, for example, good management practices mediated by extension services exert positive impacts. This finding is quite significant because it demonstrates that despite transitioning to more sustainable farming practices, farmers can maintain farm success through human capital acquisition and formation mediated through extension services and compensate for losses.

Decomposing the overall effect into the technological frontier (column 2) and technical inefficiency (column 3), we observe that the negative effects of RSPO certification arise from negative effects on the technology frontier. This Finding is also consistent with expectations, as restrictions imposed by certification relate primarily to the use of inputs, i.e., restrictions regarding agrochemicals, or land and laborer management, for example restrictions on land clearing techniques. Again, the mediation effect counteracts the negative direct effects, however, it fails to fully compensate for the negative impact. With regard to inefficiency, the results show that certification results in positive direct as well as indirect effects. It can be concluded that direct benefits provided by the RSPO supply chain, such as facilitated access to inputs, services or labor, as well as knowledge and expertise provided through extension service, reduce inefficiencies of farmers. Therefore, certification itself, which is likely to be associated with constraints and restrictive limitations on farmers, plays the main role in reducing the technology frontier. At the same time, certification, within the framework of available technology,

increases efficiency and narrows the gap to RSPO farmers' technology frontier, presumably directly through benefits from well-organized value chains and indirectly through human capital formation.

Table 4.7 shows the decompositions of the LATE with respect to net farm revenue. The results clearly show that the effects are positive despite the negative impact on yield. With respect to the overall economic farm performance, certified farmers seem to be able to increase their efficiency and shift their technology frontier upwards. The results of the mediation analysis indicate that the positive impact is mainly driven through channels unrelated to extension. These channels may include the integrated use of the benefits and assets of organized RSPO supply chains with, for example, access to workers, pickup service, guaranteed purchase quantities and other productivity enhancing inputs such as seedlings or approved agrochemicals. This implies that although certification reduces farmers' yields, farm households may ultimately benefit from the opportunities provided by international supply chains such as RSPO certified supply chains as well as extension services, depending on farmers' individual situations

Table 4.6 Local average treatment effects of RSPO certification on yield

Impact on yield	Technology Frontier	Inefficiency Frontier
LATE	LATE _h	LATE _g
-2.688 (2.836)	-3.885* (2.732)	-1.051*** (0.209)
DLATE	DLATE _h	DLATE _g
-10.242*** (1.649)	-10.829*** (1.700)	-0.618*** (0.169)
ILATE	ILATE _h	ILATE _g
7.606*** (1.927)	7.001*** (1.983)	-0.455*** (0.098)

***1% level of significance; Values in brackets are bootstrapped standard errors from 1,000 re-samples. LATE is local average treatment effect, representing the total effect of participation in organic certification and extension services; DLATE is direct local average treatment effect, representing the component of the total effect that comes from organic certification; ILATE is indirect local average treatment effect, representing the component of the total effect that comes from extension participation. Suffixes h and g indicate ATE decompositions for the technology and inefficiency frontier, respectively.

Table 4.7 Local average treatment effects of RSPO certification on net farm revenue

Impact on Net Farm Revenue	Technology Frontier	Inefficiency Frontier
LATE	LATE _h	LATE _g
0.870*** (0.254)	1.788*** (0.242)	0.943*** (0.029)
DLATE	DLATE _h	DLATE _g
1.368*** (0.259)	2.232*** (0.267)	0.884*** (0.027)
ILATE	ILATE _h	ILATE _g
-0.494*** (0.033)	-0.436*** (0.031)	0.061*** (0.003)

***1% level of significance; Values in brackets are bootstrapped standard errors from 1,000 re-samples. LATE is local average treatment effect, representing the total effect of participation in organic certification and extension services; DLATE is direct local average treatment effect, representing the component of the total effect that comes from organic certification; ILATE is indirect local average treatment effect, representing the component of the total effect that comes from extension participation. Suffixes h and g indicate ATE decompositions for the technology and inefficiency frontier, respectively.

4.6.4 Production and technology gap profile: RSPO certification

Figures 4.2 and 4.3 show the estimates of the conditional average yield gaps in deciles across different sub-populations of adopters at the technology and technical efficiency frontiers, respectively. The estimates are based on the condition of being a complier. It is important to highlight these differences as various farmers operate at different levels of production and efficiency and changes may affect heterogeneous sub-populations differently. We refer to the difference between estimated and actual yields as yield gaps.

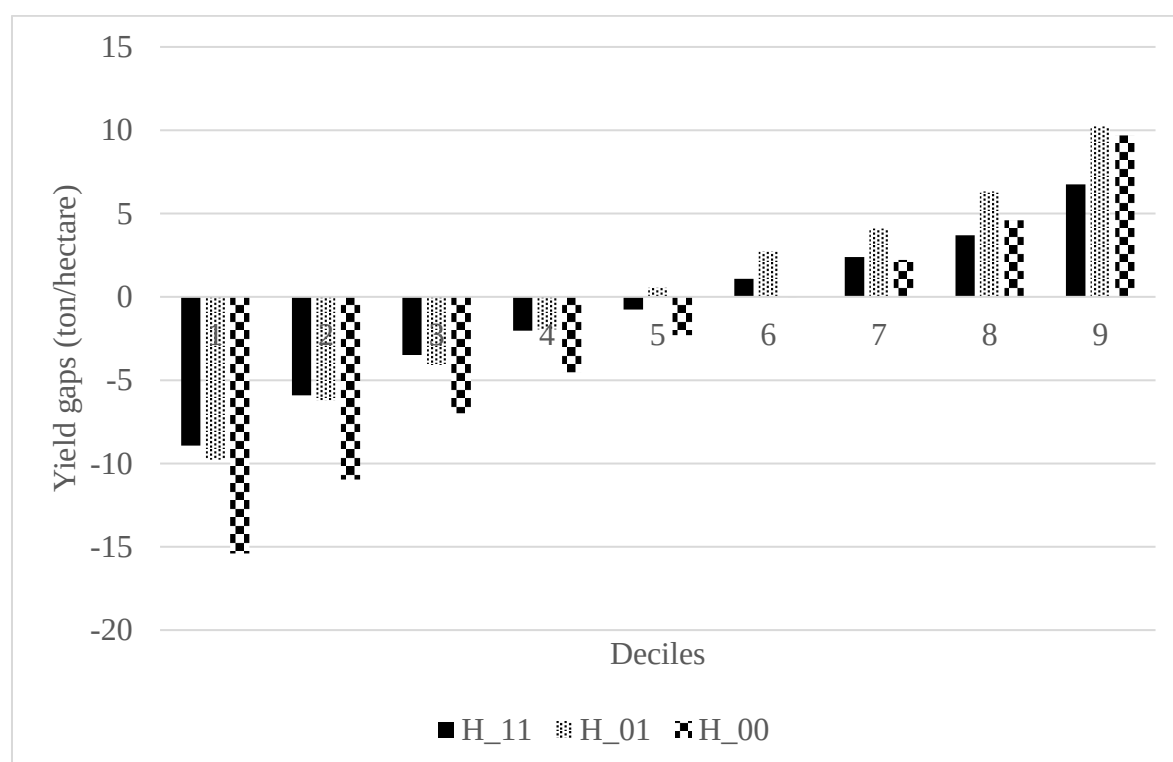


Figure 4.2 Average yield distance of farmers at the production technology frontier - RSPO

Yield gap profile at the production technology frontier. H_11, H_01 and H_00 indicate mediated adopters, mediated non-adopters and non-mediated non-adopters, respectively at the production technology function of yield. The figure illustrates the yield gap profile of farmers operating at different production technology frontiers, compared to farmers at the best production frontier operating at zero technological inefficiency.

Figure 4.2 indicates that the average yield distance of farmers who participate in the RSPO certification scheme and participate in extension (mediated adopters, H_11) appears to be relatively closer to zero at every decile, compared to mediated non-adopters (H_01) and non-mediated non-adopters (H_00).

Another important result is that the heterogeneity in yields is slightly reduced. This implies that participation in both programs provides greater certainty that yields will fall within a certain range. This can provide farmers with improved planning certainty, for example with regard to farm investments.

Figure 4.3 presents average yield gaps at the technical efficiency frontier. We observe that the average yield distance of mediated adopters (G_11) at the top five deciles is further away from the zero-yield-gap line, i.e., yield gaps are larger, than the average distance of the other groups, which appear to operate at relatively similar efficiency levels. This indicates that farmers who participate in RSPO farming and the associated extension programs are technically less efficient than farmers who do not participate in the certification scheme. This implies that presumably restrictive limitations and regulations of the certification cause farmers to be less technically efficient.

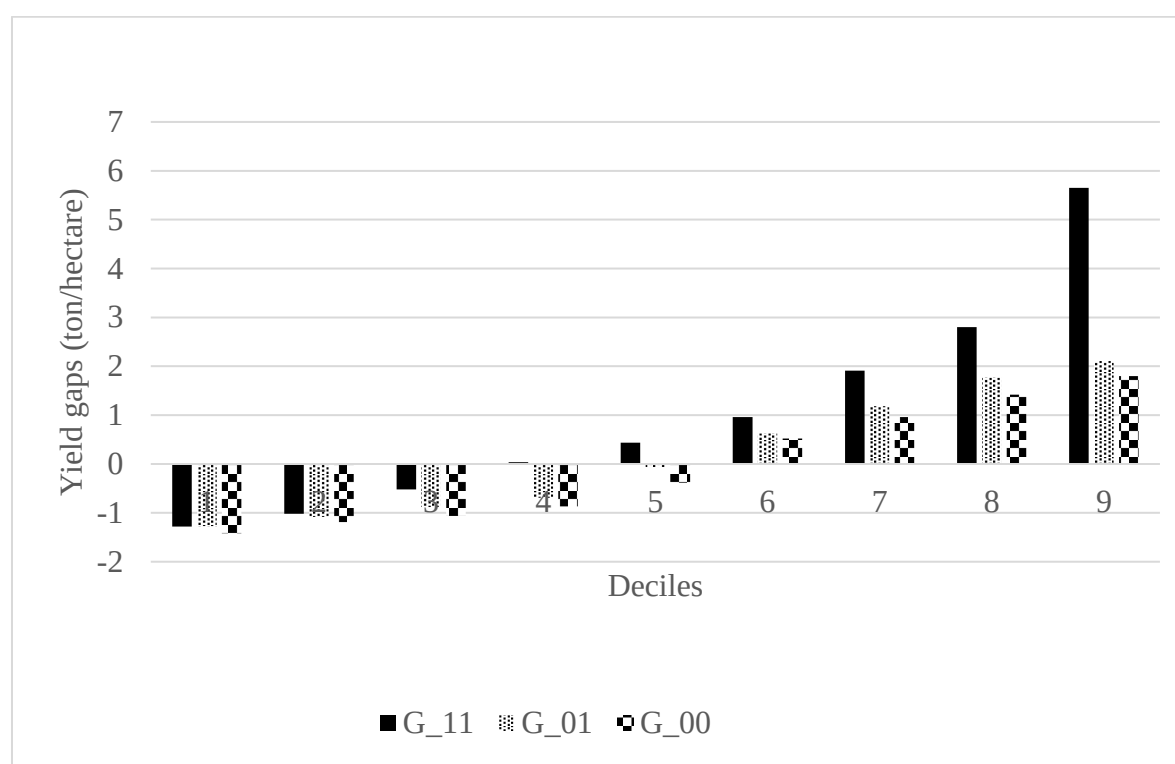


Figure 4.3 Average yield distance of farmers at the technical inefficiency frontier - RSPO

Yield gap profile at the inefficiency frontier. G_11, G_01 and G_00 indicate mediated adopters, mediated non-adopters and non-mediated non-adopters, respectively at the technical inefficiency function of yield. The figure illustrates the yield gap profile of farmers operating at different levels of technical inefficiency, compared to farmers at the best production frontier operating at zero technical inefficiency.

This is an important finding as it suggests that RSPO certification has the potential to shift farmers' technology frontier upward, yet the measures, program benefits, and educational sessions associated with certification are not sufficient to improve the efficiency of individual farmers within the new frontier which leads to large heterogeneities within the group of RSPO farmers. This leads to the conclusion that the full potential of the RSPO certification is not being achieved. One way to narrow the yield gap would be through better trained extension personnel, as the certification scheme itself holds potential to achieve higher yields.

4.6.5 First-stage bivariate probit estimates: Organic certification

Table 4.8 presents the results of the bivariate probit estimation for organic certification. The estimates show that larger farm size, increasing distance to local markets, and use of improved varieties increase the probability of a farmer participating in organic certification. This can probably be explained by the fact that farmers with more challenging farming conditions are more likely to participate in a specialized supply chain with added economic benefits. We observe that joint decision-making on the farm lowers the participation probability. The results also reveal that increased soil erosion and more off-farm activity tend to increase the likelihood of participating in extension services. These results imply that increased management challenges may lead farmers to seek increased knowledge about improved practices.

The estimates also show, that if farmers are organic certified, they are more likely to participate in extension (D), and that an increasing distance to an extension possibility significantly decreases the probability of gaining access to extension services (Z2). The statistical significance of Z1 indicates that living in an adoption neighborhood increases the probability of getting organic certification. As in the RSPO section, the negative sign and statistical significance of ρ suggest that extension and certification adoption decisions are correlated due to unobserved heterogeneities and that farmers tend to substitute certification participation with knowledge acquisition via extension participation.

Table 4.8 Participation and Adoption Decisions (First-Stage Bivariate Probit Estimates), organic

Variables	Ext.-Participation (M)		Certification-Participation (D)	
	Coeff.	(S.E.)	Coeff.	(S.E.)
Const.	-1.694**	0.791	-4.203***	(1.031)
Age	0.019**	(0.007)	0.002	(0.009)
Female	-0.107	(0.233)	0.227	(0.287)
Education	-0.016	(0.025)	0.027	(0.028)
Farm size	-0.170	(0.165)	0.367**	(0.175)
Palm oil farm age	-0.056	(0.190)	0.358	(0.231)
Labor	0.005**	(0.002)	-0.007***	(0.002)
Credit constraint	-0.042	(0.177)	0.110	(0.185)
Distance to market	-0.179	(0.175)	0.451**	(0.181)
Improved variety	0.194	(0.274)	0.686**	(0.327)
Erosion	0.663*	(0.373)	0.495	(0.402)
Joint management	0.420*	(0.229)	-0.508*	(0.289)
Off-farm income	0.004*	(0.021)	0.001	(0.022)
Property rights	-0.413**	(0.188)	0.114	(0.194)
Asuom	-0.810***	(0.258)	1.736***	(0.303)
Abaam	-0.262	(0.255)	1.785***	(0.270)
Abodom	-0.196	(0.255)	1.193***	(0.286)
Tweapease	-0.901***	(0.333)	1.733***	(0.376)
Number of AMS	0.183*	(0.101)	-0.069	(0.102)
Certification Participation (D)	2.025***	(0.166)	-	
Adoption Neighborhood (Z1)	-		0.897***	(0.199)
Distextoff (Z2)	-0.216***	(0.075)	-	
ρ	-4.229***	(1.031)		
LR test of $\rho = 0$	chi ² = 19.073			
LL =	-215.801			
Wald chi ² =	256.51***			
Number of obs =	242			

Note: ***, **, and * are 1%, 5%, and 10% level of significance; Values in brackets are standard errors.

4.6.6 Determinants of technology and inefficiency frontiers

Tables 4.9 and 4.10 present the results of the factors affecting production technology and inefficiency frontiers with respect to yields and organic farming. As in the estimates for RSPO certification, the scenarios in Table 4.9 describe farmers participating in the organic certification scheme and receiving or not receiving extension services. Table 4.10 presents the effects of the factors contributing to production technology and inefficiency frontiers for mediated as well as non-mediated organic farming non-adopters. The results show that some of the factors exert similar statistically significant effects on the technology frontier in all scenarios. Larger farms, credit constraints, greater distance to the local market and soil erosion lower the frontier, while higher educational levels as well as property rights to the farm land shift the frontier upwards. It is worth noting that an increase in the use of labor shifts the production frontier up for mediated farmers, while without mediation, an increase in the use of labor shifts the frontier down. This finding suggests that an increased use of labor also requires a better understanding of sustainable farming practices and management strategies, mediated through extension, in order for workers to perform effectively within the certification framework.

Again, the bottom rows of Tables 4.9 and 4.10 present the estimates of the post-mediation factors affecting farmers' inefficiency. The positive and statistically significant $\beta_{(0)}^g$ coefficients indicate that certification without the implementation of recommended AMS does not have a positive impact on inefficiency and, as in the RSPO certification case, if recommended management strategies are implemented, farmer productivity increases. The statistically significant and negative $\beta_{(AMS)}^g$ coefficients in all scenarios indicate that inefficiency is reduced.

Table 4.9 Adoption with Mediation – (Weighted Nonlinear Least-Squares) – Yield (lnKg/Ha), organic

Variables	Adopters ^M		Adopters ^N	
	(d, M(d')) = (1, 1)		(d, M(d')) = (1, 0)	
	Coeff.	(S.E.)	Coeff.	(S.E.)
Frontier function (<i>h</i>)				
Age	-0.053***	(0.001)	-0.113***	(0.006)
Female	-5.120***	(1.193)	0.884	(0.897)
Farm size	-1.215***	(0.093)	-1.560***	(0.344)
Education	1.064***	(0.008)	0.775***	(0.039)
Palm oil farm age	-0.019	(0.027)	0.846***	(0.212)
Labor	0.027***	(0.005)	-0.035***	(0.010)
Credit constraint	-1.702***	(0.275)	-4.914***	(0.714)
Distance to market	-1.659***	(0.129)	-0.561***	(0.110)
Improved variety	0.940***	(0.052)	0.609	(2.008)
Erosion	-2.555***	(0.069)	-1.449***	(0.410)
Joint management	0.730	(0.836)	11.265	(66.679)
Off-farm Income	0.021	(0.028)	-0.013	(0.025)
Property rights	1.829***	(0.095)	0.901***	(0.092)
Asuom	-1.054*	(0.557)	-0.674	(0.828)
Abaam	1.435*	(0.845)	-1.073*	(0.472)
Abodom	-1.398	(1.421)	-32.395	(56.257)
Tweapease	2.199***	(0.252)	3.018***	(0.693)
Const.	-0.042	(0.053)	-0.030	(0.360)
Inefficiency function (<i>g</i>)				
$\beta^g_{(AMS)}$	-0.398***	(0.121)	-1.422***	(0.212)
$\beta^g_{(0)}$	2.526***	(0.726)	1.128***	(0.309)
Number of obs.	109		109	

Note: ***, **, and * are 1%, 5%, and 10% level of significance; Values in brackets are bootstrapped robust standard errors. Columns one and two represent farmers who participate in the extension program and participate in organic certified farming (i.e. Adopters^M = Mediated-Adopters, abbreviated as (MA)) and farmers who participate in organic certified farming but not in extension programs (i.e. Adopters^N = Non-Mediated-Adopters, abbreviated as (NM-A)), respectively. $\beta^g_{(0)}$ represent estimates of the non-negative inefficiency parameter vector that did not control for the implementation of recommended agricultural management strategies and $\beta^g_{(AMS)}$ represent estimates of the non-negative inefficiency parameter vector that controlled for the implementation of recommended agricultural management strategies.

Table 4.10 Adoption with Mediation – (Weighted Nonlinear Least-Squares) – Yield (lnKg/Ha), organic

	Non-Adopters ^M		Non-Adopters ^N	
	(d, M(d')) = (0, 1)		(d, M(d')) = (0, 0)	
Variables	Coeff.	(S.E.)	Coeff.	(S.E.)
Frontier function (<i>h</i>)				
Age	-0.002	(0.016)	-0.014	(0.016)
Female	-0.023	(2.025)	1.962	(1.845)
Farm size	-1.761*	(0.980)	-0.551**	(0.265)
Education	1.064**	(0.443)	1.038*	(0.604)
Palm oil farm age	0.866***	(0.327)	0.682	(0.661)
Labor	0.002	(0.012)	0.039***	(0.003)
Credit constraint	-3.365	(2.651)	-1.445	(1.905)
Distance to market	-1.374***	(0.517)	-4.339***	(0.629)
Improved variety	1.106	(0.953)	0.959	(2.211)
Erosion	-3.974**	(1.654)	-2.087***	(0.426)
Joint management	-0.658	(1.171)	-3.842	(4.633)
Off-farm Income	-0.414*	(0.227)	-0.280***	(0.083)
Property rights	0.802	(0.792)	1.428*	(0.843)
Asuom	76.564***	(24.898)	0.111	(0.859)
Abaam	-17.435	(36.108)	0.367	(0.909)
Abodom	-1.762	(2.121)	-1.140	(0.849)
Tweapease	-15.215	(15.231)	0.814	(2.934)
Const.	-0.646	(0.882)	-0.546	(4.244)
Inefficiency function (<i>g</i>)				
$\beta^g_{(AMS)}$	-0.759*	(0.447)	-0.821***	(0.260)
$\beta^g_{(0)}$	2.450***	(0.696)	1.420***	(0.331)
Number of obs.	133		133	

Note: ***, **, and * are 1%, 5%, and 10% level of significance; Values in brackets are bootstrapped robust standard errors. Columns one and two represent farmers who participate in the extension program and do not participate in organic certified farming (i.e. Non-Adopters^M = Mediated-Non-Adopters, abbreviated as (M-NA)) and farmers who neither participate in organic certified farming nor in extension programs (i.e. Non-Adopters^N = Non-Mediated-Non-Adopters, abbreviated as (NM-NA)), respectively. $\beta^g_{(0)}$ represent estimates of the non-negative inefficiency parameter vector that did not control for the implementation of recommended agricultural management strategies and $\beta^g_{(AMS)}$ represent estimates of the non-negative inefficiency parameter vector that controlled for the implementation of recommended agricultural management strategies.

4.6.7 Impact of mediation and certification participation on productivity, efficiency and welfare

Table 4.11 presents the local average treatment effects of organic certification on yield, decomposed into direct and indirect effects on the technology and inefficiency frontier. It can be observed that the total effect is negative, which is a common finding in the organic agriculture literature. From the decomposition of the effect into the direct and indirect effects, it is evident that certification negatively affects yield for organic farmers. We emphasize the fact that the indirect effect, i.e., extension participation, exerts a positive impact on yield, however, not of sufficient magnitude to compensate for the negative direct effect of certification. This indicates that organic certification seems to be supported by extension services, which counteract the negative direct effects of restrictions and requirements, and as such allow farmers to minimize yield losses.

The results reveal that the positive effect of extension on the technology frontier has great potential to shift the overall effect on the technology frontier in a positive direction, highlighting the importance of the extension services and human capital formation. However, a significant part of the overall negative effect is driven by the increased inefficiency of farmers under the new technology frontier. From the third column of Table 4.11, we conclude that the direct effect of certification on inefficiency is the main contributor to the overall negative effect. Moreover, the extension service is not able to compensate for this effect. It can therefore be concluded that farmers' inefficiencies should be addressed in particular, and that improved extension and, for example, the implementation of improved farm management techniques by individual farmers could be a key factor in leveraging the potential of the organic certification scheme.

Table 4.12 shows that the positive shift in the technology frontier with respect to net farm revenue is driven by the direct effect of certification, i.e., channels that are unrelated to extension services. This is to be expected, as direct organic certification is associated with higher prices, guaranteed purchase

Table 4.11 Local average treatment effects of organic certification on yield

Impact on yield	Technology Frontier	Inefficiency Frontier
LATE	LATE _h	LATE _g
-3.799*** (0.335)	-0.566** (0.345)	3.224*** (0.088)
DLATE	DLATE _h	DLATE _g
-5.287*** (1.459)	-2.782** (1.526)	2.459*** (0.054)
ILATE	ILATE _h	ILATE _g
1.496 (1.370)	2.252* (1.405)	0.765*** (0.060)

***1% level of significance; Values in brackets are bootstrapped standard errors from 1,000 re-samples. LATE is local average treatment effect, representing the total effect of participation in organic certification and extension services; DLATE is direct local average treatment effect, representing the component of the total effect that comes from organic certification; ILATE is indirect local average treatment effect, representing the component of the total effect that comes from extension participation. Suffixes *h* and *g* indicate ATE decompositions for the technology and inefficiency frontier, respectively.

Table 4.12 Local average treatment effects of organic certification on net farm revenue

Impact on Net Farm Revenue	Technology Frontier	Inefficiency Frontier
LATE	LATE _h	LATE _g
2.539*** (0.340)	4.471*** (0.339)	1.929*** (0.087)
DLATE	DLATE _h	DLATE _g
4.783*** (0.568)	6.685*** (0.588)	1.869*** (0.089)
ILATE	ILATE _h	ILATE _g
-2.234*** (0.438)	-2.169*** (0.422)	0.060*** (0.004)

***1% level of significance; Values in brackets are bootstrapped standard errors from 1,000 re-samples. LATE is local average treatment effect, representing the total effect of participation in organic certification and extension services; DLATE is direct local average treatment effect, representing the component of the total effect that comes from organic certification; ILATE is indirect local average treatment effect, representing the component of the total effect that comes from extension participation. Suffixes *h* and *g* indicate ATE decompositions for the technology and inefficiency frontier, respectively.

volumes and other advantages. Nevertheless, farming practices or management changes mediated through the explicit extension service alone would be a drawback for farm household welfare. One possible explanation for the reason that the overall indirect effect is negative is the fact that extension services related to organic agricultural practices promote agricultural strategies that are more labor-intensive and time-consuming, such as, manual approaches to weeding, cover cropping or residue management (e.g Meemken and Qaim 2018). Consequently, the implementation of these strategies, without the direct benefits of certification, is expected to deprive farmers of resources, thus reducing their potential net farm revenue.

4.6.8 Production and technology gap profile: Organic certification

Figures 4.4 and 4.5 show the mean yield estimates in deciles across different sub-populations of participants and non-participants of organic certification at the technology and technical efficiency frontiers, respectively. Figure 4.4 indicates that the yield distance of farmers participating in the organic certification scheme and receiving extension (mediated adopters, H_11) is on average closer to zero than that of non-mediated non-adopters (H_00), but on average further away from the zero line than the yield distance of mediated non-adopters (H_01). This observation sheds light on the fact that the organic certification extension service ensures that there are no large yield gaps due to the restrictions imposed by the certification requirements. This is supported by the fact that the smallest yield gaps are observed in the scenario of non-adoption, but benefit from extension services. Thus, in this hypothetical scenario, farmers would reap the benefits of extension without incurring the direct disadvantages of certification. However, it should be emphasized that the differences between the groups are not excessively large, implying that the negative effect of certification on the technology frontier is not the main driver for reduced yields.

Figure 4.5 shows that yield gaps in each decile on the inefficiency frontier are the largest for mediated-adopters. This implies that a high level of inefficiency constitutes the main driver for reduced yields of organic farmers. The results reveal that organic certification causes farmers of each decile to be less efficient than non-adopters.

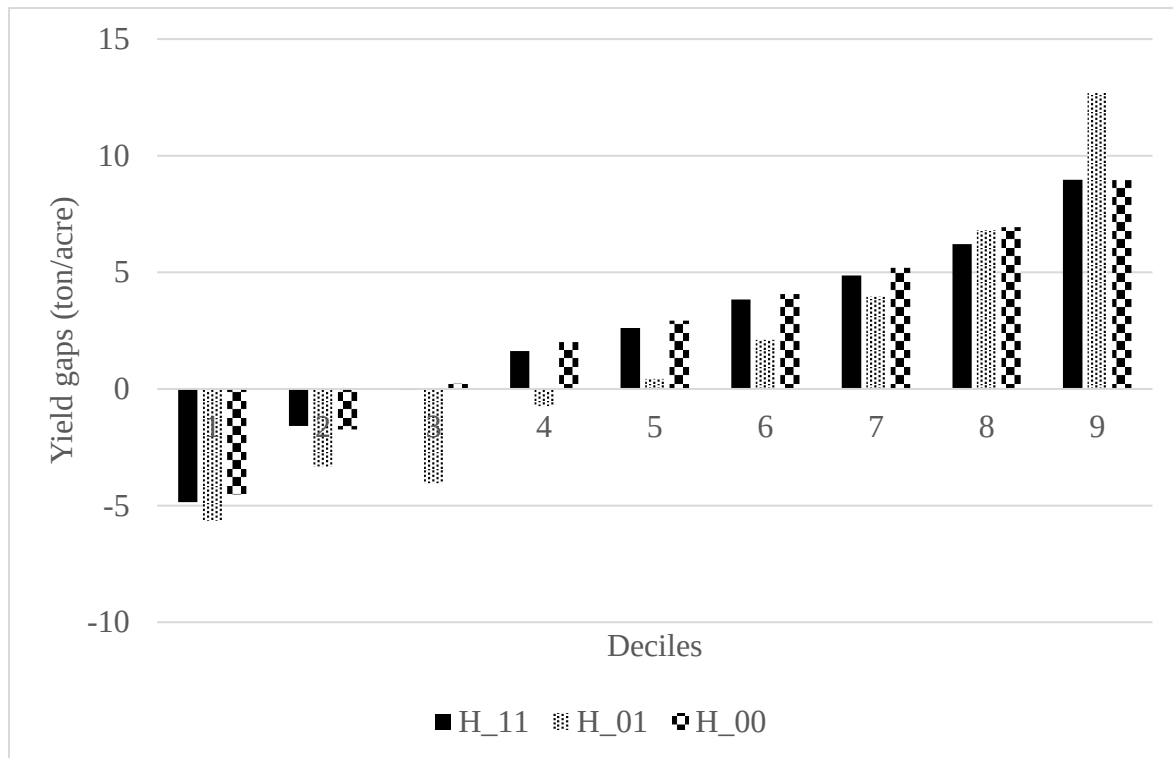


Figure 4.4 Average yield distance of farmers at the production technology frontier - Organic

Yield gap profile at the production technology frontier. H_{11} , H_{01} and H_{00} indicate mediated adopters, mediated non-adopters and non-mediated non-adopters, respectively at the production technology function of yield. The figure illustrates the yield gap profile of farmers operating at different production technology frontiers, compared to farmers at the best production frontier operating at zero technological inefficiency.

A major part of these inefficiencies can be attributed to direct effects from certification, as presented in Table 4.11, which shows that the largest component of increased inefficiencies can be linked to the $DLATE_g$. It appears that farmers are not able to work efficiently within the new technology frontier of organic certification. Indeed, we observe that these farmers are experiencing the largest yield gaps, and that inefficiencies are increasing due to certification. Moreover, the previous section revealed that extension service also fails to reduce these inefficiencies, which renders the inherently larger yield gaps of organic farmers an unsurprising result. Potential underlying drivers could be that, apart from better prices, farmers may not receive further benefits from certification, such as well-developed supply chains, access to labor for manual farming activities, or logistical support and production improvements. Additionally, poor implementation of newly acquired organic farming strategies could

also play a central role in large yield gaps. This hypothesis strongly supports the argument made in the previous section about the impact on farmers' net farm revenue.

It seems that improved prices for produce that can be declared as more sustainable is the major incentive for farmers to join organic certification. However, it is important to note that if the demand for organic palm oil increases, the area under cultivation would have to be expanded due to larger yield gaps. This would be counterproductive in terms of a holistic sustainability approach, as it would lead to more land conversion and associated species loss. Reducing the inefficiency of certified farmers should therefore be given the highest priority in further developing organic agriculture in the palm oil sector.

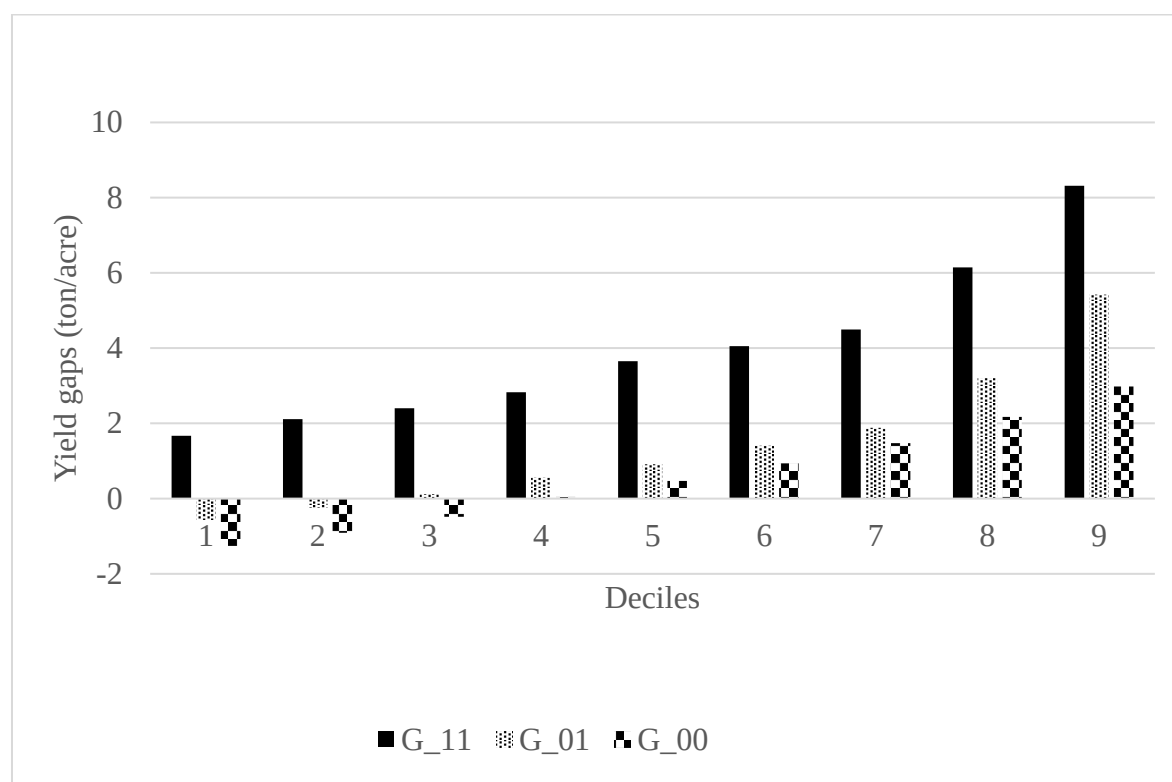


Figure 4.5 Average yield distance of farmers at the technical inefficiency frontier - Organic

Yield gap profile at the inefficiency frontier. G_11, G_01 and G_00 indicate mediated adopters, mediated non-adopters and non-mediated non-adopters, respectively at the technical inefficiency function of yield. The figure illustrates the yield gap profile of farmers operating at different levels of technical inefficiency, compared to farmers at the best production frontier operating at zero technical inefficiency.

4.7 Conclusion

In the palm oil sector, especially in the West African region, farmers face particularly strong problems of large yield gaps compared to, for example, large estates in Southeast Asia. Certifications are intended to help identify agricultural products that are characterized by an improved sustainability status. However, sustainability principles are often accompanied by reduced farm productivity. This study examined the impact of organic and Roundtable on Sustainable Palm Oil (RSPO) certifications on the production frontier and efficiency of smallholder farmers in Ghana.

In particular, the study analyzed how participation in certification schemes and associated extension services can affect farmers' technical efficiency, and also shift their technological frontier. We employed a stochastic frontier model with an endogenous treatment status and mediator, while addressing endogeneity concerns using two instrumental variables. The model allowed us to capture the direct effects of the certification, and indirect effects through extension services, as well as decompose the treatment effect into technology frontier and inefficiency components.

The empirical results revealed that both certification schemes exert negative overall effects on crop yield. The indirect effects associated with certification appear to counteract these effects, implying that both certification schemes are accompanied by the provision of relevant extension services that improve the managerial skills of farmers. These findings suggest, that extension services provide relevant information on how to overcome production limitations that are imposed by the certification itself, and thus minimize yield gaps caused by its restrictions. However, the mediated effects of extension service do not appear to fully compensate for the losses from certification. The results also revealed considerable heterogeneity among farmers, in the sense that the framework within which they join certification schemes is quite broad, resulting in lower predictability in yields and farm investments. Nevertheless, farmers under both certification schemes enjoy substantial economic benefits through improved net farm revenues, which serve as incentive for farmers to join certification schemes.

Implications to be derived from the results, especially for sustainable agriculture, are that even if the overall welfare of farm households can be increased via participation in sustainable food systems, increased environmental damage may occur in the case of increased demand for sustainably certified palm oil products, resulting in expansion of production and cultivated area. This finding calls for policy makers to promote good extension services and implementation of management practices that can effectively help in reducing yield gaps and increasing output without expansion in cultivated area.

References Chapter 4

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Appendix Chapter 4

Table 4.A1 Adoption with Mediation – (Weighted Nonlinear Least-Squares) – Net Farm Revenue (GHS/Metric Ton) – RSPO Certification

	Adopters ^M		Adopters ^N	
	(d, M(d')) = (1, 1)		(d, M(d')) = (1, 0)	
Variables	Coeff.	(S.E.)	Coeff.	(S.E.)
Frontier function (<i>h</i>)				
Age	0.007	(0.012)	-0.003	(0.013)
Female	-0.148	(1.724)	-1.170	(2.918)
Farm size	0.637***	(0.243)	1.287***	(0.163)
Education	0.969***	(0.302)	-0.954**	(0.379)
Palm oil farm age	0.034	(0.281)	0.327	(0.248)
Labor	-0.001	(0.003)	-0.039***	(0.009)
Credit constraint	-1.533***	(0.522)	-3.693	(5.134)
Distance to market	-0.221*	(0.122)	-0.610***	(0.228)
Improved variety	1.030*	(0.621)	0.304	(0.369)
Erosion	-0.039**	(0.035)	0.076	(0.105)
Joint management	-1.956	(0.987)	-0.930	(0.676)
Off-farm Income	-1.163	(2.219)	1.610**	(0.751)
Property rights	0.804	(1.008)	2.948**	(1.203)
Kwaebibirem	0.068	(0.472)	-2.390	(3.067)
Mpohor	-0.276	(0.751)	1.099	(0.754)
Tarkwa Nsuaem	-0.372	(4.575)	2.949**	(1.397)
Const.	0.019	(0.732)	0.823	(0.574)
Inefficiency function (<i>g</i>)				
$\beta_{(AMS)}^g$	-0.689*	(0.464)	-1.330***	(0.165)
$\beta_{(0)}^g$	1.804**	(0.730)	1.645***	(0.146)
Number of obs.	158		159	

Note: ***, **, and * are 1%, 5%, and 10% level of significance; Values in brackets are bootstrapped robust standard errors. Columns one and two represent farmers who participate in the extension program and participate in RSPO certified farming (i.e. Adopters^M = Mediated-Adopters, abbreviated as (MA)) and farmers who participate in RSPO certified farming but not in extension programs (i.e. Adopters^N = Non-Mediated-Adopters, abbreviated as (NM-A)), respectively. $\beta_{(0)}^g$ represent estimates of the non-negative inefficiency parameter vector that did not control for the implementation of recommended agricultural management strategies and $\beta_{(AMS)}^g$ represent estimates of the non-negative inefficiency parameter vector that controlled for the implementation of recommended agricultural management strategies.

Table 4.A2 Adoption with Mediation – (Weighted Nonlinear Least-Squares) – Net Farm Revenue (GHS/Metric Ton) – RSPO Certification

	Non-Adopters ^M		Non-Adopters ^N	
	(d, M(d')) = (0, 1)		(d, M(d')) = (0, 0)	
Variables	Coeff.	(S.E.)	Coeff.	(S.E.)
Frontier function (<i>h</i>)				
Age	-0.014	(0.015)	-0.001	(0.019)
Female	-0.444	(1.017)	0.026	(2.301)
Farm size	0.015	(0.328)	-0.538	(0.909)
Education	0.009	(0.517)	0.071	(0.546)
Palm oil farm age	-0.353	(0.717)	-0.874	(0.687)
Labor	-0.002	(0.004)	0.008	(0.027)
Credit constraint	-0.015	(1.099)	-0.019	(0.763)
Distance to market	-0.063	(0.210)	-0.236	(0.799)
Improved variety	0.536*	(0.290)	0.687*	(0.489)
Erosion	-0.040	(0.098)	0.073	(0.145)
Joint management	0.001	(1.609)	1.618	(3.060)
Off-farm Income	0.705	(1.120)	-0.247	(1.617)
Property rights	0.322	(0.279)	-0.135	(1.157)
Kwaebibirem	-0.397	(0.357)	0.955	(0.743)
Mpohor	-1.501	(2.310)	1.102**	(0.483)
Tarkwa Nsuaem	0.251	(0.848)	0.541	(1.614)
Const.	4.295**	(1.778)	3.817	(3.700)
Inefficiency function (<i>g</i>)				
$\beta_{(AMS)}^g$	-1.087***	(0.297)	-2.025***	(0.494)
$\beta_{(0)}^g$	1.150**	(0.450)	1.761***	(0.524)
Number of obs.	133		133	

Note: ***, **, and * are 1%, 5%, and 10% level of significance; Values in brackets are bootstrapped robust standard errors. Columns one and two represent farmers who participate in the extension program and do not participate in RSPO certified farming (i.e. Non-Adopters^M = Mediated-Non-Adopters, abbreviated as (M-NA)) and farmers who neither participate in RSPO certified farming nor in extension programs (i.e. Non-Adopters^N = Non-Mediated-Non-Adopters, abbreviated as (NM-NA)), respectively. $\beta_{(0)}^g$ represent estimates of the non-negative inefficiency parameter vector that did not control for the implementation of recommended agricultural management strategies and $\beta_{(AMS)}^g$ represent estimates of the non-negative inefficiency parameter vector that controlled for the implementation of recommended agricultural management strategies.

Table 4.A3 Adoption with Mediation – (Weighted Nonlinear Least-Squares) – Net Farm Revenue (GHS/Metric Ton) – Organic Certification

Variables	Adopters ^M		Adopters ^N	
	(d, M(d')) = (1, 1)		(d, M(d')) = (1, 0)	
	Coeff.	(S.E.)	Coeff.	(S.E.)
Frontier function (<i>h</i>)				
Age	-0.008*	(0.004)	0.024	(0.018)
Female	-6.430*	(3.446)	-2.318	(37.633)
Farm size	0.031	(0.362)	-0.534**	(0.239)
Education	1.040***	(0.023)	0.982***	(0.093)
Palm oil farm age	0.279**	(0.124)	0.840***	(0.172)
Labor	-0.005	(0.005)	-0.033	(0.028)
Credit constraint	-2.133	(1.491)	-5.543**	(2.430)
Distance to market	-0.533	(0.651)	-1.019	(0.904)
Improved variety	1.009***	(0.205)	0.632	(1.506)
Erosion	-2.095***	(0.454)	-1.869***	(0.666)
Joint management	1.201	(3.174)	13.721	(69.605)
Off-farm Income	-0.018	(0.114)	-0.151	(0.292)
Property rights	0.830	(0.725)	0.370	(0.890)
Asuom	-1.051	(1.817)	-1.293	(2.146)
Abaam	-1.491	(1.423)	-2.604	(2.449)
Abodom	-1.329	(1.751)	-36.240	(52.412)
Tweapease	0.948	(4.246)	2.260	(3.734)
Const.	0.850***	(0.251)	-0.304	(0.640)
Inefficiency function (<i>g</i>)				
$\beta^g_{(AMS)}$	-0.873***	(0.251)	-1.300***	0.262
$\beta^g_{(0)}$	2.585***	(0.779)	2.385***	0.317
Number of obs.	109		109	

Note: ***, **, and * are 1%, 5%, and 10% level of significance; Values in brackets are bootstrapped robust standard errors. Columns one and two represent farmers who participate in the extension program and participate in organic certified farming (i.e. Adopters^M = Mediated-Adopters, abbreviated as (MA)) and farmers who participate in organic certified farming but not in extension programs (i.e. Adopters^N = Non-Mediated-Adopters, abbreviated as (NM-A)), respectively. $\beta^g_{(0)}$ represent estimates of the non-negative inefficiency parameter vector that did not control for the implementation of recommended agricultural management strategies and $\beta^g_{(AMS)}$ represent estimates of the non-negative inefficiency parameter vector that controlled for the implementation of recommended agricultural management strategies.

Table 4.A4 Adoption with Mediation – (Weighted Nonlinear Least-Squares) – Net Farm Revenue (GHS/Metric Ton) – Organic Certification

	Non-Adopters ^M		Non-Adopters ^N	
	(d, M(d')) = (0, 1)		(d, M(d')) = (0, 0)	
Variables	Coeff.	(S.E.)	Coeff.	(S.E.)
Frontier function (<i>h</i>)				
Age	0.011	(0.009)	0.006	(0.005)
Female	-0.895**	(0.424)	0.831*	(0.363)
Farm size	-0.001	(0.040)	-0.444	(0.325)
Education	0.014	(0.013)	0.019	(0.026)
Palm oil farm age	0.531***	(0.135)	-0.460*	(0.218)
Labor	0.005	(0.004)	0.001	(0.001)
Credit constraint	0.896*	(0.546)	-0.580***	(0.138)
Distance to market	-0.141*	(0.079)	-0.584**	(0.251)
Improved variety	-0.039	(0.268)	-0.340***	(0.123)
Erosion	0.312***	(0.061)	0.741**	(0.357)
Joint management	-0.680	(0.664)	0.371	(0.288)
Off-farm Income	0.084**	(0.041)	-0.046*	(0.027)
Property rights	-0.323	(0.259)	-0.114	(0.123)
Asuom	-25.002*	(13.651)	-0.701***	(0.250)
Abaam	-0.739	(48.745)	-0.758**	(0.321)
Abodom	0.332	(0.373)	-1.407**	(0.554)
Tweapease	1.012	(7.099)	-0.965**	(0.503)
Const.	0.053	(1.252)	5.423***	(0.979)
Inefficiency function (<i>g</i>)				
$\beta^g_{(AMS)}$	-1.245***	(0.161)	-1.890***	(0.135)
$\beta^g_{(0)}$	1.208***	(0.239)	1.557***	(0.361)
Number of obs.	133		133	

Note: ***, **, and * are 1%, 5%, and 10% level of significance; Values in brackets are bootstrapped robust standard errors. Columns one and two represent farmers who participate in the extension program and do not participate in organic certified farming (i.e. Non-Adopters^M = Mediated-Non-Adopters, abbreviated as (M-NA)) and farmers who neither participate in organic certified farming nor in extension programs (i.e. Non-Adopters^N = Non-Mediated-Non-Adopters, abbreviated as (NM-NA)), respectively. $\beta^g_{(0)}$ represent estimates of the non-negative inefficiency parameter vector that did not control for the implementation of recommended agricultural management strategies and $\beta^g_{(AMS)}$ represent estimates of the non-negative inefficiency parameter vector that controlled for the implementation of recommended agricultural management strategies.

Chapter 5

Towards holistic sustainable development within the framework of the Sustainable Development Goals: Reducing inequalities and empowerment of gender equality.

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Abstract

To achieve holistic, sustainable development in line with the Sustainable Development Goals (SDGs), it is crucial to consider all, oftentimes conflicting, dimensions of the SDGs when designing development policies or sustainable food systems. In this essay, we specifically examine SDG 5, *Gender Equality*, and SDG 10, *Reduced Inequalities*, as these goals least hinder or even promote the achievement of other SDGs. Inequality takes various forms and affects individuals, groups, regions, and nations worldwide. Despite declining global poverty levels, significant disparities persist, particularly in sub-Saharan Africa. Gender inequalities in developing countries' agricultural sectors hinder socio-economic development by limiting women's access to resources. Strengthening access to land, inputs, and credit for women would enhance productivity and alleviate hunger. Strong institutions, based on the rule of law, play a crucial role by providing access to resources and legal structures. Weak institutions exacerbate vulnerabilities, especially in disaster-prone regions burdened by poverty and inequality. Climate change, driven by industrialized countries, worsens global inequality, disproportionately impacting the poorest nations. Sub-Saharan Africa faces threats to crop yields and livestock farming due to increased temperatures, emphasizing the importance of adopting climate-smart practices. Strengthening education and extension services in affected regions is crucial for adaptation. Addressing global inequality and negative impacts requires local and global efforts, and embracing policies aligned with global goals holds significant potential for positive outcomes.

Keywords: gender equality, inequalities, sustainable development goals, institutional economics, climate change

5.1 Introduction

Realizing holistic sustainable development in the sense of the Sustainable Development Goals (SDG) also requires that all aspects, i.e., as many sub-items of the SDGs as possible, are taken into account when designing development policies or providing development aid. The sometimes conflicting goals of the various SDGs pose one of the greatest challenges to the development process. A recent study by Pham-Truffert et al. (2020) describes the positive and negative interactions of the various SDGs. It becomes evident that especially with regard to the reduction of hunger or poverty or the provision of energy, there are a number of conflicting goals, e.g., with environmental factors. In this essay, we focus specifically on SDG number 5, *Gender Equality*, and SDG number 10, *Reduced Inequalities*, as these two goals have been shown to be among the goals that least hinder or even promote the achievement of other goals. At the same time, the achievement of other goals is only to a very limited extent, if at all, an obstacle to the aforementioned goals (Pham-Truffert et al. 2020). It can therefore be argued that striving to achieve these goals has almost exclusively positive effects on the development of the economic and ecological world and is particularly worthy of support as it is an indispensable part of holistic sustainable development.

Inequality comes in many different forms and facets and affects people all around the globe. Tackling inequality on a global scale is a defined goal of the United Nations (UN) and set out in the Millennium Development Goals (United Nations 2000). The subsequently formulated SDGs from 2015 even dedicate two of the 17 SDGs to this topic (United Nations 2015b). The respective goals are specified in SDG 5 “Achieve gender equality and empower all women and girls” and SDG 10 “Reduce inequality within and among countries”. As the very wording of these goals already implies, inequality occurs between individuals, groups of individuals, or even regions and entire nations. Good or even very good progress has already been made on some SDGs, and many countries such as Finland, Slovenia or Poland are on a good path to at least getting close to the targeted goals. This describes the urgency of addressing the issue of inequality in a targeted and focused manner, as global progress in these areas is rather sobering or not even measurable (Sachs et al. 2021a). Especially with regard to access to

agricultural markets, global supply chains, access to agricultural inputs, land and property rights. In addition, there are more obvious inequalities such as income inequality, wealth inequality, or unequal access to education, food and health care services. An overwhelming list that could go on and on, at the end of which stands the fact that the life of people and their ability to make determined choices in life is dependent on their place of birth and residence, their sex and gender, their ethnicity, the economic and environmental situation of the region they live in, religion, social norms and countless other factors. The SDGs that address inequality should be central to this consideration, as they are in a reciprocal relationship with many of the 17 SDGs. For example, "No Poverty", "Zero Hunger" or "Good Health and Well-Being" can only be ensured if access to food, financial and health-care services, property rights or jobs and education is provided to all members of a society. At the same time, of course, the goals go hand in hand, considering that the reduction of climate change (SDG 13) or even the protection of life under water (SDG 14) very much benefit people in the poorest and hardest hit regions (e.g. UNFCCC 2020). This paper focuses on where, with regard to the agricultural and food sector, problems of inequality can lead to serious economic, environmental or social consequences and how – in the spirit of the previous thesis chapters – different market participants around the globe can contribute to achieving the desired goals of the SDGs. When we look at developing countries, we place a special focus on sub-Saharan Africa. The rest of this chapter is structured as follows. In Section 1, we describe different forms of inequality how they can be measured, and give a general global overview over the subject. Section 2 focusses on gender-related inequalities in agriculture, especially in developing countries. Section 3 deals with the impact of climate change on inequalities. In Section 4, we discuss how inequalities of industrialized and developing countries are intertwined, and why it is therefore necessary to mitigate them in all societies. Section 5 concludes our research. We would like to emphasize here that our paper cannot address all forms of inequality. We focus on inequalities that play a major role in the agricultural and food sector in developing as well as industrialized countries.

5.2 Facets of Global Inequality: An Overview

One of the most common instruments to measure and compare income or wealth inequality on a global scale is the use of the Gini coefficient or Gini index. According to World Bank data, ever since the 1990s and an increasing global economic integration, worldwide inequality is declining for the first time since the industrial revolution (World Bank 2016). For example, the global Gini index has fallen from 0.8 in 1988 to 0.65 in 2013, representing a reduction in global income inequality. Nevertheless, this situation must still be described as far from equality, since even with the reduction described, global income is distributed rather unequally. According to the UN, reducing inequalities means that all human beings deserve the same chances to get good education, work at decent jobs, and obtain quality health care. Equality is important as, in the long run, it benefits not only those population groups and regions of the world that are severely threatened by inequality, but the world population as a whole. The consequences of inequality are as diverse as inequalities themselves. Individuals who suffer from inequality in access to education, for example due to their gender, not only have fewer opportunities for higher-quality professions, but valuable potential for human capital formation is also deprived or withheld from regional and global markets which in turn can harm the entire economy, not just the poorest (Kabeer and Natali 2013) as well as sustainable agricultural development (Wekesah et al. 2019). Furthermore, without access to capital, people and nations are less able to invest in new technologies, which slows down the ecologically sustainable development of economies and can result in massive environmental damage (Teklewold et al. 2013). In addition to hunger, unequal distribution of land, unsecured property rights, and inadequate access to food can lead to (land) conflicts and deforestation and vice versa (Puppim de Oliveira 2008), resulting in reduced agricultural output and food availability, and consequently increased migration and refugees. Both of these potential sources of problems may, in turn, lead to refugee movements to so-called developed countries, with lower levels of inequality, which can put massive pressure on their aid and welfare systems (e.g. Black 2018; Maretti et al. 2019). But the United Nations have recognized the urgency of any kind of equality and equity and has integrated it into the goals to be achieved.

Through successful international collaborative efforts, such as the pursuit of the MDGs and SDGs, the downward trend of the global Gini Index goes hand in hand with the reduction of global poverty. Figure 5.1 shows a strong downward trend in the number of people worldwide living below the absolute poverty line of \$1.90 per day. However, even though the global community has been able to reduce extreme hunger and poverty worldwide, this image should not deceive and distract from the massive inequalities that nevertheless exist. This is because different regions of the world have by no means enjoyed the same development success. For example, as illustrated in Figure 5.2, despite the downward trend in all regions of the world, significant disparities are found between sub-Saharan Africa and the rest of the world. It is clear that this part of the African continent in particular is not benefiting from economic development and divergent trends to the same extent as, for example, South and East Asian countries. More specifically, the World Bank states that “poverty reduction has been too slow in Sub-Saharan Africa for global poverty to reach the 2030 goal” and that “Extreme

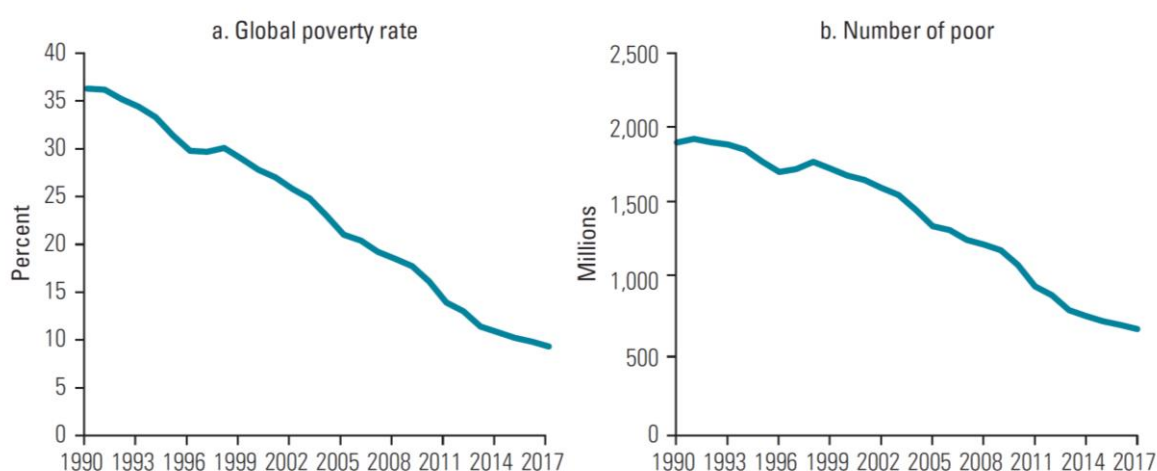


Figure 5.1 Global Poverty Rate and Number of Poor at the US\$1.90 per Day Poverty Line, 1990-2017

Source: Poverty and Shared Prosperity 2020, World Bank, Washington, DC

poverty is predicted to become increasingly concentrated in the region” (World Bank 2020). This assessment further illustrates the strict interaction of different SDGs. Although poverty reduction is well on track across the globe, it is still a drastic problem for many parts of the world’s population in the context of inequality especially because this type of extreme poverty occurs almost exclusively in countries of the global South. It is obvious that income or wealth poverty may not only lead to an

inferior nutritional status but also to a living situation with inadequate housing, limited or no access to health-care services and education and a reduced capability to make decisions on one's own place of residence. World Bank data further reveals that the monetary poverty headcount ratio is strongly correlated with their multidimensional poverty measure which includes indicators such as access to education and basic infrastructure, making monetary poverty one of the major, but not the only focus point to fight inequality (World Bank 2020).

Other multidimensional indicators also paint a picture of an unequal world. The widely used Human Development Index (HDI) is currently at a global average of 0.737 (minimum 0, maximum 1). The index combines the indicators "life expectancy at birth", "expected years of schooling and mean years of schooling" and "gross national income per capita". Global inequality becomes evident when looking at the variation of HDI values. Norway, for example, is currently at the top of the table with a value of 0.957, while Niger brings up the rear with a value of 0.394 and again, HDI values below 0.5 are found almost exclusively in sub-Sahara-African countries (United Nations Development Programme 2020b).

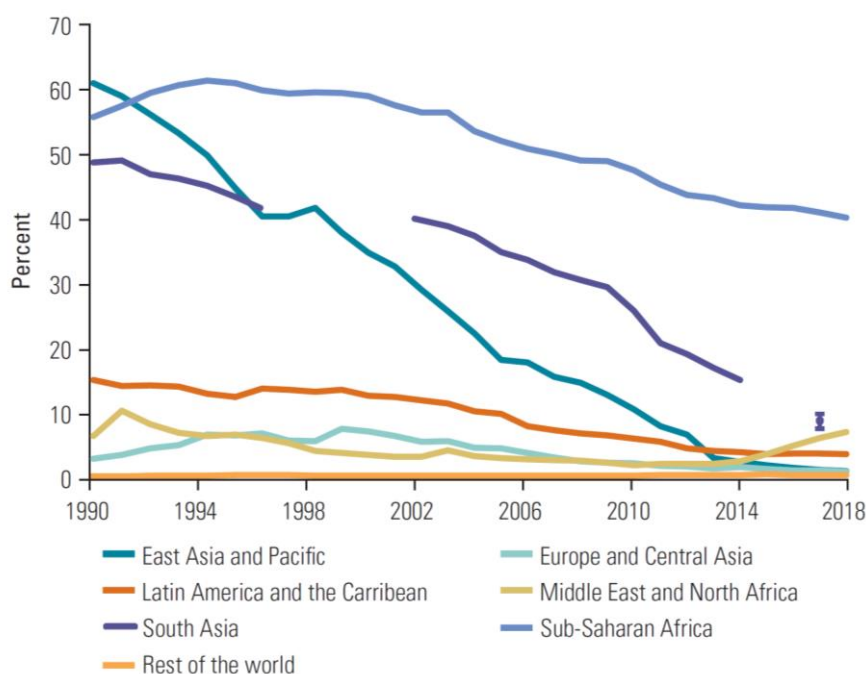


Figure 5.2 Trends in Poverty Rates at the US\$1.90 per Day Poverty Line, by region, 1990 - 2018

Source: Poverty and Shared Prosperity 2020, World Bank, Washington, DC

Inequality becomes even more evident when, in addition to income and human development, international responsibility with regard to environmental and climate damage is taken into consideration. In addition to the HDI, the Sustainable Development Index (SDI) also considers CO₂ emissions and the material footprint of a country. Unfortunately, it is evident that countries which are traditionally classified as developed countries are on a particularly worrying path, i.e., they are consuming significantly more resources than considered to be "fair" or appropriate in a global context (Hickel 2020). As part of its own SDGs, the UN also publishes SDG Index scores that enable the development of countries to be compared with each other and over time. The highest rank is held by Finland with 85.90 out of 100. At the bottom of the UN's list is the Central African Republic, with a score of 38.27 (Sachs et al. 2021a). Again, it is extremely important to note that the industrialized countries (Central Europe, North America, Australia) are consistently on a better path to achieving the Goals. However, at the same time, they are also responsible for the majority of negative spillovers (Malik et al. 2021; Sachs et al. 2021a). It is stated that shifting production to other countries can counteract national measures to mitigate climate change, thus negating or camouflaging perceived successes in decoupling impacts from economic growth (Wiedmann and Lenzen 2018). For example, UN spillover data primarily identifies Europe, North America, Australia, and a few other countries as the main contributors to CO₂ emissions embodied in imported products and services (Sachs et al. 2021b). Other studies confirm this relationship for nitrogen pollution and international trade (Oita et al. 2016). This fact illustrates how, due to their consumption patterns, economically better positioned countries are often responsible for more environmental damage than production in their own country causes.

The 2021 Multidimensional Poverty Index (MPI) report breaks down inequalities caused by ethnicity, caste and gender directly. The index is formed by three defined dimensions of poverty. Health, education and standard of living form the cornerstones of the index. They are measured by the indicators nutrition, child mortality, years of schooling, school attendance, cooking fuel, sanitation, drinking water, electricity, housing and assets (Alkire et al. 2021). The most recent 2021 report

presents - also under the influence of the global pandemic - a still persistent, strict linkage between inequality and multidimensional poverty. It states that disparities across ethnic and racial groups are greater than disparities across subnational regions, and that nearly two-thirds of multidimensionally poor people live in households in which no female has completed at least six years of schooling. Furthermore, half of the people suffering from multidimensional poverty are children under the age of 18 (Alkire et al. 2021). This indicator also reflects the picture of an unequal world with clear linkages to South Asia and especially Sub-Saharan Africa. In fact, it is these two regions that are home to about 85 percent of the world's population living in multidimensional poverty. It is important to consider multidimensionality in order to expose the different facets of poverty and inequality. According to the Global Multidimensional Poverty Index 2021 in Pakistan, for example, only 4.4 percent of all people live in monetary poverty. However, the picture worsens if one considers that about 38 percent live in multidimensional poverty, i.e., they are denied access to education or clean drinking water. For those countries for which relevant data is available, the MPI shows that the disparity in terms of race, ethnicity, or caste, with scores ranging from 0.00 to 0.70, is wider than all other disaggregations. And once again, countries in sub-Saharan Africa perform particularly poorly, also in the within-country comparison. The reason is that most of the largest differences in the incidence of multidimensional poverty across ethnic groups are to be found in these countries. Focusing on gender-related effects, the 2021 Report reveals that female-headed households have on average larger MPI values than male-headed households and that a lower MPI is associated with a higher rate of intimate partner violence against women and girls (Alkire et al. 2021).

But inequalities within countries are not only a problem of developing countries, which already suffer from global inequalities between countries. Massive inequalities of all kinds can also be found within industrialized countries. And they also play a crucial role in addressing global inequalities. OECD data indicate that between 1985 and the 2010s, the top 10, 1, and especially 0.1 percent had significantly stronger economic growth than the bottom 40 percent. To the point that low-income earners faced falling real incomes in some cases. The OECD expresses concern that when a large segment of the

population benefits little from overall economic growth, tendencies of skepticism toward established institutions may emerge (OECD 2015). Such tendencies are most certainly reflected in the current political picture of industrialized countries, where right-wing and “anti-establishment” parties are becoming increasingly popular. The OECD stresses that four main aspects should be focused on in order to expect a double dividend from economic growth. Sustainable growth and reduction of inequality. Namely, these four focus points are women’s participation in economic life, employment promotion and good-quality jobs, skills and education, and tax-and-transfer systems for efficient redistribution (OECD 2015). It is evident how these points are directly related to the SDGs. At the same time, these focus points illustrate once again how interwoven the various SDGs are and how they are mutually dependent. The above-mentioned OECD report (2015) highlights how unequal participation in economic growth can prevent the poorer part of the population from being able to invest in their own future, i.e., their own education and skills, in order to free themselves from this situation. Greater income inequality thus entails inequality in terms of opportunities for personal development.

One can very well imagine the negative cycle of effects of inequality that link inequalities of industrialized countries with those in developing countries. People with unequal opportunities for education, good jobs and therefore good pay in industrialized countries, are only to a limited extent able to take fair or sustainable production methods into consideration when making consumption decisions due to their tight budgets. The negative consequences of these decisions are often to be found in developing countries, where people in turn suffer from environmental or health problems as a result of less stringent environmental regulations. At the same time, the possibility that, for example, a higher wage is paid to plantation workers or social projects in the region are promoted via initiatives such as Fair Trade is eliminated. This is just one example of how social inequality can further contribute to the perpetuation of inequalities in other regions of the world by forcing people to buy products that are not fairly produced.

Thus, regardless of their native region, people are forced to make certain choices because of certain inequalities, or are unable to make free choices about their own lives. This principle can be applied to

discuss for example differences between the global North and South but also to discuss gender inequalities within countries and regions (SDG 5). Potential reasons for inequalities between men and women are further highlighted in the next chapter. Nonetheless, we would like to point out here that in accordance with SDG 5, we highlight gender disparities at this point, as women often face increased restrictions in their decision-making processes, e.g., due to social norms and constrained rights or entitlements. Addressing this type of inequality - i.e. the reduced ability to make free (economic) decisions about one's own life - is not only defined in SDG 5 but is also an established sub-goal of SDG 10 (United Nations 2015b). Common measures developed by the United Nations Development Programme to globally measure such development and inequalities are the HDI, the Gender Development Index (GDI), the Gender Inequality Index (GII), the Gender Social Norms Index (GSNI), the Inequality-adjusted Human Development Index (IHDI) or even the Planetary pressures-adjusted Human Development Index (PHDI), introduced in 2020, which seeks to reveal global inequalities in terms of planetary pressure and will be elaborated on later. We now focus on the GDI, GII and the GSNI to highlight global gender inequalities. The GDI is directly based on the HDI and defined as an instrument that "[...]measures gender gaps in human development achievements by accounting for disparities between women and men in three basic dimensions of human development—health, knowledge and living standards using the same component indicators as in the HDI" (United Nations Development Programme w.d.a). The GDI shows the scope of the gap between women and men and the extent to which women need to catch up in every dimension of human development. The GII measures gender inequalities in three aspects of human development: reproductive health, as measured by maternal mortality rates and adolescent birth rates, thus, it includes factettes of SDG 3 (Good Health and Well-Being); empowerment, as measured by the share of parliamentary seats held by women and the share of adult women and men aged 25 and older who have at least a secondary school diploma, again, the index includes factettes of SDG 4 (Quality Education); and economic status, expressed as labor market participation and measured by the labor force participation rate of the female and male population aged 15 and older (United Nations Development Programme w.d.b). The multidimensional index

serves as a successor to the GDI. The GSNI measures how social beliefs impede gender equality in areas such as politics, work, and education.

From the map shown in Figure 5.3, it is evident that on a global level, the African continent as well as the regions of the Middle and Near East show, based on the GDI, the lowest equality values. It thus follows the inequality trend also illustrated by the HDI. This trend becomes even more apparent if one considers the IHDI, which adjusts the HDI and controls for inequality in education, health and income, accordingly. Data published in the Human Development Report 2020 clearly indicates that the worst IHDI values are mainly found on the African continent (United Nations Development Programme 2020b). Figure 5.4 shows the global Gender Inequality Index. Darker colors indicate a higher GII value, which in turn indicates greater gender inequality. More than in the case of the GDI, the difference between the global North and the global South becomes clear, as South American countries are also increasingly on the spectrum of increased inequality. Even though the indices we have just presented all portray a similar picture, they are not able to show what causes these gender disparities. This is where the GSNI comes in, trying to decipher "how social beliefs obstruct gender equality in areas like politics, work, and education" (United Nations Development Programme w.d.c). The 2020 Human Development Perspectives Report (UNDP) describes a social phenomenon whereby approximately 90 percent of men and women are biased against women, providing new evidence of the invisible barriers women face in achieving equality (United Nations Development Programme 2020c). The literature claims that these invisible barriers are primarily based on social norms (Galván and García-Peñalosa 2018). To illustrate this, the UNDP report provides the example that there are 50 countries in which women have a higher average educational status than men. Nevertheless, they still have a 39% lower income than men (United Nations Development Programme 2020c). In its 2015 report, the UN emphasizes that the global situation of women has steadily improved in the second half of the twentieth century. They include remarkable progress in education, where the average primary school enrollment rate is almost the same, and in health, where the maternal mortality rate was reduced by 45% worldwide after 1990 (United Nations 2015a).

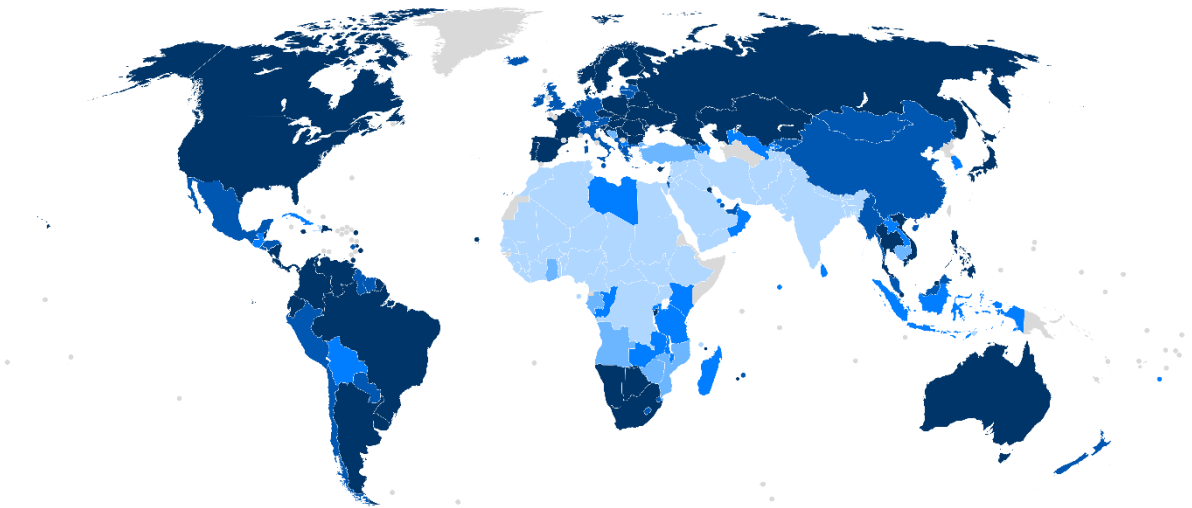


Figure 5.3 Countries by Gender Development Index with the five GDI categories (data as of December 2019)

- Group 1: GDI from 0.9751 = gap below 2.5 % = high equality: 53 countries
- Group 2: GDI from 0.9501 = Gap below 5.0 % = medium-high equality: 39 countries
- Group 3: GDI from 0.9251 = Gap below 7.5 % = medium equality: 22 countries
- Group 4: GDI from 0.9001 = Gap below 10.0 % = medium-low equality: 8 countries
- Group 5: GDI below 0.9001 = Gap from 10.0 % = low equality: 44 countries

Source: Image created under CC BY-SA 4.0, 14. Dec 2019, with Data from Human Development Report (United Nations Development Programme 2019)

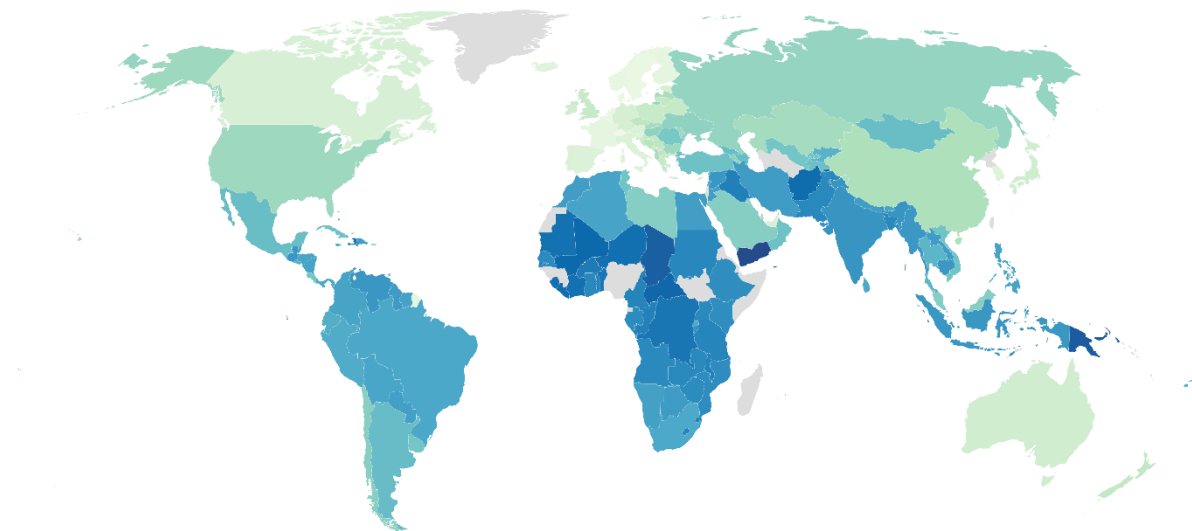


Figure 5.4 Countries by Gender Inequality Index 2019

0.03 0.8 *GII illustrated with linear coloring*

Source: Image created by Author, with Data from Human Development Report (United Nations Development Programme 2020b)

However, progress in other aspects of women's empowerment has been slower, and the process toward gender equality appears to be slowing. The UNDP expresses concern that development may have reached a plateau that cannot be overcome with the efforts and policies applied to date. Thus, there is an urgent need to address social norms and beliefs in order to eliminate prejudiced ideas from society. Based on the GSNI, the UNDP notes that there is no gender equality anywhere in the world. Despite the very good progress mentioned earlier, the average death rate of women during childbirth in sub-Saharan Africa is 20 times higher than in industrialized nations, meaning one in 180 women dies in childbirth. And in most regions, adult women are less educated, have less access to the labor market than men, and lack access to political power. So, once again, it is made clear that gender inequality impacts other areas of human development and threatens progress toward the SDGs (United Nations Development Programme 2020c). The World Economic Forum (WEF) also confirms these findings. In their latest report, they present that their Gender Gap Index (GGI) is trending negatively in terms of closing the gender gap. Instead of improving, the global gender gap situation has fallen back to its 2018 state, i.e., the gap has widened by 0.5 percentage points. The WEF uses their data to calculate how long the process of closing the gap would take if it progressed at current rates. In the current report, this figure has increased to 135.6 years. The authors attribute this development to a widening gender gap in terms of political empowerment, for example, in terms of the share of women in ministerial positions and, just like the UNDP, a plateauing situation in terms of other domains of life just as economic participation and opportunity, education and health (World Economic Forum 2021). There are different facets of capabilities. Basic and enhanced capabilities. This segmentation makes progress visible on the one hand, but on the other hand also shows the problems. On a positive note, women are catching up in basic areas of development. In most countries, legal barriers to gender equality have been removed. Women can vote and be elected, they have access to education, and they can increasingly participate in the economy without formal restrictions. Progress is uneven, however, as women move from basic areas to enhanced capabilities where gaps tend to be larger. The UNDP expresses that women make greater and faster progress where their individual empowerment or social

power is lower (basic capabilities). However, they encounter barriers when it comes to more responsibility, political leadership, and social advantages in markets, social life, and politics (enhanced capabilities) (United Nations Development Programme 2020c). A simple example is political participation. There is almost parity in participation at the entry level of political participation. However, one cannot assume that women (or men) are in major positions of power at this level. When it comes to concentrated political power at stake, women seem severely underrepresented. The higher the power and responsibility, the wider the gender gap - and for heads of state and government, it's almost 90 percent. The proportion of women becomes smaller the more important the position of power becomes (United Nations Development Programme 2020c). For example, women represent only 28 percent of the world's management positions and 12 percent of the top billionaires (ILO 2020; Forbes 2021). The International Labor Organization (ILO) describes the fact that women are not only denied access to certain professions, but also that a rise to the top is often only possible to a limited extent as horizontal and vertical gender segregation of employment. In addition to this effect, the ILO also considers the unequal distribution of unpaid work to be the main driver of inequality in working conditions such as the gender pay gap (ILO 2020). According to UNDP and others, discriminatory social norms and power relations lie at the core of these developments. Galván and García-Peñalosa (2018), for example, find that not only do social norms and expectations play a role in labor market participation, but that having children also reinforces gender-specific employment trajectories. Their findings suggest that the disparities between men and women that already exist before the birth of a child become much greater after the birth of the first child. In order to meet the two norms under consideration, that *males should be a household's main breadwinner*, and the expectation that *women will do most of the childcare*, women who earn less, as well as those who earn more than their husbands, reduce their working hours, and the probability of employment decreases dramatically, while for men, working hours and their probability of employment remain stable after the birth of their first child. Galván and García-Peñalosa (2018) thus define the problem that the social identity norm strongly shapes behavior and takes precedence over considerations of comparative advantage in the

household. This type of behavior is based on expectations, implied by the society in which a person lives. The GSNI attempts to explain these resulting patterns of social behavior through seven indicators in the categories of politics, education, economics, and physical integrity (Mukhopadhyay et al. 2019).

Table one shows how the final index is constructed.

The index reveals that globally, 91 percent of men and 86 percent of women show at least one clear bias against gender equality with respect to the indicators presented in Table 1. About 50 percent of men and women surveyed in 75 countries think men make better political leaders than women, while more than 40 percent think men make better business leaders. Nearly 30 percent of respondents think it is acceptable for a man to beat his partner. The GSNI reveals that women are less biased toward gender equality and women's empowerment than men. Among men, 52 percent have two to four gender biases. Certainly, there are advances as well as setbacks in the development of biases across Nations. Furthermore, the index currently indicates an average increase in gender bias. For example, on the one hand, the greatest progress in the proportion of men without gender bias was observed in Chile, Australia, the United States, and the Netherlands.

Table 5.1 Definition of bias for the indicators of the multidimensional gender social norms index

Dimension	Indicator	Choices	Bias definition
Political	Men make better political leaders than women do	Strongly agree, agree, disagree, strongly disagree	Strongly agree and agree
	Women have the same rights as men	1, not essential, to 10, essential	Intermediate form: 1–7
Educational	University is more important for a man than for a woman	Strongly agree, agree, disagree, strongly disagree	Strongly agree and agree
Economic	Men should have more right to a job than women	Strongly agree, agree, disagree, strongly disagree	Strongly agree and agree
	Men make better business executives than women do	Agree, neither, disagree	Agree
Physical Integrity	Proxy for intimate partner violence	1, never, to 10, always	Strongest form: 2–10
	Proxy for reproductive rights	1, never, to 10, always	Weakest form: 1

Source: Mukhopadhyay, Rivera, C. et al. 2019

On the other hand, a decrease in the proportion of men without gender bias has occurred in Sweden, Germany, India, and Mexico (United Nations Development Programme 2020c).

The reasons for the manifestations of social norms are complex. However, this also means that they can be shaped through various informal as well as formal channels. So, there are various angles for policy makers to approach the issue. Gender-specific norms and experiences, rules and stereotypes are already presented to children through their parents, the social environment or schools (e.g. Bian et al. 2017; Amin et al. 2018; Mackie et al. 2015; Marcus 2018). What it means to belong to a particular gender is learned and internalized based on experiences and encoded messages throughout life and normalized through social structures, culture, and interactions. The negative impacts range from girls and women being the last and least to eat in the household (United Nations Development Programme 2017), to girls being less likely to study subjects such as science, technology, engineering, and mathematics, as well as to early and forced marriages (United Nations Development Programme 2020a). This in turn can lead to women achieving a lower average level of education, thus a lower level of human capital accumulation (Machio et al. 2017). Especially in developing countries, gender norms often result in women being denied access to assets, land, or even finances more than men (e.g. Muñoz Boudet et al. 2013; Buss et al. 2017; Peters et al. 2016). In line with the capability approach (Nussbaum 2012), these limitations imply that an individual is not completely free to choose what to do, what to be or what to become. Personal and also economic developments are thus directly bound to possibilities or restrictions caused, among other things, by social norms. These constraints on free choices probably play an even greater role in rural areas in developing countries, as behaviors in the absence of, for example, social safety nets can often be much more directly related to food security, household income or crop yields.

As we outlined in our global overview, various inequalities exist around the world. From the indicators considered so far, it becomes evident that the African continent, in particular, has benefited least from global developments and, similarly, that there are great inequalities within the countries on the African continent. At the same time, an extremely large number of people on this continent are directly

dependent on agriculture. Therefore, the next section takes a closer look on gender inequalities in agriculture in developing countries.

5.3 Gender-related inequalities in agriculture in developing countries

The Food and Agriculture Organization of the United Nations state that the agriculture sector is not only underperforming in developing countries compared to industrialized countries, but that the fact that women do not have equal access to all kinds of resources and opportunities as men massively exacerbates that problem (e.g. Duflo 2012; Anderson et al. 2018a). They also point out that the problems targeted by the SDGs are mutually reinforcing. For the empowerment of women in agriculture alone could massively reduce hunger and significantly improve dietary diversity (Malapit and Quisumbing 2015; FAO 2011). FAO characterizes the gender gap as the fact that women everywhere face greater constraints than men in accessing productive resources, markets and services, and thereby decreasing their contribution to the agricultural sector and to the achievement of general economic and social development goals. Evidently, this is even more true for developing than for developed countries, where generally far more people contribute to production in the agricultural sector. At the same time, it is often the only source of income for people in rural areas and oftentimes they are completely dependent on agriculture (e.g. World Bank 2021; FAO 2017). The aforementioned FAO report claims that women would be as productive as men if they had equal access to land, inputs, or services. It quantifies the average estimated yield gap per hectare of land between women and men to be 20 to 30% (FAO 2011). However, the FAO (2018) also states that globally, less than 15% of all landowners are women. In the literature, however, values around 5% can also be found, e.g. in North Africa and West Asia (FAO 2011). Due to less secure land rights and landownership, women are less able to provide collateral to obtain credit, which is important for farm, and general economic development. Obtaining agricultural credit is generally a challenge in developing countries, but the percentage of female smallholder farmers who have access to credit is 5 to 10 percentage points lower than for male smallholder farmers (FAO 2011). Furthermore, women more often than men, lack legal documents to prove ownership, their livestock holdings are smaller and they often have less labor

available for farm work. Women are less likely to use purchased inputs such as fertilizer and improved seed, or to use mechanical tools and equipment (FAO 2018, 2011).

Apart from land ownership, in 1995, Udry et al. already argue that within households there is not exclusively cooperation, but also competition over resources such as agricultural inputs. Using plot-level data, they estimate production functions and conclude that intra-household reallocation of resources could increase household output by 10 to 15% (Udry et al. 1995). They thus contradict the paradigm of the pareto-optimal arranged household, in which it is not possible to “rearrange the total resources at the disposal of the household in such a way that all the members of the household are better off” (Udry et al. 1995, p. 410). Many studies conducted since then have concluded that women could be as productive as men if they had the same access to inputs and extension services. This means that a large part of the productivity gap is attributed to lack of access to inputs, extension service, but also insecure land rights or lack of access to land (Alene et al. 2008; Gilbert et al. 2002; Hill and Vigneri 2011; Saito et al. 1994). We would like to draw particular attention to this issue since SDG Goal 5a addresses equal rights to economic resources, specifically equal rights to ownership and control of agricultural land. The literature also provides evidence that secure and improved land tenure rights for women are directly related to child health determinants (Allendorf 2007). Despite such research findings, the FAO points out that women across all developing regions are “less likely to own or operate land; they are less likely to have access to rented land, and the land they do have access to is often of poorer quality and in smaller plots” (FAO 2011, p. 23). Goldstein and Udry (2008) additionally argue that women are more likely to exploit their lands, as the probability of expropriation is also increased in case of non-use or fallow due to their social statuses or, the aforementioned social norms. According to this example, unequal land rights can result in reduced soil fertility and even environmental problems, in other words, property rights can contribute to alleviate poverty, to higher levels of food security to environmental sustainability, and to increased investments in the next generation (e.g. Kumar and Quisumbing 2013; Otsuka et al. 2003; Peterman 2011; Doss et al. 2015). As mentioned in the previous chapter, Peterman (2011) also explicitly points out that the lack of gender equality in sub-

Saharan Africa can hinder not only the economic development of women, but also the economic development of society as a whole (Peterman 2011). The aforementioned social gender norms are strong in rural areas and especially in agriculture, and are responsible for the fact that women are more likely to work in agriculture part-time or as seasonal workers than men. At the same time, they often receive lower wages even though they have the same qualifications (FAO 2011).

Another major factor that plays into the inequality between men and women is the fact that a monetary valuation of reproductive work often does not occur and is thus misrecognized. The FAO (2011) states that women undertake most of the work related to child care, food preparation and other household responsibilities such as collecting fuel and water or unpaid agricultural production, resulting in working more hours daily than their male counterparts. Because of women's socially determined responsibilities, it is often difficult for them to make free decisions about individual goals on the basis of their own capabilities, which in turn partly explains the results of the indicators discussed in the previous chapter.

As in Goldstein and Udry (2008), for example, the circumstances just described are often used to explain the gender gap in land productivity. Especially under the global pressure of a growing world population, losses of fertile land and crop yields due to global warming and soil degradation, it is extremely important to increase the productivity of the available land. We have previously described that there is an estimated productivity gap of about 20 to 30% due to gender-specific access to inputs of all kinds. Closing this gender gap alone could thus efficiently tackle the above-mentioned problems. To examine this in more detail, it is essential to consider plot level data, as the quality and management of the underlying land must be included. Over the past decade, plot-level analyses have been performed with increasing frequency. Thus, it has also become more feasible to assess the productivity of the land actually worked and managed by a particular household member. The comparison of male and female farmers, and their productivity frontiers, is thus more feasible. It has become common to statistically split the gender gap into an endowment effect and an unexplained part, the structural effect (Quisumbing 1996). The endowment effect refers to differences in observable characteristics,

such as access to productive resources, while the structural effect refers to differences in unexplained returns to the inputs. In this context, different authors find varying sizes of gender gaps for different crops and regions. Aguilar et al. (2015) find a productivity difference of 23.4 percentage points in favor of men. They account for gender differences in land manager characteristics, land attributes, and access to resources and find that 13.5 percentage points (57%) still remain unexplained. They imply that differences in returns to extension services, land certification, land expansion, and product diversification may contribute to the unexplained share. Results from Oseni et al. (2015) show that after controlling for observed factors of production, women in northern Nigeria produce 28% less than men. They conclude from their decomposition results that although women have access to fewer productive resources than men, there would still be significant differences in output, even with the same level of inputs. Findings by Slavchevska (2015) suggest that measures to improve women's access to production factors will help reduce the existing gender productivity gap in Tanzania, which she estimates to lie between 14% and 21%. However, these interventions will not be sufficient because returns to productive factors and other unobservable attributes (e.g. soil quality) contribute significantly to widening the gender gap. Policies that allow women to hire especially male labor and relieve them of other time constraints so that they can put more labor into agricultural production will reduce the gender gap. A finding that Scholz (2021) also confirms. The author also points out that the structural disadvantage of women is particularly due to the difference in returns to family and hired labor. In turn, the author attributes these differences to strongly prevailing gender norms (Scholz 2021). Kilic et al. (2015) estimate the mean gender gap in Malawi to be 25.4%. The results support the view that large and significant gender related disparities in input use and asset ownership are the key drivers of the gender gap. In their study, at the median, the difference in observable covariates is associated with 87% of the gender gap. However, Kilic et al. (2015) also find that above the median, the contribution of the endowment effect to the gender gap decreases. At the 90th decile of the distribution of agricultural productivity, the structural effect explains 34% of the gender gap. Among other factors, they explain the structural effect of gender differences in terms of the availability of time

for productive activities. Greater involvement in reproductive work seems to have a negative impact on female-managed plots, thereby reinforcing the structural effect. Many previous studies have also attributed women's lower agricultural productivity levels to increased difficulty in accessing productive resources and opportunities (e.g. Akresh 2005; Horrell and Krishnan 2008; Goldstein and Udry 2008). We would like to point out that the truthfulness of this extremely important literature is in no way to be denied at this point. However, the studies cited above built on the idea that differences in access to inputs cannot fully explain the lower productivity among female managed plots, and they also come to this conclusion.

The fact that the different returns to inputs are driven by factors such as time limitation due to nursing and cooking or the educational level raises the question of whether women could actually achieve the same level of productivity if they were equally endowed with inputs. Scholz (2021) argues that if women produce less than men given the same input and because of the aforementioned constraints, then the two groups should have different production frontiers, or technical efficiency (TE). Generally, agricultural (technical) efficiency is driven by household size, children and elderly in the household, land rights, extension service, the use of inorganic and organic fertilizer, soil quality, age, the number of cultivated crops, education as well as the distance to the next market, i.e., transportation or transaction costs (e.g. Abdulai and Abdulai 2017; Ali et al. 2016; Kinkingninoun-Mêdagbé et al. 2010; Ogundari et al. 2010). Recent findings from Scholz (2021) and Scholz and Abdulai (2021) confirm that strong effects on TE come primarily from education and crop choice, and that, most importantly, gender-specific TEs exist. With regard to the metafrontier, female farmers work at a lower technology level.

Considering that many of these developments and globally prevailing structures are driven by the aforementioned social norms, there must of course also be approaches to solutions and possibly even policy implications. Marcus (2018) argues that while gender norms affect people directly at the household or community level, they are shaped and implemented by the legal and policy framework with strong social impact (Marcus 2018). In this context, studies find evidence that female participation

in traditional as well as local political structures results in women being significantly better educated than in similar regions where only men occupy traditional political structures. Additionally, they have better ownership rights regarding assets and land and greater decision-making power within their households, and better health outcomes (Anderson et al. 2018a, 2018b). Consistent with the literature (e.g. Acemoglu et al. 2001), Anderson et al. (2018b) describe that development is achieved through the provision of better institutions. However, these institutions, whether formal or informal, must incorporate gender equity in the process. Thus, a greater representation of women in political institutions also improves the institutions that depend on decisions carried out by political institutions.

5.4 Sustainable development and the role of institutions

In both research and policy, it is well recognized that strong institutions also play a key role in achieving the SDGs. Such a central role that they are even assigned a dedicated section within the goals (United Nations 2015b). Despite the fact that we do not aim at focusing on goal number 16 in this paper, the role of institutions is particularly important with regard to the goals related to equality and equity. After all, equality implies equal access to the central and trust-giving structures of a state and society. Various aspects of good governance, measured for example using indicators such as participation or adoption of democratic institutions, must unfold an equally positive impact on all members and groups within a society. As discussed in the previous section, a prominent example is access to resources, such as land rights, which is massively affected by gender inequity, especially in developing countries (e.g. World Bank 2021; FAO 2017). However, in order to provide equal access to strong institutions, strong institutions have to exist in the first place. Studies show that the existence of democratic institutions, participation, economic power, and education play a major role in achieving the SDGs (Glass and Newig 2019). Prominent literature in this research area categorizes poverty on the African continent as a classic problem of institutional economics. Acemoglu and Robinson (2010) argue that citizens in a diverse range of roles within a state do not perceive institutional incentives that could drive development in a different direction. Rodrik et al. (2004) attribute primacy to economic institutions in contributing to development, among other reasons, since other arguments, e.g., based on geography

or climate, do not withstand empirical scrutiny. In order to create inclusive economic institutions, centralized states had to (and still have to) be established, especially on the African continent, which at their core are not absolutist and patrimonial, but also inclusive (Acemoglu and Robinson 2010).

Institutions as a framework and directional guide for behavior within a society, as well as in an economy, can provide certainty that makes economic activity attractive, profitable and thus promotes investment behavior and development. Rodrik et al. (2004) emphasize the importance of impact channels that link, first, integration and income levels and, second, integration and functioning institutions. Furthermore, they outline that the relationships between channels such as Rule of Law and GDP per capita are of particular importance, as they reflect how the quality of legal institutions is positively related to the development of a country.

Legal institutions such as property rights play an essential role, especially with regard to agricultural activity. Property rights structure the incentive framework for the use of resources. They consist of formal and informal rules and rights for use, but also transfer of ownership or rights. The rights can take different forms. A private person may hold the right and title or the good or environmental service may be a public good (e.g. Alston et al. 2018). Thus, property rights constitute a tool to define a demarcation between permitted and unpermitted actions with respect to a good. Important in defining property rights is the authentic documentation of the property (Heinsohn and Steiger 2008). Exclusive rights of use in particular strengthen the incentive to invest new capital in an asset, since an investment may increase the value of the asset, e.g., land, and also the income from the use of the improved asset. Private land ownership represents an illustrative example in this context. Investing in fertilizers or other agrochemicals can increase yields to the extent that an increasing farm surplus may be available for reinvestment after the harvest period. When uncertainties regarding property rights arise, a farmer will carefully consider whether or not to invest. If his or her land title is not legally secured, so that he or she has to reckon with a permanent loss, he or she will not make any investment efforts (Alston et al. 2018). Without enforcement of the law, there will be little to no investment behavior and hence long-term development. Uncertainty or lack of evidence of ownership is one of

the main reasons why credit is not granted and capital cannot be accumulated (Soto 2000). The positive impact of property rights on access to credit, investment, agricultural production, and long-run economic growth is well documented in the literature (Field and Torero 2006; Acemoglu and Johnson 2005; Atwood 1990; Williamson 2011).

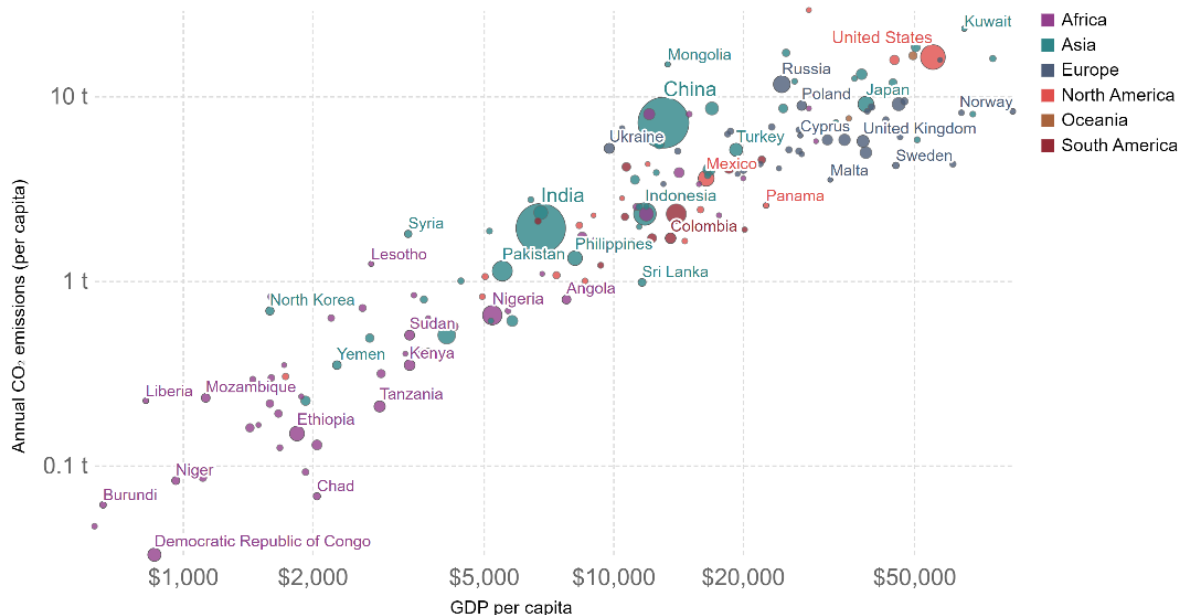
Inclusive political and economic institutions, such as property rights and access to education, are contrasted with extractive institutions. Controlling cartels, monopolies, and tariffs function in favor of elites. Authoritarian states develop extractive economic institutions, corruption, and (economic) theft. Empirical studies have shown that there are significant correlations between corruption and food insecurity, as increasing corruption increases food insecurity (Yunusa et al. 2018; Anik et al. 2013). However, even within these negative contexts and an understanding of the importance of institutions, there is still room for further inequalities. Studies show that women, and especially women working in rural agriculture, suffer to a greater extent from food insecurity than men (Botreau and Cohen 2019; Gaillard et al. 2022).

Although the focus of this essay is by no means the role of institutions per se, we have provided examples to illustrate how important and, above all, how closely interlinked institutions are with the achievement of the SDGs on which this essay focuses. It should be emphasized that functioning institutions are at the core of functioning communities, states, and economic relations. If fundamental institutions are not functional and do not provide stability for people, it will be difficult for economic and human development to take place. With as well as without equality and equity. Furthermore, not only internal factors but also externally induced and global phenomena can have negative impacts on the development of countries. This is particularly challenging for countries that are already falling behind. In the next section, we would like to illustrate that such issues also, or especially, reinforce global inequalities, and that actions are required from societies that are in a better (economic) position, or that are even major contributors to the global problems.

5.5 Inequality and Climate Change

Oxfam states that climate change is a human-made disaster that is already reversing progress made in the fight against inequality, casting an alarming perspective on the achievements, as well as the future of the SDGs (Oxfam 2021). They state that one of the major problems of this challenge for humanity is that it affects every community and every continent, but the poorest, that is, those who are least responsible for the problem suffer the most. Anthropogenic global warming, which has historically been largely caused by energy production due to the economic behavior of today's industrialized countries, has exacerbated global inequality (e.g. Diffenbaugh and Burke 2019).

This measures CO₂ emissions from fossil fuels and cement production only – land use change is not included. Gross domestic product (GDP) per capita is measured in international-\$ in 2011 prices to adjust for price differences between countries and adjust for inflation.



Source: Our World in Data based on the Global Carbon Project, Maddison Project Database 2020 (Bolt and van Zanden (2020))
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

Figure 5.5 CO₂ Emissions per capita vs GDP per capita, 2018

Figure 5.5 illustrates the relationship between CO₂ emissions and GDP per capita. The color codes also highlight the fact that rich countries in North America and Europe, but also Asia, are responsible for most of today's CO₂ emissions, while the countries of the African continent, which are marked in purple, can be found for the most part in the lower, left-hand area of the figure. This figure is a first indication that there appears to be a problem of inequality, since it is the effects of atmospheric CO₂

and the associated global warming that pose an immediate and increasingly life-threatening threat, especially to the people of the global South.

Diffenbaugh and Burke's (2019) estimates show that not only are most poor countries not sharing equally in the benefits of fossil fuel use, but that there is a greater than 90% probability that GDP per capita is lower today than it would have been without global warming. Due to the phenomenon that global warming can even have positive economic effects in colder countries, i.e., in countries of the global North, and at the same time have increasingly negative effects in countries that are already very warm today, it also becomes clear that a large disparity occurs between the global North and the global South, due to the non-linear relationship between macroeconomic productivity and temperature (e.g. Burke et al. 2015). Naturally, negative effects also occur in regions of the global North, but an additional, massive problem is that poor countries, which often suffer the greater environmental impacts, have significantly fewer resources and mechanisms to cope with and adapt to the negative effects of climate change (e.g. Field et al. 2012). Burke et al. (2015) show that productivity peaks at an annual average temperature of 13.6°C and declines sharply at higher temperatures. They conclude that this relationship is globally generalizable, unchanged since 1960 and applies to agricultural and non-agricultural activities in both rich and poor countries. In this section, we focus more on the impacts and inequalities that arise in the agricultural sector, especially for SSA, since the African continent is stated to be an exposure and vulnerability "hot spot" for climate variability and change impacts (UNFCCC 2020). The reason for the continued focus on the aforementioned poor regions of the world is unfortunately justified by the strong negative correlation found by e.g. Burke et al. (2015) between income and temperature, which suggests that warming may increase global inequality because hot, poor countries are likely to suffer the greatest decline in growth. They estimate that average income in the poorest 40% of countries will decline by 75% by 2100 compared to a world without climate change, while the richest 20% will see slight gains because they are generally cooler. Figure 5.6a, b shows the Change in GDP per capita relative to projection using constant 1980 to 2010 average

temperatures. Section a displays country-level estimates in 2100 and section b displays the effects over time for nine regions.

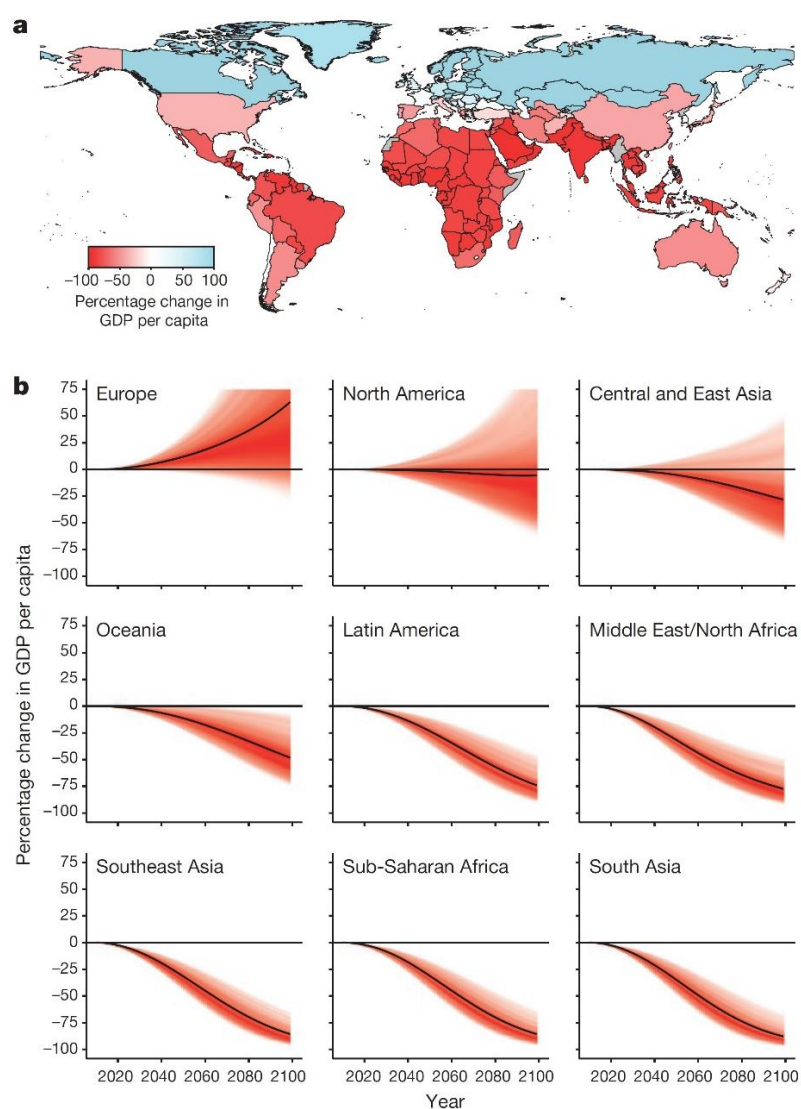


Figure 5.6 Projected effect of temperature changes on regional economies.

Black lines are projections using point estimates. Red shaded area is 95% confidence interval

Source: Burke, Hsiang et al. 2015, 238

Based on the map presented in part a, as well as the trajectories, in part b of Figure 5.6, it is evident that the global temperature increase is exacerbating the predominant patterns of global inequality (compare, e.g., Figure 5.3, Figure 5.4). It is precisely those countries that rely most on smallholder agriculture that face the greatest challenges, as their food security is under imminent threat. In West Africa in particular, people are increasingly at risk of desertification, which in turn reduces crop yields (WMO 2021). Figure 5.7 reveals that average annual temperatures in 2020 on the African continent

were significantly above the 1981 to 2010 mean in almost all regions. Evidence derived from climate data indicates that the warming trend in the 1991 to 2020 period was higher than in the 1961 to 1990

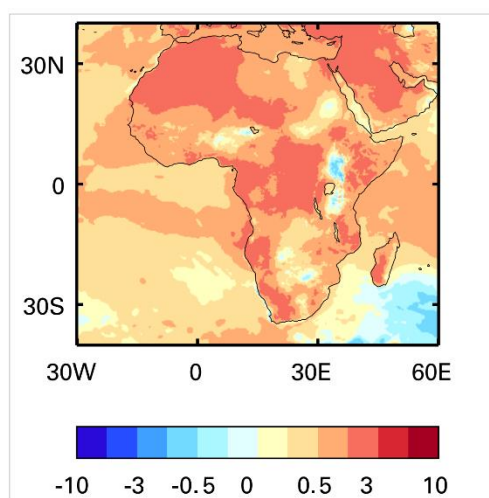


Figure 5.7 Near-surface annual air temperature anomalies relative to the 1981-2010 average, African Continent.

Source: WMO 2021, p. 7, ERA5 data set

period in all African subregions and significantly higher than in the 1931 to 1960 period (WMO 2021). Additionally, climate change impacts in Africa have already increased the frequency and intensity of droughts in many regions and even reduced livestock growth rates and productivity in pastoral systems, with negative implications for food security. For the year 2020, 55 food crises have been identified. Of the 10 worst in terms of number of people in crisis, six were located in Africa (FSIN 2021). In West Africa, rainfall has declined by 20 to 40%,

and the decline in rainfall from the 1970s to the 1990s, for example, caused the savanna zone (Sahelian, Sudanese, and Guinean savanna zones) to shift 25 to 35 km southward, resulting in the loss of grasslands and forests as well as the displacement of local populations. However, ecosystems in West Africa have also been degraded by human activities such as deforestation and soil erosion due to unsustainable agricultural practices, which often interact with climate (Stanturf et al. 2011). Islam and Winkel (2017) describe the relationship between inequality and climate change as a vicious circle. Nearly half of the population in SSA lives below the poverty line and relies on weather-dependent activities such as rain-fed agriculture, livestock farming, and fishing for their livelihoods (Stanturf et al. 2011). The African continent is the most vulnerable, since it is highly dependent on the aforementioned rain-fed agriculture, combined with widespread poverty and weak adaptive capacity (African Union 2014). Since climate-related shocks trigger direct as well as indirect negative effects, difficulties for disadvantaged groups multiply. If smallholder farmers lose their yields due to floods or droughts, they lack the product for subsistence as well as for sale. At the same time, food prices are rising due to crop shortages, as a result of which the poorest are most likely to be unable to afford the produce (Islam

and Winkel 2017). Brown et al. (2012) summarize that Africa is one of the most vulnerable regions in the world due to widespread poverty, limited coping capacities, and a highly variable climate. People are thus exposed to economic and climate-related shocks and stressors (Brown et al. 2017).

Various studies and projections indicate that in SSA in particular, crop and livestock yields could be massively affected due to increased mean temperatures that can destroy drought non-resistant crops and also shorten cropping seasons. These studies imply that one of the most important instruments that can significantly contribute to higher crop revenues, the prevention of crop loss, food shortages and food insecurities is the adoption of climate-smart and conservation technologies (e.g. Abdulai and Huffman 2013; Di Falco et al. 2011; Field and Barros 2014; Issahaku and Abdulai 2020a, 2020b; Kurukulasuriya and Mendelsohn 2008; IPCC 2014). Adoption of such technologies is crucial, as the effects of climate change are already occurring. It is estimated that with every flood or drought, food insecurity increases by 5 to 20 percentage points in Ethiopia, Malawi, Mali, Niger, and the United Republic of Tanzania (IMF 2020). The state of emergency becomes more apparent when one considers that according to the Environmental Protection Agency of Ghana, for example, cassava yields will decline by 3%, 13.5%, and 53% in 2020, 2050, and 2080, respectively, while rice yields will decline by an average of 8% due to climate change (EPA 2008). By conducting a systematic review, Daccache et al. (2011) find a mean overall decline of about 8% in crop yields due to climate change in Africa and South Asia. Using the period from 2010 to the 2050s as a time horizon. They find varying degrees of impact on different crops of 12%, 7%, 13%, and 9% for wheat, maize, sorghum, and millet, respectively. In Africa, crops with significant yield variability include wheat (-17%), maize (-5%), sorghum (-15%) and millet (-10%). It should be emphasized that as the climatic impact increases, so does the impact on crop yields (Daccache et al. 2011). Furthermore, the fact that some adaptation strategies can be technological, such as irrigation systems, further stresses the fact that poorer countries and poorer populations are less likely to be able to cope with climatic variability. The adoption of climate-smart practices is, however, extremely important, since studies reveal significant correlations between the adoption and farm productivity as well as net returns, but also on food security of poor rural

households (e.g. Kurukulasuriya and Mendelsohn 2008; Issahaku and Abdulai 2020b; Di Falco et al. 2011). Irrigation and water conservation play a major role in this context, as African agriculture is sensitive to water reduction (Kurukulasuriya and Mendelsohn 2008). Nevertheless, strategies can come in a variety of forms, including high-yielding crop varieties, changing planting schedules, drought-tolerant crops, crop insurance mechanisms, irrigation, and soil and water conservation measures (e.g. Issahaku and Abdulai 2020b). Climate shocks experienced by farmers, such as rainfall or temperature shocks, play an important role in technology adoption decisions. At the same time, household-level characteristics, such as education, extension contact, credit constraints, weather information, soil quality, and off-farm employment, have significant influence on adoption decisions (e.g. Abdulai and Huffman 2013; Kassie et al. 2015; Issahaku and Abdulai 2020b).

In their meta-analysis, Challinor et al. (2014) analyze 1700 published simulations to assess the impact of climate change on crop yield and food security. In their analysis they control for uncertainty, the timing of impacts, effectiveness of adaptation. They refer to the aforementioned crop-level adaptations, such as changes in varieties, planting times, irrigation and residue management. In contrast to the fourth Assessment Report of the Intergovernmental Panel on Climate Change (AR4), using their updated dataset, they find an increased risk of yield reductions for maize, wheat, and rice under moderate warming of 1 to 3°C in both tropical and temperate regions and especially after 2°C. Figure 5.7 shows that most wheat yield losses can be reversed up to a local warming of 2 to 3 °C in tropical regions and even over a wider range of warming in temperate regions. For tropically grown rice, there is also potential to compensate for losses through adaptation (Challinor et al. 2014).

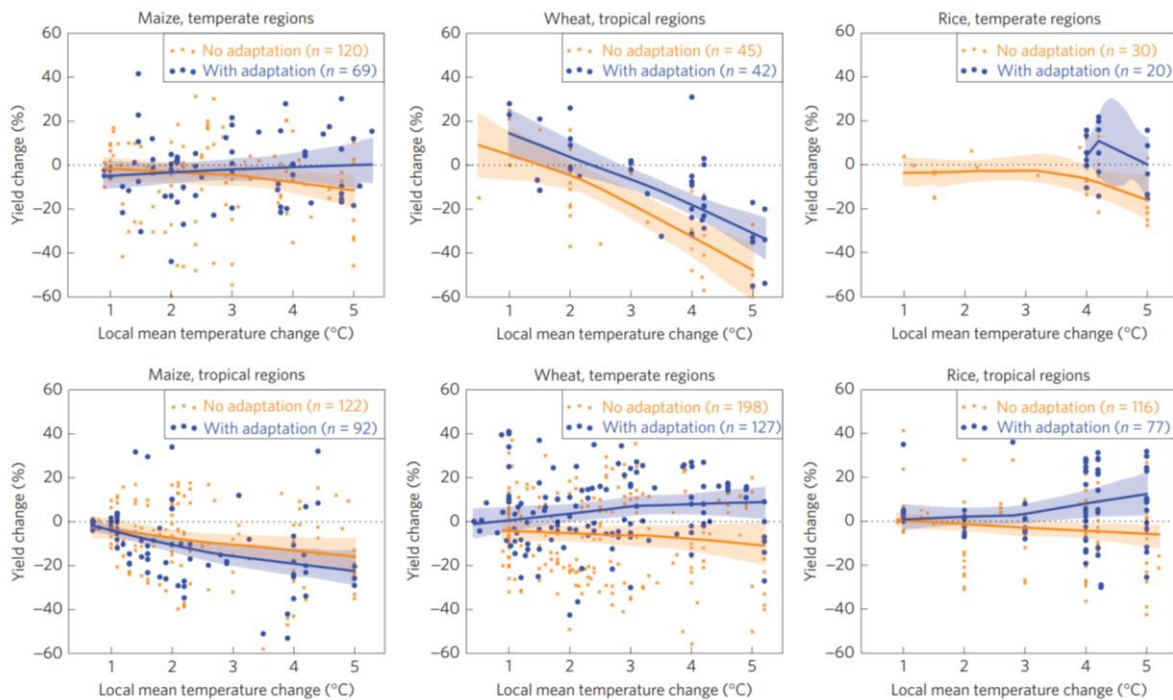


Figure 5.8 Percentage yield change as a function of temperature for the three main crops and for temperate and tropical regions for local mean temperature changes up to 5°C $n = 1,048$ from 66 studies. Shaded bands indicate the 95% confidence interval of regressions consistent with the data based on 500 bootstrap samples, which are separated according to the presence (blue) or absence (orange) of adaptation.

Source: Challinor, Watson et al. 2014, 288

The authors of the study argue that the “counterintuitive result [for Maize in tropical regions] is due to the different modelling methods used by the studies with and without adaptation. For example, more than 30% of the data points (4/13) for adapted maize with yield reduction of more than 20%, at local mean temperature increases of greater than 3.5°C, come from a single study” (Challinor et al. 2014, p. 288). However, in their general model, in which the change in yields of all crops is examined in relation to temperature increases and precipitation, the authors find a highly significant negative influence of warming, with an average yield loss of 4.90% per °C. This trend is also supported by other studies (e.g. Lobell and Field 2007). Figure 5.8 illustrates the relationships. From part c, d of the figure, it is evident that the positive effect of adoption remains relatively consistent and stable across different temperature and precipitation changes. In summary adaption to climate change using strategies as improved seeds, insecticide, fertilizer, anti-erosion measures, irrigation, and access to finance, early

warning systems and extension are thus crucial for building resilience in agricultural production (IMF 2020).

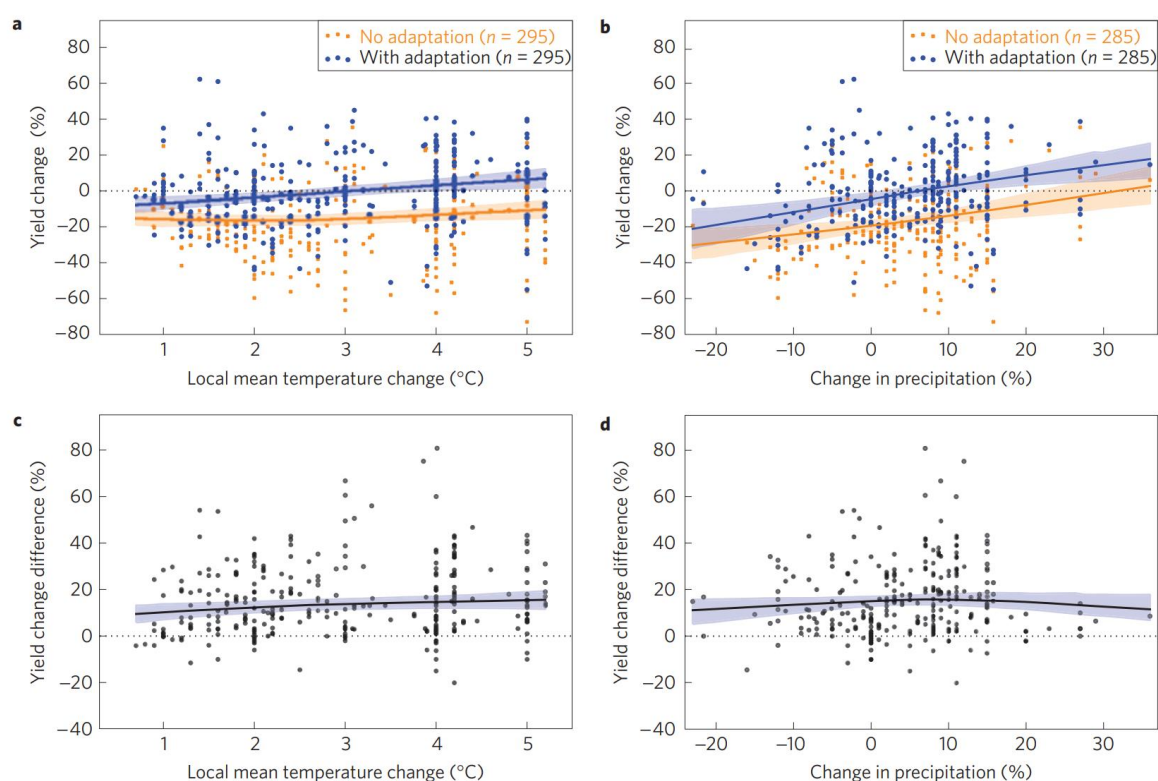


Figure 5.9 Quantification of the benefits of adaptation

Percentage yield change as a function of temperature (a) and precipitation (b), for 33 paired adaptation studies, across all regions and crops. Shaded bands indicate the 95% confidence interval of regressions consistent with the data based on 500 bootstrap samples, with blue and orange bands corresponding to with and without adaptation. The difference between simulations with and without adaptation for temperature (c) and precipitation (d) are shown, using the same bootstrapping technique. Note that part of the lack of decline at high temperatures in the non-adaptation curve in a is due to high representation of rice (23 of 28 no-adaptation studies with $T > 4^{\circ}\text{C}$ and yield change > 0), which shows less sensitivity to high local temperature change than other crops.

Source: Challinor, Watson et al. 2014, 288

Since the studies cited above all confirm that adaptation to climate change is important and the adoption of relevant technologies is helpful and effective in ensuring food security, it is equally important to point out the consequences that can arise globally if the international community does not address the problems. Inequality and the importance of global cooperation is once again emphasized. Rising temperatures, rising sea levels and rainfall anomalies are leading to an increase in the frequency and intensity of natural disasters. These include storms, droughts, desertification, locust outbreaks and more (IMF 2020). If human habitats or harvesting capacities are destroyed in the

process, the consequences are often conflicts and migration flows. It is estimated that SSA will face the world's largest climate migration flow of 85 million people by 2050 (Rigaud et al. 2018). However, well-planned migration to more viable areas can also be a helpful adaptation strategy if others are not applicable. However, this requires creating an enabling environment for migration, especially institutionally, supported by direct incentives, such as skills and job creation programs, for people to move to areas of lower risk and greater opportunity. Migration support strategies must ensure that not only the resilience of those who move is protected, but also that of receiving communities (Rigaud et al. 2018). The development of institutional security, which would often have to be accompanied by structural transformations, is a particular challenge in many regions where, for example, conflicts and political instability already prevail due to extreme poverty and hunger. The implementation of sustainable economic growth strategies to accumulate capital and invest in technologies, education and social security measures is unfortunately therefore not a realistic option in many regions (IMF 2020). However, the IMF states that "[f]inancing adaptation to climate change will be more cost-effective than frequent disaster relief" (IMF 2020, p. 16). As climate change affects people and nations across borders, there is a need for a global exchange of technologies, knowledge, and effective institutional practices that can accelerate adaptation. On the African continent, greenhouse gas (GHG) emissions are currently relatively low, but economic development is also low. In order not to fuel the cycle of increased emissions, the path of economic development on the African continent must therefore be as CO₂ neutral as possible, which is the declared goal of the African Union (African Union 2014). In order to achieve this, the previously mentioned restructuring and policies are necessary. Household resilience and agricultural production must be increased, for example, by means of the aforementioned adaptation strategies. At the same time, post-shock support needs to be provided. In order to safeguard the poorest, more assistance, such as insurance programs, must be provided. Otherwise, there is a risk that poor people will remain trapped in the cycle of poverty (e.g. Barnett et al. 2008). It is not uncommon that after shocks occur, poorer members of the population take measures that improve their situation only in the very short term. Examples include selling their

productive assets, which is often not enough to generate the necessary income to lift them out of their emergency situation, cutting spending on food, health and school fees for children, which in turn leads to potentially long-term negative consequences. The associated risk, i.e., the lack of certainty in making certain decisions, plays an essential role for the poor. For example, when farmers have insurance, they tend to invest significantly more in inputs such as fertilizer and seeds, they make larger agricultural investments or take more risky opportunities, which in turn can lead to higher incomes, reduced income volatility, income diversification, fewer distress sales of assets, and reduced incidences of food insecurity (e.g. Janzen and Carter 2019; Karlan et al. 2014; Nicola 2015). However, the uptake of, for example, weather-dependent crop insurance is low, and recent findings by Ali et al. (2021) reveal that willingness to participate in such insurance programs depends strongly on farmers' risk preferences, ambiguity aversion, liquidity constraints, wealth, trust, and education, indicating that policy makers need to tailor insurance products to the needs, including risk perceptions, of farmers. Further, the results suggest that, as with various development advances, there is a need to invest in the educational level of farmers to accurately understand insurance products, contracts, and the purpose and benefits of those products. Advanced policies such as deferred payments until the harvest season, when farmers are less liquidity constraint, can help overcome those constraints to purchase insurance products (Ali et al. 2021). Therefore, it can be concluded that measures that promote the general economic development of the poor population can also strengthen their resilience to climate change hazards if used effectively. Furthermore, income diversification for risk distribution, access to financial products, mobile information delivery systems for information distribution of e.g. weather events and also health care for people in risk regions are of the utmost importance, in order to protect themselves from shocks and to have a reduced risk of food insecurity, having to sell their assets or even having to migrate after the occurrence of shocks (IMF 2020).

Since the discussed problems of inequality inevitably connect the global North and South through international supply chains of products, the question arises what influence the global North can exert to reduce inequalities. In the next section, we raise the question to what extent consumers in

industrialized countries can contribute to reducing global inequalities, for example through conscious consumption of more sustainable products, and how inequalities within developed countries might stand in the way of such efforts.

5.6 Industrialized Countries and Consumer Choices

Although inequalities measured in terms of absolute poverty and hunger tend to be more severe for people in the Global South than for people in the industrialized nations of the Northern Hemisphere, inequalities exist in these countries as well, which in turn can contribute to perpetuating global inequalities. In this chapter, we would like to concentrate for the most part on European developments, and for purposes of exemplification, we will place a special focus on Germany.

The extent of inequality within the European Union (EU) can also be expressed using various indicators. For example, Gini coefficients range from 40.8 for Bulgaria to 22.8 for Slovakia, indicating that massive income inequalities exist in some countries within the EU. For Germany, a value of 29.7 is reported for 2019, which is below the EU average of 30.2 (eurostat 2021c). Median net disposable incomes ranged from 40,000 Euros in Norway to 3,733 Euros in Serbia in 2020. For the EU and Germany, mean disposable incomes of 17,819 Euros and 23,515 Euros, are given respectively. Gender disparities can be revealed, for example, through differences in income. In Germany, men had an average of 24,039 euros and women 22,979 euros at their disposal (eurostat 2021a).

Even though disparities between European countries are relatively large, absolute poverty, that is, living on less than \$1.90 per day, is relatively rare in the EU and Europe compared to, for example, the African continent. Therefore, the risk of poverty is normally expressed in relative terms. If a person has less than 60 percent of the median income available, he or she is considered at risk of poverty. With a share of people at risk of poverty of 14.8 percent, Germany is below the EU average of 16.5 percent in 2019. The rate of women at risk of poverty in Germany, as in Europe, is higher (15.7%, 17.6%) than that of men (13.9%, 16%). This phenomenon can be partly explained by the fact that women more often than men have part-time jobs (22,6% total; 6,9% male; 40,0% female) (eurostat 2021f), drop out

of the labor force due to parental work, or are single parents (84.3% female) (Statistisches Bundesamt 2020). However, it can also be shown that various social transfers in the EU prevent people from falling into poverty. Data from the European Statistical Office reveal that across the EU, social transfers reduce the at-risk-of-poverty rate from 25.1 to 16.5 percent, or by nearly one-third. In Germany, the at-risk-of-poverty rate is reduced from 23.2 to 16.9 percent in 2020 (eurostat 2021e, 2021d). Even as social safety nets exist in the EU, as in Germany, and prevent a certain proportion of people from falling into poverty, the chances of not falling into unemployment, for example, and thus closer to the poverty line, are not equally distributed in society. The employment rate depends very much on the level of education. This applies to both men and women. The higher the education, the higher the labor force participation. In 2020, 88.1% of the population aged 20 to under 65 with a high level of education (according to ISCED) were employed throughout Germany. For the population of the same age with a low level of education, the figure was only 62.4% (eurostat 2021b).

While developed countries might have better social systems to deal with various inequalities, the inequalities that exist within these countries contribute to global problems and inequalities. One example is the imported CO₂ as mentioned in the first section, for which industrialized countries are responsible. Since CO₂ is globally active, industrialized countries, which bear the greater part of the responsibility, should therefore try to massively reduce their level of (imported) emissions in order to mitigate global warming potential and thus also negative effects on the global South. Even with a specific focus on food, studies conclude that considering GHGs from direct production alone does not accurately reflect global pollution, and that GHG emissions from primary production, international trade and land use change must be priced in (Sandström et al. 2018). It is estimated that the share of greenhouse gas emissions from food systems is approximately 19 to 29% of total anthropogenic GHG emissions globally (Vermeulen et al. 2012). The Federal Ministry of German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) estimates the level at 13% (BMU 2019). The European Environment Agency (EEA) states that European systems of production and consumption generate diverse environmental, social and economic impacts, on the one hand

supporting livelihoods globally but on the other hand creating significant environmental pressures. They also state that one of the main challenges to achieve a more sustainable economy is the fact that improving the resource efficiency of production mostly doesn't cause absolute reductions in resource use or impacts, since efficiency improvements tend to lead to lower production costs and prices, which then leads to increased production and consumption. At this point, consumer choices can also help promote more sustainable products, thus reducing emissions, albeit on a small global scale. The EEA attributes particular importance to consumer choices because governments have limited ability to influence production processes in other countries. Consumer decisions have the potential to influence the entire life cycle of products and services. Measures targeting consumption therefore have the potential to influence resource use and production conditions worldwide (EEA 2015). This applies, for example, to product attributes of sustainability as well as attributes such as fair payment and working conditions.

While more sustainable consumption behavior is theoretically possible, it is assumed that it imposes additional costs on households, which are seen as a barrier to action. The Federal Statistical Office has examined this hypothesis for Germany using representative and weighted product bundles (Haubach and Held 2015). According to the Statistical Office, the share of private household spending on food, beverages and tobacco products was 15% in Germany in 2020 (Statistisches Bundesamt 2021). There is a negative correlation between income and expenditure share. In the first, i.e., poorest decile of the net equivalent income distribution, people spend around 20.4% of their income on food. In the tenth, i.e. richest, decile of the distribution, the share of expenditure falls steadily to only 10.4% (e.g. Held 2014). For the weighted average price measurements of 224 defined product specifications, the calculation of the price index for food and nonalcoholic beverages yields an index value of 183. Accordingly, if the organic alternatives were purchased instead of the conventional products, the price premium would be 83%. However, the price difference between organic and conventional products increases as brand value decreases. This tendency is based on the fact that the premium for organic quality is not added as a percentage to the price of the conventional product, but that above all the

brand value of a product takes a significant share of the price (Haubach and Held 2015). Haubach and Held use organic quality as an environmental sustainability indicator, as organic agriculture has strict regulations and bans regarding chemical fertilizers, pesticides and antibiotics, as well as GMOs and crop rotations. Various studies have already shown that organic agricultural systems have an inherent potential to reduce GHG emissions and to enhance carbon sequestration in the soil as well as further, also local environmental benefits, e.g., through reduction of chemical input use and adoption of environmentally friendly practices (e.g. Scialabba and Müller-Lindenlauf 2010; Blackman and Naranjo 2012). However, these results should be interpreted with caution, as studies show that they depend heavily on the product under consideration (Clark and Tilman 2017).

Taking into account the aforementioned percentage expenditure of households on food, Haubach and Held (2015) conclude that a switch from conventional products to organic products in the food sector leads to additional costs of 10% in relation to total private consumption. They point out that, because of the percentage differences in spending across the deciles, the index value for the poorest is 114 and for the richest it is only 107. This implies that relative to the individual's income, switching to a more sustainable diet is more expensive for poor households than for richer households. Nevertheless, the results show that a change in consumer choice or consumption behavior can have a significant impact on the personal premium. In the scenario where a more sustainable non-brand product is chosen over a conventional brand product, the price premium for a more sustainable diet can be reduced to 5% instead of 83% (Haubach and Held 2015). The Federal Statistical Office is thus able to show that the hypothesis of higher costs when switching to a more sustainable food product portfolio can indeed be confirmed, which is in line with findings by the BMU (BMU 2019). However, the extent of these additional costs is very much dependent on consumer choices. Since these issues and interrelationships can be extremely complex, it is of paramount importance to reduce information asymmetries in this regard and to promote factual knowledge. Sustainable food choices, require an understanding of the social, including global, interdependencies and relationships that exist through the production and purchase of food products (BMU 2019). In this context, the aforementioned

caution in evaluating products and certifications such as organic also play an important role. For example, organic products of all types consistently do worse in terms of land use or land use change but do better with regard to energy consumption (Clark and Tilman 2017). These land use changes, of course, play out on a global scale, resulting in the loss of biodiversity, ecosystem services or other potentially negative impacts. This implies that organic products cannot generally be classified as more sustainable. Studies show one of the most important influences is the choice of food item itself. For example, lamb, beef, cheese and milk have the highest land use per 100g of protein (Poore and Nemecek 2018). A striking consensus among studies suggests that the impact of the lowest-impact animal products generally exceeds that of the plant-based alternatives, underscoring the urgency of shifting to a more plant-based diet (Poore and Nemecek 2018; Sandström et al. 2018; Clark and Tilman 2017). Consumers can thus influence the level of CO₂ emissions through their choice of certain foods, which in turn can have a positive impact on the issues discussed in all of the previous sections.

Consumers in industrialized countries can also make informed consumer choices that result in a greater monetary benefit to producers of agricultural commodities in less developed regions of the world. The best-known example is the communication of this information about the use of price premiums through the use of the Fair-Trade (FT) label. In line with the idea of reducing inequality, fair trade programs have been developed to empower people who are not adequately compensated for their work and to protect them from poverty. Studies find varying degrees of impact of fair trade on farmer and household welfare indicators such as net income. Earlier studies in particular find substantial benefits for FT farmers, especially in terms of net income, household food consumption, reduced income variability as well as positive effects on the strength of their representative organizations and better access to credit and international supply chains (e.g. Jaffee 2014; Becchetti and Costantino 2008; Bacon 2005). Ruben et al. (2009) argue that previous studies have not controlled for self-selection bias and present three categories of impacts while controlling for relevant biases. They find that the largest direct effects, that is, income gains, are achieved through organic production, and that the additional income from FT is relatively modest. However, they find that the defined

indirect effects make a considerably larger contribution to the welfare gain. Since farmers are provided with guaranteed market outlets and more stable prices, it gives them a more reliable time horizon which leads to a higher willingness to invest in yield enhancing technologies (Ruben et al. 2009).

As FT promotes the inclusion of poor farmers in global product markets through a package of benefits such as, better prices, long-term business relationships, credit facilities and extension, consumers in developed countries face price premiums. This fact further stresses the importance of considering inequalities and income disparities in both developed and developing countries. First, people in developed countries must be able to afford the price premiums in order to contribute to reducing global inequalities to at least some extent. Second, people in developed countries need a significant amount of knowledge to be able to understand the complexities of global food value chains. As argued before, effects of interventions such as organic or fair trade can not necessarily be generalized for all regions, products and individuals, therefore a high level of information is essential to be able to make sustainable consumption decisions.

5.7 Summary and conclusion

The Sustainable Development Goals are closely interwoven and have a reciprocal influence on the achievement of each goal. These interdependencies can result in positive as well as negative impacts. In this essay, we focused on gender equality and reduced inequalities, as these two goals have been shown to be among the goals that least hinder or even promote the achievement of other goals. As such, they serve as a complementary tool for achieving other goals such as sustainable production and consumption.

Inequality comes in many different forms and facets, occurs between individuals, groups of individuals, or even regions and entire nations and affects people all around the globe. One of the most common instruments for measuring and comparing income and wealth inequality at the global level is the use of the Gini coefficient. According to the World Bank, after the 1990s and increasing global economic integration, global inequality has been declining for the first time since the Industrial Revolution.

However, the resulting situation is still far from equality, as worldwide income is still highly unequally distributed. The consequences of inequality are manifold and can affect economies and sustainable agricultural development, as well as lead to land conflicts, deforestation, migration and refugee movements. The downward trend in the global Gini index has been accompanied by a reduction in global poverty. However, significant gaps remain, especially between sub-Saharan Africa and the rest of the world. Furthermore, inequality in industrialized nations is fueling global inequality. People with unequal opportunities for education, good jobs, and good pay in industrialized countries are not able to consider fair or sustainable production methods in their consumption choices because of their budget constraints. However, their choices can have negative consequences in developing countries, where people may suffer from environmental or health problems due to less stringent social or environmental regulations.

Inequalities force people to make certain choices or prevent them from freely making decisions about their own lives. This is true not only with regard to differences between the global North and South, but also for gender inequalities or regional inequalities.

The agricultural sector in developing countries, which is under-technologized and under-developed, suffers particularly from these challenges. At the same time, the problems are exacerbated by gender inequalities. The gender gap in agriculture is characterized by the fact that women face greater constraints than men in accessing productive resources, markets, and services, reducing their contribution to the agricultural sector and to achieving overall economic and social development goals. Women would be as productive as men if they had equal access to land, inputs, or services, but globally, less than 15% of all landowners are women. With fewer secure land rights and land titles, women are less able to provide collateral to obtain credit, which is important for agricultural investment, thus overall economic development. Obtaining agricultural credit is generally challenging in developing countries, but the percentage of female smallholder farmers who have access to credit is far lower than for male smallholder farmers. Women are more likely than men to lack legal documents to prove ownership, have smaller livestock holdings, and have less labor available for farm

work. Yet secure and improved land tenure rights for women are directly related to child health determinants. By strengthening the role of women in agriculture alone, hunger could be significantly reduced and dietary diversity improved. At the same time, strong institutions play a key role in achieving the SDGs, particularly with regard to the goals of equity and equality. Equality implies equal access to the core and trust-building structures of a state and society, such as access to resources, education, good governance, and democratic institutions. However, equality in access cannot occur if the institutions themselves are non-existent or extremely poorly developed. The basis for (institutional) equality must thus be established through the creation of strong institutions based on the rule of law.

Where disasters occur and adaptation is necessary, countries with weak institutions, with poverty levels that are already higher than in other countries, and with inequalities that further reduce their capacity to respond face major vulnerabilities. Climate change is already undoing progress on inequality, with the poorest suffering the most. Man-made global warming, which is largely driven by energy production in industrialized countries, has exacerbated global inequality. Most poor countries do not share equally in the benefits of using, for example, fossil fuels. However, with a probability of over 90%, the GDP of poor countries which are severely affected by climate change is today already lower than it would have been without global warming. Due to the phenomenon that global warming can have positive impacts in colder countries and negative impacts in already warmer countries, it becomes evident that a large gap between the global North and the global South is being reinforced. Poor countries, which often suffer the more severe environmental impacts, have significantly fewer resources and mechanisms to adapt to the negative effects of climate change. The African continent is a hotspot of exposure and vulnerability to climate change impacts. Due to the strong negative correlation between income and temperature, warming may exacerbate global inequality, as poor, hot countries are likely to suffer the greatest reductions in growth. Global temperature increases exacerbate prevailing patterns of global inequality. Various studies and projections suggest that in sub-Saharan Africa in particular, crop yields and livestock farming could be massively affected due to

increased average temperatures. Adoption of climate-smart and conservation technologies is critical as the impacts of climate change are already being felt. Studies show that there is a significant relationship between the adoption of climate-smart practices and agricultural productivity, net yields, and food security of poor rural households. Nevertheless, household- and farm-level characteristics such as education, extension contacts, credit constraints, weather information, or soil quality have a significant impact on the decision to use new and improved technologies. This suggests that education and extension services need to be strengthened in the hardest hit regions so that farmers in affected areas have the opportunity to adapt.

Therefore, it can be concluded that combating inequality and worldwide unequally distributed negative impacts on people's lives is a task that needs to be addressed both on local as well as on global levels. After all, in an economically and socially globalized world, many factors are interdependent, so that improvements on one side of the globe can also lead to improvements on the other side. Any approach to work on the goals discussed here can unleash a great potential for progress, as negative interactions of equality and empowerment are extremely unlikely. Global goals for which enabling policies are useful in all respects.

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Chapter 6

Summary and Conclusions

6.1 The role of information in consumer preferences for sustainable certified palm oil products in Germany

This chapter examines the expectations and perceptions of the consumer side of the supply chain of a global food system. Complex decision-making behaviors, which are subject to attitudes, experiences, perceptions, expectations and heuristics, are analyzed. To determine the extent to which consumer expectations are compatible with producers' capabilities, part of this section focuses on producers in industrialized countries who require and use palm oil as an ingredient in their food production. The objective is to determine the extent to which consumers value more sustainable products, communicated through certifications. It is important to determine which certifications consumers pay attention to and how much they are willing to pay for them, in order to identify which certifications have the potential to be used by manufacturers in an economically efficient way and thus also exhibit their effects on, for example, the welfare of farmers or the environment. Since information is crucial to the assessment and awareness of labels on consumer products, this study assesses the effect of factual information on preferences as well as attribute-processing strategies. Consumer preferences and behavioral heuristics are determined by means of a discrete choice experiment. A hybrid latent variable model that allows to jointly examine the response to a stated choice model component and the responses to attribute processing questions, thus capturing attribute non-attendance to specific labels while controlling for heterogeneous preferences is applied. The results reveal that the attribute *organic* receives the highest monetary valuation in the total sample as well as in both the sub-groups with and without exposure to external information about palm oil cultivation. The results also show that providing additional information tends to change consumers' non-attendance patterns as well as willingness-to-pay values. In particular, factual information tends to increase consumers' willingness-to-pay and decreases their non-attendance for sustainability-indicating attributes. The findings suggest that the attribute *organic* has the potential to be ranked highest across all consumer segments, making

it the most promising attribute for promoting sustainable palm oil use across consumer groups. At the same time, it is important to point out that 44% of the producers that use palm oil for their food products state that they do not have any information on the region of origin of the commodity used for their products. About 45% of those producers also indicate that palm oil could be replaced at very high costs, while 30% stated that it cannot be replaced at all. However, 67% of the companies cannot imagine implementing a project initiative to ensure a sustainable palm oil supply chain for their products. This highlights the importance of establishing sustainability approaches through large conglomerates or joint-ventures or even higher-level government agencies.

6.2 Does the certification type matter for smallholder farmers' welfare and the environment? Evidence from palm oil farmers in Ghana

Motivated by the research results of the second chapter, a major objective of this thesis is to determine whether the certifications for which consumers in western industrialized countries show preferences and increased willingness-to-pay exert positive impacts on the welfare of smallholder farmers in growing regions, as well as on the environment. This study uses a multinomial endogenous switching regression model to account for potential selection bias associated with observed and unobserved characteristics. The empirical results reveal that organic and Roundtable on Sustainable Palm Oil (RSPO) certification schemes improve palm oil farmers' economic outcomes as well as food security. At the same time, environmental benefits arise as statistically significantly fewer harmful substances are used when farmers are certified. The results also show that organic certification has an advantage over RSPO certification, as farmers are able to achieve higher net farm and household income, as well as a higher food security status. When accounting for off-farm work, RSPO-certified farmers are unable to achieve higher net household incomes despite higher net farm revenues than non-certified farmers. Non-certified farmers, who tend to earn more income from off-farm labor, manage to achieve an overall improved household income despite lower net farm revenues. Organic farmers rely much less on income diversification and maintain a strong focus on their farm activities. The results also suggest that certain unobserved characteristics make RSPO certification attractive and more profitable for

some farmers. This is somewhat not surprising, as the prices for RSPO-certified produce for the farmers sampled in our study area are on average lower than prices for organic certified produce or produce that is not certified and sold on the local market. This suggests that RSPO certified farmers are likely to benefit from international RSPO supply chains through other advantages. After all, in order for environmental or welfare benefits to accrue and sustainable supply chains to be developed, farmers must derive fundamental benefits from certification participation. Otherwise, they do not have incentives to participate in certification schemes. The results of this study suggest that promoting more sustainable, certified palm oil supply chains can contribute to achieving the Sustainable Development Goals (SDG). Certified, and especially organic certified, supply chains in the palm oil sector present an opportunity to improve livelihoods and food security for people in growing regions. Furthermore, they can promote the adoption of sustainable production methods in potentially profitable, as yet undeveloped regions that are suitable for palm oil cultivation.

6.3 Impact of certification and extension services on productivity and welfare of palm oil producers in Ghana

This chapter examines the effects of RSPO and organic certifications among Ghanaian palm oil smallholders on productivity and inefficiency. Although farmers benefit from certification, it is not evident whether these effects result from improved production efficiency. From a production efficiency perspective, palm oil is of particular importance as yields of the oil palm in Western Africa are significantly lower, sometimes tenfold, than in the main growing regions in Southeast Asia. In light of the relevance of gender aspects in development, the production function accounts for gender effects in relation to farm management. Furthermore, this chapter disentangles direct impacts of certification, for example, requirements related to the use of certain agrochemicals, from indirect effects. Certified farmers often receive specific extension services to learn about techniques and adaptations which are needed to operate efficiently under certification. Extension service thus represents a mediator that can indirectly lead to shifts in production frontiers or inefficiency functions due to participation in the respective certification program. The results indicate that certifications with

sustainability requirements related to environmental aspects exert negative effects on yields in the Ghanaian palm oil sector. Consequently, global yield gaps increase when certifications are applied. However, indirect effects of extension service in RSPO and organic certification schemes counteract yield losses, suggesting that certifications are linked to the provision of relevant, well-coordinated extension services. Thus, it becomes evident that a mediator, i.e., a well-tailored extension program, represents an important policy recommendation to counteract negative effects on the production function, inefficiency, and yields. Nevertheless, both certification schemes exert positive impacts on the economic well-being of the agricultural household.

6.4 Towards holistic sustainable development within the framework of the Sustainable Development Goals: Reducing inequalities and empowerment of gender equality.

The agricultural sector in developing countries is not only underdeveloped compared to industrialized countries, but at the same time women face greater constraints in accessing productive resources, markets, and services than men, which massively exacerbates the problem of inequality and sustainable development. Simply by empowering women in agriculture, hunger could be massively reduced and dietary diversity significantly improved. To consider holistic sustainable development, this work integrates the role of achieving other SDG. The Sustainable Development Goals are closely interwoven and have a reciprocal influence on the achievement of each goal. We focused gender equality and reduced inequalities, as these two goals have been identified to serve as complementary tools for achieving other goals such as sustainable production and consumption. Globally, a downward trend in the Gini index has been accompanied by a reduction in global poverty. However, significant gaps remain, especially between sub-Saharan Africa and the rest of the world.

With less than 15% of all landowners being female, fewer secure land rights and titles, women are less able to provide collateral to obtain credit, resulting in fewer agricultural investments, thus leading to a decreased potential overall economic development. In addition, one of the greatest challenges of the 21st century is that climate change is already undoing progress on inequality, with the poorest suffering the most. This development increases the disparities between the global North and South,

resulting in poor countries, which are particularly affected by climate change, being increasingly deprived of the resources needed to integrate sustainable agricultural or climate change mitigation practices. If strong, e.g., gender disparities also prevail within the social structures of the most affected countries, only a small portion of the population is empowered to actively counteract the negative consequences. Studies show that in sub-Saharan Africa, crop yields and livestock farming are particularly negatively affected, as average temperature increase further. Adoption of climate-smart and conservation technologies is critical as the impacts of climate change are already being felt. Education and extension services need to be strengthened in those regions so that farmers have the opportunity to adapt. It is thus of utmost importance that people across all forms of inequality are empowered in order to have the opportunity to develop successfully in a negatively changing world. Achieving greater equity and equality can help increase people's access to resources and institutions so they can eventually join sustainable global food systems that enhance positive development for both people and the environment.

6.5 General Conclusion

Certifications are intended to contribute to the achievement of the Sustainable Development Goals as part of sustainable production and consumption. The results of this thesis have shown that certifications in the palm oil sector elicit higher willingness to pay among consumers in industrialized countries and that these certifications can successfully yield positive effects for smallholder farmers in cultivation regions in Ghana and on the environment. Both ends of the palm oil supply chain seem to benefit more from organic certification than from RSPO certification. This implies that consumers in Germany have a higher monetary appreciation for organic certification than for RSPO certification, and that smallholders in Ghanaian growing regions benefit more from this certification in term of welfare gains. Although RSPO certification significantly reduces the smallholders' use of agrochemicals, thus minimizing the release of potentially harmful substances into the environment, this effect is also more pronounced with organic certification, as no chemical inputs are allowed to be used. From the data regarding the use of palm oil by processing companies in the food industry in Germany, it is evident

that these companies are largely dependent on the continued use of palm oil. It should be noted that there appears to be an awareness of the need for agricultural commodities to be cultivated as sustainably as possible, however, vigorous action to improve the global cultivation situation cannot be expected. Potential reasons for this could be high entrepreneurial risks, cost structures or complex supply chain establishment and management. Certifications that are intended to have a positive impact on the environment are often associated with problems of reduced yields. This dissertation can confirm this issue in relation to palm oil production. However, it is essential to point out that these developments can be counteracted by learning specific, relevant farm management practices through efficient extension services. This allows farmers to counteract yield losses while benefiting from positive welfare effects. This finding is of paramount importance in the context of food security for a growing world population and in relation to one of the world's most important nutritional oils. It can be concluded that the development of more sustainable palm oil cultivation systems can positively contribute to the achievement of the Sustainable Development Goals. It is thus possible to reconcile consumer interests and positive effects for farmers in growing regions as well as for the environment. Although large effects cannot be expected at present due to world market positions of non-sustainable production systems, the findings of this work are of significant relevance for the future development and conversion of production and demand systems in the palm oil sector. Since the SDGs can only be achieved through active engagement between developing and developed countries, large demand regions such as the European Union must ensure that more sustainable agricultural commodities are imported and used, that the use of verifiably unsustainable commodities is massively restricted, and that farmers in growing regions in developing countries actually benefit from the intended welfare effects. This dissertation has provided evidence that sustainability certification can in fact contribute to such a development, albeit not without limitations.

Appendix A:

Questionnaire I: Consumer Study Germany

The questionnaire as well as the cover letter to the participants of the consumer study in Germany are presented in the following section. Since the study was conducted in German, both the questionnaire and the cover letter are presented in their original versions.

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Sehr geehrte/r Frau/Herr ...

Im Folgenden finden Sie den Zugang zu einem Fragebogen, der Teil eines Forschungsprojektes des Instituts für Ernährungswirtschaft und Verbrauchslehre der Christian-Albrechts-Universität zu Kiel ist. Wir möchten Sie um den großen Gefallen bitten, uns diesen Fragebogen zu beantworten.

In dem Fragebogen wird es vor allem um das Thema Nachhaltigkeitssiegel auf Lebensmitteln gehen. Dabei liegt es uns fern, Sie von bestimmten Siegeln oder Produkten zu überzeugen oder vor diesen zu warnen. Wir sind kein Marktforschungsinstitut, sondern als neutrale Forschungsstelle lediglich an Ihrer persönlichen Meinung interessiert. Es gibt also kein richtig oder falsch und es wird keinerlei Vorwissen benötigt. Mit modernen Analysemethoden werden Verbraucherinteressen erfasst, sodass im besten Fall gezielte Handlungsempfehlungen für die Politik gegeben werden können. Auf diesem Wege sollen ökologische, soziale und ökonomische, wie auch Verbraucherinteressen unmittelbar berücksichtigt werden.

Da wir sehr viele Antworten benötigen um aussagekräftige, repräsentative Forschungsergebnisse erzielen zu können sind wir auf Ihre Hilfe angewiesen. Gleichzeitig können Sie über Ihre persönliche Meinung zum Thema Nachhaltigkeitssiegel zur korrekten Erfassung der Einstellung aller deutschen Verbraucher*Innen beitragen. Ihre Adresse wurde dabei zufällig ausgewählt. Ihre Daten werden absolut vertraulich behandelt und nicht weitergegeben. Nach einmaliger Zusendung dieses Briefes werden Ihre Adressdaten sofort aus unseren Archiven gelöscht. Die Auswertung des Fragebogens erfolgt komplett anonym und mit etwas Glück können Sie am Schluss noch bis zu 80,00€ gewinnen!

Besuchen Sie zur Teilnahme einfach den untenstehenden Link oder scannen Sie den QR-Code.

Sie können sich bei jeglichen Fragen gerne jederzeit an uns wenden. Wir danken Ihnen im Voraus!

Wir wünschen schöne Feiertage und einen angenehmen Start ins neue Jahr.

Mit freundlichen Grüßen

Prof. Dr. Awudu Abdulai & Christoph Richartz, M.Sc.

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CHRISTIAN-ALBRECHTS-UNIVERSITÄT ZU KIEL
INSTITUT FÜR ERNÄHRUNGSWIRTSCHAFT UND VERBRAUCHSLEHRE

VERBRAUCHERSTUDIE



CHRISTOPH RICHARTZ, 2019

Informationen zu Palmölkontroverse (Information Intervention, GRUPPE A):

Im folgenden Fragebogen wird es vor allem um das Thema des nachhaltigen Konsums mit Bezug zum Agrarrohstoff Palmöl gehen. Aus diesem Grund möchten wir Ihnen ein paar grundlegende Informationen zum Thema Palmöl geben.

- a) Palmöl ist ein Pflanzenöl, das als Zutat in Lebensmitteln, Kosmetikartikeln oder auch als Biodiesel zum Einsatz kommt. Seit 2014 muss es als Zutat auf Lebensmitteln klar gekennzeichnet sein.
- b) Statistisch gesehen ist Palmöl derzeit als Zutat in jedem zweiten Lebensmittelprodukt im Supermarkt vorhanden.
- c) Ölpalmen wachsen wie Kokospalmen ausschließlich in den feuchtwarmen Tropen. Sie brauchen ganzjährig hohe Temperaturen und Niederschläge zum Gedeihen.
- d) Palmöl ist das weltweit meist produzierte, gehandelte und konsumierte Pflanzenöl. Durch den arbeitsintensiven Anbau oder auch den Aufbau von Infrastruktur in Anbauregionen bietet die Ölpalme vielen Menschen eine Möglichkeit ihren Lebensunterhalt zu erwirtschaften während sich die Regionen wirtschaftlich weiterentwickeln können.
- e) Gleichzeitig ist der Palmölanbau auf großen Plantagen auch mitverantwortlich dafür, dass in Anbaugebieten einheimische Bevölkerungsgruppen von ihren Ländern vertrieben werden, da entweder die Eigentumsrechte nicht klar geregelt sind oder große Konzerne sich diese Länder aneignen ohne Genehmigungen einzuholen oder Entschädigungen zu zahlen. Dabei wird ein solches Vorgehen oft durch Korruptionsstrukturen in den Anbauländern ermöglicht. Für den Fall, dass sich die ursprünglich ansässige Bevölkerung neue Flächen zur landwirtschaftlichen Nutzung erschließen muss, wird die Zerstörung von Waldflächen so weiter vorangetrieben.
- f) Die Europäische Union ist nach Indien der zweitgrößte Importeur von Palmöl.
- g) Die Ölpalme ist die produktivste Ölpflanze der Welt. Weltweit beläuft sich der durchschnittliche Ertrag pro Hektar auf ca. 3,5 Tonnen. Andere Ölpflanzen, wie Soja oder Raps hingegen schaffen es lediglich auf Erträge von 0,5 bis 1,8 Tonnen pro Hektar. Es kann somit (im Vergleich zu anderen Pflanzen) viel Öl mit einem relativ geringen Flächenverbrauch produziert werden. Beispiel: So müsste bei einem Austausch von Palmöl gegen Sonnenblumenöl für die gleiche Menge Öl eine ca. vier Mal größere Anbaufläche bewirtschaftet werden.
- h) Der weltweit größte Anteil von Palmöl wird auf großen Monokulturplantagen in Indonesien und Malaysia erwirtschaftet. Das Abholzen von Urwaldflächen führt dabei zum Rückgang von Tierpopulationen und zum Verlust von Lebensräumen für Wildtiere. Ein berühmtes Beispiel stellt hier der Orang-Utan da. Der Verlust von Wäldern und Torfmooren, welche im Gegensatz zu den errichteten Plantagen ein erhöhtes CO₂-Speicherpotenzial besitzen, hat dabei auch direkte Auswirkungen auf die globale CO₂-Bilanz und damit den menschengemachten Klimawandel. Um neue Flächen zu gewinnen werden oftmals Brandrodungen durchgeführt.
- i) Derzeit wird für den Palmölanbau ca. 38% weniger Fläche genutzt als für den Rapsanbau.

Eingangsfragen:

Im Folgenden sind einige Fragen bezüglich Ihrer derzeitigen Lebenssituation und Ihrer persönlichen Einstellung und Meinung im Allgemeinen, als auch gegenüber Nachhaltigkeitssiegeln und Lebensmitteln aufgeführt. Bitte geben Sie jeweils an, in welchem Maße Sie den Fragen und Aussagen zustimmen bzw. diese ablehnen.

1. Wie ist Ihre Meinung zu den folgenden drei Aussagen?

Kreuzen Sie bitte je ein Kästchen auf der Skala an, wobei der Wert 1 „stimme voll zu“ und der Wert 5 „lehne voll ab“ bedeutet. Mit den Werten dazwischen können Sie Ihr Urteil abstufen.

	Stimme voll zu	Stimme eher zu	Weder noch	Lehne eher ab	Lehne voll ab
	1	2	3	4	5
Im Allgemeinen kann man den Menschen Vertrauen	☐	☐	☐	☐	☐
Heutzutage kann man sich auf niemanden mehr verlassen	☐	☐	☐	☐	☐
Wenn man mit Fremden zu tun hat ist es besser vorsichtig zu sein, bevor man ihnen vertraut	☐	☐	☐	☐	☐

2. Welchen Personen, Gruppen oder Organisationen vertrauen Sie mehr oder weniger?

Wie viel Vertrauen haben Sie...	Sehr viel Vertrauen	Viel Vertrauen	teils / teils	Wenig Vertrauen	Gar kein Vertrauen
	1	2	3	4	5
...zur eigenen Familie	☐	☐	☐	☐	☐
...zu Nachbarn	☐	☐	☐	☐	☐
...zu Freunden	☐	☐	☐	☐	☐
...zu Arbeitskollegen	☐	☐	☐	☐	☐
...zu Fremden, denen Sie erstmals begegnen	☐	☐	☐	☐	☐
...zu Medien im allgemeinen	☐	☐	☐	☐	☐
...zu Organisationen (z.B. Verbraucher- oder Umweltorganisationen)	☐	☐	☐	☐	☐
...zu Behörden	☐	☐	☐	☐	☐
...zu politischen Parteien	☐	☐	☐	☐	☐
...zu großen Wirtschaftsunternehmen	☐	☐	☐	☐	☐
...zu unabhängigen Forschungsinstituten	☐	☐	☐	☐	☐

- 3. In der folgenden Liste finden Sie verschiedene Themen, über die im Zusammenhang mit der Erhaltung unserer natürlichen Lebensgrundlagen diskutiert wird. Bitte geben Sie jeweils an, wie bedrohlich Sie diese Themen im Hinblick auf den Erhalt unserer natürlichen Lebensgrundlagen erleben.**

	Sehr bedrohlich		Neutral		Überhaupt nicht bedrohlich
	1	2	3	4	5
Artensterben in der Tier- und Pflanzenwelt	☐	☐	☐	☐	☐
Abholzung von Regenwäldern	☐	☐	☐	☐	☐
Klimawandel	☐	☐	☐	☐	☐
Schadstoffbelastung in Böden, Gewässern und Luft	☐	☐	☐	☐	☐
Schadstoffe in Lebensmitteln	☐	☐	☐	☐	☐
Wachsende Weltbevölkerung	☐	☐	☐	☐	☐
Plastik in den Weltmeeren	☐	☐	☐	☐	☐
Raubbau an der Natur durch Konsumgesellschaften	☐	☐	☐	☐	☐
Konsum von Lebensmitteln tierischen Ursprungs	☐	☐	☐	☐	☐

- 4. Im Folgenden sehen Sie einige Aussagen. Bitte geben Sie jeweils an, inwieweit Sie der entsprechenden Aussage zustimmen.**

	Stimme voll und ganz zu		Neutral		Stimme überhaupt nicht zu
	1	2	3	4	5
Jede(r) einzelne von uns muss heute im eigenen Umfeld Verantwortung dafür übernehmen, dass wir für die nachfolgenden Generationen eine lebenswerte Umwelt erhalten.	☐	☐	☐	☐	☐
Es beunruhigt mich, wenn ich daran denke, in welchen Umweltverhältnissen unsere Kinder und Enkelkinder wahrscheinlich leben müssen.	☐	☐	☐	☐	☐
Es gibt natürliche Grenzen des Wachstums, die unsere industrialisierte Welt längst erreicht oder schon überschritten hat.	☐	☐	☐	☐	☐

Um unsere natürlichen Lebensgrundlagen zu erhalten, müssen wir alle bereit sein, unseren Lebensstandard einzuschränken.	☐	☐	☐	☐	☐
Umweltschutz sollte für Deutschland Vorrang haben, selbst wenn er das Wirtschaftswachstum beeinträchtigt.	☐	☐	☐	☐	☐
Um unsere natürlichen Lebensgrundlagen zu erhalten, wäre ich bereit vollständig auf tropische Produkte zu verzichten.	☐	☐	☐	☐	☐
Um unsere natürlichen Lebensgrundlagen zu erhalten, wäre ich bereit vollständig auf tierische Produkte zu verzichten.	☐	☐	☐	☐	☐

5. Wie sehr sind Sie davon überzeugt, dass Sie als deutscher Konsument über Ihr persönliches Konsumverhalten dazu beitragen können, Klima- und Umweltschäden zu reduzieren?

Voll und ganz überzeugt	Ziemlich überzeugt	Neutral	Wenig überzeugt	Gar nicht überzeugt
1	2	3	4	5
☐	☐	☐	☐	☐

6. Bitte denken Sie an den Lebensmittelkauf: Wie häufig nutzen Sie dabei zur Orientierung Siegel, die bestimmte Nachhaltigkeitskriterien ausdrücken (z.B. Bio etc.)?

Immer	Häufig	Gelegentlich	Selten	Nie
1	2	3	4	5
☐	☐	☐	☐	☐

7. Bitte geben Sie an wie sehr Sie den folgenden Aussagen zustimmen:

	Stimme voll und ganz zu		Neutral		Stimme überhaupt nicht zu
	1	2	3	4	5
Man kann auf die Wirksamkeit von Siegeln auf Lebensmitteln in deutschen Supermärkten vertrauen, da Produzenten und Hersteller in effektiver Weise kontrolliert werden.	☐	☐	☐	☐	☐
Wenn ein Produkt eine bestimmte Zertifizierung trägt, dann stelle ich diese Zusicherung nicht in Frage.	☐	☐	☐	☐	☐
Wenn ich mich zwischen zwei sehr ähnlichen Produkten entscheiden muss wähle ich normalerweise das günstigere.	☐	☐	☐	☐	☐
Es existieren zu viele verschiedene Siegel. Dieser Siegelwald bietet mir deshalb keine effektive Entscheidungsgrundlage.	☐	☐	☐	☐	☐
Es fällt mir leicht sämtliche Produktsiegel im Supermarkt spontan zu verstehen.	☐	☐	☐	☐	☐
Ich lese mir immer die Zutaten- und Nährwertangaben auf Lebensmittelverpackungen durch	☐	☐	☐	☐	☐
Ich esse was mir schmeckt und mache mir nicht so viele Gedanken über die Produktionsbedingungen	☐	☐	☐	☐	☐
Ich kaufe bewusst keine Produkte mit Siegeln, da ich potenziellen Siegelbetrügern keinen zusätzlichen Gewinn verschaffen möchte.	☐	☐	☐	☐	☐
Wenn ich mich zwischen zwei sehr ähnlichen Produkten entscheiden muss wähle ich normalerweise das nachhaltigere.	☐	☐	☐	☐	☐
Ich bin gerne bereit für ein nachhaltiges Produkt einen höheren Preis zu zahlen.	☐	☐	☐	☐	☐

8. Wenn 7.1 oder 7.2 = 3 - 5: Warum sind Sie sich über die Wirkung von Siegeln unsicher?

(offen)

9. Welche der folgenden Siegel kennen Sie?



Ja ☐

Nein ☐



Ja ☐

Nein ☐



Ja ☐

Nein ☐



Ja ☐

Nein ☐



Ja ☐

Nein ☐



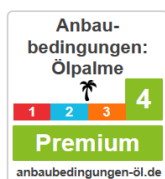
Ja ☐

Nein ☐



Ja ☐

Nein ☐

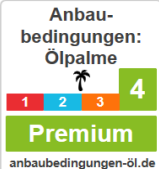


Ja ☐

Nein ☐

10. (Folgefrage, piping 9=ja) Wofür stehen diese Siegel?

	- kontrolliert biologischer Anbau - klar definierte, gesetzlichen Regelungen gemäß der EU-Ökoverordnung (Regeln zu: gentechnische Veränderungen, Einsatz synthetischer Pflanzenschutzmittel, Dünger, Antibiotika)
	- Deutsches Bio-Siegel der Bundesanstalt für Landwirtschaft und Ernährung - Vorschriften/ Regelungen strenger als die der Bio-Vorschriften des EU-Siegels
	- kontrolliert biologischer Anbau - klar definierte, gesetzlichen Regelungen gemäß der EU-Ökoverordnung (Regeln zu: gentechnischen Veränderungen, Einsatz synthetischer Pflanzenschutzmittel, Dünger, Antibiotika) - gesonderte sozialrechtliche Regelungen wie z.B. best. Mindestpreise
	- das Siegel verbindet fairen Handel mit ökologischem Anbau - Kriterien gehen über die Anforderungen nach EU-Ökoverordnung hinaus - ganzheitlich nachhaltige Produktionsanforderungen entlang der gesamten Wertschöpfungskette (ökologische, ökonomische und soziale Nachhaltigkeitskriterien) - strenge Regulierung des Einsatzes synthetischer Pflanzenschutzmittel und Dünger - dadurch sollen der Arbeits- und Gesundheitsschutz von Menschen in Entwicklungsländern gefördert und global gerechte Arbeitsbedingungen garantiert werden - Verbesserung von Handelsbedingungen für benachteiligte landwirtschaftliche Produzenten und Arbeiter in Entwicklungsländern - Beispiele: faire Preise, das Etablieren langfristiger Handelsbeziehungen. - soziale, ökologische und wirtschaftliche Standards für Produzenten, Händler und Unternehmen
	- Produkte, die schrittweise in einzelnen sozialen und ökologischen Aspekten verbessert werden, werden gekennzeichnet - Förderung von nachhaltigerem Konsum in der Breite - der gesamte Lebenszyklus des Produkts wird in Betracht gezogen - das Siegel verbindet fairen Handel mit ökologischem Anbau - Kriterien gehen über die Anforderungen nach EU-Ökoverordnung hinaus - ganzheitlich nachhaltige Produktionsanforderungen entlang der gesamten Wertschöpfungskette (ökologische, ökonomische und soziale Nachhaltigkeitskriterien) - Verbesserung von Handelsbedingungen für benachteiligte landwirtschaftliche Produzenten und Arbeiter in Entwicklungsländern - Beispiele: faire Preise, das Etablieren langfristiger Handelsbeziehungen.

	- soziale, ökologische und wirtschaftliche Standards für Produzenten, Händler und Unternehmen
	- Produkte, die schrittweise in einzelnen sozialen und ökologischen Aspekten verbessert werden, werden gekennzeichnet - Förderung von nachhaltigerem Konsum in der Breite - der gesamte Lebenszyklus des Produkts wird in Betracht gezogen
	- besonders nachhaltige, ressourcenschonende Produkte werden gekennzeichnet - Förderung von ganzheitlich nachhaltigen Produkten (bessere Sichtbarkeit für Konsumenten) - Einbezug der gesamten Corporate Responsibility: Bewertung geht über Öko-Landbau und Fair Trade Regularien hinaus.
	- Kennzeichen nachhaltiger Produkte, die sich mit einem besonders geringen Wasserverbrauch in der Produktion auszeichnen
	- kennzeichnet Produkte von Unternehmen, welche einen besonderen Beitrag zum Schutz und Erhalt tropischer Tierarten leisten
	- Ziel: Erhalt der biologischen Vielfalt und die nachhaltige Sicherung der Lebensgrundlagen durch nachhaltige Landnutzung unter Berücksichtigung ökologischer, sozialer und ökonomischer Aspekte. - Anforderungen liegen unterhalb der Fair Trade-Regularien und der EU-Öko-Verordnung
	- kennzeichnet Produkte aus Tropenhölzern aus nachhaltigen Produktionssystemen - die systematische Wiederaufforstung und der Schutz von tropischen Urwäldern stehen dabei im Mittelpunkt
	- Begrenzung von Umweltschäden durch Förderung nachhaltiger Anbaumethoden für Palmöl - Sicherung der Grundrechte indigener Landbesitzer und umliegender Dorfgemeinschaften - Schützenswerte Gebiete und Regenwaldareale dürfen nicht für den Anbau von Palmöl genutzt werden - Arten sollen geschützt und eine hohe Biodiversität erhalten werden
	- kennzeichnet Produkte von Unternehmen, welche einen besonderen Beitrag zum Schutz und Erhalt tropischer Tierarten leisten
	- Produkte, die schrittweise in einzelnen sozialen und ökologischen Aspekten verbessert werden, werden gekennzeichnet - Förderung von nachhaltigerem Konsum in der Breite - der gesamte Lebenszyklus des Produkts wird in Betracht gezogen
	- kennzeichnet Produkte aus Tropenhölzern aus nachhaltigen Produktionssystemen - die systematische Wiederaufforstung und der Schutz von tropischen Urwäldern stehen dabei im Mittelpunkt
	- Produkte, die schrittweise in einzelnen sozialen und ökologischen Aspekten verbessert werden, werden gekennzeichnet - Förderung von nachhaltigerem Konsum in der Breite - der gesamte Lebenszyklus des Produkts wird in Betracht gezogen - die Stufen 1 - 4 grenzen ganzheitlich Nachhaltige von weniger nachhaltigen Produkten ab
	- Stufe 4 kennzeichnet Produkte von Unternehmen, welche einen besonderen Beitrag zur Förderung des Tierwohls heimischer Nutztiere leisten

11. (Folgefrage piping) Welchen zwei Siegeln würden Sie am meisten Vertrauen zusprechen und diese in Ihre Kaufentscheidung für ein Lebensmittel einbeziehen?

12. (Folgefrage piping) Welchen zwei Siegeln würden Sie am wenigsten vertrauen ihre Versprechen einzuhalten?

13. Haben Sie schon einmal negative Erfahrungen mit Zertifizierungen gemacht oder davon gehört?

☐ Nein ☐ Ja, und zwar: _____

Im weiteren Verlauf des Fragebogens wird nun im Zusammenhang mit Nachhaltigkeitssiegeln etwas mehr auf das Thema Palmöl eingegangen. Dazu hier ein paar kurze Fragen.

14. Achten Sie bei der Wahl Ihrer Lebensmittel bewusst auf Palmöl als Zutat?

Immer	Häufig	Gelegentlich	Selten	Nie
1	2	3	4	5
☐	☐	☐	☐	☐

15. Wie sind Ihre spontanen Assoziationen in Bezug auf Palmöl als Zutat in Lebensmitteln?

Positiv	Eher positiv	neutral	Eher negativ	Sehr negativ
1	2	3	4	5
☐	☐	☐	☐	☐

16. Lebensmittel, welche Palmöl als Zutat enthalten können, sind z.B. Nuss-Nougat-Brottaufstriche, Schokoladenkekse oder auch Margarinen. Wo kaufen Sie derartige Produkte überwiegend ein?

-Dropdown-

Supermarkt / Verbrauchermarkt

Discounter

Drogeriemarkt

Bioladen/ Biosupermarkt

Reformhaus

17. Denken Sie nun bitte an die drei Personen die Ihnen am nächsten stehen. Denken Sie, dass diese Personen bei der Wahl ihrer Lebensmittel bewusst auf Palmöl als Zutat achten?

	Immer	Häufig	Gelegentlich	Selten	Nie
	1	2	3	4	5
Person 1	☐	☐	☐	☐	☐
Person 2	☐	☐	☐	☐	☐
Person 3	☐	☐	☐	☐	☐

Quiz über Palmölproblematik

18. Quiz: 6 Fragen (Score)

	Stimme voll und ganz zu			Stimme überhaupt nicht zu
	1	2	3	4
Produzenten sollten vermehrt Kokosöl anstatt Palmöl als Zutat in Lebensmitteln verwenden, um weitere Umweltschäden zu verhindern.	☐	☐	☐	☐
Durch ihren effizienten Ertrag pro Flächeneinheit birgt die Ölpalme das Potenzial eine relativ nachhaltige Ölpflanze zu sein.	☐	☐	☐	☐
Um die Lebensumstände der Menschen in den Palmölanbaugebieten zu verbessern sollte die EU ein generelles Palmölverbot verhängen.	☐	☐	☐	☐
Palmöl ist in nur relativ wenigen Produkten enthalten, sodass es bei der Wahl eines Lebensmittels keine große Rolle spielt.	☐	☐	☐	☐
Die derzeitigen Anbaumethoden der Ölpalme sind zu einem großen Teil mitverantwortlich für CO2-Ausstoß und Verlust von Artenvielfalt in Südostasien.	☐	☐	☐	☐
Es ist für Verbraucher oft nicht möglich Palmöl als Zutat in Lebensmitteln zu identifizieren	☐	☐	☐	☐

Choice Experiment

Bitte stellen Sie sich vor, dass Sie Schokoladenkekse (wie z.B. Prinzenrolle, Oreos, / Schoko- bzw. Nuss-Nougat-Brottaufstrich / Margarine kaufen möchten.

19. Wie regelmäßig kaufen Sie *-entsprechendes Produkt-* ungefähr?

Häufig	Gelegentlich	Selten	Nie
1	2	3	4
☐	☐	☐	☐

Wenn Sie das Produkt selbst nicht konsumieren, stellen Sie sich bitte vor, dass Sie es für einen nahestehenden Verwandten/ Bekannten kaufen möchten.

20. A) (Forward Looking Approach)

Welchen Preis würden Sie bei Ihrem nächsten Kauf für eine handelsübliche *MENGENEINHEIT* Ihres favorisierten *PRODUKTES* im Supermarkt erwarten?

_____ €

19. B) (Backward Looking Approach)

Welchen Preis haben Sie bei Ihrem letzten Kauf für eine handelsübliche *MENGENEINHEIT* Ihres favorisierten *PRODUKTES* im Supermarkt gezahlt?

_____ €

21. A) (Forward Looking Approach)

Ich erwarte, dass der Preis für mein Lieblingsprodukt in 90% der Geschäfte nicht HÖHER als _____ € liegt.

20. B) (Backward Looking Approach)

Ich denke, dass der Preis für mein Lieblingsprodukt zum Zeitpunkt meines letzten Kaufs in 90% der Geschäfte nicht HÖHER als _____ € lag.

22. A) (Forward Looking Approach)

Ich erwarte, dass der Preis für mein Lieblingsprodukt in 90% der Geschäfte nicht NIEDRIGER als _____ € liegt.

21. B) (Backward Looking Approach)

Ich denke, dass der Preis für mein Lieblingsprodukt zum Zeitpunkt meines letzten Kaufs in 90% der Geschäfte nicht NIEDRIGER als _____ € lag.

Die gleich zur Auswahl stehenden Produkte können drei verschiedene Siegel tragen (die Siegel beziehen sich dabei immer auf die Zutat Palmöl):

1. Das deutsche *Bio* Siegel



Das Bundesministerium für Ernährung und Landwirtschaft Vergibt das **deutsche Bio-Siegel**. Es handelt sich somit um ein staatliches Siegel.

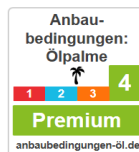
2. Das *RSPO* Siegel



Der Roundtable on Sustainable Palm Oil wurde auf Initiative des WWF und Unilever gegründet. Mitglieder des Roundtable sind Umweltschutzverbände, Nichtregierungsorganisationen, Konzerne, Banken und andere Institutionen, die an der Produktion und Verarbeitung von Palmöl beteiligt sind. **Es handelt sich somit um ein Siegel mit privatem Charakter.**

MIXED (oder Mass Balance) bedeutet, dass zum Teil RSPO zertifiziertes und zum Teil nicht-zertifiziertes Palmöl im Produkt ist. Die exakten Anteile sind dabei nicht bekannt.

3. Das *Anbau-Konditionen* Siegel



Das *Anbau-Konditionen* Siegel bezieht sich auf die Anbaubedingungen der Ölpalme. Wie auch beim neuen Tierhaltungslabel wird das hier gezeigte **Siegel durch den Handel** (z.B. Rewe, Lidl, Aldi, Edeka etc.) **etabliert. Dieser ist somit ebenfalls für die Festlegung der Kriterien, sowie die Organisation der Kontrolle verantwortlich.** Es kennzeichnet durch die Stufen eine schrittweise Verbesserung in einzelnen sozialen und ökologischen Aspekten. Im Rahmen der Siegelvergabe werden sämtliche Nachhaltigkeitsaspekte (wie ein Gesamtfußabdruck) des jeweiligen Produkts in die Bewertung mit einbezogen.

Sie werden im Experiment die Stufen 4 (Premium) oder 2 (ähnlich der zuvor beschriebenen Mass Balance) sehen.

Sie können sich im Folgenden je für eines der abgebildeten Produkte oder den nicht-Kauf entscheiden.

- CHOICE SETS, 6x -

23. Auf welche der gezeigten Produkteigenschaften haben Sie bei der Wahl des Produktes nicht oder am wenigsten geachtet.

-Dropdown-

Marke

RSPO-Siegel

Bio-Siegel

4-Stufen-Siegel (Anbaubedingungen)

Preis

24. Bitte bringen Sie die Produkteigenschaften in eine Reihenfolge, sodass die für Ihre Kaufentscheidung wichtigste Eigenschaft an erster Stelle und die unwichtigste Eigenschaft an letzter Stelle steht.

1. _____ 2. _____

3. _____ 4. _____

5. _____

Demografie

Im Folgenden geht es um allgemeine Angaben zu Ihrem Haushalt und Ihrer Person. Selbstverständlich werden auch diese Angaben streng vertraulich behandelt. Sie dienen dazu tiefergehende statistische Untersuchungen durchzuführen und können zu keinem Zeitpunkt mit Ihnen persönlich in Zusammenhang gebracht werden.

25. Wie viele Personen (Sie selbst eingeschlossen) leben in Ihrem Haushalt?

26. Leben Kinder in Ihrem Haushalt?

Ja ☐ Nein ☐

Wenn ja, wie viele Kinder sind jünger als 12 Jahre?

27. Was ist Ihr höchster Bildungsabschluss?

-Dropdown-

Noch keinen Abschluss

Keinen Abschluss

Haupt- oder Volksschulabschluss

Realschulabschluss

Abitur / Fachabitur

Berufsausbildung

Meister

Universitätsabschluss

28. In welchem Jahr sind Sie geboren worden?

29. Wie hoch ist das (ungefähre) monatliche Nettoeinkommen Ihres Haushalts?

Das Einkommen aller Haushaltsmitglieder, das nach Abzug der Steuern und zuzüglich aller Zahlungen (z.B. Kindergeld) pro Monat zum Leben, Wohnen, Einkaufen etc. zur Verfügung steht.

- | | | |
|--|--|--|
| ☐ Unter 500€ | ☐ 1501€ bis 2000€ | ☐ 3001€ bis 3500€ |
| ☐ 501€ bis 1000€ | ☐ 2001€ bis 2500€ | ☐ 3501€ bis 5000€ |
| ☐ 1001€ bis 1500€ | ☐ 2501€ bis 3000€ | ☐ Mehr als 5000€ |

30. Bitte geben Sie hier Ihr Geschlecht an.

- ☐ Weiblich ☐ Männlich ☐ Divers

31. Tragen Sie bitte hier die ersten zwei Ziffern Ihrer Postleitzahl ein.

Abschlussfrage:

Wenn am Sonntag **Bundestagswahl** wäre, würde ich mich folgende Partei entscheiden:

- | | | |
|------------------------------------|------------------------------------|-------------------------------------|
| ☐ CDU / CSU | ☐ AFD | ☐ DIE PARTEI |
| ☐ SPD | ☐ FDP | ☐ SONSTIGE |
| ☐ GRÜNE | ☐ DIE LINKE | |

Risk Elicitation Games

Abschließend möchten wir Ihnen noch ein paar spielerische Fragen stellen, bei denen Sie die Chance haben noch etwas zu gewinnen.

Stellen Sie sich bitte ein Spiel vor, bei dem verschiedenfarbige Bälle verdeckt aus zwei Urnen gezogen werden können. Ihre Aufgabe ist es sich zwischen zwei Spieloptionen, A und B, zu entscheiden. Mit etwas Glück können Sie entsprechend Ihrer getroffenen Wahl, Geld bei den Auswahlspielen gewinnen. Beim abschicken des Fragebogens steht es Ihnen frei eine E-Mail-Adresse anzugeben, um an dem Gewinnspiel teilzunehmen. Eine angegebene E-Mail-Adresse wird dabei unter keinen Umständen mit Ihren vorangegangenen Angaben im Fragebogen in Verbindung gebracht. Sollten Sie unter den 50 Gewinnern sein, wird **eine** der von Ihnen gewählten Spielreihen per Zufallsprinzip ausgewählt und Sie erhalten den Gewinn aus diesem Spiel. Da es auch zu negativen Spielausgängen kommen kann **starten alle Kandidatinnen und Kandidaten mit einem Budget von 20€**. Das Startbudget von 20€ verhindert somit, dass Sie die Spielserie mit einem Nettoverlust beenden können.

Vorab ein Beispiel wie diese Auswahlspiele funktionieren.

Zwei Urnen enthalten je 10 Bälle. Betrachten Sie die folgenden Auswahlmöglichkeiten.

Urne A 3 weiße + 7 rote		Urne B 1 weißer + 9 rote		Ihre Wahl:	
Wenn der gezogene Ball WEISS ist	Wenn der gezogene Ball ROT ist	Wenn der gezogene Ball WEISS ist	Wenn der gezogene Ball ROT ist		
3/10	7/10	1/10	9/10		
200 €	100 €	3000 €	75 €	A	B
250 €	-40 €	300 €	-210 €	A	B

Erklärung des Beispiels:

Ihre Aufgabe ist es, sich für Urne A **oder** Urne B zu entscheiden.

Urne A enthält 3 weiße und 7 rote Bälle. Wir betrachten beispielhaft die erste Zeile mit möglichen Gewinnen. Wenn ein weißer Ball gezogen wird (3 von 10 Bällen in Urne A sind weiß) gewinnen Sie einen Betrag von 200€. Wenn ein roter Ball gezogen wird (7 von 10 Bällen sind rot) gewinnen Sie einen Betrag von 100€. Für die Urne B gelten die gleichen Bedingungen. Wenn ein weißer Ball gezogen wird (1 von 10 Bällen ist weiß) erhalten Sie 3000€. Wird ein roter Ball gezogen (9 von 10 sind rot) verlieren Sie -210€.

Wie kann man gewinnen?

Sie werden auf diese Weise eine ganze Reihe von Entscheidungen in insgesamt 9 Spielserien treffen. Ihre Entscheidungen haben einen direkten Einfluss auf den möglichen Ausgang des jeweiligen Spiels. Ebenso wie die dargestellten Wahrscheinlichkeiten. Mit Teilnahmeschluss (TT.MM.2019) werden sämtliche Spielausgänge ermittelt und mit den Entscheidungen aller Teilnehmer abgeglichen. Diejenigen 50 Personen, die sich die höchsten Beträge erspielt haben sind dann in der finalen Gewinnerrunde (sollte es zu Gleichständen bei den Beträgen kommen entscheidet der Zufall zwischen diesen Personen).

Was passiert in der Gewinnerrunde?

Jeder der 50 Gewinner mit den höchsten Scores (gemäß der Geldwerte aus allen Spielen) erhält für die finale Runde per se ein Guthaben von 20€. Per Zufallsprinzip wird dann **eine** Spielzeile aus allen Spielen ausgewählt. Diese zugeordnete Spielzeile und die Entscheidung, die der jeweilige Spieler in dieser Zeile getroffen hat, bestimmen dann den Gesamtwert welcher durch 50 dividiert und zum Guthaben von 20€ hinzugerechnet bzw. davon abgezogen wird.

- 1. Beispiel:** Sollten Sie sich im zuvor gezeigten Beispiel in **Zeile 1** für **Urne B** entschieden haben und es wird eine **weiße Kugel** gezogen, so liegt Ihr Spielgewinn bei 3000€. Anschließend wird dieser Betrag durch 50 geteilt, was einen Betrag von 60€ ergibt. Hinzu kommen die von Beginn an zugewiesenen 20€. Da diese Zahlenwerte den maximalen Gewinn darstellen, **können Sie somit einen maximalen Auszahlungsbetrag von 80€ erhalten.**
- 2. Beispiel:** Sie entscheiden sich im Beispiel in **Zeile 2** erneut für **Urne B**. Es wird bei der Durchführung des Spieles eine **Rote Kugel** gezogen. Dieses Ergebnis steht für einen Wert von -210€. Der Wert wird durch 50 geteilt, was einem Betrag von -4,20€ entspricht. Dieser Betrag wird von Ihren 20€ abgezogen, sodass Sie einen Auszahlungsbetrag von 15,80€ erhalten.

Ihre Aufgabe ist es nun sich für eine der beiden Urnen zu entscheiden. Aus welcher Urne soll ein Ball gezogen werden, A oder B?

HINWEIS: Sie müssen nicht in jeder Zeile Ihre Entscheidung ankreuzen. Sie brauchen lediglich einen Strategiewechsel ankreuzen. Das heißt, wenn Sie in Zeile 1 Urne A wählen, dann brauchen Sie nur in derjenigen Zeile erneut eine Markierung setzen, ab der Sie Ihre Strategie auf Urne B ändern möchten. Beispiel: In Zeile 1 Kreuzen Sie A an und in Zeile 5 kreuzen Sie B an. Dies bedeutet, dass Sie in den Zeilen 1 bis 4 die Strategie **Urne A** spielen und in Zeile 5 bis 14 **Urne B**.

Bedenken Sie, dass (wenn Sie es möchten) per Zufall eine der Spielzeilen für Sie ausgewählt wird und Sie, wie eingangs beschrieben, gewinnen können.

Spiel 1/9:

Urne A		Urne B		Ihre Wahl:
3/10	7/10	1/10	9/10	
200 €	100 €	270 €	75 €	A B
200 €	100 €	280 €	75 €	A B
200 €	100 €	350 €	75 €	A B
200 €	100 €	390 €	75 €	A B
200 €	100 €	430 €	75 €	A B
200 €	100 €	450 €	75 €	A B
200 €	100 €	480 €	75 €	A B
200 €	100 €	520 €	75 €	A B
200 €	100 €	600 €	75 €	A B
200 €	100 €	700 €	75 €	A B
200 €	100 €	900 €	75 €	A B
200 €	100 €	1200 €	75 €	A B

200 €	100 €	2200 €	75 €	A	B
200 €	100 €	3000 €	75 €	A	B

Spiel 2/9: Bitte wählen Sie wie zuvor Ihre bevorzugte Urne. Beachten Sie, dass sich die Wahrscheinlichkeiten, das heißt die Verteilung der farbigen Bälle und die Gewinnbeträge geändert haben.

Urne A		Urne B		Ihre Wahl:
9/10	1/10	7/10	3/10	
400 €	300 €	450 €	50 €	A B
400 €	300 €	485 €	50 €	A B
400 €	300 €	500 €	50 €	A B
400 €	300 €	525 €	50 €	A B
400 €	300 €	540 €	50 €	A B
400 €	300 €	560 €	50 €	A B
400 €	300 €	580 €	50 €	A B
400 €	300 €	600 €	50 €	A B
400 €	300 €	625 €	50 €	A B
400 €	300 €	640 €	50 €	A B
400 €	300 €	680 €	50 €	A B
400 €	300 €	740 €	50 €	A B
400 €	300 €	820 €	50 €	A B
400 €	300 €	1000 €	50 €	A B

Spiel 3/9: Bitte wählen Sie wie zuvor Ihre bevorzugte Urne. Beachten Sie, dass sich die Wahrscheinlichkeiten und die Gewinnbeträge erneut geändert haben. Außerdem sind negative Beträge hinzugefügt worden.

Urne A		Urne B		Ihre Wahl:
5/10	5/10	5/10	5/10	
250 €	-40 €	300 €	-210 €	A B
40 €	-40 €	300 €	-210 €	A B
10 €	-40 €	300 €	-210 €	A B
10 €	-40 €	300 €	-160 €	A B
10 €	-80 €	300 €	-160 €	A B
10 €	-80 €	300 €	-140 €	A B
10 €	-80 €	300 €	-110 €	A B

Spiel 4/9: Bitte wählen Sie wie zuvor Ihre bevorzugte Urne. Beachten Sie, dass sich die Wahrscheinlichkeiten und die Gewinnbeträge erneut geändert haben. Achtung, hier geht es um negative Zahlenwerte!

Urne A		Urne B		Ihre Wahl:
1/10	9/10	3/10	7/10	
-200 €	-75 €	-150 €	-100 €	A B
-210 €	-75 €	-150 €	-100 €	A B
-350 €	-75 €	-150 €	-100 €	A B
-390 €	-75 €	-150 €	-100 €	A B
-430 €	-75 €	-150 €	-100 €	A B
-480 €	-75 €	-150 €	-100 €	A B
-520 €	-75 €	-150 €	-100 €	A B
-540 €	-75 €	-150 €	-100 €	A B
-580 €	-75 €	-150 €	-100 €	A B
-620 €	-75 €	-150 €	-100 €	A B
-700 €	-75 €	-150 €	-100 €	A B
-780 €	-75 €	-150 €	-100 €	A B
-850 €	-75 €	-150 €	-100 €	A B
-1000 €	-75 €	-150 €	-100 €	A B

Spiel 5/9: Bitte wählen Sie wie zuvor Ihre bevorzugte Urne. Beachten Sie, dass sich die Wahrscheinlichkeiten und die Gewinnbeträge erneut geändert haben. Achtung, es geht immer noch um negative Zahlenwerte!

Urne A		Urne B		Ihre Wahl:
7/10	3/10	9/10	1/10	
-450 €	-50 €	-400 €	-300 €	A B
-480 €	-50 €	-400 €	-300 €	A B
-490 €	-50 €	-400 €	-300 €	A B
-500 €	-50 €	-400 €	-300 €	A B
-510 €	-50 €	-400 €	-300 €	A B
-525 €	-50 €	-400 €	-300 €	A B
-540 €	-50 €	-400 €	-300 €	A B
-560 €	-50 €	-400 €	-300 €	A B
-580 €	-50 €	-400 €	-300 €	A B
-600 €	-50 €	-400 €	-300 €	A B
-625 €	-50 €	-400 €	-300 €	A B
-640 €	-50 €	-400 €	-300 €	A B
-800 €	-50 €	-400 €	-300 €	A B
-1000 €	-50 €	-400 €	-300 €	A B

Spiel 6/9: An dieser Stelle hat sich das Spiel leicht verändert. Urne A enthält 5 rote und 5 weiße Bälle. Urne B enthält entweder 10 weiße oder 10 rote Bälle. Wichtig: Sie wissen nichts über die Wahrscheinlichkeiten, mit der weiße oder rote Bälle in der Urne sind, da dies spontan durch einen Forscher entschieden wird. Diese Person kennt Ihre Entscheidung nicht, kann aber selbst willkürliche Entscheidungen bei der Auswahl der Urne treffen. Im ersten Schritt müssen Sie sich deshalb entscheiden ob Sie sich auf ROT oder auf WEISS festlegen möchten.

Zur Erinnerung: für Urne A existieren feste Wahrscheinlichkeiten, da stets 5 rote und 5 weiße Bälle in der Urne sind. Die Wahrscheinlichkeit ist bei Urne B völlig ungewiss (Sie ist nicht 50:50 nur, weil es zwei Farben gibt!).

Auf welche Farbe möchten Sie sich festlegen?

☐ ROT ☐ WEISS

Bitte wählen Sie wie zuvor Ihre bevorzugte Urne. Denken Sie daran, dass Sie auf eine bestimmte Farbe gesetzt haben.

Urne A 5 Rote + 5 Weiße		Urne B 10 Bälle der gleichen Farbe (Wahrscheinlichkeit ungewiss)		Ihre Wahl:
Ihre Farbe wird NICHT gezogen	Ihre Farbe wird gezogen	Ihre Farbe wird NICHT gezogen	Ihre Farbe wird gezogen	
0 €	1000 €	0 €	100 €	A B
0 €	750 €	0 €	100 €	A B
0 €	500 €	0 €	100 €	A B
0 €	250 €	0 €	100 €	A B
0 €	150 €	0 €	100 €	A B
0 €	110 €	0 €	100 €	A B
0 €	100 €	0 €	100 €	A B
0 €	90 €	0 €	100 €	A B
0 €	70 €	0 €	100 €	A B
0 €	50 €	0 €	100 €	A B
0 €	40 €	0 €	100 €	A B
0 €	30 €	0 €	100 €	A B
0 €	20 €	0 €	100 €	A B
0 €	10 €	0 €	100 €	A B

Spiel 7/9: Es kommt eine weitere Farbe ins Spiel. Bitte legen Sie sich zuerst auf eine Farbe fest.

Auf welche Farbe möchten Sie sich festlegen?

☐ BLAU ☐ GELB ☐ GRÜN

Bitte wählen Sie wie zuvor Ihre bevorzugte Urne. Denken Sie daran, dass Sie auf eine bestimmte Farbe gesetzt haben.

Urne A 5 Blaue + 5 Gelbe + 5 Grüne		Urne B 15 Bälle der gleichen Farbe (Wahrscheinlichkeit ungewiss)		Ihre Wahl:
Ihre Farbe wird NICHT gezogen	Ihre Farbe wird gezogen	Ihre Farbe wird NICHT gezogen	Ihre Farbe wird gezogen	
0 €	1050 €	0 €	75 €	A B
0 €	500 €	0 €	75 €	A B
0 €	250 €	0 €	75 €	A B
0 €	100 €	0 €	75 €	A B
0 €	80 €	0 €	75 €	A B
0 €	70 €	0 €	75 €	A B
0 €	60 €	0 €	75 €	A B
0 €	50 €	0 €	75 €	A B
0 €	40 €	0 €	75 €	A B
0 €	35 €	0 €	75 €	A B
0 €	30 €	0 €	75 €	A B
0 €	25 €	0 €	75 €	A B
0 €	15 €	0 €	75 €	A B
0 €	5 €	0 €	75 €	A B

Spiel 8/9: Bitte entscheiden Sie sich wieder für eine von zwei Farben. Achtung, hier geht es um negative Zahlenwerte!

Auf welche Farbe möchten Sie sich festlegen?

☐ ROT ☐ WEISS

Bitte wählen Sie wie zuvor Ihre bevorzugte Urne.

Urne A 5 Rote + 5 Weiße		Urne B 10 Bälle der gleichen Farbe (Wahrscheinlichkeit ungewiss)		Ihre Wahl:
Ihre Farbe wird NICHT gezogen	Ihre Farbe wird gezogen	Ihre Farbe wird NICHT gezogen	Ihre Farbe wird gezogen	
0 €	-10 €	0 €	-100 €	A B
0 €	-50 €	0 €	-100 €	A B

0 €	-75 €	0 €	-100 €	A	B
0 €	-100 €	0 €	-100 €	A	B
0 €	-125 €	0 €	-100 €	A	B
0 €	-150 €	0 €	-100 €	A	B
0 €	-160 €	0 €	-100 €	A	B
0 €	-170 €	0 €	-100 €	A	B
0 €	-180 €	0 €	-100 €	A	B
0 €	-200 €	0 €	-100 €	A	B
0 €	-220 €	0 €	-100 €	A	B
0 €	-250 €	0 €	-100 €	A	B
0 €	-500 €	0 €	-100 €	A	B
0 €	-1000 €	0 €	-100 €	A	B

Spiel 9/9: Im letzten Spiel geht es noch einmal um drei Farben, Blau, Gelb und Grün.

Auf welche Farbe möchten Sie sich festlegen?

☐ BLAU ☐ GELB ☐ GRÜN

Bitte wählen Sie wie zuvor Ihre bevorzugte Urne. Denken Sie daran, dass Sie auf eine bestimmte Farbe gesetzt haben. Es geht weiterhin um negative Zahlenwerte!

Urne A 5 Blaue + 5 Gelbe + 5 Grüne		Urne B 15 Bälle der gleichen Farbe (Wahrscheinlichkeit ungewiss)		Ihre Wahl:
Ihre Farbe wird NICHT gezogen	Ihre Farbe wird gezogen	Ihre Farbe wird NICHT gezogen	Ihre Farbe wird gezogen	
0 €	-5 €	0 €	-75 €	A B
0 €	-20 €	0 €	-75 €	A B
0 €	-30 €	0 €	-75 €	A B
0 €	-40 €	0 €	-75 €	A B
0 €	-50 €	0 €	-75 €	A B
0 €	-60 €	0 €	-75 €	A B
0 €	-70 €	0 €	-75 €	A B
0 €	-75 €	0 €	-75 €	A B
0 €	-85 €	0 €	-75 €	A B
0 €	-100 €	0 €	-75 €	A B
0 €	-150 €	0 €	-75 €	A B
0 €	-250 €	0 €	-75 €	A B
0 €	-500 €	0 €	-75 €	A B
0 €	-890 €	0 €	-75 €	A B

Appendix B:

Questionnaire II: Palm oil processing industry Germany

The questionnaire as well as the e-mail cover letter to the participants of the questionnaire from the palm oil processing industry in Germany are presented in the following section. Since the study was conducted in German, both the questionnaire and the cover letter are presented in their original versions.

Sehr geehrte Damen und Herren,

das Institut für Ernährungswirtschaft und Verbrauchslehre der Universität Kiel führt derzeit eine Studie im Themenbereich der Nachhaltigkeit in Bezug auf den Agrarrohstoff Palmöl durch.

Bei diesem ganzheitlichen Ansatz sollen möglichst viele Akteure der Wertschöpfungskette Berücksichtigung finden.

Aus diesem Grund möchten wir Sie um den großen Gefallen bitten, an unserer Kurzumfrage zu diesem Thema teilzunehmen, da Ihre Sichtweisen und Meinungen von absoluter Wichtigkeit bei der ganzheitlichen Darstellung einer derart komplexen Thematik sind.

Der Fragebogen wird **allerhöchstens 5 Minuten** Ihrer Zeit in Anspruch nehmen.

Wir wären Ihnen sehr verbunden, wenn Sie die Umfrage an eine Person in Ihrem Unternehmen weiterleiten könnten, die mit dem Sachgebiet des Rohwareneinkaufs vertraut ist (wie z.B. Einkauf, Geschäftsleitung oder auch Nachhaltigkeitsbeauftragte etc.).

Wichtig: Wir erfassen dabei keinerlei Daten, die in irgendeiner Weise Rückschlüsse auf Ihr Unternehmen oder gar eine bestimmte Person zulassen. Sämtliche Eingaben sind zu einhundert Prozent anonym.

Sie erreichen die Umfrage über den unterstehenden Link.

<https://ww2.unipark.de/uc/uni-kiel-nachhaltigkeit/>

Wir bedanken uns recht herzlich für Ihre Zeit.

Mit freundlichen Grüßen

Christoph Richartz

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Fragebogen

1. Nutzen Sie bei der Produktion mindestens eines Ihrer Produkte den Pflanzenrohstoff Palmöl?

Ja / Nein, bei nein → vielen Dank, **ENDE**

2. Ist dieser Rohstoff für die Qualität Ihrer Produkte von absoluter Wichtigkeit?

Likert Skala: von 1, nein, gar nicht wichtig bis 5, ja, unabdingbar wichtig

3. Nutzen Sie Zertifiziertes Palmöl?

Likert Skala: von 1, nein bis 5, ja, ausschließlich

4. Welche Zertifizierung trägt dieses Palmöl?

- RSPO (segregated)
- RSPO (andere Stufe: _____)
- Bio
- Andere: _____
- weiß nicht

5.1. Könnten Sie sich für Ihren Betrieb vorstellen, ausschließlich Bio-Zertifiziertes Palmöl zu verwenden?

Likert Skala: von 1, unter keinen Umständen bis 5, ja, extrem wahrscheinlich

5.2. Wenn nein (1, 2) : Aus welchem Grund stellt die Verwendung von Bio-Palmöl eine Schwierigkeit dar?

- Zu hohe Kosten
- Zu geringe Verfügbarkeit
- Zur große Unsicherheiten innerhalb der Lieferketten
- Anderer Grund: _____

6. Laut Christian Sewing, Vorsitzendem der Deutschen Bank, wird „In fünf oder zehn Jahren das Nachhaltigkeits-Ranking für ein [...] Unternehmen genauso wichtig sein wie heute eine herkömmliche finanzielle Bonitätsbewertung [...]“, eine Einschätzung, die laut WELT (09.01.2020)

von führenden Regierungsberatern geteilt wird. Und bei der öffentlichen Vorstellung der Klimaklage am 15.01.2020 äußerte Luisa Neubauer als Sprecherin für die Klimabewegung *Fridays for Future*, dass sämtliche Unternehmen heute vor der Wahl stünden, „Teil des Problems oder Teil der Lösung“ zu sein.

Fürchten Sie dieses Szenario oder stehen Sie einer derartigen Entwicklung positiv erwartungsvoll gegenüber?

Likert Skala: von 1, überhaupt nicht positiv bis 5, ausschließlich positiv erwartungsvoll

7. Denken Sie als Unternehmen, in diesem Zusammenhang und hinsichtlich der derzeitigen Sensibilisierung dieser Thematik in der Bevölkerung darüber nach, Ihren Betrieb auf immer nachhaltigere Produktionsprozesse Umzustellen?

Likert Skala: von 1, nein, überhaupt nicht bis 5, ja, es bestehen konkrete Pläne zur Transformation

8. Könnten Sie sich vorstellen, dass Ihr Unternehmen ein eigenes Projekt aufbaut oder mitträgt, in welchem ausschließlich Bio-zertifiziertes Palmöl (z.B. aus Ghana, Nigeria, Kolumbien oder Ecuador) produziert wird, um so Ihr Unternehmen nachhaltiger zu machen und / oder durch die Distanzierung von asiatischem Öl von der Öffentlichkeit als nachhaltiger wahrgenommen zu werden?

Likert Skala: von 1, nein, auf keinen Fall bis 5, ja, mit großer Wahrscheinlichkeit

9. Wie ist die ungefähre Betriebsgröße Ihres Unternehmens (Anzahl der Mitarbeiter)?

- 1-19
- 20-49
- 50-99
- 100-249
- 250-499
- 500 und mehr

10. Falls Sie uns noch ein Kommentar hinterlassen möchten haben Sie hier die Gelegenheit.
-

Appendix C:

Questionnaire III: Survey on smallholder palm oil farmers in Ghana

Survey Identification		General Information	
Questionnaire number		Region	
Name of enumerator		District	
Code of enumerator		Name of village / town	
Date of interview		Household Number	
Time started		Name and Surname of Household Head	
End of Interview		Name of Respondent (if different from Household Head)	
GPS coordinates of homestead		Mobile Number	

Section A: Socio demographic characteristics of respondents

1	Name of respondent	
2	Age	
3	Sex 1 = Male 2 = Female	
4	Relationship to household head 1 = Head, 2 = Spouse, 3 = Son/Daughter, 4 = Son/Daughter in law, 5 = Father/Mother, 6 = Father/Mother in law, 7 = Brother/Sister, 8 = Grandchild, 9 = Other relative, 10 = Non relative	
5	Marital status 1 = Married (monogamous), 2 = Married (polygamous), 3 = Single, 4 = Divorced, 5 = Widowed	
6	Family type 1 = nuclear, 2 = extended, 3 = other (specify)	
7	Household size	
8	Years of education	
9	Can head of HH read and write in English?	
10	Please indicate the distance from your homestead to the closest primary school (km)	
11	Please indicate the distance from your homestead to the closest secondary school (km)	
12	Religion 1 = Islam, 2 = Christianity, 3 = Traditional, 4 = Others specify	
13	Ethnicity/Tribe 1 = Akan, 2 = GA, 3 = EWE, 4 = Northerner, 5 = Foreigner (Togo, Burkina Faso, ...)	

14	Status in the locality 1 = chief, 2 = village executive, 3 = member, 4 = Migrant, 5 = Religious, leader, 6 = political party leader, 7 = other (specify)				
15	Occupation (List main and secondary occupation according to time spent) 1 = Farmer (crops, trees, livestock and aquaculture) 2 = Non-farm owned business (e.g. tailoring, etc.); 3 = Casual laborer on another farm 4 = Civil/public servant; 5 = Housewife 6 = Unemployed; 7 = Student; 8 = Retired; 9 = Other, specify				
a.	Main occupation	b.	Secondary occupation		
16	Other sources of income: Please specify				
17	Please specify if A 15 includes option 2 (non-farm business)				
18	Please indicate the amount of money you earn from your off-farm work per year. (GHS)				
19	Experience in own farming activities (years)				
20	For how many years have you been cultivating Oil Palms?				
21	How much time do you spend on your:				
22	Main occupation (h / d)	A. 20b	Secondary occupation (h / d)		
23	What is the distance between your homestead and the village chief's homestead [WALKING MINUTES]				
26	Please indicate total number of household members in their respective category as in the table below				
27	Household member	Gender		Age	Enrolled in school? 0 = No 1 = primary 2 = secondary
	Name	Male	Female		

Section B. Land tenure

We would like to ask some questions about the land (oil palm plots!) which the household used either free of charge or rented in the last 12 months. Please record all information per plot (maximum of 5 plots). **manager means decisionmaker for the plot and all activities related to this plot (e.g. which crop, SAS, etc.)

Plot ID	Size (In Acres)	Household member responsible for this plot 1=Household head 2=Spouse 3=child	Is the Plot managed** by 1 = male 2 = female or 3 = jointly-managed	Land tenure See code below	Years of ownership if the farmer owns the land	Years of usage	If rented, what is the cost of renting per year (per acre)? (if option 6 is chosen)	Did the household have a deed on this plot? 1. Yes 2. No	What kind of deed? 1. Certificate (deed from Lands Commission) 2. Letter from village chief 3. Contract of sale 4. Other, specify	Does the household have the right to sell the plot or to use it as collateral? 1. No 2. Sell 3. Collateral 4. Both	If the plot were to be sold now, how much would it be worth? (GHS)	Main land use See code below		What is the distance from the homestead to the plot? Miles
												a	b	
	LT 1	LT 2.1	LT 2.2	LT 3	LT 4	LT 5	LT 6	LT 7	LT 8	LT 9	LT 10	LT 11	LT 12	LT 13
1														
2														
3														
4														
5														

Code LT 3

1. Owned by respondent
2. Owned by other household member
3. Owned by family
4. Community land, distributed by the chief
5. Land made arable by the household
6. Rented-in for fixed pay
7. Sharecropper (Abunu)
8. Sharecropper (Abusa)

Code LT11/LT12 (up to 2 answers per plot)

1. Rented-out for oil palm cultivation
2. Rented out for cultivation of other crop production
3. Sharecropped-out for oil palm cultivation
4. Sharecropped-out for other crop production
5. Forest
6. Pasture
7. Bushland / wetland
8. Fallow

9. Other, specify

9. Cultivation of oil palms

10. Cultivation of other cash crops (please specify)

11. Cultivation of other food crops (please specify)

12. Other, specify

Section D. Information on Cultivated Oil Palms

Now I would like to know more about your oil palm plots during the last cropping season / last 12 months.

*Interviewer information: *1 mixed cropping: all crops are cared equally. There is competition between oil palm and all other crops growing. *2 inter cropping: the main object is to utilize the space left between rows of oil palm trees. More emphasis is given to the oil palm.*

	Repeat for each plot [plot_ID: 1 to 5]
33	Slope of this plot 1 = Flat 2 = Moderate 3 = steep
34	Vegetation before you started farming on the plot 1=forest (>200 trees), 2=semi-forest (200 to 50 trees) 3=savanna (<50 trees) 4=other crop for home consumption 5=other cash crop
35	What is the major type of soil of this plot? 1=sandy 2=loamy 3=clay 4=laterite 5=other, specify
36	Rank the level of erosion of the plot 1=no erosion 2=minimal erosion 3=moderate erosion

	4=eroded 5=severe erosion
37	Soil quality (fertility) 1=infertile, 2= moderately fertile 3=fertile 4=highly fertile
38	Did you use fire (slash-and-burn) for the <i>FIRST</i> clearing? (1=yes, 2=no)
39	Which one of the 3 systems is dominant on your plots? 1 = Mono cropping (only oil palms) 2 = Mixed cropping* ¹ 3 = Inter cropping* ²
40	If D1. = 2 or 3: What other crops are planted on this plot? 1. Maize 2. Cashew 3. Cotton 4. Groundnut 5. Sorghum 6. Mango 7. Millet 8. Rice 9. Soybeans 10. Yam 11. Vegetables 12. Other, specify
41	Are you aware of certifications for palm oil cultivation? [NOT PLOT LEVEL] Yes / No

42	Which certification is associated with this plot? 1 = RSPO, 2 = Organic, 3 = global GAP, 4 = Fair trade, 5 = Rainforest Alliance, 6 = other (specify), 7 = none
43	Which household member is the decision maker on this oil palm plot? [SELECT HH_MEM_ID]
44	How many oil palm trees do you have on each plot? (UNIT: NUMBER OF TREES) <i>* IF THE FARMER CANNOT GIVE A PRECISE NUMBER, ASK HIM TO SAY WITHIN RANGES: E.G. 0-5, 5-10, 10-20, 20-30.</i>
45	Did you use lining and pegging planting patterns for your oil palm plot? Yes / No
46	If D.4.1 = Yes, how far is the distance <u>between</u> each oil palm? (UNIT: METER)
47	Have you planted oil palms in the past 3 years on this plot? Yes / no If NO >> IGNORE NEXT Q.
48	How many oil palms have you planted in the last 3 years? (UNIT: NUMBER OF TREES, <i>IF THE FARMER CANNOT GIVE A PRECISE NUMBER, ASK HIM TO SAY WITHIN RANGES: E.G. 0-5, 5-10, 10-20, 20-30</i>)
49	How old is the <u>youngest tree</u>? [AGE OF TREE]
50	How old is the <u>oldest tree</u>? [AGE OF TREE]
52	In which year were you able to make your first harvest? [YEAR]
53	Which varieties of Oil Palm do you grow on your land at the moment? (1 = DURA; 2 = TENERA; 3 = PISIFERA; 4 = OTHER) → GET INFO FROM EXT. OFF.

54	Why did you decide to plant this variety and not another one? 1 = BUYER DEMANDS OR MARKET NEED; 2 = LOWER COST OF PRODUCTION; 3 = AVAILABILITY OF SEEDLINGS; 4 = NEVER DECIDED / VARIETY WAS ALREADY ON THE PLOT 5 = OTHER (SPECIFY)			
55	How did you obtain the seedling? 0=NEVER PURCHASED A SEEDLING 1=PURCHASED WITHOUT SUBSIDY 2=IN-KIND CREDIT 3=GIFTED 4=OWN PRODUCTION 5=PURCHASED THROUGH SUBSIDY 6=PROVIDED BY COMPANY / CONTRACT FARMING			
56	From whom did you obtain the seed? 1=EXTENSION WORKER 2=OTHER FARMER IN THE VILLAGE 3=OTHER FARMER OUTSIDE THE VILLAGE 4=OWN PRODUCTION 5=LOCAL MARKET 6=TRADER 7=OTHER(SPECIFY)			
58	How many times a year are you able to harvest FFB?			
	Plot Level End.			
59	Have you been working in the palm oil value chain sector prior to starting your own farm? [0=No; 1=Yes]			
60	If D. 14 = YES (1), in what position were you working? (OPEN)			
61	How did you learn oil palm farming? 1 = FROM FAMILY MEMBERS; 2 = AS A LABORER ON A FARM; 3 = FROM FRIENDS; 4 = FROM A TRAINING COURSE; 5 = BY MYSELF.			
62	How much of your oil palm yield do you...?	1 = use for own consumption	2 = sell on local market	3 = sell for export
		%	%	%

63	Do you intend to cultivate more, less or the same amount of oil palms next year? 1 = more; 2 = less; 3 = the same
64	In total, did you cultivate more, less or the same amount of oil palms 5 years ago? 1 = more; 2 = less; 3 = the same
65	What do you do with your agricultural production waste? 1 = I burn it; 2 = I throw it away; 3 = I re-use it as manure; 4 = I sell it; 5 = Other (specify)

Section E. Certification

E. 1	Do you currently hold any certification for your oil palms? [0=No; 1=Yes]																																															
E. 2	Certification 1 = RSPO, 2 = Organic, 3 = Fair Trade, 4 = other (specify)																																															
E. 3	Do you currently hold any certification for any other crop? [0=No; 1=Yes, SPECIFY]																																															
E. 4	If E.1 = 0 (No), what are your reasons for not being certified? <table border="1"> <thead> <tr> <th>Statements</th><th>Agree</th><th>Partly agree</th><th>Neither</th><th>Partly disagree</th><th>Disagree</th></tr> </thead> <tbody> <tr> <td>I get higher prices on the spot market.</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr> <tr> <td>I don't want to lose autonomy/ I don't want to become dependent on the contract partner.</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr> <tr> <td>I'm not able to adapt international traceability obligations.</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr> <tr> <td>I haven't found a buyer yet who wants to buy certified FFB.</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr> <tr> <td>I have been selling under contract in the past, but the partnership was not reliable.</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr> <tr> <td>There is just no need for me to join a contract.</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr> </tbody> </table>						Statements	Agree	Partly agree	Neither	Partly disagree	Disagree	I get higher prices on the spot market.	☐	☐	☐	☐	☐	I don't want to lose autonomy/ I don't want to become dependent on the contract partner.	☐	☐	☐	☐	☐	I'm not able to adapt international traceability obligations.	☐	☐	☐	☐	☐	I haven't found a buyer yet who wants to buy certified FFB.	☐	☐	☐	☐	☐	I have been selling under contract in the past, but the partnership was not reliable.	☐	☐	☐	☐	☐	There is just no need for me to join a contract.	☐	☐	☐	☐	☐
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I get higher prices on the spot market.	☐	☐	☐	☐	☐																																											
I don't want to lose autonomy/ I don't want to become dependent on the contract partner.	☐	☐	☐	☐	☐																																											
I'm not able to adapt international traceability obligations.	☐	☐	☐	☐	☐																																											
I haven't found a buyer yet who wants to buy certified FFB.	☐	☐	☐	☐	☐																																											
I have been selling under contract in the past, but the partnership was not reliable.	☐	☐	☐	☐	☐																																											
There is just no need for me to join a contract.	☐	☐	☐	☐	☐																																											
E. 5	Type 1 = Single Farmer or 2 = Group Certification / cooperative																																															
E. 6a	Please indicate the distance from your homestead to the closest certified cooperative (km)																																															

E. 6b	if E. 2 = Group (2), please name the group / cooperative
E. 6c	if E. 2 = Group (2), please indicate the age of the cooperation. (years)
E. 6d	if E. 2 = Group (2), please indicate the number of members in your group / cooperative /...
E. 6e	if E. 2 = Group (2), please indicate the cellular network provider of coop leader.
E. 7	Please indicate your own cellular network provider (if any). <i>[MULTIPLE CHOICE POSSIBLE?]</i>
E. 8	Do you market your palm oil / FFB within <u>this</u> (according to E.5a) / <u>a</u> (if E.1 = 5 (none) or E.2 = 1) farmer group?
E. 9	Please indicate the first time [year] you were certified.
E. 10	Please indicate your date of last renewal.
E. 11	Did you have certifications in the past that you did not renew? 0 = No; 1 = Yes
E. 12	If E. 9 = Yes (1), which one(s) (specify)
E. 13	If E. 9 = Yes (1), why did you not renew this certification/ these certifications? Reason(s) for not renewing certifications: A maximum of two options is allowed (<i>DO NOT read all the options to the farmer</i>): 1 = The palm oil exporter/international organization/NGO did not pay for the renewal; 2 = We did not have the means or the money to pay for the renewal; 3 = We did not know that we had to renew the certification; 4 = We thought we would not need the certification anymore; 5 = It was too difficult. 6 = Other (specify)

WHENEVER CERTIFICATIONS ARE MENTIONED IN THE QUESTIONNAIRE: IF FARMERS ARE BOTH ORGANIC AND RSPO CERTIFIED, THEN TREAT THEM AS BEING 'ORGANIC' FARMERS. THIS SHOULD CORRESPOND WITH QUESTION E. 1.

	In the following, farmers should be addressed as being ORGANIC or RSPO certified according to E. 2.
E. 16	How did you get to know about the possibility to get RSPO / ORGANIC certification? [MORE THAN ONE OPTION IS ALLOWED.] 1 = from other farmers/producer's groups; 2 = from relatives; 3 = from a government agency; 4 = from an NGO/international organization; 5 = from an exporter/buyer; 6 = other (specify)
E. 16	Why did you decide to get certified? [A MAXIMUM OF THREE OPTIONS IS POSSIBLE; DO NOT READ ALL THE OPTIONS TO THE FARMER] 1 = Production costs are lower than for conventional production. 2 = Prices are better. 3 = Health or food safety reasons. 4 = Environmental concerns. 5 = Contracts with exporters are better. 6 = The market is better/there is less competition. 7 = Cultural reasons and/or tradition. 8 = Customer/buyer demands. 9 = Other farmers/friends recommended it to me. 10 = Other reasons, please specify
E. 18	In your opinion, has farming according to RSPO / ORGANIC standards affected you and/ or your family's health? <i>[0=No; 1=Yes]</i>
E. 19	IF E. 14.1 YES (1), please explain: 1 = Improved, (explain) 2 = Deteriorated, (explain)
E. 20	What is preventing you from switching to, organic (if RSPO); any certified (if not certified at all) production? 1 = Lack of money/capital to invest. 2 = Lack of market/buyers. 3 = Lack of time and/or knowledge. 4 = This type of production is too difficult. 5 = This type production is less profitable.

	6 = Never thought about it. 7 = Other reasons, please specify														
E. 21	Has the certification affected the way you do your farming (in terms of land maintenance, input use, harvesting methods)? [0=No; 1=Yes;]														
E. 22	Who organized the certification process? 1 = Me myself; 2 = The farmer group; 3 = The exporter; 4 = An international aid organization; 5 = NGO; 6 = Other, specify														
E. 23	Did you or someone else pay for the certification process? [0=No; 1=Yes;]														
E. 24	If E.21.1=YES: Who paid for the certification? 1 = Me myself; 2 = The farmer group; 3 = The exporter; 4 = An international aid organization; 5 = NGO; 6 = Other, specify														
E. 25	How much did you have to pay for the initial certification? [WRITE 0 IF THE FARMER DID NOT HAVE TO PAY FOR IT.] [GHC]														
E. 26	How much do you have to pay for the yearly renewal of the certification? [WRITE 0 IF THE FARMER DID NOT HAVE TO PAY FOR IT OR DID NOT HAVE TO RENEW IT YET.] [GHC]														
E. 27	Did you receive special training in preparation of the certification? [0=No; 1=Yes]														
E. 28	If E. 19 = YES (1), have you implemented any of the techniques or methods that you have learned in the training? 0 = No; 1 = No, was not suitable for my farm; 2 = No, but I am planning to do so; 3 = Yes														
E. 29	What kind of investments did you have to make in order to achieve the certification? Please tell me about ALL the investments that you had to make. [DO NOT READ OPTIONS TO THE FARMERS.] E.G.: <table border="1"> <thead> <tr> <th>Investment</th><th>Costs in GHC</th><th>Time spent on this investment [days]</th></tr> </thead> <tbody> <tr> <td>Equipment (like chemical storage facilities, protective clothing, toilets, etc.)</td><td>...</td><td>...</td></tr> <tr> <td>Training</td><td>...</td><td>...</td></tr> <tr> <td>Other, specify:</td><td>...</td><td>...</td></tr> </tbody> </table>			Investment	Costs in GHC	Time spent on this investment [days]	Equipment (like chemical storage facilities, protective clothing, toilets, etc.)	...	...	Training	...	...	Other, specify:	...	...
Investment	Costs in GHC	Time spent on this investment [days]													
Equipment (like chemical storage facilities, protective clothing, toilets, etc.)	...	...													
Training	...	...													
Other, specify:	...	...													
E. 30	Are you planning or would you like to get any (additional) certification in the near future? [0=No; 1=Yes]														
E. 31	If E. 27 = yes (1), which one? (specify)														
E. 32	Would you renew your certification even if the current buyer / exporter would no longer buy from you? 0 = No.														

	1 = Yes, I would find another buyer/ exporter. 2 = Yes, in any case.
E. 33	Please indicate the number of FARMERS within a 1.5 mile radius (ALL FARMERS)
E. 34.1	Please indicate the number of ORGANIC certified farmers within a 1.5 mile radius (ALL FARMERS).
E. 34.2	Please indicate the number of RSPO certified farmers within a 1.5 mile radius (ALL FARMERS).
E. 35	Please indicate your level of satisfaction with the current certification 1 = very satisfied 4 = unsatisfied 2 = satisfied 5 = very unsatisfied 3 = indifferent

E. 33 Perception of certification effects

PLEASE TICK BOXES

					No change					
	Scale	decreased	1	2	3	4	5	6	7	increased
E. 33a	crop production	decreased								increased
E. 33b	crop quality	decreased								increased
E. 33c	production area (new land)	decreased								increased
E. 33d	expenses on agricultural inputs	decreased								increased
E. 33e	farm income	decreased								increased
E. 33f	diversity of income sources	decreased								increased
E. 33g	food security/ self-sufficiency	decreased								increased
E. 33h	health situation	worsened								improved
E. 33i	Network among members	worsened								improved
E. 33j	Migration	decreased								increased
E. 33k	soil moisture	decreased								increased
E. 33l	soil organic matter	decreased								increased
E. 33m	soil loss	increased								decreased
E. 33n	vegetation cover	decreased								increased

E. 33o	pests/ diseases	decreased								increased
E. 33p	Inorganic fertilizer use	increased								decreased
E. 33q	Pesticide use	increased								decreased
E. 33r	Herbicide use	increased								decreased
E. 33s	Work safety (e.g. protective clothing)	worsened								improved

1=Very negative (– 50-100%); 2=Negative (– 20-50%) 3=slightly negative (– 5-20%); 4=Negligible impact;
5=slightly positive (+5-20%); 6=Positive (+20-50%); 7=Very positive (+50-100%)

E.34 How specific have the quality of your FFB changed since you have been participating in certified farming practices?

	PLEASE TICK!	No change	Improved	Worsened
E.34a	Fruit size	☐	☐	☐
E.34b	Fruit weight	☐	☐	☐
E.34c	Quantity/volume of FFB	☐	☐	☐

E.35 How has your income from oil palm farming changed since you participated in certified farming?

☐ (1) It has not changed ☐ (2) It has increased ☐ (3) It has reduced

E.36 To how many buyers do you currently sell your FFB?

☐ (1) One ☐ (2) Two ☐ (3) Three ☐ (4) More than three ☐ (5) None

Section F.1 Contract farming

Now let's talk about your participation in an outgrower scheme (contract farming) with buyers that you might have, even if you do not hold any certification. With buyers I mean middlemen, processors and exporters. We define an outgrower scheme as an agreement/ contractual partnership between you as a farmer (or group of farmers) and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices."

F.1 Do you currently participate in an outgrower scheme (contract farming) with buyers?

☐ 0 = No ☐ 1 = Yes

F.2 If certified according to E.1, is the contract directly related to your certification (e.g. does the certification include a farming/marketing contract or vice versa;...)?

☐ 0 = No ☐ 1 = Yes

IF F.1 = YES >> PLEASE CONTINUE WITH SECTION FY.

IF F.1 = NO >> PLEASE CONTINUE WITH SECTION FN.

Section FY. Contract farming: F.1 = YES (PARTICIPATION IN OUTGROWER SCHEME/ CONTRACT FARMING)

FY.2a If you have one contract arrangement: What is the name of your buyer (who is your most important buyer if more than 1)?

(e.g. BOPP, TOPP, SerendiPalm, ...) _____ Name

FY.3 What type of buyer is your most important buyer?

- ☐ (1) Middlemen/Trader ☐ (2) Exporter ☐ (3) Farmers group/ Cooperative ☐ (4) Shop keeper/ Market woman ☐ (5) Processor (for export) ☐ (6) Processor (for local market) ☐ (7) Other _____

FY.4 How was the contract arrangement initiated?

- ☐ (1) By NGO ☐ (2) By MoFA ☐ (3) By a buyer (processor, exporter, middlemen) ☐ (4) By myself (self-initiative) ☐ (5) OPRI _____ ☐ (6) Other _____

FY.5 To what extent does this buyer control you?

- ☐ (1) I only have a **marketing contract**. The buyer does not provide any inputs and I am completely independent from him in terms of production.
- ☐ (2) The buyer provides me with some production inputs. There is **some measure of company control**.
- ☐ (3) The buyer provides all production inputs. I am under **full company control** and dependent on the buyer in terms of production as well as marketing.
- ☐ (4) Other _____

FY.6 If farmer is certified, does the buyer or a third-party control whether or not your production / farm / methods meet the criteria for the certification you hold?

- ☐ (0) No ☐ (1) Yes, buyer
☐ (2) Yes, third party, specify

FY.7 If farmer is certified: How often does the buyer / third party control whether or not your production / farm / methods meet the criteria for the certification you hold?

OF INSPECTIONS PER YEAR

FY.8 If farmer is certified: Are there any consequences if your production / farm / methods do NOT meet the certification criteria?

- ☐ (0) No ☐ (1) Yes: Please specify / explain

FY.9 If GY.10 = “yes”, did you ever experience any consequences?

- ☐ (0) No ☐ (1) Yes: Please specify / explain

FY.10 Is there any formal agreement with the buyer that you sell to?

- ☐ (0) No ☐ (1) Yes, Written Contract ☐ (2) Yes, Oral Contract ☐ (3) Yes, both (Written & oral)

FY.11 When was the year of contract setting? _____ Year

FY.12 What is the contract duration? _____ (YEARS)

FY.13 If FY.12 = Yes..., what provisions or terms are included in the contract?

Please tick the ones applicable. Multiple answers possible.

- | | |
|---|---|
| ☐ (1) Oil Palm Variety / seedling | ☐ (9) Application of fertilizer |
| ☐ (2) Quantity | ☐ (10) Provision of pesticides |
| ☐ (3) Quality requirements (e.g. min weight) | ☐ (11) Application of pesticides |
| ☐ (4) Grading requirements | ☐ (12) Irrigation |
| ☐ (5) Price | ☐ (13) Harvest time |
| ☐ (6) Package/ bagging requirements | ☐ (14) Buyer's guarantee to buy a certain volume |
| ☐ (7) Delivery requirements | ☐ (15) Other _____ |
| ☐ (8) Provision of fertilizer | ☐ (16) Other _____ |

FY.14a Have you ever experienced contract breach* on your side?

**Failure to fulfill the contract*

- ☐ (0) No ☐ (1) Yes

FY.14b If Yes, Why? _____

FY.15a Have you ever experienced contract breach on the buyer's side?

- ☐ (0) No ☐ (1) Yes

FY.15b If Yes, Why? _____

FY.16 Before participating in contract farming, what were your expectations? (PLEASE DO NOT READ ALL THE OPTIONS TO THE FARMER AT FIRST).

- ☐ (1) Increased revenue
- ☐ (2) Provision of inputs
- ☐ (3) Provision of training/ Extension service
- ☐ (4) Overcoming of market entry barriers/ Easier access to international markets
- ☐ (5) Stable income
- ☐ (6) Provision of credit
- ☐ (7) Other (specify)

FY.17 If certified: Did you have higher expectations from the fact that you would get a contract or from the fact that you would get a certification?

Please explain / specify

Now let's talk about equipment, training and inputs you received from this buyer or any other organization.

FY.18 Have you received any of the following types of support from the buyer or another organization in the last 5 years (since 2016)?

Yes / No

If Yes, Complete table:

	Input or equipment received in the last 5 years	YES/ NO	Name(s) of institution(s), or buyer(s) granting this support	When was the last time you received it? (UNIT: YEAR)	Approx. number of times support received (since 2012)	Did you have to pay for it (directly or indirectly)?	Did / do you have to pay an interest for this input supply?	How is it paid off? (e.g. directly, % of yield, please specify unit and indicate amount)
FY.18a	Provision of loan					1 = directly; 2 = indirectly		
FY.18b	Payment in advance					1 = directly; 2 = indirectly		
FY.18c	Help in getting loan from bank					1 = directly; 2 = indirectly		
FY.18d	Provision of oil palm seedlings					1 = directly; 2 = indirectly		
FY.18e	Provision of fertilizer or chemicals					1 = directly; 2 = indirectly		
FY.18f	Provision of equipment_____					1 = directly; 2 = indirectly		
FY.18g	Training on how to improve your farming techniques					1 = directly; 2 = indirectly		
FY.18h	Farm inspections by exporter/ organization staff or external inspection officers					1 = directly; 2 = indirectly		
FY.18i	Any other support _____					1 = directly; 2 = indirectly		

➔ PLEASE CONTINUE WITH SECTION F.2

Section FN. Contract farming: F.1 = NO (NO PARTICIPATION IN OUTGROWER SCHEME/ CONTRACT FARMING)

FN.2 What kind of buyer is your most important buyer?

- ☐ (1) Middlemen/Trader
 ☐ (2) Exporter
 ☐ (3) Other farmers/ Cooperative
 ☐ (4) Shop keeper/ Market woman
 ☐ (5) Processor (for export)
 ☐ (6) Processor (for local market)
 ☐ (7) Other _____

Now let's talk about equipment, training and inputs received from this buyer or any other organization.

FN.3 Have you received any of the following types of support from this buyer or another organization in the last 5 years (since 2016)?

	Input or equipment received in the last 5 years	TICK!	Name(s) of institution(s), or buyer(s) granting this support	When was the last time you received it? (UNIT: YEAR)	Approx. number of times support received (LST 5 YRS)	Did you have to pay for it (directly or indirectly)?
FN.3a	Provision of loan	☐				☐ (0) No ☐ (1) Yes
FN.3b	Payment in advance	☐				☐ (0) No ☐ (1) Yes
FN.3c	Help in getting loan from bank	☐				☐ (0) No ☐ (1) Yes
FN.3d	Provision of oil palm seedlings	☐				☐ (0) No ☐ (1) Yes
FN.3e	Provision of fertilizer or chemicals	☐				☐ (0) No ☐ (1) Yes
FN.3f	Provision of equipment _____	☐				☐ (0) No ☐ (1) Yes
FN.3g	Training on how to improve your farming techniques	☐				☐ (0) No ☐ (1) Yes
FN.3h	Farm inspections by exporter/ organization staff or external inspection officers	☐				☐ (0) No ☐ (1) Yes
FN.3i	Any other support _____	☐				☐ (0) No ☐ (1) Yes

FN.4 What are the reasons for not selling your FFB under contract?

	Statements	Agree	Partly agree	Neither	Partly disagree	Disagree
FN.4a	I get higher prices on the spot market.	☐	☐	☐	☐	☐
FN.4b	I don't want to lose autonomy/ I don't want to become dependent on the contract partner.	☐	☐	☐	☐	☐
FN.4c	I'm not able to adapt international traceability obligations.	☐	☐	☐	☐	☐
FN.4d	I haven't found a buyer yet who wants to party a contract with me.	☐	☐	☐	☐	☐
FN.4e	I have been selling under contract in the past, but the partnership was not reliable.	☐	☐	☐	☐	☐
FN.4f	There is just no need for me to join a contract.	☐	☐	☐	☐	☐
FN.4g	Other, specify					

Section F.2 Contract farming (continued)**F. 3 For how long have you been selling your produce/goods to this [MOST IMPORTANT] buyer?**

☐ (1) For one year or shorter ☐ (2) For two to three years ☐ (3) For four years or longer

F. 4 How would you describe the quality of the relationship between you and this [MOST IMPORTANT] buyer?

☐ (1) Very good ☐ (2) Good ☐ (3) Ok ☐ (4) Bad ☐ (5) Very bad

F. 5 Is the buyer usually coming to pick up the goods at the agreed time (i.e. is not too late or too early)?

☐ (0) No ☐ (1) Yes

F. 6 Are you happy with the amount of FFB that the buyer is buying from you?

☐ (0) No ☐ (1) Yes

F. 7 Who sets the price for the goods that you sell?

☐ (1) The buyer sets the price ☐ (2) The price is negotiated ☐ (3) The price is set by me

F. 8 How often is the price for the goods renegotiated/reset between you and this buyer?

- ☐ (1) Once a year ☐ (2) More than once a year ☐ (3) Less than once a year ☐ (4) At every purchase

F. 9 Are you promptly paid* for your produce?

*By *paid I mean cash or bank transfer.*

- ☐ (0) No ☐ (1) Yes

F. 10 Does this buyer visit your plots in order to inspect your crops before harvesting?

- ☐ (0) No ☐ (1) Yes, sometimes ☐ (2) Yes, always

F. 11 How do you get information on the export market for your crops?

- ☐ (1) From the main buyer ☐ (2) From other buyers ☐ (3) From other farmers/farmer organizations ☐ (4) From a market news service (internet, radio, sms, ...)
- ☐ (5) From MOFA (Ministry of Food and Agriculture) ☐ (6) From elsewhere, specify: _____
- ☐ (7) Don't get export market information

Section G. Production and Management

[AGAIN, IF FARMERS ARE BOTH ORGANIC AND GLOBALGAP (FORMERLY EUREPGAP) CERTIFIED, THEN REFER TO ORGANIC CERTIFICATION]

[IF THE FARMER HAS PLANTED MORE THAN ONE VARIETY OF OIL PALMS AND TREATS THESE VARIETIES DIFFERENTLY IN TERMS OF THE QUESTIONS THROUGHOUT THE QUESTIONNAIRE, ASK FOR THE VARIETY THAT IS PRIMARILY SOLD FOR EXPORT & THEN REFER TO THIS VARIETY.]

G. 1	Has the number of trees per acre changed since you received RSPO / ORGANIC certification? [0 = No; 1 = Yes, increased; 2 = Yes, decreased]	
G. 2	Has the productivity of your farm changed since you received RSPO / ORGANIC certification? [0=no, remained constant; 1=Yes, increased; 2=Yes, decreased]	
G. 3	If YES (1 or 2), can you estimate by how much it has decreased or increased? [IF POSSIBLE, GIVE %, OTHERWISE CLEARLY STATE THE UNIT USED]	
G. 4	What proportion of your FFB / oil palm harvest did you sell to exporters before you received RSPO / ORGANIC certification? [PERCENTAGE]	
G. 5	What proportion of your FFB / oil palm harvest do you sell to exporters now (after receiving RSPO / ORGANIC certification)? [PERCENTAGE]	
G. 6	Compared to other farmers in the region, do you think your oil palm yields are: 1 = higher; 2 = average; 3 = lower	
G. 7	Do you process the FFB / Fruits yourself? No = 0; yes = 1	
G. 8	If G7 = yes; All of it or just the fruits for household consumption or local markets? HHC = 1; HHC and / or local market = 2; everything (HHC, local, export) = 3	
G. 9	If G7 = yes; what part of the fruit do you process yourself 1 = whole fruit; 2 = fruit without kernel; 3 = kernel only	
G. 10	Normally, how long do you store FFB before processing / selling / pickup / ... (hours)	
G. 11	How long does it take you to go from your farm to the closest local market using your usual method of transportation? [SPECIFY UNIT: HOURS / MINUTES, OR SIMILAR]	
G. 12	How far away from your farm is the closest market? [distance in km]	
G. 13	How far away from your farm is the closest road? (km)	

G. 14	How far away from your farm is the closest PAVED road? (km)	
G. 15	How far away from your homestead is the closest extension possibility (e.g. extension office)	
G. 16	How far away from your homestead is the closest credit institution	
G. 17	How far away from your homestead is the closest local bank	
G. 18	How far away from your homestead is the closest rural /city center	

Section H. Adoption of Sustainable Agricultural Strategies (SASs)

Section H. Part I: Please refer to the **plots** where oil palms **are** cultivated; (monocrop as well as intercropped / mixed)

SA 1	Have you changed the way you manage soil and water on your other plots since you got certified? (ORGANIC / RSPO)										Converted to general question
	0 = No; 1 = started; 2 = increased; 3 = decreased; 4 = stopped;										
	Have you ever used this technology for your palm oil production? 1 = yes 2 = no	If yes, in which year did you use it for the first time? If 1=yes, in which year?	Extent of adoption (in terms of plot percentage) 	If no, why have you never adopted this technology? If 2=no, reason for non-adoption. See code below	Did you discontinue the use of SASs at any point? 1 = yes 2 = no	If yes, in which year did you discontinue? If there are several times of discontinuation, please answer about the last one. If 1=yes, in which year?	If yes, why did you discontinue this SASs? If 1=yes, reason for discontinuation. See code below	Did you re-adopt the SAS? 1 = yes 2 = no	If 1=yes, in which year?	How did you acquire knowledge on SASs (in general)? (Code SA11)	SA12. Why do you practice these strategies? PLEASE ONLY SELECT THE MOST IMPORTANT REASON.
	SA 2	SA 3	SA 4	SA 5	SA 6	SA 7	SA 8	SA 9	SA 10	SA 11	SA 12
Conservation Agriculture											
Minimum/zero tillage											

Cover cropping/Mulching (e.g. with EFB)											
placement of pruned fronds and/or trunk chips											
Use of leguminous crops											
Intercropping											
Ripping											
Others, specify											
Crop diversification											
Using improved /drought resistant varieties											
Other, specify											
Soil and Water Conservation											
Grass stripping											
Slit Pits											
Contour ploughing											
Terracing											
Stone bunding											
Earth bunding											
Zai technique											
Others, specify											
Soil Fertility											
Application of manure											
Compost Application											
Organic fertilizer											
Others, specify											

Code for SA5/SA8:	1=not aware of this technology	2=lack of technical know-how	Code for SA11:	1=own experimentation	2=observation of neighboring farmers (without direct instructions)
	3=lack of cash/credit	4=not profitable		3=taught by neighboring farmers	4=government extension agents
	5=unavailability of labor	6=unavailability of product (herbicide/fertilizer/improved variety seed)		5=media	6=non-government agencies
	7=unavailability of service (e.g. tractor)	8=others, specify		7=private institutions	8=others, specify
Code for SA 12:	1 = Improve production	2 = Reduce, prevent, restore land degradation (soil, water, vegetation)			
	3 = Conserve ecosystem	4 = protect a watershed/ downstream areas – in combination with other Technologies			
	5 = Preserve/ improve biodiversity	6 = Reduce risk of disasters (e.g. droughts, floods, landslides)			
	7 = Adapt to climate change/ extremes and its impacts (e.g. resilience to droughts, storms)				

Section Choice Sets CS1

CS1. When decisions were made regarding the [ACTIVITY] on your plots, who is it that normally takes the decision?

- ☐ Respondent him/herself
- ☐ Other hh member [select from household roster]
- ☐ Joint decision (Including the respondent)
- ☐ Other:

Note: This Question is asked for the following ACTIVITIES:

- (A) Clearing the plot
- (B) Planting, including the purchase of material
- (C) Spraying/ applying agrochemicals, including the purchase of material
- (D) Hiring labor, including payment decisions
- (E) Selling/ Marketing
- (F) Spending of the revenues

CS2. In the following, you will be presented with a choice between 2 crops that have different outputs in good and bad years. We assume that a bad year occurs one out of 5 years. Please indicate the crop you prefer to plant in the next season. [Present the choice sets to the farmers]:

- ☐ Crop 1
- ☐ Crop 2

Note: This question is asked for 5 different choices. Please find the according choice sets attached to the questionnaire

CS3. Would you be willing to enter a certification scheme that would increase your annual income from oil palm production by setting-up an entire acre of oil palm plantation, but to get certified would necessitate an initial investment of...?

☐ Yes

☐ No

Note: This question is asked for the following initial investments:

- (1) An initial investment of 500 GHS
- (2) An initial investment of 1000 GHS
- (3) An initial investment of 1500 GHS
- (4) An initial investment of 2000 GHS
- (5) An initial investment of 2500 GHS
- (6) An initial investment of 3000 GHS
- (7) An initial investment of 3500 GHS
- (8) An initial investment of 4000 GHS

CS4. If you were offered a credit over 3000 GHS, to set up an additional acre of oil palm plantation with a X percent interest rate, using this oil palm as collateral, would you accept it? (The credit duration is 20 years)

☐ Yes

☐ No

Note: This question is asked for the following interest rates:

- | | | | |
|------------------------------|------------------------------|--------------------------------|------------------------------|
| (1) 5 percent interest rate | (2) 8 percent interest rate | (3) 11.5 percent interest rate | (4) 15 percent interest rate |
| (5) 20 percent interest rate | (6) 25 percent interest rate | (7) 30 percent interest rate | (8) 35 percent interest rate |
| (9) 40 percent interest rate | | | |

Section Choice Sets CS2

Choice 1

	Good Year	Bad Year
Crop 1	20	0
Crop 2	19.5	2

Choice 2

	Good Year	Bad Year
Crop 1	19.5	2
Crop 2	18	4

Choice 3

	Good Year	Bad Year
Crop 1	18	4
Crop 2	16	6

Choice 4

	Good Year	Bad Year
Crop 1	16	6
Crop 2	13	8

Choice 5

	Good Year	Bad Year
Crop 1	13	8
Crop 2	9	2

Section I. Fertilizer Application, Pest, disease and Weed Management

It is very important that the exact names of the chemical products are recorded so that the actual active ingredients can be calculated later.

I.1 Did you apply fertilizer to your oil palms during the past 12 months?

Yes = 1; No = 0

I.2.0 If yes (1) to I.1, please provide detailed information on fertilizer over the past 12 months in the table below.

Type of Fertilizer (NPK, UREA, AMMONIA ETC.)	NAME of fertilizer (PLS. EXACT NAME BRAND / PRODUCT)	Price/ kg (GhC)	What is your recommended dosage (lit./Kg /acre)?	Quantity of fertilizer applied (kg) (please state for each round of application)						Total cost (GhC)	Have you changed the way you use fertilizer on your palm oil plots since you got certified? (ORGANIC / RSPO) 0 = No; 1 = started 2 = increased 3 = decreased 4 = stopped
				Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Total qty (kg)		
I.2.1	I.2.2	I.2.3	I.2.4	I.2.5	I.2.6	I.2.7	I.2.8	I.2.9	I.2.10	I.2.11	I.2.12
NPK											
Urea											
Ammonia											
Manure											

I.3	Was there any pest infestation on your oil palms during the last 12 months? 1 = yes; 2 = no	
I.4	If I. 4 = yes, which pest (please specify)	
I.5	Was there any disease infestation on your oil palms during the last 12 months? 1 = yes; 2 = no	
I.6	What is the value of your crop lost to pest and diseases?	
I.7	Did you use any pesticide for pest control? 1 = yes; 2 = no.	

I. 8.0		Kindly provide information on chemical used for disease and pest control for 2020 growing season								
Name of pesticide (PLS NAME EXACT PRODUCT / BRAND)	Price per liter (GhC)	What is your recommen- ded dosage (lit./Kg /acre)?	Volume of pesticide used							Have you changed the way you use pesticides on your palm oil plots since you got certified? (ORGANIC / RSPO) 0 = No; 1 = started 2 = increased 3 = decreased 4 = stopped
			Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Total Volume (Liter)	Total Cost (GhC)	
I.8.1	I.8.2	I.8.3	I.8.4	I.8.5	I.8.6	I.8.7	I.8.8	I.8.9	I.8.10	I.8.11
...										
...										

I.9 What method did you use for weed control?

1 = Chemical; 2 = Manual; 3 = both; 4 = others (specify)

I.12 if chemical, kindly provide detailed information on chemical weed control – if applied – on your farm during the past 12 months.

Name of chemical (herbicides) (PLS NAME EXACT PRODUCT / BRAND)	Volume of chemical used (Litres)					Total volume (litres)	Price per litre (GhC)	Total cost (GhC)	Have you changed the way you use these chemicals on your palm oil plots since you got certified? (ORGANIC / RSPO) 0 = No; 1 = started 2 = increased 3 = decreased 4 = stopped
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5				
I.12.1	I.12.2	I.12.3	I.12.4	I.12.5	I.12.6	I.12.7	I.12.8	I.12.9	I.12.10
Pre-emergence									
Post-emergence									
Total									

		Fertilizer	Herbicide	Pesticide	Others
I.13	Who recommended to you what you are currently using?				
I.14	Who applies it for you on your farm?				
I.15	How many times in the last 12 months, did a household member [I.17] participate in training on agrochemicals use from the MoFA / Agricultural District office?				

I.16. During spraying, does the person (household member or hired worker) wear a safety mask?

- Yes
- No
- Sometimes

I.17. During spraying, does the person (household member or hired worker) wear a safety suit?

- Yes
- No
- Sometimes

I.18. During spraying, does the person (household member or hired worker) wear safety goggles?

- Yes
- No
- Sometimes

I.19. Does the person (household member or hired worker) washes face and skin after spraying?

- Yes
- No

I.20. Chemical-related health symptoms.

Within the last 12 months, how often have the persons [I.17] experienced the following symptoms after spraying or after entering a sprayed plot?
(multiple answers possible) [INDICATE NUMBER]

general weakness		stomach pain		headache,		diarrhea	
vomiting		sleeplessness,		fever		coughing,	
excessive sweating		skin irritation		eye irritation		breathlessness	
other respiratory problems		other symptoms: specify					

Section J. Input costs – hired and family labor

Please count all hired and family laborers during the last 12 months on the oil palm plots. Please count working days for each task for each plot for the last 12 months. Please include cash and in-kind payments when calculating the average pay per day by task. Please repeat these questions for each plot if possible.

Plot ID	Activity	J1. Did you hire any worker? 1.Yes 2.No	J2. Type 1=Permanent 2=temporary	J3. Number of hired workers			J4. Total number of man days	J5. Did you use family labour? 1.Yes 2.No	J6. Number of family labour			J7. Total number of man days per each worker	J8. Cost of family per man-day.	J8. Wage rate per man-day
				J3a. male	J3b. female	J3c. Total no. of labourer			J6a. Adult Men	J6b. Adult Female	J6c. Children Under 15 yrs.			
	Applying Fertilizer													
	Applying Insecticide/pesticide / Herbicide													
	Manual weeding													
	Pruning													
	Sustainable agricultural strategies													
	Harvesting													
	weighing													
	Storing													
	loading (vehicle)													
	milling (oil)													
	Selling product													

Oil Palm input costs – other expenditures

Please list all other expenditures related to oil palm cultivation on the farmer's plot incurred during 2020 farming season.

		Total amount spent in 2020 (GHS)
J.9	Cost of implementing sustainable agricultural strategies	
J.10	Purchase or rental of agricultural equipment (e.g. spaying machines, hand tools, bags, drying mats)	
J.11	Transportation costs (e.g. for buying inputs, bringing FFB from farm to home, bringing FFB to point of sale)	

Section K. Harvest of FFB

Please indicate the quantity harvested (FFB) with the corresponding plot ID, as well as the distribution of the harvests during 2020 farming season.

Plot ID	Quantity harvested (FFB in kg)	Quantity consumed (kg)	Quantity sold (kg)
	K1	K2	K3
1			
2			
3			
4			
5			

Please indicate the quantity harvested (FFB) with the corresponding plot ID BEFORE THE GLOBAL PANDEMIC SITUATION (COVID-19) (harvesting season 2019/2020). Did you experience any changes due to the covid-19-situation?

Plot ID	Quantity harvested (FFB in kg)	Quantity consumed (kg)	Quantity sold (kg)
	K1.2	K2.2	K3.2
1			
...			
5			

Section L. Sales of FFB

Please indicate the quantity harvested (FFB) with the corresponding plot ID, as well as the distribution of the harvests during the last 12 months.

L1. How do you access market information?

1=neighbor, 2=FBO, 3=Mobile phone, 4=Radio, 5=Extension agents, 6=others specify, 7=I don't access market information

Please ask for all FFB sales of the respondent for the produce harvested in 2020 farming season. One oil palm sale includes all the FFB sold to the same buyer at the same price. In case you sell to the same buyer later for a different price, it is counted as another sale. Please ask these questions for each plot.

Sale ID	Oil Palm Harvest Revenue			To whom did you sell?	Where did you sell the produce?
	Quantity Sold (from K3)	Unit	Price per Unit (GHS)		
				1. Contractor 2. Farmer; 3. local trader; 4. Middlemen 5. Institution/company 6. Other, specify	1=Farm gate 2=Local village 3=Neighboring town/village 4=big town market 5=Other, specify
	L2a	L2b	L2c	L3	L4
1					
2					
3					
4					
5					

L3x. Please repeat the table with the corresponding plot ID BEFORE THE GLOBAL PANDEMIC SITUATION (COVID-19) (harvesting season 2019/2020). Did the farmer experience any changes due to the covid-19-situation?

Section N. Migration

N.1. Were you born in this village/community? 1. Yes ; 2. No	
N.2. If no, when did you move to this village/community? (year)	
N.3. Place of birth 1 = Outside this village, same district 2 = Outside tis district, same region 3 = Other region in Ghana 4 = Outside Ghana	
N.4. Why did you move to this village/community instead of somewhere else? [PLEASE LIST ORDER OF IMPORTANCE] 1. High production and productivity of agriculture 2. Availability of fertile lands /high soil fertility 3. High level of income 4. Employment, seasonal employment 5. Small sized land holdings 6. Good educational facilities 7. Adequate health-care services 8. Lack of infrastructural facilities 9. Evil social customs and practices 10. Others.	
N.5. Have you ever lived outside this area [DISTRICT/TOWN/CITY] in the last 3 years? 1. Yes ; 2. No	
N.6. If yes, where did you go? 1 = Outside this village, same district 4 = Burkina Faso 7 = Nigeria 2 = Outside this district, same region 5 = Côte d'Ivoire 8 = Togo 3 = Other Region of Ghana 6 = Mali 9 = other, specify	

Section O. Household Assets

Asset		O1. Number of items solely owned by HH	O2. Total value (GHC) (current value)	In the past 12 months		Asset		O4. Number of items solely owned by HH	O5. Total value (GHC) (current value)	In the past 12 months	
				O3a. Number of items purchased	O3b. Number of items sold					O6a. Number of items purchased	O6b. Number of items sold
Farm Implement						Other Items					
Tractor	1					Bicycle	15				
Plough	2					Radio	16				
	3					Iron	17				
Wheelbarrows	4					TV	18				
	5					Mobile Phone	19				
Motorized spraying machine	6					Satellite dish / Multi TV / DSTV	20				
Knapsack Sprayer	7					Chair / Sofa	21				
	8					Table	22				
Beehives	9					Bed / mattress	23				
	10					Refrigerator	24				
Catless	11					Motorbike	25				
Hand Hoe	12					Vehicle	26				
Husking Machine	13					Tricycle	27				
Palm oil mill	14					Tablet	28				
Other agricultural eq., specify	50					Computer	29				

On the respondent's house

O7: Is this house your own? 1= yes 2=no

O8: How old is this house?.....years old

O9: What is the worth of your house now?.....GHC (approximation)

Section P. Livestock

		March 2021		Change in Number in the last 12 months		
Livestock Type	Livestock Code	Number owned by HH members	Total value in GHC	Number Consumed at home	Number Bought	Number Sold
NAME	Livestock CODE		P4	P5	P6	P7
Cows						
Goats						
Sheep						
Chicken						
Pigs						
Guinea Fowls						

Section Q. Food Security

Q0. Was the Household able to provide adequate food for its members during the year 2020? 0=No 1=Yes

Q1. Which months of the year does the household have food in abundance (multiple choice)

1=Jan 2=Feb 3=Mar 4=Apr 5=May 6=Jun 7=Jul 8=Aug 9=Sept 10=Oct 11=Nov 12=Dec

Q2. Which months of the year does the household have just adequate food? (Multiple choice)

1=Jan 2=Feb 3=Mar 4=Apr 5=May 6=Jun 7=Jul 8=Aug 9=Sept 10=Oct 11=Nov 12=Dec

Q3. Which months of the year does the household barely have enough food (lean period) (multiple choice)

1=Jan 2=Feb 3=Mar 4=Apr 5=May 6=Jun 7=Jul 8=Aug 9=Sept 10=Oct 11=Nov 12=Dec

Q.4 Household Food Insecurity Access Scale (HFIAS)

No.	Question	Response Options
Q.4.1a	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q.4.2a) 1=Yes
Q.4.1b	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
Q.4.2a	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q.4.3a) 1=Yes
Q.4.2b	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
Q.4.3a	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q.4.4a) 1=Yes
Q.4.3b	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
Q.4.4a	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q.4.5a) 1=Yes
Q.4.4b	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
Q.4.5a	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q.4.6a) 1=Yes
Q.4.5b	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)

Q.4.6a	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q.4.7a) 1=Yes
Q.4.6b	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
Q.4.7a	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q.4.8a) 1=Yes
Q.4.7b	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
Q.4.8a	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q.4.9a) 1=Yes
Q.4.8b	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
Q.4.9a	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (skip Q.4.9b) 1=Yes
Q.4.9b	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)

Q.4.1 Household Food Insecurity Access Scale (HFIAS) (repeat table in COVID19 context)

Q.5 How did you manage food distribution in the household?

		Abundance period	Period of average availability	Lean period
Q.5a	Number of meals per day (on average)			
Q.5b	If less than 3, give reasons			
Q.5c	Number of days per month you took only two meals per day because of lack of money/food			
Q.5d	Number of days per month you took only one meal per day because of lack of money/food			
Q.5e	Number of days without food in the period because of lack of money/food			
Q.5f	Number of months in which you did not have enough food to meet your family's needs (cut the size of your meals)?			

Section S. Expenditure on Food and non-food items

Indicate how much the household spend on food and non-food items (listed in section Q) in the last week.

	Item	Amount (GHS)		Item	Amount (GHS)
	Food expenditure			Non-food expenditure	
S.1	Cereals, roots, and tubers		S.11	Tobacco/Cigarettes	
S.2	Pulses and legumes		S.12	Electricity	
S.3	Vegetables		S.13	Communication	
S.4	Fruits		S.14	Firewood	
S.5	Meats, fish and seafood, and eggs		S.15	Charcoal	
S.6	Dairy products		S.16	Kerosene/Gas	
S.7	Oils and fats		S.17	Soap/washing products	
S.8	Salt		S.18	School fee, textbooks, etc.	
S.9	Coffee/Tea: powder		S.19	Medical care	
S.10	Drinks (including alcohol)		S.20	Transportation	
			S.21	Clothing/Shoes	

Section T. Extension and Training

HH See code below	Did any member of HH received any extension visits in the last two years? 1=yes 2=no	Extension service provider See code below	Frequency of visit See code below	How satisfied are you with the content of information provided by the extension service?	Did any member receive training? 1=yes 2=no	Provider of training See Code below	What kind of training?	Number of days of training in the last 2 seasons	How satisfied are you with the content of training provided by the extension service?
	T.1	T.2	T.3	T.4	T.5	T.6	T.7	T.8	T.9

HH CODES: 1. Household head 2. Spouse 3.Children (Male adults) 4.Children (Female adults);

Code for **T.2 / T.6**: 1=agricultural extension agents, 2=extension worker from NGO, 3= private extension agents, 4=Farmer based organization, 5=extension worker from contractor, 6=other (specify)

Code for **T.3**: 1=weekly, 2=monthly, 3=once in 3 months, 4=once every 6 months, 5= Once a year a year, 5=others, specify.....

Code for **T.7**: 1=Sustainable Agricultural Strategies, 2=Palm oil production; Farming as a business, 3= Records Keeping, 4=others, please specify.....

Code for **T.4 / T.9**: 1=very satisfied, 2=somewhat satisfied, 3=not satisfied, 4=totally unsatisfied

Section U. Access to Credit

U1. Do you face credit constraints in your farm operations? 1=yes; 2=no

U2: If yes, do you source credit to finance your farm operations?..... 1=yes; 2=no

U3: If no, please state the reasons for not sourcing credit?

U4: If yes, please indicate name of credit agency.....

U5: What are your other sources of finance for your farm operations?.....

U6: Did you source credit for your farm business in the 2020 farming season? ----- 1=yes; 2=no

U7: If yes, what form was it 1=cash; 2= in-kind (3) Other (specify).....

U8: Did you pay with interest?..... 1=yes; 2=no

U9: What was the interest rate?..... (in percentage)

U10: what was the average repayment period months?

U11: Are you aware of other farming credit sources in your locality? 1=yes; 2=no

U12: If yes please name them.....

U13: Have you sourced credit from them before?.....1=Yes; 2=No

U14: If yes, do you still source credit from them and why?.....

U15: Did you enjoy any input subsidies from government in the 2020 farming season?

U16: If yes to U15, on which inputs, ...

U17: If yes to U15, how much per input?.....

U18: If yes to U15, what was the repayment plan?.....

Section V. Access to Insurance

V.1 Are you aware of agricultural insurance? 1=Yes 0= No

V.2 If yes, have you ever purchased insurance products to cover your oil palm farm? 1=Yes 0= No

V.3 If No to V.2, why have you not purchased insurance product? 1=Lack of funds, 2=No idea of how it works, 3=It doesn't pay, 4.Other,
specify_____

Section X. Information sharing and adoption process

Farmers	HH ID Do you discuss/ Share Certification issues with X?	Does (X) inform you of upcoming extension meetings	Who first told you about certification possibilities? (refer to section D for examples of SASs)	Who convinced you to adopt any certification ?	When did X adopt the Certification ? (years)	Do you exchange more than farming information with X? 1=Yes, 2=No	If yes to SN6, which other information do you share?	How many blood relatives do you have in the community	Do you belong to a royal family	Are/were your parents leaders?
	SN1	SN2	SN3	SN4	SN5	SN6	SN7	SN8	SN9	SN10
1										
2										
3										
4										
Code SN5: 1=Not yet, 2=Before me, 3=At the same time as me, 4=After me Code SN7: 1=credit, 2=labour, 3=marketing, 4=access to inputs, 5=insurance, 6=others specify.....										

Section Y. Shocks and coping mechanisms

Please list all shocks that hit the household during the past 2 years (2019 and 2020).

	Y.0 Shock	Y.1. Did the HH experience any of the following shocks in the last 2 years? 1=yes; 2=no	Y.2. If S1 is yes, How many times did it occur in the last 2 years?	Y.3 If S1 is yes, which year did it occur? (month/ year)	Y.4 How much time did it take to economically recover from the shock? 1. < 1 month 2. 1-3 months 3. 4-6 months 4. 7 months-1 year 5. > 1 year 6. Not yet recovered	Y.5 What is the likelihood that these shocks will happen again (1-2 years)? 1. Very likely 2. A bit likely 3. Fifty/fifty 4. Not so likely 5 Completely unlikely 6. I don't know
1	Flooding					
2	Long dry spells					
3	Erratic rainfall pattern					
4	Windstorm					
5	Pest and disease					
6	Livestock disease					
7	Bushfire					
8	Increase in prices of farm inputs					
9	Very low market/farm gate price for produce					
10	High unemployment					
11	Sickness of household member					
12	Death of household member					
13	Very low yields					
14	Crop failure					
15	Others, specify					

Y.6 How did your HH deal with the shocks? Please list (4) in order of importance		
1. Prayed to God 2. Hardworking 3. Diversification 4. crop diversification 5. Inputs substitution 6. Reduction in HH expenditure 7. Use of weather information	7. Took children out of school 8. Sent children to relatives/friends 9. Adult household member migrated 10. Sold assets 11. Used savings 12. Purchased insurance product 13. Borrowed money from family/ friends/ neighbors	14. Borrowed money from informal financial institution (pawnshop, moneylender, susu collectors, traders) 15. Borrowed from formal financial institution (bank, microfinance) 16. Government/NGO support 17. Support from social networks 18. Other, specify
Y6a:		
Y6b:		
Y6c:		
Y6d:		
S.7. What measures have you (HH) put in place to reduce or prevent these shocks if they reoccur? Please list 4 in order of importance		
1. Prayed to God 2. Hardworking 3. Diversification 4. crop diversification 5. Inputs substitution 6. Reduction in HH expenditure	9. Hold savings at formal institution (bank, microfinance) 10. Hold savings at informal institution (Susu, etc.) 11. Participate in network activities 12. Purchase insurance 13. Other, specify	
Y7a:		
Y7b:		
Y7c:		
Y7d:		

Appendix D: Declaration of co-authorship



Christian-Albrechts-Universität zu Kiel

Agrar- und
Ernährungswissenschaftliche Fakultät

Declaration of co-authorship

If a dissertation is based on co-authored articles, a declaration from each of the authors regarding the part of the work done by the doctoral candidate must be enclosed when submitting the dissertation.

1. Doctoral candidate

Name: Philip Christoph Richartz

2. This co-author declaration applies to the following article

The role of information in consumer preferences for sustainable certified palm oil products in Germany

The extent of the doctoral candidate's contribution to the article is assessed on the following scale:

- A. Has contributed to the work (0-33%)
- B. Has made substantial contribution (34-66%)
- C. Did the majority of the work independently (67-100%)

3. Declaration on the individual phases of the scientific work (A, B, C)

Extent

Concept: Formulation of the basic scientific problem based on theoretical questions which require clarification, including a summary of the general questions which, it is assumed, will be answerable via analyses or concrete experiments/investigations

C

Planning: Planning of experiments/analyses and formulation of investigative methodology, including choice of method and independent methodological development, in such a way that the scientific questions asked can be expected to be answered

C

Execution: Involvement in the analysis or the concrete experiments/investigation

C

Manuscript preparation: Presentation, interpretation and discussion of the results obtained in article form

C

4. Signature of all co-authors

Date	Name	Signature
July 12, 2023	Prof. Dr. Awudu Abdulai	

4. Signature of doctoral co-authors

Date	Name	Signature
July 12, 2023	Philip Christoph Richartz	

Declaration of co-authorship

If a dissertation is based on co-authored articles, a declaration from each of the authors regarding the part of the work done by the doctoral candidate must be enclosed when submitting the dissertation.

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Name: Philip Christoph Richartz

2. This co-author declaration applies to the following article

Does the certification type matter for smallholder farmers' welfare and the environment? Evidence from palm oil farmers in Ghana.

The extent of the doctoral candidate's contribution to the article is assessed on the following scale:

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- B. Has made substantial contribution (34-66%)
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Execution: Involvement in the analysis or the concrete experiments/investigation

C

Manuscript preparation: Presentation, interpretation and discussion of the results obtained in article form

C

4. Signature of all co-authors

Date	Name	Signature
July 12, 2023	Prof. Dr. Awudu Abdulai	

4. Signature of doctoral co-authors

Date	Name	Signature
July 12, 2023	Philip Christoph Richartz	

Declaration of co-authorship

If a dissertation is based on co-authored articles, a declaration from each of the authors regarding the part of the work done by the doctoral candidate must be enclosed when submitting the dissertation.

1. Doctoral candidate

Name: Philip Christoph Richartz

2. This co-author declaration applies to the following article

Towards holistic sustainable development within the framework of the Sustainable Development Goals:
Reducing inequalities and empowerment of gender equality.

The extent of the doctoral candidate's contribution to the article is assessed on the following scale:

- A. Has contributed to the work (0-33%)
- B. Has made substantial contribution (34-66%)
- C. Did the majority of the work independently (67-100%)

3. Declaration on the individual phases of the scientific work (A, B, C)**Extent**

Concept: Formulation of the basic scientific problem based on theoretical questions which require clarification, including a summary of the general questions which, it is assumed, will be answerable via analyses or concrete experiments/investigations	C
Planning: Planning of experiments/analyses and formulation of investigative methodology, including choice of method and independent methodological development, in such a way that the scientific questions asked can be expected to be answered	C
Execution: Involvement in the analysis or the concrete experiments/investigation	C
Manuscript preparation: Presentation, interpretation and discussion of the results obtained in article form	C

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