Written Evidence on Innovation and Global Food Security

Submitted by

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Reason for Submission

Our team's collective background in and ongoing UKRI funded research on food insecurity, nutrition, social protection, and inequalities in Global Majority countries is of direct relevance to the questions posed in the call for evidence.

Prof. Jasmine Fledderjohann (JF) is a social demographer with expertise in food insecurity, nutrition, social protection, and health inequalities in Global Majority countries. She is a UKRI Future Leaders Fellow, leading the Food Security for Equitable Futures project. The project examines the consequences and measurement of food insecurity in Global Majority countries.

Dr. Ankita Rathi (AR) is social scientist whose work has focussed on the impact of rapid agrarian change and urbanization in India in engendering precarity and social inequality—particularly intra and inter caste-class, family, and gender. Her current research investigates divergent experiences of families facing food precarity, and its racialized and gendered dimensions.

Dr. Charumita Vasudev (CV) is a sociologist with experience of working with different socio-religious groups in India on issues of gender, intra-household inequalities and masculinization of child sex ratios. Her current work focusses on the issues of intra-household resource allocation, especially exploring the distribution of food within families in relation to shifts in the political economy.

Dr. Swayamshree Mishra (SM) is a social anthropologist whose work lies at the intersection of gender, caste, and mobility. Her ongoing research endeavours focus on the intricate dynamics of food, inequalities, and social protection in India.

Introduction

We raise the following key points for the committee's consideration:

1. Low-tech innovations must be designed and implemented with careful consideration of the socio-cultural contexts that shape adoption and effectiveness.
2. Use of technological innovation in agriculture can exacerbate economic vulnerability for low-income households, thereby exacerbating inequalities.
3. Uptake of technological innovations can contribute to indebtedness and loss of land for those are land and credit poor, compounding food insecurity.
4. Mechanisation in agriculture and use of heavy machinery can adversely affect farm ecology and hamper future yields, potentially threatening long-term food security.

Our evidence is primarily based on fieldwork conducted in two Indian states (Uttar Pradesh and Goa) conducted over three extended visits from December 2022 to March 2025. We draw our insights from our interviews and focus group discussions with farmers and their families.

Ensuring utility through context-specific innovation

This section directly speaks to two priorities outlined in the Call for Evidence. First, it shows how scientific and technological innovations can be combined with low-tech practices to strengthen global food security. It highlights current challenges and points to low-tech options, while also outlining potential ethical and practical barriers to new technological solutions. Second, it identifies barriers to implementing innovations within the existing agricultural system arising from its intersections with other local social systems.

Human-animal conflict emerged as a serious concern among families we spoke with, since crops were often damaged by wild animals. These crops are primarily grown for household consumption throughout the year; the economic and nutritional implications of such losses are severe. Human-animal conflicts usually coincide with critical stages of the agricultural cycle, particularly during the pre-

harvest period. Farmers in several parts of Uttar Pradesh (UP) complained of crop losses due to monkeys and stray cattle. The latter often include abandoned cows which were no longer productive for milk and so were left to roam freely. These animals frequently enter fields in groups late at night, causing extensive damage to standing crops. The challenge is compounded by scattered landholdings, many of which are located at a distance from farmers' residences. Traditional fencing is difficult for farmers to implement due to high costs. Meanwhile, options such as traps may harm animals—a situation which conflicts with religious beliefs which identify some animals as sacred.

Families often coped by leaving a household member to stay overnight in the field to guard against animal intrusion, leading to exhaustion of on-guard family members. This guard work impaired their ability to contribute to the household economy in other much-needed ways (e.g. through daytime labour), thereby contributing to food scarcity. Innovative technological adaptations such as low-cost fencing, motion-sensor alarms, camera traps, or drones can mitigate these risks by alerting farmers in real-time, reducing the impact of crop damage and the need for continuous manual guarding. However, the reach and adoption of technological solutions is shaped by complex local contexts.

The case of smokeless chulhas (ovens) in India—a low-tech solution that has been developed in various forms since the 1980s—illustrates how low-tech solutions can face limited uptake due to the social context in which they are introduced. Despite clear health and environmental benefits, such interventions often struggle to penetrate households where established norms shape labour distribution, fuel choices, and daily practices. Gender norms that devalue women's health needs are a hinderance to investment in cleaner sources of cooking-fuel. As confirmed during our fieldwork, a sizable proportion of the population relies on firewood and biomass for fuel. The cost of adoption and maintenance of alternatives (e.g. gas), however low-cost/subsidized, cannot beat the use of cow-dung cakes and firewood as fuel; the latter options are naturally and locally available and present no additional fuel costs for households. Thus, although traditional chulhas have been linked to indoor air pollution and respiratory disease (especially for women and children), they continue to be pervasively used despite the Indian Government's recent focus on subsidized cooking gas and renewable energy programmes.

This example illustrates how local norms and practices shape uptake of technological solutions, which often compete with entrenched social and systemic structures. Policy approaches must prioritise context-sensitive, adaptable solutions that can be scaled effectively. For instance, technologies to address human-animal conflict should be designed with local social norms in mind, ensuring they are practical, cost-effective, and gender sensitive. In light of the socio-religious significance of certain species and potential community tensions some technologies might generate, such innovations should be designed to deter rather than harm animals. Such attention to social context can encourage community uptake and sustainable impact.

Technological innovation can create financial vulnerability

This section speaks to the effects technological innovations have on agricultural systems, potential barriers to implementing innovations within existing systems, and the shape of a future agricultural system to achieve global food security, with particular focus on the impact of technological solutions on inequality within local communities.

Our team repeatedly spoke with farming households in UP in different cropping seasons, spread over a period of three years, to understand the issues that affect their consistent access to safe and nutritious food. Some of the key problems farmers discussed were deeply connected to the compounded vulnerabilities resulting from the use of farm machinery. Most farmers we spoke with were small- and medium-scale farmers with fragmented landholdings. In UP, there are a variety of crop sharing agreements between landowners and farmers which. The most common arrangement is the chouthayayi (one-fourth) arrangement, which dictates that, post-harvest, the landowner receives three-fourths of the total produce and the farmer receives one-fourth. Most labouring families are heavily reliant on this stock of produce to meet their families' annual food requirements, with little to no other cashflow.

The introduction of farm machinery, however, has made a substantial difference in the costs of production. Most farmers and small landowners do not own the machines; instead, machines are rented on an hourly basis, often from big landowners who belong to dominant communities. The rental costs are generally borne by the farmer, not the landowner. While farm machinery might save time and hard labour in some cases, it has several repercussions for household budgets, with implications for their ability to afford food. Payments for machine rentals are often made post-harvest by selling a portion of the crop, reducing the stock that would have been available for families' consumption. When asked if the use of machinery affects how much grain is available for consumption, one farmer explained:

> *It will affect the food certainly. The thing* [referring to the specific machine] *is on rent. Now, for example, it cut wheat or paddy and it cut 10 packets of wheat and out of that he took one packet. Now we are left with 9 packets of wheat only... so we manage with that only.*

Since the machines are rented on an hourly basis, entire families often labour together to reduce the number of rental hours. This not only contributes to collective exhaustion, but it can also have knock-on effects, such as children being forced to skip school to assist with this agricultural labour. Landowners often insist on the use of machinery, hoping for a higher yield—sometimes against the wishes of farmers, who see it as a drain on their share. Renting machinery from the few owners is difficult not only because of the limited number of machines available, but also because of infrastructural constraints like unreliable electricity connections/routine electricity cuts, which further limit the hours of operation for the machines.

Increased costs of production linked to technological innovations are not sustainable in highly inequitable agricultural systems where only a limited few have access to the technology. The role of locally informed policy is essential to facilitate subsidized access for all and ensure the introduction of technology is not widening existing social chasms.

Technological interventions may compound food insecurity by necessitating debt

In this section we address the shape of a future agricultural system to achieve global food security and potential barriers to implementing innovations within existing systems. We examine the impact of technological solutions on inequality within local communities, focusing specifically on the role of debt. Our evidence suggests productivist ideas of technological innovation for increasing global food production can perversely create food shortages, especially for those who own limited or no land.

One implication of the rising cost of cultivation is rising indebtedness of land-poor families. Our fieldwork in UP suggests technological solutions have frequently been financed through loans. Technological shifts and revolutions have created additional demands for medicine, manure, chemicals, irrigation, and water sources, which must now be supported through privatized and informal sources of finance. Such loans have further exacerbated food crisis, especially for land poor cultivating groups, who must often rely on inequitable sharecropping arrangements. In UP, families we spoke with emphasised debt repayments have created food shortages at the household level.

Climate hazards and agro-ecological changes have compounded families' financial losses, leading to further debts. One woman from a marginalised caste group in rural UP, whose family owe multiple debts, reported their debts keep piling up due to crop losses associated with seasonal floods and frequent animal attacks. She shared how money for agriculture comes from loans, which can only be repaid if crops can be saved:

> *Money will come from loan (karza). When crops will be there, then it will be given. Otherwise the loan (karza) is adding up only... The money you invest by taking out loan, that also goes away. When crops are there, then the loans will be repaid. Otherwise, the loan is adding up only.*

In UP, most landless tenant agrarian families we spoke with had to sell their limited crops. These crops would otherwise be kept as buffer stock for their own annual consumption and/or to repay debts to the

landowning castes. For example, in rural UP, one young girl we spoke with lived in a family who owns no land and therefore undertakes sharecropping cultivation. When asked if her family had to compromise on food to pay back the loans, she replied, 'Yes it happens, like whatever is cultivated on the land, we sell it off, so there is less to eat.'

Technological innovations have reinforced inequalities based on caste-class. For instance, AR's fieldwork in Punjab shows many Dalit (marginalised caste) and marginal cultivators could not cope with rising financial pressure of commercial cultivation and rising cost of tenancy-based cultivation (Rathi, 2020). As a result, they had to sell their land to dominant caste farmers. The big farming communities were the greatest beneficiaries of commercial agriculture as the dominant caste groups were able to accumulate more land and invest in technology. Meanwhile, the landless and small cultivating families were forced to look for casual wage work outside agriculture as they could not cope with the financial pressure within agriculture.

While debt-sustained subsistence production has increased yields, this has come at the cost of mounting debts and pressure to sell off land. This situation depletes families' resources to meet their basic needs, leaving them at a greater risk of food insecurity. It is vital that technological innovations do not add to the financial burden for those are land and credit poor. Attention to equitable access must be a core component of technological innovation.

Local environmental costs of technology adoption

This section addresses the effect of scientific and technological innovations on the agricultural system in India, barriers to innovations, and the shape of a future agricultural system. Specifically, it shows how adoption of new technologies can negatively impact crop yields and agricultural sustainability, documents limits on crop diversification driven by global agricultural demands, and identifies how farmers' experiences have led to negative views of some technologies.

Over time, technological adaptations can have ecological impacts. Some farmers we spoke with in UP felt the soil texture was deteriorating because of continued use of tractors. They argued tractors were causing soil compaction and leading to lower yields than manual methods—an assertion supported by existing literatureClick or tap here to enter text. (e.g. Chan et al., 2006; Zhang et al., 2024). One farmer shared his understanding of impacts of mechanisation on soil and crop yields as follows:

> Interviewer: *Do you feel that as you are telling about so many machines, there is any change in the yield (paidavaar) or are you able to grow more?*
>
> Participant: *No, it is lesser than before.*
>
> Interviewer: *Lesser than before. Why is it so?*
>
> Participant: *It is so because when plough and all was used, using the bulls, the growth was more. The soil used to swell from beneath…The way rice used to be planted. Now when tractor is used, it does not grow…. the field gets tight, the soil beneath… That leads to reduction in growth… It converts the undersoil to stone. Makes it hard like this* [referring to the dried earth he is sitting on]. *It swells the topsoil little bit, so the soil beneath is hard. That's why -when the wheat is sown, they can only be put in the swollen topsoil to grow.*
>
> Interviewer*: So when the bulls were used to plough, you feel it ploughed deeper?*
>
> Participant: *Yes, the ploughing was deeper and better.*

In UP, our fieldwork revealed that while staples of potatoes, rice, and wheat are cultivated to meet families' food requirements, they often struggle to eat a nutritious and diversified diet. Inadequately diversified diets can lead to micronutrient deficiencies and other health problems; consistent availability of safe and nutritious food is essential for achieving food security. Yet for the families we spoke with,

cultivating diversified crops remains financially challenging, especially for the land-poor agrarian peasantry. This is compounded further by limited availability of crop insurance, which can only be availed by growing crops in certain areas in specified seasons. In fact, in rural UP, a Dalit landless farmer explained the different cropping cycles and crops that are grown across the year in his village, noting it is only viable for those who have land. He emotionally shared, 'I will die of hunger if we do this [implying growing different crops] because we don't have land.'

Technological revolutions and shifts in cropping patterns, especially towards monocropping of rice and wheat, rely on extracting limited natural resources in ways that can deplete long-term agricultural capacity. The pressure towards monocropping and cash crops is shaped in part by the requirement for farmers to compete on a global agricultural market. This negatively affects families' consistent access to diversified and nutritious food. While technological innovations have increased production, enabling crop diversification and food security of the land-poor families remains a challenge.

Conclusion

While agricultural technology has no doubt increased crop yields over the past several decades, technologies which do not attend to their social and environmental costs may do more harm than good in the long run. There is an urgent need to better understand and address the needs of the most marginalised people in Global Majority countries, both because they are at greatest risk of food insecurity and because they are often on the frontline of food production. Based on the evidence we have presented above, we suggest the following initial steps to better-tailor emerging technologies to the context-specific needs of agrarian families in Global Majority countries such as India:

1. Partner with country- and community-specific institutions on joint projects to develop low-cost, low-tech innovations that can be adapted to local conditions.
2. Develop policies to support research, subsidized access, and investment in community-level infrastructure for such technologies.
3. Provide funding for truly interdisciplinary evidence on food and agricultural related schemes, where technology developers are brought into direct conversation with the communities their innovations will serve.

The UK can contribute to advancing agricultural innovation and promoting global food security through research support in advancing more scientific and social science research on technologically supported and socially acceptable ways of enabling crop diversification. More research partnerships and collaborative work with governments, policy institutions, agrarian communities, local rural and farm organizations (farmer produce organization, farm unions, self-help groups), NGO's, social scientists, biotechnologists, and crop scientists across UK and India can be effective to foster technological innovations in agriculture which meets the need for consistent access to safe and nutritious food for all, now and into the future.

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