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Marginalised Small-Scale Farmers as Actors in Just Circular-Economy Transitions: Exploring Opportunities to Circulate Crop Residue as Raw Material in India

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Abstract: Facing substantial sustainability challenges, sustainable transitions to circular systems are increasingly called for. The use of biomass to produce textile fibres is a niche that could contribute to a circular textile system. In this niche, farmers supplying biomass would play a crucial role. Through a literature review, we argue in this article that farmers are important actors in this context, but their agency is limited by numerous institutional factors, such as cultivation practices, labour markets and information systems. These factors together can create an institutional void, which can hamper both the agency of farmers and their ability to participate, as well as the justness of the niche. The void's strength depends on the institutional interface a farmer is subjected to. Before just transitions to circular systems can occur, marginalised actors' agency and ability to participate in the niche, in a just way, must be improved, by decreasing the strength of the institutional void.

Keywords: Agency, transition, institutional void, crop residue, straw, India

1. Introduction

The major sustainability challenges of our time require urgent solutions [1]. A transition to a circular economy has been suggested by several researchers and policy-making organisations as a potential strategy to simultaneously tackle diverse sustainability challenges [2–5]. In this paper, we address the complex linkages between food and textile systems that become evident in ambitions to utilise crop residues as raw materials to produce new textile products.

Utilisation of crop residue as raw material can be considered a niche activity in transition research. Transition research examines systemic sustainability changes and the dynamics through which they are achieved. This paper focuses on the socio-technical sustainability transition toward a circular economy [e.g. 6–8]. Looking at this niche activity, which aims to develop textile fibres from crop residues, we attempt to understand the structural factors that could contribute to this niche's justness and success. This niche is still in technological development phase and collection and refining of crop residues into fibers does not yet happen in industrial scale. The novel circular economy practise could contribute to a sustainable future, but, as we will argue, it is imperative to consider feasibility and justness of novel circular economy practices and niches before they are in operation, to be able to build successful and just new practices that do not (re)produce unjust structures.

The idea of just transitions has been developed to understand and promote transitions which take into notion aspects of social justice [9–11]. The justness perspective is especially relevant in the context of this research because the global textile system has been linked to heavy pollution and social inequality [e.g. 12–13], and the agricultural system is associated with deteriorating soil quality, heavy use of chemicals, and rural poverty – especially in developing countries, such as India, which is the geographic focus of our paper [14].

In the context of the biomass-to-fibre niche, we examine local, small-scale farmers as actors in the circular-economy transition. Research on circular-economy transitions has largely focused on innovations and companies' roles, and other actors' perspectives have not gained so much attention [15]. Thus, the context under scrutiny underpins the notions of agency and structure. Accordingly, this paper's perception of *agency* and *structure* is influenced by structuration theory and its extensions of critical realism and strong structuration. We interpret *agency* as the human capability to make free choices and affect one's environment [16–17]. According to this view, *agency* is perceived as a bidirectional movement between individuals and their environments [16]. Structure and agency do not exist as a dichotomy but, rather, as two separate functions in constant movement; agency constantly affects structure, yet structure also constantly affects agency [17]. Agency has also been perceived to involve the possession of power – that is, actors' ability to make a difference in their institutional environments [18]. In this paper, we posit that considering actors whose agency is currently limited in global value chains (i.e. the marginalised) is also important because their roles can be critical in the success of a just transition towards a circular economy.

In this paper, by "structure" we mean the institutional environment in which actors act. If agency and structure are in constant movement, then it is important to also pay attention to the institutional environment. We understand 'institutions' as structures that determine the societal 'rules of the game' [19]. Institutions are built by humans, and they structure political, economic, and social interaction [20]. Developing-country contexts often exhibit complex institutional environments that maintain unequal power structures or exclude certain groups from certain activities [21]. According to Ramos-Mejia et al. [22, p. 22] 'the main challenge of sustainability transitions in developing countries is to avoid reproducing ill-functioning institutions that continue benefitting the privileges of a few while undermining the wellbeing of many'. The concept of an *institutional void* is helpful in uncovering structures that might reproduce poverty and marginalisation in the face of novel market practices [23]. Instead of empty spaces or a lack, we define *voids* as analytical spaces 'resulting from conflict and contradiction among institutional bits and pieces from local political, community, and religious spheres' [23, p.819]. We demonstrate this institutional void's function by providing examples of situations where various combinations of institutional factors limit farmers' agency in their operational environment or in the wider systems in which they operate.

Geographically, our research focuses on India because ill-functioning institutions and above-mentioned sustainability challenges come together here, in various configurations, as companies try to increase utilisation of agricultural residues as raw materials. In this context, formal and informal institutional factors specific to spatial dimensions – such as specific social norms within a community, as well as local beliefs and traditions – can affect the success of niches aiming to promote wider circular-economy transitions [24–25]. Motivated by our curiosity to understand institutional dynamics and agency in this context, we pose the following research questions:

1) Which institutional factors can influence the possible use of agricultural residue as raw materials for industrial application?
2) How does the institutional environment affect farmers' agency and the niche's justness?

For circular niches to even function – let alone to succeed, i.e. upscale and break through to the regime level – changes to many people's lives are needed [26]. In the studied case, the use of waste-based fibres especially entails changes to the lives and practices of the farmers who would ultimately supply the residue. New practices face a risk of opposition and a lack of legitimacy if local people's voices and needs are not considered [9]. Novel circular-economy practices might reproduce poverty and marginalisation if they are not constructed with a consideration of aspects of social justice, such as equality and distribution of wealth [27]. Therefore, the implications of local institutional factors – which affect the feasibility and justness of new practices and the agency of farmers – must be considered ex-ante.

The remainder of this paper is structured as follows. First, we describe our research setting and methods. Next, we present our findings related especially to our first research question about which institutional factors influence the possible use of agricultural residue as raw materials in industrial applications. Then, in our 'Discussion' section, we present how these institutional factors can, together, form an institutional void, and we reflect upon how that void links to agency and justness. Finally, we conclude with some possible solutions and ideas for further research.

Materials and Methods

Research Context

Companies and researchers are increasingly developing new technological innovations to produce more sustainable circular materials for the textile industry. One such novel technological innovation aims to make textile fibres from crop residues, such as rice and wheat straw. The innovation has the potential to contribute to circularity and decrease virgin material consumption in the textile industry and provide opportunities and income to rural areas. Our research helps to understand how this could happen. This technology is still in developmental stage, and to our knowledge no supply chain has yet been set up. This paper focuses on India due to the high amount of residue produced in the country and its associated sustainability challenges and opportunities. In the studied context, we examine local, small-scale farmers as critically important actors who can define the prospects of the circular-economy transition. If these farmers can provide their residues to other actors, this transition may gradually start. In other words, the provision of crop residues for further refining is a niche activity in which local farmers can be seen as possible agents for change. Such agents' important roles in transforming regimes and triggering societal shifts have been identified in previous research [28–29].

Indian agriculture is characterised by a large amount of small and marginal farmers and several sustainability challenges, which are linked to water use, soil quality, access to food, and farmers' income [14]. A major sustainability challenge that has gained international recognition is the burning of crop residue [30]. This practice is detrimental to the health of humans, animals, and the soil [30]. In India, 86.2% of all farmers are small (1–2 ha) or marginal (<1 ha) [31]. The average monthly income of agricultural households in India is approximately 73 euros (₹6426) [32].

Crop residues are the non-food parts of cultivated plants or parts which are not the main agricultural product – such as straw, in the case of rice and wheat. Estimations vary, but the overall amount of crop residue generated in India is approximately 500 million tons per year, and the highest residue amounts are found in the states of Uttar Pradesh (60 Mt), Punjab (51 Mt), and Maharashtra (46 Mt) [33]. The current residue management methods in India are burning, incorporation into the soil, mulching, and collection for further use (including own use and selling) [e.g. 34]. The percentages of each method's use varies widely across India (see section on Alternate and Traditional Uses).

Multiple policies have been implemented by the Government of India to curb the practice of burning, but so far, these attempts have not been highly successful; the practice of burning residue remains ongoing [30]. The burning of rice residue is especially prevalent in northwest India – particularly Punjab and Haryana – and in Uttar Pradesh; in the rest of the country, rice residue is used for various other applications, and only minor amounts are burned [35]. The widespread, organised selling of rice residue for industrial applications has not yet occurred, although some collection and selling of straw happens – for example, to cardboard factories [36]. Bioenergy plants have been set up, but they have struggled to survive and are still not widespread [37]. Widespread straw trading as fodder does occur in some parts of the country, however (see Section on Alternate and Traditional uses).

The sourcing of straw in a potential novel niche practice is possible in multiple ways. We identified three main scenarios for such straw collection and logistics: collection and transportation by farmers; collection at least partially by farmers, with transport by another actor; and collection and transport by another actor. These options ought to be kept in mind while reading our paper, as these different models imply differences in how certain factors influence the situation.

Method

This article employs a qualitative literature analysis as its method. As opposed to quantitative literature review that focuses on systemic meta-analysis of a specific sample of articles, qualitative literature analysis emphasizes the role of a researcher in the assessment of the relevance of the articles in the research context. [38]. The search engines used were Scopus, Web of Science, and Google

Scholar. Our searches on these platforms were conducted between February 2020 and October 2020. The search phrases used included, in various configurations, 'collection', 'straw', 'biomass', 'farmer', 'crop residue', 'feedstock', and 'India'. Additional articles were also found through the references in the articles identified during the primary search process. Only peer-reviewed journal articles with at least a partial focus on India were included in our analysis. We did not apply any additional criteria to the journal articles reviewed. We decided that including, for example, Indian academic journals was important due to the many empirical articles which gathered data directly from farmers in India. In total, 43 articles were included in our analysis. The majority of these articles are referenced directly in the text, but a full list of the articles consulted can be found in Appendix 1.

Papers were included according to various criteria. Both our paper and the most of the reviewed literature focuses on rice and wheat straw, but papers focusing on other or unspecified crop residues were also included in cases where they provided other valuable information. Also, articles relating to several different residue management methods were included because they also provided important insights into our research questions. Our starting point was to understand the status quo of straw use and what factors underlie current straw use. We included articles that served this aim. This approach helped us understand how potential future applications might fit into the present straw use scenario, and it also helped us identify factors that might affect farmers' agency and ability to supply their crop residue. Some of the factors we identified derived from our analysis of the status quo, and some we derived directly from the literature.

The reviewed articles' geographical focus was on northwest India – particularly in the states of Haryana and Punjab. We wanted to focus on this area due to its sustainability challenge of widespread straw burning and business interests. Nevertheless, articles concerning other areas in India were also included in our data set to the extent that we deemed their data helpful in answering our research questions. Also, the available data pertaining only to the northwest was limited. Because of large regional differences in institutional factors potentially affecting wide-scale straw collection for industrial purposes, our results cannot be generalized throughout India or other countries.

Results

From our literature review, we identified multiple institutional factors that could influence farmers' ability and agency in supplying crop residues as raw materials. We classified these factors according to broader themes, namely: *time*, *resources*, *logistics*, *information*, *market dynamics*, and *beliefs*. Table 1, presents the main institutional factors potentially affecting farmers' agency or ability to participate in the biomass-to-fibre niche. We present these factors in more detail below. The factors are not in order of importance and we do not in this research rank them according to importance.

Table 1. Institutional Factors That Could Influence Farmers' Ability and Agency to Participate in the Biomass-to-Fibre Niche.

Themes	Institutional factors	Sources
Time	Cultivation practices	e.g. 35, 36, 37, 39, 40, 41
Resources	Machinery use schemes	e.g. 35–37, 39, 42–47,
	Labour markets	e.g. 41, 44, 48–55
	Credit schemes	48
	Subsidy schemes	56
Logistics	Physical infrastructure	e.g. 36, 37, 39, 43, 51, 53, 55–59
Information	Information systems	30, 42, 51, 55, 60

Market dynamics	Straw markets	36, 39, 40, 53, 54, 59, 61
	Intermediaries	36, 53
	Contractual relationships	36, 53, 62
	Price reflections	36, 53
	Alternative and traditional straw uses	16, 34, 35, 44, 47, 48, 50, 54, 55, 58, 61, 63-69
Beliefs	Common assumptions	e.g. 41, 56, 50, 36, 45, 44, 35, 70, 67
	Social norms	50, 51

Time

Cultivation Practices

Current cultivation practices can impose time limitations upon the collection of crop residues. These time limitations can present a challenge for the use of crop residue in industrial applications due to the limited time allowed for the collection of residues from fields [e.g. 37, 39].

A short period (approximately seven to 20 days) elapses between harvesting rice and sowing wheat in the rice-wheat double-cropping system, especially in northwest India [e.g. 35–36]. This time limitation is due, for example, to the crop varieties used, regulations on sowing time for rice (to conserve water), and climatological factors affecting wheat yield [e.g. 40]. When rice sowing time is regulated, harvesting is also delayed. Also, the succeeding wheat yield can suffer from delays in sowing and, thus, farmers can hurry to clear their fields of rice straw and prepare the land for sowing during this short period. Many farmers resort to burning the residue because it is a fast way to clear their fields [e.g. 41].

Resources

Machinery Use Schemes

Access to straw management machinery can enable or restrict the collection of crop residues. Especially with combine-harvested crops, machines leave stubble and spread straw over a field – thus creating a need for extra effort and machinery for potential straw collection [e.g. 42]. Research on the use of biomass as a feedstock at energy plants in India has recognised efficient transportation to be key to these plants' economic feasibility [e.g.43] and recognised baling or briquetting straw as early in the supply chain as possible to significantly lower transportation costs [e.g. 44]. Machines used to operate and collect straw include, for example, straw reapers, straw rakes, and balers [e.g. 45].

Several constraints limit access to such machinery, including the low availability of baling machines (rentals), costs of machinery (despite subsidies), costs and burdens for operation, and machines' power needs [e.g. 36, 39, 44, 45]. These constraints can especially limit smallholders.

Balers' efficiency was also questioned in some of the literature due to their low field capacity, their potential to recover only a portion of straw, and bales' small size [e.g. 35-36]. In addition, a large number of bales in the field, the number of labourers needed to clear bales, and large bale systems which require heavy machinery add to the difficulty of using baling machines [36, 46]. Drying straw in the field can also be necessary before baling, which adds to time stress [e.g. 36, 43]. Another study on conservation agriculture [CA] noted that CA machinery – such as zero-till seeders – often require high horsepower while smallholders face economic limitations and need smaller versions of these machines and in some cases, bullock-drawn machinery is needed [47].

Manual crop harvesting methods allow straw and stubble to be simultaneously collected in bundles for further use, but this method does not compress straw, and it can be more expensive than mechanical harvesting and require more time [e.g. 36, 42]. Thus, access to machinery is important for an efficient, timely, and economic collection system, but – as the above analysis has shown – such access is restricted in many ways.

The Government of India has many schemes in place to promote machinery use [45], but challenges remain (see also the section on Subsidies). Several custom hiring centres – where farmers can rent machinery – operate in the country, but more and better-placed custom hiring centres could alleviate machinery use challenges [e.g. 36]. Joint ownership can also help overcome challenges associated with machinery use [e.g. 45]. Contracting services can also lessen the problem of machine unavailability. Already in Haryana, baling is often done by contractors or at separate sites off-field – though farmers have criticised these arrangements due to frequent failures on contractors' part in executing the planned collection processes [36].

Labour Markets

Labour markets can affect straw management in multiple ways, as straw collection requires labour. Labour shortages and scarcities, especially during peak times, have been reported especially in the rice-wheat areas of northwest India [e.g. 48, 49]. In Haryana, studies have reported the unavailability of workforce for harvesting straw and the high cost of hiring labour as resulting to burning of stubble [e.g. 41, 50]. Also, in Punjab, some farmers identified – albeit to varying extents – a shortage of labour to manage paddy straw and high wages during peak times as constraints in paddy straw management [e.g. 51, 52, 44]. In Madhya Pradesh, a lack of seasonal workers and a lack of financial resources to employ these workers were amongst the barriers identified for supplying biomass to a power plant [53]. Farmers in Chhattisgarh State also highlighted high labour costs for collection as a constraint [54]. In West Bengal, farmers' family members participate in harvesting operations and straw management – thus, labour costs did not concern these farmers, as they do not hire labour [55]. The percentages of farmers who identify labour as a problem in straw management varied considerably, possibly indicating variance in labour markets and availability [e.g. 44, 51].

Credit Schemes and Subsidy Schemes

Credit and subsidy schemes are important institutional factors that influence farmers' ability to manage their straw. If the straw supply requires an investment from farmers, the lack of formal credit opportunities might present a problem. One study noted that in northwest India, the bulk of credit came from informal sources, with which interest rates averaged 26% [48]. In addition, informal land arrangements, joint land ownership, and informal land leasing can hinder access to government subsidies for straw management technologies [56]. Also, subsidies for some straw management machines – such as the Happy Seeder – have been provided on a reimbursable basis, which presents a major barrier for poorer farmers [56]. Farmers' willingness to spend money to mobilise residues from their land differed, from 32% in Madhya Pradesh to 77% in Maharashtra [53].

Logistics

Physical Infrastructure

Infrastructure, or the lack thereof, can influence farmers' ability to manage and supply their straw and to access the supply chain in a timely and profitable manner.

Crop residues are spatially and temporally fragmented resources due to the large numbers of small-scale farmers, different cropping patterns, and varying alternative uses and surplus [e.g. 43, 57]. In addition, straw is bulky, with a low density, and road conditions in India are not always favourable. In this context, one key issue which the literature identified as a challenge for establishing straw supply chains – especially concerning biomass-to-energy projects – is logistics: transportation and possible storage [e.g. 58, 39]. Logistical challenges were closely linked to machinery challenges; the use of compressing or other processing machinery can ease the costs and burdens of transportation and storage [e.g. 58, 37, 43].

The ultimate price of a feedstock might vary, according to the quality of available infrastructure. One study on the fodder market discovered that the straw price paid to farmers differed within a village due to poor access to some locations or unfavourable roads [59]. The same study found that small-scale and marginal farmers had especially limited storage facilities [59]. This difficulty also forced such farmers to sell their straw immediately after harvest [59]. The vast storage space needed for straw was also a challenge which farmers reported in Haryana [36].

Infrastructure and the existing pool of old vehicles can make access to straw markets more difficult and costly for farmers [53]. Poor road conditions in India generally might present a challenge to the large-scale collection and supply of straw [e.g. 59]. In Punjab and Haryana, farmers identified transportation as too laborious and too high-cost [51, 56]. In Madhya Pradesh, transportation barriers to supplying a power plant were identified by 16% of farmers, whereas in Maharashtra, 72% of farmers identified this barrier, citing that their transportation fleet was old, unreliable, and costly [53]. On the contrary, in West Bengal, the majority of farmers in a study did not perceive transportation to be a problem since they mainly kept their straw for their own use and transported it with bullock carts [55].

Some straw collection centres are already in operation, which can help resolve logistics issues [36]. Possible solutions identified in the literature included joint storage facilities, community-driven initiatives for logistics, and government storage and procurement centres [e.g. 53].

Information

Information Systems

Information systems can affect farmers' possibility to participate in straw supply chains. Some farmers' sources of information are heavily skewed towards local peer groups and other farmers, and some farmers have limited mass media exposure, extension contracts, and cosmopolite contacts [60, 55]. Using alternative straw management techniques other than burning was linked to more mass media exposure, more extension contacts, and higher television and agricultural magazine exposure [51, 42].

Some studies suggested limited information and awareness among farmers about alternative straw management possibilities in some states – but such awareness varied widely and was sometimes high [e.g. 60, 30]. One study in West Bengal concluded that although such awareness was high, these techniques were not used due to their costs or other limiting factors [55]. Another study found that, in trading rice and wheat straw at fodder markets in Bihar, traders and sellers used cell phones but face-to-face communication remained important – especially in rural areas among petty traders [59].

Market Dynamics

Straw Markets

Informal straw markets can promote insecurity, and a lack of formal market opportunities can constrain farmers' use of paddy straw. Currently, straw is traded for fodder use and bought by a small number of industrial actors for – for example – bioenergy, packaging materials, and the paper industry around India [e.g. 61, 40]. Farmers highlighted a lack of marketing facilities and a lack of market demand as the main constraints to paddy straw collection in one study [54]. Some studies emphasised that current market dynamics have promoted insecurity amongst farmers since demand can be inconsistent, prices can be low, and prices can also vary unpredictably [e.g. 53, 36, 40]. One study on fodder markets in Bihar concluded that these markets have neither a formal, organised structure nor formal institutional support [59] Organised and formal marketplaces that are easily accessible could alleviate these difficulties [39].

Intermediaries

According to one study, farmers' willingness to sell crop residue to intermediaries was as low as 18% in Madhya Pradesh, 39% in Tamil Nadu, and 42% in Maharashtra [53]. The majority of these farmers were, thus, unwilling to sell to intermediaries and preferred to sell directly to energy producers or through village-level cooperative bodies [53]. Intermediaries were seen as unreliable, with delays in compensation. In addition, their subjugation, price control and price variance, and monopoly were some reasons for this low willingness to supply to intermediaries [53]. Also, in Haryana, informality and frequent abandonment of contracts by baling contractors has led farmers to be sceptical about arrangements in which contractors bale and transport straw [36].

Contractual Relationships

In one study, almost all the interviewed farmers in Madhya Pradesh, Maharashtra, and Tamil Nadu were willing to supply crop residues directly to an energy producer – but their willingness to enter into a contractual obligation varied between 69%, 79%, and 97% in Tamil Nadu, Madhya

Pradesh, and Maharashtra, respectively [53]. A high willingness to enter into long-term straw supply contracts was also observed in Haryana, given that compensation was adequate and the removal of stubble took place within an average of 10 days [36]. Another study also found that supplying to bioenergy plants and industry was also regarded as farmers' preferred method of straw management [62].

Price Reflections

A few studies examined the prices farmers wanted for their biomass, finding a wide variation in prices, which reflects varying alternative uses and demand in different areas [53]. In Madhya Pradesh, Maharashtra, and Tamil Nadu, prices varied from 12–73 euros per tonne, reflecting states' supply and demand and degree of local consumption [53; did not specify a biomass or collection method]. In Haryana, farmers indicated a price for 43–79 dollars per hectare (when collected by someone else) as adequate compensation, varying by district [36].

Alternative and Traditional Straw Uses

The traditional and necessity-based uses of straw varied between and within states. The alternative uses of straw can act as restricting factors as they can increase opportunity costs and trade-offs, but also as enabling factors in the case of straw surplus.

Crop residues are used for multiple purposes throughout India. The extent of this use and straw applications depends on several factors, such as crop and variety, harvesting methods, the intensity of crop production, traditions, knowledge or beliefs about straw qualities, farmers' socioeconomic status, the intensity of livestock production, technological diffusion, and access to other resources [e.g. 50, 61, 63, 64]. The amount of surplus, thus, varies between and within states, districts, and villages [e.g. 61], and the spatial variation of alternative crop residue uses can be difficult to determine [58]. According to one study, cereal crop residues (including rice and wheat) had an overall surplus of 29%, and in Haryana and Punjab, the surplus stood at 34% [58]. Deficits in rice straw can occur in some households and locations (more often in northeast India) while surplus rice straw can occur elsewhere (more often in the northwest) [64, 65]. Due to agricultural intensification, surplus amounts are expected to increase in several states – although, in some crops' cases, new varieties producing higher yields might lower straw yields [66, 67].

The use of straw as fodder may be one of the main factors limiting straw use in industrial applications, as livestock is an important part of many farmers' livelihoods [64]. Crop residues are widely used as feed, but the extent of this use varies across India and depends on, for example, human and livestock density and agricultural intensification, crop variety, tradition, and access to other feed sources [e.g. 65]. In some areas, feed shortages are regular occurrences [e.g. 44, 65]. Even if some people regard rice straw as a poor-quality feed and fuel, resource deprivation forces some farmers to use the straw as both [55, 68]. Farmers in Chhattisgarh suggested, in one study, that the use of paddy straw for mostly cattle feeding was a constraint in straw collection [54]. Northeastern states face more challenges with overall fodder availability – a fact that is aggravated by, for example, low cropping intensity, high livestock density, small farm sizes, population pressure, and seasonality [64].

Crop residue is also used as a domestic fuel, variably across states, with rice and wheat not used at all in Haryana and Punjab but used to some extent in Bihar, West Bengal, and Uttar Pradesh [69]. One study discovered that, in West Bengal, all farmers who participated in the study used paddy straw for various purposes – such as fodder, domestic fuel, mushroom production, and thatching [55].

The extent of straw use appears to positively correlate with rural poverty and low standards of living [48, 55]. Also, landless households and the poorest households might depend on livestock and differing exchange mechanisms or gifts for straw feed access, lacking the resources to purchase fodder [64]. In some districts of Punjab, as much as 20% of paddy straw was given to poor, landless families [44].

Declining soil quality threatens the sustainability and development of agriculture in India [67], and a return of the straw to the soil as 'fertilizer' has been called for by many studies [e.g. 67, 35]. The existing 'continuous mining of soil fertility and organic matter' [64] due to fodder use is already regarded as highly problematic. Conservation agriculture studies have highlighted the competition between CA and feed as one of the biggest obstacles to increasing CA in India and abroad [e.g. 47, 65]. One study calculated that mulching and using machinery, such as the Happy Seeder, is the most economical choice for farmers with the lowest social cost for communities [34]. Nevertheless, the effects of CA can be seasonal and context-dependent [63].

Beliefs

Common assumptions

Beliefs about the advantages and disadvantages of various residue management options for soil can affect farmers' ability and willingness to supply straw.

The literature indicated that some farmers believe burning crop residue enhances the soil's nutritional and physical properties and that some farmers are unaware of burning's negative effects on soil [41, 56]. One study found that, when farmers believe burning benefits or harms the soil, they might increase or reduce such burning, respectively [50]. In addition, beliefs that burning helps control weeds and pests [45, 36] and provide maximum yield, as opposed to other straw management methods, were noted [44].

Burning does, indeed, control pests and weeds to some extent, and it promotes the availability of certain short-term nutrients [35]. The actual impacts of straw removal on soil are not completely known, but the literature has suggested that straw retention as mulch or incorporation benefits soil's physical, chemical, and biological properties [35, 70] and is superior to complete removal [e.g. 63]. Continuous removal might lead to a short-term net loss of nutrients and higher nutrient input costs and, in a long term, to decreasing soil quality and productivity [71]. In addition, declining soil fertility in many regions of India has caused pressure to use straw as manure and return it back to the soil [67]. One solution identified in the literature is the partial removal of straw [58] – although the amount which can be extracted while maintaining soil quality depends on many factors, such as soil texture and climate [72].

Social Norms

One study found that social norms and herd behaviour to some extent determine residue burning – that is, farmers choose residue burning as a management technique because they believe other farmers commonly practice this method [50]. Another study found that, in Punjab, farmers using other straw management than burning had higher incomes, higher risk orientation, greater innovativeness, and more ecological consciousness [51].

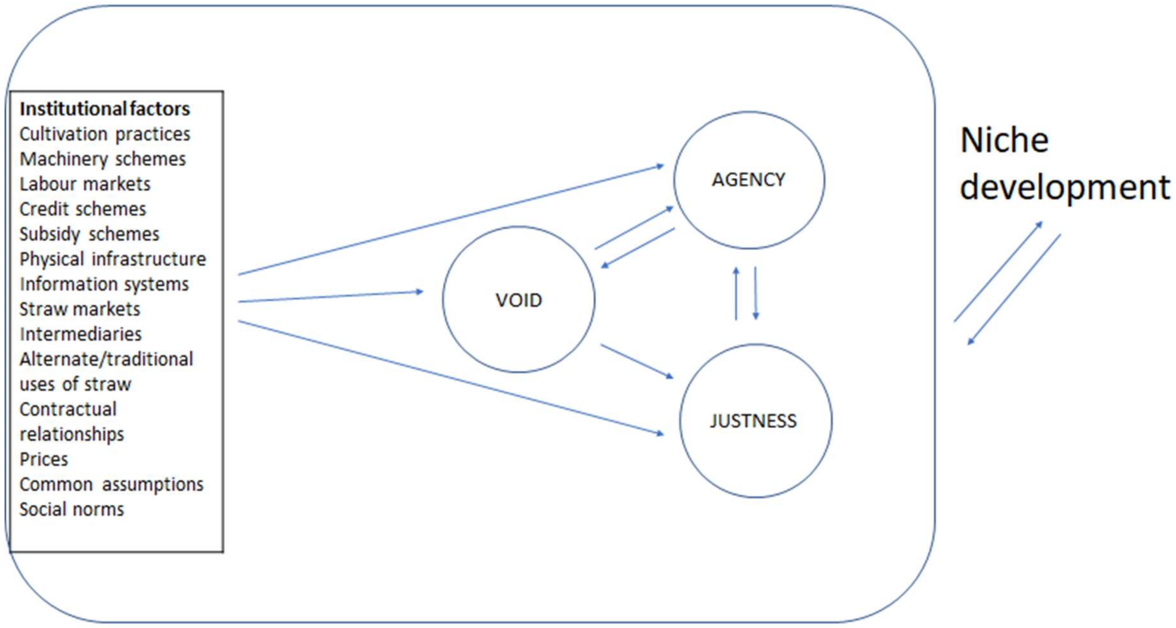
Discussion

Our findings suggest that several institutional factors can potentially restrict or enable farmers' participation and agency in relation to the biomass-to-fibre niche. The main institutional factors were presented in Table 1, together with the main themes. In the discussion section, we aim to answer our second research question: How does the institutional environment affect farmers' agency and the potential niche's justness?

We do this by first showing how the institutional factors can together create an institutional void. Second, we analyse how this void affects farmers' agency. Third, we reflect on how the void together with related lack of agency can contribute to the (un)justness of the biomass-to-fibre niche. Finally, we present some recommendations on how to overcome this void.

The identified institutions do not appear everywhere in India constantly but are very context dependent, as farmers can live in very different realities. These realities appear, for example, in different spatial, cultural, political and climatological dimensions. Farmers can be positioned in different institutional intersections, meaning they are subjected to different mixes or none of those institutions, which we have identified in our Results.

To understand better the institutional environment, context dependency of the institutions and institutional consequences, in our discussion, we draw upon the definition of *institutional voids* by Mair et al. [23]. They argue that institutional voids are not empty spaces but, rather, spaces which are inhabited by bits and pieces of multiple different institutional demands and norms and that voids occur at the interfaces of these demands and norms [23]. We argue that there can be an institutional void relating to the possibility of farmers to participate in the biomass-to-fibre niche and that this void is formed at the intersection of the institutions which structure farmers' lives and work, as presented in our 'Results' section above. Next, we introduce how these institutions can combine to form a void. Figure 1. Institutional Factors Affecting the Biomass-to-Fibre–Niche



The Institutional Void Related to the Biomass-to-Fibre Niche

The institutional void, in our case, relates to participation in the biomass-to-fibre niche. This void is formed at the intersection of the existing institutions which structure farmers' lives. In this case, the interface or mix of institutions to which a farmer is subjected determines the void's strength. The void can maintain farmers' marginalised position in the supply chain.

We will illustrate this void through examples. Consider the following hypothetical situation. A small-scale farmer living in India can be subjected to many institutions that enable or constrain their participation in different markets and choices regarding one's profession, as we have shown in our Results. We found that a farmer might be subjected to weak subsidy schemes [56], which may limit the farmer's access to straw management machinery. Regulations on sowing times can limit the time period for straw collection [e.g. 36]. In addition, weak information infrastructure may limit the farmer's knowledge of different straw management options [60] and of the implications of different options to for example soil quality [41]. The quality of physical infrastructure, such as storage room or living next to decent roads, can limit the choices a farmer can make about when to sell and at what prices [59]. Further, the farmer may employ many traditional uses of straw, such as fodder for livestock. This can be an impediment to participating in the selling of the straw [e.g. 54]. The farmer can also believe that burning the straw will improve soil quality and yields [e.g. 56]. The farmers possibilities to hire labour to manage straw or access machinery might also be restricted [e.g. 54, 36]. In this case, the institutional void relating to the biomass-to-fibre niche for this farmer would be strong, as they would be subjected to many institutions restricting their ability to participate in the niche, and the farmer's agency would be slight.

Let us imagine another situation. Say a farmer has access to high-quality information infrastructure, which helps the farmer understand the possibilities of straw management, selling, and prices. The farmer also has access to baling machinery and good physical infrastructure, lives close to decent roads, and has storage space available. The farmer has livestock but also has resources to buy good-quality fodder. For this farmer, the void would be smaller than for the farmer in the previous example, and their agency would be greater.

In the crop residue use context in India, a stronger void often relates to poverty or pre-existing marginalisation. Poorer farmers, for example, have more necessity-based uses of straw due to a lack of other resources [48]. They also might depend more on various support institutions (such as subsidies), and they can more often lack physical storage facilities and have fewer resources to hire labour or access machinery [e.g. 59] By restricting possibilities to act and access to markets and resources, the institutional void can reproduce and maintain farmers' poverty, marginalisation, and related lack of agency,

The institutions presented here do not necessarily restrict or enable farmers per se, but most can work either way, and their individual influence can be slight. For example, social norms might restrict or enable a farmer's participation or agency, depending on the type of norm involved. Sowing regulations can restrict farmers due to the time limitations they impose, but this restriction in itself might not be very strong if a farmer is not subject to other restricting institutions, such as lack of access to machinery or storage space or a weak information infrastructure.

The above considerations also reflect the void's context-dependency. The void does not affect everyone equally since farmers are a heterogeneous group and live in different institutional interfaces.

The Institutional Void and Agency

In this chapter we analyse how the factors we have found and presented in our results and the institutional void can affect farmers' agency. The discussion addressing institutions and institutional voids reflects a debate over agency and structure [16]. Arguably, several structural and institutional constraints restrict farmers' ability to participate in niche development justly. In turn, the void – to some extent – mediates farmers' agency or ability to act freely as well. Based on our review, we observed that farmers are constrained or enabled by multiple social positions, such as socioeconomic status or knowledge level.

Our findings imply that both formal and informal institutional factors appear as limiting elements for farmers. For example, machinery schemes, noted e.g. by Ravindra et al.,[39] and limited access to machinery [e.g. 36] are highly restricting factors. These structural constraints block farmers' actions despite their willingness to exercise their agency. Another example of a restricting structure is farmers' lack of information. In our review, lack of information was stressed, for example, by Roy et al [51, 55]. Limited access to information appears as a structural problem disabling farmers' ability to learn about different options for straw uses. Consequently, due to such knowledge shortages, farmers are unable to make decisions according to their full potential. These limitations lead to a question of whether the institutional environment allows room for agency if it restricts knowledge levels to the point where actors are unable to make decisions based on justified knowledge. In addition, unfavourable combinations of institutional factors create a void which may restrict farmers' agency even further. For example, weak trust in intermediaries, which was raised e.g. by Zyadin et al. [53], combined with poor subsidy schemes [e.g. 56], may hinder farmers' will to engage in the niche development. In general, the restrictive institutional environment situates some farmers in a marginalised position within the wider value chain, which appears to be controlled both by structures and more powerful actors – such as multinational corporations and large landholders [73].

In sum, echoing Giddens [16] and Sewell [74], we observe that while actors aim to make a difference, this volition does not necessarily mean their actions will have their desired effect. While our findings point to a highly restrictive institutional environment which limits small-scale farmers' agency, we note that these constraining institutional factors may offer opportunities for actors as well. According to Emirbayer and Mische [75], actors who feel restricted in confronting problematic situations can actually operate as pioneers in exploring and reconstructing actions' contexts.

Justness of the Niche

In this chapter we try to imagine and hypothesise the implications that the institutional void and the lack of agency might have on the potential justness of the biomass-to-fibre niche. By justness we mean issues of social justice, such as equality and distribution of wealth. Our findings support the view that some institutional factors and a strong institutional void can hamper access to markets and reproduce or create new inequalities [76]. In addition, limiting farmers' agency can increase the risk of negative impacts from novel niche activities on farmers, if farmers cannot participate according to their own terms and will. Next, we illustrate our argument with an example.

Let us return to our example of the small-scale farmer who is subjected to a strong institutional void. For example, limited access to information restricts possibilities and understandings of different options for straw management. In practice, this restriction on information could mean restricted knowledge about supply possibilities, which could hamper market access. Lack of access to information could also mean restricted knowledge about the most economical straw management option and restricted awareness of different straw price options, which then again could increase the risk of participation's negative impacts or of increased inequality. A lack of decent physical infrastructure – such as good roads or storage space – could increase vulnerability to price subjugation by intermediaries or price volatility, as noted by Singh et al. [58], increasing the risk of increased inequality in participation. Access to machinery can be hindered by subsidy and credit limitations and unavailability of machinery and can limit possibilities for managing straw how and when farmers choose to. This could increase the risk of negative or inequal impacts (such as delayed sowing time of next crop or not receiving the best straw prices due to reliance on contractors and intermediaries) and could hamper market participation. Common assumptions and beliefs about the impacts of different straw management options on soil might also hamper participation or lead to long-term harm to soil, if collection and the associated possible impacts to soil are not known and compensated. Low trust in intermediaries can also hinder participation, as some farmers were unwilling to supply to intermediaries [53]. High alternative uses of straw might lead to a need to acquire fodder or domestic fuel from other sources if a farmer wishes to participate in selling their straw. But other uses for straw may also hamper participation, if the straw is needed for domestic use. We must note, though, that acquiring fodder or domestic fuel may be a positive development if a farmer can then access higher-quality fodder or fuel, but then the prices paid to the farmer for their straw should reflect this need [61]. The varied price reflections (see section on Price reflections) reflect the difficulty in determining a price in a varied landscape with multiple different straw uses and contexts. The question of a fair price is a complicated one and deserves further attention in future studies.

The stronger the void (i.e. the more the farmer is subjected to the above institutions), the greater the risk of negative or inequal distributive implications and/or non-participation. Such justness considerations should be fundamental to niche development – especially in developing-country contexts. By considering these issues, it is possible to create more just transitions.

Working the Void

Having presented the institutional void, we now move on to our ideas and suggestions on how to manage this void and improve farmers' agency and create a just niche. We argue that institutional work which aims to reduce the void's power enables the niche's success and justness. Small-scale and marginal farmers can especially be threatened by a stronger institutional void. As we have shown, institutions do not affect all farmers the same way, and the same institutions can restrict some farmers more than others, depending on the mix of institutions in effect. Farmers with limited resources can have fewer opportunities to overcome the restrictions imposed upon them by their institutional environment and fewer opportunities to climb out of the void. Our first and primary recommendation is, thus, lifting farmers out of poverty – and, indeed, reforming some of the institutions mentioned above can grant farmers greater agency and contribute to this aim.

The void's strength can be decreased by reforming some of the institutions which contribute to the void's restrictive environment and creating support structures which decrease some institutions' restrictive influence. The Government of India has already implemented multiple policies to help farmers manage straw more sustainably – for example, subsidies, awareness-raising programs, and burning fines [45]. Nevertheless, these actions have not yet been able to create an enabling environment for all farmers [e.g. 30]. Using the concept of institutional voids to try to imagine the kinds of mixtures of institutions which farmers are subjected to could offer a way forward, creating policies that could account for farmers' different positions and, likewise, reform institutions.

Reforming institutions separately and with a one-size-fits-all approach might not work in such a complex institutional environment. For example, subsidies are insufficient if a farmer is subjected to a strong void and thus multiple other institutions which restrict the farmer's agency and ability to participate justly. Many of the articles we reviewed mentioned awareness-raising among farmers as a key method to enhancing sustainable straw management – though many articles concluded that awareness alone will not provide an overarching solution [e.g. 30, 39]. Transcending mere awareness-raising, we argue that strengthening the information infrastructure in general – such as access to information technology and farmers' contact networks – can also strengthen farmers' agency. Formal, easily accessible, and trustworthy marketplaces and market infrastructures can contribute to greater trust, limit unwanted intermediaries behaviour, and make markets more accessible [e.g. 39] Community-level co-operation – such as joint storage facilities, logistics, machinery – could also be an option [53]. We will not address such reforms further here, beyond these few examples, but we call for further research on this topic.

Our final note concerns the feasibility of using straw for industrial operations. We have focused mostly on restricting structures and limited agency; nevertheless, many enabling structures and possibilities exist for the niche to succeed. This point should be taken into consideration in the future studies. Yet, we argue, before venturing into this novel business, policy and business actors must examine farmers' varied contexts and institutional environments and develop the niche in consideration of agency and justness.

Conclusions

Our research has looked at the structural factors that can affect the potential justness and agency of actors in an upcoming niche, which aims to make fibres out of crop residue supplied by Indian farmers. Based on our research, we have found that small-scale farmers' agency and possibility to participate in circular economy transitions can be limited by numerous factors. These factors – which, in many situations, are structural or institutional – can place farmers into a marginalised position within a potential wider value chain. The institutional factors we found include: Cultivation practices, Machinery use schemes, Labour markets, Credit schemes, Subsidy schemes, Physical infrastructure, Information systems, Straw markets, Intermediaries, Contractual relationships, Price reflections, Alternative and traditional straw uses, Common assumptions and Social norms. These factors do not affect every farmer equally, but can combine to create an institutional void, the strength of which is determined by the specific mix of factors to which a farmer is subjected. The institutional void can decrease farmers' agency. Further, the void and farmers' marginalised position can hamper the emergence of just transitions because – due to these diverse and context-specific factors – marginalised actors may be unable to take action, according to their own terms, to enact new niche actions. When farmers cannot act according to their will, the risk of negative impacts or inequalities grows. Some farmers might be unable to participate in the niche at all due to the void. There is potential in this novel circular economy practise to contribute to a sustainable future, but for just niches and transitions to occur, institutional work and niche development must take into account marginalised actors and issues of justness.

Limitations of our research and further research directions

Although our results cannot be directly applied to different countries and contexts, they offer lessons for studying small-scale farmers and structural hindrances in implementing novel (more sustainable) practices. The marginalised position of farmers may hinder just transitions, due to inability of farmers to act under restricting institutional environment. These institutions can be different in for example different political, cultural or geographical contexts, and thus should be evaluated case-by-case. The concept of institutional voids can be helpful in uncovering the multiple mixes of restricting and enabling environments farmers live in.

Looking at a practice before it has been implemented in real life brings certain limitations and uncertainties to our analysis. Many of the reviewed articles are empirical analyses and as such do observe real-life situations, like opinions of the farmers and status quo of current straw usage. But to some extent our findings remain hypotheses. This is due to the fact that the specific niche we examine is not yet in operation and its' full implications or possibilities to farmers thus cannot be observed in real life. Further research could benefit from thinking about ways how we could look at practices and imagine their impacts and possibilities ex-ante. It is a difficult task, but one that must be done if we are to create sustainability transitions that are truly sustainable and just.

Another limitation is our research uses only previously published articles as sources of information. Some of the institutional factors we found were not extensively covered by the articles we reviewed. Further research could benefit from qualitative and quantitative empirical evidence from the farmers and their communities in India and elsewhere. All of the institutional factors we found could benefit from further empirical examination to understand their importance, strength and impacts in different contexts. More research is needed to understand more precisely how the different institutional factors work in different spatio-cultural dimensions and what kinds of methods could be and are used to overcome the restricting institutional environment. It would also be intriguing to look at those farmers who already supply to industrial use and analyse the impacts this has had to their lives and the circumstances that have made the supply possible.

Since our perception of *agency* was grounded on structuration theory, we observed that our case stresses the structural context in which actors are situated. To better understand changes in institutional environments, questions of power and legitimacy require further appreciation. According to the literature on institutional work, the slow pace of institutional change may be explained through powerful actors' conscious decisions to maintain existing institutional environments [77]. Examining the literature more closely reveals that institutional change unfolds through various practices by a broad range of actors, including both defensive and disruptive institutional work [78]. These dynamics deserve further consideration and more upcoming research in order to understand the different actors and their efforts in creating or hindering just sustainability transitions.

Supplementary Materials: The following are available online at www.mdpi.com/xxx/s1, Figure S1: title, Table S1: title, Video S1: title.

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Appendix A

Full list of the 43 articles consulted for the literature review, in alphabetical order.

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