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Perishability and market power in Nepalese food crop production

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Abstract

This study provides empirical evidence for the relation between perishability in vertically coordinated supply chains and the market power exercised over smallholders in Nepal. Using survey data from small-scale farms of tomatoes, ginger, high-yielding variety paddy seeds, and lentils, we demonstrate how varying levels of perishability affect the degree of market power exercised by contractors and in cooperative farming. We show how much value-added is diverted from farmers, compared to the benchmark set by the least perishable good. Results indicate that more perishable crops are subject to a greater degree of market power. A subsequent scenario analysis reveals that the redistributive effects of market power based on crop perishability are substantial: smallholders' farm profitability increase by 18% as crop perishability is reduced by 50%. We conclude by discussing policy measures to reduce power imbalances due to crop perishability.

KEYWORDS

market power, Nepal, perishability, storability

JEL CLASSIFICATION

L14; L15; Q12; Q13

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1 | INTRODUCTION

Smallholders in developing and emerging economies (DEE) face substantial time constraints when marketing agricultural output, especially when selling highly perishable crops (Hendrikse & Veerman, 2001). This is particularly true under tropical and subtropical conditions with high temperature and humidity levels in regions of Asia and Africa, where agricultural value chains tend to lack transport facilities appropriate to conserve agricultural output (Basavaraja et al., 2007), as well as adequate storage facilities (Bala et al., 2010; Basavaraja et al., 2007; Kumar & Kalita, 2017; Tefera et al., 2011). In the marketing of agricultural output, the crop perishability affects farmers' bargaining positions because the spoilage frequency poses a considerable risk to farmers. The market power of agricultural traders over smallholders that is already present in many value chains (Kopp & Sexton, 2021), be it companies or contractors, is likely to increase with the increasing perishability of crops (Singh, 2002b). The same is true for the extractive activities within mismanaged agricultural cooperatives, the second governance structure subject to this analysis.

Contract farming (CF)¹ was introduced initially as an effective approach to overcome moral hazard in terms of unobservable quality characteristics that are determined by farmers' efforts (Hennessy, 1996). In CF, agribusiness firms contract with external farmers to receive the goods with the certainty of delivering specified quality, quantity and time. Rather than owning farms themselves, the firms rely on these smallholders to produce and provide their goods. CF also increases crop yields and incomes of smallholders through reduced transaction costs, particularly in DEE (Bellemare & Lim, 2018; Dedehouanou et al., 2013; Mishra et al., 2018b, 2018c). Further, agricultural markets in DEE are often unreliable. However, CF has also been found to be associated with the market power of contractors of agricultural goods over smallholders (Sivramkrishna & Jyotishi, 2008; Weldegebriel, 2004). Thus, in DEE, where farmers' educational attainment and information on future and current market conditions are often limited, firms may tend to differentiate producers and offer pricing schemes based on the perishability of the produce. Singh (2002b, p. 187) considers monopsony 'as crucial for the viable functioning of the contracting firm, regarding a reasonable return on investment'. Further, Baumann (2000, p. 24) argues that 'a market monopsony is an essential component of CF as it is the only way to ensure that companies can secure a return on their investment'. The already substantial market power that contractors can exercise over smallholders can be further increased by the perishability of farm products, especially of high-value crops.

One particular form of CF is cooperative farming, in which farmers cooperate in order to create a counterweight to the contractors' market power. CF with cooperatives generally requires that the product meets minimal quality standards. Short-term crops like tomatoes and vegetables are suitable for cooperatives and provide fresh vegetables to wholesalers (Niroja et al., 2015). It is believed that 33% of 9758 cooperatives in Nepal are agricultural cooperatives. Agricultural cooperatives have enhanced bargaining power and resource sharing, negotiated better terms in CF, and increased farmers' food security and income. Shrestha and Adhikari (2010) argue that cooperatives in Nepal can help farmers achieve economies of scale in production, reduce transaction costs and associated risks, access to distant markets, and receive development services and inputs more effectively and efficiently through CF. However, this positive image of cooperative farming is partially shadowed by some studies which found that mismanagement of cooperatives in Nepal has undermined the benefits of the collective bargain (Simkhada, 2013) as well as instances of cronyism and outright corruption amongst cooperatives' leaderships (Fulton & Giannakas, 2020; Tortia et al., 2013).

¹Here defined as a contractual relationship between one buyer ('contractor') and a number of independent farmers, in which the contract specifies the farming practices and guarantees a price premium for the farmer. More details on governance structures are provided in Section 2.

To the best of our knowledge, this is the first study to quantitatively assess the impact of the perishability of agricultural products on the amount of market power that is exercised over farmers. Although the importance of perishability for the characteristics of transactions in agricultural value chains and the distribution of value-added is generally acknowledged (e.g. Hendrikse & Veerman, 2001; McCorrison, 2013; Weaver & Moon, 2018), and the adverse effects of poor availability of storage facilities on health outcomes have been demonstrated in the literature (Ankita et al., 2012; Bhandari et al., 2013), no previous study systematically analyses how different levels of perishability among commodities affect the amount of market power exercised by contractors. Further, while the literature often treats perishability as a binary attribute, perishable crops are in fact unequally vulnerable to spoilage and the market power of contractors over smallholders may increase with the increasing perishability of the crops.

The effect of crop perishability on market power is investigated for small-scale farming in the Terai region of Nepal. Smallholders in Nepal face several complex production, marketing and financial constraints, including high transaction costs and limited access to inputs, information, new technology and output markets. To overcome these constraints, policy-makers and development organisations alike have been promoting CF in Nepal. The high prevalence of CF makes the Terai region an excellent case in point for evaluating the potentially associated adverse effects.

The empirical analysis is executed in two steps. First, we assess the variation in the levels of perishability between the crops produced under different governance structures, relying on farm-level data for a selection of crops that differ in their respective levels of perishability, namely tomato, ginger, high-yielding varieties (HYV) of paddy seeds, and lentils. The second step is to identify how the degree of perishability among the crops affects the market power exercised by contractors in comparison to spot markets. Given the ambiguous role of cooperatives (counterweight bargaining power of contractors vs. potential mismanagement and corruption) and in order to provide a conservative, lower bound estimate of the effect of perishability, we include cooperative farmers in the contract farmers' group.

We also derive the share of the yearly value-added that was redistributed from farmers to contractors because of contractors' market power based upon perishability, by comparison with a benchmark set by the more storable crops under contract production.

The remainder of the paper is organised as follows: the following sections provide background information on the dominant governance structures in the Terai region of Nepal, market power in CF and mismanagement in cooperative farming, and subsequently on the farming system in the study region. The econometric analysis follows with the description of the empirical approach, data description and estimation results. The final section discusses policy implications and concludes.

2 | GOVERNANCE STRUCTURES, MARKET POWER AND PERISHABILITY

2.1 | Challenges in crop production, marketing and corresponding governance structures

In DEE, marketing challenges include, most prominently, prices and production risks, transportation and credit, access to technology, farming practices and markets. Farms are often small and located in remote areas, away from urban areas and cities. Smallholders face uncertainty in the market prices due to the variation in product quality and market conditions. Variability in output may arise due to poor agronomic practices, temporary lack of fertiliser and other inputs, access to irrigation, limited technical knowledge and weather risks. Secondly, smallholders lack transportation facilities, such as trucks and motorised

vehicles, and access to main roads to market their produce in a timely fashion. Timely access to markets is crucial for perishable commodities like tomatoes and other vegetables because consumers demand freshness in these products, valuing freshness through higher prices. Thirdly, access to capital is severely constrained for smallholders in DEE, either due to a lack of lenders or lenders charging excessive interest rates on borrowed capital. Fourthly, during the last two decades, due to budgetary pressures and the development of private markets, there has been a reduction in DEE in the role of the government in providing market access, inputs and technical services. Finally, smallholders lack on-site storage facilities due to high set-up costs and lack of electricity. Instead, storage facilities are often located in urban areas connected to major distribution hubs for domestic and international markets.

These value chain specific challenges are determinants for the emergence of different governance mechanisms. Hendrikse (2003) refers to *governance* as the set of rules that administer exchange between producers and buyers. Governance structures can be classified on a continuum, ranging from the spot market with many independent buyers and sellers and absence of any coordination to vertical integration, where one firm controls all production and distribution stages in the same industry (Williamson, 1979, 2002). Factors that lead to closer vertical coordination include business partner specific investments and asymmetric information. The relevant governance structures for the case at hand are spot markets, contract farming (CF), cooperatives with CF (CCF) and cooperatives with assets at an adjacent stage (CAS).

Spot markets are more likely to emerge when products are homogeneous, many (identical) suppliers and buyers populate the market, or information is symmetric. Spot market governance is straightforward. Smallholders own the assets and receive residual income. Note that different market segments of one crop can be subject to different governance mechanisms if products are differentiated, such as sustainability certification or fair trade, for example.

On the continuum between spot markets and vertical integration, contract farming represents a governance structure between these extremes (Peterson et al., 2001), where one buyer and many sellers engage in a contractual relationship. Factors that lead to the emergence of contract farming include access to new technology, inputs, output markets and credit (Otsuka et al., 2016). Under CF, the contracting firms help smallholders during the production or marketing process with improved technology such as seeds and other inputs, access to information, extension knowledge and service, storage and transportation facilities, or guaranteed output markets and may thus reduce the transaction costs compared to a spot market arrangement. The firm or the contractor owns the assets, controls rights, negotiates the contract, sets quality and quantity standards and delivery time, and regularly monitors the cultivation practices. Compared to spot market arrangements, asset specificity is the most critical transaction characteristic of CF. Residual returns (after paying all entities) go to the company or the proprietor (Chaddad & Cook, 2004; Chaddad & Iliopoulos, 2013).

Cooperatives likely emerge in situations of asymmetric bargaining power, access to input and output markets, and financial resources. Smallholders form cooperatives to enhance their economic power. A farmers' cooperative can serve one or more functions, including the provision of loans and information, selling of inputs, bargaining on behalf of its members, providing transportation services, and marketing of agriculture products. Cooperatives also negotiate contracts with firms and then redistribute the contract between the members of the cooperative (Cobia, 1989). The governance structure present in Nepal combines CCF and CAS: they are patron-owned organisations, with patrons being smallholders. The ownership rights are restricted to member-patrons. The cooperatives own assets and financial resources to help smallholders with their needs in farming (access to inputs, transportation, markets, information and technical services). Cooperatives negotiate contracts with downstream companies and subsequently write contracts with individual members. Residual income is distributed to members in proportion to patronage (Srinivasan & Phansalkar, 2003).

2.2 | Livelihood effects of contract and cooperative farming

Many studies have investigated contract and cooperative farming's roles and their impact on farmers' economic well-being in DEE (Masakure & Henson, 2005; Mishra et al., 2018b; Otsuka et al., 2016; Oya, 2012; Prowse, 2012; Winters et al., 2005). Most of the empirical literature on the topic focuses on exploring the drivers of participation in CF and CF's impact on farms and households. In assessing the drivers of the involvement in CF, the role of several socio-economic and demographic variables has been investigated. For example, the operator's age and caste, gender, education, farm size, farming experience, access to credit, and distance to road and market have often been included in the analysis of a farmer's decision to participate in CF.²

Contrary to popular belief, in India, a neighbouring country of Nepal, the country of interest in this analysis, studies have found that CF in labour-intensive and perishable crops generated more employment in the economy. These studies include examinations of gherkin cultivation in different regions (Dev & Rao, 2005; Kumar & Kumar, 2008; Nagaraj et al., 2008), tomato, potato and chilli cultivation in Punjab (Dileep et al., 2002; Singh, 2002a), and milk production in Punjab and Rajasthan (Birthal et al., 2005, 2008). Ramaswami et al. (2006) investigated gains from CF for poultry farmers in India. They found that profits for contracted farmers were higher than their counterparts and conclude that poultry growers may have benefited from CF, but lacked bargaining power. Tripathi et al. (2005) concluded that the cost of cultivation, yield and incomes (gross and net) were higher for potato farmers with CF than their counterparts. In the early 2000s, Singh (2002a) found that, compared to independent farmers, contract farmers of tomato, chilli and potato in Punjab received higher farm income. However, Singh (2002a) also notes that farmers mentioned a lack of trust between themselves and the contracting firms, expressing concerns about monopolisation by firms. Swain (2011) found that contracted large farmers in rice seed and gherkin commodities in Andhra Pradesh received higher profits and employed more labour than non-contracting farmers. The author explains this finding with the observation that in this specific case, the firm engaged in re-grading without informing the farmers, and concludes that the firm's monopsonistic behaviour and product rejection was economically unsustainable. Finally, Sharma (2016) found that contract farmers in potato and basmati rice farms in Punjab had higher income and resource use efficiency than non-contract farmers.

The majority of cooperatives members are from poor and marginal farmers in rural areas. One can interpret cooperative as a community-based business. Cooperatives provide access to credits, marketing, information and training, technologies, and transport of products from rural to urban areas. It also provides capital for enterprise development. All these measures combined ensure livelihood earnings for smallholders (Markelova & Mwangi, 2010; Mishra et al., 2018a; Sporleder & Hong, 2007). Through cooperatives, rural households in Nepal have increased access to such services and, most importantly, increased their bargaining capacity. Finally, cooperatives have been identified as essential entities in poverty reduction (Bharadwaj, 2012).

²For space limitations and brevity, we will focus on the literature on CF's impact on indicators of farming households' economic well-being, such as income, profits and yields. CF in many developing countries depicts a mixed picture with both successes and failures (Little and Watts, 1994; Key and Runsten, 1999; Glover, 1990; Glover, 1984; Simmons et al., 2005). Studies have investigated the impact of CF on income and employment (Glover, 1990; Key and Runsten, 1999; Glover, 1984) and found that CF improves the income of farmers and increases the employment of workers (Singh, 2002a; Warning and Key, 2002; Tripathi et al., 2005; Birthal et al., 2005; Simmons et al., 2005; Ramaswami et al., 2006; Setboonsarng et al., 2008; Miyata et al., 2009; Wainaina et al., 2014; Kalamkar, 2012; Michelson, 2013; Bellemare and Lim, 2018). In a recent book, Mishra et al. (2020) collect case studies in South Asia that exemplify the success of CF in high-value and low-value crops in Nepal, India and Bangladesh.

2.3 | Market power of contractors and management issues in cooperatives

Market power in contract farming has been found by a number of authors (Kwoka & White, 2004; MacDonald et al., 2004; Weldegebriel, 2004). A farmers' contractor-specific investments due to contracts characterised by high levels of vertical coordination likely cause supplier lock-in. Whenever a contracting farmer is locked in a contract, contractors can potentially extract monopsony or oligopsony rents at the expense of the farmers' welfare (Little & Watts, 1994; Singh, 2002b). These authors highlight the exploitative nature of CF due to the monopsonistic power of the firm as a buyer. Singh (2002b) notes that contracting in DEE may lead to market irregularities, including the exploitation of producers by contracting companies, and identifies additional problems associated with CF. These problems include violation of terms of the agreement, social differentiation—based on caste and religion—and degradation of soils and water due to monoculture. Rehber (2000) notes that companies engaging in CF could exploit farmers by taking advantage of gaps or loopholes in the contract, enforcing mono-cropping, or manipulating agreements relating to quality standards. Thus, the contractors' market power eventually affects the financial performance and welfare of farming families in DEE. However, about 60% of smallholders stated being content with the CF system nevertheless, even though contracts are often 'biased against the farmer' (Singh, 2002b, p. 181).

To form a counterweight to contractors' market power, cooperatives have engaged in collective bargaining processes. But though cooperatives have strengthened rural Nepalese livelihoods, there are a couple of weaknesses that need to be pointed out. There are cases in which the knowledge of principles and values of cooperatives is lacking within its members' base. Corruption and mismanagement due to weak monitoring have led to difficulties and a lack of trust from members. Finally, other significant problems faced by cooperatives in Nepal include a lack of financial objectives, corruption and weak portfolio management (Simkhada, 2013).

2.4 | Market power from perishability

Market power in CF as well as mismanagement in cooperatives can be amplified in the presence of quick perishability in specific crops. The rates at which different crops deteriorate are consequentially related to respective market outcomes.

One possibility for a farmer of a highly perishable crop to assure prompt selling after harvest is to participate in a vertically more coordinated supply chain (Hubbard, 1997) by entering a contract, either individually or through a cooperative. In the Terai region of Nepal, these contracts commonly legislate the quantity, quality and inputs used on the contracted farmer's fields (Mishra et al., 2016). Prices are determined based on the quality, quantity and delivery date. As crops differ in their level of perishability, farmers vary systematically in their risks of making negative profits: the less time after harvest a farmer has for selling, the bigger is their risk to incur a loss. Hence, farmers of a more perishable crop have a higher incentive to enter a production contract. Since the storability of crops is generally known, there is symmetric information between the seller and the contractor. Both parties know about the farmer's urgency to sell the more perishable crop soon after harvest and are therefore more interested in closing a production contract in advance. In other words, the farmer growing the crop that can be stored for longer periods has a substantially better bargaining position compared to the farmer of the highly perishable crop already at the day of harvest, which in turn affects the farm's business outcome. This puts farmers of more storable commodities in a better bargaining position vis-à-vis contractors, compared to the ones of more perishable commodities.

The contractor's purchase price for output is determined by a combination of factors such as cost of production, quality of produce, and prevailing local market price. The

contractors assess in advance the quantity of produce that each contract farmer anticipates producing and supplying. The firm gives a higher price for better quality. The contracts are signed annually before the planting of the crop. Contracts are written and generally survive on mutual trust between the contracting parties. All products produced under contract by smallholders, regardless of the commodity, should meet specified quality, grade and timely delivery. HYV paddy seeds and lentils produced in the Terai region are relatively homogeneous in terms of quality, with minor differences across farmers or over time. For tomato and ginger, output is more heterogeneous. For both tomato and ginger, quality is graded by visual and olfactory inspection, the main determinants being colour and odour (there are no credence attributes). Thus, while the four crops differ in terms of the variability in quality, there is no information asymmetry, either in contract relationships or spot markets. Consequently, quality is valued equally in spot market transactions as well as in contracts. As there is no systematic difference in how crop quality is measured and valued, quality-related characteristics are not to be expected to pose another source of systematic price depression of contracted crops.

Some anecdotal evidence exists on the relationship between crop perishability and gains from CF. However, this relationship has not been subject to systematic analysis in the past. For example, both gherkins and chillies have limited shelf-life after harvest and need to be consumed timely (fresh gherkins can last up to 2 weeks if stored properly and chillies lose freshness if not refrigerated within a week). Consumers in South Asia like to consume fresh gherkins and buy from local vendors, in season, about 2–3 times a week. Similarly, South Asian consumers use green chillies in food preparation or eat them raw with meals. Consumers tend to buy chillies in local/farmers' vegetable markets. Dev and Rao (2005) found that contract gherkin producers had higher yields than independent gherkin producers. In 2008, Nagaraj et al. found that contract baby corn, gherkin and chilli farmers in Karnataka, India, had higher net returns. Other commodities classified as high-value crops and characterised by short shelf-lives and immediate consumption are, in this order, poultry, milk and vegetables. Birthal et al. (2005) examined the role of CF of smallholders in these commodities and found that, compared to independent growers, CF smallholders received higher prices. In 2014, Narayanan (2014) found that farmers with a contract in papaya, broilers and gherkins earned higher net profits than their independent counterparts. However, there is also conflicting evidence. Kalamkar (2012) found that, compared to independent farmers, contract broiler farmers received lower net returns. Similarly, Singh and Asokan (2003) found that, compared to independent growers, contract basmati paddy producers had lower yields and incomes. Note that basmati rice has longer storability and the grain quality gets better with time, and that grain quality in terms of grain length and aromatic intensity also increases with length of storage, similar to the ageing of wine.

2.5 | Hypotheses

However, none of these studies assess whether crop perishability affects any advantage to contract farmers. We evaluate if farmers of more perishable crops are, on average, subject to higher levels of market power exercised by contractors, *ceteris paribus*. Two hypotheses are to be evaluated for the case of contract farmers in the Terai region in Nepal:

Hypothesis 1 *Crop perishability increases market power in contract farming.*

Hypothesis 2 *A reduction of crop perishability increases contract farmers' welfare.*

For both hypotheses, contract farming includes both contracts between firms and individuals and between firms and cooperatives.

3 | AGRICULTURAL PRODUCTION IN THE TERAI REGION, NEPAL

The Terai region of Nepal covers several climatic zones, making it ideal for growing a vast variety of horticultural crops such as tomatoes and ginger, as well as HYV paddy seeds and lentils. At the extreme ends of the perishability distribution, tomato farmers have to sell their produce within a week, whereas lentil smallholders can store their crops for years under the phytosanitary circumstances that are common in the region. Further, all four crops are sold both on spot markets and via contracts.

3.1 | Agroclimatic conditions

Nepal is a landlocked country of 27 million people. The country is divided into three major geographic regions—the Terai, the Hills and the Mountains—and 48% of the country's population lives in the Terai region. Representing the lowest elevations of Nepal, the Terai enjoys subtropical—that is, warm and humid—climatic conditions favourable for growing three crops in a year, and is known as the grain house of Nepal. Additionally, the Terai region has climatic variation from east to west and substantial diversity in water resources and the availability of irrigation facilities (rivers and irrigation canals), due to a wide range of agro-climatic and topographical conditions. The Terai region has alluvial and sandy alluvial soil that is most suitable for growing crops, vegetables and other food items (Bhandari et al., 2016). Irrigation, roads and market infrastructures are relatively well developed. Finally, producer groups and processors/exporters of crops and vegetables are mainly concentrated in the region. Therefore, it is no surprise that most vegetables and HYV paddy seeds are grown in the Terai region.

3.2 | Crop types cultivated in the study region

Tomato is an essential vegetable crop with high market potential. Most tomato produced in Nepal is a staple in Nepalese cuisine, used in the preparation of food items at home, restaurants and cafeterias. They are used to make chutney (*achar*), and act as a base to many curry recipes and soups. Raw tomatoes are further used in salads and sandwiches. Small quantities of tomatoes are used for industrial purposes (ketchup, paste, puree). In Nepal, unlike in industrialised economies, the same varieties are used for both purposes. Tomato output peaks in the summer in the Hills region (from May to September) and it is produced in the Terai region in winter (from November to March) when it is too cold in the Hills. Tomato is a labour-intensive crop and labour wages make up 50% of the total cost of production (Mishra, Shaik, et al., 2018). Other production costs include seeds, fertilisers, pesticides, manure and stacking. Farmers use chemical fertilisers and pesticides to increase or maintain land productivity. The mean sales value in our sample is the equivalent of £1.53 per quintal. Tomatoes are highly perishable. According to Surekha et al. (2010, table 5), 60% of tomatoes spoil after 6 days which makes it the least storable crop included in this investigation. High transportation costs and storage loss contribute to market price variability with the season and location in Nepal. Post-harvest losses in fresh tomatoes are about 5% each at producer, collector, wholesaler and retailer levels (Surekha et al., 2010). As a result, several cooperatives in conjunction with international companies specialising in value chains and vertical linkages are engaged in CF with smallholders in the Terai and Hill regions of Nepal.

Ginger is an important spice crop for Nepal, contributing about 9% to the world's total ginger production, making it the fourth-largest producer of ginger in the world, behind India, China and Indonesia. Ginger cultivation is mainly on small farms and the crop is essential in terms of employment, the area under cultivation, the value of production and export earnings.

Its importance has been steadily rising, with Nepalese farmers having increased land allocated to ginger by 32% between 2009/10 and 2015/16 and the total output by about 25% in the same period (Pandey et al., 2019). This production has made the country self-sufficient for domestic consumption. Ginger is traditionally grown in the mid-hill areas of Terai from April to October. The mean sales value in our sample is £3.20 per quintal. Smallholder ginger producers face significant constraints, including inadequate knowledge on quality seed suppliers and a lack of technical knowledge on crop production and disease protection (rhizome rot disease), resulting in low productivity. They also face high storage and transportation costs. This poses a substantial challenge to farmers, as the crop is the second least storable crop under consideration. Mishra et al. (2004, tables 1 and 2) report that the quality of ginger was already unacceptable after 20 days and that samples spoiled entirely after 28 days. While a share of ginger is marketed via village spot markets, a general lack of farmers' knowledge on post-harvest handling and food safety issues (cleaning/washing facilities, inefficient processing technology), as well as access to markets and credit, make CF an attractive option.

Rice is the most important food crop in Nepal, accounting for more than half of the cultivated cropped area and food production in Nepal. Enhancing rice production through productivity increases is a strategy to meet growing rice demands and to improve the income and livelihood of farmers in the country. The use of HYV seeds enhances the efficiency and productivity of other key inputs such as fertilisers, irrigation and labour. Given that the seed is essential in agricultural production and its attributes are vital to meet agro-climatic and soil conditions of the region, a method to increase rice productivity is to use improved crop varieties and quality seeds. This measure alone can increase crop yields by 20–30% (Sah et al., 2015). Mishra et al. (2016) report that the Nepalese government wants to increase improved seed production by threefold in the period 2013–2025. Consequentially, the seed business is emerging as a viable and sustainable enterprise in Nepal. The use of hybrid rice seeds is expanding with a higher profit margin for seed dealers and retailers and an increasing trend for market-oriented production in favourable rice-producing domains of Terai and the Hill regions of Nepal. The mean sales value in our sample is £1.47 per quintal. HYV rice paddy is produced throughout the Terai region, with the main growing season stretching from July to December. The storability of HYV rice paddy is measured in a different way than for the food crops, as it is not grown for direct consumption but for planting. The indicator equivalent to the food crops is the half-viability index (P50), which is the time after which less than 50% of the seeds retain their ability to germinate (Ozden et al., 2017). According to Gupta (2010, Table 1), HYV paddy seeds have a half-viability of 36 months. HYV paddy seeds are grown by individual farmers or on a contractual basis with seed companies. While the marketing of seeds is done mainly through seed dealers, retailers and companies that are involved in CF, a substantial share is marketed on spot markets.

Lentil is the most important legume crop in Nepal, being the primary source of protein for the majority of the population. Farmers primarily produce lentils for selling as a pulse crop. The cultivation of lentils has been increasing because of domestic consumption and the potential for the export market, given that Nepalese lentils face a high demand in the international market. The share of lentils in the gross cropped area of Nepal has increased by 23.5% from 1981 to 2013. Most lentils in Nepal are grown in the Terai region from October to March as a sole crop, a mixed crop with tillage or a relay crop. The mean sales value in our sample is the highest of all crops under consideration at £4.52 per quintal. In their study on the perishability of red lentils, which went on for 16 weeks, Sravanthi et al. (2013) found that within that time, no damage could be observed on the lentils. According to a company that markets seeds to end consumers³, lentils last about 5 years if stored in a cool, dry and dark storage place with a temperature of 5570 °F and a humidity of 70% or less. Mishra et al. (2018b) report that although

³<https://sproutpeople.org/growing-sprouts/sprouting-basics/seed-storage>

TABLE 1 Characteristics of crop types

Characteristic	Tomato	Ginger	HYV paddy seed	Lentil
Durability (months)	0.2	1	4	36
Cooperatives engage in CF	Yes	No	No	Yes
Spot market presence	Yes	Yes	Yes	Yes
CF presence	Yes	Yes	Yes	Yes
Number of contractors in CF	6	1	5	5
Fertilisers	Yes	Yes	Yes	Yes
Pesticides	Yes	Yes	Yes	Yes
Seeds	Yes	Yes	Yes	Yes
Manure	Yes	Yes	Yes	Yes
Transportation costs	High	High	Low	Low
Storage costs	High	High	Low	Low
Labour costs/total costs	40%	37%	33%	27%
Mean sales value (£ per quintal)	1.53	3.20	1.47	4.52

lentil is the number one export crop of Nepal, it faces substantial yield gaps compared to China, India, Turkey and Australia. To increase the productivity and income of lentil farmers, the Nepalese government has implemented increased use of vertical linkages, through CF, in production, transportation, processing and storage.

A summary of the crop characteristics is provided in [Table 1](#).

3.3 | Market environment in Terai

Farmers in the Terai region market their produce via up to three possible channels which coexist in the study region. These include selling in the local village market, selling to contractors through production contracts, or selling to agricultural cooperatives. The most important buyers for all four commodities are firms engaged in CF. The firms are locally owned and operated with a dual mission: first, helping smallholders with their livelihood strategies and food security and, secondly, selling the final product in the coveted urban markets and exporting products, such as tomato and ginger, to other countries, mainly in South Asia. In the case of ginger, only one firm provides contracts to ginger smallholders. Tomatoes, HYV paddy seeds and lentils are also purchased by cooperatives involved in selling the product at urban markets and to exporters for international markets. For the three food crops under consideration, the value-chains are typically not very long, usually consisting of the farmers, contracting firms/cooperatives at the local level and final users—consumers in urban areas or export markets.

Selling in a local village market can be described as fairly competitive, whereas selling to contractors is characterised by the possibility of oligopsonistic market power. Although selling to cooperatives is generally assumed to be more competitive than selling to contractors, it may also involve rent-seeking activities. The following provides detailed information on the three marketing channels available to smallholders in Terai, Nepal.

3.3.1 | Spot markets

The majority of produce sold in the spot market is, for all four types of crops, in village markets. Our experience on the ground suggests that the village markets in Terai are frequented by villagers meeting their own home consumption requirements, labourers working in local farms and factories, and other small-scale farmers who buy vegetables and farm inputs like HYV paddy seeds as input for farm production. The buyers are not only many in numbers but also purchase small quantities. Hence, these village markets are of an 'atomistic' structure (Shepherd, 1972, p. 25), characterised by many sellers and buyers.

3.3.2 | Contract farming

The Nepalese government, faced by permanent budgetary pressures, is looking at ways to innovate and increase food production, productivity and efficiency of smallholder agriculture. This is true for high-value crops like tomato and ginger and staples like rice and lentil. One way to remedy the above problems, especially with the private sector's help, is the use of CF. For that reason, the government of Nepal (GoN), under the Nepal Agriculture and Food Security Country Investment Plan (CIP) and the National Agriculture Sector Development Priority for the Medium-Term (NASDP 2010/11–2014/15), enacted the Poverty Reduction and Food Security plan to strengthen the national economy. The CIP outlined ten agriculture and food security programs and activities, including CF, that were to be carried out by the GoN Ministry of Agriculture and Cooperatives over the next 5 years (MoAC, 2010; MoAD, 2014). The GoN opened the door for private firms, national and multinational companies to engage in CF. Cooperatives in Nepal have a long history—first established in 1992—and engage in CF with their members (Mishra et al., 2018b). In our study, cooperatives engage in CF with tomato, lentil and HYV paddy seed production. The GoN does not subsidise CF schemes.

Selling via contracts is more attractive to smallholders, as they are generally associated with higher profit margins (in terms of total revenue minus total costs), and higher returns to labour and land. This also holds for the Terai region, where the mean profit advantage of a contract-farmer over non-contract farmers across all crops is a factor of 2.86. Further, the return on land for contract farmers is 2.42 times more than the non-contract farmers'. The price advantage is a factor of 1.06.⁴ The contracting companies participate in CF by conducting formal contracts with smallholders in ginger, lentil, HYV paddy seed and tomato production. The contracts specify the negotiated output price, quantity of produce and quality of output to be delivered by the smallholder. Contractors agree to provide seeds and extension services to smallholder farms in exchange for the exclusive rights to commodities.

The contract market is likely to be characterised by market power, as due to entry barriers, only a handful of contractors offer contracts to smallholders. The number of contractors involved in CF differs by commodity. The farmers' poor bargaining power vis-à-vis contractors is further amplified for several reasons, such as poor education of farmers and lack of court systems that can solve disputes in a timely fashion. Even then, farmers do not have access to proper representation in courts because of costs (court and attorney costs) and accessibility due to distance to towns and courts. The initial market power held by contracting firms over smallholders can be exacerbated by the fact that, depending on the durability of the product, smallholders are under time pressure to sell their product.

⁴All numbers are based on original survey data.

For all commodities, contractors and cooperatives offer production contracts, legislating the business relationship and production methods in the form of yearly written contracts. Although the contract characteristics are similar across contractors/cooperatives and crops, the typical legal form of the contractor differs by crop.⁵ Contractors for tomatoes and lentils are more often cooperatives, whereas for HYV paddy seeds, cooperatives and private companies serve as contracting firms. Finally, contracts for producing ginger are offered by one single firm.

3.3.3 | Cooperatives

Finally, cooperatives engage in CF by negotiating with the contracting company, effectively acting as intermediaries between farmers and contractors. Contracting firms also prefer to enter into contracts with cooperatives to reduce negotiation times, costs and contract writing with individual farmers (Mishra et al., 2018a). Smallholders may want to work with cooperatives because of better trust and proximity to leadership and information sources. The motivation behind setting up farmers' cooperatives is to increase farmers' incomes. Cooperatives create countervailing bargaining power by allowing their members to jointly negotiate with the next value chain stage and are therefore able to pay higher farm gate prices to their members (Hendrikse, 2011). This is amplified by the fact that cooperatives do not intend to make profits, unlike the contractors they replace (Liang & Hendrikse, 2016). However, the profits received by farmers marketing to contractors through cooperatives can also be lower than under direct farm-firm contracts because of substantial administrative costs of running the cooperatives. Another reason for lower returns in cooperative farming is that people in power in the cooperatives may act more in their interest than collectively for the entire membership of the cooperative (Tortia et al., 2013). For instance, cooperative leadership could favour contracts with buyers that favour their personal farms or through outright corruption (Fulton & Giannakas, 2020).

Once a certain number of contracting firms have been replaced by cooperatives, the competitive yardstick argument suggests that the resulting increased farm incomes of cooperatives' members lead to a higher price level in general, due to competition between cooperatives and contractors for agricultural input (Liang & Hendrikse, 2016). Empirical evidence is provided by Hanisch et al. (2013) for the EU dairy market, who find that an increase in the produce share that is marketed via cooperatives increases the average price level in that market.

In the study region, three of the four crops under consideration are marketed via contracts through private companies, contracts by cooperatives and on the spot markets. For instance, lentils, HYV paddy seeds and tomatoes are marketed in spot markets and to contractors from private firms and cooperatives. Ginger is marketed only in the spot market and via cooperatives to contractors. The empirical analysis, as detailed below, anticipates that, in general, cooperatives increase the prices paid to their members compared to contractors (countervailing power argument). This in turn leads to an increase in prices paid by contractors too (competitive yardstick argument), resulting in the estimates representing a lower bound of contractors' market power from crop perishability.

Our focus here is on the effects of perishability on market power, rather than on differences between contracting and cooperative marketing. There are good reasons for examining the latter differences. However, our data (lack of information about transfers of cooperative revenues to farmers) and the particular conditions of cooperatives in Nepal (inefficiencies, mismanagement, and even corruption at cooperatives' management levels have been reported for Nepal, Bharadwaj, 2012; Puri & Walsh, 2018) mean that examination of the differences between contract and cooperative marketing are both difficult in our case, if possible at all, and would

⁵In other environments, cooperatives vary substantially between crop types in their respective organisation of production (Bijman and Iliopoulos, 2014).

detract from our main focus on perishability. To do so, we combine cooperative and contract marketing into a single group to be compared with the returns from the spot market. We argue that this comparison provides a lower bound estimate of the effects of perishability on market power, reinforced by the possible effects of both marketing channels on the spot price itself.

4 | ESTIMATION OF EFFECT OF CROP PERISHABILITY ON CONTRACT CHARACTERISTICS: DATA AND METHODOLOGY

The market power caused by different degrees of perishability between crops may lead to contract conditions being systematically worse for farmers of highly perishable crops compared to producers of more storable goods. The empirical analysis quantifies this effect and derives distributional consequences by calculating the contract farmers' profit advantage over spot market farmers and then comparing these advantages between farmers whose output differs in the level of storability. To avoid overestimation of the measured effect, farmers who market to contractors through a cooperative are included in the CF group, given the opposing effects of collective bargaining versus mismanagement of cooperative membership on farmers' business outcomes. The relative advantage of a specific contract farmer j over farmers who sell in the spot market in village i is denoted by $\Gamma_{j,i,c}$, and given by:

$$\Gamma_{j,i,c} = \frac{\pi_{j,i,c}^{CF}}{\bar{\pi}_{i,c}^S}, \quad (1)$$

The numerator of Equation (1), $\pi_{j,i,c}^{CF}$, represents the per-hectare profit margin of *one specific* contract farmer j in village i , while $\bar{\pi}_{i,c}^S$ in the denominator denotes the *mean* margin of all non-contract (i.e., spot market) farmers active in village i , with superscripts CF and S standing for sales through contracts and on the spot markets, respectively. Profits are a function of production costs, downstream prices, and market power, as illustrated by Equation (2):

$$\Gamma_{j,i,c} = \frac{\pi_{j,i,c}^{CF} (c_c^{CF}, p_{o,c}^{CF}, \lambda_{i,c}^{CF} (S_c | O_{i,c}))}{\bar{\pi}_{i,c}^S (c_c^S, p_{o,c}^S, \lambda_{i,c}^S (O_{i,c}))}. \quad (2)$$

Farmers' production costs, c_c , vary between crops and depend on whether the output is destined to be sold under contract or on the spot market. Contractors' output prices of crops, $p_{o,c}$, are identical across villages because contractors compete on the output market. The farm gate price, on the other hand, depends on the market power $\lambda_{i,c}$ that farmers of crop c are subject to in village i . The combined buyer power exercised over smallholders of crop c in village i is denoted by the index $\lambda_{c,i} \in [0, 1]$. Parameter $\lambda_{c,i}$ can be interpreted as the conjectural elasticity in purchasing input (Perloff et al., 2007) and depends on storability, S_c , as well as determinants of market power other than storability, denoted by $O_{i,c}$. Storability S_c is defined as the half-life of crop c , calculated from the number of periods after harvest that the farmer has for marketing the crop before it spoils.⁶ $O_{i,c}$ captures the oligopsonisation between contractors, who form

⁶More details on this measure are provided in the data section. For a specific batch of product, S_c is unobservable. However, both smallholders and contractors can rely on observable information to proxy the remaining days to spoilage immediately after harvest. One such information is the crop type: different types of crops are known to be more or less durable.

TABLE 2 Number of farmers in the sample

	Ginger	Tomato	HYV paddy seed	Lentils	Total
Contract	221	294	223	231	969
Independent	362	207	215	281	1065
Total	583	501	438	512	

TABLE 3 Summary statistics of the variables used in the estimation

Variable	Mean	Std. Dev.	Min.	Max.	<i>N</i>
$\Gamma_{j,i,c}$ relative advantage of contracting	1.3	0.93	0.01	6.66	969
S_c half-life of crop <i>c</i> in days	6119	10,351	4.5	24,594	969
θ_d contractors per survey farmer in district <i>d</i>	0.06	0.05	0.01	0.12	969

Note: $\Gamma_{j,i,c}$ captures the ratio between business outcome of a contract farmer over the village-means of non-contract farmers in terms of per-hectare profit as defined in Equation (1), and S_c is the perishability of crop *c*, measured as half-life in days. Only contract farmers represent single observations in the estimation since the village means of the non-contract smallholders enter the denominator of the LHS in Equation (3).

closer or tighter oligopsonies, differing between districts. Table 3 in the data section below provides summary statistics on the number of contracting firms per surveyed farm household active in one district.⁷ The value $\lambda = 0$ represents perfect competition, $\lambda_c = 1$ means perfect monopsony, and values of $\lambda_c \in]0, 1[$ represent oligopsony of different degrees.

The key difference between the numerator and denominator in Equation (2) is that storability of crop *c*, denoted by S_c , enters the measure of market power only in the CF case (numerator), while for the spot market case (denominator) market power is determined exclusively by determinants other than storability, $O_{i,c}$.

4.1 | Data

Our data come from a primary survey with smallholder households in the Terai region of Nepal in 2014–2015. The smallholders specialise in ginger, tomato, HYV paddy seed, and lentil production. For each crop, the three districts in the Terai region that displayed the highest concentration of contract farmers entered the survey. The share of respondents per district was determined by the proportion of the contract farmers located in the respective district.⁸ Within the selected districts, each village's Village Development Council (VDC) provided list information on the total number of farmers, as well as on farmers who were engaged in CF and those pursuing independent farming in each commodity. Villages were selected based on the presence of contract farmers specialising in the specified commodities. Stratified by crop, about 300 contract farmers were selected randomly within all selected villages. In addition, an approximately equal number of independent farmers were randomly identified for the survey in each VDC in the same or immediate *Wards*, resulting in the sample being stratified roughly

⁷For example, due to potentially lower levels of education and limited experience in contract negotiations, in combination with no or little recourse in the judicial system of the country, farmers are generally at a systematic disadvantage towards the contractors when negotiating contracts and prices. This applies to all farmers without discrimination between crop types.

⁸Selected districts: Ginger: Pyuthan, Arghakhanchi, Palpa; Tomato: Palpa, Dhading, Chitawan; HYV paddy seeds: Chitawan, Rupandehi, Dang; Lentils: Bardiya, Banke, Chitawan.

equally across the four crops, as well as across status as contract or non-contract farmer. The surveys with tomato and ginger farmers were conducted from December 2014 to August 2015 and the ones with HYV paddy seed and lentil farmers were conducted during February and March, 2015.

The survey relied on a structured questionnaire on various farm characteristics, including information on farm operator, family size, farm structure, crop diversification, production costs, profits, use of CF, marketing channels and implementation of good agricultural practices. Data cleaning involved omitting observations with (partially) missing data, as well as a plausibility check in which observations with unrealistically high negative profits or contradictory information were dropped. After data cleaning, 969 contract farmers and 1065 independent farmers remained in the sample (Table 2).

The resulting sample includes data from 139 villages. On average, there are 17.3 respondents in a village and 81.7% of all respondents live in villages with 15 observations or more. All observed villages either have their market or access to one within a 10-mile radius, so all farms are located within 10 miles of the closest market and therefore have the option to sell in a spot market. The average farm size is 1.73 acres, and the average respondent was 46.2 years old at the time of the interview; 72.0% of all survey households were male-headed.

Summary statistics of the key variables entering the analysis are provided in Table 3. The main dependent variable, $\Gamma_{j,i,c}$, was generated as total profits per hectare divided by the village mean of non-contract farmers in the respondent's village.⁹ Total profits per hectare were calculated by dividing total profits by the land area of each farm. Total profits are revenue (output quantity * output price) minus costs. The latter include costs of inputs (seeds, seed treatment, urea, potash, micronutrients, manure, pesticides), operation costs (renting bullocks, renting tractors for ploughing, harvester, transport costs, irrigation costs), as well as land rent, land tax, and labour costs for ploughing, land preparation, fertiliser application, mulch collection, sowing, irrigation, weeding, spraying, harvesting and cleaning.

Contracted crops are seasonal and, thus, farmers may allocate land for other crops in other seasons. Whenever farmers cultivated different crops within and across seasons, only the costs that actually emerged from the cultivation of the crop under consideration entered the cost calculation. The land-specific costs (rent and tax) were weighted by their respective yearly time shares dedicated to each crop. Different seasons were taken into account in the profit calculation by asking farmers about their activities in an entire year. Hence, the information from all the seasons were incorporated. When farmers sold produce at multiple times, the average price was used.

4.2 | Econometric model

The evaluation of the contractors' ability to exercise market power over farmers of more perishable crops is undertaken through an ordinary least squares (OLS) regression approach by parameterising Equation (2). Our identification strategy for the market power is to exploit the variation in the advantages of selling through a contract over sales in the spot market between farmers of the different crops. The dependent variable, $\Gamma_{j,i,c}$, denotes the profit margin advantage of contract farmers over spot market farmers, defined as the ratio of contract farmer j 's per-hectare profit margin over the village-mean of non-contract farmers of the same crop.

⁹The mean $\Gamma_{j,i,c}$ being substantially above 1 is in contrast with Michelson et al. (2012), who found for Central America that contract farmers who produce for local retailers (/international retailers) receive similar (/lower) prices for their produce when compared to independent producers. These results would only be equivalent in Terai if production costs of contract farmers were substantially below the ones of independent smallholders, which is rather unlikely for the case of Nepal where contracts regulate the production process.

The key explanatory variable is the storability of crop c , measured consistently across crops by their respective half-life, S_c . For tomatoes, the half-life is calculated based on the observation that 60% of a given sample spoils under the climatic conditions in the study region within 6 days (Surekha et al., 2010). This is equal to a half life of 4.54 days, assuming exponential decay. For ginger, Mishra et al. (2004) find that nearly all samples spoil after 28 days, which was interpreted as 5% of the original quantity having survived after that period, which is equivalent to a half-life of 6.48 days (robustness checks are described below). For the HYV paddy seeds, Gupta (2010) already provides the half-life of 1098 days. For lentils, the seed retailing company *sproutpeople* states that lentils last about 5 years, which was interpreted as a survival rate of 95% after that period, resulting in a half-life of 25,594.40 days. As a robustness check, we repeated the analysis with the survival rates for ginger assumed to be a tenth of a percent and 99.9% for lentils after the respective periods. The storability variable enters the estimation as an ordered categorical variable with unknown effects of the distances between the respective values. We follow Pasta (2009) and Williams (2020) who recommend to rely on the logarithmic approximation in the analysis of the effects of such kinds of ordinal variables.

The portion of market power that is based on the market's structure, $O_{i,c}$, is controlled for by including the concentration of contracting firms, a commonly used proxy for market power (e.g., Perloff et al., 2007). This variable is denoted by θ_d and measured as the number of contract firms per survey farmer in the district of farmer j . We further control for location-specific characteristics through dummy variables on the village level, D_i . These control, first, for agro-climatic conditions in the respective villages. Second, since policy-makers have different views on contracting firms, some locations are more likely to engage with contracting firms than others. The village dummy variables, therefore, control for the ease of doing business. Third, these variables may include information on the standard of living in the village of the district. Finally, the village dummy variables capture different characteristics of infrastructure, road access, logistics and ability for companies to communicate with farmers. The crop types tomato, ginger and HYV paddy seeds are included in the regression to control for cropping practices, soil conditions and input use through dummy variables D_c , with lentils serving as the base category. The following equation is estimated:

$$\Gamma_{j,i,c} = \beta_0 + \beta_1 \ln S_c + \beta_2 \ln \theta_d + \sum_d D_i + \sum_c D_c + \varepsilon_j \quad (3)$$

where S_c denotes the half-life of crop c (higher value stands for longer storability), θ_d is the concentration of contractors, D_i stands for village dummies and D_c for crop dummies, β_0 is a constant and ε_j represents independent Gaussian errors with mean zero. The dependent variable, $\Gamma_{j,i,c}$, is the per-hectare profit margin of contract farmer j of crop c in village i , divided by the village mean of smallholders that sell on the spot market.

Regarding quality differences, it is essential that there is no systematic difference in how quality is assessed in spot markets or sold under contracts. In both, information is symmetric and observable quality differences allow price premiums for better quality. In general, contracted crops are of higher quality because contracts legislate the production process. However, for the empirical analysis this is of minor relevance because the primary interest of this analysis is in the advantage of a specific contractor over the village mean of spot market farmers. Price differences due to quality differences across contract farmers exist as a source of heterogeneity of contract-farmers' advantage over the mean of non-contract farmers in addition to perishability. However, this heterogeneity can be treated as stochastic noise in the empirical analysis, as these differences envelop the measured signal of perishability on contract-farmers' advantage.

TABLE 4 OLS estimation results

Variables	Γ Profit per ha
$\ln S_c$	0.38** (0.19)
$\ln \theta_d$	1.01** (0.46)
D_{Tomato}	3.21* (1.71)
D_{Ginger}	5.11** (2.56)
$D_{HYV Paddy}$	1.49* (0.77)
Village dummies included	Yes
Observations	969
R^2	0.75

Notes: Regression includes only contract farmers. Standard errors in parentheses.

*** $p < 0.01$; ** $p < 0.05$, * $p < 0.1$

The relatively high R^2 values across all specifications (see also the robustness checks) indicate that the heterogeneity due to quality differences can be expected to be low.

To test the robustness of the results, Equation (3) is estimated for alternative dimensions of farmers' business outcomes other than per-hectare profit margin, π_j , including total farm profitability (as total revenues minus total costs) and profit per unit of output. Results of all robustness checks are provided in Table S5 of the Appendix, indicating very similar results for the estimated coefficient of interest across different measures of perishability, as well as contract farmers' advantages over non-contract farmers.

5 | RESULTS AND DISCUSSION

5.1 | Results

The regression results are presented in Table 4. They reveal a positive and statistically significant coefficient of $\ln S_c$, confirming Hypothesis 1: producers of the crop with longer storability indeed receive a higher mark-up in CF than their counterparts who produce crops with a lower storability. A doubling in the storability of a crop increases the mark-up in CF which is, given the mean advantage of CF over spot marketing of 1.3 (Table 3), equal to a possible per-hectare profit increase of $0.38 / 1.3 = 29.2\%$.¹⁰ The mark-down due to short storability is particularly problematic from the smallholders' perspective because CF is more likely to emerge in value chains of less durable goods (Swinnen et al., 2010).

Market concentration, θ , affects the profit advantage of CF positively and statistically significantly, indicating that—as expected—a higher number of contractors per farmers increases competition and is therefore beneficial for the farmers. A doubling in the number of contractors increases the profit advantage of contract farmers over independent smallholders by 77.7%. Differences in other crop characteristics, such as differences in the importance of quality, differences in the heterogeneity of quality across the different crops,

¹⁰Because the LHS variable of this lin-log model is the ratio indicating the relative profit advantage of contract farmers over independent smallholders.

and so on, are captured by the crop-specific dummy variables. They indicate that in ginger production the profit advantage of contractors is highest, followed by tomato and HYV paddy seeds. Lentils, as the base category, come last, indicated by positive coefficients of the other three categories.

These findings also hold for alternative measures of farm profitability and of the key variable of interest, crop perishability. The results of the robustness tests are reported in the Appendix Table S5. Columns 1 and 2 display the results for alternative measures of farm profitability, namely total farm income and price per kg. Columns 3 and 4 display results for alternative measures of perishability, namely shelf life in weeks, and half-lives based on alternatively defined survival rates of ginger and lentils. In each robustness test, the estimated coefficients for the effect of crop perishability display the same sign and lie in the same order of magnitude. The remaining variations, especially in Columns 1 and 2, can be explained by the fact that the depending variables are not generated by linear transformations of the main estimation reported in Table 4 (e.g., because farms differ in their land area). The same is true when comparing the control variables' signs across all robustness checks, with one exception that is statistically not significant (contractor competition in the estimation with price advantage as dependent variable). The measured coefficients for the crop dummies lead to an equal ordering in the crop specific contractors' profit advantage over independent smallholders, across all robustness checks. Finally, the high R^2 values across all estimations (main estimation and robustness checks) show that the model is able to explain a substantial share of the variation in the dependent variable.

These results contribute to the literature by being the first to quantify how different levels of perishability affect market power in agricultural value chains. They inform future analyses of market power in agricultural value chains in general of the importance of perishability. This is especially relevant in environments of low technical development of agricultural value chains under climatic conditions that can lead to faster spoilage, and especially so in analyses that combine different types of crops. An additional contribution of the results is that they serve to complement published research on market power which accounts for perishability, but only as a binary variable (e.g. Hendrikse & Veerman, 2001; McCorriston, 2013; Weaver & Moon, 2018).

5.2 | Distributive effects and policy scenarios

We calculate the distributional impact as the lower bound of the forgone incomes from farming (as total revenues minus total costs). In the following we therefore investigate the size of the redistributive effect from farmers to contractors, on average, *c.p.*

The potential profit increase of farmers in an alternative scenario of reduced market power is derived by calculating fitted values of Equation (3) under the assumption that the storability of the more perishable products, tomato and ginger, could be increased by 50%. Based on this estimate, we derive the hypothetical per-hectare profit increase for farmers of more highly perishable products if they were subject to substantially less market power, given by the benchmark producers of HYV paddy seeds and lentils.

Results indicate that the profit advantage of contract farmers of tomato and ginger over independent smallholders could increase by a factor of 1.18, on average (SD =0.08) if these crops' storabilities could be increased by 50%. Thus, our findings provide confirmatory evidence for Hypothesis 2: if contracting companies could not exercise market power based on the degree of perishability, the profits of producers of the more perishable commodity could increase by a factor of 1.18. In other words, profits of high-value commodity producers in Nepal would be almost 20% higher if the product durability could be substantially extended.

One policy option to limit market power from crop perishability would be to reduce farmers' dependence on the prompt selling of perishable output. Several policies could achieve this goal, including improved storage facilities. One strand of the literature invites policy-makers to provide incentives for the construction of cold storage facilities (Goodwin et al., 2002; Reardon, 2015). Storage facilities with reduced, reasonable storage rates would generally reduce the perishability and the urge for quick selling of the agricultural output. Secondly, the construction of decentralised processing facilities—for example, at the district level—would provide farmers with a market for non-top-quality agricultural output. Further, generating incentives for developing better transport facilities and infrastructure has been suggested for other value chains of high-value crops (Kopp & Salecker, 2020). Some of these measures have been implemented in the past by governments and development agencies, for example, in India, where the government actively supports the construction and maintenance of cold storage facilities through subsidies and tax exemptions. However, experience shows that such measures need to be complemented by innovations at the administrative level, as they have been reported to be associated with rampant bureaucracy and cronyism (Sivaraman, 2016).

6 | CONCLUSIONS

Contract and cooperative farming have been considered a boon for smallholders in many developing and emerging economies. A plethora of studies in Africa and South Asia have empirically estimated the factors affecting the development of these government structures, the impact of the involvement in CF and cooperatives on crop yield, and the financial well-being of smallholders. However, contracting firms face several problems in implementing and monitoring contracts. These problems include lack of trust and institutional supervision of contracts: settling disputes related to the contract in courts, as well as market power exercised by contracting firms over farmers. In particular, farmers with small landholdings are marginalised in contract negotiations. This challenges policy-makers in several DEE: on the one hand, due to decreasing or stagnant agricultural productivity, food and income insecurity as well as increasing budgetary pressures, policy-makers are continually encouraging private companies to engage in CF. On the other hand, policy-makers are confronted with complaints from social and community leaders and smallholders who believe that the contracting firms exercise substantial market power in CF. Specifically, literature shows that contracting firms may be rigging the contracts, lowering prices and excluding small farmers from contracts. Although cooperative farming is seen as a means to reduce the power imbalances between farmers and contractors, it also introduces new problems at the managerial level, such as mismanagement and cronyism, which might cause the benefits of collective bargaining to not reach the farmers. Further, recent studies have failed to show how the degree of perishability of the product affects the market power exercised over smallholders in both of these governance structures.

Therefore, this study investigates the degree of perishability on the market power exercised over smallholders. Findings reveal that farmers that engage in more perishable crops are subject to a higher level of market power. A subsequent scenario analysis finds that the redistributive effects of market power based on crop perishability are substantial, with the potential for a profit increase of 18% if the most perishable crops' storability could be increased by 50%. This suggests that improved storage and transportation systems would help.

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