Schmollers Jahrbuch 132 (2012), 463 – 471
Duncker & Humblot, Berlin

A Survey of Commercial Cattle Farmers in Semi-arid Rangelands of Namibia on Risk, Management and Sustainability

By Roland Olbrich, Martin F. Quaas, and Stefan Baumgärtner*

1. Introduction

Farmers depend upon the specific spatio-temporal provision of ecosystem services which is influenced by risks acting on various space and time scales. To what extent farmers are affected by these risks depends on the risks' characteristics, risk and time preferences and their endowment (Gollier, 2001; Machina / Rothschild, 2008). Farmers employ a variety of management strategies to lessen risk (Shogren / Crocker, 1999; Perrings, 2004). Some of these strategies induce environmental changes that may adversely affect the well-being of future generations (Stern, 2000) and thus threaten the sustainability of the system.

Both environmental risk and sustainability are especially critical in semi-arid rangelands, a globally important ecological-economic system that covers approximately 8% of the Earth's surface and provides livelihood for hundreds of millions of people (MEA, 2005: 627). One prime example is commercial cattle farming in Namibia, which is subject to a number of environmental, economic, political and social risks. It also suffers from degradation in the form of extensive bush encroachment (de Klerk, 2004) and of biodiversity loss (MET, 2006). Finally, it is economically important, contributing by far the largest share (37%) to total agricultural output and directly 1 – 2% to GDP (MAWF, 2009: 7, 9).

To study risk, management and sustainability, we conducted a survey among 2,119 Namibian commercial cattle farmers in August 2008, consisting of a mail-in questionnaire and in-field experiments for the elicitation of risk and time preferences. As detailed in Table 1, we collected information on 1) personal and

* Many scientist, experts and farmers contributed with their comments and discussion to the design of this survey, and we wish to express our gratitude to all of them. Special thanks go to Volker and Ursula Dieckhoff, Arne Gressmann, Claus Hager, Harald Marggraff, Thomas and Heidrun Peltzer, Elsabe Steenkamp, Welmoet van Kammen, Peter Zensi and Ibo Zimmermann. We also thank our cooperating organizations Namibia Agricultual Union, Namibian Agricultural Trade Board and Agra Co-operative Ltd. Finally, we are grateful to the German Federal Ministry of Education and Research (BMBF) for financial support under grant 01UN0607.

farm features, 2) risk perception, 3) risk management strategies, 4) normative views of sustainability, and 5) individual risk and time preferences. This paper describes the survey's content (Section 2.) and its conduction (Section 3.), provides examples of research applications (Section 4.) and describes the conditions for data access (Section 5.). It is the concise version of a detailed working paper (Olbrich et al., 2009) which contains the complete survey documentation.

2. Survey Content

2.1 Personal and Farm Features, Risk Perception, Risk Management Strategies

We recorded information on a variety of personal and farm features that we identified in previous qualitative interviews with farmers and decision makers in March / April and October 2007 as relevant in the context of risk, management and sustainability. We also elicited farmers' perception on 13 environmental, economic, political and social risks. Finally, we asked farmers to rate 16 risk management strategies which either adjust organization and production processes of the farm (termed "on-farm risk management"), make use of financial products, off-farm assets or off-farm income ("financial risk management") or entail membership to certain groups ("collective risk management").

2.2 Normative Views of Sustainability

Normative views of sustainability that we elicited in the questionnaire are formulated in the context of a specific operational criterion for strong sustainability under uncertainty, namely ecological-economic viability (Baumgärtner / Quaas, 2009). The basis for the criterion is the traditional notion of strong sustainability, that is that relevant natural and economic components of a given system have to be conserved at or above specified thresholds, and have to be conserved independently of each other (Pearce et al., 1989; Daly et al., 1994; Ekins et al., 2003). The criterion then expands on the notion by also requiring the specification of the acceptable risk that the components' conservation fails due to stochastic system dynamics.

For the questionnaire, we pre-selected ecosystem condition of the rangeland (measured as grazing capacity in the unit hectare per Large Stock Unit) and income (measured as net annual income) as the two most critical components for conservation. We then elicited the respective threshold levels at or above which both components should be conserved, the time horizon for their conservation and the acceptable risk that the conservation of either component fails.

In addition, we inquired in an open question which other components farmers consider important for preservation. Here, we did not inquire for threshold levels, time horizon or acceptable risk.

2.3 Individual Risk and Time Preferences

We elicited risk and time preferences by an adapted multiple price list format, both within the questionnaire as experiments with hypothetical payout ("questionnaire experiments") and in field experiments with payout of real money ("field experiments"). In these risk (time) experiments, subjects choose for a number of scenarios between taking part in a lottery or receiving a certain payout instead (between receiving a payout at a certain point in time or a higher payout later). Scenarios differ with regard to the certain amount (the amount of the later payout) which increases from the first to the last scenario. Subjects typically prefer the lottery (earlier amount) when the certain amount (later amount) is low and switch once the certain amount (later amount) is deemed high enough. Based on the choices, risk (time) preferences can be inferred as detailed, for example, in Holt/Laury (2002), Andersen et al. (2008) and Olbrich et al. (2011a).

In the risk *questionnaire* experiments, we offered farmers six scenarios, where we framed the lottery in the context of selling cattle at an auction. The auction had two possible outcomes, N$90,000[1] and N$130,000, each occurring with equal probability of 1/2. The expected value of the auction (N$110,000) corresponds to about one third of the annual net income of the average farmer. Instead of taking part in the risky auction, farmers could chose to sell to a trader for a certain amount which started at N$100,000 in the first scenario and increased in steps of N$2,500 to N$112,500 in the sixth and last scenario. In the risk *field* experiments, the lottery was context-free with two possible outcomes, N$500 and N$2,500, each occurring with equal probability of 1/2. The expected value of N$1,500 corresponds to the value of a calf. To achieve a higher resolution of risk aversion measures, 16 scenarios were presented. The certain amount started at N$550 in the first and increased to N$1,900 in the last scenario. In contrast to the questionnaire experiments, payouts were real: after the farmer had made his choices one of the scenarios was randomly picked (by throwing a dice) and paid out, that is the farmer either received the certain amount or the lottery in turn was played out (again by throwing a dice). Due to monetary constraints we could pay only 10% of farmers which were randomly selected by letting farmers draw lots. Payouts were made in cash instantly.

In the time *questionnaire* experiments, farmers had to choose in a context free frame in five scenarios between receiving a payout in one month or a higher payout in seven months. The payout in one month of N$100,000 was constant throughout all scenarios. The payout in seven months increased from N$104,881 in the first scenario, which corresponds to an annual interest rate

[1] N$ denotes Namibian dollars. On 1st of August 2008, N$1,000 equaled €88.14 or US$137.50.

with quarterly compounding of 10%, to N$122,474 in the fifth and last scenario, which corresponds to an interest rate of 50%. Values for later payouts in the scenarios in between the first and the last were chosen in such a way that the corresponding interest rate increased by 10% per scenario. In the time *field* experiments, 20 scenarios were presented with a payout in one month of N$2,000 and a payout in seven months which increased from N$2,025 in the first to N$2,449 in the last scenario (corresponding to interest rates of 2.5% and 50%, respectively). After the farmer had made his choices in all scenarios, we randomly picked one (by throwing a dice) for payout. Payouts were guaranteed by the NAU which would transfer the money to the farmer's account with the respective delay chosen by the farmer. Again, due to monetary constraints we could pay only 10% of farmers which were randomly selected by letting farmers draw lots.

In addition to the questionnaire experiments, risk and time preferences were also elicited in the questionnaire in an alternative format involving self-assessment on nine-item Likert-scales. Answers were calibrated through the respective field experiments, a strategy which has already been applied in a survey of the German Socio-Economic Panel (Dohmen et al., 2011).

2.4 Linkage with other Databases

To allow a link of survey data to data from other data sources, we firstly elicited in which district and region the farm is located. Secondly, we elicited in an optional question the farm number which allows for the unique identification of each farm.

Table 1

Variables and their types in the survey

Variable	Variable type
1) Personal and farm features	
Personal features	
Gender	B
Household size	C
Age	C
Farm experience, duration of	C
Operation of own farm, duration of	C
Retirement: expected time until retirement, expected reason, fate of farm	C, Op, Op
Ethnicity	N
Education: level, main field	Or, Op
Full-time farmer	B
Emerging Commercial Farmer	B
NAU-member	B

Variable	Variable type
Farm features	
District / region of farm	Op
Farm number (optional)	Op
Rainy season assessment: seasons 2003/04 till 2007/08	L
Precipitation on farm: Oct 2006 till Sept 2008	C
Operator status	N
Ownership structure	N
Farmland size: owned, rented/rented out, operated, designated as rangeland	C
Camps, number of	C
Land quality	L
Bush cover: actual, optimal	Or, C
Grazing capacity	C
Cattle: in Nov 2007, in Apr 2008	C
Production system, type of	C
Income: total income, income from cattle farming, income from other on-farm sources, income from off-farm sources	Or
2) Risk perception	
Environmental risks: rainfall, low groundwater level, bush fire, cattle diseases, cattle predation	L
Economic risks: output prices, input prices, rising living expenses	L
Political risks: changing labour market conditions, expropriation, unfavourable trade agreements	L
Social risk: cattle theft, failure of farm equipment	L
3) Risk management strategies	
On-farm management strategies: purchase of supplementary feed, choice of cattle production system, choice of breed adapted to high in grass production, resting part of rangeland in good rainy seasons, purchase / lease of rangeland for spatial diversification, purchase / lease of rangeland for scale effects	L
Financial management strategies: forwards contracts, advances on livestock sales, checking account as financial buffer, loans for covering operating losses, income from off-farm employment or assets, investment into agricultural derivatives	L
Collective management strategies: cooperative ownership of farmland, governmental support, interest groups on a local level, interest groups on a national level	L
4) Normative views of sustainability	
Sustainable annual net income	C
Sustainable grazing capacity	C
Time horizon for sustaining income and grazing capacity	C
Acceptable income risk	C
Acceptable grazing capacity risk	C
Other system components that should be sustained	Op

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Table 1 (continued)

Variable	Variable type
5) Individual risk and time preferences	
Risk questionnaire experiments: choices in 6 scenarios	B
Risk field experiments: choices in 16 scenarios	B
Time questionnaire experiments: choices in 5 scenarios	B
Time field experiments: choices in 20 scenarios	B
Self-assessment of risk preferences	L
Self-assessment of time preferences	L

Colons behind a variable indicate that subcategories of that variable were elicited. For variables with subcategories, more than one variable type is listed, if the different subcategories have different variable types. The first variable type then applies to the first subcategory and so on. Variable types: B = binary variable, C = continuous variable, N = nominal variable, L = Likert-scale ordinal variable, Or = ordinal variable, Op = open question.

3. Survey Conduction

3.1 Address Database and Survey Design

The exact number of commercial cattle farmers is not known. Experts guestimate that there are 2,250 farmers (Hager / Marggraff, 2007). Furthermore, no up-to-date address database containing all these farmers exists. We therefore compiled our own database by joining existing databases of the Namibia Agricultural Union (NAU) and of MeatCo of Namibia (MeatCo).

The NAU is the main interest group of commercial farmers with approximately 2,000 members (Keulder / Hishoono, 2009: 9). 1,324 of these are located in the commercial cattle farming regions (the states Erongo, Khomas, Omaheke, Otjiozondjupa, and adjoining districts of neighboring states), and the NAU provided us with their address details. For farmers who are not members of the NAU we considered that they (like NAU farmers) deliver cattle to slaughterhouses.[2] For commercial cattle farmers, the relevant slaughterhouse is MeatCo (Schutz, 2010), which provided us with information on all cattle-delivering farmers of the period 2005 – 2008. We extracted 795 entries which were not already contained in the NAU database. Altogether, our address database thus has 2,119 entries and essentially contains all commercial cattle farmers.[3]

[2] The three main outputs of cattle farms are oxen, weaners and breeding bulls. Oxen are naturally delivered to the slaughterhouse, but even weaner- and bull-producing farmers will regularly deliver an unproductive or severely injured cow to the slaughterhouse.

[3] We may have missed non-NAU members who did not deliver cattle to MeatCo in the period 2005 – 2008. However, we consider their numbers to be negligible (see previous footnote). Furthermore, the number of 2,119 entries in our database agrees well with the guestimate of 2,250 for the total number of commercial cattle farmers (Hager / Marggraff, 2007).

For designing the survey we conducted qualitative interviews with local decision makers and farmers in March / April and October 2007 to acquire in-depths information on the system. We then compiled a first version of the questionnaire which we pre-tested with ten farmers and decision makers in June 2008. Based on the feedback, we finalized the questionnaire.

3.2 Conduction and Participation

We mailed out a first batch of questionnaires in the period 19 – 21 August 2008 to the 2,119 farmers in our database (see Section 3.1), and a second batch as a follow-up on 15 September 2008. For the field experiments, we randomly selected 39 NAU-members that produced cattle and worked on the farm full-time.[4] We visited the majority of participants (79.4 %) on their respective farm, and the remaining ones at pubic locations in major cities. Experimental sessions started with the participant filling in the questionnaire. He was then presented with the written experimental documentation and the experimental sheet which he filled in.[5] Duration of sessions varied between one and two-and-a-half hours.

We received 398 questionnaires, including the 39 of the experimental participants. Altogether, this equals a return rate of 19 %. The optional question for the farm number which identifies the farm was answered in 299 questionnaires (75 % of the received questionnaires).

4. Research Potential

The survey's information on risk, management and sustainability allows for a variety of studies in the context of the use of ecosystem services under uncertainty. Given the high proportion of participants who identified their farm, the research potential is greatly increased since survey information may be combined with information from other databases.

One example for the research potential, especially by combination with other databases, is given in Olbrich et al. (2011a) who study the impact of environmental risk on risk preferences. Using the farm number to identify the farm,

4 To this end, 72 farmers were randomly selected from among the NAU members and contacted. If the farmer produced cattle and worked on his farm full-time we sought to schedule a session, which applied to 57 (79.1 %) of the contacted farmers. Due to schedule difficulties or cancellations only 39 sessions were actually conducted. All field experiments were conducted by Roland Olbrich.

5 There was one exception: upon arrival at the session the farmer remarked that his time would not permit both filling-in of the questionnaire and conducting experiments, and we directly proceeded to the experiments.

they link survey information on farmers' risk preferences and socio-demographics to farm specific information on rainfall risk, as generated by a climate model, and on previous farm ownership, as provided by the Deed's Office of Namibia. By doing so, they can analyze how the individual rainfall risk a given farmer experiences throughout his life shapes his risk preferences. Other examples for the research potential are a study of the impact of normative views on farm management (Olbrich et al., 2011b), and a characterization of farms with respect to risk, management and sustainability (Olbrich et al., 2011c).

5. Data Access

Since data was elicited within a research project conducted at the Leuphana University of Lüneburg, located in the German state Lower Saxony, the use of data is subject to this state's data protection regulations. This means that data may not be distributed to third parties, but may only be analyzed locally at the Leuphana University of Lüneburg. Interested researchers may contact the authors for arranging access. Data may not be used for teaching.

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