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Bundling of inputs and services for sustainable smallholder agriculture: the concepts, theoretical arguments and bundle designs using conjoint analysis

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ABSTRACT

Product bundling is receiving increasing attention in sustainable agricultural development as a means to ensure access to and enhance the uptake of, agricultural technologies by smallholders. Yet, the how and why of bundling for smallholders are not well-understood. The current paper, therefore, brings bundling theory from the marketing literature to the smallholder context. We use a conjoint experiment, a proven marketing technique for designing new products, services and bundles, to design agricultural input and service bundles for soybean-producing smallholders in rural Ethiopia. The empirical findings from 252 smallholders suggest that product bundling enhances smallholders' preferences and hence intentions to adopt technologies but that bundles must be designed carefully following a smallholder-centric approach. Drawing on our findings and the literature, we delineate the different steps that need to be taken to develop bundles for the successful uptake of new technologies by smallholders.

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Sustainable agriculture; smallholder-centric; conjoint analysis; preference; adoption; bundling; bundle design; grain legumes; rhizobium inoculants

1. Introduction

Bundling of products and services has become an increasingly popular tool for sustainable smallholder development in sub-Saharan Africa (SSA). Tsan et al. (2019), for example, highlight that about 53% of digitalization for agriculture (D4Ag) solutions offer a bundle of two or more services. Mukherjee et al. (2017a) report that finance and insurance companies that struggle to sell their services to smallholders in SSA increasingly use bundling strategies. Furthermore, governments promote bundling of agricultural inputs to increase smallholder productivity. For example, the Ethiopian government has given bundling a central role in its agricultural sector policy and investment framework (see, Chanyalew et al., 2010, p. 17). A recent project funding call explicitly invited proposals using bundled agricultural inputs and services (BMGF, 2020).

The bundling concept was introduced to the smallholder context to encourage smallholders to invest in sustainable agriculture, to increase productivity ensuring food security and to increase farm incomes (see, Bulte et al., 2020). To improve food security in low-income countries, it is widely recognized that technology adoption by smallholders is a vital step (see, for example, Asfaw et al., 2012; Verkaart et al., 2017). Yet, the adoption of productivity-enhancing technologies is hindered by a multitude of barriers that smallholders face, including distance to the market, lack of cash and uncertain climatic conditions (see, Arslan et al., 2014; Takahashi et al., 2020). Bundling helps to combine and offer products and services

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(see, Stremersch & Tellis, 2002) that together can address the barriers that hinder the ability of smallholders to adopt a technology. A bundle of microcredit and crop insurance services together with seeds can address smallholder capital constraints and risks of drought on agricultural production, respectively, thereby encouraging smallholders to invest (Mukherjee et al., 2017a). The bundling strategy can thus compensate for missing input and service markets. In line with this argument, research on institutional gaps argued that stakeholders should collaborate to provide a more complete solution when multiple institutional gaps hinder adoption (Nakata & Viswanathan, 2012; Rivera-Santos et al., 2012). Each stakeholder then brings in different products and services for the bundle.

Along with the growing popularity of bundling, there is an increasing concern about the appropriateness of product bundle designs. Researchers typically evaluate the effectiveness of bundling (Boucher et al., 2021), but pay little attention to design. Tsan et al. (2019), for example, called for more attention to the smallholders' needs and contexts in the design of D4Ag bundles. Companies and development organizations often overlook this step by taking a supply-driven approach whereby input products are designed based on what organizations 'want to sell' to smallholders rather than what smallholders need (see, Tsan et al., 2019). This reflects a gap in the understanding of how and why bundling enhances smallholders' adoption of agricultural inputs.

This study draws on marketing (e.g. Leszczyc & Häubl, 2010; Stremersch & Tellis, 2002) and innovation adoption and diffusion (see, Rogers, 1983) literature to derive the arguments and develop a conceptual framework for *why* input bundling is likely to work in the context of the smallholders. Following marketing scholars in new product development (see, Green et al., 2001; Rao, 2009) we use conjoint analysis to also show *how* bundles can be designed in line with smallholders' needs and preferences. The conjoint technique helps to quantitatively determine the relative importance of bundle attributes, which are bundle features, components, prices and packages (cf. Kotler & Armstrong, 2010), to develop a compelling product bundle. We conduct this study in the context of soybean-growing smallholders in Bako district in Western Ethiopia. Technologies to enhance soybean production (improved seeds, inoculants and fertilizers) have the strongest impact on yields when used in combination with each other (Ronner et al., 2016), thus making bundling a potential solution for joint adoption of these inputs. Smallholders in Ethiopia also face multiple institutional gaps such as the unavailability of inputs and the unpredictability of buyers (Asfaw et al., 2012). The conventional Ethiopian extension system creates less space for market-based actors and lacks a user-centred approach in its design and inclusiveness in providing the services needed by farmers (Spielman et al., 2011; Steinke et al., 2021). This context, therefore, allows us to study the influence of bundling on smallholders' adoption intentions for complementary inputs and to design several alternative bundles for specific smallholder groups that remove adoption barriers for these inputs. Drawing on the insights we provide a step-wise model for an effective bundle design for sustainable smallholder development.

In the remainder of this article, we first provide the theoretical background on how and why bundling enhances product adoption in general and in the context of smallholders. Then, we present the context of our study and the conjoint quasi-experiment design. Finally, we present and discuss our empirical results from the conjoint study, and provide a step-wise model to design product bundles for smallholders.

2. Background

2.1. Bundling and its impact on product adoption

Bundling is defined as the sale of two or more separate products and/or services in one package (Stremersch & Tellis, 2002; Yadav & Monroe, 1993). The study of bundling has a long tradition in the fields of marketing (see, Johnson et al., 1999; Stremersch & Tellis, 2002) and economics (e.g. Martin, 1999; Whinston, 1989). The work on economics does contain relevant ideas for the smallholder context, like debates on whether and when bundling reduces competition (Pierce & Winter, 1996; Whinston, 1989) and the broader welfare consequences of bundling (Martin, 1999; Salinger, 1995). As we are in this article concerned with the rationales underlying bundling and the subsequent design implications, we will draw more heavily on the bundling literature from marketing. Whereas the emergence of a body of literature on bundling initially led to ambiguity around the concepts and interchangeable use of terms with distinct meanings, later work has reorganized the concepts in unifying frameworks

(Stremersch & Tellis, 2002). The underlying core argument for bundling in the marketing literature is that it increases perceived buyer value, which is the buyer's evaluation of the difference between the benefits and the costs associated with the bundle relative to separate items (Kotler & Armstrong, 2010). Congruently, to reduce the initial conceptual confusion, the literature has proposed to distinguish between two main bundling strategies, namely, price bundling, which mainly reduces the costs encountered by buyers, and product bundling, which mostly intends to increase the benefits (e.g. convenience) that they experience (see, for example, Stremersch & Tellis, 2002).

Price bundling focuses on the sale of two or more separate products in a package at a discount, without further integration of the products (Guiltinan, 1987). While it is widely agreed that the discount on the bundle can increase perceived value (Stremersch & Tellis, 2002), marketing researchers have long debated why this is the case (see, for example, Biswas & Blair, 1991; Stremersch & Tellis, 2002; Yadav & Monroe, 1993). First, they argued that the prices of the separate items in the bundle replace the internal reference price of buyers (the price that buyers have in mind as the price that is reasonable to pay). As the discounted bundle price then emerges as more favourable, it increases the perceived value (Biswas & Blair, 1991). Second, building on mental accounting principles, Johnson et al. (1999) argued that buyers perceive multiple separate prices to be higher than when they are combined into a single overall price – buyers thus perceive the bundle to be cheaper (Yadav & Monroe, 1993).

Product bundling focuses on the integrated sale of two or more separate products or services at any price (Stremersch & Tellis, 2002). The integration generally provides buyers with added value which can be explained by greater perceived convenience, complementarity and reduced transaction costs for searching and handling (see, for example, Leszczyc & Häubl, 2010). In particular, bundling of items that complement each other increases the functionality and performance of the product bundle, thereby resulting in perceived complementarity value (Estelami, 1999; Yadav & Monroe, 1993). Complementarity may go beyond the bundling of physical, tangible products and also include services that complement the tangible items in the bundle and/or each other. Some, therefore, talk about *product and service* bundling (Dixon & Verma, 2013; Herrmann et al., 1997). As sellers sell more items in bundles than they would have when all items were offered separately, bundling increases product adoption, buyer expenditures and seller profits (Leszczyc & Häubl, 2010).

2.2. Bundling in the smallholder context

The use of bundling in smallholder agriculture is a relatively recent idea that emerged mostly as a solution for disappointing adoption rates of new technologies to enhance the productivity of smallholders (e.g. Bulte et al., 2020; Mukherjee et al., 2017b). Thinkers about food security see potential in the increase of smallholders' agricultural productivity, for which improved agricultural inputs, like seeds and fertilizers, are developed (Evenson & Gollin, 2003; Giller et al., 2013). Smallholders are, however, hindered in the adoption of these inputs because their environment offers little or no solutions for constraints in terms of whether all the necessary inputs will be available in time, whether they are affordable, whether buyers will show up in the harvest season and whether they will offer prices that cover the costs of the inputs plus a rewarding profit margin (cf. Arslan et al., 2014; Asfaw et al., 2012). These constraints can be solved by the provision of services to smallholders like micro-loans and output market contracts (Barrett et al., 2012; Mukherjee et al., 2017b). In the current situation, smallholders may obtain the products and services at best from different providers. The inputs and services may reach them through farmer organizations, extension workers, dealerships, microfinance institutions, informal markets, etc., in an incoherent and uncoordinated manner. As a consequence, smallholders are confronted with uncertainty, search costs and multiple decision moments.

Bundling can create several benefits for the smallholders that can be explained by how smallholders perceive bundled compared to unbundled items (see Figure 1). First, through coordinated action, the different providers of inputs and services can bring their products and services together in one bundle. Bundling the inputs will lead to reduced costs of searching, assembling and holding the separate agricultural inputs that need to be used in combination (cf. Harris & Blair, 2006; Leszczyc & Häubl, 2010). This reduction in transaction costs is very important to increase adoption in the smallholder context where poorly functioning input and service markets often increase transaction costs (Dillon & Barrett, 2017; Gollin, 2014; Hazell et al., 2010). Hence, bundling will

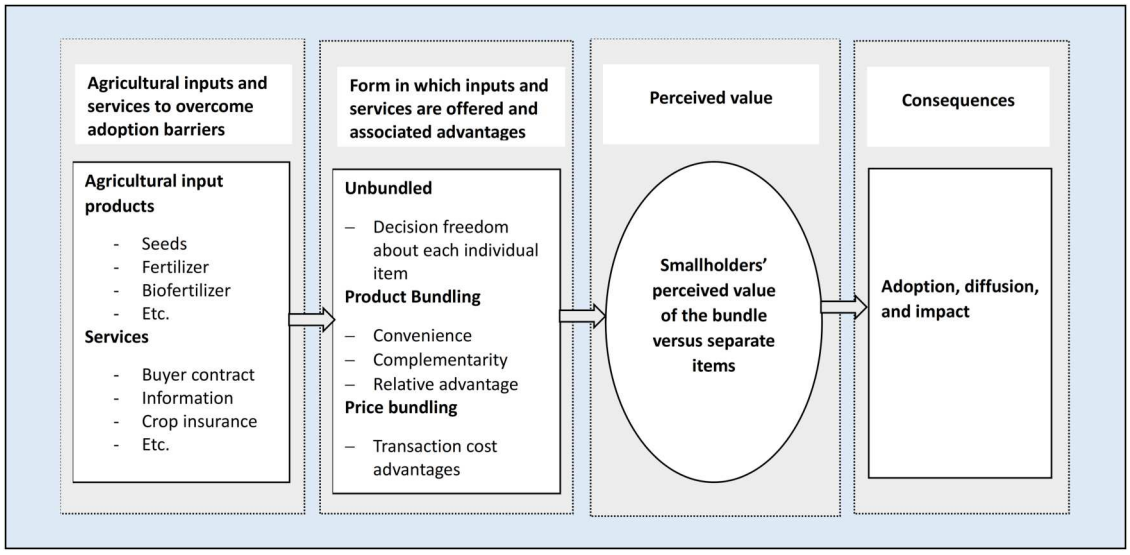

Figure 1. A conceptual framework showing the influence of agricultural input product and service bundling on adoption, diffusion and impact of agricultural technologies.

be more convenient for smallholders. Second, product bundling can result in increased complementary value to the smallholders and hence perceived relative advantage and observability, which can be explained through enhanced yield gains when, for example, seeds are bundled with complementary inputs such as fertilizer. Bundling the appropriate amount of fertilizer with each unit of seed makes it easier to apply it in the right quantities, thus decreasing the perceived complexity of adopting technologies (Kaur et al., 2023).

Also, radically new technologies are more likely to be adopted when they are bundled with inputs that are complementary and somehow familiar to the adopters (Reinders et al., 2010). Bundling inputs that are familiar to farmers like seeds with new technologies like inoculant will hence enhance perceived compatibility and trialability (see, Rogers, 1983, p. 223 & 231 for the definition of concepts), thereby increasing the chances of combined input purchases. The complementarity value can be further increased when services like a buyer contract are added to the bundle, explained in terms of increased income gains to the smallholders (Mukherjee et al., 2017a). Such services will remove barriers faced by smallholders and will decrease perceived buyer uncertainty associated with adoption (see, Ha et al., 2023).

Along the lines of Rogers (1983), bundling can, therefore, increase perceived convenience, relative advantage, observability, compatibility and trialability as well as decrease complexity and uncertainty. Research on adoption following Rogers (1983) model, sees these perception dimensions as essential leading to positive adoption intentions, adoption behaviour, further diffusion of the technologies adopted through, for example, positive word of mouth, and creating an overall positive impact (see for a review Arts et al., 2011).

Product bundling is more logical for smallholders than price bundling because it integrates and helps to create access to complementary agricultural inputs and services. In other words, it underlines the solutions that inputs and services provide for the productivity growth of smallholders. Nevertheless, price bundling can potentially be a feasible complement to product bundling, because price reduction increases affordability. Because the joint transport of the products in bundles to the smallholders may reduce transportation costs, such a discount may also become financially feasible for input providers. The discounts will provide an overall saving (see, Estelami, 1999; Yadav & Monroe, 1993) and thus further stimulate adoption.

2.3. Designing smallholder-centric bundles

With the perception of the bundle attributes by smallholders being an essential step, the success of a

product bundle in enhancing the adoption of the products highly depends on the *bundle design* (see, for example, Dixon & Verma, 2013; Rao, 2009; Stremersch & Tellis, 2002): the specific approaches that the decision-makers follow to develop the bundle (Bloch, 2011; Rao, 2009). Marketing scholars, therefore, recommend that the development of a product bundle should follow comparable steps as the development of any other product or service innovation (e.g. Stremersch & Tellis, 2002). Researchers in new product development and those in design thinking often see product development as a sequential process consisting of several stages (see, Cooper, 2019; Luchs & Swan, 2011). It involves 'empathizing' with buyers to become immersed into the buyer context and experiences (Brown, 2008; Luchs et al., 2015), conducting market research to determine product and service features that should be incorporated in the new product to satisfy buyer needs (Eliashberg et al., 1995; Van Kleef et al., 2005), developing the new products, testing to see how buyers react to the product and finally implementing the new product (Cooper, 2019).

Conjoint analysis is a tool for new product development that is central to the process of designing product bundles (see, Goldberg et al., 1984; Rao, 2009). An empathizing stage can potentially reveal a high number of bundle attributes that potential buyers would like to see included in the bundle. Conjoint analysis allows managers or researchers to make decisions about which attributes should compose an optimal bundle(s), whether they can be included cost-effectively, and whether one bundle can serve the entire target market or whether multiple bundles should be developed (see, Eliashberg et al., 1995; Rao, 2009). In other words, it helps to create an optimal bundling solution that maximizes smallholders' chance of acceptance of productivity-enhancing inputs. In this respect, conjoint analysis gives average scores on how important each attribute is in terms of influencing buyer preferences and providing utility values (the level of satisfaction offered to the buyer by the respective bundle items) and thus guides the subsequent decision to develop the product bundle (Goldberg et al., 1984; Green et al., 2001). The conjoint technique allows the researcher to find multiple more refined bundles, and not a single one-size-fits-all bundle, that particularly informs which segments of the buyers to target with which bundle (Green et al., 2001). The technique is, therefore, also suitable for designing product bundles for smallholders who are facing multiple adoption barriers. The technique is, however, to date barely used by input suppliers in the context of the smallholders.

3. Method

3.1. Study context

We applied conjoint analysis to design product bundles in the context of soybean-growing smallholders in the Bako district, Western Oromia region in Ethiopia. Like other legumes, soybean is rich in protein and a crop that can improve food security and farm incomes. Importantly, it also improves soil fertility through nitrogen fixation, thereby improving the productivity of subsequent crops grown in rotation (Giller et al., 2011). Building on these properties, the N2Africa (www.n2africa.org) project developed yield-improving technologies including improved seed varieties, rhizobial inoculant, fertilizer and related practices (Giller et al., 2013). While smallholders in this context are well-acquainted with seeds and fertilizers, rhizobial inoculants are relatively new to them. The technologies are complementary as the combined use of seeds with inoculant and fertilizer results in increased productivity (see, Ronner et al., 2016; Wolde-meskel et al., 2018).

However, soybean is grown only on small plots in Bako, where maize is the dominant staple crop as it has relatively better functioning input and output markets that increase smallholder participation in maize production and marketing (Barrett, 2008). Evidence also shows that the uptake of the technologies by smallholders is not consistent (see, Dontsop & Al, 2020) calling for further investigation and consideration in input product offerings to smallholders. The conventional extension system, led by the state, focuses mainly on information dissemination and not much on the provision of other services like input and output prices to solve technology adoption and scaling-up problems (Leta et al., 2017). It also leaves less space for market-based actors, lacks a user-centred approach in its design and lacks inclusiveness in providing the services needed by farmers (Spielman et al., 2011; Steinke et al., 2021). As the input technologies are complementary and smallholders are confronted with many adoption barriers that can be addressed in complementary services, bundling can be a logical strategy to increase the uptake of the technologies and with that increase smallholder productivity.

3.2. Empathizing with smallholders

As a first step in the bundle design process, we *empathize* with smallholders, meaning that we understand the context to incorporate smallholders' needs and aspirations in the process (see, for example, Luchs et al., 2015). While the concept is receiving more emphasis in contemporary design thinking, many scholars have also put potential buyers such as smallholders at the core of the product design process by emphasizing the importance of voice-of-the-customer, market orientation and customer orientation (see, Griffin & Hauser, 1993; Kirca et al., 2005). This is because the success of a new product development depends much on how the product is evaluated by the buyer (Brady & Cronin, 2001). Specifically, we used qualitative techniques such as field observations, interviews and focus groups (see, Krueger, 2014; Patton, 2014). We use the insights from these techniques to determine the attributes and attribute levels for the conjoint study. We report the results briefly in Table 1.

The insights from the qualitative techniques point out that smallholders experience added value from the combined use of soybean seed, inoculant and fertilizer. Due to the past project activities, smallholders are aware that the combined use of the technologies will increase productivity. However, smallholders face barriers to adopting the technologies. Seeds and inoculants are not available at the local market, and searching for them elsewhere is time-consuming and may fail. Based on this insight, we included the bundle attribute *technology bundling* in the conjoint study, with the levels to receive seeds alone, seeds with inoculant or seeds with inoculant and fertilizer. In Bako, soybean seeds may be provided by the Bore Bako union, Anno agro-industry as well as by the Ethiopian Seed Enterprise (ESE). We include these as three brand names, under the attribute *brand name,* because the insights indicate that smallholders want to specifically know seed sources.

We consider *package size* as an attribute, with the levels small (for 0.25 ha of land) and medium (for 0.5 ha land) based on smallholders' needs. Smallholders also highlighted that they had difficulties in the application of the inoculant technology hinting at the need for simple aiding material to be offered along with it. Thus the presence of *manuals* pictographically showing the application of inoculant to soybean seed (present or not) is included as an additional bundle attribute.

Smallholders also expressed the fear that there might be no buyers for their soybeans or that the price after harvest would be attractive. We used this insight to include a *buyer contract* that guarantees a buyer and a price in advance for the produce. Likewise, smallholders in Bako complained that they have a labour shortage for soybean hand weeding. Because they are familiar with the use of herbicides to protect their maize crop from weed infestation instead of hand weeding, we included *herbicide service* (present or not) as an attribute. Furthermore, while soybean is an important protein source, the insights from interviews show that the drudgery in food processing for women and the lack of processing tools made household consumption low. Among other suggestions, we included the attribute *common bean seed for home consumption* in the conjoint design. Beans are rich in protein, and because smallholders can grow and easily process at home, including beans can encourage smallholders to grow soyabean that has high market value for sale (see Table 1).

3.3. The conjoint design

We used the bundle attributes that are qualitatively identified to design the conjoint study in the process of designing product bundles (see, Rao, 2009). We combined the bundle attribute levels to develop alternative product bundles or 'profiles' as they are called in conjoint terminology (Green et al., 2001). Using the seven attributes, two attributes with three levels and five attributes with two levels each, we can generate 288 (3*3*2*2*2*2*2) bundles through a full factorial design (Green & Srinivasan, 1978). Because the respondents cannot meaningfully evaluate so many product bundles, we used a fractional factorial design (on the basis of D-efficiency) combined with a blocking design to develop a sub-set of product bundles, following the advice of Hensher et al. (2005) and Lusk and Norwood (2005). We developed two blocks of 18 soybean input product bundles for the main preference rating task, 1 so-called warming-up profile and 6 profiles for the holdout task. Each respondent then received a block of 18 product bundles in a preference rating task.

Because less educated respondents tend to engage with pictographic thinking, we developed cards with pictographic representations of the attributes and their levels for each of the 43 profiles

Table 1. An overview of key insights, bundle attributes and levels to be used in conjoint design.

No.	Insights from empathizing	Bundle attributes	Explanations of how attributes increase adoption intention	Bundle attribute levels
1.	Smallholders experience complementarity value from using a combination of soybean seed, inoculant and phosphorus fertilizer. Constrained availability and high costs of transaction hinder adoption.	Technology bundling	Offering a package of complementary input products may enhance perceived convenience, performance (yield) and cost-saving leading to enhanced adoption intention.	Soybean seed alone Soybean seed and inoculant Soybean seed, inoculant and fertilizer
2.	Smallholders ascribe different values to seeds from different sources. Information asymmetry due to lack of branding makes product evaluation and adoption difficult.	Brand name	Branding may ease the evaluation of seed quality and its association with perceived added value (yield) thereby influencing adoption decisions.	Anno-agro industry Ethiopian seed enterprise Bore Bako Cooperative Union
3.	Smallholders have capital constraints to buy seed and fertilizer. They also need input package sizes that fit with the land area that they wish to allocate to soybeans.	Package size	Offering product bundles in options of package sizes may increase perceived convenience while handling and application leading to enhanced adoption intention	"Small (for quarter-hectare of land)" "Medium (for a half-hectare land)"
4.	Smallholders have difficulty with inoculant application to soybean seed due to the knowledge gap	Manuals	Manuals that pictorially show how inoculants are applied can minimize the perceived costs of information searching and increase complementarity	Manuals on inoculant application included in the product bundle Manuals on inoculant application not included
5.	Smallholders have labour constraints for soybean hand weeding. They are accustomed to using herbicides to control weeds in maize and expect the same for soybean.	Herbicide service	Adding herbicides to the product bundle could increase perceived added value (yield) and increase intention to adopt.	Herbicides are made available additionally at the union shop No further arrangement was made with herbicide
6.	The soybean grain market is unpredictable so smallholders are not sure if they can have a buyer or that prices may be lower.	Buyer contract	Offering buyer contract terms can increase the perceived performance (income gain) of the product bundle and increase the adoption intention	Buyer contract terms included No buyer contract terms included
7.	Low soybean household consumption due to drudgery in processing that hinders adoption	Common bean seed for home consumption	Offering an extra common bean seed, which is rich in protein and easier to process to be grown for home consumption may increase perceived food value and encourage soybean adoption as an income source.	Protein supplement included Protein supplements not included

NB: We used cost-based pricing for product bundles. So, price is not added as a stand-alone attribute. Actual costs were attached to each product bundle based on the constituents of the respective product bundles.

(see, Ingenbleek et al., 2013). The cards provide detailed visual information about which bundle attribute levels constitute the bundle, the price and who offered the bundle as indicated by brand names. We computed and attached actual prices to each product bundle on the basis of the prices of the components. For the bundle price computation, we used the actual prices of the components and then took into account some reductions (e.g. 10 Ethiopian Birr in case the bundle contains all the inputs). The discount is based on the suggestions from suppliers considering the reduced transportation and transaction costs that bundling could bring to them, which is also an advantage for smallholders (Figure 2).

3.3.1. Conjoint experiment and preference rating

In the conjoint task in the questionnaire, respondents were asked to indicate their rating on a 7-point rating scale ranging from '*1 = I would be extremely unsatisfied*' to '*7 = I would be extremely satisfied*'. We selected a 7-point rating scale over more detailed response scales to avoid making the rating task overly complex for the smallholders while also generating information of sufficient detail (Viswanathan, 2005). Before they were to rate the 18 profiles from the fractional-factorial design, respondents were first asked to rate the warming-up profile to acquaint themselves with the preference rating task (Asioli

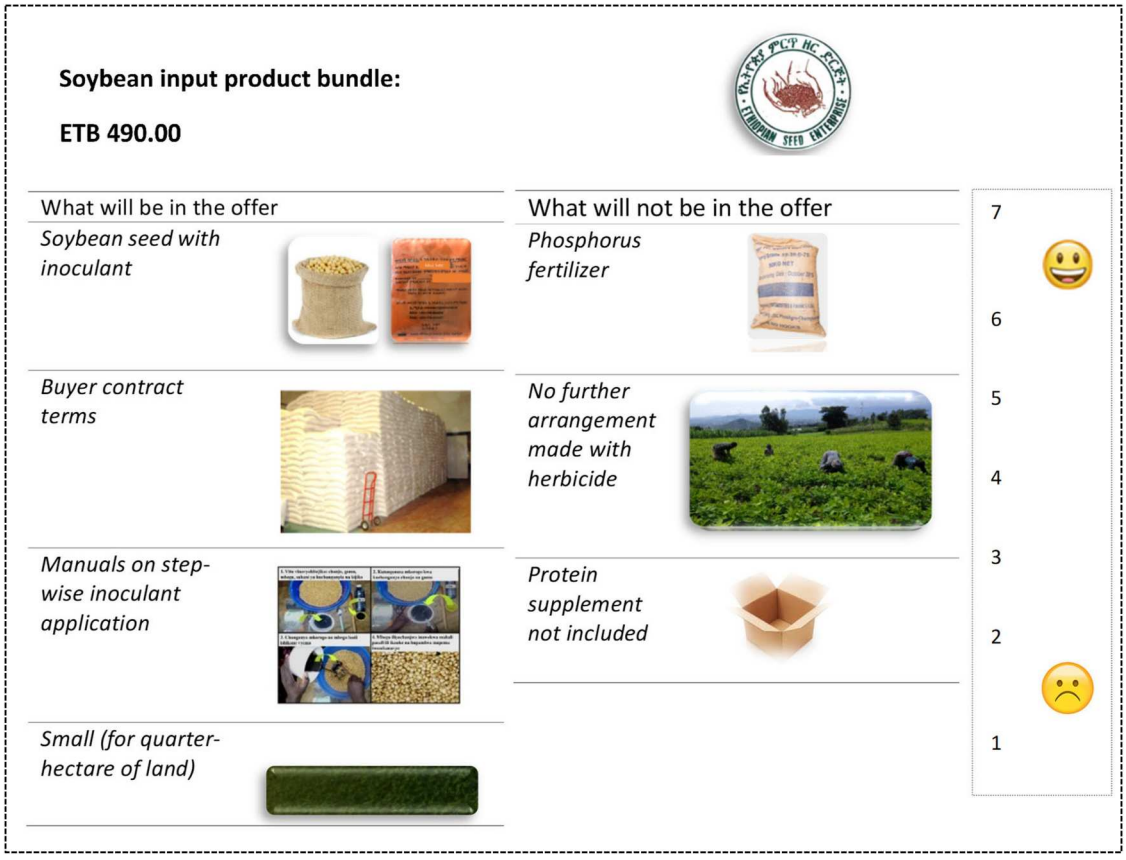

Figure 2. Sample card of product bundles as used in eliciting preference rating task (translated to English).

et al., 2016). This was also meant to help the smallholders to refresh their context in terms of what are their needs, barriers and aspirations to inform their evaluation of the product bundles. These ratings for the warming-up profile were not used for analysis.

Table 2. Description of respondents taking part in the preference ratings of product bundles.

Characteristics	*n*	Mean	Std. Deviation
Age (years)	252	41.00	10.54
		Frequency	**Per cent**
Sex	Male	224	88.9
	Female	28	11.1
Respondent is household-head	No	21	8.3
	Yes	231	91.7
Education	No school	35	13.9
	Adult educ.	7	2.8
	Primary	132	52.4
	Secondary	61	24.2
	Post-Secondary	17	6.7
Stopped growing soybean after trial	No	154	61.1
	Yes	98	38.9

Subsequently, each smallholder received the 18 pictorial representations of the product bundles from the fractional-factorial design. To evaluate the bundles , they were first asked to make three piles of the product bundles: those which they liked most, those which they liked least and those in-between (also see, Green & Srinivasan, 1978). The respondents then went through the piles indicating their ratings. Finally, to check for the internal validity of their bundle evaluation, the respondents were provided with three hold-out choice tasks (Huber et al., 1993). In each choice task, the respondents were asked to indicate their choice between two product bundles, even if they preferred neither.

3.3.2. Sampling and data collection

We used a stratified sampling strategy. Study villages were classified into three strata based on distances from the main road that we used as a proxy to capture differences in access to input and service

markets (Ingenbleek et al., 2013): (i) along or near the main road; (ii) away from the main road in the distances of 3–4 kilometres and (iii) far from the main road (more than 7 kilometres). We selected three villages from each stratum. We purposively selected those villages for which we got collaborations from development agents for the follow-up farmer selection and interviews. With the help of the development agents, we then selected a comparable number of respondents from each village resulting in a total sample of 252 smallholder farmers (see Table 2 for sample description). At the start of the interviews, we asked how interested the respondents were in receiving soybean inputs for their next growing season on a 7-point rating scale, and respondents indicated that they were very interested in doing so (M = 6.29; standard deviation = 0.87). In addition, 38.9% of the respondents indicated that they stopped growing soybeans after the trial due to access-related barriers. This indicates that our respondents were ready to rate and provide meaningful responses on the product bundles. We assigned respondents from each village equally to the blocks of 18 product bundles. Thus, there were no systematic differences between the blocks in terms of access. Data on smallholder socio-demography and access to markets and extension services were also collected to understand whether or not preferences vary based on these characteristics.

Data were collected using structured interviews by experienced data collectors who knew the local language and culture under the close supervision of the first author (Ingenbleek et al., 2013). The interviewers were trained on the interview and the preference rating procedure thoroughly to avoid biases that may be induced by the interviewer. In particular, the interviewers were trained and instructed to strictly follow the introductory notes in the questionnaire to implement preference ratings. To help the interviewers become acquainted with the procedure and to gain some insight to refine the questionnaire, we conducted a pre-test in a village that was not included in our main study.

3.3.3. Data analysis

We analysed data to generate two results from the conjoint experiment. The first one was to determine the importance of the bundle attributes in concrete quantitative terms to make an informed decision regarding which attributes to use in the development of an optimal product bundle that results in a high likelihood of smallholder technology adoption (Goldberg et al., 1984). For this purpose, we used the conjoint data analysis technique (Green et al., 2001). The technique is also used to estimate the utility values for bundle attribute levels which is an indication of the level of smallholders' preferences and hence adoption intention as a result of the inclusion of the particular attribute levels in the product bundle. The second was to know the significance of the overall effects of bundle attributes on smallholder preference and whether smallholders' preferences were moderated by household and access-related characteristics. We used the analysis of variance and covariance (ANOVA and ANCOVA, respectively) techniques for this purpose (Lattin et al., 2003). The results from ANCOVA gave insights into whether or not multiple product bundles are needed to encourage different segments of smallholders to adopt soybean technologies. Below we first present results of the conjoint analysis followed by results from the ANCOVA.

4. Results

4.1. Which attributes make up an optimal bundle?

Figure 3 presents the average importance (%) of the bundle attributes from the conjoint analysis ($n = 252$).

The average importance values show that buyer contract and technology bundling have mostly influenced the overall preference ratings with combined importance values of 56.91% compared to the others (see Figure 3). Some 37.45% difference in preference between soybean input product offerings is due to the presence or absence of a buyer contract. Similarly, 19.46% of the overall difference in preference is due to whether the offering is just for soybean seed alone, a combination of soybean seed with inoculant or a combination of soybean seed with inoculant and fertilizer.

A comparison of smallholders' hold-out choices with predicted preferences shows that there were 6 farmers with less than two consistent choices (Huber et al., 1993). These farmers were excluded from further analysis.

We now present the overall effects of the bundle attributes on smallholder preferences with the use of results from ANOVA (main effects) provided in Table 3. The main effects model fit is significant ($p < .01$) with a partial η^2 value of .57 for the corrected model

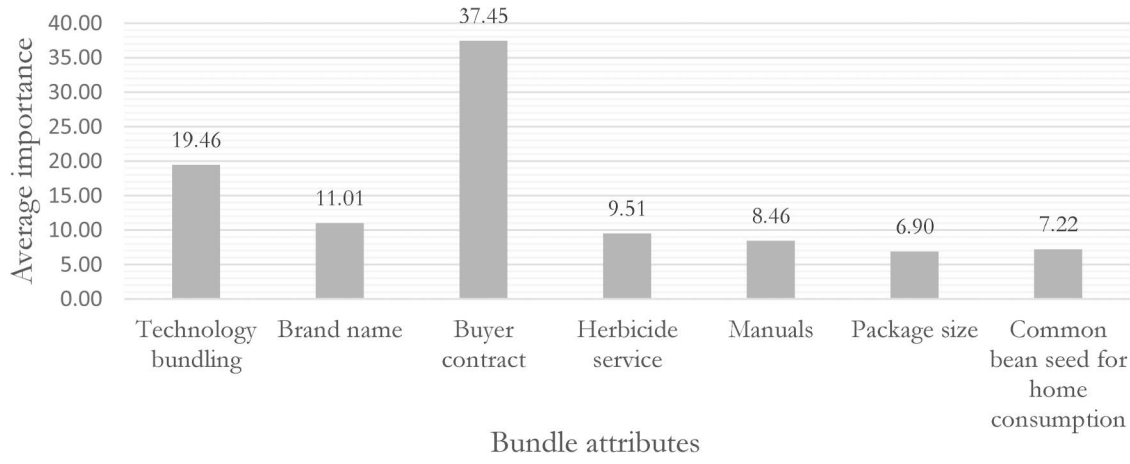

Figure 3. Average importance scores of soybean input product bundle attributes.

(also the same with R Squared). The ANOVA outputs show significant mean differences in preference for all product bundle attributes except for the brand name (see the main effects column in Table 3). Consistent with importance values, a large effect size is observed for the buyer contract (partial $\eta^2 = .52$, $p < .01$). The presence or absence of a buyer contract in the input offerings results in a significant and large variance in farmers overall preference ratings. Technology bundling accounts for the second large and significant effect size (partial $\eta^2 = .12$, $p < .01$). The effect sizes for herbicide service, common bean seed for home consumption, manuals and package size are about .05, .02, .02 and .01, respectively. Package size explained only a small part of the variance in smallholder soybean input product preferences. These results are similar to those obtained from conjoint analysis (see Figure 3).

We observed small but significant block effects on smallholder bundle preferences for bundle attributes technology bundling, brand name and package size (see interaction effects with blocks column in Table 3). The results indicate that smallholders show different preferences for these bundle attributes across the blocks of product bundles.

4.2. Heterogeneity in smallholder preferences

We present the moderation effects of smallholder characteristics and access-related variables on preferences at the right columns of Table 3 (see the columns under 'c'). The corrected model fit is significant ($p < .01$) with a partial η^2 value (R squared) of .59 indicating that our data explained about 59% of the variation in the model.

The analysis of covariance shows that preferences to bundle attributes varied based on smallholder characteristics and access variables. We observed significant effect sizes of interactions (we consider $p < .01$ to discuss relatively larger effect sizes even if there are other significant interaction terms) that included the bundle attributes buyer contract and technology bundling with one or more of the moderator variables education, extension contact and hours to the nearest market centre. The interaction effects indicate that smallholder preferences for the buyer contract varied depending on their education level, how frequently they had contact with extension agents and how close they were to the nearest input market centre. The results show that for better-educated smallholders, the presence or absence of a buyer contract results in a significantly high preference. Similarly, for smallholders who make frequent contact with extension agents, we observed a significant high preference for buyer contracts. Hours to the nearest input market centre provide information about how close smallholders are to the input market and the output market as input and output market services are sometimes provided at the same place in rural villages (e.g. at cooperatives, (Bernard et al., 2008)). So, the significant interaction between the buyer contract and hours to the nearest input market centre indicates that farmers who live far away from input markets give a stronger preference to the buyer contract than those who live closer to the input market centres (cooperative shops).

Table 3. Analysis of variance to smallholder soybean product bundle preferences (main and interaction effects).

Dependent Variable: Smallholder preferences to soybean product bundles												
(a) Main effects					(b) Interaction effects (blocks)				(c) Interaction effects (blocks and farmer characteristics)			
Source	df	F	Sig.	Partial η^2	df	F	Sig.	Partial η^2	df	F	Sig.	Partial η^2
Corrected Model	9	628.65	0.00	0.57	19	308.02	0.00	0.58	59	108.17	0.00	0.588
Technology bundling	2	286.07	0.00	0.12	2	292.43	0.00	0.12	2	313.86	0.00	0.123
Brand name	2	1.21	0.30	0.00	2	1.23	0.29	0.00	2	1.32	0.29	0.001
Buyer contract	1	4548.90	0.00	0.52	1	4635.63	0.00	0.52	1	4974.36	0.00	0.526
Herbicide service	1	221.52	0.00	0.05	1	230.78	0.00	0.05	1	247.72	0.00	0.052
Manual	1	78.71	0.00	0.02	1	88.83	0.00	0.02	1	95.17	0.00	0.021
Package size	1	42.74	0.00	0.01	1	46.86	0.00	0.01	1	50.31	0.00	0.011
Common bean seed for home consumption	1	91.08	0.00	0.02	1	81.60	0.00	0.02	1	87.56	0.00	0.019
Technology bundling*												
Block					2	15.69	0.00	0.01	2	16.90	0.00	0.008
Age									2	2.79	0.06	0.001
Education									2	0.89	0.41	0.000
Extension									2	0.90	0.41	0.000
Hours to market									2	5.90	0.00	0.003
Brand name*												
Block					2	12.60	0.00	0.01	2	11.68	0.00	0.005
Age									2	1.65	0.19	0.001
Education									2	1.24	0.29	0.001
Extension									2	0.44	0.64	0.000
Hours to market									2	0.54	0.58	0.000
Buyer contract*												
Block					1	0.80	0.37	0.00	1	0.65	0.42	0.000
Age									1	4.71	0.03	0.001
Education									1	8.45	0.00	0.002
Extension									1	9.50	0.00	0.002
Hours to market									1	10.44	0.00	0.002
Herbicide service*												
Block					1	1.33	0.25	0.00	1	2.23	0.14	0.001
Age									1	0.53	0.47	0.000
Education									1	0.13	0.72	0.000
Extension									1	2.79	0.09	0.001
Hours to market									1	0.07	0.80	0.000
Manual*												
Block					1	0.22	0.64	0.00	1	0.26	0.61	0.000
Age									1	3.08	0.08	0.001
Education									1	7.47	0.01	0.002
Extension									1	0.82	0.36	0.000
Hours to market									1	2.54	0.11	0.001
Package size*												
Block					1	23.19	0.00	0.01	1	24.38	0.00	0.006
Age									1	0.24	0.62	0.000
Education									1	0.00	0.98	0.000
Extension									1	2.01	0.16	0.000
Hours to market									1	0.54	0.46	0.000
Common bean seed for home consumption*												
Block					1	5.37	0.02	0.00	1	3.50	0.06	0.001
Age									1	2.92	0.09	0.001
Education									1	0.04	0.84	0.000
Extension									1	1.94	0.16	0.000
Hours to market									1	0.01	0.91	0.000
Error	4275				4265				4225			

For technology bundling, the moderator variable hours to the nearest input market centre shows a significant interaction effect indicating that smallholders' preferences for input bundling vary depending on how close or far the smallholders are to the nearest input marketplace. Smallholders, who live far away from the nearest input marketplace, showed significant and positive preferences

for technology bundling. This has practical importance considering the current input supply practices and infrastructures in rural villages where we have conducted this study. The different inputs that are important for enhancing soybean productivity are offered separately and not as bundles. Besides, the input dealers are dispersed making the access more difficult for the farmers. Thus smallholders who travel long hours to the nearest input market centre to buy inputs probably incur more transaction costs and have a stronger preference for bundled inputs.

4.3. Smallholder preferences for bundle attribute levels

We present smallholder attribute-level utility estimates in Table 4. The utility estimates further provide detailed information about the bundle attributes by providing evidence on how much utility can be provided by the respective attribute levels and thus how much impact is created by the bundle offering. As expected, the results show significant and large negative utilities when soybean seed is offered alone (−1.10), and even when bundled with inoculant only (−.51), compared to seed bundling with both inoculant and fertilizer (see Table 4). The large negative utilities with seed alone are an indication that smallholders recognize the complementarity value of soybean technologies and indicate strong smallholder preferences and intentions to adopt soybean inputs when they are provided as bundles.

The utility estimates provided further evidence that smallholder adoption can be increased further by adding services to the input bundles. In particular, the presence of a buyer contract (as compared to its absence) resulted in significant and higher utilities (2.55). Similarly, the presence of herbicide services for soybean weed protection and manuals that pictographically demonstrate inoculant application to soybean seeds showed significant positive utilities compared to the absence of the services. In addition, the smallholders also preferred the product bundles to be offered in a package size that fits the farm area that they wanted to allocate to soybeans. Smaller bundles were perceived to be more affordable as indicated by the significant positive utility estimates compared to medium bundle sizes. We also observed higher utilities for including common bean seed for home consumption in the input offering. Our results do not show a significant difference in the utility estimates between brand name levels showing that branding does not have an effect on smallholder bundle preferences.

5. Discussion

The empirical findings from the conjoint experiment provide several contributions to enhancing the adoption of productivity-increasing technologies for the sustainable development of smallholder agriculture and food security. The evidence indicates that bundling positively affects the adoption of complementary inputs. The smallholders recognize the complementarity of legume technologies (seeds, inoculant and fertilizer) and prefer the technologies to be offered to them in bundles. This finding suggests that arguments made in the marketing literature, that bundling of complementary products results in increased perceived customer value and purchase intentions (cf. Estelami, 1999; Yadav & Monroe, 1993) also apply within a smallholder context. Our findings further suggest that bundling increases the adoption of inoculants. This finding is in line with the previous study that reported that bundling of radical innovations with other complementary innovations which are somehow familiar to buyers increases the likelihood of adoption of the radical innovations (see, Reinders et al., 2010).

Bundling with additional services further increases preferences for productivity-increasing technologies. This is probably because service bundling eliminates adoption barriers that matter most to the smallholders such as unpredictable output market, labour constraints, difficulty in applying the technologies, capital constraints to buy the inputs and accessing protein source food for home consumption. The existing bundling literature from the field of economics studying the impact of bundling on smallholder adoption ignores the fact that smallholders face multiple environmental barriers by including only predetermined bundle components, mainly insurance and credit services, in their bundle design (Boucher et al., 2021; Bulte et al., 2020).

Buyer contract comes out as strongly influencing smallholder preferences followed by bundling of technological inputs. These results call for a value chain approach (see, Gereffi, 2018) because the collaboration between actors in the input and output markets can jointly address the barriers on both sides of the value chain. There is a strong possibility

that this opportunity would be missed by just trying to address input market side barriers by making inputs available, as some advocate (see, for example, Asfaw et al., 2012). Addressing the output market side barriers simultaneously through, for example, contract arrangements in contexts where smallholders have poor access to output market services can highly impact adoption (Barrett et al., 2012). Soybean grain buyers were scarce in the context of our study some farmers were keeping their harvest for another season to look for buyers. The strong influence of buyer contracts thus signifies this context. On the one hand, this may be seen as a limitation of the study, on the other hand, it shows the need for an in-depth understanding of the context during the empathizing step to identify the bundle attributes for the respective context.

Our analysis further showed that smallholders were heterogeneous in their preferences. As such, they are likely to respond differently to a bundle. Consistent with the literature on business markets (see, Kotler & Armstrong, 2010), the findings provide insights that there is a need to target smallholder communities (target markets) differently with slightly different product bundles. To target all smallholder communities in the region multiple bundles may be needed, or decisions may be made to limit the market to those smallholders that have similar preferences for a particular bundle, or those that offer an attractive market (see, Cooper, 2019) for bundle interventions that can also foster regional development.

In general, our study underlines the point that a smallholder-centric approach applying empathizing and conjoint techniques helps to identify barriers and to design compelling product bundles, respectively. Empathizing prevents overlooking potential barriers and needs that are not obvious to researchers, thus avoiding the risk that they consider only a few attributes in their bundling studies. The conjoint technique provides quantitative information on bundle attributes through importance scores that guide decisions on which attributes to consider in developing optimal bundle solutions that can address smallholder adoption barriers and satisfy their needs (cf. Eliashberg et al., 1995; Rao, 2009). Conjoint research, therefore, does not replace evaluation and monitoring research to assess the impact and effectiveness of the implementation. Rather, it focuses on the design stage of the bundle process, a stage of the policy cycle that, in general, receives less attention in adoption research than impact evaluation (De Janvry et al., 2017; Duflo et al., 2007). With the current study, we hope to contribute not only to better-designed bundles but also to the more proficient design of development interventions for smallholders in general because more smallholder-centric and rigorously designed interventions will eventually have a greater impact on productivity, food security and well-being.

6. Implications for bundling projects

Our study has implications for projects that intend to design and implement bundles of inputs and/or services for smallholders. Specifically, the insights from this study together with the lessons from marketing literature on product bundles and new product development (e.g. Cooper, 2019; Luchs & Swan, 2011; Stremersch & Tellis, 2002) imply several design steps that benefit future projects. These include steps that we have illustrated in our study and several subsequent steps. They are summarized in Table 5 and discussed below.

Technology development: Although perhaps not strictly part of the bundling, new product development often starts with a technology push (Eliashberg et al., 1995; Ulrich, 2003). With the current pressure on smallholder agriculture to increase productivity sustainably to meet the structural increases in the demand for food and feed (FAO, 2017), many agronomic and other fundamental research activities, therefore, continue to develop technological breakthroughs. During technology development, researchers usually consider the target beneficiaries. New technologies such as inoculants often look different and require different practices than what smallholders are used to. The psychological distance between the new technologies that are offered and what users already know typically hinders the adoption of the technologies (Le et al., 2021) and this psychological distance is likely to vary among smallholder groups. Bundling can help the adoption if at least one of two conditions is satisfied. First, the technology may be part of a set of different complementary technologies such that its adoption can be improved through bundling (see, Reinders et al., 2010). A clear example is the aforementioned additive effects of seed of improved varieties, phosphate fertilizer and rhizobium inoculants to improve the productivity of soybean and other grain legumes (Ronner et al., 2016). Second, if the smallholders face adoption

Table 4. Smallholder preferences (utility estimates) for the bundle attribute levels.

Parameter Estimates
Dependent Variable: Farmer preferences for soybean product bundles

	Parameters	B	Std. Error	t	Sig.	Partial η^2
Bundle attributes	Attribute levels					
Technology bundling	Soybean seed alone	−1.10	0.05	−24.59	0.00	0.12
	Soybean seed with inoculant	−0.51	0.05	−11.32	0.00	0.03
	Soybean seed with inoculant and fertilizer	0[a]				
Brand name	Anno agro	−0.06	0.05	−1.35	0.18	0.00
	Ethiopian seed enterprise	0.00	0.05	0.07	0.94	0.00
	Bore Bako	0[a]				
Buyer contract	Buyer contract included	2.55	0.04	69.40	0.00	0.52
	No buyer contract	0[a]				
Herbicide service	Herbicides made available at union shop	0.56	0.04	15.31	0.00	0.05
	No arrangement for herbicides	0[a]				
Manuals	Manuals included	0.34	0.04	9.13	0.00	0.02
	Manuals not included	0[a]				
Package size	Small (for quarter-hectare of land)	0.25	0.04	6.73	0.00	0.01
	Medium (for a half-hectare land)	0[a]				
Common bean seed for home consumption	Bean seed included	0.36	0.04	9.82	0.00	0.02
	Bean seed not included	0[a]				

[a]This parameter is set to zero because it is redundant.

barriers, these may be the basis of bundling the technology with services or products that eliminate the barriers.

Empathize: In the context of the smallholders, the aim of the empathizing step is to understand how the smallholders for whom the technology is developed perceive the technologies, to identify their needs and motivations to use the technologies, as well as the barriers to adopt the technologies. Typical methods that may help to 'empathize' are interviews or focus groups with the smallholders, possibly complemented by expert interviews and observations (see Patton (2014) or Krueger (2014) for more methodological advice pertinent to this step). To select smallholders for interviews, it is important that researchers have at least a rough idea about the diversity of the smallholders in the potential target market. This is to avoid extreme cases, for example, distance to the road or market, agronomic conditions, culture and literacy, determine the picture that emerges from the results (see, Ingenbleek et al., 2013).

With an in-depth understanding of the needs of smallholders, including the potential adoption barriers, researchers can make a concrete list of attributes that the bundle may include. As such, they constitute the basic solutions to the needs and barriers of smallholders. This concrete list is important to continue in the next step of the process.

Market research: Once the researchers have qualitatively identified smallholders' needs and barriers and listed the corresponding attributes, the next challenge is to determine the preferences of smallholders in quantitative terms to understand how strong the preferences are for the different attributes compared to each other, and to what extent the preferences vary across the targeted smallholders.

The required information can be gathered through a quantitative market research study. Market studies with pre-set questionnaires and systematic interview protocols are by now well-established tools in the toolboxes of most development researchers (see, for example, Beckley et al., 2012). Awareness about the subtle but important differences between the research techniques may help to generate insights to answer the focal questions in a way that is as little as possible to social desirability and other biases (Ingenbleek et al., 2013). The conjoint analysis technique applied in this study is widely used in the literature to design bundles (see, Goldberg et al., 1984; Rao, 2009). Appropriate use of the method requires decisions about the specific conjoint design including combining the bundle attributes, developing hypothetical alternative product bundles and examining smallholders' preferences for the alternatives, as well as about the research process and sampling (for the latter see Ingenbleek et al. (2013)). The application of the technique has implications for defining target smallholders as target markets, and which optimal bundle(s) can satisfy the needs of the target markets.

Table 5. A step-wise flow chart for designing a product bundle for the smallholders.

Steps in bundle design	Explanation	Key references
1. Technology development	*Aim*: Find a technological solution to increase smallholder sustainable productivity, food security and/or income *Activity*: Basic research in, for example, crop variety improvement and fertilizer development, identify synergistic and complementarity effects *Outcomes*: Selection and development of effective technologies	Evenson and Gollin (2003), Giller et al. (2013)
2. Empathize	*Aim*: Understand smallholders' needs, motivations barriers to adoption and perception of the technologies *Activities*: Observations, smallholder and expert interviews, focus groups *Outcome*: Identification of potential products and services (bundle attributes) that can meet expectations and provide solutions to the adoption barriers	Luchs et al. (2015), Brown (2008), Ingenbleek et al. (2013)
3. Market research	*Aim*: Understand the importance of the bundle attributes to determine which attributes make optimal product bundles for specific market segments *Activities*: Design and conduct a conjoint study. Combine the bundle attributes, develop hypothetical alternative product bundles and examine smallholders' preferences for the alternatives *Outcome*: Selection of preferred bundle attributes that compose optimal product bundle(s)	Ingenbleek et al. (2013), Goldberg et al. (1984), Green and Srinivasan (1978), Rao (2009)
4. Engage stakeholders (product development)	*Aim*: Communicate research findings and sensitize stakeholders for coordinated action in product development and marketing *Activities*: Identify stakeholders, conduct stakeholder consultations and workshops, define roles, functions and benefits *Outcomes*: Consensus on coordinated action and development of product bundle	Rivera-Santos et al. (2012), Parmigiani and Rivera-Santos (2015)
5. Pilot and test	*Aim*: Test the effect of the new product (product bundle) on smallholder actual adoption behaviour *Activities*: Conduct a field experiment, like an RCT or test market *Outcomes*: Modified and improved product bundle, insights into expected costs and potential earnings	Duflo et al. (2007), Gaurav et al. (2011)
6. Implement the product bundle	*Aim*: Create access for smallholders to the productivity-increasing technologies as product bundles *Activities*: Create awareness with smallholders, train agro-dealers and agents, organize supply chain, logistics and market the product *Outcomes*: Adoption of productivity-increasing technologies, wide-scale production and marketing	Cooper (2019), Parmigiani and Rivera-Santos (2015)
7. Evaluation	*Aim*: Check satisfaction, impact on productivity, income and food security *Activities*: Track purchases, impact evaluation through interviews and contribution analysis *Outcome*: Improved offerings for sustainable smallholder development (incremental innovation)	Kotler and Armstrong (2010), Befani and Mayne (2014)

Although our study focused on the aforementioned stages, we see four more steps of the process that need mentioning here: *engage stakeholders, pilot and test the product bundle, implement the product bundle, and evaluation*.

Engage stakeholders: The findings from the conjoint analysis should be used as a starting point to engage stakeholders to develop and market the product bundles. This is important because the different inputs and services that should constitute the product bundle as attributes are usually provided by different stakeholders. Many researchers studying how to fill institutional gaps in low-income contexts also advise the use of stakeholder collaboration (see, for example, Parmigiani & Rivera-Santos, 2015; Rivera-Santos et al., 2012). The conjoint analysis results on smallholder preferences should be used to nurture a joint action of stakeholders, as in stakeholder workshops leading to agreements, coordination and resource allocations (see, Brouwer et al., 2016; Ingenbleek & Immink, 2010; Wubben et al., 2013), which are also challenged in their business

undertakings because of low adoption from the smallholders.

Pilot and test the product bundle: Testing product bundles provides evidence of whether or not smallholders' actual adoption behaviour changes as a result of bundle offering. Testing products provide evidence of buyer acceptance of the new product (Eliashberg et al., 1995). In the context of businesses, it includes identifying test markets (or trial sells) where buyers are exposed to the new products in an experimental set-up to verify the expected sales of the new product before committing to the full implementation of the product (see, Cooper, 2011). In a development project context, it may be difficult to obtain an ideal test market. Researchers may then use randomized control trial (RCT) techniques to test product bundles in a field experiment setting in a real-life situation of the smallholders, for example, by building on the traditional input marketing practices in rural areas (see, for example, Duflo et al., 2007; Gaurav et al., 2011). Bundle testing allows us to confirm whether or not the product bundle meets smallholders' expectations and to make the necessary improvements to further enhance sales and wide-scale adoption.

Implement the product bundle: To launch new products, businesses usually develop marketing strategies to reach as many buyers as possible (see, Cooper, 2019). Much effort is made to reach and satisfy the target market, a set of buyers sharing common needs or characteristics that they will serve (Kotler & Armstrong, 2010), with the right products, right pricing strategies, promotions and distribution channels (see, Cooper, 2011). Likewise, in the context of the smallholders, much effort should be made at this step to create access of smallholders to productivity-increasing technologies as bundles and convince them to become actual buyers of the technologies. In this regard, the stakeholders are required to build their marketing strategy around the target market creating awareness of the product bundles, training agro-dealers and agents to enhance their market knowledge, organize distribution channels using, the cooperatives and supplying the product bundles (Kelly et al., 2003). From a development perspective, the smallholder market can be also further targeted to enhance wider regional development through networking and integration with other smallholder communities.

Evaluation: As an iterative performance check process, businesses conduct a continuous evaluation of performance at each design step on the basis of some pre-established criteria. In the early steps, these are mostly qualitative while in the later steps the criteria tend to be mostly quantitative such as uptake rates and returns (Cooper, 2011). Positive outcomes should be obtained from the evaluation process to proceed to the next step to minimize potential risks. A similar approach can be followed to develop and implement successful product bundles for smallholders.

7. Conclusions

The empirical findings from this study show that bundling increases smallholders' intentions to adopt productivity-increasing technologies, assuming a careful and smallholder-centric design process. The study implies that the development of a product bundle should involve a process of several steps including technological innovation, but emphasizing empathizing and conjoint market research steps (Luchs et al., 2015). The growing popularity of bundling in marketing inputs for smallholders can be logically explained by the value added that comes with offering complementary products together and the gaps that may be covered by services. Such value increase can be explained by smallholders' perceptions of the bundle attributes which, in turn, will influence farmers' decisions to purchase combined inputs.

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Ethics statement

The ethical clearance for this study has been obtained from the Social Sciences Ethics Committee of Wageningen University & Research under review number 2022-168-Ingenbleek-retrospective.

Disclosure statement

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