Anwendung von Discrete Choice Experimenten in der Agrarökonomie

Präferenzstruktur und Zahlungsbereitschaft von Landwirten bei Entscheidungen in den Bereichen Vermarktung, Kooperationen, Investitionen und Vertragsanbau

Dissertation

zur Erlangung des Doktorgrades

der Fakultät für Agrarwissenschaften

der Georg-August-Universität Göttingen

vorgelegt von

Friederike Anastassiadis

geboren in Wolfenbüttel

Göttingen, im November 2015

D 7

1. Referent: Prof. Dr. Oliver Mußhoff

2. Korreferent: Prof. Dr. Ulf Liebe

3. Korreferent: Prof. Dr. Achim Spiller

Tag der mündlichen Prüfung: 09. November 2015

Danksagung

Nun ist es geschafft!

Auf meinem Weg zur Promotion gibt es eine lange Liste von Menschen, die mich begleitet, unterstützt, kritisiert, motiviert, geerdet, abgelenkt, und getragen haben. Einigen davon möchte ich mit diesen Zeilen persönlich danken.

Zu aller erst gilt mein Dank meinem Doktorvater Herrn Professor Dr. Oliver Mußhoff. Bei ihm möchte ich mich für seine uneingeschränkte Unterstützung meiner Arbeit bedanken. Er stand mir während meiner Promotionszeit immer für ein offenes Gespräch zur Verfügung. Sein Rat und seine konstruktive Kritik hat mich und meine Arbeit weitergebracht und mich gleichzeitig motiviert, immer nach einer noch besseren Lösung zu suchen. Sein Enthusiasmus für die Forschung, das Interesse, welches er meiner Arbeit entgegengebracht hat, und sein Engagement für jeden einzelnen Doktoranden haben dazu beigetragen, dass ich meine Promotionszeit als eine sehr wertvolle und prägende Zeit erlebt habe. Ebenfalls besonderer Dank gilt Herrn Professor Dr. Ulf Liebe, meinem Zweitprüfer. Ohne ihn hätte ich das Themengebiet der Discrete Choice Experimente nicht für mich entdeckt. Mit seiner enthusiastischen Vermittlung des experimentellen Ansatzes im Seminar „Agrarsoziologie“ hat er meine Neugierde geweckt. Insbesondere, für die Anschub-Unterstützung bei meinem ersten Experiment möchte ich mich bei ihm bedanken. Herrn Professor Dr. Achim Spiller sei hier ebenfalls für die Übernahme des Drittgutachtens meiner Promotion gedankt.

Selbstverständlich möchte ich auch meinen Kollegen am Arbeitsbereich der Landwirtschaftlichen Betriebslehre für Ihre konstruktiven Tipps, die Unterstützung und Zusammenarbeit in zahlreichen Projekten und gemeinsamen Vorhaben danken. Genauso geht mein Dank auch an Jessica Olbrich. Sie hat aus meinem doch manches Mal sehr speziellen Englisch lesbare und grammatikalisch richtige Sätze gemacht. Liebe Jessica, vielen Dank dafür!

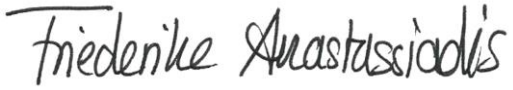
Nicht fehlen darf an dieser Stelle der Dank an meine Familie und Freunde. Ohne die zahlreiche und unkomplizierte Unterstützung wäre meine Promotion nicht so zügig und unkompliziert von Statten gegangen. Meine drei Rabauken haben sicher eine wunderbare Zeit mit Euch verlebt.

Liebe Conny, dir als unsere Tagesmutter gilt ebenfalls mein Dank. Deine liebevolle Art mit meinen Kindern umzugehen, ihnen viel Zeit und Liebe zu schenken und sie auf ihrem Weg zu begleiten, sind für mich ein großes Geschenk und zu einem unverzichtbaren Teil in unserem Familienalltag geworden. Danke auch für die oftmals spontan angekündigten, aber immer realisierbaren Überstunden. Mir ist bewusst: das ist nicht selbstverständlich.

Liebe Renata, auch für dich gibt es an dieser Stelle ein Riesen-Dankeschön. Du hast alle meine Kinder von Anfang an betreut und auf liebevolle Art und Weise begleitet. Auf dich konnte und kann ich mich auch heute noch verlassen. Es ist schön, zu sehen, wie viel Spaß die Kinder mit dir und deiner Familie haben.

Außerdem möchte ich mich bei meinen Eltern, Christine und Walter, für Ihre Unterstützung in all den Jahren meiner Ausbildung bedanken. Ihr habt immer an mich geglaubt, egal mit was für Plänen und Ideen ich vor Euch stand. Ich durfte meine Erfahrungen machen, meinen Weg gehen und hatte doch immer ein Zuhause in der Hinterhand, wenn etwas Mal nicht geklappt. Das ist unendlich wertvoll.

Schlussendlich gilt mein Dank meinem Mann. Sokratis, ohne Deine uneingeschränkte Unterstützung, Deine Geduld, Deine Motivationsappelle, Deine kritischen Worte und Deine Liebe wäre ich nicht da, wo ich jetzt bin. Ich danke Dir von ganzem Herzen!



Bornum, im November 2015

Inhaltsverzeichnis

I. Einleitung

1. Zielstellung der Dissertation

Der landwirtschaftliche Sektor in Europa ist geprägt von technischem Fortschritt, volatilen Absatz- und Beschaffungsmärkten, agrarpolitischen Reformen und den Auswirkungen des Klimawandels. Landwirte sehen sich somit ständig veränderten Rahmenbedingungen gegenüber. Um wettbewerbsfähig zu bleiben, sind unternehmerische Anpassungen daher unerlässlich. Die damit notwendig werdenden Entscheidungen treffen die Landwirte unter Unsicherheit. Eine Reduzierung dieser Unsicherheit ist möglich, indem die Informationsgrundlage, auf deren Basis die Landwirte in der jeweiligen Entscheidungssituation entscheiden, verbessert wird. Mittels einer Analyse des Entscheidungsverhaltens von Landwirten in bestimmten Entscheidungssituationen können entscheidungsrelevante Determinanten ermittelt, mit der Entscheidung in Zusammenhang stehende Anreize und Barrieren aufgedeckt und die Bedeutung von betriebsspezifischen und persönlichen Charakteristika des Landwirts geklärt werden. Diese Informationen wiederum können dem Landwirt helfen, zu einer fundierten Entscheidung zu finden. Gleichzeitig können Berater und Politiker die Ergebnisse einer solchen Entscheidungsanalyse für ihre Arbeit verwenden.

Nachfolgend werden exemplarisch vier agrarökonomisch-relevante Entscheidungssituationen und der damit verbundene Forschungsbedarf vorgestellt:

Entscheidungssituation 1: Vermarktungsentscheidung

Europäische Landwirte sind seit der Einschränkung der politisch indizierten Preisstützung vermehrt Preisrisiken ausgesetzt (vgl. bspw. European Commission, 2005). Seither stehen Landwirte zwangsweise selbst vor der Entscheidung, ob sie eine Reduzierung der Preisrisiken anstreben und wenn ja, welche(s) Absicherungsinstrument(e) sie hierfür auswählen.

Um auf die Bedürfnisse von Landwirten zugeschnittene Preisabsicherungsinstrumente entwickeln und anbieten zu können, ist es notwendig zu klären, welche individuenspezifische Faktoren die Entscheidung eines Landwirts beeinflussen, für seine Ernte ex ante eine Preisabsicherung vorzunehmen. Ebenso wichtig ist es, neben den in der Regel bekannten Absicherungsinstrumenten, wie Forward-Kontrakt, Futures-Kontrakt oder Futures-Option (vgl. bspw. Goodwin und Schroeder, 1994; Sartwelle et al., 2000), auch die in Deutschland eher unbekannten Absicherungsinstrumente, wie bspw. das „Managed Marketing“, auf ihr Vermarktungspotential hin zu untersuchen.

Entscheidungssituation 2: Entscheidung über das Eingehen einer Betriebskooperation

Der Strukturwandel in der Landwirtschaft führt zu steigendem Kosten- und Preisdruck. Außerdem ist in den Betrieben eine steigende Fixkostenbelastung zu verzeichnen (vgl. bspw. NASS, 2015). Eine Strategie, um steigenden Fixkosten zu begegnen, kann im Eingehen von Kooperationen mit anderen Betrieben gesehen werden. Zahlreiche Studien belegen den monetären Vorteil solcher Kooperationen (Nielsen, 1999; de Toro und Hansson, 2004; Andersson et al., 2005; Artz et al., 2010; Larsén, 2010; Aurbacher et al., 2011; Wolfey et al., 2011). Es stellt sich jedoch die Frage, warum

Betriebskooperationen in der Praxis eher selten zu finden sind, wenn doch die ökonomischen Vorteile groß sind. Es ist daher notwendig, die Präferenzen von Landwirten für das Eingehen einer Kooperation unter expliziter Berücksichtigung von nicht monetären Faktoren zu analysieren.

Entscheidungssituation 3: Investitionsentscheidung

Investitionen in landwirtschaftlichen Betrieben weisen immer größere Volumina auf und erfolgen in immer kürzeren Abständen (Bahrs et al., 2004: 11). Folglich steigt die Kapitalintensität zunehmend an. Eine weitgehende Innenfinanzierung, eine der Hauptfinanzierungsquellen in der Landwirtschaft (Odening, 2003), ist daher kaum mehr möglich. Ein höherer Fremdkapitalanteil bzw. sinkende Eigenkapitalquoten sind die Folge.

Realisieren landwirtschaftliche Betriebe eine Investition mit hohem Fremdkapitalanteil, kann dies ihre zukünftige finanzielle Flexibilität reduzieren. Kennzeichen einer reduzierten zukünftigen finanziellen Flexibilität sind ein höherer Reservationspreis für die verbleibende Kreditreserve und damit verbunden höhere Kreditkosten (Barry et al., 1981: 221-222). Ist dies der Fall, müssen Opportunitätskosten der Fremdkapitalaufnahme bei der Investitionsentscheidung berücksichtigt werden (DeAngelo et al., 2011: 258). In der klassischen Investitionstheorie spielen Opportunitätskosten des Fremdkapitals jedoch nur eine untergeordnete Rolle. Vor diesem Hintergrund gilt es zu klären, welche Bedeutung Landwirte der finanziellen Flexibilität in ihren Investitionsentscheidungen zukommen lassen.

Entscheidungssituation 4: Entscheidung über den Vertragsanbau von Zuckerrüben zur Biogasgewinnung

In Deutschland spielt die Biogasgewinnung aus landwirtschaftlichen Rohstoffen eine zentrale Rolle in der Energiewende. In den letzten Jahren wurde jedoch die Kritik am Silomais, der Hauptfrucht des Substratmixes, immer lauter (Starke und Hoffmann, 2014). Dies führte dazu, dass dessen Anteil am Substratmix einer neugebauten Biogasanlage mit der Novellierung des Erneuerbaren Energien Gesetzes im Jahr 2012 beschränkt wurde (Act on granting, 2012). Aufgrund dessen besteht die Notwendigkeit, die Substratpalette für die Biogasgewinnung um geeignete und nachhaltige Früchte zu erweitern. In diesem Zusammenhang gewinnt die Zuckerrübe als Biogassubstrat an Bedeutung (Gissén et al., 2014). Es stellt sich daher die Frage, wie Anbauverträge für Zuckerrüben zur Biogasgewinnung aus Sicht der anbauenden Landwirte ausgestaltet sein müssen.

Zielstellung der vorliegenden Dissertation ist es, die Präferenzen von Landwirten in den oben skizzierten Entscheidungssituationen unter Berücksichtigung des aufgezeigten Forschungsbedarfs zu analysieren und damit die Informationsbasis als Entscheidungsgrundlage für Politiker und Berater, aber auch für die Landwirte selbst zu erweitern.

2. Methodenwahl

Zur Messung von Präferenzen werden grundsätzlich zwei Methoden unterschieden: der *Revealed* und der *Stated Preference* Ansatz. Beim *Revealed Preference* Ansatz wird reales Marktverhalten beobachtet. Mittels dieser Methode können reale Präferenzen gemessen werden, die durch den nachweislich realen

Kauf des Guts legitimiert sind (für weitergehende Informationen zu diesem Ansatz vgl. Bateman et al. (2002)). Der Vorteil des *Revealed Preference* Ansatzes liegt daher auf seiner hohen Reliabilität und Validität. Nachteilig wirkt sich jedoch aus, dass die Präferenzmessung stark von latenten Faktoren des beobachteten Marktverhaltens abhängt. Gleichzeitig lassen sich mit diesem Ansatz ausschließlich Präferenzen für frei handelbare Güter messen. Für innovative Güter oder Gütereigenschaften sowie hypothetische Handlungsalternativen ist der *Revealed Preference* Ansatz nicht geeignet (Train, 2009). Somit kommt er auch für die in Kapitel I.1 vorgestellten Präferenzanalysen nicht in Betracht. Denn in allen beschriebenen Entscheidungssituationen kann nicht auf beobachtbares Marktverhalten zurückgegriffen werden: zum einen, weil es die Datengrundlage hierfür nicht gibt (vgl. Entscheidungssituation 2 und 3), zum anderen, weil die Entscheidungssituation neue Güter bzw. Handlungsalternativen oder neuartige Eigenschaften der Güter bzw. Handlungsalternativen umfasst (vgl. Entscheidungssituation 1 und 4).

Bei dem *Stated Preference* Ansatz werden Präferenzen als innere Gedankenkonstrukte wahrgenommen (Louviere et al., 2000). Dabei wird angenommen, dass von den vorhandenen, aber nicht artikulierten Präferenzen eines Individuums auf dessen reale Wahlhandlung geschlossen und so zukünftiges Entscheidungsverhalten prognostiziert werden kann (Pfarr und Ulrich, 2011). Daraus folgt, dass mithilfe dieses Ansatzes Präferenzen auch für neue Güter bzw. Handlungsalternativen sowie deren innovative Eigenschaften analysiert werden können. Der *Stated Preference* Ansatz ist somit für die Präferenzanalyse der in I.1 vorgestellten Entscheidungssituationen geeignet.

Zum *Stated Preference* Ansatz werden sowohl die Methode der *Kontingenten Bewertung* als auch der *Discrete Choice Experimente* (DCE) gezählt. Die *Kontingente Bewertung* sollte zur Anwendung kommen, wenn das Ziel verfolgt wird, Präferenzen für ein Gut oder eine Handlungsalternative als Ganzes zu analysieren. In Studien, die die Methode der *Kontingenten Bewertung* anwenden, wird somit also auch einzig die Frage nach der Zahlungsbereitschaft für das Gut oder die Handlungsalternative im Ganzen gestellt. Sind hingegen die Präferenzen für einzelne Gütereigenschaften oder Charakteristika einer Handlungsalternative von Interesse, ist die Methode der DCE vorzuziehen. Da in den Präferenzanalysen der in I.1 vorgestellten Entscheidungssituationen jeweils die Präferenzen für einzelne Eigenschaften der Güter bzw. Handlungsalternativen von Interesse sind und nicht die Präferenz für das Gut bzw. die Handlungsalternative als Ganzes, kann in dieser Arbeit nur die Methode der DCE zur Anwendung kommen.

DCE finden in der agrarökonomischen Forschung inzwischen eine breite Anwendung. Im Folgenden werden einige DCE-Studien mit Landwirten exemplarisch vorgestellt. So untersuchen bspw. Breustedt et al. (2008) mithilfe eines DCE die Bereitschaft von deutschen Landwirten gentechnisch veränderten Raps anzubauen. Ruto und Garrod (2009) analysieren welchen Einfluss das Design von Agrarumweltmaßnahmen auf die Teilnahmebereitschaft von Landwirten hat. Hierzu bitten sie Landwirte aus zehn Regionen der EU um die Teilnahme an einem DCE. Auch Espinosa-Goded et al. (2010) untersuchen eine ähnliche Fragestellung. 300 Landwirte aus zwei Regionen in Spanien nehmen

an einem DCE teil. Mithilfe des DCE sollen die Präferenzen der Landwirte für unterschiedlich ausgestaltete Agrarumweltmaßnahmen basierend auf stickstofffixierenden Pflanzen gemessen werden. Paulrud und Laitila (2010) analysieren die Einstellung schwedischer Landwirte zum Anbau von Energiepflanzen. In einem ersten DCE untersuchen sie die Präferenzen der Landwirte für verschiedene Energiepflanzen und deren Eigenschaften. Mithilfe des zweiten DCE messen sie die Bereitschaft der Landwirte zum Energiepflanzenanbau unter verschiedenen Subventions- und Einkommensszenarien. Christensen et al. (2011) nutzen ein DCE, an dem 444 dänische Landwirte teilnehmen, um zu ermitteln, unter welchen Umständen diese Landwirte bereit sind, Verträge für pflanzenschutzmittelfreie Pufferzonen abzuschließen. Abebe et al. (2013) führen ebenfalls ein DCE durch. Sie untersuchen die Präferenzen von Kleinbauern für den Vertragsanbau im Generellen und für die vertraglich festgehaltenen Konditionen im Speziellen. Schulz et al. (2014) analysieren mithilfe eines DCE, an dem 128 deutsche Landwirte teilgenommen haben, deren Reaktion auf die vorgeschlagene Ökologisierungskomponente (genannt „Greening“) der gemeinsamen EU Agrarpolitik. Mithilfe eines DCE mit australischen Hirten und Viehzüchtern untersucht Greiner (2015) Faktoren, die deren Entscheidung beeinflussen, Vertragsnaturschutz durchzuführen. Lizin et al. (2015) führen ein DCE mit belgischen Landwirten durch, um herauszufinden, welche Kosten den Landwirten aufgrund von Landnutzungsrestriktionen entstehen.

3. Struktur der Dissertation

Die vorliegende Dissertation ist folgendermaßen strukturiert: Im Anschluss an die Einführung der Dissertation wird in Kapitel II) der Beitrag “*Analysing farmers' use of price hedging instruments: an experimental approach*” vorgestellt. Dieser ist im *Journal of Agricultural & Food Industrial Organization* veröffentlicht worden. Mit Hilfe eines DCE wird untersucht, welche individuenspezifischen Faktoren die Entscheidung von Landwirten beeinflussen, den Preis für ihr Erntegut ex ante abzusichern.

Kapitel III) umfasst den Beitrag mit dem Titel “*Analyzing farmers' preferences for collaborative arrangements: an experimental approach*”, welcher als Diskussionspapier des Department für Agrarökonomie und Rurale Entwicklung veröffentlicht worden ist. Der Beitrag verfolgt das Ziel, die Präferenzen von Landwirten für das Eingehen einer Kooperation unter expliziter Berücksichtigung von nicht-monetären Faktoren zu analysieren.

In Kapitel IV) wird der Beitrag mit dem Titel “*Berücksichtigen Landwirte bei ihren Investitionsentscheidungen die damit verbundenen Auswirkungen auf die finanzielle Flexibilität ihres Betriebes?*” vorgestellt. Dieser Beitrag ist im *German Journal of Agricultural Economics* veröffentlicht worden. Mit Hilfe eines DCE wird im Beitrag untersucht, welche Rolle die finanzielle Flexibilität in Investitionsentscheidungen von Landwirten spielt.

Kapitel V) umfasst den Beitrag mit dem Titel “*Analyzing farmers‘ preferences for substarte supply contracts for sugar beets*”, welcher als Diskussionspapier des Department für Agrarökonomie und Rurale Entwicklung veröffentlicht worden ist und sich zurzeit bei *Bioenergy and Biomass* im

Begutachtungsprozess befindet. Der Beitrag beantwortet die Frage, wie Anbauverträge für Biogas-Zuckerrüben aus Sicht der anbauenden Landwirte ausgestaltet sein müssen. Hierzu wurde ebenfalls ein DCE mit Landwirten durchgeführt.

Die Dissertation schließt mit einer Zusammenfassung der Ergebnisse. Außerdem wird diskutiert wie die Ergebnisse im Einzelnen dazu beitragen können, die Informationsgrundlage als Entscheidungsbasis für Politiker und Berater sowie der Landwirte selbst in den jeweiligen Entscheidungssituationen zu verbessern.

II. Analysing Farmers' Use of Price Hedging Instruments: An Experimental Approach

Autoren: Friederike Anastassiadis, Jan-Henning Feil, Oliver Mußhoff und Philipp Schilling

Veröffentlicht im *Journal of Agricultural & Food Industrial Organization (2014), 12 (1): 181–192. DOI: 10.1515/jafio-2014-0007.*

Abstract

This paper analyses the influencing factors of farmers' use of price hedging instruments (PHIs) based upon a discrete choice experiment with German grain farmers. A mixed logit model is used to determine whether farmers' choices of PHIs against cash sales are influenced by their price expectation, their risk attitude and their available storage capacities. The results show that farmers with a price expectation below the actual price level have a higher preference for using PHIs against cash sales in general and that the individual degree of risk aversion can have a significant impact on farmers' choices of a specific PHI. A generally lower preference of farmers with available storage capacities for using PHIs as assumed in many theoretical contributions in the literature, however, cannot be confirmed.

Keywords

price hedging instruments, grain marketing, discrete choice experiment, mixed logit

III. Analyzing farmers' preferences for collaborative arrangements: an experimental approach

Autoren: Jan-Henning Feil; Friederike Anastassiadis; Oliver Mußhoff, Philipp Kasten

Veröffentlicht als *Diskussionspapier Nr. 1510, Georg-August-Universität Göttingen, Fakultät für Agrarwissenschaften, Department für Agrarökonomie und Rurale Entwicklung*.

1. Introduction

Currently the agricultural sector is globally exposed to strong changes in its general conditions, resulting in increasing pressure on costs and margins for farms. Especially, the costs for machinery and labour have escalated dramatically in recent years. For instance, the purchase prices for standard tractors with 188 horse powers on average rose 63% in real terms over the past decade in Germany, considering comparable technical configuration (cf. KTBL, 2005, 2015). Since both machinery and labor can often just be adopted in discrete amounts, such as the investment in one tractor or the recruitment of one worker, one way to counteract this rise in fixed costs would be to expand production and get access to economies of scale (e.g. Johnson and Ruttan, 1994). However, this strategy is not always appropriate or feasible in agriculture because of insufficient access to land and capital. Furthermore, the high (and further increasing) level of uncertainty in farming due to its weather-dependent nature often requires profound knowledge and quick decision-making, which cannot easily be taken over by employed workers. This can be seen as one of the main reasons for the prevalence of family owned and operated farms in many countries all over the world (e.g. Allen and Lueck, 1998; Deiniger and Byerlee, 2012).

For many farms, an alternative strategy to handle these increasing fixed costs is to share the associated assets and labor with other farms. In many European countries, farms are organized in collaborative arrangements (CAs) on a comparatively formal basis, that is, in the form of inter-farm cooperation, machine cooperatives, machine rings and the use of sub-contractors. This applies particularly to Germany, Great Britain and Sweden (e.g. Craig and Sumberg, 1997; de Toro and Hansson, 2004; Doluschitz, 2001). In Canada, some farmers are likewise organized in formal machinery cooperatives, such as 47 CUMA's (e.g. Harris and Fulton, 2000). In the United States, farms traditionally share equipment and labour on a more occasional basis, however, formal and routine-based CAs are also getting more and more popular in recent years (e.g. Artz, 2014).

Most of the existing literature on farm-level CAs focuses on the respective economic advantages for their members due to access to substantial economies of scale, based on exemplary case studies in different countries (e.g. Andersson et al., 2005; Artz et al., 2010; Aurbacher et al., 2011; de Toro and Hansson, 2004; Nielsen, 1999, Wolfey et al., 2011). Larsén (2010) confirms this by empirically analyzing the technical efficiencies of collaborating and non-collaborating Swedish farms by using FADN data, complemented with survey data. She finds that the average efficiency is indeed higher for collaborating farms than for non-collaborating farms, which applies to both crop and livestock farms.

The question arises, as to why farm-level CAs are still so rare in practice despite of the potential economic advantages of sharing equipment and labour with other members (e.g. Artz, 2014). Aurbacher et al. (2011) calculate the economic implications of a CA between five relatively small arable farms in south Germany and come to the result, that one reason that inhibits inter-farm machinery use could be path dependency. Lagerkvist and Hansson (2012) conduct a coordination game with farmers and find that personal factors like intolerance of ambiguity can influence famers' willingness to establish CAs. Apart from that, all of the aforementioned studies emphasize that a further important reason for not establishing CAs in reality is the risk of future conflicts with the potential partner, like problems of timeliness, free-riding and opportunism (e.g. Artz, 2014). These conflicts might moreover result in substantial additional transaction costs for the members of a CA, which might (partially) offset the economic advantages resulting from economies of scale. However, the actual influence of these potential conflicts on the decisions of farmers to establish CAs in the first place has not been investigated yet.

Against the background of this research gap, the objective of this paper is to analyze farmers' preferences for establishing CAs under explicit consideration of non-monetary factors that allow conclusions on the functioning of the future partnership. In this context, an empirical investigation based on historical data would be of limited explanatory power, as it is challenging or impossible to clearly distinguish the influencing factors of farmers' decisions to establish CAs in retrospective. Experiments can provide a solution to this issue as they collect data under controlled conditions. In particular, discrete choice experiments (DCEs) allow for the determination of preferences for action alternatives without explicitly asking for them (e.g. Train, 2009). By relating the respondents' choice behavior to the attributes of the action alternatives and the respondents' individual characteristics, complex structures of the decision-making process can be revealed (e.g. Louviere et al., 2010). DCEs have already been successfully applied to analyze farmers' preferences, including different technologies (e.g. Paulrud and Laitila, 2010) or agri-environmental schemes (e.g. Espinosa-Goded et al., 2010). And could hence also be an appropriate methodological approach to investigate farmers' preferences for CAs.

Therefore, the data for the analysis was gained through a DCE that was carried out by 107 German farmers in the year 2014. The farmers had to make a choice between two alternative collaboration partners and the opt-out alternative of no collaboration. The collaboration partners were specified by non-monetary attributes that varied over the different choice sets, like their years of acquaintance with the respondent, their age and their production activities. Moreover, the expected increase in profit of the respondent for establishing a collaboration with a partner was included as a monetary attribute, to allow for calculating the average individual's willingness-to-pay (WTP) or 'implicit price' for a change in each of the non-monetary attributes. Since WTP values are upwards biased when not considering for scale heterogeneity (Train and Weeks, 2005), we apply the generalized multinomial logit (GMNL) model introduced by Fiebig et al. (2010) to identify residual preference heterogeneity. The advantage of the GMNL over the more generally applied mixed logit (ML) model is that, in addition, it accounts for heterogeneity in the scale of the error term. This means it is possible to control for respondents with

nearly lexicographic preferences and respondents showing very "random" behavior. To the authors' knowledge, GMNL have not yet been commonly applied to DCE studies in the agricultural context.

This study provides farmers, agricultural consultants and agricultural politicians with important information with regard to an improved understanding of the motives and obstacles of establishing farm-level CAs. For instance, it can be shown that a farmers' preference to establish a CA increases, the closer his/her age is to the age of the potential collaboration partner. Furthermore, farmers' preferences for CAs increase the more years of (positive) acquaintance between them and the potential partner exist. And the results show that farmers' willingness to establish mutual CAs increase, the more similar their production activities are. Based on this, the study might also lay the foundation for agricultural politicians to design potential measures for supporting farm-level CAs and thus actively affecting structural change in agriculture.

The rest of the paper is structured as follows: In section 2, the hypotheses with regard to farmers' preferences for CAs that shall be tested by means of the DCE are derived from the literature. The design of the questionnaire, which includes the DCE, as well as the descriptive data are described in the subsequent section. Afterwards, the theoretical background of the analysis methods is explained in section 5. Finally, the results of the DCE are presented in section 6. The paper ends with some conclusive remarks (section 7).

2. Farmers' motives and obstacles to establish CAs

A central motive for a farmer to establish a CA is the improvement of the own future profitability of his/her farm. This motive arises from the expectation that the participation in farm-level CAs, in which resources like machinery and labour are shared, and in which the purchasing of inputs and the marketing of outputs are coordinated, involve an access to internal and external economies of scale (e.g. Valentinov, 2007). Internal economies of scale result from improvements in technological efficiency. For instance, sharing machinery tends to increase the area under cultivation serviced by the same machinery size, like one mutual combine harvester instead of two, resulting in reduced average costs for a given amount of output. In practical terms, this means that sharing can make larger and more technologically advanced equipment economical. In addition, group members can improve labour productivity by coordinating their tasks within the CA. This effect is widely confirmed by many normative model-based case studies (e.g. Andersson et al. 2005; de Toro and Hansson, 2004), by surveys (e.g. Artz et al., 2010; Hein et al., 2011) as well as by empirical investigations of the technical efficiencies of farms in CAs (Larsén, 2010). External economies of scale result from potential advantages of larger farms in accessing and purchasing inputs, in obtaining and negotiating bank loans as well as in marketing their outputs (e.g. Johnson and Ruttan, 1994; McBride, 2003). Although these advantages of size are difficult to verify empirically based on real data, they are nonetheless widely confirmed in surveys among farmers already working in collaborations (e.g. Artz et al., 2010; Hein et al., 2011). One can expect that farmers are carefully estimating the potential increase in future profits

resulting from internal and external economies of scale prior to making the decision to establish a CA with a potential partner. This leads to the following hypothesis:

H1 (profit increase): The higher the expected increase in profits, the higher is a farmer's preference to establish a CA.

Besides the potential positive economic effects resulting from internal and external economies of scale, CAs might also produce manifold conflicts between its members (e.g. Artz et al., 2010; Holderness, 2003). Examples are timeliness concerns, moral hazard problems, cost of collective decision-making and opportunism. These conflicts can imply additional considerable transaction costs and risks, which partially offset the economic advantages from the access to economies of scale. However, it can be expected that farmers have difficulties to quantify these costs and risks correctly when estimating the overall economic benefits of a CA prior to making the respective decision. This is due to the fact that these costs and risks resulting from the aforementioned conflicts are very difficult to measure. They may just occur occasionally and strongly depend upon the (mis)behavior of the potential collaboration partner (e.g. Artz, 2014; de Toro and Hanson, 2004). However, there are suggestions in the literature that these costs and risks can be reduced significantly by choosing a partner who is "like-minded" and with whom there exists a high degree of "trust" (e.g. Artz et al., 2010; Hein et al., 2011; Larsén, 2007). To operationalize these rather vague, superior and subjective concepts for the DCE, it is assumed that objectified factors exist, which directly affect the individually perceived "like-mindedness" and "trust" between potential collaboration partners and thus affect their willingness to collaborate. As a result of extensive expert discussions with collaborative and non-collaborative farmers as well as with agricultural consultants prior to the experiment, such objectified factors are the age of the potential collaboration partner, the duration of the acquaintance with the partner as well as the production activities of the partner. Accordingly, a similar age, a longest possible positive acquaintance and similar production activities can be seen as proxies for a high degree of trust and like-mindedness between potential collaboration partners. This is also confirmed by surveys among collaborating and non-collaborating farmers (e.g. Hein et al., 2011, Larsén, 2007). From this, the following three hypotheses can be derived:

H2 (age): The closer the age of the potential collaboration partners, the higher is a farmer's preference to establish a CA.

H3 (acquaintance): The more years of positive acquaintance between potential collaboration partners, the higher is a farmer's preference to establish a CA.

H4 (production activities): The more similar the production activities between potential collaboration partners are, the higher is a farmer's preference to establish a CA.

3. The experiment

The questionnaire is divided into two parts. In the first part, the farmers have to conduct the DCE. In the second part, they are asked to answer questions about their risk attitude and their socioeconomic background. In Subsection 3.1, the decision situation, the attributes and the respective levels of the

DCE are described. Afterwards, the experimental design is shortly explained. Subsequently, the descriptive statistics of the questionnaire are presented in Subsection 3.3.

3.1. Decisions situation, attributes and levels

In the DCE, the decision-making situation in each choice-set comprises two different and mutually exclusive collaboration alternatives A and B, as well as the status-quo alternative of no CA. The farmers are advised to make a decision between these three alternatives as if it was their personal decision for their own farm. The DCE is adressed to both farmers already working in a CA (collaborative farmers) and farmers who are not (non-collaborative farmers). To ensure comparability of the decision-making situation, collaborative farmers are asked to make the decision as if they would still run their farm without a CA. The two different versions of the experiment instruction can be read up on in Appendix 1.

According to the four derived hypotheses in Section 2, the above-mentioned three decision alternatives are described by the four attributes 'average annual expected increase in the respondent's profit for the first ten years of collaboration', 'years of positive acquaintance with the potential collaboration partner', 'age of the potential collaboration partner' and 'production activities of the potential collaboration partner'. The levels, within which these attributes vary over the different choice sets, are provided in Table 1. The attributes as well as the levels are the result of extensive expert discussions with collaborative and non-collaborative farmers and agricultural consultants as well as a careful consideration between reality and complexity. It should also be noted that the farmers are asked to assume prior to each choice set that the level of the 'average annual expected increase in profit' has been determined in extensive calculations prior to the decision under explicit consideration of the production activities of the potential collaboration partner. This means that the attribute 'production activities of the potential collaboration partner' is merely included in the choice sets to additionally account for psychological factors, which could result in (potentially costly) conflicts of interest.

Table 1: Attributes and levels in the DCE

Attributes	Levels
Average annual expected increase in the farmer's profit for the first ten years of collaboration (in €/year)	10,000; 20,000; 30,000
Years of positive acquaintance with the potential collaboration partner (in years)	1; 5; 10
Age of the potential collaboration partner (in years)	30; 45; 60
Production activities of the potential collaboration partner	Arable farming; Arable farming and animal husbandry; Arable farming and biogas production

Source: Author's own illustration.

3.2. The experimental design

The experimental design of the DCE with two generic alternatives and four attributes with three levels respectively (cf. Table 1) results in a full factorial design of ($4^3_{CA\,A} \cdot 4^3_{CA\,B}$=) 6,561 potential possible choice sets. To minimize the concomitant and unavoidable loss of information when reducing the full factorial design, an optimal orthogonal in the differences (OOD) design (Burgess and Street, 2005) is used. In addition to maintaining orthogonality, an OOD design aims to maximise the differences in the attribute levels across alternatives. By means of the software Ngene 1.1.1 (ChoiceMetrics, 2012), we create an OOD design with a D-efficiency of 100%. Thus, the number of choice sets presented to the participating farmers is reduced to nine. Such a design has a D-efficiency of 100%. Table 2 shows one of these nine choice sets that are presented to the farmers in a random order to avoid order effects. A detailed explanation of the decision-making situation and the nine choice sets of the DCEs are illustrated in Appendix 1.

After conducting the DCE, the farmers are asked for information regarding their risk attitude and their socioeconomic background. Following Dohmen et al. (2011), the farmers' risk attitude is measured by the 'general risk question' using an ordinal scale from 0 to 10, whereby 0 represents 'not willing to take risk at all' and 10 represents 'very willing to take risk'. Hence, farmers evaluate their risk attitude subjectively. The questions with regard to the farmers' socioeconomic background relate to factors like age, education and production activities.

Table 2: Choice set in the DCE

	Collaborative arrangement A	**Collaborative arrangement B**	**No collaborative arrangement**
Average annual expected increase in your farm's profit in the first 10 years of collaboration	€ 10,000	€ 20,000	
Production activities of the potential collaboration partner	Arable farming	Arable farming and animal husbandry	
Years of positive acquaintance with the potential collaboration partner	1 year	5 years	
Age of the potential collaboration partner	30 years	45 years	
Which collaborative arrangement would you choose? (Please select and mark only one alternative)	◯	◯	◯

Source: Author's own illustration.

After conducting the DCE, the farmers are asked for information regarding their risk attitude and their socioeconomic background. Following Dohmen et al. (2011), the farmers' risk attitude is measured by the 'general risk question' using an ordinal scale from 0 to 10, whereby 0 represents 'not willing to take risk at all' and 10 represents 'very willing to take risk'. Hence, farmers evaluate their risk attitude subjectively. The questions with regard to the farmers' socioeconomic background relate to factors like age, education and production activities.

3.3. Descriptive statistics

The online survey was completed by 107 farmers from all over Germany during May and June 2014 and was brought to farmers' notice through social networks. In addition, students were also asked to make farmers aware of the experiment. On average it took about 23 minutes to complete the whole questionnaire. Table 3 reports personal information and farm characteristics of the participating farmers. The farmers are 11% female, with an average age of 34 years and a standard deviation of 12 years. 45% of them manage the farm in an executive position and the remaining 55% are farm successors and/or employed on a farm. Overall, 66% hold a college or university degree. On average, they are nearly risk-neutral (μ=5.7; σ=1.7; ordinal scale from 0='not willing to take risk' to 10='very willing to take risk'). Furthermore, 64% of the farmers already work within a CA. The average farm size is 278 hectares with a standard deviation of 424 hectares.

Table 3: Descriptive statistics [a]

Farmers	
Share of female participating farmers	11
Average age (in years)	34 (12)
Share of farm managers	45
Share of participating farmers with an university degree	66
Average risk attitude (self-assessed) [b]	5.7 (1.7)
Share of farmers already working in a CA	64
Farms	
Share of farms who generate their main income with farming	85
Average farm size (in ha)	278 (424)
Share of farms with production activity 'arable farming' [c]	93
Share of farms with production activity 'animal husbandry' [c]	81
Share of farms with production activity 'renewable energies' [c]	35
Decision situation	
Number of non-answered choice sets out of 963 choice sets	0
Proportion of the decisions for CA A or B in %	73

Source: Author's own illustration.

Notes: [a] n=107, standard deviation in brackets.
[b] Ordinal scale from 0 to 10; 0='not willing to take risk at all'; 10='very willing to take risk' (cf. Dohmen et al., 2011).
[c] Multiple references possible.

On the basis of the descriptive statistics, it becomes clear that the sample is not representative for the population of German farmers. However, the study aimed to recruit farmers who are diverse regarding their farm structure, instead of generating a representative sample. This is for instance indicated by the large standard deviation of the variable 'farm size'.

4. Modelling approach

4.1. The generalized multinomial logit model

According to the random utility theory (McFadden, 1974), it is possible to determine an indirect utility function U_{int} for each respondent *n* and each collaboration alternative *I* in choice occasion *t* (cf. Hensher and Greene, 2003):

$$U_{int} = \boldsymbol{\beta}_n{}' \boldsymbol{x}_{int} + \boldsymbol{\varepsilon}_{int} \quad (1)$$

U_{int} can be described by *K* attributes $\boldsymbol{x}_{int}$ (in our study the four attributes described in Section 3.1) weighted by the respondent-specific taste parameters $\boldsymbol{\beta}_n$ that cannot be observed by the researcher. Non-observable individual preferences are considered in the stochastic component $\boldsymbol{\varepsilon}_{int}$, for which we assume an independently and identically distributed (i.i.d.) extreme value distribution.

For the so called ML model, the following definition of $\boldsymbol{\beta}_n$ is assumed:

$$\boldsymbol{\beta}_n = \overline{\boldsymbol{\beta}} + \Delta \boldsymbol{s}_n + \boldsymbol{\Gamma} \boldsymbol{v}_n \quad (2)$$

where $\overline{\boldsymbol{\beta}}$ is the fixed mean of the assumed distribution for $\boldsymbol{\beta}_n$. The *K*x*M* parameter matrix Δ expresses how the preference of chosing a certain collaboration alternative *i* changes due to the influence of *M* respondent's individual characteristics $\boldsymbol{s}_n$ in comparison to the reference respondent (with taste parameter $\overline{\boldsymbol{\beta}}$) while all other effects remain constant. Therefore, $\Delta \boldsymbol{s}_n$ captures the observed heterogeneity in preferences, whereas $\boldsymbol{\Gamma} \boldsymbol{v}_n$ represents the unobserved heterogeneity in preferences. $\boldsymbol{v}_n$ is a vector of *K* variables for which zero means, known variances and zero covariances are assumed. In our case, $\boldsymbol{\Gamma}$ is a diagonal matrix. Thus, the stochastic parameters are not allowed to be correlated.

As e.g. Fiebig et al. (2010) and Keane (2006) state, the ML model and also the multinomial logit model do not adequatly consider for scale heterogeneity. Therefore, we also introduce the GMNL model here. Following Fiebig et al. (2010), the abovementioned definition of $\boldsymbol{\beta}_n$ is stretched out in the GMNL model in the following way:

$$\boldsymbol{\beta}_n = \sigma_n[\overline{\boldsymbol{\beta}} + \Delta \boldsymbol{s}_n] + [\gamma + \sigma_n(1-\gamma)]\boldsymbol{\Gamma} \boldsymbol{v}_n \quad (3)$$

σ_n is the respondent-specific scale of the error term. Fiebig et al. (2010) assume a log-normal distribution for σ_n with standard deviation τ and mean $(\bar{\sigma} + \boldsymbol{\delta} \boldsymbol{z}_n)$, where $\bar{\sigma}$ is a normalizing constant and $\boldsymbol{z}_n$ is a vector of *L* indiviual-specific variables. If $\boldsymbol{z}_n$ is spezified in the model formulation, the researcher can explain why σ_n is heterogenous across respondents. γ is a weighting parameter that indicates how variance in unobserved preference heterogeneity varies with scale. As Greene and Hensher (2010: p. 2) point out, γ is essential for the GMNL model, because it "controls the relative importance of the overall scaling of the utility function, σ_n , versus the scaling of the individual preference weights contained in the diagonal elements of $\boldsymbol{\Gamma}$". In accordance with Keane and Wasi's (2012) argumentation, we do not impose the constraint that γ takes on values between 0 and 1, as Fiebig et al. (2010) do. Three special cases of the GMNL model are shortly named here: (i) the ML model: if $\sigma_n = 1 \rightarrow \boldsymbol{\beta}_n = \overline{\boldsymbol{\beta}} + \Delta \boldsymbol{s}_n + \boldsymbol{\Gamma} \boldsymbol{v}_n$ (cf. Equation (2)), (ii) the S-MNL model: if $\gamma = 0 \rightarrow \boldsymbol{\beta}_n = \sigma_n \overline{\boldsymbol{\beta}}$ and (iii) the MNL model: if $\sigma_n = 1$ and $\gamma = 0 \rightarrow \boldsymbol{\beta}_n = \overline{\boldsymbol{\beta}}$.

Respondent *n*, as a utility maximizer, chooses collaboration alternative *j* instead of *i* from a given set of alternatives C_{nt} if the following applies: $U_{jt} > U_{it} \;\forall\, j \in C_n,\; j \neq i$. For a given value of $\boldsymbol{\beta}_n$, the conditional choice probability that respondent *n* chooses choice sequence $y_n = \{y_{n1}, \dots, y_{nT}\}$ is given as follows:

$$Pr(y_n|\boldsymbol{\beta}_n) = \prod_{t=1}^{T} \frac{e^{\boldsymbol{\beta}_n' \boldsymbol{x}_{y_{nt}nt}}}{\sum_{i=1}^{I} e^{\boldsymbol{\beta}_n' \boldsymbol{x}_{int}}} \tag{4}$$

Since $\boldsymbol{\beta}_n$ is not observable, the unconditional probability should be calculated by integration of Equation (4) weighted by the population density distribution $f(\boldsymbol{\beta}_n|\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma})$ of $\boldsymbol{\beta}_n$ (cf. Equation (3)):

$$Pr(y_n|\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma}) = \int Pr(y_n|\boldsymbol{\beta}_n) f(\boldsymbol{\beta}_n|\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma})\, d\boldsymbol{\beta}_n \tag{5}$$

The log likelihood for the GMNL model is the following:

$$LL(\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma}) = \sum_{n=1}^{N} ln\; Pr(y_n|\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma}) \tag{6}$$

Since the integral does not have a closed form, it has to be approximated through simulation. To do so, *R* simulation runs are conducted, in which *R* realizations out of $f(\boldsymbol{\beta}_n|\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma})$ are raised and the associated utility parameters $\boldsymbol{\beta}_n^R$ are calculated. For more detailed information how the simulated log-likelihood were calculated in STATA see Gu et al. (2013).

To obtain individual level parameters for the willingness to pay calculation, we follow the method described by Train (2009). The distribution of $\boldsymbol{\beta}_n$ conditional on the observed choice sequence y_n and the moments of the population density function $f(\boldsymbol{\beta}_n|\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma})$ is calculated as follows (for further insights see Train, 2009):

$$h(\boldsymbol{\beta}_n|y_n, \overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma}) = \frac{Pr(y_n|\boldsymbol{\beta}_n)\; f(\boldsymbol{\beta}_n|\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma})}{Pr(y_n|\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma})} \tag{7}$$

Individual level utility parameters $\widetilde{\boldsymbol{\beta}_n}$ for each respondent *n* can be obtained by means of Equation (8):

$$\widetilde{\boldsymbol{\beta}_n} = \int \boldsymbol{\beta}_n \cdot h(\boldsymbol{\beta}_n|y_n, \overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma}) d\boldsymbol{\beta}_n \tag{8}$$

The integral in Equation (8) does not have a closed form and, therefore, has to be calculated by means of simulation. The willingness to pay for the attributes are calculated on the basis of the obtained individual level utility parameters as the quotient of the attribute's utility parameter and the utility parameter of the attribute 'profit' as the price attribute.

4.2. Variable coding and model estimation

All models include a dummy-coded, alternative-specific constant (ASC). The ASC takes on the value of one for collaboration alternatives and the value of zero for the status-quo alternative 'no CA'. Furthermore, the attribute 'profit' is included in the model estimations. A Wald test for linear restriction[1] confirms the linearity of the attribute 'profit' (p-value=0.15). Thus, the attribute variable 'profit' is included in the model estimations as a continuous variable. Modelling the monetary attribute 'profit' as a continuous variable enables us to estimate WTP values as mentioned in Section 4.1, otherwise we had to employ a more complex calculation method. In contrast, for the attributes 'partner acquaintance' and 'partner's age' it is not possible to assume a linear interdependency (p-values of the Wald test for linear restriction<0.01). Therefore, effect-coded variables with discrete values instead of the continuous attribute variables are included in the model estimation. Moreover, the qualitative attribute 'production activities' is included in the model estimations as effect coded variable (for detailed information regarding the coding of all variables see Table A.2 in Appendix 2). Effect coding relaxes linearity assumptions and implies that level specific effects should be interpreted as deviations from the average, whereas dummy coded variables are interpreted as differences from the reference level. Therefore, orthogonalising the attribute effects with the ASC is one of several advantages of effect coding versus dummy coding. For a detailed comparison between these two types of coding, readers are referred to Bech and Gyrd-Hansen (2005). In addition, the WTP for the basic level of the effect coded attribute can be calculated as the negative sum of the estimated WTP values of the other two attribute levels ($WTP_{Basic}=(-WTP_{Level\ 1}-WTP_{Level\ 2})$).

The attribute 'profit' as well as the effect coded variables of the attribute 'partner acquaintance' and the variable 'partner's age 60years' were modeled as normally distributed random parameters. The statistical significance of the coefficients associated with the standard deviations of the random parameters indicates that they are significantly different from zero, and that the variables should indeed be modeled as random (Hensher and Greene, 2003: p. 145). Additionally, this is a strong evidence of unobserved preference heterogeneity. Furthermore, the structural parameter τ is significantly different from zero indicating substantial heterogeneity in individual scale. Therefore, using GMNL models is an appropriate approach, since unobserved heterogeneity in preferences and scale are both present. This is supported by means of the AIC-criterion, which indicates that the calculated GMNL models fit the data better than the ML model (cf. Table 4). The codes used to calculate the models and the WTP measures with STATA 12 are fully provided in Appendix 2.

[1] In order to examine the assumption that the utility in the utility parameters of the quantitative attributes is linear, a test of linearity is carried out. To do so, the attributes are dummy-coded (cf., Hensher et al., 2005: pp. 344-351). Each time, the middle value of the three levels is chosen as reference. Thus, for each attribute, there are two dummy-coded variables included in the model estimation - one variable codes the higher and one the lower level. The linearity assumption is regarded as complied if it is possible to estimate significant utility parameters, which are in the same ratio as the distances of the levels to the reference level, for both dummy-coded variables of an attribute. Based on the reference level, it is ensured in this way that a change in the attribute by one unit - no matter in which direction - results in a not significantly different change in the absolute value of the selection probability.

Table 4: Results of different models [a]

Variable	ML model	GMNL model	GMNL model with interactions
Utility parameters:			
ASC [b]	0.27635	0.01719	-0.03769
Profit	0.00008 ***	0.00018 ***	0.00017 ***
Partner's age 30years [c]	0.15863 *	0.22254	0.17265
Partner's age 30years [c] · farmer's age [d]			-0.00705 *
Partner's age 60years [e]	-0.23433 *	-0.70634 *	-0.52349 *
Partner's age 60years [e] · farmer's age [d]			0.01404 *
Partner acquaintance 1year [f]	-1.16189 ***	-2.60772 ***	-2.41514 ***
Partner acquaintance 10years [g]	0.87944 ***	2.05799 ***	1.90037 ***
Partner arable [h]	0.47181 ***	1.11749 ***	1.69302 ***
Partner arable [h] · farmer renewable [i]			0.09302
Partner arable [h] · farmer husbandry [k]			0.32272
Partner biogas [l]	-0.28110 **	-0.61778 **	-0.56706 +
Partner biogas [l] · farmer renewable [i]			3.23018 +
Partner biogas [l] · farmer husbandry [k]			-3.28280 +
Standard deviation (SD) of the random parameters:			
SD ASC [b]	2.98792 ***	3.50567 ***	3.57337 ***
SD profit	0.00006 ***	0.00013 **	0.00014 ***
SD partner's age 60years [e]	0.73184 ***	1.19586 **	1.05106 ***
SD partner arable [h]	0.58359 ***	1.03161 **	0.92109 ***
SD partner biogas [l]	0.55028 ***	1.09915 **	1.19919 ***
Structural parameters:			
Tau	---	1.24774 ***	1.10335 ***
Gamma	---	-0.69725 +	-0.33551
Model fit:			
Number of participating farmers (N)		107	
Observations (N · number of choice sets)		963	
Simulated log likelihood at convergence	-733.70	-717.43	-706.39
AIC (calculated on the basis of the number of observations)	1,493.40	1,464.87	1,454.77
Likelihood ratio index	0.18	0.20	0.22

Source: Author's own calculations using the command 'mixlogit' (Hole, 2007) and 'gmnl' (Gu et al., 2013) in STATA 12.

Notes: + p <0.1; * p < 0.05; ** p < 0.01; *** p < 0.001.

[a] 10,000 Halton Draws; panel structure of the data was taken into account; indented variables depict the interaction terms.

[b] Binary coded; reference: Status-quo alternative 'no CA'.

[c] Effect coded attribute variable that takes on the value 1 if the potential collaboration partner is 30 years old, (-1) if he/she is 45 years old and 0 if he/she is 60 years old.

[d] Age of the participating farmer is centered around the mean (38.38).

[e] Effect coded attribute variable that takes on the value 1 if the potential collaboration partner is 60 years old, (-1) if he/she is 45 years old and 0 if he/she is 30 years old.

[f] Effect coded attribute variable that takes on the value 1 if the potential collaboration partners know each other with positive acquaintance of 1 year, (-1) if they know each other with positive acquaintance of 5 years and 0 if they know each other with positive acquaintance of 10 years.

[g] Effect coded attribute variable that takes on the value 1 if the potential collaboration partners know each other with positive acquaintance of 10 years, (-1) if they know each other with positive acquaintance of 5 years and 0 if they know each other with positive acquaintance of 1 year.

[h] Effect coded attribute variable that takes on the value 1 if the potential collaboration partner runs a farm with the production activity 'arable farming', (-1) if he/she runs a farm with the production activity 'animal husbandry' and 0 if he/she runs a farm with the production activity 'biogas production'.

[i] Effect coded respondent specific variable that takes on the value 1 if the farmer runs a farm inter alia with the production activity 'renewable energies', (-1) if the farmer runs a farm inter alia with the production activity 'arable farming' and 0 otherwise.

[k] Effect coded respondent specific variable that takes on the value 1 if the farmer runs a farm inter alia with the production activity 'animal husbandry', (-1) if the farmer runs a farm inter alia with the production activity 'arable farming' and 0 otherwise.

[l] Effect coded attribute variable that takes on the value 1 if the potential collaboration partner runs a farm with the production activity 'biogas production', (-1) if he/she runs a farm with the production activity 'animal husbandry' and 0 if he/she runs a farm with the production activity 'arable farming'.

Table 5: WTP measures based on the GMNL model with interactions in €

WTP in € [a]	**N**	**Mean**		**SD**	**Confidence Interval**	
Partner's age 30years	107	664		595	-516	1,844
Partner's age 45years	107	2,840	+	1,592	-316	5,997
Partner's age 60years	107	-3,504	*	1,529	-6,535	-474
Partner acquaintance 1year	107	-13,047	*	8,889	-24,723	-1,371
Partner acquaintance 5years	107	2,781	*	1,255	292	5,269
Partner acquaintance 10years	107	10,266	*	4,634	1,079	19,453
Partner arable	107	8,902	+	4,575	-168	17,973
Partner biogas	107	-3,370		4,470	-12,233	5,493
Partner biogas if farmer renewable [b]	40	20,500	***	7,915	4,491	36,509
Partner biogas if farmer husbandry [c]	55	-24,651	***	3,007	-30,679	-18.622
Partner husbandry	107	-5,532		5,312	-16063	4,999
Partner husbandry if farmer renewable [b]	40	-36,757	***	9,944	-56,869	-16,644
Partner husbandry if farmer husbandry [c]	55	12,057	***	2,939	6,164	17,950

Source: Author's own calculations using the post-estimation command 'gmnlbeta' (Gu et al., 2013) for the GMNL model with interactions (cf. Table 4) in STATA 12.

Notes: [+] p <0.1; * p < 0.05; ** p < 0.01; *** p < 0.001.

[a] We used a t-test to analyze whether the mean of the calculated WTP is statistically different from zero.

[b] The participating farmer runs a farm inter alia with the production activity 'renewable energies'.

[c] The participating farmer runs a farm inter alia with the production activity 'animal husbandry'.

5. Results

The results of all calculated models reveal a non-significant ASC (cf. Table 4). Therefore, a general willingness to establish a CA that cannot be explained by the attributes is not existent. In this respect, it should be noted that an additional GMNL model with the farmers individual risk attitude as interaction terms with the attributes was calculated. The results show that the preferences heterogeneity cannot be explained by the individual risk attitude of the farmer. The WTP measures calculated on the basis of the GNML model with interaction terms are presented in Table 5. The attribute 'profit' is chosen as the price attribute in the WTP calculations, therefore, the WTP values

are measured in Euros of the average annual expected increase in the respondents' farm profit when establishing a collaboration with a potential partner.

H1 (profit increase): The higher the expected increase in profits, the higher is a farmer's preference to establish a CA.

The utility parameter of the attribute 'profit' is significantly positive in all calculated models (cf. Table 4). Thus, the farmers' willingness to establish a CA rises if the average annual expected increase in profit of the CA's first ten years rises as well. This result supports H1 that farmers' preferences to establish CAs rises with increasing profits. Thus, H1 cannot be rejected.

H2 (age): The closer the age of the potential collaboration partners, the higher is a farmer's preference to establish a CA.

The utility parameter of the effect coded attribute variable 'partner age 30years' is only significant in the ML model (cf. ML model in Table 4: significantly positive utility parameter), whereas the utility parameter of the effect coded attribute variable 'partner age 60years' is significantly negative in all calculated models.

In the GMNL model with interactions, the interaction term 'partner's age 30years · farmer's age' is significantly negative. This means that farmers who are older than 38 (which represents the age of the reference farmer) prefer a 45-year-old over a 30-year-old potential collaboration partner, whereas farmers who are younger than 38 prefer a 30-year-old over a 45-year-old partner. The interaction term 'partner's age 60years · farmer's age' is also significant in the GMNL model with interactions. This means that the reference farmer who is 38 prefers a 45-year-old over a 60-year-old partner. This preference increases with decreasing age of the farmer and decrease with increasing age of the farmer.

Looking at the respective WTP measures in Table 5, one can see that the WTP for a 30-year-old potential collaboration partner is not significantly different from zero. Furthermore, the average WTP for a 45-year-old partner is 2,840 €. The average compensation requirement for a 60-year-old partner is 3,504 €. Thus, the resulting marginal WTP for a partner who is 45 instead of 60 years old is 664 € (= 3,504 – 2,840).

In light of these results, H2 cannot be rejected, that is farmers' preferences to establish CAs increase the closer the age between the potential partners is.

H3 (acquaintance): The more years of positive acquaintance between potential collaboration partners, the higher is a farmer's preference to establish a CA.

The utility parameter of the effect coded attribute variable 'acquaintance 1year' is significantly negative in all calculated models (cf. Table 4). Therefore, a farmer will assign a negative utility to the case that he/she is acquainted with the potential collaboration partner for only one year. However, the utility parameter of the effect coded attribute variable 'acquaintance 10years' is significantly positive in all calculated models. As expected, the farmer's utility of establishing a CA is positive when the potential partners are acquainted for ten years.

The farmers' average maximum willingness to pay for being acquainted with the potential collaboration partner for five (ten) years is 2,781 € (10,266 €). If the farmer is only acquainted with the potential collaboration partner for one year, he/she will on average have a maximum compensation requirement of 13,047 €. The farmers' marginal willingness to pay for being acquainted with the potential collaboration partner for five (ten) years instead of one (five) year(s) is 10,266 € (7,485 €).

In summary, H3 cannot be rejected, that is farmers' preferences to establish CAs increase, the more years of positive acquaintance between the potential partners exist.

H4 (production activities): The more similar the production activities between potential collaboration partners are, the higher is a farmer's preference to establish a CA.

In all calculated models (cf. Table 4), the utility parameter of the effect coded attribute variable 'partner arable' is significantly positive. Therefore, the utility farmers assign to a potential collaboration partner with the production activity 'arable farming' is positive. The GMNL model with interactions in Table 4 reveals that the utility parameters of the interaction terms with the attribute variable 'partner arable' are not significantly different from zero. Thus, there exists no difference in the utility animal husbandry-farmers and renewable energy-farmers assign towards a potential collaboration partner with the production activity 'arable farming'. Farmers' average maximum WTP for a CA with such a potential collaboration partner is 8,902 € (cf. Table 5).

The utility parameter of the effect coded attribute variable 'partner biogas' is significantly negative in all calculated models (cf. Table 4). Hence, the utility linked to a CA where the partner has the production activities 'arable farming and biogas production' is negative. The utility parameter of the interaction term 'partner biogas · farmer renewable' ('partner biogas · farmer husbandry') is significantly positive (negative) (cf. GMNL model with interactions in Table 4). Thus, farmers with the production activity 'renewable energies' assign a positive utility to a CA with a partner that has the production activity 'biogas production'. As Table 5 depicts, farmers with the production activity 'renewable energies' have a maximum average WTP of 20,500 € for establishing a CA with a partner that has the production activity 'biogas production'. However, they have a maximum compensation requirement of 36,757 € for establishing a CA with a partner that has the production activity 'animal husbandry'. In contrast, animal husbandry-farmers have a maximum average WTP of 12,057 € for a CA with a partner that the production activity 'animal husbandry', whereas they have a maximum compensation requirement of 24,651 € for a CA with a partner with the production activity 'biogas production'.

In described results reveal that H4 cannot be rejected. Farmers who operate animal husbandry or renewable energies besides arable farming, are preferred more for establishing CAs by farmers who have the same production activities than by farmers who just operate arable farming.

6. Concluding remarks

Farm-level CAs are a possible strategy for agricultural entrepreneurs to handle escalating costs for equipment and labor, which can often just be adopted in discrete amounts. Existing studies on farm-level CAs mainly focus on the respective economic advantages for their members as a result of accessing

economies of scale. However, these analyses do not consider potential conflicts between the members of CAs, like problems of timeliness, free-riding and opportunism. The risk of a future occurrence of these conflicts and the associated additional costs could be an important reason for farmers' reluctance to enter CAs in the first place in reality. Hence, the objective of this paper was to analyze farmers' preferences for CAs in an experimental setting. For this, a DCE was performed in which German farmers had to choose their preferred collaboration partner. Besides the monetary advantage of establishing a CA with a potential partner, also non-monetary attributes were considered, which could indicate the above-mentioned conflicts in the future of a partnership, like the age of the partner or the years of acquaintance with the partner. The gained data was subsequently analyzed by means of a GMNL model and average individual WTP measures for a change in each of the non-monetary attributes were calculated.

The results of the DCE reveal interesting insights into the drivers of farmers' decisions to establish CAs. Accordingly, it can be shown that a farmers' preference to establish a CA increases, the closer his/her age is to the age of the potential collaboration partner, which is in-line with existing survey results (e.g. Hein et al., 2011). This indicates that a similar age can be seen as an indicator for "trust" and "like-mindedness" among potential collaboration partners, which are suspected (but not investigated quantitatively) in many contributions to be important factors to mitigate future (costly) conflicts in CAs (e.g. Artz et al., 2010; Hein et al., 2011; Larsén, 2007). Furthermore, the results of the present study confirm that a farmers' preference for CAs increase the more years of (positive) acquaintance between him/her and the potential partner exist. Therefore, knowing the potential partner for a longer time can also be seen as an indicator for "trust" and "like-mindedness", which increases the preparedness to establish a CA. Finally, the outcome of the DCE suggests that the production activities also play an important role in the occurrence of CAs. Accordingly, the preferences of farmers to establish a mutual collaboration increase, if the production activities of the two potential partners are similar, for instance if both practice animal husbandry besides arable farming. Besides economic considerations, this could be also traced back to non-monetary motives like traditional thinking (e.g. Benz, 2006).

The findings of this study are of practical importance for farmers as well as for agricultural consultants and politicians. On the basis of the results, farmers are able to make decisions regarding the establishment of CAs in a more structured and objectified way due to an improved understanding of their respective motives and obstacles. In this respect, especially the calculated WTP measures for the non-monetary attributes like 'age of the collaboration partner' could help to improve comparability between monetary and non-monetary attributes and thus facilitate the establishment of farm-level CAs in the future. Likewise, agricultural consultants receive useful information for improved and objectified advices to farmers, if and which CAs are an appropriate strategy for the farm in the future. And agricultural politicians could include the results into the design of potential measures for supporting farm-level CAs in countries, in which a high potential for increasing the efficiency of primary agricultural production exist.

Nevertheless, the results of the study should be interpreted with due care due to some limitations of the data gained in the DCE. First, the results are based on hypothetical decisions like in all other studies which apply laboratory experiments. The question of whether the decision-making behavior of real decision situations is different of those in hypothetical decision situations has been examined several times. The respective results provide abundant evidence that there is little discrepancy between real and hypothetical decision-making behavior (e.g. Kuehberger et al., 2002). Nevertheless, this should be confirmed by comparable studies in the agricultural context. Second, the transferability of the findings should be tested in additional DCEs, particularly with regard to other countries in other regions where the conditions of agricultural production are different. And third, the preference of a farmer to establish a CA could also depend on the degree of collaboration (e.g. merely share machinery and labour, or additionally buy inputs together) and the chosen legal form. For complexity reasons, no specifications are made about this in the present DCE.

References

Allen, D.W. and D. Lueck (1998): The Nature of the Farm. In: The Journal of Law & Economics XLI: 343-386.

Andersson, H., K. Larsén, C.J. Lagerkvist, C. Andersson, F. Blad, J. Samuelsson and P. Skargren (2005): Farm cooperation to improve sustainability. In: AMBIO: A Journal of the Human Environment 34(4): 383-387.

Artz, G. (2014): Equipment sharing in agriculture. In: Encycolpedia of Food and Agricultural Ethics: 1-7. Springer Science+Business Media Dordrecht. DOI: 10.1007/978-94-007-6167-4_66-4.

Artz, G., G. Colson and R. Ginder (2010): A Return of the Threshing Ring? A Case Study of Machinery and Labor-Sharing in Midwestern Farms. In: Journal of Agricultural & Applied Economics 42(4): 805-819.

Aurbacher, J., C. Lippert and S. Dabbert (2011): Imperfect markets for used machinery, asynchronous replacement times, and heterogeneity in cost as path-dependent barriers to cooperation between farmers. In: Biosystems Engineering 108(2): 144-153.

Benz, M. (2006): Entrepreneurship as a Non-profit-seeking Activity. In: International Entrepreneurship and Management Journal 5: 23-44.

Breustedt, G., J. Müller-Scheeßel, J. and U. Latacz-Lohmann (2008): Forecasting the adoption of GM oilseed rape: Evidence from a discrete choice experiment in Germany. In: Journal of Agricultural Economics 59(2): 237-256.

Burgess, L. and D. J. Street (2005): Optimal designs for choice experiments with asymmetric attributes. In: Journal of Statistical Planning and Inference 134 (1): 288-301.

ChoiceMetrics (2012): Ngene 1.1.1: User manual and reference guide. Choice Metrics Pty Ltd.

Craig, S. and J. Sumberg (1997): Machinery rings in UK agriculture: an example of opportunistic cooperation. In: Journal of Rural Cooperation 25: 3-20.

Deininger, K. and D. Byerlee (2012): The rise of large farms in land abundant countries: Do they have a future? In: World Development 40(4): 701-714.

Doluschitz, R. (2001): Kooperationen in der Landwirtschaft. In: Berichte über Landwirtschaft 79: 375-398.

Dohmen, T., A. Falk, D. Huffman, U. Sunde, J. Schupp and G.G. Wagner (2011): Individual risk attitudes: measurement, determinants, and behavioral consequences. In: Journal of the European Economic Association 3: 522-550.

Espinosa-Goded, M., J. Barreiro-Hurlé, J. and E. Ruto (2010): What do farmers want from Agri-environmental scheme design? A choice experiment approach. In: Journal of Agricultural Economics 61(2): 259-273.

Fiebig D.G., M.P. Keane, J.J. Louviere and N. Wasi (2010): The generalized multinomial logit model: Accounting for scale and coefficient heterogeneity. In: Marketing Science 29: 393- 421.

Gu, Y., A.R. Hole and S. Knox (2013): Fitting the generalized multinomial logit model in Stata. In: The Stata Journal 13: 382 397.

Harris, A. and M. Fulton (2000): The CUMA Farm Marchinery Co-operatives. Center for the Study of Co-operatives. University of Saskatchewan.

Hein, K., P. Lavèn and R. Doluschitz (2011): Voraussetzungen, Vorteile und Probleme in Kooperationen zwischen landwirtschaftlichen Unternehmen—theoretische Analyse und empirische Überprüfung. In: Berichte über Landwirtschaft 89(1): 13-37.

Hensher, D.A. and W.H. Greene (2003): The mixed logit model: the state of practice. Transportation, 30(2): 133-176.

Holderness, C.G. (2003): Joint ownership and alienability. In: International Review of Law and Economics 23(1): 75-100.

Hole, A.R. (2007): Estimating mixed logit models using maximum simulated likelihood. The Stata Journal 7: 388-401.

Johnson, N. and V. Ruttan (1994): Why are farms so Small? In: World Development 22: 691-706.

Keane, M. (2006): The generalized logit model: preliminary ideas on a research program, presentation at Motorola-CenSoC Hong Kong Meeting, 22 October, 2006.

Kuehberger, A., M. Schulte-Mecklenbeck and J. Perner (2002): Framing decisions: Hypothetical and real. In: Organizational Behavior and Human Decision Processes 89(2): 1162-1175.

Lagerkvist, C.J. and H. Hansson (2012): Machinery-sharing in the presence of strategic uncertainty: evidence from Sweden. In: Agricultural Economics 43(1): 113-123.

Larsén, K. (2007): Participation, incentives and social norms in partnership arrangements among farms in Sweden. Selected paper at the American Agricultural Economics Association Annual Meeting. Portland, OR, 29th July-1st August 2007.

Larsén, K. (2010): Effects of machinery-sharing arrangements on farm efficiency: evidence from Sweden. In: Agricultural Economics 41(5): 497-506.

Louviere, J. D., D.A. Hensher and J.D. Swait (2010): Stated choice methods - analysis and applications. University Press, Cambridge.

McBride, W.D. (2003): Production costs critical to farming decisions. In: Amber Waves 1(4): 38-45.

McFadden, D. (1974): Conditional logit analysis of qualitative behaviour. In: Zarembka, P. (eds.): Frontiers in econometrics. Academic Press, New York: 105-142.

NASS (2015): Farm Production Expenses Annual Summary. Internet site: http://usda.mannlib.cornell.edu/MannUSDA/viewDocumentInfo.do?documentID=1066. Accessed 25 January, 2015.

Nielsen, V. (1999): The effect of collaboration between cattle farms on the labour requirement and machinery costs. In: Journal of Agricultural Engineering Research 72(2): 197-203.

SAOS (2008): Co-operative Rural Business Rings Socio Economic Impact Study. Ingliston, Scotland: SAOS, Ltd., March 2008.

de Toro, A. and P.A. Hansson (2004): Machinery Cooperatives – a case study in Sweden. In: Biosystems Engineering 87: 13-25.

Train, K. (2009): Discrete Choice Methods with Simulation. University Press, Cambridge.

Train, K. and M. Weeks (2005): Discrete choice models in preference space and willingness-to-pay space. Springer Netherlands, 2005.

Valentinov, V. (2007): Why are cooperatives important in agriculture? An organizational economics perspective. In: Journal of Institutional Economics 3(01): 55-69.

Varian, H.R. (1992): Microeconomic analysis. 3rd Edition. New York: Norton.

Wolfley, J.L., J.W. Mjelde, D.A. Klinefelter and V. Salin (2011): Machinery-Sharing Contractual Issues and Impacts on Cash Flows of Agribusinesses. In: Journal of Agricultural and Resource Economics 36(1): 139-159.

Appendix 1: Decision-making situation and choice sets of the experiment

[The online survey was put online during May and June 2014 and was brought to farmers' notice through social networks. In addition, students from the University of Göttingen were also asked to make farmers aware of the experiment.

All participating farmers made the nine choice sets of the DCE in one sitting, although they had the possibility to interrupt the experiment. Farmers were not offered an incentive or compensation to participate in the experiment. In addition, any feedback was provided.

To avoid an order effect when presenting the choice sets to the farmers, the sequence of the choice sets was randomly chosen by the computer. In the following, the DCE is presented.]

[The instructions and choice sets are translated from German. The abbreviation "CA" is continued here for homogeneity in the paper. In the experiment, it was written out in full.]

[Decision situation for farmers who are already running their farms in (a) CA(s)]

You stated that you run your farm today in one or more agricultural CA(s). The decision regarding these arrangements was most likely up to you or your predecessor.

In the context of our study, we would like to examine what are reasons for or against a CA between farmers. Thus, we need to establish comparability between you as a collaborative partner and farmers who are not involved in a CA. Therefore, please, imagine that you do not run your farm within a CA. Furthermore, imagine that you are faced once more with the decision to enter a CA. Please, when deciding, use your knowledge and experience about CAs gained in the past.

In the following, we will ask you ninetimes, one behind the other, which alternative out of the supplied CAs you will choose. The CAs A and B differentiated in the following:

- average annual expected increase in your farm's profit for the first ten years of collaboration,
- years of positive acquaintance with the potential collaboration partner,
- age of the potential collaboration partner and
- production activities of the potential collaboration partner.

Of course, you can also choose the alternative 'no CA'. Please, choose the alternative that you consider to be appropriate for your farm!

Note: The information to the CAs always refers to the potential collaborative partner (except the increase of your profits).

Thank you!

[Decision situation for farmers who do not run their farms in a CA]

You stated that you do not run your farm today in an agricultural CA. The decision against a CA was most likely up to you, your predecessor or was not existent up to now.

In the context of our study, we would like to examine what are reasons for or against a CA between farmers. Thus, we need to establish comparability between you as a non collaborative farmer and farmers who run their farm within a CA. Therefore, please, imagine that you have the possibility to enter a CA.

In the following, we will ask you ninetimes, one behind the other, which alternative out of the supplied CAs you will choose. The CAs A and B differentiated in the following:

- average annual expected increase in your farm's profit for the first ten years of collaboration,
- years of positive acquaintance with the potential collaboration partner,
- age of the potential collaboration partner and
- production activities of the potential collaboration partner.

Of course, you can also choose the alternative 'no CA'. Please, choose the alternative that you consider to be appropriate for your farm!

Note: The information to the CAs always refers to the potential collaborative partner (except the increase of your profits).

Thank you!

[The nine following choice sets are presented to the farmers in a random order.]

[Choice set 1]

	CA A	**CA B**	**No CA**
Average annual expected increase in your farm's profit in the first 10 years of collaboration	€ 10,000	€ 20,000	
Production activities of the potential collaboration partner	Arable farming	Arable farming and animal husbandry	
Years of positive acquaintance with the potential collaboration partner	1 year	5 years	
Age of the potential collaboration partner	30 years	45 years	
Which CA would you choose? (Please select and mark only one alternative)	◯	◯	◯

[Choice set 2]

	CA A	**CA B**	**No CA**
Average annual expected increase in your farm's profit in the first 10 years of collaboration	€ 30,000	€ 10,000	
Production activities of the potential collaboration partner	Arable farming and animal husbandry	Arable farming and biogas production	
Years of positive acquaintance with the potential collaboration partner	5 years	10 years	
Age of the potential collaboration partner	30 years	45 years	
Which CA would you choose? (Please select and mark only one alternative)	◯	◯	◯

[Choice set 3]

	CA A	**CA B**	**No CA**
Average annual expected increase in your farm's profit in the first 10 years of collaboration	€ 20,000	€ 30,000	
Production activities of the potential collaboration partner	Arable farming and biogas production	Arable farming	
Years of positive acquaintance with the potential collaboration partner	10 years	1 year	
Age of the potential collaboration partner	30 years	45 years	
Which CA would you choose? (Please select and mark only one alternative)	◯	◯	◯

[Choice set 4]

	CA A	**CA B**	**No CA**
Average annual expected increase in your farm's profit in the first 10 years of collaboration	€ 20,000	€ 30,000	
Production activities of the potential collaboration partner	Arable farming and animal husbandry	Arable farming and biogas production	
Years of positive acquaintance with the potential collaboration partner	1 year	5 years	
Age of the potential collaboration partner	45 years	60 years	
Which CA would you choose? (Please select and mark only one alternative)	◯	◯	◯

[Choice set 5]

	CA A	**CA B**	**No CA**
Average annual expected increase in your farm's profit in the first 10 years of collaboration	€ 10,000	€ 20,000	
Production activities of the potential collaboration partner	Arable farming and biogas production	Arable farming	
Years of positive acquaintance with the potential collaboration partner	5 years	10 years	
Age of the potential collaboration partner	45 years	60 years	
Which CA would you choose? (Please select and mark only one alternative)	◯	◯	◯

[Choice set 6]

	CA A	**CA B**	**No CA**
Average annual expected increase in your farm's profit in the first 10 years of collaboration	€ 30,000	€ 10,000	
Production activities of the potential collaboration partner	Arable farming	Arable farming and animal husbandry	
Years of positive acquaintance with the potential collaboration partner	10 years	1 year	
Age of the potential collaboration partner	45 years	60 years	
Which CA would you choose? (Please select and mark only one alternative)	◯	◯	◯

[Choice set 7]

	CA A	**CA B**	**No CA**
Average annual expected increase in your farm's profit in the first 10 years of collaboration	€ 30,000	€ 10,000	
Production activities of the potential collaboration partner	Arable farming and biogas production	Arable farming	
Years of positive acquaintance with the potential collaboration partner	1 year	5 years	
Age of the potential collaboration partner	60 years	30 years	
Which CA would you choose? (Please select and mark only one alternative)	◯	◯	◯

[Choice set 8]

	CA A	**CA B**	**No CA**
Average annual expected increase in your farm's profit in the first 10 years of collaboration	€ 20,000	€ 30,000	
Production activities of the potential collaboration partner	Arable farming	Arable farming and animal husbandry	
Years of positive acquaintance with the potential collaboration partner	5 years	10 years	
Age of the potential collaboration partner	60 years	30 years	
Which CA would you choose? (Please select and mark only one alternative)	◯	◯	◯

[Choice set 9]

	CA A	**CA B**	**No CA**
Average annual expected increase in your farm's profit in the first 10 years of collaboration	€ 10,000	€ 20,000	
Production activities of the potential collaboration partner	Arable farming and animal husbandry	Arable farming and biogas production	
Years of positive acquaintance with the potential collaboration partner	10 years	1 year	
Age of the potential collaboration partner	60 years	30 years	
Which CA would you choose? (Please select and mark only one alternative)	◯	◯	◯

Appendix 2: STATA code

In the folowing the STATA codes used for the calculation of the models are presented. Table A.2 holds information regarding the variables and their coding. For more information regarding the abovementioned STATA-commands 'mixlogit', 'gmnl' and 'gmnlbeta' readers are referred to the respective STATA help-files.

Code for ML model

```
mixlogit
    choice
        partner acquaintance 1year
        partner acquaintance 10years
        partner's age 30years,
    rand(  asc
        profit
        partner arable
        partner biogas
        partner's age60years)
    group(occasion) id(number) nrep(10000)

estat ic, n(963)
```

Code for GMNL model

```
gmnllogit
    choice
        partner acquaintance 1year
        partner acquaintance 10years
        partner's age 30years,
    rand(  asc
        profit
        partner arable
        partner biogas
        partner's age60years)
    group(occasion) id(number) nrep(10000)

estat ic, n(963)
```

Table A2. Variables and their coding

Variables	Coding	Hypotheses
ASC	Binary coded alternative-specific constant takes on the value one for a CA and the value zero for the status-quo alternative 'no CA'.	
Profit	Average annual expected increase in profit of the first ten years of collaboration in €	H1
Partner arable	Effect coded attribute variable that takes on the value 1 if the potential collaboration partner runs a farm with the production activity 'arable farming', (-1) if he/she runs a farm with the production activity 'animal husbandry' and 0 if he/she runs a farm with the production activity 'biogas production'.	H2
Partner biogas	Effect coded attribute variable that takes on the value 1 if the potential collaboration partner runs a farm with the production activity 'biogas production', (-1) if he/she runs a farm with the production activity 'animal husbandry' and 0 if he/she runs a farm with the production activity 'arable farming'.	
Farmer husbandry	Effect coded respondent specific variable that takes on the value 1 if the participating farmer runs a farm inter alia with the production activity 'animal husbandry', (-1) if he/she runs a farm inter alia with the production activity 'arable farming' and 0 otherwise.	
Farmer renewable	Effect coded respondent specific variable that takes on the value 1 if the participating farmer runs a farm inter alia with the production activity 'renewable', (-1) the he/she runs a farm inter alia with the production activity 'arable farming' and 0 otherwise.	
Partner acquaintance 1years	Effect coded attribute variable that takes on the value 1 if the potential collaboration partners know each other with positive acquaintance of 1 year, (-1) if they know each other with positive acquaintance of 5 years and 0 if they know each other with positive acquaintance of 10 years.	H3
Partner acquaintance 10years	Effect coded attribute variable that takes on the value 1 if the potential collaboration partners know each other with positive acquaintance of 10 years, (-1) if they know each other with positive acquaintance of 5 years and 0 if they know each other with positive acquaintance of 1 year.	
Partner's age 30years	Effect coded attribute variable that takes on the value 1 if the potential collaboration partner is 30 years old, (-1) if he/she is 45 years old and 0 if he/she is 60 years old.	H4
Partner's age 60years	Effect coded attribute variable that takes on the value 1 if the potential collaboration partner is 60 years old, (-1) if he/she is 45 years old and 0 if he/she is 30 years old.	
Farmer's age	Age of the participating farmer is centered around the mean (38.38).	

Choice	Dummy coded dependent variable that depicts the choice made by a farmer in a specific choice occasion. The variable takes on the value 1 if the alternative is chosen and the value zero if the alternative is not chosen.
Occasion	Numeric identifier for the choice occasions that ranges from1 to 9.
Number	Numeric identifier for the participating farmers that ranges from 1 to 107. In this way it is taken into account that the farmer answer nine choice sets.

Source: Author's own illustration.

Code for GMNL model with interactions

To integrate independent variables which do not vary over alternatives into the model it is necessary to generate interaction terms with the alternative specific constant or the attributes.

```
gmnl
    choice
            partner arable · farmer renewable
            partner arable · farmer husbandry
            partner biogas · farmer renewable
            partner biogas · farmer husbandry
            partner acquaintance 1year
            partner acquaintance 10years
            partner's age 30years
            partner's age 30years · farmer's age
            partner's age 60years · farmer's age,
    rand(  asc
            profit
            partner arable
            partner biogas
            partner's age60years)
    group(occasion) id(number) nrep(10000)

estat ic, n(963)

gmnlbeta
            partner arable · farmer renewable
            partner arable · farmer husbandry
            partner biogas · farmer renewable
            partner biogas · farmer husbandry
            partner acquaintance 1year
            partner acquaintance 10years
            partner's age 30years
            partner's age 30years · farmer's age
            partner's age 60years · farmer's age,
    nrep(10000) noscale sav("file name")
```

IV. Berücksichtigen Landwirte bei ihren Investitionsentscheidungen die damit verbundenen Auswirkungen auf die finanzielle Flexibilität ihres Betriebes?

Autoren: Friederike Anastassiadis und Oliver Mußhoff

Veröffentlicht im *German Journal of Agricultural Economics (2014), 63 (4): 240-258.*

Zusammenfassung

Der Agrarstrukturwandel ist mit Anpassungsprozessen verbunden, die oftmals mit größtenteils fremdfinanzierten Investitionen einhergehen. Eine Folge davon sind sinkende Eigenkapitalquoten in landwirtschaftlichen Betrieben. Dies kann dazu führen, dass sich die finanzielle Flexibilität – verstanden als betriebliche Kreditreserve – ebenfalls verringert. Es stellt sich daher die Frage, ob Betriebsleiter die Auswirkungen auf die finanzielle Flexibilität ihres Betriebes bei Investitionsentscheidungen berücksichtigen. Im vorliegenden Beitrag werden landwirtschaftlichen Betriebsleitern in einem Discrete Choice Experiment hypothetische Investitionsalternativen zur Entscheidung vorgelegt. Die Investitionsalternativen unterscheiden sich dabei in ihrer Rentabilität, dem Risiko und ihrer Auswirkung auf die finanzielle Flexibilität des Betriebes. Es zeigt sich, dass die finanzielle Flexibilität entscheidungsrelevant ist. Die Bedeutung, die ihr ein Betriebsleiter dabei beimisst, hängt unter anderem von seiner Risikoeinstellung und dem betrieblichen Erfolg ab.

Schlüsselwörter

Finanzielle Flexibilität, Investitionsentscheidungen, Discrete Choice Experiment.

Abstract

The structural change in the agricultural sector calls for adaption processes which often involve leveraged investments that, in turn, cause decreasing equity capital ratios of farms. It is, therefore, possible that financial flexibility - as the farm's debt capacity - will also decrease. The question arises to what extent decision makers consider the effects on the financial flexibility of the individual farm when making their investment decisions. In the present study, farmers are faced with hypothetical investment alternatives in a discrete choice experiment. The investment alternatives presented to the farmers differ in their profitability, risk and effect on the financial flexibility of the individual farm. The results show that financial flexibility is relevant in their investment decisions. The importance farmers attach to the financial flexibility depends, among others, on their risk attitude and the profitability of the farm.

Key Words

Financial flexibility, investment decisions, discrete choice experiment.

V. Analyzing farmers' preferences for substrate supply contracts for sugar beets

Autoren: Saramena Sauthoff; Friederike Anastassiadis; Oliver Mußhoff

Veröffentlicht als *Diskussionspapier Nr. 1509, Georg-August-Universität Göttingen, Fakultät für Agrarwissenschaften, Department für Agrarökonomie und Rurale Entwicklung*.

1. Introduction

The global demand for energy is continuously rising (IEA, 2013). At the same time, the availability of finite resources is decreasing. Additional challenges are to mitigate climate change and its consequences (Mbzibain et al., 2013; Østergaard, 2012). Therefore, the promotion and expansion of renewable energy sources has become a vital part of many countries' strategies to achieve a sustainable energy transition (Paulrud and Laitila, 2010). Against this background, the German government has laid the foundation to this energy transition process with the "Renewable Energy Sources Act (RES Act)" in 2000 (Act on granting, 2000). The latest amendment of the law aims to continuously and cost-efficiently increase the share of electricity generated from renewable energy sources to at least 40% by 2025 (Act on the development, 2014).

Biogas production from biomass of agricultural origin plays a key role in Germany's energy transition process making Germany a worldwide leader in this field (Kreuger et al., 2011). The conversion of biogas to biomethane provides both a source for the generation of either electrical or thermal energy and the possibility of feeding biomethane directly into the natural gas grid or using it as gaseous fuel (Reise et al., 2012; Weiland, 2010). The German Biogas Association estimates the number of biogas plants to reach 8,000 at the end of 2015, which corresponds to an eightfold increase since the year 2000. In other words, approximately eight million households will receive biogas-based electricity in 2015 (German Biogas Association, 2014). With this development comes an increased cultivation of energy crops, such as maize and grains (FNR, 2014). Maize accounts for nearly three-quarters of the biomass-based share of the substrate mix. In some regions maize affects the landscape massively, leading to a declining acceptance in society (Starke and Hoffmann, 2014). As a result, the German government introduced the so-called "maize cap" through an amendment to the RES Act, limiting the amount of maize or cereal grains as a substrate in biogas plants to 60 percent, which has been in effect for new built biogas plants since 2012 (Act on granting, 2012).

As sustainable and socio-political accepted energy production in biogas plants becomes increasingly important, it is necessary to widen the range of suitable substrates. For the aforementioned reasons, sugar beets are a new and highly interesting alternative for the production of biogas (Gissén et al., 2014). Compared to silage maize, the dry matter of sugar beets essentially consists of sugar that can be easily and almost completely converted into biogas. In addition, the yield as well as the energy yield per hectare is comparable to that of maize (Starke and Hoffmann, 2014). This is a crucial factor, since the energy

production from agricultural biomass often competes with food production, and it must be ensured that the scarce factor of land is used optimally (Gissén et al., 2014). It must also be pointed out that sugar beets can only be grown in crop rotation (Draycott, 2006). Therefore, a concentration of cultivation such as in maize is not possible. Thus in current maize growing regions sugar beet production could contribute to more diversity. Furthermore, the expiration of the EU sugar beet quota in 2017 increases the necessity to consider alternative uses of sugar beets as farmers are facing a decline in stable financial support for the traditional sugar beet production (European Commission, 2015; Ilbery et al., 2010). From this point on, sugar beets will be traded at world market prices, which vary greatly as the retrospective reveals. On the one hand, bringing sugar beets as a biogas substrate into farmers' focus could be one opportunity to provide farmers with more planning certainty in their decisions (Tate and Mbzibain, 2011), and on the other hand, the use of sugar beets can make a contribution to a sustainable and diversity-promoting energy transition. As both sugar beet cultivation in the EU and biomass feedstock supply of biogas plants are almost entirely organized as contract farming (Granoszewski and Spiller, 2013; Draycott, 2006), it appears most suitable to establish a future sugar beet cultivation for biogas production with supply contracts. The literature review reveals that there are some contributions that focus on the substrate supply of biogas plants. Reise et al. assessed factors that are crucial for farm managers to accept substrate supply contracts through a choice experiment. However, this contribution determines the preferences of farmers for maize but not for sugar beets as a biogas substrate. Paulrud and Laitila conducted a choice experiment to assess farmers' attitudes on growing energy crops in Sweden. Their results indicate that the decision to cultivate energy crops depends on the increased utility farmers expect by growing such crops. Broch and Vedel revealed farmers' agri-environmental contract preferences with choice experiments. Their results show that farmers have a preference for short contract periods and the possibility to return to the status quo if they are uncertain of the future benefits and the costs of their contract. Further examples in the literature give evidence that risk-averse farmers or farmers with larger than average farms tend to accept contracts earlier that protect them against risk (Key and MacDonald, 2006; Katchova and Miranda, 2004). To date, there are no studies that address the attitude of farmers towards the alternative use of sugar beets in biogas plants.

Using sugar beets for biogas is a new production method, thus resulting in a lack of data regarding substrate supply contracts for this specific crop. Furthermore, supply contract data is sensitive information that cannot be easily collected and consequently requires an experimental design (Reise et al., 2012). To investigate farmers' preferences for the design of supply contracts for sugar beets prior to their implementation in the market, a discrete choice experiment (DCE) appears most suitable (Breustedt et al., 2008; Louviere et al., 2000). As we aim at achieving a realistic contract design that appeals to farmers to grow sugar beets for biogas under contract, we pursue the following two objectives: (1) We examine whether farmers with contract experience are more willing to sign contracts for sugar beets as a biogas substrate than farmers who are not substrate suppliers under contract. (2) We analyze if there

is an impact of the farmers' risk attitude on their contract choice, taking into consideration that using sugar beets for biogas is a new production method.

By closing the research gap on supply contract design for sugar beets as an alternative biogas substrate, the novelty of this paper lies in the transfer of the preference valuation technique of a DCE to the agricultural biomass production sector for producing biogas from sugar beets. Therefore, our paper contributes to the literature on each of the research topics, and it fills a gap by amalgamating these topics. This study has significant benefits for farmers as well as biogas plant operators who gain important information about the farmers' view on sugar beet supply contracts. Moreover, our study allows policy makers to draw conclusions on how an alternative as well as a society-supported path of substrate supply may look. This is particularly important because increasing adoption rates of sugar beet cultivation for biogas production could enable a more sustainable energy transition from the current standard.

The following section deals with the hypotheses derivation. Section 3 provides information about the experiment, specifically regarding the experimental design. Based on the results, the hypotheses are tested and discussed (section 4), while in section 5 conclusions are drawn.

2. Hypotheses generation

Experience and Knowledge

Goodwin and Schroeder (1994) found that educational programs as well as advisory services encourage farmers to adopt marketing contracts. Pennings and Leuthold (2000a) pointed out that in the contract adoption phase, decision-makers evaluate to what extent a contract has an added value to them or not. In another contribution, the knowledge in contracting is considered to have a positive impact on adopting contracts in the future (Pennings and Leuthold, 2000b). Granoszewski and Spiller (2013) revealed that farmers who have already concluded substrate supply contracts in the past are more likely to enter into contracts for biomass again. Therefore, the following hypothesis can be derived:

> **H1: Farmers who have experiences with contracts for supplying biogas substrates are more willing to choose a supply contract for sugar beets as a biogas substrate.**

Farmer's risk attitude

"Farming is a risky business" leading to the fact that income from farming depends on "unanticipated changes and unpredictable events" (Key and MacDonald, 2006: 27, 28). Furthermore, literature gives evidence that farmers as a group are thought to be risk-averse (Key and MacDonald, 2006; Hudson and Lusk, 2004; Pope and Just, 1991). Especially in the field of renewable energy it is hardly assessable for farmers to predict the economic consequences their actions might have (Broch and Vedel, 2012). Uncertainty seems to be a key barrier to a widespread and a successful uptake of bioenergy production among farmers (Clancy et al., 2012; Meijer et al., 2007; Domac et al., 2005). Clancy et al. (2012) found that farmers associate possible additional production and financial risks with cultivating biomass crops.

These concerns might be caused by the relative novelty of the bioenergy production sector leading to uncertainty and restraint in farmers' adoption decisions. This leads to the following hypothesis:

H2a: The more risk-averse a farmer is, the less he/she is willing to choose a supply contract for sugar beets as a biogas substrate since this utilization is very innovative, and outcomes are hardly predictable.

Risk aversion plays a vital role in farmers' decision-making to produce or cultivate goods under contract (Key, 2005; Hudson and Lusk, 2004; Gillespie and Eidman, 1998). It might appear that to reduce income risks, for instance, using long-term supply contracts would seem to be highly beneficial because of providing utility to the farmer through long-term risk reduction (Key and MacDonald, 2006). However, Hudson and Lusk (2004) as well as Roe et al. (2004) pointed out that farmers are more likely to contract over short periods, as they found that producer utility decreases with an increasing contract period. Granoszewski and Spiller (2013) showed that farmers who are considered to be risk-averse tend to choose supply contracts for biomass with a short contract period. Thus, the following hypothesis can be derived:

H2b: The more risk-averse a farmer is, the less he/she is willing to contract sugar beets for biogas production over a longer period.

The decision to what extent a farmer should grow agricultural biomass for energy production on his/her arable land depends, for example, on how well he/she can assess the future benefits of such energy crops for his/her farm business (Paulrud and Laitila, 2010). The results of a survey among German farmers supplying contractual biomass indicated that risk-averse farmers want to provide only a small share of their acreage for bioenergy crop cultivation (Granoszewski and Spiller, 2013). Hence, the hypothesis can be formulated as follows:

H2c: The more risk-averse a farmer is, the less he/she is willing to provide a share of his/her area of arable land to cultivate sugar beets for biogas production under contract.

Interest has recently been focused on a spring harvest of sugar beets to ensure a year-round substrate supply (Starke, 2012; Märländer et al., 2010). However, by cultivating sugar beets that will be harvested after hibernation, the farmer is exposed to the risk that impairments in the harvest or crop failures may occur, and thus a financial loss incurs (Key and MacDonald, 2006). Therefore, we expect a relationship as described in the following hypothesis:

H2d: The more risk-averse a farmer is, the more he/she opposes a harvest of sugar beets for biogas production in spring instead of autumn.

Crop rotation restrictions

Sugar beets have specific demands from the soil, climatic conditions, and previous crops (Draycott, 2006). Since sugar beets are not self-compatible, cultivation in crop rotation is required (Dewar and Cooke, 2006; Koennecke, 1967). The more frequently sugar beets are cultivated, the more quickly disease organisms and nematode populations increase and damage sugar beet yields (Wilson, 2001). By

widening the rotation of host crops, sugar beet quality and quantity improve significantly (Dewar and Cooke, 2006; Wilson, 2001). Particularly, in less favorable locations a maximum sugar beet share of 25% should not be exceeded, leading to a four-year crop rotation cycle (Wilson, 2001; Baeumer, 1992). On optimal suited locations, a maximum possible share of 33%, i.e. a three-year crop rotation cycle, can be implemented (Baeumer, 1992). Consequently, if a farmer already grows sugar beets, his/her cultivation capacity decreases due to crop rotation restrictions. On the basis of these considerations, H3 is the following:

> **H3: Because of crop rotation restrictions, a farmer already growing a high share of sugar beets on his/her farm land prefers a supply contract for sugar beets as a biogas substrate including a small area covered by contract, measured against his/her farm land.**

3. The Experiment

3.1. The stated preferences approach

The preferences analysis differentiates between the *revealed* and *stated* preferences approach. The former aims to observe market behavior and represents real buying behavior of individuals. Through the verifiable purchase of a product, "real" preferences become visible (for further empirical analysis, see Bateman et al. (2002)). However, with this approach, it is not possible to detect preferences for new products, e.g. those not yet available at the time of the study, nor can preferences be displayed for hypothetical scenarios and services (Train, 2009). In these cases, the stated preference approach is most suitable as it allows for drawing conclusions from previously non-articulated preferences about real choice decisions (Pfarr and Ulrich, 2011). According to Louviere et al. (2000), this approach understands preferences as internalized settings of an individual which can be revealed by means of a survey. The DCE represents a method within the stated preferences approach in which an attribute-based measure of respondents' preferences through a scenario of hypothetical decision-making situations is possible (Pfarr and Ulrich, 2011; List et al., 2006). In a DCE, participants are confronted with a so-called choice set with different alternatives and are then invited to select one of them. Each given alternative consists of pre-defined attributes and their associated levels. Within a DCE the choice sets can be repeated several times. In these choice sets, the attributes with their levels are systematically varied to determine the respective influence on the selection decision (Louviere et al., 2000; List et al., 2006).

To examine the preferences of German farmers for the design of substrate supply contracts for sugar beets prior to an effective application of those contracts, the DCE is advisable because substrate supply data is sensitive information that cannot be easily accessed by external parties. Therefore, no sufficient data for an econometric analysis is available; thus an experimental design is necessary if preferences for certain contractual arrangements should be identified. By doing so, initial predictions can finally be made on how contracts for sugar beets as a biogas substrate have to be designed to find practical application.

3.2. Decision situation, attributes, and levels

In our DCE, the following decision situation was described to the participating farmers (cf. Appendix A for the exact wording in the experiment): The operator of a biogas plant offered two contract alternatives for cultivating sugar beets as a biogas substrate to the participating farmer. The operator committed by contract to organize the harvest and the transportation of the sugar beets including all associated costs. Each decision situation (choice set) provided two different and mutually exclusive contract alternatives. Being neutrally referred to as "contract A" and "contract B", these are generic alternatives. A status-quo alternative ("no contract") was also available.

In each decision situation, the participating farmers chose from two contract alternatives that were described by the following four attributes: "contract period", "area covered by contract", "contract price" and "spring harvest". The attributes and their levels were chosen based on the derived hypotheses (cf. Section 2). Furthermore, the results of a literature review, the analysis of biomass supply contracts, and the results of expert talks with farmers contributed to the selection of the attributes and their levels:

- We offered contract alternatives to the participating farmers with varying contract periods: one year, three and six years.
- The area covered by contract varied between 5%, 10%, and 20% of the individual area of arable land. We did not use fixed amounts for the attribute "area covered by contract" but we related the attribute levels to the individual area of arable land. By doing so, we ensured that contracts with an area matched with the individual farm size were offered to the participating farmers.
- The attribute "contract price" was derived from prices of sugar beets used for industry purposes. We varied the attribute "contract price" in the DCE as follows: € 22, € 25, and € 29. These prices refer to one metric ton of fresh weighted sugar beets containing 18% sugar.
- The attribute "spring harvest" comprised two levels: On the one hand, the sugar beets are harvested in autumn as usual or, on the other hand, a quarter of the area covered by contract is harvested in spring.

3.3. Experimental design

The experimental design of the DCE with two generic alternatives and three attributes with three levels as well as one attribute with two levels (cf. Section 3.2) resulted in a full-factorial design of $((3 \cdot 3 \cdot 3 \cdot 2)_{\text{contract A}} \cdot (3 \cdot 3 \cdot 3 \cdot 2)_{\text{contract B}} =)$ 2,916 possible decision situations or choice sets. For practical use, this design was found to be too extensive and, therefore, the number of choice sets had to be reduced. To do so, a D-efficient Bayesian Design (D-error of 0.078; for detailed information regarding D-efficient designs, please refer to Bliemer et al. (2005) and Sándor and Wedel (2008)) was created using the software Ngene 1.1.1 (ChoiceMetrics, 2012). The necessary ex-ante information for the D-efficient Bayesian Design was conducted with the help of a pretest with 18 farmers. As a result, the number of choice sets per farmer used in the final experiment was reduced to twelve. Table 1 shows one of these twelve choice sets with which the participating farmers were faced. A complete list of the twelve choice sets is included in Appendix A.

Table 1: One of the twelve choice sets used in the discrete choice experiment

	Contract A	Contract B	No contract
Contract period	3 years	1 year	
Area covered by contract	10% of the farm's area of arable land [a)]	20% of the farm's area of arable land [a)]	
Contract price	29 € t^{-1}	25 € t^{-1}	
Spring harvest	¼ of the area covered by contract will be harvested in spring	No – the whole area will be harvested in autumn	
Which contract alternative would you choose?	⬭	⬭	⬭

Source: own illustration; translated from German to English.
Notes: [a)] This value is calculated individually for every participating farmer and is depicted in the choice set as an individual value in hectare.

Finally, we have designed an online survey by proceeding as follows: First, the participating farmers were asked to provide their general farm operating data. In the second part, we conducted the above-described DCE. Then, questions were raised to identify differences in the farmers' perceptions of the performance of sugar beets and maize as energy crops. The fourth part of the questionnaire primarily intended to collect socio-demographic data as well as the farmers' risk attitudes.

4. Results and discussion

4.1. Description of the sample

For our empirical analysis, we collected primary data from German farmers who either grow sugar beets or other biogas substrate crops or who can imagine cultivating sugar beets as an energy crop in the future. We used an online survey which was available from November 2013 to February 2014. The farmers were invited to participate in the survey through a mailing list of our department, a reference to our study in an agricultural magazine, and social media channels. Furthermore, farmers were personally addressed at an agricultural exhibition. In total, 349 hits to the survey's homepage were counted. Of those interested, 148 submitted a questionnaire giving a response rate of 42%. Thirty questionnaires were assessed as incomplete and could not be used for the analysis. Thus, the questionnaires of 118 farmers could be included in the evaluation. The farmers needed 21 minutes on average to complete the experiment.

The participating farmers are aged between 19 and 68 years with an average age of 39 years (standard deviation (SD): 15 years). A total of 85% of them are agriculturally trained; half of the sample (52%) holds a university degree. Of the 118 farms, 84% are farmed on a regular basis. This is markedly above the German average, where only 45% of the farms are run on a regular basis (BMEL, 2014). Farm size ranges from 5 to 4,010 ha of arable land with an average farm size of 308 ha (SD: 544 ha). Thus, the

average farm size of our participants is well above the average German farm size with 59 ha (BMEL, 2014). The sample included 76 sugar beet growers (64%) and 75 farmers with crops for biogas production (63%). Of these 75 farmers, 15 farmers (20%) cultivated sugar beets as a biogas substrate; half of these sugar beets were used by the farmers in their own biogas plants. On a three-year average, beet growers estimated their average yield level at 71 t ha^{-1} (SD: 10 t ha^{-1}), whereas non-beet growers expected their average yield level for sugar beets to be 57 t ha^{-1} (SD: 16 t ha^{-1}).

The participating farmers were asked to rate their risk attitude on a scale from 0 (not willing to take risk at all) to 10 (very willing to take risk) according to the German Institute of Economic Research (DIW) (2010; Dohmen et al., 2009). On average, farmers assessed themselves as slightly risk-taking (6 on the scale).

Table 2 provides an overview of the participating farmers' opinions on biogas production from sugar beets. The data reveals that more farmers have a positive attitude towards biogas production from sugar beets compared to biogas production in general. It becomes apparent that at least two-thirds of the sample evaluate sugar beets as a sustainable and promising substrate alternative to maize.

Table 2: Farmers' opinions on biogas production from sugar beets

Statements [a)]	Percentage of participating farmers
Farmers who have a positive attitude towards biogas production in general	56
Farmers who think sugar beets for biogas production are an important alternative after the EU sugar regime reform in 2017	70
Farmers who evaluate sugar beets as a sustainable alternative to maize substrate	67
Farmers perceiving sugar beets as a financially interesting extension of their farm enterprise	66

Source: own illustration; translated from German to English.
Notes: [a)] Not all questions were answered by all participants. The number of given answers varies between 72 and 118.

4.2. Hypotheses testing

Models in preference space are the current state of the art when it comes to the analysis of DCEs. In such models, distributional assumptions regarding the parameter estimates are necessary. To derive the willingness to pay (WTP) on the basis of a model in preference space, the ratio of two randomly distributed parameter estimates has to be calculated. However, this ratio can be unstable or leading to implausible WTP values (Scarpa et al., 2008). Hensher and Greene (2011), Scarpa and Willis (2010), Thiene and Scarpa (2009), Scarpa et al. (2008) as well as Louviere et. al. (2005) Recent studies demonstrated that directly obtaining WTP values produce more realistic values for the participants' WTP (Hensher and Greene, 2011; Scarpa and Willis, 2010; Thiene and Scarpa, 2009; Scarpa et al.,

2008; Louviere et al., 2005). In comparison to the standard model in preference space, studies applying models in WTP space are not widely used. Nevertheless, studies analysing DCEs with models in WTP space can be found in a growing number of disciplines such as health (e.g. Hole and Kolstad, 2012; Özdemir, Johnson and Hauber, 2009), transportation (e.g. Hensher and Greene, 2011; Train and Weeks, 2005), food (e.g. de-Magistris, Gracia and Nayga, 2013; Campbell and Plerty, 2012), and environmental sciences (e.g. Lanz and Provins, 2013; Scarpa and Willis, 2010). However, in studies with an agricultural background, models in WTP space are rarely used (e.g. Bennett and Balcombe, 2012).

The models depicted in Table 3 are estimated in WTP space. As Greene and Hensher (2010) note, models in WTP space are a specified form of the generalized multinomial logit model (GMNL model) introduced by Fiebig et al. (2010). The coefficients of the model in WTP space represent the marginal WTP for each variable. For further details regarding the estimation details the reader is referred to the studies of Bennett and Balcombe (2012), Scarpa and Willis (2010), and Scarpa et al. (2008).

Model 1 in Table 3 illustrates how the average participating farmer values the contractual arrangements. In Model 2, we additionally include several farmer-specific variables as interaction terms with the different contractual arrangements. These interaction terms account for possible causes of the detected heterogeneity in the valuation of the contractual arrangements. On the basis of Model 2, the hypotheses derived in Section 2 are tested and discussed. In our context, a marginal compensation requirement (negative marginal WTP) can be interpreted as a mark-up which the farmer demands for a specific change in the contractual arrangements. To be able to better connect the estimation results with the hypotheses, the risk attitude variable is recoded as follows: 0=**very** willing to take risk (reference farmer is risk-seeking); …; 10=**not** willing to take risk at all. The complete STATA code used to calculate our models as well as information regarding the variable coding are attached in Appendix B.

The results of Model 1 reveal a significantly negative coefficient of the "alternative-specific constant (ASC)" implying that the average participating farmer has a general preference for the status-quo which cannot be explained by the contractual arrangements. Consequently, the average farmer demands a contract price of € 22.69 for choosing a supply contract for cultivating sugar beets as a biogas substrate instead of choosing the status-quo (cf. Table 2 Model 1). If the average farmer accepts a supply contract for cultivating sugar beets as a biogas substrate with c.p. a one-year longer contract period, the contract price has to be € 0.43 higher. An area covered by contract measured in percent of the individual area of arable land which is c.p. a percentage point higher results in a higher price demand of the average farmer of € 2.11. The average mark-up for a spring harvest of a quarter of the area covered by contract is c.p. € 2.29.

Table 3: Results of the generalized multinomial logit models in willingness-to-pay space [a)]

Variables	Model 1	Model 2
Alternative-specific constant (ASC) [b)]	-22.69 ***	-26.87 ***
	[-23.34; -22.03]	[-27.67; -26.06]
ASC [b)] · supplier of biogas substrate [c)]		-0.18
		[-0.49; 0.13]
ASC [b)] · farmer's risk attitude [d)]		1.10 ***
		[0.85; 1.35]
Contract period	-0.43 ***	0.16
	[-0.53; -0.32]	[-0.04; 0.37]
Contract period · farmer's risk attitude [d)]		-0.13 ***
		[-0.18; -0.07]
Area covered by contract	-2.11 ***	-0.55 *
	[-2.57; -1.65]	[-1.15; -0.05]
Area covered by contract · share of sugar beets [e)]		-0.04 ***
		[-0.06; -0.02]
Area covered by contract · area of arable land [f)]		-0.001 **
		[-0.001; -0.0001]
Area covered by contract · farmer's risk attitude [d)]		-0.26 ***
		[-0.38; -0.14]
Spring harvest [g)]	-2.29 ***	-1.64 ***
	[-2.60; -1.98]	[-1.93; -1.35]
Spring harvest [g)] · farmer's risk attitude [d)]		-0.13 **
		[-0.22; -0.05]
Participating farmers/observations	118/4,248	118/4,248
Log-Likelihood at convergence	-1,045	-1,035
Akaike information criterion	2,109	2,105

Source: own calculations by means of the STATA-command "gmnl" (Gu et al., 2013) in STATA 12.

Notes: [a)] * $p < 0.1$; ** $p < 0.05$; *** $p < 0.001$; intended variables depict the interaction terms; the 95% confidence intervals of the estimated marginal willingness-to-pay (WTP) values are shown in brackets; all the WTP coefficients are assumed to be normally distributed and correlated; the price coefficient was normalized to be log-normal and constrained to 1; estimated standard deviations of the random utility parameters and the structural parameters of the models are not shown here for simplicity (see Appendix C for the complete results).

[b)] Binary coded variable; reference: status-quo alternative "no contract".

[c)] Effect coded; reference: farmer supplies no biogas substrate.

[d)] Self assessed risk attitude; this variable is recoded for estimation purposes: 0=**very** willing to take risk; …; 10=**not** willing to take risk whatsoever.

[e)] Share of the area of arable land planted with sugar beets.

[f)] Area of arable land in hectare.

[g)] Effect coded; reference: a quarter of the area covered by contract will be harvested in autumn.

Experience and knowledge

The coefficient of the interaction term "ASC · supplier of biogas substrate" is not significant (cf. Table 3, Model 2). Compared to farmers who currently do not supply biogas substrates, farmers who are already suppliers of a biogas substrate do not have a significantly lower price demand for choosing a supply contract for sugar beets as a biogas substrate instead of choosing the status-quo. In light of these results, we have to reject **H1 that farmers who have experiences with contracts for supplying biogas substrate are more willing to choose a supply contract for sugar beets as a biogas substrate**.

We also controlled for the farmers' experience in already cultivating sugar beets for biogas production as a possible cause of heterogeneity in choosing the status-quo instead of choosing a contract alternative. However, the model results, which are shown in Appendix D reveal a non-significant coefficient of this variable. Thus, we can conclude that having experience in cultivating sugar beets as a biogas substrate does not influence the farmer's decision for or against a contract alternative. It is conceivable that experience is not the main aspect influencing farmers in the decision to choose or reject a contract. Other considerations, such as the contract partner or support from the family and local people, might be deemed by the farmers equally relevant.

Farmer's risk attitude

As the significant coefficient of the interaction term "ASC · farmer's risk attitude" in Model 2 of Table 3 reveals, the farmer's risk attitude greatly influences the abovementioned general preference for choosing the status-quo over a supply contract. Without accounting for specific contractual arrangements, we found that the more risk-averse a farmer is, the less is his/her price demand for concluding an offered supply contract for cultivating sugar beets for biogas production. For example, compared to the risk-seeking reference farmer who has a price demand of € 26.87 for choosing a supply contract over the status-quo, a farmer who is not willing to take risk at all (risk attitude in the model estimation is coded 10) has a price demand of € 15.87 (-15.87=-26.87-1.10·10). Consequently and contrary to our expectations, **H2a that the more risk-averse a farmer is, the less he/she is willing to choose a supply contract for sugar beets as a biogas substrate since this utilization is very innovative, and outcomes are hardly predictable** must be rejected.

In addition, the farmer's risk attitude can explain why farmers evaluate the different contractual arrangements heterogeneously (all coefficients of the interaction terms with the variable "farmer's risk attitude" are significant). For the attribute "contract period" the results reveal that the risk-seeking reference farmer does not pay any attention to the length of the contract period (non-significant coefficient of the attribute "contract period"), whereas a more risk-averse farmer demands a mark-up for a longer contract period (significantly negative coefficient of the interaction term "contract period · farmers' risk attitude"). For example, the mark-up that a farmer who is not willing to take risk at all demands for a supply contract with a period that is one year longer is c.p. € 1.30 (-1.30=-0.13·10).

These results confirm **H2b that the more risk-averse a farmer is, the less he/she is willing to contract sugar beets for biogas production over a longer period.**

The coefficient of the interaction term "area covered by contract · farmers' risk attitude" is significantly negative. This result indicates that the more risk-averse a farmer is, the higher is c.p. his/her mark-up for a one percentage point shift in the area covered by contract. For example, compared to the risk-seeking reference farmer with a price demand of € 0.55 for a shift in the area covered by contract of one percentage point, the mark-up a farmer who is not willing to take risk at all demands is € 3.15 (-3.15=-0.55-0.26·10). Consequently, we can conclude, that **the more risk-averse a farmer is, the less he/she is willing to provide a share of his/her area of arable land to cultivate sugar beets for biogas production under contract. Therefore, H2c** cannot be rejected.

The participating farmers are opposed to harvesting a quarter of their sugar beets for biogas production in spring instead of autumn (significantly negative coefficients of the attribute "spring harvest" as well as of the interaction term "spring harvest · farmer's risk attitude"). Most likely, the farmers assess a spring harvest of sugar beets as a harvest option that is still in the developmental stages and, therefore, the risk associated with such a spring harvest is evaluated as being too high. The mark-up a farmer demands for a spring harvest of a quarter of the area covered by contract increases if the farmer gets more risk-averse. For example, the risk-seeking reference farmer demands a mark-up of € 1.64 in such a case, whereas the mark-up a farmer who is not willing to take risk at all demands is € 2.94 (-2.94=-1.64-0.13·10). In light of these results, **H2d that the more risk-averse a farmer is, the more he/she opposes a harvest of sugar beets for biogas production in spring instead of autumn** is confirmed.

In the harvest years 2011, 2012, and 2013 sugar beet farmers benefited from above-average yields as well as from very high prices for sugar beets (LIZ, 2014). However, it has to be considered that the sugar production quota expires in 2017, resulting in a free world market for sugar beets. Taking this into account the results regarding the farmers' risk attitude indicate that, at this moment in time, risk-averse farmers might deem biogas substrate contracts for sugar beets as a risk-reducing alternative. Due to their preferences for short contract periods and a small area covered by contract, we however presume that risk-averse farmers aim to test these alternatives for a future use. On the other hand, we can observe that risk-seeking farmers tend to wait to determine how the market will perform. Findings suggest that it might not make sense to try to convince these farmers to sign an abovementioned contract as they use the contract to drive the price up.

Crop rotation restrictions

Crop rotation restrictions are expected to play a role when deciding for or against an offered supply contract for sugar beets as a biogas substrate. This expectation is confirmed by the significantly negative coefficient of the interaction term "area covered by contract · share of sugar beets" which implies that the higher the percentage of the area of arable land with sugar beets, the higher the farmer's price demand for a one percent point shift in the area covered by contract. For example, a farmer who cultivates sugar

beets on 10% of his/her area of arable land demands c.p. a mark-up of € 0.95 (-0.95=-0.55-0.04·10) for a supply contract with a one percent point higher area covered by contract. In comparison, a non-beet grower demands a mark-up of € 0.55 if the area covered by contract gets one percentage point higher. In light of these results, **H3 that because of crop rotation restrictions, a farmer already growing a high share of sugar beets on his/her farm land prefers a supply contract for sugar beets as a biogas substrate including a small area covered by contract measured against his/her farm land** is confirmed. However, we expected crop rotation restrictions to play a more significant role than the results reveal. With this in mind, the fact that participating farmers have a preference for a small area covered by contract is not surprising as crop rotation issues likely are not restrictive.

Furthermore, the results reveal that the farm size, which is understood as the area of arable land a farmer manages, is also relevant for evaluating the attribute "area covered by contract" (significant coefficient of the interaction term "area covered by contract · area of arable land"). For example, a farmer of a 100 ha farm has an additional price demand of € 0.65 (-0.65=-0.55-0.001·100) for a change in the offered area covered by contract of one percentage point which, in this case, is 1 ha. A farmer with a farm of 1,000 ha has an additional price demand of € 1.55 (-1.55=-0.55-0.001·1,000) for a change in the offered area covered by contract of one percentage point which, in this case, are 10 ha. His/her mark-up for a one-hectare change is, therefore, € 0.16. We thus can summarize that the mark-up a farmer demands for a one-hectare change in the offered area covered by contract c.p. decreases if the farm size measured as the share of arable land increases.

5. Conclusions and outlook

This paper contributes to the literature on German farmers' perceptions of sugar beets as an alternative biogas substrate, their willingness to cultivate sugar beets within a supply contract arrangement, and to the literature on preference valuation through a DCE. Furthermore, we contribute to a political debate, which discusses different strategies to achieve a sustainable and renewable energy production in Germany without impairments in the support of the society. Therefore, in terms of energy production from biomass, sugar beets appear as a suitable substrate alternative to the controversial maize. Our results reveal that the majority of the participating farmers assesses the production of biogas from sugar beets as an important alternative to maize. However, with respect to their own farm conditions, the results indicate that the farmers have a general preference for their status-quo, meaning that they generally would not want to grow sugar beets for biogas production under contract at the time that the survey was conducted. Contrary to the literature and to our expectations, experience and knowledge in biomass supply contracts do not have a significant influence on the willingness of the participating farmers to contract sugar beets as a biogas substrate. There may be other factors that have a greater impact on the decision to conclude a contract or not, for example, the contract partner. However, our findings reveal that a farmer's risk attitude has an influence on choosing an offered contract or not. Farmers who are willing to contract are more likely to be risk-averse and aim to test contracting sugar beets for biogas production as a risk reduction alternative. These farmers prefer short contract periods

and a small share of their arable land covered by contract, which is contrary to the interests of biogas operators who want a secure substrate supply on a long-term basis. This objective of biogas operators can only be reached with high, probably non-economic mark-ups.

Both the EU sugar market and the energy sector are currently undergoing a period of transition. Thus, it has to be questioned if a diverse substrate mix as the EEG novel requires for new biogas plants, can currently be attained with sugar beets without financial incentives from policy. It is conceivable that the temporal distance until the reform of the sugar regime is carried out in 2017 leads to the fact that biogas from sugar beets might not appear to farmers as an urgent topic. It would therefore be valuable if further research would repeat the experiment at a later time to examine if farmers' decision making behaviors change when the end of the EU sugar regime approaches. In a subsequent experiment, the varying contractual arrangements should be completed with potential contract partners, because the contract partner can influence the farmers' willingness to enter into a contract (Reise et al., 2012). Additionally, the questionnaire should be expanded with questions on the importance of farmers' autonomy (Key and MacDonald, 2006; Key, 2005; Hudson and Lusk, 2004).

References

Act on Granting Priority to Renewable Energy Sources (Renewable Energy Sources Act) [Internet]. Available from: http://www.bmub.bund.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/res-act.pdf; 2000 [accessed: 2015 Apr 20].

Act on the Development of Renewable Energy Sources (Renewable Energy Sources Act – RES Act 2014) [Internet]. Available from: http://www.bmwi.de/English/Redaktion/Pdf/renewable-energy-sources-act-eeg-2014,property=pdf,bereich=bmwi2012,sprache=en,rwb=true.pdf; 2014 [accessed: 2015 Apr 20].

Act on Granting Priority to Renewable Energy Sources (Renewable Energy Sources Act) [Internet]. Available from: https://www.clearingstelle-eeg.de/files/node/8/EEG_2012_Englische_Version.pdf; 2012 [accessed: 2015 May 18].

Baeumer K. Allgemeiner Pflanzenbau. 3rd ed. Stuttgart: Ulmer; 1992. German.

Bateman IJ, Carson RT, Day B, Hanemann M, Hanley N. (2002): Economic valuation with stated preference techniques: A manual. London: Edward Elgar Publishing; 2002.

Bennett R, Balcombe K. Farmers' willingness to pay for a tuberculosis cattle vaccine. J Agric Econ 2012;63(2):408-424.

Bliemer MCJ, Rose JM, Hess S. Approximation of Bayesian efficiency in experimental choice designs. J Choice Modelling 2008;1(1):98-127.

BMEL (Federal Ministry of Food and Agriculture). Understanding Farming – Facts and figures about German farming [Internet]. Available from: http://www.bmel.de/SharedDocs/Downloads/EN/Publications/UnderstandingFarming.pdf?__blob=publicationFile; 2014 [accessed: 2014 Aug 25].

Breustedt G, Müller-Scheeßel J, Latacz-Lohmann U. Forecasting the adoption of GM oilseed rape: Evidence from a discrete choice experiment in Germany. J Agric Econ 2008;59(2):237-256.

Broch SW, Vedel SE. Using choice experiments to investigate the policy relevance of heterogeneity in farmer agri-environmental contract preferences. Environ Resour Econ 2012;5(4):561-581.

Campbell D, Doherty E. Combining discrete and continuous mixing distributions to identify niche markets for food. Eur Rev Agric Econ 2013;40(2):287-312.

ChoiceMetrics (2012): Ngene 1.1.1: User manual and reference guide. Choice Metrics Pty Ltd.

Clancy D, Breen JP, Thorne F, Wallace M. A stochastic analysis of the decision to produce biomass crops in Ireland. Biomass Bioenerg 2012;46(1):353-365.

De-Magistris T, Gracia A, Nayga RM. On the use of honesty priming tasks to mitigate hypothetical bias in choice experiments. Am J Agric Econ 2013;95(5):1136-54.

Dewar AM, Cooke DA. Pests. In: Draycott AP, editor. Sugar Beet, Oxford: Blackwell Publishing Ltd.; 2006, p. 316-350.

DIW (German Institute for Economic Research). Leben in Deutschland: Befragung 2010 zur sozialen Lage der Haushalte [Internet]. Deutsches Institut für Wirtschaftsforschung. Available from: http://www.diw.de/documents/dokumentenarchiv/17/diw_01.c.369781.de/soepfrabo_personen_2010.pdf; 2010 [2011 Oct 12]. German.

Dohmen T, Falk A, Huffman D, Sunde U, Schupp J, Wagner GG. Individual risk attitudes: measurement, determinants, and behavioral consequences. J Eur Econ Assn 2011;9(3):522-550.

Domac J, Richards K, Risovic S. Socio-economic drivers in implementing bioenergy projects. Biomass Bioenerg 2005;28(2):97-106.

Draycott AP. Introduction. In: Draycott AP, editor. Sugar Beet, Oxford: Blackwell Publishing Ltd.; 2006, p. 1-8.

European Commission. Agriculture and rural development. Sugar [Internet]. Available from: http://ec.europa.eu/agriculture/sugar/index_en.htm; 2015 [updated 2015 Apr 22; accessed: 2015 Mar 30].

Fiebig DG, Keane MP, Louviere JJ, Wasi N. The generalized multinomial logit model: Accounting for scale and coefficient heterogeneity. Marketing Sci 2010;29(3): 393-421.

FNR (Agency for Renewable Resources e.V.). Bioenergy in Germany: facts and figures January 2014 [Internet]. Gülzow-Prüzen: FNR. Available from: http://mediathek.fnr.de/media/downloadable/files/samples/b/a/basisdaten_9x16_2013_engl_web.pdf; 2014 [accessed: 2014 Mar 30].

German Biogas Association (Fachverband Biogas e.V.). Biogas segment statistics 2014 [Internet]. Freising: German Biogas Association. Available from:

http://www.biogas.org/edcom/webfvb.nsf/id/DE_Branchenzahlen/$file/14-11-25_Biogasindustryfigures_2014-2015_english.pdf; 2014 [accessed: 2015 Apr 3].

Gillespie JM, Eidman VR. The effect of risk and autonomy on independent hog producers' contracting decisions. J Agric Appl Econ 1998;30(1):175-188.

Gissén C, Prade T, Kreuger E, Nges IA, Rosenqvist H, Svensson SE, et al. Comparing energy crops for biogas production – Yields, energy input and costs in cultivation using digestate and mineral fertilisation. Biomass Bioenerg 2014;64(1):199-210.

Goodwin BK, Schroeder TC. Human capital, producer education programs, and the adoption of forward-pricing methods. Am J Agric Econ 1994;76(4):936-47.

Granoszewski K, Spiller A. Vertragliche Zusammenarbeit bei der energetischen Biomasselieferung: Einstellungen und Bindungsbereitschaften von deutschen Landwirten. Proceedings of the 53th Jahrestagung der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaus e.V.; 2013 Sep 25-27.; Humboldt-Universität zu Berlin, Germany; 2013. German.

Greene WH, Hensher DA. Does scale heterogeneity across individuals matter? An empirical assessment of alternative logit models. Transportation 2010;37(3): 413-428.

Gu Y, Hole AR, Knox S. Fitting the generalized multinomial logit model in Stata. The Stata J 2013;13:382-397.

Hensher DA, Greene WH. Valuation of travel time savings in WTP and preference space in the presence of taste and scale heterogeneity. J Transport Econ Pol 2011;45(3):505-525.

Hole AR, Kolstad J. Mixed logit estimation of willingness to pay distributions: a comparison of models in preference and WTP space using data from a health-related choice experiment. Empirical Econ 2012;42(2):445-469.

Hudson D, Lusk J. Risk and transactions cost in contracting: results from a choice-based experiment. J Agric. Food Industrial Organization 2004;2(2).

Ilbery B, Watts D, Little J, Gilg A, Simpson S. Attitudes of food entrepreneurs towards two grant schemes under the first England Rural Development Programme, 2000-2006. Land Use Pol 2010;27(3):683-9.

International Energy Agency. World energy outlook 2013 factsheet [Internet]. Available from: http://www.iea.org/media/files/WEO2013_factsheets.pdf; 2013 [accessed: 2014 Jun 16].

Katchova AL, Miranda MJ. Two-step econometric estimation of farm characteristics affecting marketing contract decisions. Am J Agric Econ 2004;86(1):88-102.

Key N, MacDonald J. Agricultural contracting trading autonomy for risk reduction. Amber Waves 2006;4(1):26-31.

Key N. How much do farmers value their independence? Agric Econ 2005;33(1):117-126.

Koennecke G. Fruchtfolgen. 2nd ed. Berlin: VEB Deutscher Landwirtschaftsverlag; 1967. German.

Kreuger E, Nges IA, Björnsson L. Ensiling of crops for biogas production: effects on methane yield and total solids determination. Biotechnol Biofuels 2011;4(44).

Lanz B, Provins A. Valuing local environmental amenity with discrete choice experiments: Spatial scope sensitivity and heterogeneous marginal utility of income. Environ Resource Econ 2013;56(1):105-130.

List JA, Sinha P, Taylor MH. Using choice experiments to value non-market goods and services: evidence from field experiments. Adv Econ Anal Pol 2006;6(2): Art. 2.

LIZ (Agricultural information service sugar beet). Rübenpreise, Rübenvergütung ab 2011[Internet]. Available from: http://www.liz-online.de/themen/betriebswirtschaft/uebersicht-der-basispreise-je-ruebenart/ruebenpreise-ab-2011.html; 2014 [accessed: 2015 Jan 28].

Louviere JJ, Hensher DA, Swait JD. Stated choice methods: analysis and applications. 1st ed. Cambridge: University Press; 2000.

Louviere JJ, Train K, Ben-Akiva M, Bhat C, Brownstone D, Cameron TA, Carson RT, Deshazo JR, Fiebig D, Greene W, Hensher D, Waldman D. Recent progress on endogeneity in choice modeling. Marketing Letters 2005;16(3-4):255-265.

Märländer B, Augustin D, Hartung E, Hoffmann C, Setzer F, Stockfisch N. Biomasse-Rüben – Die Zuckerrübe als Biogassubstrat. DLG-Merkblatt 2010;363:4-19. German.

Mbzibain A, Hocking TJ, Tate G, Ali S. Renewable enterprises on UK farms: Assessing levels of uptake, motivations and constraints to widespread adoption. Biomass Bioenerg 2013;49(1):28-37.

Meijer ISM, Hekkert MP, Koppenjan JFM. The influence of perceived uncertainty on entrepreneurial action in emerging renewable energy technology; biomass gasification projects in the Netherlands. Energ Pol 2007;35(11):5836-54.

Østergaard PA. Comparing electricity, heat and biogas storages' impacts on renewable energy integration. Energy 2012;37(1):255-262.

Özdemir S, Reed Johnson F, Brett Hauber A. Hypothetical bias, cheap talk, and stated willingness to pay for health care." Journal of health economics 2009;28(4):894-901.

Paulrud S, Laitila T. Farmers' attitudes about growing energy crops: A choice experiment approach. Biomass Bioenerg 2010;34(12):1770-9.

Pennings JME, Leuthold RM. A behavioral approach towards futures contract usage. University of Illinois: OFOR Paper Number 00-08; 2000a.

Pennings JME, Leuthold RM. The role of farmers' behavioral attitudes and heterogeneity in futures contracts usage. Am J Agric Econ 2000b;82(4):908-919.

Pfarr C, Ulrich V. Discrete-Choice-Experimente zur Ermittlung der Präferenzen für Umverteilung. Discussion-Paper 03-11. Universität Bayreuth: ISSN 1611-3837; 2011. German.

Pope RD, Just RE. On testing the structure of risk preferences in agricultural supply analysis. Am J Agric Econ 1991;73(3):743-8.

Reise C, Liebe U, Mußhoff O. Design of substrate supply contracts for biogas plants. Proceedings of the 56th AARES Annual Conference; 2012 Feb 7-10; Fremantle, Western Australia, Available from: http://ageconsearch.umn.edu/bitstream/124428/2/2012AC%20Reise%20CP.pdf; 2012 [accessed: 2014 Jul 9].

Roe BE, Sporleder TL, Belleville B. Hog producer preferences for marketing contract attributes. Am J Agric Econ 2004;86(1):115-123.

Sandor Z, Wedel M. Heterogeneous conjoint choice designs. Journal of Marketing Research, 2005;42(2): 210-218.

Scarpa R, Thiene M, Train K. Utility in willingness to pay space: a tool to address confounding random scale effects in destination choice to the Alps. Am J Agric Econ 2008;90(4): 994-1010.

Scarpa R, Willis K. Willingness-to-pay for renewable energy: Primary and discretionary choice of British households' for micro-generation technologies. Energy Econ 2010;32(1):129-136.

Starke P. Ertragspotenzial und Anforderungen an die Qualität von Zuckerrüben bei der Vergärung. Mitt Ges Pflanzenbauwiss 2012;24:52-55. German.

Starke P, Hoffmann C. Yield parameters of Beta beets as a basis to estimate the biogas yield. Sugar Ind 2014;139(3):169-176.

Tate G., Mbzibain A. The future contribution of bioenergy enterprises to rural business viability in the United Kingdom. Int J Agric Manag 2011;1(2):23-37.

Thiene M, Scarpa R. Deriving and testing efficient estimates of WTP distributions in destination choice models. Environ Resource Econ 2009;44(3):379-395.

Train KE. Discrete choice methods with simulation. 2nd ed. Cambridge: University Press; 2009.

Train KE, Weeks M. Discrete choice models in preference space and willingness to pay space. In: Scarpa R, Alberini A (Eds.). Applications of Simulation Methods in Environmental and Resource Economics. Boston: Springer; 2005: 1-16.

Weiland P. Biogas production: current state and perspectives. Appl Microbiol Biot 2010;85(4):849-860.

Wilson RG. Crop Rotation. In: Wilson RG, Miller S, Smith J, editors. Sugarbeet production guide EC01-156, Scottsbluff: University of Nebraska-Lincoln; 2001, p. 21-2.

Appendix A: The DCE (section 2 of the questionnaire)

[The instructions and choice sets have been translated from German into English. In the following, the DCE is presented.]

Please, imagine that an operator of a biogas plant offers **you** the opportunity to buy sugar beets used as a biogas substrate. You can agree to a supply contract with him/her.

The operator of the biogas plant offers you **two different contract alternatives**. In both of the contracts, he/she **commits his/herself by contract,** organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Subsequently, to enable a better understanding, there is a brief explanation of how the offered contract alternatives differ:

1. Contract period

The contract period is the duration measured in years in which you commit to growing sugar beets for the biogas plant under contract. The contract period can vary between the offered contract alternatives.

2. Area covered by contract

The area covered by contract means the share of arable land on which you commit to grow sugar beets for the biogas plant under contract. The area covered by contract can vary between the offered contract alternatives. Please, notice that you are not obliged to supply a certain amount of sugar beets but instead to grow a certain share of land with sugar beets used as a biogas substrate.

3. Price

The price you will receive after the sugar beet harvest refers to the supplied amount of sugar beets containing 18% of sugar. If the content of sugar deviates from this threshold, the operator of the biogas plant pays out one euro per metric ton and percentage point of sugar content above 18% more to you. On the other hand, the price decreases by one euro per metric ton and percentage point of sugar content if the supplied sugar beets' sugar content is below the threshold of 18% sugar.

Example:

In the concluded contract, the operator of the biogas plant commits by contract to paying you € 23 per metric ton sugar beets containing 18% sugar. If the supplied sugar beets contain 18% sugar, you will receive 23 € t^{-1} sugar beets. However, if the sugar beets contain 20% (16%) sugar, you will receive 25 € t^{-1} (21 € t^{-1}) sugar beets.

4. Spring harvest

The contract alternatives offered by the operator of a biogas plant normally provide a sugar beet harvest in autumn. However, the operator of the biogas plant also offers contracts in which you covenant that a quarter of the area covered by contract will be harvested in spring (until the end of March). There are no direct costs arising from the spring harvest. However, you have to take into account that the area

covered by contract is cleared late and the risk that impairments or crop failures occur may increase in comparison to a traditional sugar beet harvest in autumn.

In the following, we will ask you twelve times, one behind the other, which contract out of the different contract alternatives you would like to choose. Every time, the operator of the biogas plant offers other contract alternatives. Of course, you can also choose the alternative 'no contract' meaning that you will not grow sugar beets as biogas substrate. Please, choose the alternative that you consider to be appropriate for your farm! Please, decide independently in every decision situation.

We are interested in your personal assessment. Therefore, there are no "wrong" answers. Please, choose the alternative that you consider to be appropriate for your farm! Only by doing so do you make realistic decisions.

----------*[page break]*

[The following twelve choice sets are presented to the farmers in a random order to avoid an order effect. The percentage numbers stated for the attribute "area covered by contract" in the choice sets refer to the arable farmland of the participating farmer which is requested in the first part of the questionnaire. In the DCE, the individually calculated share of hectares (=percentage number · arable farmland/100) is shown in the choice sets to the farmer instead of the percentage numbers.]

[Choice set 1]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	3 years	1 year	
Area covered by contract	10% of the farm's area of arable land	20% of the farm's area of arable land	
Price	29 € t^{-1}	25 € t^{-1}	
Spring harvest	¼ of the area covered by contract will be harvested in spring	No – the whole area will be harvested in autumn	
Which contract alternative would you choose?	⬭	⬭	⬭

[Choice Set 2]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	1 year	6 years	
Area covered by contract	5% of the farm's area of arable land	10% of the farm's area of arable land	
Price	25 € t^{-1}	29 € t^{-1}	
Spring harvest	¼ of the area covered by contract will be harvested in spring	No – the whole area will be harvested in autumn	
Which contract alternative would you choose?	⬭	⬭	⬭

[Choice Set 3]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	3 years	6 years	
Area covered by contract	10% of the farm's area of arable land	20% of the farm's area of arable land	
Price	22 € t^{-1}	25 € t^{-1}	
Spring harvest	No – the whole area will be harvested in autumn	¼ of the area covered by contract will be harvested in spring	
Which contract alternative would you choose?	⬭	⬭	⬭

[Choice Set 4]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	6 years	3 years	
Area covered by contract	20% of the farm's area of arable land	5% of the farm's area of arable land	
Price	29 € t^{-1}	25 € t^{-1}	
Spring harvest	¼ of the area covered by contract will be harvested in spring	No – the whole area will be harvested in autumn	
Which contract alternative would you choose?	⬭	⬭	⬭

[Choice Set 5]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	1 year	3 years	
Area covered by contract	10% of the farm's area of arable land	5% of the farm's area of arable land	
Price	25 € t^{-1}	29 € t^{-1}	
Spring harvest	No – the whole area will be harvested in autumn	¼ of the area covered by contract will be harvested in spring	
Which contract alternative would you choose?	⬭	⬭	⬭

[Choice Set 6]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	1 year	6 years	
Area covered by contract	20% of the farm's area of arable land	5% of the farm's area of arable land	
Price	29 € t^{-1}	29 € t^{-1}	
Spring harvest	¼ of the area covered by contract will be harvested in spring	No – the whole area will be harvested in autumn	
Which contract alternative would you choose?	⬭	⬭	⬭

[Choice Set 7]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	1 year	3 years	
Area covered by contract	5% of the farm's area of arable land	10% of the farm's area of arable land	
Price	25 € t^{-1}	22 € t^{-1}	
Spring harvest	No – the whole area will be harvested in autumn	¼ of the area covered by contract will be harvested in spring	
Which contract alternative would you choose?	⬭	⬭	⬭

[Choice Set 8]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	6 years	3 years	
Area covered by contract	10% of the farm's area of arable land	20% of the farm's area of arable land	
Price	25 € t^{-1}	22 € t^{-1}	
Spring harvest	¼ of the area covered by contract will be harvested in spring	No – the whole area will be harvested in autumn	
Which contract alternative would you choose?	⬭	⬭	⬭

[Choice Set 9]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	6 years	1 year	
Area covered by contract	5% of the farm's area of arable land	10% of the farm's area of arable land	
Price	25 € t^{-1}	29 € t^{-1}	
Spring harvest	No – the whole area will be harvested in autumn	¼ of the area covered by contract will be harvested in spring	
Which contract alternative would you choose?	⬭	⬭	⬭

[Choice Set 10]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	3 years	1 year	
Area covered by contract	20% of the farm's area of arable land	10% of the farm's area of arable land	
Price	22 € t^{-1}	22 € t^{-1}	
Spring harvest	¼ of the area covered by contract will be harvested in spring	No – the whole area will be harvested in autumn	
Which contract alternative would you choose?	⬭	⬭	⬭

[Choice Set 11]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	6 years	6 years	
Area covered by contract	5% of the farm's area of arable land	20% of the farm's area of arable land	
Price	22 € t^{-1}	22 € t^{-1}	
Spring harvest	¼ of the area covered by contract will be harvested in spring	No – the whole area will be harvested in autumn	
Which contract alternative would you choose?	⬭	⬭	⬭

[Choice Set 12]

The operator of a biogas plant offers you two different contracts for **growing sugar beets as a biogas substrate**. Please, notice that the operator of the biogas plant commits by contract to organizing the harvest and the transportation of the sugar beets as well as bearing the associated costs. Please, notice that the operator of the biogas plant commits to organize the harvest and the transportation of the sugar beets as well as to bear the costs arising from this by contract. Furthermore, you will receive back the nutrient solution in a ratio of 1 to 0.8 (free to the field).

Please, decide for **one** of the alternatives presented below.

	Contract A	**Contract B**	**No contract**
Contract period	3 years	1 year	
Area covered by contract	20% of the farm's area of arable land	5% of the farm's area of arable land	
Price	29 € t^{-1}	22 € t^{-1}	
Spring harvest	No – the whole area will be harvested in autumn	¼ of the area covered by contract will be harvested in spring	
Which contract alternative would you choose?	⬭	⬭	⬭

Appendix B: STATA code

Below you will find the STATA codes used for the calculation of the models. Table B.1 presents information regarding the variables and their coding. For more general information regarding the abovementioned STATA-command "gmnl", please refer to Gu et al. [66].

Code for the model in WTP space

```
generate tprice=contract price
generate constant=1
constraint 1 [Mean]tprice=1
constraint 2 [tau]_cons=0
```

[Before estimating the final model, it was necessary to estimate pre-models which are more simple (less random variables). The coefficents of these pre-models are used as starting values for the calculation of the final model. In this way, it was ensured that the estimation time of the final model was appropiate.]

```
matrix start=b[1,1..6],0.1,b[1,7..10]
gmnl
        choice
                tprice,
                        rand(
                                ASC
                                contract period
                                area covered by contract
                                spring harvest)
                        group(occasion)
                        from(start, copy)
                        het(constant)
                        constraint(1)
                        id(number)
                        nrep(500)
                        gamma(0)
estat ic, n(1416)
nlcom (price_mean: [Het]cons-[tau]_cons^2/2)
```

To integrate farmer-specific variables which do not vary over alternatives into the model, it is necessary to generate interaction terms with the ASC or the attributes.

Code for model in WTP space with interactions

```
generate tprice=contract price
generate constant=1
constraint 1 [Mean]tprice=1
constraint 2 [tau]_cons=0
```

[Before estimating the final model, it was necessary to estimate pre-models which are more simple (less random variables). The coefficents of these pre-models are used as starting values for the calculation of the final model. In this way, it was ensured that the estimation time of the final model was appropiate.]

```
matrix start = b[1,1..13],0.1,b[1,14..17]
gmnl
    choice
        ASC · supplier of biogas substrate
        ASC · farmer's risk attitude
        Area covered by contract · share of sugar beets
        Area covered by contract · area of arable land
        Area covered by contract · farmer's risk attitude
        Contract period · farmer's risk attitude
        Spring harvest · farmer's risk attitude
        tprice,
            rand(
                ASC
                contract period
                area covered by contract
                spring harvest)
            group(occasion)
            from(start, copy)
            het(constant)
            constraint(1)
            id(number)
            nrep(500)
            gamma(0)
estat ic, n(1416)
nlcom (price_mean: [Het]cons-[tau]_cons^2/2)
```

Table B.1: Variables and their coding

Variables	Coding
ASC	Binary coded alternative-specific constant takes on the value 1 for a contract alternative and the value 0 for the status-quo alternative 'no contract'.
Contract period	The contract period is the duration measured in years in which the farmer commits by contract to growing sugar beets for the biogas plant.
Area covered by contract	The area covered by contract means the share of arable land on which the farmer commits by contract to growing sugar beets for the biogas plant.
Contract price	The price the farmer receives after harvesting the sugar beets refers to the supplied amount of sugar beets containing 18% of sugar and is measured in euro per metric ton (€ t^{-1}).
Spring harvest	Effect coded attribute variable that takes on the value 1 if the whole area covered by contract will be harvested in autumn, (-1) if a quarter of the area covered by contract will be harvested in spring, and 0 otherwise.
Supplier of biogas substrate	Effect coded farmer-specific variable that takes on the value 1 if the farmer supplies no biogas substrate, (-1) if the farmer already supplies biogas substrate, and 0 otherwise.
Farmer's risk attitude	Farmer-specific variable; self-assessed risk attitude on a scale ranging from 0 (=**very** willing to take risk) to 10 (=**not** willing to take risk at all).
Farmland for sugar beets	Farmer-specific variable; share of farmland grown with sugar beets measured in percent.
Farmland	Farmer-specific variable; farmland in hectare.
Choice	Dummy coded dependent variable that depicts the choice made by a farmer in a specific choice occasion. The variable takes on the value 1 if the alternative is chosen and the value 0 if the alternative is not chosen.
Occasion	Numeric identifier for the choice occasions that ranges from1 to 12.
Number	Numeric identifier for the participating farmers that ranges from 1 to 118. By doing so, it is taken into account that the farmer answers twelve choice sets.

Source: Own illustration

Appendix C: Complete results

Table C.1: Complete results of the estimated models in willingness-to-pay space [a)]

Variables	Model 1	Model 2
Marginal WTP values		
ASC [b)]	-22.69***	-26.87***
	[-23.34; -22.03]	[-27.67; -26.06]
ASC [b)] · supplier of biogas substrate [c)]		-0.18
		[-0.49; 0.13]
ASC [b)] · farmer's risk attitude [d)]		1.10***
		[0.85; 1.35]
Contract period	-0.43***	0.16
	[-0.53; -0.32]	[-0.04; 0.37]
Contract period · farmer's risk attitude [d)]		-0.13***
		[-0.18; -0.07]
Area covered by contract	-2.11***	-0.55*
	[-2.57; -1.65]	[-1.15; -0.05]
Area covered by contract · share of sugar beets [e)]		-0.04***
		[-0.06; -0.02]
Area covered by contract · area of arable land [f)]		-0.001**
		[-0.001; -0.0001]
Area covered by contract · farmer's risk attitude [d)]		-0.26***
		[-0.38; -0.14]
Spring harvest [g)]	-2.29***	-1.64***
	[-2.60; -1.98]	[-1.93; -1.35]
Spring harvest [g)] · farmer's risk attitude [d)]		-0.13**
		[-0.22; -0.05]

Coefficients for the SD		
SD ASC [b)]	2.75***	3.08***
SD contract period	0.55***	0.44***
SD area covered by contract	2.46***	2.58***
SD spring harvest [g)]	1.65***	1.98***
Structural Parameter		
Tau	-0.97***	1.21***
Parameters of model fit		
Participating farmers/observations	118/4,248	118/4,248
Log-Likelihood at convergence	-1,045	-1,035
AIC	2,109	2,105

Source: own calculations by means of the STATA-command "gmnl" in STATA 12 [66].

Notes: [a)] * p < 0.1; ** p < 0.05; *** p < 0.001; intended variables depict the interaction terms; the 95% confidence intervals of the estimated marginal WTP values are shown in brackets; all the WTP coefficients are assumed to be normally distributed and correlated; the price coefficient was normalized to be log-normal and constrained to 1.

[b)] Binary coded variable; reference: status-quo alternative "no contract."

[c)] Effect coded; reference: farmer supplies no biogas substrate.

[d)] Self assessed risk attitude; this variable is recoded for estimation purposes: 0=**very** willing to take risk; …; 10=**not** willing to take risk at all.

[e)] Share of the area of arable land planted with sugar beets.

[f)] Area of arable land in hectare.

[g)] Effect coded; reference: a quarter of the area covered by contract will be harvested in autumn.

Appendix D: Results of the additionally calculated model

Table D.1: Results of the additionally calculated model in willingness-to-pay space [a)]

Variables	Additional model
Marginal WTP values	
ASC [b)]	-24.20***
	[-26.71; -21.69]
ASC [b)] · supplier of sugar beets as a biogas substrate [c)]	0.24
	[-0.52; 1.00]
ASC [b)] · farmer's risk attitude [d)]	0.33
	[-0.18; 0.83]
Contract period	-0.03***
	[-0.53; -0.32]
Contract period · farmer's risk attitude [d)]	-0.11 *
	[-0.20; -0.02]
Area covered by contract	-0.42
	[-2.09; 1.25]
Area covered by contract · share of sugar beets [e)]	-0.08 ***
	[-0.11; -0.05]
Area covered by contract · area of arable land [f)]	-0.001 **
	[-0.001; -0.0002]
Area covered by contract · farmer's risk attitude [d)]	-0.25
	[-0.58; 0.07]
Spring harvest [g)]	-2.46***
	[-3.39; -1.54]
Spring harvest [g)] · farmer's risk attitude [d)]	0.09
	[-0.14; 0.31]

Coefficients for the SD	
SD ASC [b)]	3.64***
SD contract period	0.42***
SD area covered by contract	2.42***
SD spring harvest [g)]	2.27***
Structural Parameter	
Tau	-1.03***
Parameters of model fit	
Participating farmers/observations	118/4,248
Log-Likelihood at convergence	-1,030
AIC	2,094

Source: own calculations by means of the STATA-command "gmnl" in STATA 12 [66].

Notes: [a)] * $p < 0.1$; ** $p < 0.05$; *** $p < 0.001$; intended variables depict the interaction terms; the 95% confidence intervals of the estimated marginal WTP values are shown in brackets; all the WTP coefficients are assumed to be normally distributed and correlated; the price coefficient was normalized to be log-normal and constrained to 1.

[b)] Binary coded variable; reference: status-quo alternative "no contract".

[c)] Effect coded; reference: farmer supplies no sugar beets as a biogas substrate.

[d)] Self assessed risk attitude; this variable is recoded for estimation purposes: 0=**very** willing to take risk; …; 10=**not** willing to take risk at all.

[e)] Share of the area of arable land planted with sugar beets.

[f)] Area of arable land in hectare.

[g)] Effect coded; reference: a quarter of the area covered by contract will be harvested in autumn.

VI. Zusammenfassung und Diskussion

Die vier Beiträge der vorliegenden Dissertationsschrift untersuchen das Entscheidungsverhalten von Landwirten in unterschiedlichen Entscheidungssituationen. Das übergeordnete Ziel ist es, die Präferenzstruktur und Zahlungsbereitschaft von Landwirten in den untersuchten Entscheidungssituationen zu analysieren, um so die Informationsgrundlage als Entscheidungsbasis für Politiker und Berater sowie der Landwirte selbst zu erweitern. Hierzu hat die Methode der DCE in allen vier Beiträgen Anwendung gefunden. Im Folgenden werden die durchgeführten DCE und ihre Zielstellung kurz dargestellt, die gewonnenen Ergebnisse zusammengefasst und Bezug zur praktischen Relevanz hergestellt:

Beitrag 1: Vermarktungsentscheidung

Mithilfe eines DCE, welches im Januar 2012 durchgeführt worden ist, sollte ermittelt werden, welche individuenspezifischen Faktoren die Entscheidung eines Landwirts beeinflussen, für seine Ernte ex ante eine Preisabsicherung vorzunehmen. Hierzu wurden die teilnehmenden Landwirte gebeten, eine Vermarktungsentscheidung für zwei Drittel ihrer Erntemenge der bevorstehenden Weizenernte zu treffen. Die Landwirte konnten zwischen den in der Regel bekannten Absicherungsalternativen Forward-Kontrakt, Futures-Kontrakt und Option (vgl. bspw. Goodwin und Schroeder, 1994; Sartwelle et al., 2000) sowie der in Deutschland eher unbekannten Alternative des „Managed Marketing“ wählen. Zudem bestand die Möglichkeit keine Preisabsicherung vorzunehmen und den Weizen erst ex Ernte auf dem Kassamarkt zu verkaufen. Die teilnehmenden Landwirte haben im Experiment mehrere Auswahlentscheidungen unter verschiedenen Preiskonstellationen getroffen.

Die erhobenen Daten wurden mithilfe eines Mixed Logit Modells analysiert. Die Ergebnisse zeigen, dass Landwirte, die eine negative Preiserwartung haben, also eine negative Preisentwicklung erwarten, eine generelle Präferenz für die Preisabsicherung haben. Weiterhin zeigt sich, dass die individuelle Risikoeinstellung der Landwirte einen Einfluss auf die Entscheidung für spezielle Preisabsicherungsinstrumente hat, ein genereller Zusammenhang lässt sich jedoch nicht herstellen. Hier widersprechen die Ergebnisse vielen vorhandenen Studien, die postulieren, dass ein hoher Grad an Risikoaversität generell auch eine starke Präferenz für eine Preisabsicherung nach sich zieht. Außerdem zeigen die Ergebnisse, dass das Vorhandensein von Lagerkapazitäten bei zwei von vier zur Auswahl stehenden Absicherungsinstrumenten einen Einfluss auf die Entscheidung der Landwirte hat. Eine generell geringere Präferenz für die Preisabsicherung, wie in vielen theoretischen Beiträgen zum Thema angenommen (vgl. bspw. Barry und Fraser, 1976; Saha und Stroud 1994; Beal 1996), lässt sich für Landwirte mit Lagerkapazitäten jedoch nicht finden.

Diese Ergebnisse können landwirtschaftliche Handelsunternehmen nutzen, um anstelle standardisierter Produkte effektivere und mehr an dem Nutzen von Landwirten ausgerichtete Preisabsicherungsinstrumente zu entwickeln. Ebenso können diese Handelsunternehmen, aber auch Berater und Politiker die aufgezeigten Zusammenhänge bei der Entscheidung über die Preisabsicherung

für die Entwicklung von Weiterbildungsangeboten verwenden. Die Landwirte selbst profitieren ebenfalls von den Ergebnissen. Möglicherweise sind sie in der Lage ihre Getreidevermarktung objektiver und profitabler zu gestalten, wenn sie ihre Motive kennen und deren Einfluss auf die Absicherungsentscheidung besser verstehen lernen.

Beitrag 2: Entscheidung über das Eingehen einer Kooperation

Mithilfe eines DCE sollten die Präferenzen von Landwirten für das Eingehen einer Kooperation unter expliziter Berücksichtigung von nicht-monetären Faktoren analysiert werden. Den teilnehmenden Landwirten wurden hierzu zwei verschiedene Kooperationsalternativen zur Auswahl gestellt. Neben dem monetären Vorteil, der sich beim Eingehen einer Kooperation ergibt, variierten die Kooperationsalternativen auch in nicht monetären Attributen, die mögliches Konfliktpotential zwischen Mitgliedern einer Kooperation wiederspiegeln. Als Indikatoren für dieses Konfliktpotential dienen im DCE die Betriebszweige des potentiellen Kooperationspartners, sein Alter sowie die Anzahl an Jahren, die der potentielle Kooperationspartner dem Landwirt bekannt ist. Es bestand selbstverständlich die Möglichkeit, keine der angebotenen Kooperationen einzugehen.

Die erhobenen Daten wurden mithilfe eines Generalized Multinomial Logit Modell analysiert. Die Ergebnisse zeigen, dass Landwirte eher bereit sind eine Kooperation einzugehen, wenn der potentielle Kooperationspartner ähnlich alt ist. Mehrere Studien (vgl. bspw. Hein et al., 2011) stützen den gefundenen Zusammenhang. Im selben Alter zu sein, kann als Indikator für „Vertrauen“ und „Gleichgesinnt Sein“ von potentiellen Kooperationspartnern gesehen werden. Viele Studien (vgl. bspw. Artz et al., 2010; Hein et al., 2011; Larsén, 2007) vermuten zwar, dass diese beiden Faktoren zur Vermeidung von Konflikten in Kooperationen wichtig sind, können dies jedoch nicht quantitativ belegen. Des Weiteren zeigen die Ergebnisse, dass Landwirte eine Kooperation eher eingehen, wenn sie den potentiellen Kooperationspartner schon lange kennen. Auch dies kann als Indikator für „Vertrauen“ und „Gleichgesinnt Sein“ eingeschätzt werden. Schlussendlich kann festgehalten werden, dass auch die Betriebszweige des potentiellen Kooperationspartners eine wichtige Rolle bei der Kooperationsentscheidung spielen. Ein viehhaltender Landwirt präferiert eine Kooperation mit einem ebenfalls viehhaltenden Landwirt, wohingegen er eine Kooperation mit einem Partner, der auch erneuerbare Energie erzeugt, ablehnt. Neben ökonomischen Überlegungen könnte hier auch traditionelles Denken (vgl. bspw. Benz, 2006) eine Rolle spielen.

Die Ergebnisse des DCE sind von praktischer Relevanz für Landwirte, deren Berater und Politiker. Mithilfe der Ergebnisse ist es den Landwirten möglich, in einer strukturierteren und objektiveren Weise über das Eingehen einer Kooperation zu entscheiden, weil sie Motive und Hemmnisse besser kennen. Insbesondere die ermittelten Zahlungsbereitschaften können dazu führen, dass Landwirte besser in der Lage sind, zwischen monetären und nicht-monetären Einflussfaktoren abzuwägen, da diese nun vergleichbar sind. Zudem erhalten landwirtschaftliche Berater mit den erzielten Ergebnissen nützliche Informationen, um Landwirte hinsichtlich des Eingehens von Kooperationen besser und objektiver zu beraten. Agrarpolitiker können die Ergebnisse verwenden, um in Ländern, in denen Potential zur

Steigerung der Effizienz der landwirtschaftlichen Produktion besteht, eine Förderung von betrieblichen Kooperationen zu etablieren.

Beitrag 3: Investitionsentscheidung

Zielstellung des durchgeführten DCE war es zu klären, welche Bedeutung Landwirte der finanziellen Flexibilität in ihren Investitionsentscheidungen zukommen lassen. Den teilnehmenden Landwirten wurde im DCE daher ein Szenario beschrieben, in dem sie über 100.000 € eigene liquide Mittel verfügen. Die Entscheidungssituation umfasste dabei zwei verschiedene Investitionsalternativen, die sich hinsichtlich der Auswirkung auf die finanzielle Flexibilität des Betriebs unterscheiden. Außerdem sind die Rentabilität der Investition und das mit der Investition verbundene Risiko variiert worden. Statt zu investieren, konnte ein Landwirt aber auch entscheiden, das Geld bei einer Bank anzulegen.

Die erhobenen Daten des DCE wurden mittels eines Mixed Logit Modells analysiert. Es kann festgehalten werden, dass Landwirte die Auswirkung, die die Durchführung einer Investition auf die betriebliche Kreditreserve und damit auf die zukünftige finanzielle Flexibilität ihres Betriebes hat, bei der Entscheidung für oder gegen eine Investitionsalternative berücksichtigen. Die Bedeutung, die ein Landwirt dabei der finanziellen Flexibilität zukommen lässt, hängt unter anderem von seiner Risikoeinstellung und dem betrieblichen Erfolg ab. Ebenfalls bedeutend ist, ob die Betriebsnachfolge zum Zeitpunkt der Entscheidung geklärt ist.

Die klassische Investitionstheorie fokussiert auf Rentabilität, Liquidität und Stabilität. Die Auswirkungen einer Investition auf die finanzielle Flexibilität eines landwirtschaftlichen Betriebs finden wenig bis gar keine Berücksichtigung bei der Beurteilung einer Investition. Da die finanzielle Flexibilität aber auch beim Rating der Banken eine zentrale Rolle spielt, ist es wichtig, dass die Landwirte um ihre finanzielle Flexibilität wissen. Insofern sind die Ergebnisse des DCE für Landwirte und deren Berater relevant. Berater sollten ihre Investitionsberatung um den Punkt der finanziellen Flexibilität erweitern und so die Landwirten explizit auf die Auswirkungen einer geplanten Investition auf die zukünftige finanzielle Flexibilität des Betriebs hinweisen. Weiterer Forschungsbedarf besteht hinsichtlich der expliziten Berücksichtigung der finanziellen Flexibilität in der Investitionstheorie.

Beitrag 4: Entscheidung über den Vertragsanbau von Zuckerrüben zur Biogasgewinnung

Mit dem durchgeführten DCE wird das Ziel verfolgt, eine Aussage darüber treffen zu können, wie Anbauverträge für Zuckerrüben zur Biogasgewinnung aus Sicht der anbauenden Landwirte ausgestaltet sein müssen. Den am DCE teilnehmenden Landwirten werden daher von einem fiktiven Biogasanlagenbetreiber zwei verschiedene Verträge über den Anbau von Zuckerrüben zur Biogasgewinnung angeboten. Die Verträge unterschieden sich hinsichtlich der Vertragsdauer, der Vertragsfläche und des vertraglich vereinbarten Preises. Außerdem konnte vertraglich festgeschrieben sein, dass ein Drittel der Vertragsfläche erst im Frühjahr gerodet wird. Wohingegen bei anderen Verträgen für die gesamte Vertragsfläche die klassische Herbstrodung vorgesehen war. Der Landwirt hatte in den einzelnen Entscheidungssituationen natürlich auch die Möglichkeit, keinen der beiden ihm angebotenen Verträge zu wählen.

Die Daten des DCE sind mithilfe eines Generalized Multinomial Logit Modells in willingness-to-pay space analysiert worden. Die Mehrheit der teilnehmenden Landwirte gibt bei der dem DCE vorgelagerten Befragung an, die Gewinnung von Biogas aus Zuckerrüben für eine wichtige Alternative gegenüber der Biogasgewinnung aus Silomais zu halten. Die Ergebnisse des DCE zeigen jedoch, dass die Landwirte bei der betrieblichen Entscheidung über den Vertragsanbau von Zuckerrüben zur Biogasgewinnung den Status-quo generell präferieren. Entgegen unserer aus der vorhandenen Literatur abgeleiteten Erwartung hat die Erfahrung, die der Landwirt im Vertragsanbau von Kulturen bereits erworben hat, keinen signifikanten Einfluss auf die Entscheidung für oder gegen den Vertragsanbau von Zuckerrüben für die Biogasgewinnung. Gleichzeitig kann festgehalten werden, dass die Risikoeinstellung des Landwirts die Entscheidung beeinflusst. Die generelle Preisforderung eines Landwirts für das Eingehen eines Vertrags zum Anbau von Zuckerrüben für die Biogasgewinnung sinkt mit steigendem Grad an Risikoaversität signifikant. Möglicherweise möchten die risikoaversen Landwirte den Vertragsanbau von Zuckerrüben mit Blick auf das Ende der Zuckermarktordnung als Risikoreduzierungsmöglichkeit testen. Dies zeigt sich auch darin, dass risikoaverse Landwirte eher kurze Vertragslaufzeiten und geringe Flächenumfänge präferieren. Abschließend muss festgehalten werden, dass das Ziel von Biogasanlagenbetreibern, ihre Substratversorgung über einen langen Zeitraum zu sichern, wahrscheinlich nur schwer und nur über nicht rentable Preisaufschläge realisierbar sein wird.

Die Ergebnisse des DCE zeigen, dass die grundsätzliche Einstellung der Landwirte für eine Erweiterung der Substratpalette zur Biogasgewinnung positiv ist. Für ihre Betriebe sehen die Landwirte allerdings einen Vertragsanbau von Zuckerrüben zur Biogasgewinnung noch nicht als relevante Alternative an. Einzig risikoaverse Landwirte sehen in dem Vertragsanbau eine mögliche risikoreduzierende Alternative, die es im Hinblick auf die endende Zuckermarktordnung auszutesten gilt. Möglicherweise sollte die Politik hier ansetzen und die Landwirte verstärkt auf die mögliche Alternative Nutzung der Zuckerrüben und die damit verbundenen Vorteile aufmerksam machen. Eine breite Versorgung der Biogasanlagen mit Zuckerrüben als Substrat scheint jedoch zu rentablen Konditionen derzeit nicht realisierbar. Hier gilt es abzuwarten, ob die Preisentwicklung am Weltmarkt für Zuckerrüben nach dem Jahr 2017 zu einem Umdenken der Landwirte und zur Suche nach Alternativen führt. Ist politisch weiterhin eine Diversifizierung der Substratpalette gewünscht, ist die Politik gefragt.

Literatur

Abebe, G.K., Bijman, J., Kemp, R., Omta, O. und A. Tsegaye (2013): Contract farming configuration: Smallholders' preferences for contract design attributes. *Food Policy* 40: 14-24.

Act on Granting Priority to Renewable Energy Sources (Renewable Energy Sources Act) (2012) [Internet]: https://www.clearingstelle-eeg.de/files/node/8/EEG_2012_Englische_Version.pdf [aufgerufen am 18.05.2015].

Andersson, H., Larsén, K., Lagerkvist, C.J., Andersson, C., Blad, F., Samuelsson, J. und P. Skargren (2005): Farm cooperation to improve sustainability. *AMBIO: A Journal of the Human Environment* 34: 383-387.

Artz, G., Colson, G. und R. Ginder (2010): A Return of the Threshing Ring? A Case Study of Machinery and Labor-Sharing in Midwestern Farms. *Journal of Agricultural & Applied Economics* 42: 805-819.

Aurbacher, J., Lippert, C. und S. Dabbert (2011): Imperfect markets for used machinery, asynchronous replacement times, and heterogeneity in cost as path-dependent barriers to cooperation between farmers. *Biosystems Engineering* 108: 144-153.

Bahrs, E., Fuhrmann, R. und O. Muziol (2004): Die künftige Finanzierung landwirtschaftlicher Betriebe – Finanzierungsformen und Anpassungsstrategien zur Optimierung der Finanzierung. In: Rentenbank (Hrsg.): Herausforderung für die Agrarfinanzierung im Strukturwandel – Ansätze für Landwirte, Banken, Berater und Politik. *Schriftenreihe der landwirtschaftlichen Rentenbank* 19: 7-49.

Barry, P.J., Baker, C.B. und L.R. Sanint (1981): Farmers' credit risk and liquidity management. *American Journal of Agricultural Economics* 63: 216-227.

Barry, P.J. und D.R. Fraser (1976): Risk management in primary agricultural production: methods, distribution, rewards, and structural implications. *American Journal of Agricultural Economics* 58: 286-295.

Beal, D.J. (1996): Emerging issues in risk management in farm firms. *Review of Marketing and Agricultural Economics* 64: 336-347.

Benz, M. (2006): Entrepreneurship as a Non-profit-seeking Activity. *International Entrepreneurship and Management Journal* 5: 23-44.

Bateman, I.J., Carson, R.T., Day, B., Hanemann, M. und N. Hanley (2002): Economic valuation with stated preference techniques: A manual. London: Edward Elgar Publishing.

Breustedt, G., Müller-Scheeßel, J. und U. Latacz-Lohmann (2008): Forecasting the adoption of GM oilseed rape: evidence from a discrete choice experiment in Germany. *Journal of Agricultural Economics* 59: 237-256.

Christensen, T., Pedersen, A.B., Nielsen, H.O., Mørkbak, M.R., Hasler, B. und S. Denver (2011): Determinants of farmers' willingness to participate in Subsidy Schemes for pesticide-free buffer zones - A Choice Experiment Study. *Ecological Economics* 70: 1558–1564.

DeAngelo, H., DeAngelo, L. und T.M. Whited (2011): Capital structure dynamics and transitory debt. *Journal of Financial Economics* 99: 235-261.

European Commission (2005): Communication from the commission to the council on risk and crisis management in agriculture. *COM* (2005) 74, Brussels.

Espinosa-Goded, M., Barreiro-Hurlé, J. und E. Ruto (2010): What Do Farmers Want From Agri-Environmental Scheme Design? A Choice Experiment Approach. *Journal of Agricultural Economics* 61: 259-273.

Gissén, C., Prade, T., Kreuger, E., Nges, I.A., Rosenqvist, H., Svensson, S.E., Lantz, M., Mattsson, J.E., Börjesson, P. und L. Björnsson (2014): Comparing energy crops for biogas production – Yields, energy input and costs in cultivation using digestate and mineral fertilisation. *Biomass and Bioenergy* 64: 199-210.

Goodwin, B.K. und T.C. Schroeder (1994): Human capital, producer education programs, and the adoption of forward-pricing methods. *American Journal of Agricultural Economics* 76: 936-947.

Greiner, R. (2015): Factors influencing farmers' participation in contractual biodiversity conservation: a choice experiment with northern Australian pastoralists. *Australian Journal of Agricultural and Resource Economics*, DOI: 10.1111/1467-8489.12098.

Hein, K., Lavèn, P. und R. Doluschitz (2011): Voraussetzungen, Vorteile und Probleme in Kooperationen zwischen landwirtschaftlichen Unternehmen—theoretische Analyse und empirische Überprüfung. *Berichte über Landwirtschaft* 89: 13-37.

Larsén, K. (2007): Participation, incentives and social norms in partnership arrangements among farms in Sweden. Selected paper at the American Agricultural Economics Association Annual Meeting. Portland, OR, 29th July-1st August 2007.

Larsén, K. (2010): Effects of machinery-sharing arrangements on farm efficiency: evidence from Sweden. *Agricultural Economics* 41: 497-506.

Lizin, S., Van Passel, S. und E. Schreurs (2015): Farmers' perceived cost of land use restrictions: A simulated purchasing decision using discrete choice experiments. *Land Use Policy* 46: 115-124.

Louviere, J.J., Hensher, D.A. und J.D. Swait (2000): Stated choice methods: analysis and applications. Cambridge: University Press.

NASS (2015): Farm Production Expenses Annual Summary. [Internet]: http://usda.mannlib.cornell.edu/MannUSDA/viewDocumentInfo.do?documentID=1066 [aufgerufen am 25.01.2015].

Nielsen, V. (1999): The effect of collaboration between cattle farms on the labour requirement and machinery costs. *Journal of Agricultural Engineering Research* 72: 197-203.

Odening, M. (2003): Financial management in farms. Does size matter? In: Balmann, A. und A. Lissitsa (Hrsg.): Large farm management. *Studies on the Agricultural and Food Sector in Central and Eastern Europe* 20: 301-315.

Paulrud, S. und T. Laitila (2010): Farmers' attitudes about growing energy crops: A choice experiment approach. *Biomass and Bioenergy* 34: 1770-1779.

Pfarr C. und V. Ulrich (2011): Discrete-Choice-Experimente zur Ermittlung der Präferenzen für Umverteilung. Discussion-Paper 03-11. Universität Bayreuth: ISSN 1611-3837.

Ruto, E. und G. Garrod (2009): Investigating farmers' preferences for the design of agri-environment schemes: a choice experiment approach. *Journal of Environmental Planning and Management* 52: 631-647.

Saha, A. und J. Stroud (1994): A household model of on-farm storage under price risk. *American Journal of Agricultural Economics* 76: 522-534.

Sartwelle, J., O'Brien, D., Tierney, W.J. und T. Eggers (2000): The Effect of Personal and Farm Characteristics upon Grain Marketing Practices. *Journal of Agricultural and Applied Economics* 32: 95-111.

Schulz, N., Breustedt, G. und U. Latacz-Lohmann (2014): Assessing Farmers' Willingness to Accept "Greening": Insights from a Discrete Choice Experiment in Germany. *Journal of Agricultural Economics* 65: 26-48.

Starke, P. und C. Hoffmann (2014): Yield parameters of Beta beets as a basis to estimate the biogas yield. *Sugar Industry* 139:169-176.

de Toro, A. und P.A. Hansson (2004): Machinery Cooperatives – a case study in Sweden. *Biosystems Engineering* 87: 13-25.

Train, K.E. (2009): Discrete choice methods with simulation. Cambridge: University Press.

Wolfley, J.L., Mjelde, J.W., Klinefelter, D.A. und V. Salin (2011): Machinery-Sharing Contractual Issues and Impacts on Cash Flows of Agribusinesses. *Journal of Agricultural and Resource Economics* 36: 139-159.

Publikationsliste

Beiträge veröffentlicht bzw. angenommen in referierten wissenschaftlichen Zeitschriften:

Anastassiadis, F.; Sauthoff, S.; Mußhoff, O. (2015): Ist der Anbau von Zuckerrüben als Biogassubtrat für Landwirte eine Alternative? Ein Discrete Choice Experiment zur Ausgestaltung von Substrat-Lieferverträgen für Zuckerrüben. German Journal of Agricultural Economics (im Druck).

Anastassiadis, F.; Liebe, U.; Mußhoff, O. (2015): Financial flexibility in agricultural investment decisions: A discrete choice experiment. Agricultural Economics Review (im Druck).

Anastassiadis, F.; Feil, J.-H; Kasten, P.; Mußhoff, O. (2015): Motive und Hemmnisse für landwirtschaftliche Kooperationen: Eine experimentelle Untersuchung. Zeitschrift für das gesamte Genossenschaftswesen (im Druck).

Anastassiadis, F.; Mußhoff, O. (2014): Berücksichtigen Landwirte bei ihren Investitionsentscheidungen die damit verbundenen Auswirkungen auf die finanzielle Flexibilität ihres Betriebes?. German Journal of Agricultural Economics 63 (4): 240-258.

Feil, J.-H.; Anastassiadis, F.; Mußhoff, O.; Schilling, P. (2014): Analysing farmers' use of price hedging instruments: an experimental approach. Journal of Agricultural & Food Industrial Organization 12 (1): 181-192.

Working Paper:

Feil, J.-H.; Anastassiadis, F.; Mußhoff, O.; Kasten; P. (2015): Analyzing farmers' preferences for collaborative arrangements: an experimental approach. Göttingen: Diskussionspapier Nr. 1510, Georg-August-Universität Göttingen, Fakultät für Agrarwissenschaften, Department für Agrarökonomie und Rurale Entwicklung.

Sauthoff, S.; Anastassiadis, F.; Mußhoff, O. (2015): Analyzing farmers' preferences for substrate supply contracts for sugar beets. Göttingen: Diskussionspapier Nr. 1509, Georg-August-Universität Göttingen, Fakultät für Agrarwissenschaften, Department für Agrarökonomie und Rurale Entwicklung.

Beiträge in Fachzeitschriften:

Anastassiadis, F.; Kunz, V.; Pape, C.; Mußhoff, O. (2013): Nachrechnen lohnt sich. DLG Mitteilungen 11/13.

Tagungsbeiträge:

Sauthoff, S.; Anastassiadis, F.; Jacobs, A.; Märländer, B.; Mußhoff, O. (2015): Zuckerrüben für die Biogasproduktion? – Empfehlungen für die Ausgestaltung von Substratlieferverträgen mittels Discrete-Choice-Ansatz. Tagungsband der 58. Tagung der Gesellschaft für Pflanzenbauwissenschaften e. V., in Braunschweig (im Druck).

Feil, J.-H.; Anastassiadis F.; Mußhoff, O. (2015): Analyzing farmers' preferences for collaborative arrangements: an experimental approach. 55. Jahrestagung der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues (GeWiSoLa), 23. September - 25. September 2015 in Gießen, angenommen als Tagungsbeitrag.

Feil, J.-H.; Anastassiadis, F.; Mußhoff, O.; Schilling, P. (2014): Analysing farmers' use of price hedging instruments: an experimental approach. Tagungsband der 54. Jahrestagung der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues (GeWiSoLa), 17. September-19. September 2014 in Göttingen, Band 50: im Druck.

Anastassiadis, F.; Mußhoff, O. (2013): Financial flexibility in agricultural investment decisions: a discrete choice experiment. 50th Anniversary Conference of The Public Choice Society, March 7-10, 2013 in New Orleans, USA.

Anastassiadis, F.; Mußhoff, O. (2013): Evaluating the role of financial flexibility in agricultural investment decisions using latent class analysis. 87th Annual Conference of the Agricultural Economics Society (AES), April 8-10, 2013 in Warwick, Great Britain.

Anastassiadis, F.; Liebe, U.; Mußhoff, O. (2012): Finanzielle Flexibilität in landwirtschaftlichen Investitionsentscheidungen: ein Discrete Choice Experiment. 52. Jahrestagung der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues (GeWiSoLa), 26. September-28. September 2012 in Stuttgart-Hohenheim, Band 48: 3-16.

Erklärung über den geleisteten Eigenanteil in der Arbeit

Hiermit erkläre ich den geleisteten Anteil an den in die Dissertationsschrift aufgenommenen Beiträgen.

Der erste Beitrag mit dem Titel „*Analysing farmers' use of price hedging instruments: an experimental approach*" ist in Zusammenarbeit mit Herrn Dr. Jan-Henning Feil, Herrn Prof. Dr. Oliver Mußhoff und Herrn M. Sc. agr. Philipp Schilling verfasst worden. Folgende Bereiche sind dabei von mir übernommen worden: Konzeptionelle Entwicklung des Forschungsprojektes, Erhebung der Daten, Durchführung der Rechnungen und der Analysen sowie der Interpretation der Ergebnisse jeweils in enger Zusammenarbeit mit den beteiligten Autoren.

Der zweite Beitrag mit dem Titel „*Analyzing farmers' preferences for collaborative arrangements: an experimental approach*" ist in Zusammenarbeit mit Herrn Dr. Jan-Henning Feil, Herrn Prof. Dr. Oliver Mußhoff und Herrn M. Sc. agr. Philipp Kasten verfasst worden. Folgende Bereiche sind dabei von mir übernommen worden: beratenden Funktion bei der Konzeption und Durchführung des Experiments, alleiniges Erstellen des Experimentdesigns und Durchführung der Rechnungen, Analyse und Interpretation der Ergebnisse in enger Zusammenarbeit mit den beteiligten Autoren.

Der dritte Beitrag mit dem Titel „*Berücksichtigen Landwirte bei ihren Investitionsentscheidungen die damit verbundenen Auswirkungen auf die finanzielle Flexibilität ihres Betriebes?"* ist in Zusammenarbeit mit Herrn Prof. Dr. Oliver Mußhoff verfasst worden. Folgende Bereiche sind dabei von mir übernommen worden: Idee und Konzeption des Projektes in Zusammenarbeit mit Prof. Dr. Oliver Mußhoff, Erstellung des Design mit Beratung durch Herrn Prof. Dr. Ulf Liebe, alleinige Durchführung der Rechnungen, Analyse und Interpretation der Ergebnisse jeweils in enger Zusammenarbeit mit Herrn Prof. Dr. Oliver Mußhoff.

Der vierte Beitrag mit dem Titel „*Analyzing farmers' preferences for collaborative arrangements: an experimental approach*" ist in Zusammenarbeit mit Frau M. Sc. agr. Saramena Sauthoff und Herrn Prof. Dr. Oliver Mußhoff verfasst worden. Folgende Bereiche sind dabei von mir übernommen worden: Idee und Konzeption des Projektes in Zusammenarbeit mit allen beteiligten Autoren, alleiniges Erstellen des Experimentdesigns und Durchführen der Rechnungen; Analyse und Interpretation der Ergebnisse jeweils in enger Zusammenarbeit mit den beteiligten Autoren.

Eidesstaatliche Erklärungen

Hiermit erkläre ich eidesstattlich, dass:

(1) diese Arbeit weder in gleicher noch in ähnlicher Form bereits anderen Prüfungsbehörden vorgelegen hat.

(2) ich mich an keiner anderen Hochschule um einen Doktorgrad beworben habe.

Göttingen, den 17.09.2015

Hiermit erkläre ich eidesstattlich, dass ich diese Dissertation selbstständig und ohne unerlaubte Hilfe angefertigt habe.

Göttingen, den 17.09.2015