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Abstract

So-called 'agriculture 4.0' technologies, such as robotics, AI, drones etc., are apparently set to revolutionise farming, helping us to produce more, with less. However, a growing literature from social science disciplines, such as Science and Technology Studies (STS), Sociology, and Transition Studies, illustrates that new technologies have both positive and negative consequences. For the future of farming to be responsible, the consequences of adopting different technologies and practices need to be anticipated. Students at university, who are studying courses related to agri-food systems, are a key cohort that will shape the future of farming. This paper describes the use and refinement of creative teaching methodologies that help to expose students to literature from Science and Technology Studies (STS), particularly on 'responsible innovation,' which many agri-food students rarely study. The concept of responsible innovation is important for agri-food students to understand because it enables them to consider the opportunities and risks of different future farming systems, helping to make future trade-offs more tangible. With one main learning objective in mind, to enable students to interrogate the opportunities and risks of agricultural technologies, we shared student-led stories of future agricultural utopias and dystopias, using them as a tool for critical discussion.

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Introduction and Problem Statement

Game-changing 'agriculture 4.0' technologies, such as robotics, artificial intelligence, and drones, are being heralded as a way of revolutionising agriculture, helping to produce more with less (Klerkx & Rose, 2020). Despite their potential benefits for people, production, and the planet, however, empirical studies have also illustrated their potential to have negative consequences. Social scientists have identified a number of areas of concern, including impacts on mental health and farmer autonomy with the rise of 'algorithmic rationality' (Brooks, 2021; Carolan, 2023; Gardezi & Stock, 2021; Miles, 2019), challenges for cybersecurity and data privacy (Ruder & Wittman, 2025), the risk of greater intensification (or at least not changing from damaging system) (Miles, 2019), uneven adoption and digital divides (Mehrabi et al., 2021; Rotz et al., 2019), threats to some jobs and the potential for surveillance capitalism (Rotz et al., 2019; Ruder, 2024), amongst others. The social science literature, including from sociologists and Science and Technology Studies (STS) scholars, therefore, indicates that emergent agricultural technologies are likely to have uneven impacts, potentially perpetuating injustices (Fairbairn et al., 2025).

Educators have a key role to play in equipping the next generation of agricultural leaders with the critical thinking skills required to navigate complex challenges associated with digital tools and artificial intelligence. As a general rule, most agricultural courses at universities tend to contain more content from the agricultural sciences and engineering than social science. Literature from STS, which is a field established to consider both the opportunities and risks of technology, is more rarely studied. The key concept of 'responsible innovation,' which asks us to (a) anticipate the consequences of innovation (both good and bad and for whom), (b) include widely across society in setting future visions, (c) reflexively challenge uncritical assumptions on the path forward, and (d) change direction in response to societal feedback (Stilgoe et al., 2013), is usually not prominent on agricultural curricula. As a consequence, there could be a tacit bias towards techno-solutionism and techno-optimism (Rose et al., 2023), which means that students are not equipped with the knowledge and skills to interrogate critically the potential role, if any, of agricultural technologies in sustainable agricultural futures.

Theoretical and Conceptual Framework

Utilising methodologies from the arts, rather than just from science and engineering, allows us to open up conversations about the future of farming to different voices and different possibilities. Quoting a previous paper by Stern, Lehmann et al. (2023, p. 488) argue that arts-based approaches can help to "bring people there, both the general public and specialist researchers, to see, and feel, and say previously unsayable things that might lead somewhere new, again". Responsible innovation demands that society is included in anticipating consequences of innovation, both easily and uneasily foreseen, intended and unintended. Therefore, creative methodologies that allow problems to be better unpacked and to consider various possibilities inclusively are important (Gould, 2023). One such arts-based approach that

lends itself well to bringing society, including students, into the anticipation of futures is storytelling.

Resources provided by the Higher Education Academy in the UK (Advance HE, 2025) promote the value of storytelling as a student learning tool. Stories can help to introduce students to new literatures in an accessible way. The use of stories in the classroom has many benefits, including:

1. Making learning more memorable – as Neuhauser (1993, p. 4) writes "stories allow a person to feel and see the information as well as factually understand it … because you 'hear' the information factually visually and emotionally it is more likely to be imprinted on your brain in a way that it sticks with you longer with very little effort on your part,"
2. Making sense of abstract futures – they can help make concepts more tangible for students, including in scenarios where they must imagine futures and potential controversies (Evans & Evans, 1989),
3. Introducing new literatures - stories can help to introduce students to new literatures in an accessible way (Evans & Evans, 1989),
4. Encourage critical thinking and multiple perspectives – bringing out discussions over values and controversy (Alterio, 2003),
5. Encourage reflective dialogue – allowing students to discuss with critical issues with one another (Alterio, 2003).

Telling stories is also a good way to think about the future since "foresight needs imagination" (Hauptman & Steinmüller, 2018, p. 50). Stories do not necessarily need to be plausible, or likely to come true, and indeed science-fiction stories may deliberately tend towards the wild or the extreme. It is through these extremes that conversations around values and belief systems can be made more tangible.

In agriculture, social scientists are using a variety of creative methods to imagine the future of farming and the role, if any, of technology in it. These include scenario planning, in which participants are asked to consider different pathways for the future of agriculture and policy strategies to support desirable futures (e.g. Ehlers et al., 2022; Fleming et al., 2021); artistic methods inviting farmers, members of the public, and other stakeholders to construct their visions of future farming (e.g. Ditzler & Driessen, 2022; Prost et al., 2024; Rust et al., 2021); living labs where futures may be co-created with farming stakeholders (Gardezi et al., 2024); and serious games to explore trade-offs associated with different futures (Dernat et al., 2025; Salvini et al., 2020). When considering the future of agri-food systems, creative storytelling methods have also been used to encourage critical reflection on what futures are desirable and what the role of technology should be, if any. Daum (2021) constructed two stories of ecological utopia and dystopia to imagine how similar agricultural technologies could be used to facilitate very different farming futures. The class described in this paper is inspired by the pedagogical literature on the value of storytelling in the classroom and the work of Daum (2021).

Purpose

This paper outlines the use of creative methods in teaching, specifically a storytelling approach, to introduce agricultural students (and Geography students studying agri-food systems) to literatures in STS, as a means of giving them the tools to be more critical of the role of technology in future agri-food systems. This approach was tested as a way of introducing students to a new type of literature, which they had not studied before, in an engaging way.

Methods

This section is split into two main parts; firstly, it describes how the class lesson was taught, which can be utilised and modified by other agricultural educators. Secondly, it outlines the method by which feedback was gathered from students who participated in the lesson, which helped to refine the lesson taught to the third and final class and can help inform future delivery. A significant limitation of this study's empirical evaluation relates to the unexpected nature of preparing this paper for publication. When the first two classes were originally taught, there was no expectation that the process would be written up as part of the academic pedagogic literature. However, it was apparent that the exercise was useful for students and it was subsequently decided that recording the process would be valuable for educators. This explains the delay between the delivery of some classes and data collection.

A version of the class described below was delivered to three different student cohorts: at Cornell University (September 2023, 13 students), primarily to undergraduate and masters students on agriculture- or global development-related courses; at the University of Cambridge, to undergraduate Geography students (March 2024, 39 students) studying a module on 'Political Appetites: Geographies of Food and Power'; and finally at Harper Adams University (February 2025, 7 students), to masters students studying on the module 'Food Sustainability Ethics.'

The storytelling class followed a double lecture (up to two hours) that had introduced key concepts in Science and Technology Studies, responsible innovation, agriculture 4.0 technologies, and the potential opportunities and risks of emergent technologies. Students in the first two classes (Cornell, Cambridge) had one week to prepare their individual stories post-lecture, whilst the third class (Harper Adams) prepared them immediately following the 90-minute introductory lecture, having the remaining 90 minutes to construct and discuss their stories. If timetabling allowed, it would have been preferable to give the third class a week to prepare too. The following instructions were given to all classes:

> Exploring possible 'socio-technical imaginaries' of the future of farming in different parts of the world, we will engage with literatures in Science and Technology Studies, Rural Sociology, Human Geography etc., to interrogate not just what technology 'is', but what it 'does'. The future of agriculture could make better use of emergent technology, such as AI-enabled drones and robots, gene editing, precision livestock farming, or alternative food technologies like cultured meat; or there may be room for old ideas

> reimagined with concepts such as regenerative farming or agroecology and the return of more 'traditional' farming methods. No matter what future pathways are encouraged, however, the choice about if and how to make sustainable transitions will be disruptive, normative, and political. The lectures and the seminar focus on who might win, who might lose, and who has the power to decide about future trajectories. We will explore ideas such as justice and responsible innovation. The seminar asks students to imagine future farming by using the tool of science fiction. A useful methodology to consider possible future visions and the trade-offs associated with each, science fiction-based narratives have been used for a variety of topics, including climate change. Climate fiction (Death, 2022) has been a tool used to imagine the future, making it more tangible and bringing forth social and ethical debates about who might win and who might lose. Based on the lectures, their reading lists, and additional references below, each student is asked to produce their own story of the future of farming. This could be utopian, dystopian, or a mixture of both, but should act as a vehicle through which to critically interrogate possible impacts on the human and non-human world (depending on choice of context). There is no set format for your story, but you are expected to bring it to the seminar and talk about it." The students were given the following papers to read, cited in this article's reference list – Daum (2021), Death (2022), Hauptman and Steinmüller (2018).

Students in the first class (Cornell) were directed particularly towards the Daum (2021) paper for inspiration, whilst students in the latter two classes (Cambridge, Harper Adams) were given a selection of stories produced from the first class to guide them, as well as the literature in the task description. It is considered beneficial to give students a range of examples of what others have produced, particularly to guide those who may not be naturally confident in creative approaches.

In the first two classes, we held a discussion after each student presented their story, as well as a reflective discussion once all had presented. This was an open discussion, reflecting on the opportunities and risks of technology. In response to student feedback, the third class used prompts to help structure the discussion post-story presentation (a) who might 'win' if your vision comes true?, (b) who might 'lose' if you vision comes true?, (c) who ought to be included in discussions around the development of the innovation/s you anticipate?, (d) how useful do you think it is to use a sci-fi based narrative to imagine the future of agri-food systems?, (e) what are the pros and cons of the storytelling method?

Students were asked if their work could be showcased in this paper, with or without credit. Only a sample of the portfolio of work is included from those students who gave permission. Students were asked to give feedback on the class, both positive and negative, with a focus on whether it had enabled them to better consider the opportunities and risks of agricultural technology. This feedback was given at different time intervals post-class – Cornell students providing feedback circa 18 months after the class, Cambridge students circa 12 months after the class, and Harper Adams students straight after the class. The limitations of asking for feedback after a significant time interval are noted. For Cornell and Cambridge, students were

contacted through LinkedIn (12/13 Cornell students contacted, 13/39 Cambridge students contacted) since it was likely that their institutional emails may have expired with the time interval, whilst all (7) Harper Adams students were emailed. Each student was asked:

> Would you each be prepared to send a paragraph or so on what you learned from the session and what you liked/didn't like from it? Was that a useful session in helping you to imagine the future and discuss some of the key issues? Was it not useful? How could it have been more useful? Positive or negative feedback is useful.

The feedback was not given anonymously, although students were told that quotes would not be attributed to individuals in the paper. It is noted that an anonymous survey may have given different answers, although other data collection approaches that could have been chosen (e.g. interviews, focus groups) would have equally been valid, but not anonymous. Responses were received from five Cornell students, eight Cambridge students, and one Harper Adams student. The limitations of this response rate are also noted. Data collection of student feedback was approved by the Harper Adams University Research Ethics process (proportionate review).

Findings

This section illustrates some of the stories generated by students, as well as their feedback on the lesson and whether it helped them to achieve the learning objective of equipping them with the knowledge to interrogate the opportunities and risks of agricultural technology.

Across the three classes, the following formats for telling stories were used (sample only provided if student gave permission):

1. Short stories
   Nutritionism to the extreme – sucked all the joy out of eating food. You can get all the nutrients you need from one biofortified plant. In my dystopian vision of the future, you can see vast laboratories of monoculture filled with white crops, engineered to provide all essential nutrients needed for optimal balanced diets. Each white capsule is the head of the crop which can be removed each day by picking robots and then the stems re-grow the capsule in 24 hours for the next harvest…This is quite environmentally sustainable. A lot of disused agricultural land has been given over to nature and biodiversity has increased. Factory farming and all ethical concerns relating to eating meat have disappeared. It has addressed global nutritional challenges by providing crops with a complete nutrient profile. Every individual has access to a convenient and readily available source of nutrition, and health issues including obesity have greatly decreased. An equal nutritional baseline for all people. But it is dystopian because it has removed the social and cultural experiences related to eating. This is a very political project, because the state has the biopolitical power to control the nutrient intake of a population. It completely changes life. (Lucy Martin, Cambridge)

> A Utopian Dystopia with a Silver Lining. It is year 2050, the digital agricultural revolution has been hailed as the Great Leap Forward by the highly developed Western countries. Farming – a labour-intensive and exhausting job – has now become a "lazy boy" activity. Farmers who once took pride in the physical muscle they built by doing farm-related work now take pride in the luxury of time and wealth they have. Profits have maximized. Farmers live in mansions instead of self-made scanty shelters. Their chubby (read obese) sons now play the game Farmville in VR – virtual reality, created by the global conglomerate, Meta, that also makes digital agriculture robots. Food insecurity has been tackled in this part of the world, but the question remains, at what cost? Was production of food the only purpose of farming? Was it not important to stay connected to the soil, to your roots, through farming? After all, it is the soil that nurtures all life on Earth. And this disconnect is grim. Soils are now being exploited as the toxic hypercompetitive capitalist economy forced all farmers to transition to advanced digital and autonomous agriculture where robots did all the work and the farmer just sat inside the comfort of his living room. Simply moved his finger. Sometimes, too complacent to not even do that so he uses voice activation. The soils that have seen history, may now become history and we may be the last few generations to inhabit this planet. Because without healthy soils, no life can sustain. So, are we food secure? For how long? (Abdullah Jehanzeb, Cornell, extract only)

These stories reflect the double-edged nature of agriculture 4.0 technologies and the need to consider both opportunities and risks, rather than just taking a blinkered optimistic view of technology futures.

2. Poetry, including a haiku – one poem (not included) imagined a world in which labour-saving automated technologies had seemingly made life easier on the farm, before taking a sinister turn as the farmer's mental health suffered as a result of loss of connection with the land (after e.g. Carolan, 2023). The haiku (see Figure 1 [a haiku is a Japanese form of poetry that uses five syllables in the first line, followed by a line of seven syllables, and then five]) was used as a tool to describe how emergent agricultural technologies could create opportunities for women farmers in Colombia.

Figure 1

Haiku Imagining Opportunities for Women Farmers in Colombia Using Agri-tech (José Miguel Maldonado Vélez, Cornell)

3. Letters to different generations of family (past and future) – example cannot be shared, but a student wrote a letter to his Grandmother, who lived in another country, to tell her about 'modern farming', using it as a tool to reflect on 'progress'.

4. Dance – a student performed a dance set to music and words from a Sanskrit [ancient Indo-Aryan language, classical language of India and of Hinduism] text, drawing on themes related to connection to land and the possible influence of technology on that connection, or lack thereof (see Figure 2).

Figure 2

Still Image from Dance by Shivani Aysola (Cornell, face blurred).

5. Artwork – including comic books, sketches, paintings, collages, and AI-enabled pictures. Some examples are presented below. In the collage (see Figure 3), a future world is imagined where the planet has been destroyed by overconsumption. The rich, privileged few are able to leave for another planet where new technologies are used to produce food, which is only accessible to the few. The comic-book style sketch (Figure 3) imagines a similar future where humans require a new planet after destroying their own. Both were used as a tool to reflect on how humans often put their faith in emergent technologies to solve problems they have created, rather than changing their behaviour to mitigate against the problem. In the AI-generated images (see Figure 4), various keywords are used to imagine an ecological utopia and dystopia (top left, right), another ecological utopia (bottom left), and a dystopian view of future mixed farming (bottom right). These images were used to reflect on how similar technologies could be used in different ways to create different versions of the future. The students argued that we should ask what agricultural technologies do, how they change the world, and how policies can be used to make different versions of the future more or less likely.

Figure 3

Collages Showing the Consequences of Destroying Earth Through Overconsumption and the Uneven Accessibility of Alternative Futures for Some People [left, Rhealynn Ravarra (Cornell), right, Maria De Lourdes Orozco Ramirez (Cornell)].

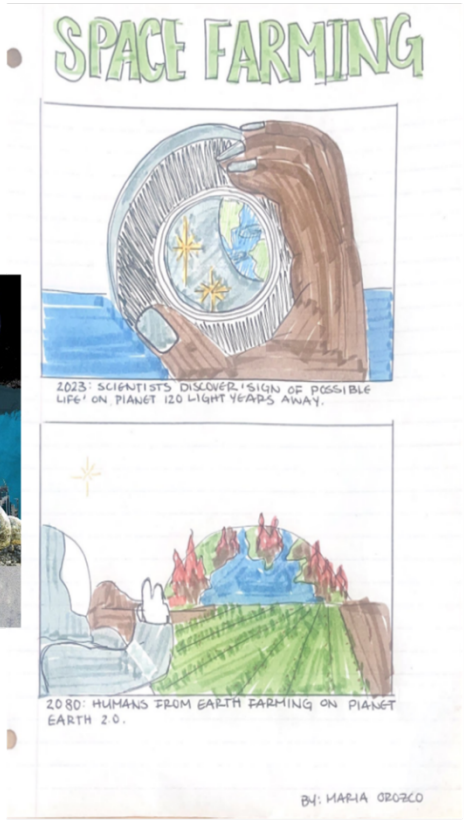

Figure 4

AI-generated Images Based on Keywords (using e.g. Dall-E, Bing). From top left – ecological utopia (anonymous Cambridge student). Ecological dystopia (anonymous Cambridge student), Ecological utopia (Rebecca Neely, Cambridge), Mixed farming dystopia (Charles Hancock, Cambridge).

6. Photographs – not shared as it identifies a student. A student used a photograph of himself standing next to an old tractor and compared it with an image of a toy John Deere tractor, using them to reflect on the evolution of mechanisation and possible future developments.

   Various feedback quotes are included from students on different themes.

Opening Up Critical Avenues for Discussion

A series of feedback quotes from students articulated that the storytelling exercise enabled them to have critical discussions over the role, if any, of agricultural technology in the future of farming. The stories, many of which tended towards the extremes of utopia or dystopia,

prompted critical exchanges over many issues, including scale, equity, sustainability, gender, and mental health:

> When I was preparing for the supervision, I was initially sceptical about the value of the exercise. I wasn't sure what the point was; the concept I had devised was an extremely unrealistic and improbable vision of the future. However, the supervision helped me to think differently about this. I learnt that, actually, using sci-fi based narratives was not about predicting or anticipating likely futures, but rather about opening up creative avenues for discussion – allowing us to explore which elements of these imagined futures we found appealing or concerning. By engaging with extreme scenarios through speculative storytelling in this way, we were able to examine a range of important ideas and debates surrounding the future of farming. This helped me to recognise the value of such thought experiments as methods to critically evaluate what truly matters to society from a broader, more holistic perspective. (Cambridge student)

> I found it useful to think of the key issues and controversies as a whole within a picture and not just as separate issues. However, it did not provide me new knowledge or surprised me of what was shown or discussed. (HAU student)

> The session was insightful as it showcased diverse perspectives on how technology could shape the agricultural landscape. Each presentation painted a unique vision, from precision farming to AI-driven solutions for smallholder farmers and even a human invasion of Mars for farming. This sparked valuable discussions on key issues like sustainability, equity, and scalability. I appreciated the variety of ideas, which broadened my understanding of challenges and opportunities. (Cornell student)

Challenging Assumptions about Agricultural Technology

Whilst for some students, the exercise opened them up to more critical insights into the future of agricultural technology, one said that hearing other students articulate the possibilities of agri-tech had made them re-consider their own sceptical view. The student quoted below refers to the Haiku (see Figure 1) presented by another student, which had explored how agricultural technology could create opportunities for women farmers in Colombia, stating:

> I gained the most insight from seeing how my peers imagined the future of farming. After seeing Jose's piece (see Figure 1), I realized that I held a rather pessimistic perspective towards agricultural technologies and that my own biases had blinded me from seeing technology as an opportunity to uplift the communities that were left behind by prior agricultural revolutions. As we had discussed in class, technology is socially situated-- they are reflections of our society. Though society is deeply flawed, it is always changing. When I created [my story], it was with the illusion of continuity. My predictions of the future were made with the assumption that nothing would have changed between now and then. Alternatively, Jose's piece depicts resilience-- which the botanist, Dr. Lance H. Gunderson, beautifully defines as the "capacity for renewal," or in other words, the capacity for change. If I were to complete that same assignment

> now in my career, I think my story would look different and possibly a little more like Jose's {see Figure 1}. (Cornell student)

An Opportunity to Express Yourself – "Removing the Shackles"

Several feedback quotes commented on how enjoyable the session was compared to more standard teaching sessions, including this comment:

> I really enjoyed this format of teaching. After three years of overwhelmingly doing essays, this was an interesting prompt that encouraged me to think in a different way. That this task was based around imagining different futures was hugely refreshing. (Cambridge student)

Several students commented that telling their own stories in a format of their choice gave them the opportunity to express themselves, "removing the shackles" and for one student, reducing stress:

> Using art as a method, I was able to express concerns about these trends and later discuss with classmates and reflect on the potential for hope and resilience. I loved this assignment because it encouraged us to engage creatively across various formats and share through class discussion. (Cornell student)
>
> It was a welcome break from work which I often felt limited our creativity due to the formulaic nature of essays. It also helped reduce the stress of a busy and demanding term. (Cambridge student)
>
> Removing the shackles/constraints of a usual essay-structured class gave me the opportunity to lean into possibility, innovation, and exploration. Too often, for me at least, studying was a case of finding an argument, reading it, accepting it, and regurgitating it to make a point. The creative exercise, however, allowed us to take more agency in the critical thought we were exposed to. To imagine futures, participate in them, and in turn feel more empowered to enact and create them. I think this is the real aim of higher education, to be inspired to take critical thought forward, and the exercise did just this. (Cambridge student)

Using creative methods in teaching (and wider research) allows people to express themselves in authentic ways instead of being more constrained by more traditional methods. However, it is noted that some students could be daunted by the exercise. One student commented on this but found that it was good to think creatively for a change:

> I initially found the task daunting, but it was nice to think so creatively for once; this was one of very few supervisions that I did not have to sit and write a traditional essay for, and the only one which allowed me to think truly creatively in this way. (Cambridge student)

Easier to Remember

One student commented that the class was memorable and made it easier to remember key information for the exam:

> Although it could be argued that essay-focused classes are more useful in relation to exams, I actually think that the class was more helpful because it made the topic area more interesting and easier to remember when it came to the exams. It did make me engage and read more on the future of farming, and I chose to write about it in the exam. (Cambridge student)

Prompts to Structure the Discussion

The first two classes asked students to partake in unprompted discussion after each student had presented their story. Responding to feedback received from one student, the third class used prompts to help structure the discussion around key questions in Science and Technology Studies related to responsible innovation. The feedback was:

> While the session encouraged imaginative thinking, I felt it could have been more structured with guided prompts to deepen the discussion and align focus areas to keep the conversation realistic. However, I also see the idea behind giving a free prompt to allow every student to explore their imagination. (Cornell student)

Conclusions, Discussion, and Recommendations

The class achieved its learning objective of introducing students to the concept of responsible innovation and to develop their knowledge to interrogate the potential opportunities and risks of agricultural technology. Student feedback illustrated that the storytelling exercise was memorable, allowed them to express themselves, and encouraged reflective dialogue around key concepts related to responsible innovation (e.g. scale, gender, values, equity, sustainability). This supports pedagogical literature on the value of storytelling exercises in the classroom (Alterio, 2003; Evans & Evans, 1989; Neuhauser, 1993). Though utopian and dystopian stories encourage ‘extreme’ visions of the future to be generated, they facilitated critical avenues for discussion in the same way as science-fiction stories. In order for future agri-food systems to be responsible and ‘just’ (de Boon et al., 2023), a wide cross-section of human and non-human society needs to be included in setting trajectories (Ayris et al., 2024). Storytelling approaches could be an accessible way of anticipating futures with diverse publics and therefore could be used outside of the classroom environment.

Key recommendations for agricultural educators can be made. Firstly, that the use of storytelling exercises should be considered to help make controversial issues more tangible to students and to enable reflective dialogue. Such an approach may be particularly useful when introducing newer, more critical social science literature to agricultural students, who may be more exposed to techno-optimistic content from science and engineering. Secondly, it was valuable for students to be given an open choice as to the format in which to present their

stories. Students have diverse talents, some better at writing, others better at artwork etc., and therefore the format of delivery should be kept open. Thirdly, students should ideally be given time to prepare stories. Research time is needed in order for them to gather the information need to articulate their vision. In the first two classes, students had over a week after the lecture to prepare their stories, and consequently they were more developed than the class who did not have time to prepare. Fourthly, the pathway towards story development must be properly scaffolded. Students will find it hard to consider the opportunities and risks of agricultural technology in their stories without receiving lecture material and reading that addresses these issues. The storytelling exercises is likely to be most useful if they can link discussions back to theoretical concepts and empirical studies where similar controversies have been discussed.

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