



Affordances and agricultural technology

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ABSTRACT

This paper discusses how the theory of affordances can be used to investigate how a spectrum of opportunities, benefits, costs and risks is generated and unevenly distributed by different kinds of technology (where ‘technology’ is understood as techniques, processes and practices of doing and making, rather than technical artefacts and systems). Affordances are possibilities for action, which arise from relations between humans and entities that surround them. This paper discusses three kinds of affordances: material, cultural and socio-economic. The theory of affordances offers a coherent way to explain why different technologies have different implications, and why those implications vary for different stakeholders. Applied to the domain of development-oriented agricultural research and innovation, the theory of affordances could be used by researchers and practitioners to examine the differentiated implications of different kinds of farming technology and alternative programmes of technological change in agriculture, both *ex ante* (e.g. in their design, development and implementation) and *ex post* (e.g. in their evaluation). To illustrate the argument, the paper uses the example of weeding in the System of Rice Intensification. Since affordances in theory are generated relationally and situationally for each person, the full array of implications arising from the introduction of new technology could be wide and diverse. A practical challenge, therefore, is whether and how the theory of affordances can be used practically and operationally to design, implement and evaluate the appropriateness, accessibility, utility and value of agricultural technology and technological change for specific people and groups of interest.

1. Introduction

In this paper, my goal is to explain how the theory of affordances might be used by researchers and practitioners in the domain of development-oriented agricultural research, to investigate and understand how a spectrum of opportunities, benefits, costs and risks is generated and unevenly distributed by different kinds of agricultural technology. My aim is to suggest that the theory could be applied during the design, implementation and evaluation of new farming technologies and of projects and programmes that aim to stimulate technological change in agriculture. I want to show that the theory of affordances offers a coherent way to explain why the economic, socio-cultural and institutional implications of different kinds of agricultural technology differ from one another, and why the implications of the same type of technology are likely to be different for different stakeholders. To explain and illustrate the argument, I will discuss the case of weeding in the System of Rice Intensification (SRI), an alternative method of rice cultivation.

The theory of affordances is essentially a relational theory of perception, specifically a theory about how animals interpret sensory

information from the environment that surrounds them, and discern opportunities and threats within it. The theory was developed originally by James Gibson, an ecological psychologist. Gibson explained that ‘[t]he affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill’ (Gibson 1979, 127, emphasis in original). The affordance concept has since been taken up and adapted by scholars in various fields, including product design (e.g. the design of user interfaces, human-centred design, ergonomics), computing and information systems, organisation studies, philosophy of science, and the anthropology and sociology of technology.

The theory of affordances has been discussed in the past by a few contributors to the fields of agriculture and rural development. Among them are Pfaffenberger (1988) and Sigaut (1996), whose work I will discuss in some detail below. More recently, the affordance concept has been invoked by several contributors to these and related fields, including Wyche and Steinfield (2016), Berthet et al. (2018) and Gaddefors et al. (2020), but without unpacking the affordance concept at length or examining in much detail its practical application to agriculture, technology and rural development. This is the gap which my paper seeks to fill. There is a short list of authors in these fields who have

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explored the affordance concept in some detail while applying it in empirical research, including Ditzler et al. (2018), Smith et al. (2021) and Obeng Adomaa et al. (2022). Nally and Kearns (2020) have used the concept for a detailed political-ecological examination of the affordances of the potato. Towards the end of this paper – after exploring the affordance concept at length – I will argue that these authors’ treatments of affordance theory demonstrate its usefulness in our fields of research, while maintaining that the affordance concept still has more to offer, which has yet to be fully explored or exploited.

It will be helpful if I state at the outset that I am taking a technographic approach to technology (Jansen and Vellema 2011). This means that I use the term technology to mean not only technical artefacts, tools and systems, but also the techniques, practices, institutional cultures and forms of social organisation that are involved with the deployment and use of those artefacts, tools and systems. This is a technographic understanding of technology, associated with the ethnographic scholarship of social anthropologists such as Marcel Mauss (Schlanger 2006), François Sigaut (1998), and Paul Richards (2000). Through a technographic lens, technology is viewed as a domain of technical practices, in which various tools and techniques are deployed purposefully to transform materials and so to achieve human, social objectives (Jansen and Vellema 2011).

My approach to the affordance concept is sympathetic with recent discussions about materiality and relationality within rural studies, agricultural development, technology and innovation, and related fields. For instance, it was suggested by a reviewer of this paper that the affordance concept has something to say about farmers grappling with materiality, and the roles of nonhumans as ‘actants’ in agriculture (e.g. Pigford et al. 2018; Higgins et al., 2017). Along the same lines, it was also suggested that affordances belong to a relational sociology, in which the world may be interpreted as a fabric made of dynamic interactions among humans and entities that surround them, in which nonhumans of all kinds express a lively agency (Darnhofer 2020, 505).

In the discussion below, I will discuss how the theory of affordances expresses the material and interactive qualities of dynamic relationships that connect humans and other entities, and refer to the relational ontology of actor–network theory (ANT) to elaborate upon these points. These approaches to technology and farming belong to a strand of scholarship that seeks to understand the world as a dynamic, always-emergent expression of entangled practices, performances and interactions, rather than a fixed or stable stage on which independent human agents act (Darnhofer 2020). The technographic understanding of technology – as practices and relationships and emergent institutions, rather than discrete ‘things’ that have independent force (Jansen and Vellema 2011; Arora and Glover 2017; Glover 2018) – is, in my view, one sympathetic expression of this kind of ‘more-than-human’ agrarian sociology, which has been discussed in this and other journals (Legun and Henry, 2017; Higgins et al., 2017; Seshia Galvin, 2018).

In this paper, from a practical and methodological perspective, I argue that affordances are a helpful ‘way in’ to an understanding of how and why technological designs offer different possibilities and opportunities to different kinds of people, depending upon who they are (their personal characteristics and capacities) and how they are situated (their structured position within institutions, networks, relationships and histories). My approach to the concept of affordance has been inspired and informed by scholars working within the anthropology and sociology of technology, including Bruno Latour (1992, 2005), Michel Callon (1986), Bryan Pfaffenberger (1992), Alan Costall (1995), François Sigaut (1996, 2002), Ian Hutchby (2001), Tim Ingold (2000), Tim Dant (2005) and Auke Pols 2012, 2015. Two other very valuable resources are Andrea Scarantino’s *Philosophy of Science* article, ‘Affordances Explained’ (Scarantino 2003) and Anne-Laure Fayard and John Weeks’ *Information and Organisation* article, ‘Affordances for Practice’ (Fayard and Weeks, 2014). Perhaps the most concise and accessible overview of affordances (applied as a principle in design) can be found in Don Norman’s entertaining book, *The Design of Everyday Things* (Norman

2002).

The paper is organised as follows. Section 2 introduces the affordance concept and section 3 explains the interactional, perceptual, experiential and relational qualities of affordances. The next three Sections (4–6) develop an argument that affordances can serve as an appropriate and useful lens through which to study development interventions and technological change, including in agriculture. My argument is that, before considering how the affordance concept can be applied usefully to the study of agricultural development interventions, it is helpful to consider three key questions: first, how affordances enable and constrain agency; second, how affordances change and can be intentionally modified; third, how affordances express and shape relationships between designers and developers of technical artefacts and systems, on one hand, and the potential or intended ‘users’ of those artefacts and systems, on the other. These three themes are addressed in turn (Sections 4–6) and they are keys to articulating a politics of technology and innovation, which is at the heart of many agricultural development encounters. Section 7 then summarises, offering a practical suggestion that we should seek affordances within three kinds of relations: material, cultural, and socio-economic. In other words, Section 7 provides an initial indication of how affordances can be used to inform methodologies for research into technology, technological change, and related topics.

Section 8 is a short section, which segues between the abstract and theoretical sections of the paper (2–7) and the empirical case of weeding in SRI, which is used in Section 9 to illustrate how the affordance concept could be applied to analyse an empirical case of agricultural technology and development. Section 10 then discusses how the affordance concept has already been applied to date by scholars such as Ditzler et al. (2018), Nally and Kearns (2020), Smith et al. (2021) and Obeng Adomaa et al. (2022). This section also compares the affordance concept to the concept of ‘landscapes of opportunity’ (Sumberg et al., 2019) and the capabilities approach (Alkire 2002), with which it shares some common features. Section 11 concludes with a short summary of this paper’s contributions, as well as some brief remarks about methods and approaches for applying the affordance concept in research on agricultural technology and agrarian change.

2. What are affordances?

Gibson claims to have coined the term *affordance*, although it is simply a noun derived from *afford*, an ordinary verb, albeit in one of its less commonly used senses. While the term has something to do with being accessible or reachable, it is not centrally about financial or economic *affordability*. Affordances are immaterial things that are made available by the environment that surrounds an individual. Affordances might be thought of as dispositions of objects and environments, which provide opportunities for functional interaction, in other words, which generate potentials for those objects and environments to be put to use. The affordances of an object or environment are possibilities for action that enable and constrain agency, where ‘agency’ is understood simply as a ‘capacity to act’. They have been called ‘opportunities for action’ (Pols 2012), ‘opportunities for behavior [sic]’ (Pols 2015, 239) and ‘opportunities for use’ (Pols 2015, 240). A list of synonyms that might substitute for the verb *afford* might include terms such as *propose*, *provide*, *offer*, *furnish*, *present* [an opportunity] or *invite*. Norman proposes that the word *affords* could be replaced by ‘is for,’ although, as I will discuss below, the notion that an object or environment ‘is for’ a certain purpose is potentially treacherous (Norman 2002, 11). Alternative nouns to replace *affordance* could include *proposition*, *proposal*, *offer* or *invitation*.

Box 1 displays some examples of ways affordances have been defined by sociologists and anthropologists of technology. Perhaps the most intuitive way to convey what affordances are is Alan Costall’s suggestion that ‘We can see, for example, that something can be eaten or thrown’ (Costall 1995, 470). In this example, the possibilities of eating and

Box 1 Defining affordances

“An affordance is a perceived property of an artefact that suggests how it should be used.” (Pfaffenberger 1992, 503)

“Affordances are defined as ‘environmental resources for behavior’: a flat and smooth surface ‘affords’ physical opportunities that are put to use by a skater ... The fact that wheat and rice produce both edible grains and straw, whereas reeds and rushes produce only useable straw, and maize or sorghum only edible grains, points to different affordances ...” (Sigaut 1996, 432)

“... affordances are functional and relational aspects which frame, while not determining, the possibilities for agentic action in relation to an object.” (Hutchby 2001, 444)

“... the concept of affordance ... refer[s] to the properties of an object that render it apt for the project of a subject.” (Ingold 2002)

“An affordance is a relationship between the properties of an object and the capabilities of the agent that determine just how the object could possibly be used.” (Norman 2002, 11)

throwing are affordances – opportunities for functional interaction – perceived by us. However, while Costall’s example is neat and simple to grasp, it is perhaps deceptively so, because it turns out that there are serious theoretical questions to be asked about whether affordances are best understood as intrinsic properties belonging to objects and environments; as dispositions of objects towards other entities within their environments; or as subjective perceptions in the minds of organisms that discern opportunities to put objects and environments to some kind of use (Scarantino 2003). I see no need to choose among these interpretations. All of them contribute to a fuller picture, which suggests to me that the concept of affordance encompasses simultaneously material, perceptual, experiential and relational aspects. I believe that this richness of the affordance idea is what makes it interesting as a conceptual tool for thinking about technology, including agricultural technology, and its role in development. The next section elaborates briefly on the way affordances are made available materially, perceptually, experientially and relationally.

3. The character of affordances: interactional, perceptual, experiential and relational

For an object to be ‘eatable’ or ‘throwable’ in practice, it must have material, physical characteristics that make it so; but the properties of the object provide only half of the story (Costall 1995). According to Gibson, the affordances of eating or throwing exist in the potential for *material interaction* between two entities. There must be a compatibility in the interaction between an object that is capable of being eaten or thrown and an organism that is capable of eating or throwing that object. In other words, the possibility of a material interaction between the two entities depends on the material, physical characteristics of both entities. The affordance arises out of this relationship between their respective capacities: the capacity of throwing or eating and the capacity of being thrown or eaten. Gibson called this relationship ‘complementarity,’ which defined the two entities as a functional pair. This relationship has been also been termed ‘entanglement’ by thinkers in the fields of design (Maier and Fadel, 2009) and information and organisation studies (Fayard and Weeks 2014).

Affordances are *perceptual* in so far as they are not intrinsic properties of objects and environments, but properties of those objects and environments as perceived by the senses and apprehended by the minds of potential users (Pols 2012). In this sense, affordances are subjective rather than objective but, as we have just seen, they do relate to real biophysical characteristics of objects and environments, which are independent of the perceiver. However, for an affordance to exist for a given individual, it is not enough that the functional interaction is theoretically possible (e.g. that a person is in fact strong and dextrous enough to move a given object). The potential for use must be present in the mind of a potential user (Scarantino 2003, Fayard and Weeks 2014).

Affordances are *experiential* in so far as they may be discovered through interaction and recognised through experience (Pols 2012). Norman prefers to say that affordances must be ‘discoverable,’ as well as ‘perceivable,’ if they are to be ‘effective’ (Norman 2002, 11). The point is that affordances can be discovered in practice (e.g. by trial-and-error), but also learned by observation and emulation, and this makes them cultural, or ‘traditional’ in the sense used by Marcel Mauss in his classic definition of techniques as *actes traditionels efficaces*,¹ because they can be passed by one individual, generation or cohort to the next. The sociologist Tim Dant picked up this point when he observed that an affordance could be perceived through both personal experience and by learning from others:

The affordance is not simply a fixed or physical property of the object or the environment because it is related to the human agency that perceives what it offers. Different human agents will perceive different agency in different objects although they may learn, either by trial and error or from each other, what a specific object might afford (Dant 2005, 74).

Dant’s account also highlights the *relational* character of affordances, which hinges on the fact that the possibilities for material interaction are properties that emerge out of a relationship between an object or environment that has certain biophysical attributes (e.g. size, shape, dimensions, apparent weight) and an organism, endowed with senses and abilities, that perceives opportunities which those attributes present to it (i.e. an appreciation that the object’s or environment’s size, shape, etc. place it within or beyond that specific organism’s capacity to interact with it) (cf. Fayard and Weeks 2014).

4. Affordances as enablers of and constraints upon human agency

It follows from the relational quality of affordances that the affordances of a given object or environment will be different for different individuals (Dant 2005). According to Norman,

This relational definition of affordance gives considerable difficulty to many people. We are used to thinking that properties are associated with objects. But affordance is not a property. An affordance is a relationship. Whether an affordance exists depends upon the properties of both the object and the agent. (Norman 2002, 11)

While Dant’s and Norman’s accounts might seem to imply that affordances arise in relation to individual human agencies, it may be more precise to state that agency itself – the capacity to act in a specific

¹ “Traditional efficient [or effective] acts.”

situation – emerges as a distributional effect of the way affordances are generated for particular people in relation to the objects and environments that surround them in particular places and at particular times (Ingold 2002). In other words, agency itself is an effect that arises from the dynamic relations among people, places and things. And, because agency is not evenly distributed through actor–networks, power is distributed in this way, unequally, across socio-technical systems and processes (Arora and Glover 2017; Stirling 2014). Our challenge, as scholars of agricultural development, is to discover ways to think practically about how different kinds of farming technology generate affordances relationally and distribute them unevenly, for particular configurations of rural people, places and times.

Norman (2002) distinguishes between *affordances*, which are objective possibilities for physical interaction, and *perceived affordances*, which are the sub-set of affordances actually noticed and recognised by an agent. This leads him further to suggest that affordances come to be noticed by means of *signifiers*. For designers like Norman, the practical lesson is that affordances can be made more apparent to potential users by means of hints and prompts, which can be built into, or added onto, an object. Examples of signifiers would include an obvious handle that is given to an object, or signs and symbols that designers add to a device to make its intended functions more apparent (Norman 2002, 18). But this designer's account of affordances seems to imply, after all, that affordances are features that are intrinsic to objects, rather than emergent properties of relationships between people and things. It also highlights the designer's framing of potential users, as people with known or predictable attributes, who need to be encouraged and enabled to interact with the object in certain, desired or expected ways. This is obviously a practical way for a designer to proceed, but for technographers it is a potentially risky approach, for two reasons: first, because it downplays the understanding that affordances arise in relation to natural environments of all kinds, not just designed artefacts; second, different people bring unique capacities, values, needs and intentions to an interaction with the environment. If we want to understand why it is that two people can look at the same farming technology and perceive different affordances within it, we need a more thoroughly relational account (Maier and Fadel, 2009).

The perception of affordances obviously depends on biomechanical, sensory, neurological and cognitive processes within the individual, but it is also social and cultural (Pols 2012). Relations between entities, which generate affordances, involve symbolic and ritual interactions as well physical and material ones. Pfaffenberger (1992) explained this neatly in a short discussion of the symbolic meanings conveyed by the furniture placed in Victorian entry hallways. Chairs and benches in this liminal space had to look attractive, but they were also designed to be austere and uncomfortable. They were intended to clearly demarcate the social and class distinctions between tradespeople, who were made to wait in the hall, and guests and visitors of the master, who saw the hall as they were conducted through it directly into the more comfortable and exclusive spaces beyond it (Pfaffenberger 1992). The hallway and its furnishings were supposed to present different affordances to different types of people. Moreover, an individual needs some contextual knowledge regarding their positionality in relation to institutions and cultural norms in order to perceive the opportunities afforded to them by the objects and environments which they encounter (Pols 2012).

Some accounts of affordance theory distinguish affordances from 'negative affordances' or 'anti-affordances' (e.g. Norman 2002, 11). This is a way to highlight the potential for some types of affordance to operate as constraints on, rather than enablers of, agency (Fayard and Weeks 2014). An object or environment might offer a rich array of affordances that empower by creating many action possibilities, or multiple constraints that stifle every initiative. The specific combination of affordances and anti-affordances in each situated relationship makes some objects more versatile than others, and some environments richer in opportunities for agency to act in pursuit of its goals.

5. Affordances and development processes: the dynamism of affordances

Affordances are dynamic. Just as the affordances of an object or situation could be quite different for individuals at different ages or stages of life, it follows that they can change for the same individual through the life course. For example, an adolescent who is growing taller and stronger discovers that the range of affordances available to them has increased, whereas an elderly person, whose physical strength is declining, finds that their capacity to interact with objects and environments is decreasing. As well as biophysical alterations, changes in affordances can arise from alterations in cultural status (e.g. transitioning from childhood to adulthood, becoming a parent, or needing a carer) or socio-economic position (e.g. a change of job or an increase or decrease in income).

Affordances can change in this way, qualitatively and quantitatively as time passes, without any requirement of intentionality on the part of the person concerned; but they are also potentially malleable, intentionally, at the initiative of the actor him or herself or through an intervention by a third party. For example, an individual could enlarge the affordances available to her by increasing her income or accumulating wealth, acquiring knowledge, developing new skills, and gaining experience:

While the complete beginner may be incompetent with even the most basic tools, her gradually increasing bodily skills and accumulating embodied knowledge open up the affordances (both cultural and material) of more advanced and sophisticated tools, which become more accessible to her, and thus her field of practice and the range of achievement available to her also increase (Arora and Glover 2017: 6).

In other words, as Dant (1998) has shown for the case of windsurfing, a combination of competence, cultural capital and economic capacity determine the possibilities for a particular windsurfer and a given assemblage of windsurfing equipment (board, mast, boom, sail and harness) to interact together. A complete novice and a beginner's kit are fit for one another in terms of skill and ease of use, whereas an experienced windsurfer progressively expands her capacity to use more advanced and sophisticated equipment as her capabilities (i.e. the affordances available to her) are enlarged, through a combination of superior biophysical capacities (i.e. dexterity, strength, agility, etc.), cultural capital (being recognised as a skilled user, for whom advanced kit is suitable) and socio-economic resources (e.g. the wherewithal to purchase, hire or borrow, and perform more risky feats with, more specialised and refined equipment, which is typically more expensive).² Both the subject and the object in this relationship matter: an experienced windsurfer can accomplish more than a beginner can with a beginner's board and sail, yet, if they want to attempt some advanced manoeuvres or tricks, they will still need to use more sophisticated equipment. Ecological anthropologist Tim Ingold argues that this reciprocal constitution of a particular object's affordances and a specific subject's capabilities – in other words, their agency – is fundamental. It defines the subject's 'effectivity' – or the 'action capabilities of the agent—what he or she is practically equipped to do' (Ingold 2002, 31).

If a working definition of development is the engagement of a subject's action capabilities, or agency, and specifically their ability to achieve goals they value (Sen 1999), then it becomes clearer that enlarging and improving each person's affordances should be the essential purpose of development interventions. Technological

² Being recognised by peers as a competent practitioner is a non-trivial factor alongside actual ability and the financial capacity to hire or buy advanced equipment. This 'social licence' to practise difficult skills at advanced levels is reflected in the language sometimes used by sporting initiates to make fun of incompetent-but-affluent beginners, who have 'all the gear but no idea'.

innovation, and the circulation and promotion of new technologies, are often central to agricultural development efforts, where the underlying goal is to expand and raise awareness of the affordances available to members of a given community or group. Any such intervention is freighted with ethical concerns: whose interests, goals, assumptions and values are embodied in the initial design of a technology? The affordances of a technology express and reflect the relationship between the organisations and people that design, develop and introduce technologies, on one hand, and populations of intended or potential ‘users’ and beneficiaries, on the other. This is a relationship that is typically infused with inequalities of power.

6. Affordances, agency and power: relations between designers and ‘users’

Affordances may be found and recognised in natural objects and environments, but they can also be created or introduced intentionally by the designers of technical tools, machines and systems (Norman 2002; Pfaffenberger 1988; Winner 1980; Suchman 1987; Ingold 2002). Designed affordances establish relationships, or mediate, between the designers/makers and other people and groups, who interact with the designed artefacts, perceive their potential uses, and respond (or not) to the opportunities which they represent. The affordances embody the designers’ assumptions about the intended users of their artefacts, and their expectations about how the artefacts should be properly used. The affordances are intended to encourage and facilitate proper use, and discourage uses that might be undesirable (according to some perspective or interest) or dangerous (Fayard and Weeks 2014; Pols 2015). The affordances that are built into crop varieties, farm machinery and agricultural technology packages are expressions of a programme or script, which aims to govern the behaviours of farmers, labourers and others involved in agricultural production (Akrich 1992). However, the script needs to be interpreted for performance, and it can be subverted or ignored, as well as obeyed (Arora and Glover 2017). This means that the local configurations of social and technical relations and patterns of practice, which emerge from processes of innovation and technological change, are expressions of a contingent negotiation among situated actors, who are endowed with various resources and capacities, and animated by a variety of motives, values and priorities (Glover et al. 2017; Glover 2018). While the designed affordances of an artefact or technical system might be optimised to support an intended use, they could still allow, or might fail to prevent, alternative uses. It is also important to notice that features which create positive affordances for one individual or group might generate negative affordances (or outcomes) for another group (Maier and Fadel, 2009).

Here, the relational ontology of actor–network theory (ANT) is useful, because it provides a language for thinking about the ways objects and artefacts mediate between human actors. By mediating, they help to crystallise configurations of social relationships, including unequal distributions of power and influence (Callon 1987; Latour 1991, 1992). Inventors, designers and makers of technological artefacts and systems attempt to use objects and artefacts to enrol other actors into their networks, configure their social relations, and impose scripts upon them in ways that channel and constrain their agency. However, those intended ‘users’ of technology may also resist and subvert the roles assigned to them (Akrich 1992; Arora and Glover 2017; Glover et al. 2017; Fayard and Weeks 2014; Pols 2015).

This is why it is potentially treacherous to say that an object ‘is for’ a specific purpose: the purpose could be indefinite, contingent, and contested. An object might be designed with an intended application or technique in mind, but the uses to which that object is eventually put, how, and by whom, depend on the needs, intentions and initiatives of other agents (whose agency is conditioned by their physical and mental capacities and mediated by the material, symbolic, socio-economic and political relationships that exist within the situation). As Pfaffenberger explains,

Affordances are inherently multiple: Differing perceptions lead to different uses. You can drink water from a cup to quench thirst, but you can also use a cup to show you are well bred, to emphasize your taste in choosing decor, or to hold model airplane parts. (Pfaffenberger 1992, 503)

An artefact might be put to uses that were not intended or anticipated by its designer or maker, or which might even be inimical to the interests and values of the designers. (This exploitation of emergent affordances, to apply designed artefacts and systems to purposes that were not conceived or planned by their designers, has been termed *exaptation* in the innovation literature (Gaddefors et al. 2020).) Some such uses could be risky or dangerous. The existence of these undesirable uses might lead designers or regulators to apply signifiers, such as warning signs and prohibition notices (backed perhaps by fines and other punishments or disincentives), to discourage the exploitation of some kinds of affordance (Norman 2002; Pols 2012). Contractual terms and civil sanctions might also be used to prevent or discourage unwanted actions that would otherwise be available to users. A relevant example from the agricultural domain is the imposition of licensing conditions which prevent farmers, who purchase transgenic seeds from commercial companies, from saving, exchanging or re-using seed: infringement is punishable through civil courts.

7. Where to seek affordances

We are now equipped to draw out some general inferences, which could enable development scholars and professionals to think about technology (including agricultural technology) through the conceptual language of affordances. I suggest that a major implication is that we should approach the study of technology through three types of relations:

1. *Material*. This is the domain of material interactions and biophysical relations between users and objects/artefacts. Essentially, the guideline here is to consider the relationship between attributes of things and environments, such as size, weight and dimensions, relative to capacities of individuals and groups, such as height, strength and dexterity. For example, the same farming implement will likely have very different affordances for an infant, an able-bodied adult, an adult with a physical disability, and a frail, elderly person. This could be called a realist perspective on affordances.
2. *Cultural*. This is the domain of symbolic relations and ritual interactions. Cultural institutions and norms, such as gender roles, relations between generations, and performances of identities such as caste, ethnicity and sexuality, strongly influence the scope of people’s entitlements and freedoms to engage with technologies of different kinds. For example, in any given society, the freedom of an individual to use certain objects (e.g. types of machines, clothing, modes of transport or articles of furniture) may be conditioned by social rules and institutions, with sanctions imposed for transgression. This means that the affordances of a given object could be different for a young woman compared with her classmate of a different ethnicity, her own mother, an adult male, or a priest. This might be called a constructivist or interpretivist perspective on affordances.
3. *Socio-economic*. This is the domain of social and economic relationships. Wealth, income, consumption, jobs and livelihoods are all important shapers of human relations. They distribute economic capacity (power), and by doing so they help to determine the affordances of objects and environments for different individuals and groups. Obviously, a rich land-owner is likely to perceive many more opportunities in his environment than a landless farm labourer, and will enjoy a much greater capacity to exploit them. A more important point is that people whose position within economic institutions

endows them with greater power can have a larger influence on the configuration of affordances and opportunities that are available to others, as well. This might be termed a political economy perspective on affordances. For example, a Bill Gates or a Steve Jobs has a very substantial capacity to shape, not only how technological artefacts and systems are designed to work, but also how and where they are manufactured, how and to whom they are marketed, the price at which they are sold, and so on.

8. Affordances as a lens on agricultural technology and development

The theory of affordances opens up insightful ways to think about farming technology as technical practice, which brings into the centre of attention the relationships between technical artefacts and systems on one hand – including living organisms, such as scientifically improved crop cultivars – and potential users (i.e. farmers, labourers and agricultural communities) on the other. This technographic perspective places the agency of technological practitioners – farmers, agricultural labourers and rural households – at the centre of attention. It sees their agency as capacities for action that are enabled and constrained by positive and negative affordances, which arise from contextually specific configurations of material, cultural and socio-economic agrarian relations.

In turn, this focus on the agency of technological practitioners offers a distinct perspective on agricultural development interventions, which affirms that, instead of thinking about the introduction of new farming technologies to new users as a ‘transfer’ or ‘adoption’ of discrete, readymade ‘technology packages,’ we are better off understanding the new technologies as ‘propositions,’ comprising new tools, techniques and modes of working, which lead (at least potentially) to a reconfiguration of material, symbolic, social and economic relationships (Glover et al., 2019).

This perspective through the lens of affordances also brings into focus the potential for miscommunication, misunderstanding and conflict between organisations that promote novel farming technologies, on one side, and rural people whose existing livelihoods and farming methods are targeted for change, on the other. This is a relationship between agents who are typically endowed with unequal resources of wealth and power, whose views and perceptions – about what a technology is ‘for,’ its usefulness and relevance, and the value to be placed on its costs and benefits – may not be aligned, or compatible. Recognising the potential for such divergent dispositions in relation to a technology provides a window onto the technology’s politics and its potential to emancipate and empower or oppress and dispossess. The next section explores an empirical case to shed light on how this works.

9. Affordances in the System of Rice Intensification

SRI is an alternative method of rice cultivation that was inspired by certain physiological and morphological characteristics (i.e. biophysical and material affordances) of rice plants. SRI’s developer, Henri de Laulanié, had learned from scientific sources and direct observation that rice seedlings have the capacity to produce numerous shoots and large, grain-bearing panicles (ears) when they are raised in a fertile nursery for just a few days, then transplanted gently into well prepared soil, where they are given abundant space, sufficient but not excessive moisture, and effective protection from competition from weeds and other rice plants. SRI was designed to exploit this precocious and vigorous growth potential of individual rice plants (Glover 2011).

SRI was also designed with and for a specific community of resource-poor rice farmers in a specific location and time. The local conditions made it desirable to develop and promote methods of rice cultivation that could be productive on small plots of land cultivated largely by hand, without depending on external inputs of fertiliser or improved rice varieties that were completely unavailable or costly and hard to obtain.

Laulanié explicitly anticipated that, since SRI methods were based partly on the physiology of rice plants, they could be useful to rice growers in other settings, but he knew that adaptations would be needed to suit different socio-economic and agro-ecological conditions (Glover 2011). In other words, a consideration of the affordances of irrigated rice farming was intrinsic to SRI’s development, and to its prospects for extension to other sites.

Under well controlled conditions, SRI methods can produce more grain while saving seed and reducing water consumption; however, compared to traditional methods of transplanted wet-rice farming, SRI requires more attentive management and a more punctilious performance of key farming operations (Berkhout et al. 2015). Laulanié said that the seedling nursery should be ‘garden-like’, and this in a way is a key to understanding his ambition for SRI as a whole system: that it could translate onto the scale of the (small) field and farm the special care that a gardener gives to individual plants and small beds in his or her garden.

This translation across scales has proved to be challenging. Multiple academic studies and other field reports have found that many rice farmers, having been introduced to SRI, have not followed the recommended practices faithfully, or have abandoned SRI after experimenting with it for a season or two – in some instances, despite having personally experienced high yields or a good economic outcome (e.g. Moser and Barrett 2003; Taylor and Bhasme 2019; Senthilkumar et al., 2008). With a focus on weeding, and citing examples from peer-reviewed studies of SRI in South Asia, this section explores the material, cultural and socio-economic affordances that help to explain why this is so.

In the limited space available here, it is not possible to explore all the ramifications of a change to weeding methods. The objective is only to illustrate how the material, cultural and socio-economic affordances of different methods and tools influence the performance of weeding in SRI, shape the distribution of SRI’s costs, benefits, risks and opportunities, and help to determine who practises SRI, and how they do so.

Weeding is a notable area in which SRI diverges from traditional methods of irrigated rice cultivation. Flooding paddy fields is an effective way to suppress many kinds of weeds, but in SRI the rice fields are supposed to be kept moist, or only shallowly flooded, and allowed to drain at intervals, instead of remaining continuously under a deep layer of water. Under these conditions, alternative methods of weed control are needed. Weed suppression is especially important, because very young rice seedlings are tiny when they are transplanted, making them very vulnerable to being overtaken by fast-growing weeds. For decades, agronomists have promoted mechanical rotary weeders as tools for weed control with reduced irrigation. Rotary weeders churn the soil between rice plants, uprooting, chopping and burying weeds as they go (Hansda 2018).

The SRI-induced changes to weeding alter the material, cultural and socio-economic affordances of rice farming. In traditional wet rice, weeds are removed manually, typically by working parties of women. The introduction of mechanical weeders disrupts this convention, with several ramifications. First, work with machines is typically regarded in rural South Asia as men’s domain. This view is linked to perceived and real differences in men’s and women’s capacity to do heavy and technical work. Asking women to use machines may be regarded as culturally inappropriate as well as beyond their physical capacity. (In fact, many of the available machines are found heavy and cumbersome by both male and female operators.) Thus, the transition to mechanical weeding disrupts traditional gender roles, either by involving men in weeding or by involving women in the use of machines (Hansda 2018; Taylor and Bhasme 2019).

The material relationships among weeders, labourers, and soils have shaped the affordances, for different people, of weed management according to SRI principles. For example, weeders of different designs perform differently in different kinds of soils and different moisture conditions, making them easier to use and more effective in some situations than in others (Taylor and Bhasme 2019). Rotary weeders are also

unsuitable for removing weeds that grow very close to the rice seedlings, so that, in practice, farmers often find it necessary to follow a pass with the mechanical weeder with a supplementary manual weeding to remove weeds that have emerged right next to rice plants. However, this supplementary weeding can be done by just one or two people (usually women) instead of a larger group (Taylor and Bhasme 2019).

Difficulties of refining and optimising the material and economic affordances of weeders has made it challenging to translate some of Laulanié's rice-farming principles into practice. Laulanié argued that the optimum distance between rice plants should vary according to the local growing conditions. He recommended that the spacing of transplanted seedlings should be adjusted by farmers to suit the characteristics of the rice variety, the soil quality, ambient temperature, and other factors that could affect the growth of the young plants (Berkhout and Glover 2011). For this principle to be put into practice, rotary weeders of different widths, or adjustable widths, would be required. A few weeders with adjustable heads have been developed, however, with additional moving parts they have proved to be more complex and expensive to design and manufacture, heavier and more cumbersome to use, and liable to break down. It is partly for this reason that, in practice, SRI training protocols typically recommend a fixed standard for spacing transplants, usually 25 cm by 25 cm; it is very rare that farmers are encouraged to deviate from this norm (Glover 2014).

The transition to mechanical weeding also changes the sociality of weeding, as it transforms the task from a group activity (often performed by women) to a solitary one (which may be performed by men). Mechanical weeding eliminates drudgery for women (Vent et al. 2017), but it also reduces their opportunities for employment and eliminates the sociable interaction that formerly accompanied the work. Women working alone in fields can feel, and be, more vulnerable to sexual assault or gender-based violence. The fact and the perception that operating mechanical weeders is physically demanding, solitary, and repetitive make it more likely that the task will be performed by younger, male manual workers who are constrained to work for a wage (Hansda 2018). There is an intersection here, of cultural and socio-economic relations, which shapes the affordances of mechanical weeding, and influences the dispositions of different actors (e.g. women and men, farmers and wage labourers) towards SRI.

The change to mechanical weeding reduces the number of workers needed to perform the task, making it easier for a farmer to convene a working party and sharply reducing the time required to complete the job. It reduces demand for labour overall, which can be an advantage for the farmer but a disadvantage for wage workers; or, in some studies, the shift from collective female to individual male labour in weeding entailed an increased cost for the farmer, due to the higher wages typically paid to men than to women (Gathorne-Hardy et al., 2016; Senthilkumar et al., 2008). In households that rely on family labour to manage a small rice plot, mechanical weeding can save time, which allows the responsible household members (usually women) some respite, or the opportunity to spend time on other domestic tasks or income generation (Hansda 2018; Vent et al. 2017).

The brief illustrations presented here are enough to show how and why the ramifications of switching to mechanical weeding and SRI could be different for large and small farmers, men and women, land-owners and landless wage labourers, and so on. While SRI might offer, in principle, a set of technical and economic advantages to rice farmers, the specific affordances encountered by each actor involved in the cultivation process emerge situationally, through a kind of refraction, from particular material, cultural and socio-economic interactions and relations. My argument in this paper is that a methodical study, through the lens of affordances, could bring these ramifications to the surface.

In India, the differential affordances of various SRI practices for different age and gender groups were appreciated as they were experienced by farmers, farm workers and extensionists on the ground, in diverse agro-ecological, institutional and policy settings. As they grappled with the opportunities and challenges presented by SRI, individuals

and groups explored practical ways to apply (or not) the SRI principles to their own situations and purposes. This resulted in the development of a variety of differently configured farming practices in different places (Sen et al., 2017). This diversity of real-world practices was an effect that could be celebrated as a reflection of SRI's intrinsic adaptability, an expression of its flexible principles. However, this flexibility in adaptive practice was rarely well anticipated or supported by programmes and organisations that promoted SRI to farmers. Usually, preoccupied with applying cultivation methods that had been designed around the physiology of rice plants, SRI's promoters introduced the new method in ways that were remarkably dogmatic and inflexible (Glover 2011, 2014). The material and biophysical affordances of rice plants and their relations with soils, water and nutrients received a lot of attention, but other kinds of affordance and other relationships in the rice farming enterprise received much less. An affordance lens could have been applied to better anticipate individual and local needs and support local adaptation. This might have allowed the community of SRI practitioners and promoters to meet with more success.

10. Applications of affordance theory in agricultural development literature

The theory of affordances has been discussed by only a few contributors to the literature on agriculture and rural development, including Sigaut (1996) and Pfaffenberger (1988). In a more recent contribution, Ditzler et al. (2018) used the affordance concept to assess the utility of a selection of systems-analysis tools that could be used to support decision making and problem solving in an agricultural innovation and development context. Drawing on a different selection of sources than the ones used in this essay, Ditzler and colleagues defined affordances as 'a function provided by an object through an interaction with a user' (Ditzler et al., 2018, 20). This is a functional definition, which emphasises what an artefact is supposed to be for (e.g. according to a designer or within the terms of a design specification), rather than a more open conception of the opportunities it might offer for use by a spectrum of different actors (Polis 2015). Ditzler et al. (2018, 21) also distinguished 'functional affordances' from 'structural affordances,' which they defined as intrinsic properties of a tool. Their approach implicitly emphasised the intentional creation of affordances by designers - albeit through an iterative consultation process with intended users - rather than the relational emergence of affordances through relational interactions with diverse actors, regardless of whether those actors were intentionally engaged with by designers during the design process. Applying this approach, Ditzler et al. (2018) identified a list of affordances which they believed were provided by each system-analysis tool they considered, as viewed from the perspective of the organisations and programmes that might want to use such tools to increase their own effectiveness in pursuit of their development objectives.

This is one way to apply the theory of affordances, however, in my view it is rather an instrumental application, which prioritises the perspectives of programme designers and implementers. The theory can also be used in a more critical mode, to investigate the distribution of agency and the relationships of conflict and cooperation among the range of actors and interests involved in innovation and development processes. In other words, Ditzler and colleagues might have used a more thoroughly relational approach and a different methodology to reveal constraints (i.e. anti- or negative affordances) as well as affordances; or to reveal the range of affordances for other involved stakeholders instead of the programme managers; or to allow other, more unruly and discordant affordances to be revealed, such as might arise from conflictual or non-consensual interactions between development organisations and their supposed beneficiaries.

The approach taken by Smith et al. (2021) is, I think, more open than the one adopted by Ditzler et al. (2018). Smith et al. (2021) developed an 'innovation-affordance framework' and applied it to a comparative study of two development interventions, which sought to introduce

Climate-Smart Agriculture (CSA) to farmers in the Usambara Mountains, Tanzania. They considered the discrete affordances made available to farmers by the orgware, hardware and software of the two CSA interventions. In common with critiques of many such development interventions, Smith and her co-authors found that the design and especially the implementation processes of the two CSA projects generated affordances that were more likely to benefit the better resourced, more privileged, more capable and better connected farmers in the two targeted communities. As I have argued in this paper, the affordance lens helped [Smith et al. \(2021\)](#) to expose why and how this process of differential inclusion and marginalisation occurs. Their study neatly illustrates the potential for affordances to be used to inform the design, implementation and evaluation of development interventions.

A very recent study by [Obeng Adomaa et al. \(2022\)](#) is another in which the authors applied the affordance concept to an agricultural case. They showed how the potentially beneficial affordances of pruning practices for cocoa cultivation became gradually more inflexible and constrained as they were translated, in a short series of steps, from the domain of applied agronomic research, through extension manuals and training events, into farmers' technical repertoires. In this mediated journey from lab to field, abstract scientific knowledge about the vitality and productivity of cocoa trees was codified into simplified and standardised sets of pruning practices that were communicated in training manuals via diagrams and instructions. Along the way, some of the potential advantages of pruning practices for different cocoa farmers were obscured, and the potential to exploit pruning's affordances for different sites was lost – leading to a low uptake of the recommended practices, which disappointed evaluators. The study by [Obeng Adomaa et al. \(2022\)](#) displays the authors' appreciation of the relational, situated and emergent qualities of affordances for different kinds of practitioners (e.g. scientists, extensionists, farmers) and in different 'sites' (e.g. research, extension, cultivation).

Another interesting application of affordance theory, overlapping with the field of agricultural and rural development, is a historical and political-ecological analysis of the affordances of the potato and their connections to the wider political economies of different locations where potatoes have been cultivated ([Nally and Kearns 2020](#)). [Nally and Kearns' \(2020\)](#) study explains how potatoes offered contrasting affordances and anti-affordances to peasants, colonisers, plantation owners, land owners and capitalists in the contrasting settings of Latin America and Ireland; and that these affordances were modified through time to facilitate the appropriation of land, accumulation of capital and immiseration of poor people. [Nally and Kearns' study](#) expressly confirms the view advanced in this paper, that the theory of affordances can be used to expose the politics of agrarian technology and technological change in agriculture.

The affordance concept can be compared with the notion that a given place and time presents a spectrum of different 'landscapes of opportunity' to the assortment of people and groups inhabiting that situation, depending on their individual capabilities as well as the contingencies of the moment ([Sumberg et al., 2019](#)). [Sumberg et al. \(2019\)](#) distinguish opportunities, which are realisable livelihood and career options as seen from the perspective of a certain individual, from possibilities, which are economic activities that are theoretically or objectively present in the situation, yet some of them may be out of reach for some people. Their conceptual framework clearly describes phenomena that are perceptual, relational and interactional in the same way as affordances. For example, the theoretical possibilities must first be perceived, and the ability to perceive them is conditioned by each person's experience, awareness, expectations, self-confidence, social connections, and so on. Once perceived, the possibilities will quickly be sorted into categories, depending on whether the individual concerned is able to see them as a realistic opportunity for them, something out of reach, or something potentially attainable if only they could overcome an obstacle, such as by acquiring a professional qualification, accumulating some savings, or getting a loan. Some possibilities will be temporarily or permanently out

of reach to some people and groups, thanks to biophysical limitations, socio-economic constraints, social or spatial isolation, or restrictive cultural norms.

The distinction which I have explored in this article, between affordances seen as objectively observable and quantifiable characteristics of objects and environments, and affordances understood as perceptions arising in the minds of people encountering those objects and environments, seems to remind some people of the capabilities approach, a paradigmatic theory of development economics that was originally proposed by Amartya Sen, then elaborated by Martha Nussbaum and others. The capabilities approach distinguishes between *functionings* and *capabilities*, where functionings are understood as the actual practices and states that constitute a person's being and doing, while capabilities are defined as a person's substantive freedom to engage in or achieve a range of functionings, which are feasible for that person. A person's 'capability set' depends on their capacity to act (their agency) ([Alkire 2002](#)).

Affordances have a similar character, in that they emerge out of the relations between the real and measurable characteristics of objects and environments on one hand and, on the other hand, the capacities of human beings who encounter those objects and environments to interact with them and exploit the opportunities they present. The capabilities approach and the theory of affordances also share an ability to accommodate change: A person's capability set can change (for example, enlarge or contract) depending either on changes in the context that surrounds them, or changes in that person's capacities to perceive and act upon opportunities that exist in that context. Similarly, the affordances of a situation may change when the context changes over time (e.g. a change in government policy, illness in the family, or a natural disaster) and when the person's capacity changes (e.g. their experience enlarges, their skill and confidence increase, or they grow stronger or weaker).

A possible point of contrast between the capabilities approach and the way I have discussed affordances in this article relates to the way agency is conceived. Sen defines agency purposively, as the ability not merely to act – which, in a trivial sense, everybody can do – but to *pursue valued goals*. This normative element infuses the development process with a commitment to expanding freedom and empowering choice. In this paper, I have used a more open concept of agency, inspired by an ANT perspective on power as agency that is distributed asymmetrically through actor—networks ([Arora and Glover 2017](#); [Stirling 2014](#)). The value of this more open concept is in recognising analytically that the affordances of new technology can be negative as well as positive, constraining as well as empowering – and that the distribution of these opportunities, benefits, risks and costs will be uneven. Inequalities in power can be expressed, amplified and entrenched through technology; but technological innovation can also be used to attack and reduce inequalities by generating affordances that are inclusive, generous, and empowering.

11. Conclusions and some methodological implications

This paper has proposed that the theory of affordances should be used as a conceptual framework for thinking about the effects of technology and ramifications of innovation in agriculture. The paper has explained theoretically, and illustrated with examples from SRI, why and how the affordances of farming technologies are situational, different for different stakeholders, and dynamic. Based on an understanding of technologies as practices and processes of doing and making, the paper has described how the capacity to act with technical artefacts and systems – in other words, technological agency – is generated through affordances that arise from material, cultural and socio-economic relationships between people and other entities in their surroundings. The affordances that emerge through these interactions and relations help to determine who is empowered and motivated to engage with a technology, and they influence the distribution of opportunities,

benefits, risks and costs that arise from that engagement. The affordances also describe the scope of practitioners' freedom to interpret, adapt and reconfigure a technological design to suit their own purposes and interests.

The paper's objective has been to suggest that the affordance concept can be practically useful to professionals and scholars working in the field of development-oriented agricultural research. On one hand, the theory of affordances can be used *ex ante* to guide developers of new technologies and designers and implementers of projects and programmes that aim to stimulate technological change in developing-country agriculture. On the other hand, the theory can also be applied *ex post* by evaluators of agricultural development interventions, to identify the impacts of the interventions and investigate the mechanisms through which the impacts have arisen.

A range of research methods might be used to investigate the affordances of agricultural technology for different stakeholders and situations of interest. Darnhofer (2020) has discussed some of the methodological challenges involved in applying a thoroughly relational conception of agriculture, focusing on entangled relations rather than discrete subjects and their intentions towards objects. Her view is that this requires de-centring humans and their expressed intentions in scholarly accounts of farming practice. My own inclination, which I consider pragmatic, is to adopt the technographic assumption that human intentions and purposes are central to understanding agriculture or any technological practice, yet those intentions and purposes are not prior to or separate from the spatially and temporally situated practices, techniques, embodied skills, communications and tools which they involve, or the traditions and cultures which they express. This implies an eclectic tool-kit of methods, comprising a strong emphasis on observational and descriptive methods, but not excluding the accounts which practitioners, designers and technicians themselves provide (Jansen and Vellema 2011; Buob et al. 2019). As a contributor to the field of Development Studies, I am also inclined towards participatory methods of enquiry.

Pols (2012) suggests a different way to contemplate the methodical steps which could be used to capture and study affordances. He argues that the actions which are afforded by an artefact can be described at four different levels of increasing abstraction: how the artefact can be manipulated ('manipulation opportunities'), what the reliable effects of those manipulations will be ('effect opportunities'), what can be done with the whole artefact (or technical system) in itself ('use opportunities'), and what can be done with the whole artefact as component of a socio-technical system ('activity opportunities') (Pols 2012, 114,120). Evidently, different methods are likely to be needed in order to uncover affordances at different levels of abstraction, for example, the manipulation opportunities might be discovered via direct observation, photography or personal experimentation, whereas the activity opportunities might require an understanding of the user's implied motivations or expressed intentions (explored in interviews or through revealed preferences), situated in the context of a political economy analysis or social network analysis. This reaffirms the need for a flexible, bespoke tool-kit of mixed methods assembled for the purpose in view; and suggests the value of inter- and transdisciplinary collaboration (e.g. economists, technographers, agronomists and engineers generating new knowledge and technologies in cooperation with farmers or other practitioners).

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