Method Article – Title Page

Title	**Combining Service Design and Discrete Choice Experiments for Intervention Design: an Application to Weather Index Insurance**
Authors	Naira Dehmel[1] (*), Ylva Ran[2], Matthew Osborne[2], Arjan Verschoor[3], Fiona Lambe[2], Joshua Balungira[4], Giovanni Alberto Tabacco[5], Borja Perez-Viana[6], Erik Widmark[7], Stefan Holmlid[8]
Affiliations	1. King's College London 2. Stockholm Environment Institute 3. University of East Anglia 4. The Field Lab 5. Free-lance researcher 6. University of St Gallen 7. Expedition Mondial 8. Linköping University
Corresponding Author's email address	naira.dehmel@kcl.ac.uk
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ABSTRACT

In this paper we provide a detailed description of the methodological steps involved in conducting a Service Design study in combination with Discrete Choice Experiments (DCEs). It complements the conceptual and epistemological argument developed for this methodological combination in Osborne et al. (2021, World Development, in review WD-19535). Service Design for the co-creative development of policy interventions in complex adaptive systems involves an iterative process of moving between the six methodological stages of (1) problem co-definition, (2) actor-centred mapping, (3) experience-based problem diagnosis, (4) rapid prototyping, (5) design and testing and (6) upscaling. We suggest using DCEs as a quantitative method that is contextually adaptable and comparatively fast and cheap to implement, as part of stage (6) design and testing. Whilst both methods can operate independently with their own strengths and limitations, we find their combination to add value to the processes and outcomes of each. We illustrate the general methodological approach with a step-by-step description of its application to Weather Index Insurance in eastern Uganda.

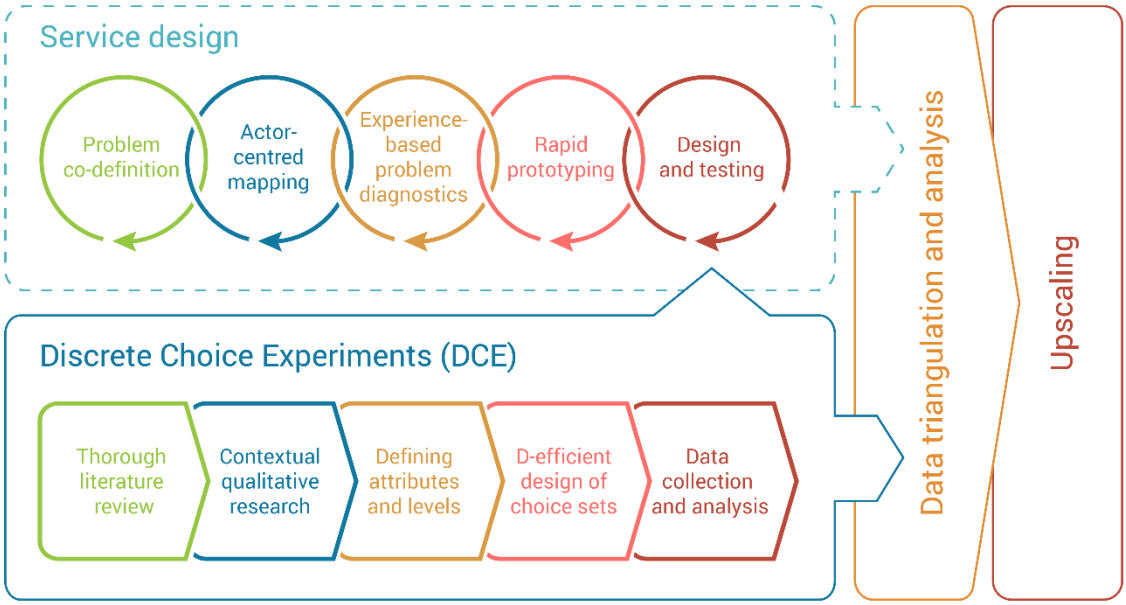
Bullet points:

- Service Design co-creatively develops well-targeted solutions in complex adaptive systems
- Discrete Choice Experiments quantitatively elicit actors' preferences over the design of goods or services
- Their combination can bring deeply contextualised, user-centred, operational and experimentally verified ideas for development interventions prior to their implementation

Abbreviations:

DCE – Discrete Choice Experiment
FGD – Focus Group Discussion
VSLA – Village Savings and Loan Association
WII – Weather Index Insurance

Graphical Abstract:



SPECIFICATIONS TABLE

Subject Area	Economics and Finance
More specific subject area	Development Economics, Behavioural Sciences, Policy Design and Market Research
Method name	Combining Service Design Thinking and Discrete Choice Experiments
Name and reference of original method	Lambe, F., Ran, Y., Jürisoo, M., Holmlid, S., Muhoza, C., Johnson, O., & Osborne, M. (2020). Embracing complexity: A transdisciplinary conceptual framework for understanding behavior change in the context of development-focused interventions. *World Development*, *126*, 104703. https://doi.org/10.1016/j.worlddev.2019.104703 Mangham, L. J., Hanson, K., & Mcpake, B. (2009). How to do (or not to do). .. Designing a discrete choice experiment for application in a low-income country. *Health Policy and Planning*, *24*, 151–158. https://doi.org/10.1093/heapol/czn047

Background

Successful interventions that require behavioural change in complex adaptive systems must embrace non-linearity and complex system dynamics. Thus, interventions in a development context should be designed using a highly iterative process incorporating feedback loops and opportunities for evaluation and redesign throughout the process. This paper illustrates the methodological application of a conceptual framework described in Lambe et al. (2020a) that combines behavioural insights, service design theory and social-ecological systems thinking. The application illustrates that by combining qualitative methods derived from Service Design, with quantitative validation, in this example Discrete Choice Experiments (DCEs), it is possible to provide fine-grained, verified and locally relevant insights that can be transformed and incorporated into scalable and effective development interventions and development programmes. This paper is to accompany the conceptual and epistemological argument for combining Service Design methodology with Discrete Choice Experiments made by Osborne et al. (2021, World Development, in review WD-19535) as its methodological counterpart. It does so by presenting the methodological steps involved in a case study on Weather Index Insurance (WII) in eastern Uganda.

The framework by Lambe et al. (2020a) follows six consecutive steps with built in iterations between each stage, (1) problem co-definition, (2) actor-centred mapping, (3) experience-based problem diagnosis, (4) rapid prototyping, (5) intervention/programme design and testing and (6) upscaling. The approach combines a range of methods, but at all times is co-creative, experience-based, and actor centred (Adner 2012). It adopts a 'wide lens' innovation perspective from the start of the intervention design process and incorporates elements of verification at each step (Table 1).

The methodology aims to map the decision-making landscape of actors in a complex adaptive system where a development programme is operating, or a development intervention is being introduced. This includes mapping the landscape and identifying key actors along the 'user journey' for the main actor. When this landscape has been thoroughly mapped and understood, prototype interventions can be co-designed with stakeholders and tested in-situ in order to inform the final intervention(s). In this paper, we particularly demonstrate how the testing stage can be achieved through the implementation of a Discrete Choice Experiment. To elucidate the practicalities of implementing the combined research approach, we first provide a generalised description of the six stages in the conceptual approach and suggest appropriate methodologies for each. We then describe how they operate over a project cycle, and finally illustrate how the approach can be applied in practice based on the empirical case-study example on designing Weather Index Insurance in eastern Uganda.

Method details

1. Service Design Methodology

Service Design is a qualitative, actor centred approach that aims to understand actors' needs, wider context, motivation and behaviours and additionally aims to, in conjunction with the same actors, co-develop and co-design improved services or systems that better meet the needs of the actors involved (Edvardsson et al., 2012; Manzini, 2015; Pfannstiel & Rasche, 2017). Service Design methodology has proven to be successful in identifying simple solutions to complex policy challenges that have shown to be difficult to resolve (Meroni, 2011). Service Design can be seen as a set of tools as well as a methodology to address for example challenges in the public sector (Malmberg, 2017;

Bason, 2017; Escobar, 2017) and wicked problems in social systems (Banathy, 1996; Jones, 2014). In particular, Service Design is useful to understand and map the interdependencies between actors, system components and multiple levels of a system (Sangiogri et al., 2017)

The approach and application of the Lambe et al. (2020a) framework should be viewed as a combination of different methodological stages which build upon each other to deliver an overall objective. Rather than prescribing a rigid methodology in of itself to be stringently followed from the start to the end, it provides a scaffolding within which to move back and forth in various rounds of iteration. Depending on the overall objective, related research questions and the contextual setting, different methods can be used under each methodological step. In table 1 we summarise the methodological approach, including each stage's objective, requirement for verification and potential methods, as well as the methods applied in the case study in Uganda.

Table 1. Methodological approach and suggested methods

Conceptual framework stage		Verification	Objective/Threshold	Methods	
				Potential[1]	Applied in Uganda
1	*Problem co-definition*	Desirable	Co-defined and clear understanding of objective	Key Informant Interviews, Focus Group Discussions (Meso)[2], Review of secondary data and relevant literature	FGDs (Meso) (n=2) Key informant interview (n=1) Household survey (n=100)
2	*Actor-centred mapping*	Desirable	Map out the decision-making landscape; identify and establish 'boundary edges'.	Participant Observation, Key Informant Interviews, Focus Group Discussions (Micro), Surveys, Transect walks Participatory Mapping: e.g. Time-lining, Seasonal Calendars, Social/Actor Network Mapping, Market Systems Diagrams (MOSC), Ecosystem Service Mapping (TESSA)	Participant Observation (n=20) In-depth interviews (n=12) FGDs (Micro) – incl. participatory mapping: time-lining, seasonal calendars, actor network and value chain mapping (n=7)
3	*Experience-based problem diagnosis*	Essential	Understand actors' current behaviours and experiences within the decision-making landscape. Identify relevant user archetypes, aim for saturation.	In-depth to targeted interviews with users, Key Informant Interviews, Focus Group Discussions (Micro/Meso), Participatory mapping: e.g. Actor Journey Mapping, Time-lining, Seasonal Calendars	In-depth interviews (n=8) Targeted interviews – actor journey mapping (n=23) FGDs (Micro) – time-lining, seasonal calendars (n=7) FGDs (Meso) – VSLA (n=4) Key informant interviews (n=5)
4	*Rapid prototyping*	Optional	Establish multiple intervention models that correspond with the landscape and archetypes needs. Use as validation and trigger material.	Coding of gathered data Key Informant Interviews, Focus Group Discussions (Micro & Meso)	Coding of gathered data, analysis of systematic gaps and brainstorming on solution by research team FGD (Micro & Meso): Verification workshop (n=30 participants)

[1] This list is not exhaustive and alternative methods may be added

[2] Micro-level FGDs represent discussions amongst the specific actors targeted by a particular intervention whereas meso-level FGDs refer to discussions with groups of individuals who represent a cohort of such actors, examples might include farmer group, cooperative society or market board representatives.

5	*Design and Testing*	Essential	Elaborate intervention design(s) based on all previous steps. Qualitative and/or quantitative evidence of efficacy of intervention and implementation.	Focus Group Discussions (Micro/Meso/Macro), Monitoring and Evaluation Methods, Field Experiments, (Randomised) Control Trials, Choice Experiments, Behavioural Experiments	DCE (n=196)
6	*Upscaling*	Essential	Validate assumptions and intervention design at new location(s). Adapt and iterate phases as required.	Repeat stage 1-5	

In the following section we describe each of the six steps in the iterative Lambe et al. (2020a) framework.

1. Problem co-definition

Funders and/or programme designers may have a clearly defined vision of success that may involve some preliminary assumptions about the nature of the 'problem' and how this could be addressed. Crucially, these assumptions and any proposed solution need to be challenged and ideally ground-truthed through engagement with actors[3] who are the target of the intervention. Although often overlooked, engaging in an open discussion about the nature of the problem and critically reflecting on the assumptions that underpin any development intervention, prior to any form of design and implementation can ensure that the intervention aims to solve a problem that is defined or understood as such by the intended beneficiaries. As Leask et al. (2019) mention, the reason why many co-creative processes fail is because they set out with a project aim that is too broad and it can be beneficial to have end-users and other stakeholders to help researchers identify the objective of a study aiming to solve a complex problem.

2. Actor-centred mapping

Starting with the actors in question, the objective of this stage is to map out the decision-making landscape. This should encompass all aspects of the socio-economic, ecological, structural and institutional dimensions of the setting that explain actors' current behaviour. Whilst the research team will be guided to a certain point by the wider objectives of the study (stage 1), at this point the objective is not to try to build solutions into this landscape, but rather to achieve a grounded and nuanced appreciation of the setting and space in which actors are operating in-situ. Multiple research approaches will be required to understand how different factors can influence the actors' behaviour and explain features of their current circumstances. The threshold that is required from this stage is to establish an organic 'boundary' within which all significant discrete factors that can influence the targeted beneficiaries and their decision-making landscape, are mapped and understood. Identification of such factors is guided by the principle of 'differences that make a difference' to the user group in question (Bateson, 1972), and their significance is established

[3] Given the scope of the programmes that we are hoping to support this term is difficult to define precisely for all settings but in general 'actors' refer to either interested groups or individuals within the setting in question. These could include individual households who are the targeted beneficiaries of a particular intervention, civil society groups, market traders and/or companies, government extension departments, etc.

through an ongoing process of verification and questioning to the point of saturation (Saunders et al, 2018).

3. Experience-based problem diagnosis

Having confidently mapped out the boundaries, significant characteristics and influencing factors of the system, the next stage refocuses attention directly on the behaviour of the actors within the system that appear relevant to the wider objective of the study. At this point, it is thus reasonable that the problem definition established in stage 1 comes more clearly into view.

Using methodologies adapted from Service Design approaches such as user journey mapping, key-informant interviews and stakeholder verification workshops, the research team begins to develop a picture of actors' behaviour within the system mapped out in stage 2. It is crucial to allow the actors themselves to lead the researchers through their actions and behaviours within the system over a relevant time period to help avoid inherited biases via common power dynamics between researchers and stakeholders. Trigger material can be used to facilitate the journey mapping and allow the actors to lead the process more easily. Over a repeated series of such interactions, actors' behaviours may be mapped in the system until reaching saturation.

It should be noted that the objective of the exercise is not to exclude differences between actors in the system intervention design, but rather establish how interventions may be able to meaningfully support transformational change to different actors or actor 'archetypes' that represent a composite image of a significant number of observed actors operating in the context. With archetypes we here mean patterns in the data that indicate that a certain behaviour, part of behaviour or even a set of behaviours can be attributed to a specific actor in regard to other factors such as socio-demographic characteristics or key drivers and motivations. These can be identified and derived from the coding and analysis of the qualitative data. However, these are ideally the result of both qualitative data analysis and a quantitative validation of archetypes to enable an investigation into the statistical significance and support for the identified archetypes.

4. Rapid Prototyping

In stage 4, the research team should be ready to develop a number of prototype interventions which are targeted to overcome the established problem. These prototypes could be single actions but more often will be a package of different actions that, in combination, encourage a normatively more positive outcome for the different actors or actor archetypes.[4] The purpose of the exercise is twofold, i) to encourage input by actors into the creation of new prototypes and ii) to present and validate potential solutions. As such, the research team is encouraged to create an array of prototypes and share these with as many actors as possible – using them as trigger material to promote open and creative dialogue.

Stakeholder verification of the research team's understanding of the contextual and behavioural landscape is essential to the meaningfulness of the methodological approach and should be considered as part of an ongoing process. Table 1 highlights at which stages verification is particularly crucial. Yet, it is context and budget dependent what form this verification may take. It can be built into the daily field research cycle (see method details section 2), e.g. through intentional questions

[4] For further insights on the range of interventions possible see Lambe et al, (in review).

included in interview guides for the subsequent fieldwork days, or occur in additional verification workshops. At an absolute minimum the product of stages 2-4 in the framework should be presented to a group of stakeholders who have knowledge about the system and can provide critical validation of system boundaries and features, identified archetypes and their relevant behaviour patterns. Last but not least, such a validation workshop should include a discussion and further development of the proposed prototypes.

5. Design and testing

Once insights from stages 2-4 have been validated and prototypes discussed, the research approach shifts from an exploratory to a more deterministic perspective. Integrating all important contextual insights from previous steps and the iterations of prototyping, more elaborate and operationalizable designs for interventions can be proposed and developed. These should be co-developed, and consider not only the design, but also the implementation of an intervention or development programme. The step is similar to that of prototyping in that the design is tested and verified by stakeholder interactions in iterative cycles before being finalised upon saturation. Testing can happen a priory any implementation, or as part of early localised pilot projects. However, the change in methodological approach should not be seen as final, separate or distinct, but rather as a further iterative step in the process. As in any stage, if the need arises to move back to the exploratory stage, this is welcome and encouraged.

Several methods are available to perform such testing - from qualitative methods of monitoring and evaluation, to quantitative experimental methods to provide a rigorous test of intervention efficacy - and methodological choice will depend on the nature of the intervention and/or the capacities of the research team. In Osborne et al. (2021, World Development, in review WD-19535) we elaborate on the value of combining Service Design with quantitative experimental designs, in particular with Discrete Choice Experiments, as a means of verification and testing throughout steps 4 (prototyping) and 5 (design and testing). As Discrete Choice Experiments are a methodological approach in their own rights, the practical steps involved in their implementation are described in a separate section below.

6. Scaling up

After analysis of the testing stage, the possibility to expand beyond the original geographic scope can be explored. This will, to amount to the underlying principles of our methodology, require a repetition of all of the previous stages – to ensure that assumptions are tested, the decision-making landscape and actor's behaviour is mapped within the 'new' system, incorporating any relevant differences into the design of new interventions. In practice however, the project iteration of the conceptual framework can be completed in a far quicker and more targeted fashion than the original operation. Nonetheless, it is crucial that space is provided to allow for creative input and the agency to influence the intervention design by the proximate targeted actors.

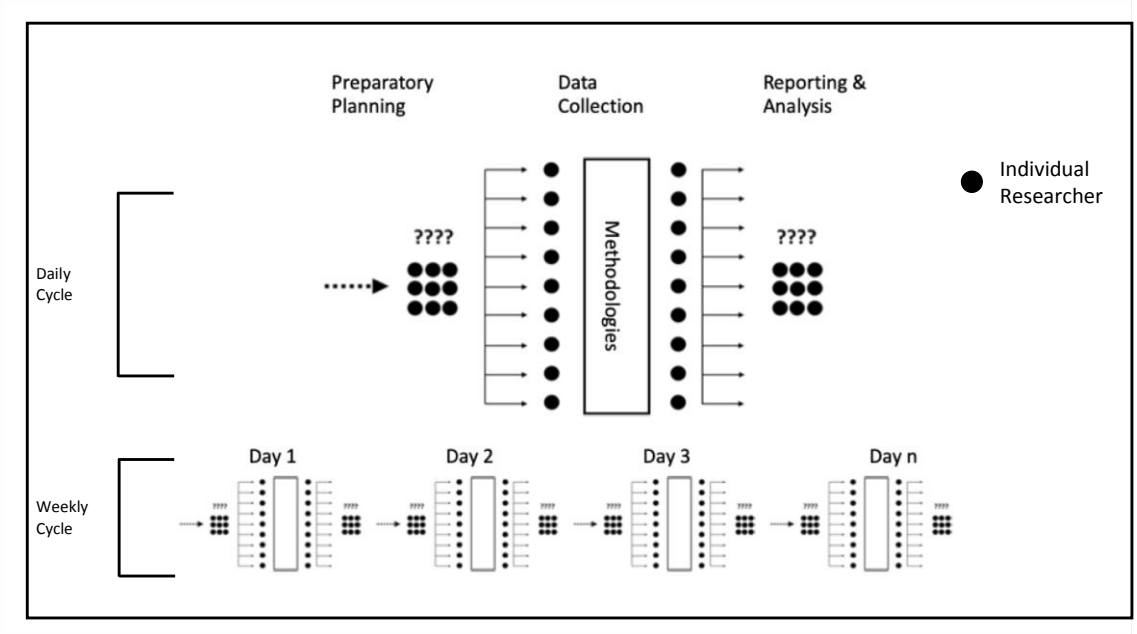
2. Field Research Cycle

A research project team will usually consist of 4-8 lead researchers with a similar number of local research assistants/translators. The length of time required to complete the cycle described above will depend on the complexity of the challenge and the availability of resources. Typically, stages 1-4

can be completed in under a month of fieldwork, and usually in significantly less time than this (see e.g. Lambe et al. 2018, 2020b; Muhoza and Johnson 2018; Jürisoo et al. 2018)). The time required for the quantitative assessment (stage 5) will vary significantly dependent on the nature of the intervention. Discrete Choice Experiments are a comparatively low-cost and rapid testing strategy compared to more extensive experimental designs, such as Randomised Control Trials, and brings the advantage of providing informative results prior to programme implementation (Osborne et al., 2021, World Development, in review WD-19535).

During qualitative fieldwork – stages 2-4 – the daily cycle of activities is organised in three distinct phases: i) a preparatory planning session, ii) a data collection session and iii) a reporting and analysis session (Figure 2).

Figure 2. Field Research Cycle



Preparatory planning session

At the start of each fieldwork day, the research team meets to review the primary questions of interest and consequent methods for that day and organise the composition of the individual research units for that day's data collection. This meeting will be informed by the findings of the previous day(s)' fieldwork, meaning that a range of different questions may be explored by different research units using different methods. Once the research team has an agreed approach for the day, the team divides into units and begins the fieldwork.

Data collection session

Data collection is conducted by smaller research units, typically composed of one lead researcher and one research assistant/translator, but could be larger for group-based activities. Individual research units should be encouraged to think and act independently and pursue unanticipated questions of interest that may present themselves during the course of their activities. This disaggregated approach not only increases the number of independent observations obtained - and in so doing allows for the speedy triangulation of findings - but also creates space for the inclusion of

unanticipated, but potentially highly significant insights into the wider research team's collective understanding of the context, practice or action under observation.

Reporting and analysis session

Reporting and analytical sessions are always conducted at the end of each day's fieldwork when the entire research team reconvenes to report back their findings. Each research unit begins by reporting back to the wider team the findings of their day's activities. Reporting back can be expressed in different formats depending on the context of the project. However, the reporting session always results in a shared board of collectively coded data, comprised on the findings of all research units. In addition, individual research teams always record data from each field activity, so that any analysis of data can always be traced to the raw data source.

Once the daily findings have been reported and recorded, a process of immediate analysis is engaged in as a collective group. During these discussions, multiple observations of similar actions or characteristics of the context are grouped together, and over a number of days a detailed mapping of the context under examination will be obtained. It is also during these discussions that differences in observations are explored and, if deemed pertinent, time and resources are set aside to further explore such inconsistencies during subsequent fieldwork days. As different aspects of the context become consolidated, the focus of the research project will begin to shift to new areas of investigation and stages in the process, which will then feed into the direction and agenda for the subsequent day's fieldwork preparatory planning session.

3. Discrete Choice Experiments

Discrete choice experiments are a quantitative method to elicit potential users' preferences over design elements of a good, service or programme (Mangham et al., 2009). In a face-to-face questionnaire setting, potential users or targeted beneficiaries (hereafter called 'actors') are repeatedly presented with a set of hypothetical alternatives of a good, service or programme (hereafter called 'intervention'), and asked to indicate which they would prefer to purchase or participate in (Greiner et al., 2014; Raes et al., 2017; Vorlaufer et al., 2017). Based on utility theory (Brett Hauber et al., 2016; McFadden, 1974), potential actors' preferences are assumed to be determined by the design features that define and distinguish interventions. Hence, in a DCE, each intervention alternative is described by a list of attributes. The attributes take on different levels across the alternatives, with varying combinations between the attributes (Kløjgaard et al., 2012). Through the experimental design of alternatives and sets of alternatives within which different designs are compared (hereafter referred to as 'choice sets'), statistical inference can be drawn about the relative importance of different attributes and levels for future users' preferences (Brett Hauber et al., 2016; Mangham et al., 2009). It is assumed that participants' stated preferences indicate their real-world willingness to pay, participate, or accept (Johnston et al., 2017).

DCEs are a particularly useful methodology to complement Service Design for three reasons. First, they allow to upscale and leverage in-depth insights from the participation of comparatively few potential users during Service Design fieldwork to the wider community level. DCEs can be designed to validate insights and compare the potential of different ideas for programme design elements resulting from qualitative Service Design. Using typical household survey strategies, they can capture the perspectives from a representative sample of potential users. Second, DCEs are compatible with

Service Design's core values and guiding principles. As DCEs build on hypothetical scenarios, their content is adaptable to local contexts and other qualitative Service Design results (Coast et al., 2012). Targeted at understanding participants' individual preferences (e.g. compared to cost and benefit analyses), targeted actors are set at the centre of investigation. Through collecting additional information on participant characteristics, attention can be paid to heterogeneity and potential differences in preferences across actors and actor archetypes (Johnston et al., 2017). Additionally, DCEs can incorporate engaging visual material to illustrate the alternative scenarios (Veldwijk et al., 2015). Third, DCEs appear particularly suitable as an experimentation in early rounds of iteration as part of Service Design, as they can provide ex-ante insights, before any service implementation has to take place (Johnston et al., 2017). Relative to other experimentation, such as Randomised Control Trials, they are also low cost and quick to implement.

The design of DCEs is highly decisive in whether valuable, valid and reliable information can be inferred (Johnston et al., 2017; Kløjgaard et al., 2012; Mangham et al., 2009). It involves the two steps of selecting attributes and levels; and combining levels and alternatives into choice sets.

Attributes describe each alternative and thus determine the explanatory variables for participants' choices that can be analysed through a DCE (Brett Hauber et al., 2016). They should be chosen carefully, with a set of criteria in mind: The scenarios presented in a DCE should most closely match real-life conditions, and be correctly and identically understood by all participants (Mangham et al., 2009; Abiiro et al., 2014). Their descriptions need to be maximally complete, leaving no gaps for individual interpretation to avoid omitted variable bias (Coast et al., 2012; Kløjgaard et al., 2012). Yet, at the same time, the number of attributes is limited by participants' cognitive capacity to take into account all alternating attributes (DeShazo & Fermo, 2002). Lastly, there should be no conceptual overlap between attributes to avoid multicollinearity (Mangham et al., 2009). These considerations have led to the established best practice of selecting and defining attributes based on combining a thorough (systematic) literature review with prior in-depth qualitative fieldwork (Abiiro et al., 2014; Mangham et al., 2009). Depending on the number of attributes and levels, there are typically several thousand possibilities to combine alternatives into choice sets. As it is unfeasible to present participants with a complete set of combinations, a sample of these need to be drawn. Hole (2016) provides a simplified explanation to the statistical procedure of selecting the most effective sample of choice sets to be included. For illustration, we describe how we applied this in our Ugandan case study below. DCEs are typically analysed using random effects models to account for the panel structure in the data through repeatedly presenting choice sets to the same participants (Johnston et al., 2017).

Methodological Application to Weather Index Insurance in eastern Uganda

Our fieldwork in Uganda was conducted between February and August 2018. The research team for the stages 1-4 consisted of 4 lead researchers and 4 research assistants/translators. All interviews and focus group discussions were held in a mixture of the local language (Lugisu) and English. Stages 2-4 were conducted within one week in April. Data collection for the DCE in stage 5 was conducted by 5 enumerators (4 of which participated as assistants/translators and one as lead researcher during stages 2-5) and required 2 weeks in July.

1. Problem co-definition

In our case study, the problem co-definition was rooted in a long engagement of researchers with research users and beneficiaries that suggested to us the importance of the Service Design-DCE research reported on here.

Experimental economists from the University of East Anglia (UEA) and partnership institutions have studied the risk-taking and risk-sharing habits of smallholder farmers in Bugisu in eastern Uganda since 2001.[5] Working with major insurance companies in the country, agricultural extensionists, farmers' organisations, seed companies and agro-dealers, research findings were translated into recommendations for risk protection measures that would encourage agricultural investment, increase the productivity of farms, and lead to higher incomes and poverty reduction (Balungira et al., 2016; McSherry, 2017). The main recommendation was to bundle Weather Index Insurance with authenticated agricultural inputs and credit, as well as to offer this to established risk-sharing groups, in particular village savings and loans associations (VSLAs) (Verschoor et al., 2016).

However, UEA's economists involved in the research were not confident in this recommendation. It was inferred from research findings obtained in lab-in-the-field experiments and therefore based on behaviour observed in stylised settings, in which hypotheses are tested about particular factors in isolation by keeping all other relevant factors at bay that determine behaviour in real life. In complex settings, these other factors interplay with the factors tested, which may undo or reinforce (as the case may be) the effect of the factors studied in the experiments. Moreover, it was silent about some of the other factors that previous studies of WII have found to be important in determining its desirability for purposes of risk protection.[6]

UEA's economists thus faced the challenge of understanding better (than their experiments had allowed them to) the complexity of factors behind risk protection that would interplay with the provision of WII in the context of farmers' livelihoods in Bugisu. In order to meet this challenge, they teamed up with Service Design experts from the Stockholm Environment Institute for implementing the study whose methods are described in this paper.

We started off our fieldwork in Bwikhonge, a sub-county of Bugisu, where UEA's work on risk and insurance had taken place, with a household survey, two meso-level focus group discussions (FGDs) with farmer representatives, and a key informant interview with the local council III chairperson. The household survey with randomly sampled household heads or their spouses (n=100) and one FGD (n=8 participants) confirmed that most families in Bwikhonge (above 90%) had been affected by both drought or dry spells and agricultural pests in the proceeding twelve months and perceived them as the most worrying agricultural risks. The key informant interview gave insight to existing formal and informal social institutions that support farmers, including amongst others external microcredit institutions. Learning about the challenges these external financial organisations had

[5] Research findings are reported in *inter alia* Humphrey and Verschoor (2004a,b), Harrison et al. (2010), D'Exelle and Verschoor (2015), Verschoor et al. (2016) and Verschoor and D'Exelle (2021).

[6] For instance, a large number of studies have found that illiquidity, i.e. not having sufficient cash at hand when the premium payment is due, is negatively associated with WII uptake (Giné et al., 2008; Cole et al., 2012, 2013; Hill et al., 2013; Akter et al., 2016; Casaburi and Willis, 2018; Belissa et al., 2019). As well as illiquidity, lack of trust in the provider and/or lack of trust in the product has frequently been found to impede WII uptake (Giné et al., 2008; Cole et al., 2012, 2013; Karlan et al., 2014), and the suggestion has been made to use trusted pay-out channels to increase uptake (Giné et al., 2008; Cole et al., 2013).

experienced in spurring trust and uptake amongst the local population highlighted that any financial service offered in the area would have to closely reflect local conditions in design and delivery. A repeated FGD (n=8 participants, 16 sessions) specifically aimed at proposing and discussing WII revealed an interest to learn about the mechanism, but also the need for close consideration of how it could be made affordable, attractive and trustworthy in the local context.

2. Actor-centred mapping

To better understand the key actors, i.e. Bwikhonge's smallholder farmers, and their decision-making landscape in regard to the focus of the problem and potential intervention we set off aiming to understand farmers' daily lives in their everyday context – including agricultural practices, livelihood strategies, roles within the household (particularly regarding income generation and financial decision making), market value chains, and social networks. A particular focus area that recurred in the actor-centred mapping was to understand how farmers experienced and perceived risks throughout the year. The actor-centred mapping was carried out using three methods; i) semi-structured interviews, ii) participatory observations and iii) focus group discussions (FGDs). These methods are further described below.

Following an interview frame covering the above mentioned themes, we conducted in-depth semi-structured interviews (n=12, sessions of 1-2h) with individual household heads and spouses. To allow the interviewee to lead the researchers through their everyday life and context, rather than that researchers asked leading questions about farmer activities, we used trigger material such as laying picture cards and drawings of everyday recurring items and activities that the interviewee could use to map their doing during a time cycle of a day, a month and a year. To triangulate these narrated insights and gain a contextualised and visual impression, we also conducted participant observations (n=20, sessions of 1-2h). Participant observations involved being shown around people's houses and farms whilst talking through daily practices and common experiences in situ. During FGDs (n=7, 4-6 participants and sessions of 1-2h), household heads and spouses – some of which were separated by gender to encourage open participation – mapped typical daily practices and yearly cycles of agricultural production, weather patterns and risks, as well as market value chains for different crops. In the same way as in interviews, trigger material was used in order to allow participants to lead researchers through the mapping of daily, monthly and yearly cycles (see supplementary material for illustrative photographs). The FGDs were facilitated by lead researchers asking probing questions along the key lines of enquiry.

During the actor-centred mapping we learnt that the majority of active social networks and market interaction (i.e. direct selling of agricultural produce and buying of inputs) is bound to the Bwikhonge sub-county level. Contacts to external actors are generally channeled through selected local actors (e.g. cotton agent, local traders/store owners) and only few farmers extend their regular interactions to the next closest town Mbale. We therefore decided to keep our focus at the threshold of the local level.

3. Experience-based problem diagnosis

As saturation was reached on contextual factors during the actor-centred mapping, we focused questions more around perceptions and behaviours relevant to WII. During further FGDs (n=7, 4-6 participants and sessions of 1-2h) we more thoroughly mapped patterns of risk occurrence and overlapped this with annual cycles of income and expenses, or glut and lean times. In individual

interviews (n=8 and sessions of 1-2h), we mapped individual households' risk response journeys by asking about their coping strategies the last time they were affected by a drought or pest. Researchers asked questions like; what did you do first when exposed to a drought/pest? What did you do next? What did you do last?

Drawing together the insights from the different research teams in reporting and analysis sessions (as described in the method details section 2 above), we started to loosely observe a pattern in different households' risk response mechanisms. To support our forming of hypotheses, we moved to conducting shorter targeted interviews (n=23, sessions of 0,5h), which, besides mapping risk responses, captured households' agricultural and economic diversification, formal institutional, and informal social networks. For this, we developed a one-page template to be filled in during each interview (see supplementary material for an example). This allowed to compare and roughly categorise interviewed farmers by their risk coping capacity based on the four areas found to enable and strengthen effective risk responses (i.e. agricultural and economic diversification, and formal institutional and informal social networks). This exercise reinforced the importance of challenging the notion of 'the community' as a homogenous unit by recognising the inequalities in capabilities and power within the community.

A pattern emerged and allowed to tentatively frame three archetypes in relation to farmers' risk coping capacity. For illustration purposes, we named the three archetypes by the locally common names 'Andrew', 'Betty' and 'Charles' (see supplementary material for an illustration of the three archetypes).

- 'Andrews', own up to ten acres of land and six cows, grow a variety of cash crops, run a store and local brew business, as well as run and participate in several savings groups, and count with several friends and family inside and beyond the community. Consequently, they have an array of risk response options.
- 'Betties' in contrast are the least resilient to agricultural shocks, with very limited options for diversification. 'Betties' own very little land, no livestock, earn some cash income through casual labour, yet insufficient to participate in savings groups, and count with limited social support from friends and family.
- 'Charleses' in turn count with medium risk coping capacity. They own two to three acres of land, grow a diversity of subsistence and cash crops, hold around two goats and a cow, and enjoy close integration in the community as well as participation in a variety of community savings groups.

We found that different archetypes build on different social support mechanisms in times of hardship. To better understand the role of these different support mechanisms, we conducted key informant semi-structured interviews (n=5, sessions of 1-2h) with selected actors along market value chains that had been mentioned as trusted sources of financial support and advice, such as a cotton agent (broker between the community and cotton development organisation) and a store owner. We also conducted additional FGDs (n=4, 4-6 participants, sessions of 1-2h) with members of savings groups, such as VSLAs, burial groups and merry-go-rounds, to understand their functioning, as well as with non-members to understand their reasons not to participate.

4. Rapid Prototyping

Building on the insights from the three first steps of the methodological framework applied in this paper, we gained insights on the current risk perceptions, behaviours and coping capacities that WII

would be placed into and should build on for these to be useful for farmers. Thus, through manual coding and analysis of the interviews, FGDs and participatory observations in the actor-centred mapping and the additional interviews and FGDs conducted to perform experience-based problem diagnosis, the research team identified four potential insurance designs to propose to farmers as prototypes of WII interventions. An important finding at this stage was that it appeared important to acknowledge the different archetypes' needs and capabilities in the spectrum of suggestions in order for interventions to be useful more broadly in the community and not only or specifically for one type of farmer.

The four prototypes were simple in their design and were, at this stage, used to spur discussion with the farmers that would help elaborating more detailed design elements in later steps of the design of interventions.

All four prototypes built on the general logic of insurance providing compensation payouts in the occurrence of a shock, whilst the first three worked through an external financial agent. Under the first prototype, large monetary premiums would allow for large risk coverage and large monetary payouts. The second is a smaller version of the first with small monetary premiums and equivalently small risk coverage and monetary payouts. The third prototype was of medium size, with moderate monetary premiums, and payouts in form of agricultural inputs, such as seed and pesticides. The fourth prototype built on the local system of risk sharing through savings groups aimed at allowing more cash constraint households to participate through small weekly contributions compared to a one-off premium. Community-based insurance groups would save together throughout the year, and in the event of a weather shock would jointly invest in agricultural inputs to recover for the next season.

To terminate the qualitative fieldwork phase we organised a validation workshop to which we invited 40 representatives from local community organisations, including VSLAs and farmer groups, but also 'ordinary' farmers, and representatives from different local churches, mosques and schools, as well as local government. We ensured close to equal representation of female and male participants. Representatives from locally operating banks and NGOs were also invited, however, did not attend the workshop. The workshop consisted of two parts, starting with the presentation and validation of research findings in the morning, followed by a discussion on the viability of the different prototypes in the afternoon. The participants were separated into four working groups, in which the findings from the stages 2-4 were presented and discussed. Fieldwork assistants facilitated the discussions in the local language and took notes throughout. Visual aids, such as illustrative posters with paintings and picture cards made the process interactive. When information was added or changes suggested, these were noted down and added to the visual material used in the workshop. After each stage was presented and discussed in working groups, feedback from each group was reported in plenary. Particular emphasis was put on the annual cycle of agricultural practices, risks, income flows and times of hardship, the archetype distinctions and how the prototypes could or not meet the different archetypes' needs.

5. Design and testing

In line with the methodological combination proposed in this paper and Osborne et al. (2021, World Development, in review WD-19535), we chose to conduct a Discrete Choice Experiment in this case study to test and further build on the design emerging from the prototyping and the qualitative insights from the stages 1-4.

DCE Design

To design the DCE on WII for Bwikhonge, we started with a literature review with the aim to identify all important features defining a WII service. We compiled these in a list and systematically added to each element relevant observations from the local context in Bwikhonge by reviewing fieldwork notes and reports from the prior Service Design stages (see supplementary material). We then selected 5 attributes which most strongly captured areas of sensitivity highlighted in the literature and could provide clarity on open questions that had emerged through or remained after the prior Service Design fieldwork and analysis. These became the attributes distinguishing one alternative from the other in the DCE. The rich contextual knowledge gained through the prior qualitative fieldwork guided the general framing of the DCE (table 2).

Farmers were asked to imagine being offered an insurance service by an external company that provides payouts in the occurrence of insufficient rainfall (i.e. drought and dry spells) for the cultivation of maize during the first annual season. The price for the insurance was left unspecified, but to be imagined as generally affordable and reasonable. Affordability in a context of limited liquidity remained an important concern among the participants of the verification workshop. Rather than including a price at artificial and potentially unrealistic levels, we introduced two viable instruments as alternating attributes in the DCE that could help improve affordability. The first attribute offered reducing the cost by covering single growth phases rather than the whole season (Hazell & Hess 2010). From stage 2 of the Service Design we know that the growth phases of maize sensitive to sufficient rainfall are 'germination, 'plant growth', and 'flowering'. The second attribute aimed at easing liquidity constraints by enabling premium payment at times of increased cash availability (Mcintosh et al., 2013). From mapping annual cycles of lean and glut times in stage 3 we learnt that cash is relatively abundant in August-September (after the main maize harvest) and November-December (after the harvest of the second season). The natural period for purchasing WII just before the main growing season (January-February) in contrast is characterised by financial pressures for several simultaneously necessary expenses (e.g. for school fees, agricultural inputs and/or renting in land). These three periods were thus included as different options for the timing of premium payments.

Next to affordability, lack of trust in the provider and/or product has been found a frequent barrier to WII uptake (Giné et al., 2008; Cole et al., 2012, 2013; Karlan et al., 2014). By mapping market value chains, we identified local actors and payment channels that seemed worth investigating as trusted pay-out channels to potentially increase the uptake of WII (Giné et al., 2008; Cole et al., 2013). The levels included for the attribute 'pay-out delivery channel' were a 'local agent', an 'agro-input shop' and 'mobile money'.

To help address also non-weather-related risks, 'bundling' – combining the insurance with the purchase of other agricultural inputs or services – has been discussed a strategy to increase the value of WII (Awondo et al., 2017; Ward & Makhija, 2018). In Bwikhonge, crop pests and diseases and purchasing counterfeit inputs are the next most prominent risks after droughts and dry spells. To alleviate these, we suggested providing WII in combination with 'certified seed' and 'pesticide'. Additionally, we investigated whether adding an 'agro-input loan' to the bundle would increase the WII's attractiveness.

Finally, Trærup (2012), De Janvry et al. (2014) and Mobarak and Rosenzweig (2012, 2013) propose offering WII to savings groups rather than individuals. This, to support savings groups when

accumulated funds are insufficient to provide loans to all its members in times of common shocks. In our preliminary household survey, 61 percent of respondents reported at least one household member to participate in a VSLA, more than for any other social institution. At the same time, however, the qualitative fieldwork revealed considerable mistrust in the functioning of VSLAs, e.g. having heard of incidences where money went missing. To identify the demand for group insurances, we specified two levels for the attribute 'policy holder' – 'individual' and 'savings group'.

Table 2. DCE attributes and levels based on Service Design observations

Phase 1: Service Design	**Phase 2: Discrete Choice Experiment**	
Observation	**Defined Attribute**	**Defined Level**
A. Farming & Risk Cycle	Coverage Period	Whole Season
		Germination
		Plant Growth
		Flowering
B. Agricultural Financing and Income Cycle	Premium Payment Period	January-February
		August-September
		November-December
C. Trust in Actors/Institutions	Payout Channel	Local Agent
		Agro-input Shop
		Mobile Money
D. Farming & Risk Cycle	Bundling	No Bundling
		Certified Seeds
		Certified Seeds & Pesticides
		Certified Seeds, Pesticides & Loans
E. Risk Coping Strategies and Social Institutions	Insured Unit	Individual Insurance
		Savings Group Insurance

The defined attributes and levels can be combined into $((4 \times 3 \times 3 \times 2 \times 4) \times (4 \times 3 \times 3 \times 2 \times 4 - 1))/2 = 41{,}328$ possible choice sets, an unfeasible number to present each participant with. Instead, as is common practice, we obtained an optimal fractional factorial design using the user-written STATA-command dcreate (Hole, 2016; appendix 6). An optimal fractional factorial design is a sample of choice sets that is maximally orthogonal, i.e. with statistically independent attribute levels, balanced, i.e. with each level occurring equally often, and utility balanced, i.e. with no objectively

superior alternative, with minimal overlap of levels within choice sets (Mangham et al., 2009). Dcreate utilises the Fedorov-algorithm to identify the design with maximal D-efficiency, an inverse function of the covariance-matrix of the attributes' parameter estimates (Hole, 2016). The calculation is based on parameter priors equal to zero, as is common practice in the absence of legitimate priors from the literature (Johnston et al., 2017).

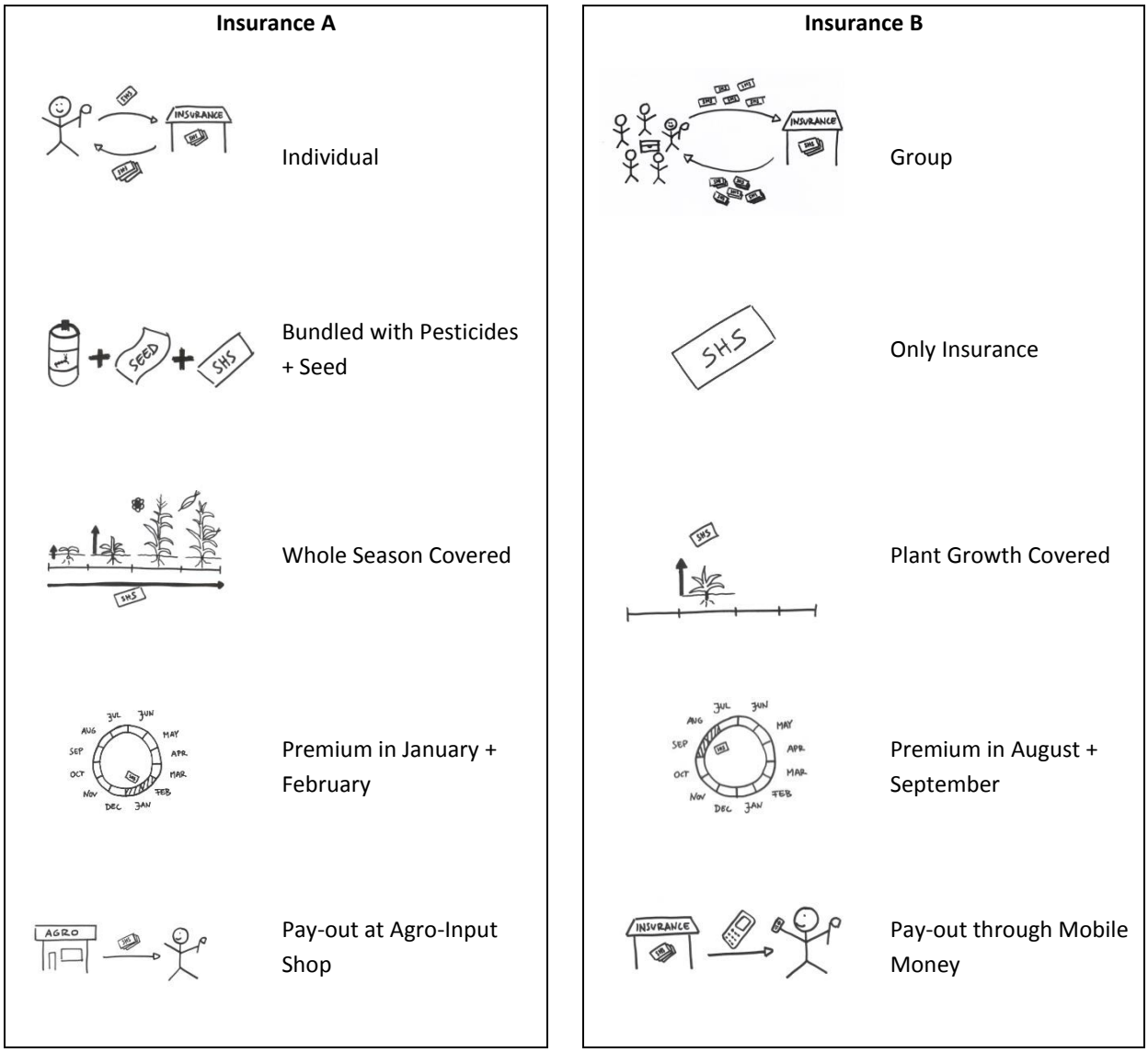
In addition to the DCE, we asked each participant a number of generic survey questions. Importantly, we added questions in relation to the archetypes identified during stage 3. On the one side, we collected data on people's agricultural and economic diversity (e.g. land ownership, cultivated crops and number of owned livestock, and the household's involvement in non-agricultural economic activities), as well as membership in community organisations and informal social networks. On the other side, we showed participants three cards visually illustrating the three archetypes and their distinctive characteristics – 'Andrew', 'Betty' and 'Charles' – and asked them to indicate which archetype they would allocate themselves to (see supplementary material).

DCE data collection

Data collection for the DCE occurred in the same 10 villages in Bwikhonge sub-county that participated in previous fieldwork. For each selected village, local mobilisers compiled a sampling frame of all households and their heads and spouses. A simple random sample of 22 households per village was selected of which 2 served as replacement for non-response. With equal inclusion probability, either the household head or spouse was invited to participate. During stage 2 we learnt that both household heads and spouses take agriculture-related decisions and are equally aware of agricultural hazards. When the sampled household representative was unavailable, their spouse was interviewed instead. The final sample consists of 196 respondents and 4 choice set non-responses. This sample size falls within the range of rule of thumb DCE sample size requirements (de Bekker-Grob et al., 2015).

Given the relatively complex concept of WII, we ran a workshop for each participant to take part in before participating in the DCE. The workshop was designed with sensitivity to different levels of literacy and education amongst the participants using visualisations and locally understandable terms to describe the concept of WII (see supplementary material for the workshop outline). Qualitative feedback questions during the workshop ensured each participant's understanding. The DCE was administered in local language using laminated choice set cards with illustrations for each attribute (Figure. 3). Each respondent was presented with 12 choice sets of two alternatives each, followed by the more generic questionnaire. Data was collected following a script (see supplementary material) and entered into tablets.

Figure 3. Example Choice Set



DCE analysis

For the analysis of the choice data we proceeded as follows. The choice data set can be thought of as having a panel structure: it contains the sets of 12 responses each, i.e. 12 choices between two insurance options, of 196 respondents. To account for unobserved heterogeneity at the respondent level, we estimated a random effects probit model. The dependent variable takes the value 1 if an option is chosen, 0 if it is not. We estimated two models, one estimating the unconditional effect of insurance being offered to savings groups (model 1), the other with that effect conditioned on land ownership and trust in the savings group (model 2) (see Osborne et al., 2021, World Development, in review WD-19535). The rationale for conditioning on these factors is straightforward. Land ownership proxies for local influence: more influential members of the VSLA should be expected to be able to draw on the VSLA's reserves before others and would therefore benefit more than others when WII fails to pay out when agricultural losses are made. Trust in the VSLA proxies for the confidence members have that when WII fails to pay out, the VSLA will support them. Both models control for age, sex, level of education, and land owned.

6. Scaling up

After completion of the Service Design and DCE phases the data and evidence established is evaluated in the round. At this point it is important to explore and analyze what each approach has been able to contribute and what collective recommendations can be made, based on this process of triangulation, to inform the design of subsequent intervention models. As described in Osborne et al. (2021, World Development, in review WD-19535), the study's combined Service Design and DCE findings led UEA economists to drop their recommendation to provide WII through VSLAs, while advocating bundling WII with certified inputs and credit. The recommendation was adopted by the Ugandan insurance companies united in the Agriculture Insurance Consortium, which industry experts recognise had a considerable impact on the success of its nation-wide WII scheme. The contribution of UEA economists' recommendations to the provision of bundled WII in Uganda is described in UKRI (2020). Work is ongoing on risk-protection schemes that do justice to the heterogeneity of risk coping that the Service Design research helped to uncover.

Conclusion

Whilst both Service Design and DCEs can operate as an independent body of work, and each has its own strengths and limitations, as a combined approach, it is cheap, quick and reduces the risk of doing harm whilst providing an opportunity to deliver well-designed projects at scale. Our experience of combining both approaches in the application to WII in eastern Uganda demonstrated their complementarity: DCEs can help test and validate the fine-grained locally informed insights of Service Design, whilst Service Design provides the rich contextual knowledge required for an effective and robust experimental design. As with all new methodological innovations, we would be very happy to see what lessons may be learnt from its application in new areas and to new research questions, nonetheless we are confident that it can provide a positive contribution to designing development interventions in complex and challenging settings.

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary Material

Image 1. Meso-level Focus Group Discussion (FGD) – Stage 1

Image 2. Participant Observation (1) – Stage 2

Image 3. Participant Observation (2) – Stage 2

Image 4. Micro-level FGD (Laying daily cycles using picture cards) – Stage 2

Image 5. Micro-level FGD (Mapping the maize value chain) – Stage 2

Image 6. Seasonal calendar (Annual cycle of weather patterns/risks, agricultural practices and lean and glut times) – Stage 3

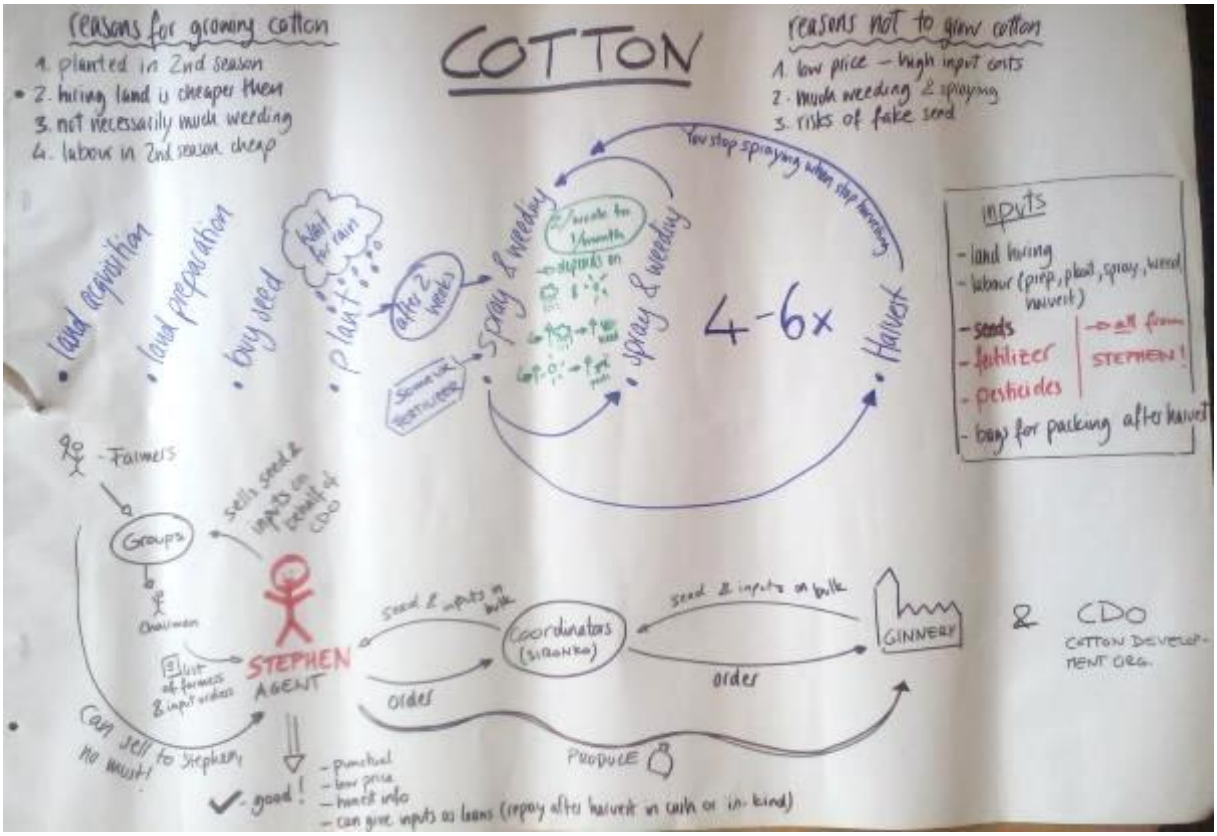

Image 7. Value chain map with important actors – Stage 3

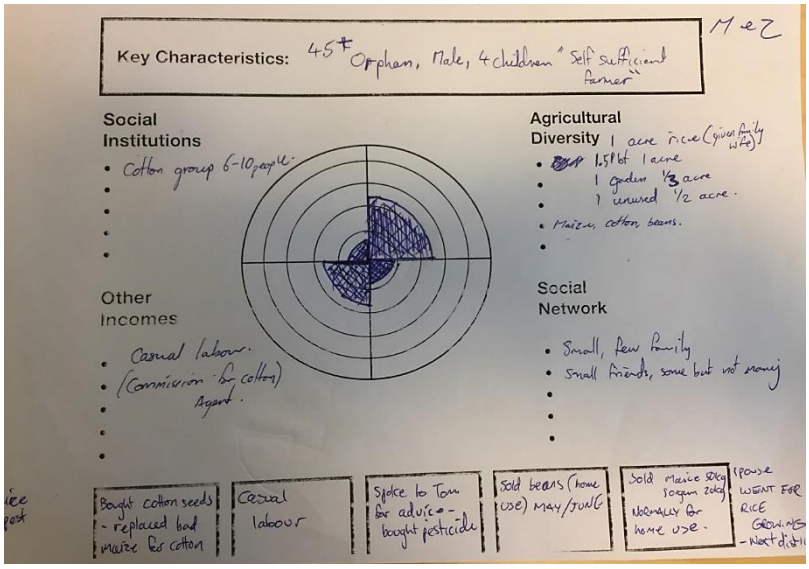

Image 8. Interview template for targeted interviews (mapping risk coping capacity in terms of agricultural diversity, non-agricultural income, social networks and institutions in the circle, as well as risk response journeys in the boxes below) – Stage 3

Image 9. Validation workshop (1) – Stage 5

Image 10. Validation workshop (2) (Presentation of corrections to the annual cycle) – Stage 5

Image 11. Validation Workshop (3) (Simple representation of archetypes on posters) – Stage 5

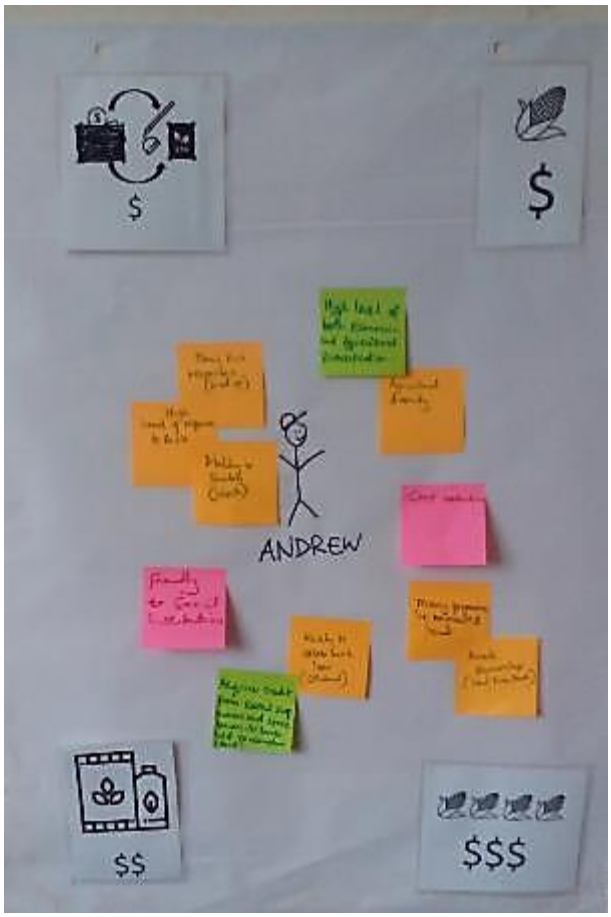

Image 12. Validation Workshop (4) (Output from discussion on the viability of the different prototypes for 'Andrews') – Stage 5

Table 1. DCE design: Literature review and relevant primary data for attribute and level selection – Stage 6

Attributes	Levels	Observations made by WII authors	Relevant observations from field work
Risk coverage	Drought/flooding/dry spells/strong winds/pests and diseases/counterfeit inputs/theft/limited market/price fluctuations	WII should be offered in areas where weather brings the highest risk, otherwise, basis risk is higher (2, 16, 25) and the product loses attractiveness (13). Open for discussion, whether low impact, high frequency (6) or high impact, low frequency risk should be covered (14) Weather does not provide the only risk to agriculture. Can also other risks be included in the insurance schemes? (6) Size of the insured risk increases uptake, similarly, higher basis risk decreases uptake. (12)	96% of respondents to the *household survey* mentioned drought as an agricultural risks they face as a household, with 54% finding it the most worrying risk. Only 54% mentioned flooding and 21% unfitting rainfall patterns, whilst 97% mentioned pests and diseases. The high awareness of the risk of pests and diseases may be linked to a recency bias, as an army worm attacked maize for the first time in many years in 2017.
Crop Coverage	One single crop/multiple crops/ crop unrelated – Subsistence crops/cash crops – Crops grown most/providing most income/consuming most investment – Crops most prone to risk	For index composition, only insuring single crops is most easily feasible. Yet, with increasing prevalence of mixed cropping systems, this may not be as meaningful to insurance holders (3). In order not to discourage diversification, multiple crops should be covered (6). The crops bringing most income should be targeted (6).	99% of respondents to the *survey* grow maize and 78% state it to be their first most important crop, 16% regard it as the second most important, 3% as the third most important. Assuming, the drought happens in May/June, then mostly first season crops are affected: maize, for few farmers cotton and sunflower. The rice, tomatoes and cabbage grown during this season is planted in the wetlands, were the drought does not hit as severely (*stakeholder workshop reflections by facilitators*). As the income from one crop often finances the investment into growing the next, crops are not grown in isolation and should not be regarded as such when being insured. (*SD analysis*)

Contract Phases	Germination/plant growth/flowering/ maturation/whole season	Often WII covers the whole season, whilst there are specific times that are most prone to crop damage through the weather induced risk. Concentrating on a specific time can make the premium cheaper (2). The phase facing the most severe risk should be insured against (14). Giving the farmer the choice, which phase to protect may increase attractiveness (24).	The first season starts in January/February and ends in July/August. The second season starts in August and ends in November/December. Maize is only grown during the first season. Drought is reported to occur mostly during May/June, within which the exact occurrence varies. This is typically during the flowering stage of maize. (*SD POs and PIs*, *stakeholder workshop*)
Index composition	Different technical variables taken into account	The index should capture multidimensional data most closely reflecting the actual losses farmers occur in order to reduce basis risk (1, 7, 8, 12, 26). This may include rainfall data from satellite/weather stations (1), accumulative rainfall over time /number of dry days (17), soil water holding capacity (26) etc..	
Premium level	Different price levels dependent on technical calculations and subsidies	Premium levels matter for insurance demand and affordability (3, 9, 15, 16, 18). Due to affordability constraints, there is the expectation of lower income households relying on low premium rates for WII uptake (12). Studies find that WTP is generally below actuarially fair prices (22, 23). Some evidence suggests that premium levels should not be fully	Andrews (i.e. farmers with large risk coping capacities) can afford high premiums and would be willing to pay as 1. they have enough income for affording it and 2. may be interested in a high pay-out, given that they invest a lot. Betties (i.e. farmers with very low risk coping capacities) could only afford very small levels, relying on little money received though casual labour. (*SD analysis and stakeholder workshop*)

		subsidised, but rather shared for long-term development of WII (4).	
Loading of the insurance	Different ratio levels dependent on technical calculations and subsidies	(ratio of premium and expected pay-out) Higher loading rate is expected to lead to higher uptake (9).	
Premium payment mode	Cash/mobile money/ labour/produce etc.	Paying for premiums through produce or labour may enable farmers with little cash availability to take part in the insurance scheme (21).	Betties rely on cash income from casual labour. Currently, they do not have enough money to join savings/burial groups. (*SD POs and PIs and stakeholder workshop*) Yet, generally, there seems to be an active commercial market for produce and labour, so that such goods and services can relatively easily be translated into monetary terms (almost constant farm labour demand, proximity of produce stores who buy and sell small and big quantities of produce throughout the year and availability of agro-input dealers selling inputs). (*SD key informant interviews and field workshops*)
Pay-out mode	Cash/mobile money/food/inputs etc.	Farmers farming on a commercial basis may prefer monetary outcomes. Those relying on their yield for consumption may be in need of pay-outs in kind (food or inputs for the next season) (3).	Andrews would be interested in monetary pay-outs, in order to cover lost investments. Charleses (i.e. farmers with medium risk coping capacities) may be interested in inputs for the next season, however may appreciate to choose by themselves what to use the pay-out for, i.e. would prefer a pay-out in monetary terms. Betties may be most interested in food for consumption, as this is what their original loss occurred in. Betties grow for food security. If the yield fails, this means food is missing. (*SD POs and PIs and stakeholder workshop*) Yet, generally, there seems to be an active commercial market for produce/food and inputs, so that such goods can relatively easily be bought, when a monetary pay-out is received (proximity of produce stores who sell small and big quantities of produce throughout the year and availability of agro-input dealers selling inputs). (*SD key informant interviews and field workshops*)
Delivery channel (for premium payments	Financial institution/ agro-input/produce trader/money lenders/ informal risk	Often uptake is limited by lacking trust in that policy holders indeed will receive pay-outs they are entitled to (4, 5, 15). How trust in the insurance product can be generated is crucial especially	Farmers in Bwikhonge seem used to working through agents and being organised in groups (there is a cotton agent, agents assisting produce stores or traders, agents of NGOs/banks, savings/burial/farmers groups etc.) (*SD PI and Field Workshops, key informant interviews, FGDs on market value chains, crop decision making and savings*

and pay-outs)	sharing groups/co-operatives/farmers groups/local agent etc.	when targeted to risk averse farmers (6, 9) in contexts lacking a functioning legal framework (2) and where insurance providers have built bad reputations (6). Trust in the marketing agents could increase trust in the product and thus demand (15, 25). Familiarity with the vendor increases uptake (12) The delivery channel may be organised in such a way, that an agent in agreement with farmers buys the insurance him/herself and in event of the risk distributes the pay-out amongst the farmers, who in compensation pay through labour or produce at the end of the season (26). Creating partnerships between insurance providers and providers of complimentary services can facilitate the success of the insurance initiative (1, 13).	*groups.*) Particularly about the cotton agent (passing over inputs (seed, pesticides and fertiliser) and payments between farmers and the Ginneries and Cotton Export Association/Cotton Development Organisation) many people express trust and positive relations. (*SD field workshops, FGD on crop value chains and key informant interviews*) ACE is an active co-operative in the area, yet not the majority of farmers is involved in it. (*FGD with savings groups*)
Timing of Premium Payments and Pay-outs	One-off/in instalments – Fixed/flexible – At the beginning of the season/at harvest.	Insurance often paid for at the beginning of the season. Yet, this is the time, many other investments are being made and insurance may not easily compete with necessary goods such as seed. Premium payments should be made at times of liquidity availability (6). Regular small pay-outs may increase the perceived value of the insurance, rather than long periods of the insurance company's absence (6).	See yearly cycle income and pressure points: Jan-March: Outflows due to land preparation and agricultural investments for the first season. Cash inflow opportunities through high labour demand. April: Hardest time, as stored food is coming to an end. No available harvest and little labour demand, so there is no income. May-July: First harvest for consumption, no cash inflow yet. Labour demand for harvest. Aug-Sep: Selling of first seasons harvest brings first major inflows of the year. Outflow demand for paying debts, school fees and next seasons investment. Nov-Dec: Money available from harvest of second seasons cash crops. Outflow demand for school fees and Christmas. (*SD field workshops and stakeholder workshop*)

			Most savings groups end their cycle and distribute their savings in November-February. (*FGD with savings groups*) Andrews and Charlses plan their agricultural investments in November to February for the whole year. (*FGD on crop decision making*)
Policy Holder Unit	Individual contract/group contract	Complementarity between informal risk sharing and index insurance should be promoted (11, 24). Working with informal risk-sharing groups can be a successful strategy for this, possibly also enhancing trust into the product (11, 24). Dichotomous WTP study reveals that insurance offered to groups seems to increase demand among individuals who would presumably face higher transaction costs in accessing insurance (women and the less educated), provided that trust in the other members of the group is high enough (25). Deserves special attention due to its possible contribution to reducing basis risk (10, 11, 18, 19). Portfolio sales are less expensive than retail index insurance sold to individuals through reduction in transaction costs (10).	61% of survey respondents' households are part of at least one savings group, and the same state to turn to it for financial help. (*household survey*) Yet, respondents reported the problem of insufficient money available for giving a loan to each member applying for one, particularly at times all members are occurring financial hardship. (*SD PIs and FGD with savings groups*) Savings groups generally have a size of 30-50 members, and collect regular savings ranging from 500-10.000/week. A certain part of the population seems unable to be part of savings groups, as they cannot afford membership fees and regular savings. (*SD PIs and FGD with savings groups*) Amongst some farmers there seems to be certain mistrust into savings groups, some reporting of negative experiences having lost their savings through mismanagement or theft. (*SD PIs*)
Bundling	Inputs/loans/market access/agricultural training/weather forecast etc.	Case studies (ACRE and India's National Agricultural Insurance Scheme) show that bundling increases the appeal of insurance (1, 13). The bundling model should include services that directly translate into increased income (e.g. market access) (14). Different bundling options will appeal differently to different farmers (e.g.	84% of respondents used improved maize seeds in 2017. Only 29% of respondents used fertiliser for maize during 2017, whilst 64% used pesticides. 26% reported to have used a loan for growing maize in the first season of 2017. (*Household survey*) Andrews can easily purchase improved seeds, fertiliser, pesticides and other inputs from their own income, but can also easily access financial loans. Betties cannot afford improved seeds, pesticides, or fertiliser and have no access to

		credit to commercial farmers, but not subsistence farmers) (3). Bundling with products or services that reduce other agricultural risks can reduce basis risk (20, 21, 26).	financial loans. People seem used to making orders in form of lists for purchasing inputs. (Andrews report to form 'delivery groups', delegating one farmer to buy inputs from an input-dealer in Mbale, the cotton agent's work is facilitated through farmers groups making orders, friendship groups are often based on the benefitting member to 'order' a number of items). (*SD PIs, field workshops on crop value chains and FGD on crop decision making*) Some people reported difficulties of the cotton ginneries failing to deliver inputs on time. (*Key informant interview*)

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Code 1. STATA code for D-optimal design – Stage 6

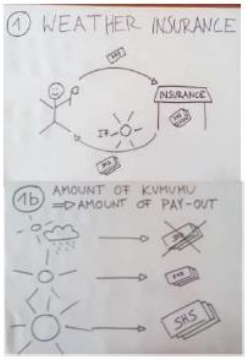
```
***
matrix levmat = 4,3,3,4,2
genfact, levels(levmat)
list, separator(4)
rename x1 risk_coverage
rename x2 premium_payment_timing
rename x3 payout_channel
rename x4 bundling
rename x5 insurance_unit
matrix b = 0,0,0,0,0,0,0,0,0,0
dcreate i.risk_coverage i.premium_payment_timing i.payout_channel i.bundling i.insurance_unit, nalt(2) nset(12) bmat(b)
list, separator(4) abbreviate(24)

***End of code***
```

Note: This code is based on the user-written STATA command dcreate (Hole, 2016).

Table 2. DCE Workshop Outline – Stage 6

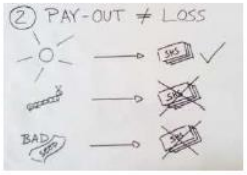
In this workshop, we would like to share with you some principles of a service called Weather Insurance in order to then find out from you, if and in which way it could be useful to you.

A. What is WII – the concept



Learning Objectives
1. General understanding of weather insurance against lack of enough rainfall/drought for growing of maize
   - Premium payment
   - Pay-out in case the risk happens
   - No pay-out in case the risk does not happen
   - The company has reliable tools of knowing the rainfall levels in the area
2. The amount of Pay-out is determined by the amount of lacking rainfall/sunshine

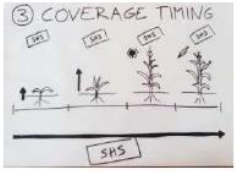
B. Pay-out =/= loss



Learning Objectives
1. Insurance against lack of enough rainfall; not against any case of a loss.
   - Not insured against other risks, e.g. pests and diseases/counterfeit seed.
2. Insurance based on rainfall data from the whole area, not for each single plot.
   - One farmer insured may have had less rainfall than another farmer from the same area, yet they receive the same pay-out.

➔ One's pay-out may be lower or higher than someone's loss.

C. Timing of coverage

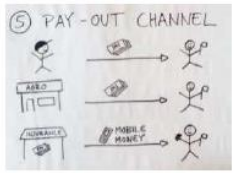


Learning Objectives
1. The insurance covers the lack of enough rainfall during a specific period.
   - The whole crop season
   - For specific parts of the season (i.e. ONLY during germination, plant growth, flowering, or maturing)
2. The shorter the time you are protected against, the lower the price of the premium.

D. Timing of premium payment

Learning Objective
1. The insurance company will ask you to pay for the insurance at a specific time in the year.

E. Pay-out delivery channel

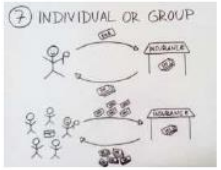


Learning Objectives
1. There can be different ways through which to receive the pay-outs:
   - Local agent of the company who receives the pay-outs in cash and distributes them to all insurance holders.
   - Local agro-input dealer, whom the insurance holders come to to collect their pay-out in cash.
   - The company transfers the pay-out directly to the insurance holders through mobile money.

F. Bundling

Learning Objectives
1. The insurance can be a stand-alone product or bundled with other products
   - Stand-alone
   - Bought together with certified seed (with any improved variety)
   - Bought together with certified seed and fertiliser
   - Bought together with certified seed, fertiliser and a loan from a financial institution.

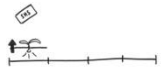
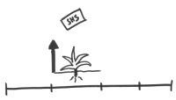
G. Individual vs. group insurance

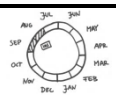
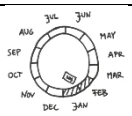
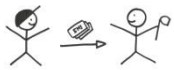
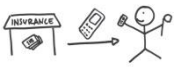
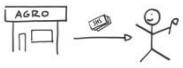


Learning Objectives
1. Insurance could be given in individual or group contracts.
   - Single farmer paying the premium herself, receiving the pay-out herself.
   - Every member of a (savings) group paying the premium. The group will then receive the pay-out together and decide how it shall be distributed (e.g. according to levels of loss or need).

Table 3. DCE script – Stage 6

Intro: Suppose a company is offering you a Weather Insurance for growing maize during the first season in reality. You are indeed interested, because they want to sell it to you at a premium you can afford and are happy to pay. They offer the insurance in various ways. I'm going to show you two cards that show you two ways in which weather insurance is offered. Could you tell me which you prefer?

1 a		*Under this arrangement, you pay for insurance as an individual, and if there is a drought, the insurance company pays you directly as an individual.*
1 b		*Under this arrangement, you pay for insurance as a member of a savings group, if you belong to one. Each member within the group pays for insurance through the group and if there is kumumu, the insurance company pays the money to the group (and not to you directly). The group then decides how the money should be shared among the members.*
2 a		*You only buy the insurance.* *(In case people ask: The insurance company sets different prices a farmer can pay for the insurance (premiums), and how much the company would pay them in case there was kumumu. It is up to the farmer to decide what premium they want to pay well knowing how much they would get from the insurance company in case there was kumumu.)*
2 b		*Under this arrangement, when you buy genuine maize seed, you also pay for insurance. You don't pay for insurance separately, as the cost of insurance is included in the price of maize seed.*
2 c		*Under this arrangement, when you buy pesticides ad genuine maize seed, you also pay for insurance. You don't pay for insurance separately, as the cost of insurance is included in the price of pesticides and maize seed.*
2 d		*Under this arrangement, you get a loan from the bank and with this loan; you can pay for pesticides and genuine maize seed. You don't pay for insurance separately as the cost of insurance is included in the loan. In case of kumumu, the bank can help you pay part of the loan, or all of it.*
3 a		*Under this arrangement, you pay insurance only for the germination stage of maize during the first season. Only if there is a drought, or the rain is not enough during the germination stage, the insurance will pay you. The money you pay for insurance for the germination stage is lower than if you were to pay for the whole season.*
3 b		*Under this arrangement, you pay insurance only for the stage when maize has started growing(khutiya). Only if there is drought, or the rain is not enough during the growth stage, the insurance will pay you. The money you pay for insurance for the growth stage is lower than if you were to pay for the whole season.*
3 c		*Under this arrangement, you pay insurance only for the flowering stage of maize during the first season. Only if there is drought, or the rain is not enough during the flowering stage, the insurance will pay you. The money you pay for insurance for the flowering stage is lower than if you were to pay for the whole season.*

3 d		*Under this arrangement, you pay insurance for all the stages of maize growth during the first season. That means you pay for germination, plant growth and flowering. Should there be a drought, or not enough rainfall at any of these stages during the season, the insurance company pays you. Because you are paying for the whole season, the price you pay is relatively higher.*
4 a		*Under this arrangement, the insurance company fixes August and September as the months within which you should pay for insurance. It is up to you to decide if you want to pay in August or September.*
4 b		*Under this arrangement, the insurance company fixes November and December as the months within which you can pay for insurance. It is up to you to decide if you want to pay in November or December.*
4 c		*Under this arrangement, the insurance company fixes January and February as the months within which you can pay for insurance. It is up to you to decide if you want to pay in January or February.*
5 a		*Under this arrangement, if there is a drought in Bwikhonge and the insurance company wants to pay you, they send the money to their agent who is from your community. This agent then delivers the money to you.*
5 b		*Under this arrangement, if there is a drought in Bwikhonge and the insurance company wants to pay you, they send the money directly to you using mobile money.*
5 c		*Under this arrangement, if there is a drought in Bwikhonge and the insurance company wants to pay you, they send the money to a dealer in agro-inputs who's located near you. You then have to pick the money from the shop of this agro-input dealer.*

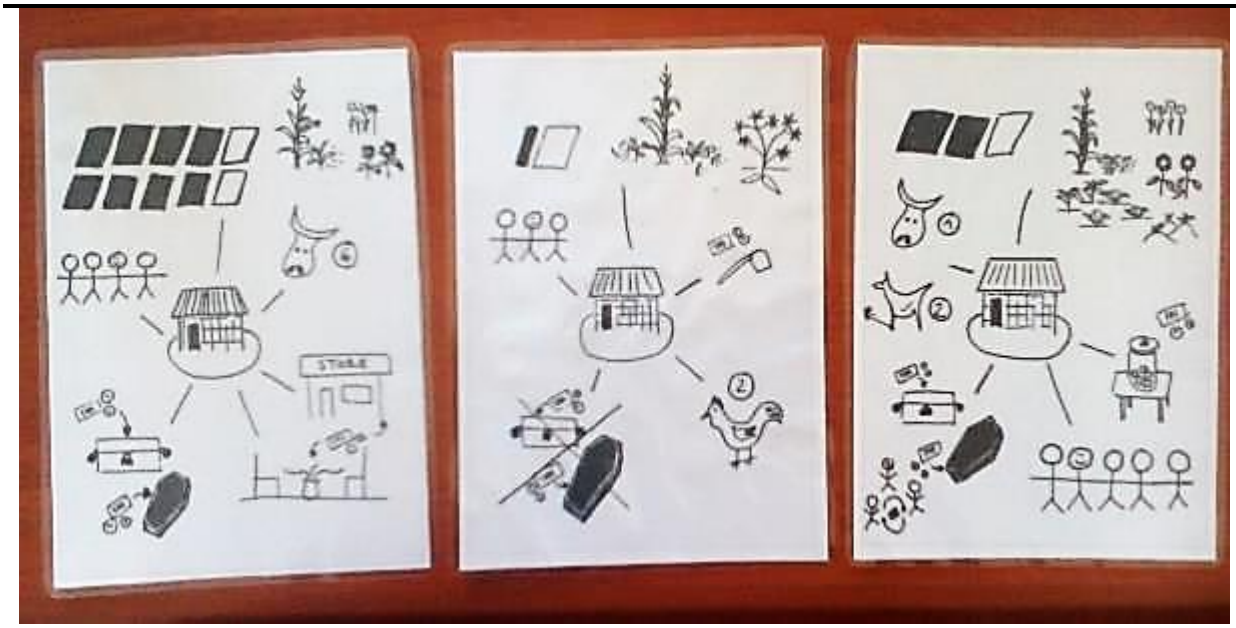


Image 13. Archetype cards presented as part of the post-DCE questionnaire (from left to right: 1. Andrews 2. Betties 3. Charleses)– Stage 6

Graphical Abstract