Improving the Drought Resilience of the Small Farmer Agroecosystem

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The farming systems followed by farmers in Asia, Africa and Latin America have the potential to deal with the problems thrown up by climate change. This article examines the changing drought ecosystems of poor farmers and also points out that the present paradigm of agricultural development and what it means for small farmers needs to be critically evaluated.

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Droughts in 2016 affected a quarter of the Indian population (2,55,923 villages in 254 districts in 10 states). Debates over drought preparedness and development priorities have been widespread. Current drought management practices are based on crisis management and are ineffectual. This article attempts to arrive at a better understanding of the changing drought ecosystems of poor farmers. The proposed "ecosystem of drought" framework gives a holistic view of droughts and explores whether living with drought is possible. Lessons from regional traditions raise questions about mainstream agricultural trends.

Drought: A Fact and Reality

Drought, a hydro-meteorological phenomenon, is as natural as climate and its variability. Droughts are believed to be creeping phenomena because of their slow onset (Gillette 1950), intensity, and uncertainty of duration. Droughts can be meteorological, hydrological, agricultural, or socio-economic depending on rainfall or run-off deficiencies, the availability of water for crops in the growing season, or the impact of drought on human activities, both direct and indirect (O'Farell et al 2009). Yevjevich et al (1978) have suggested the term "sociological drought," which refers to the meteorological and hydrological conditions in which less water is available than anticipated and relied on for a normal level of social and economic activity in the region.

In a country like India, where rain-fed agriculture is the dominant source of food production, drought inherently coexists with farmers, society, and the economy. Approximately, 16% of India's geographic area—mostly arid, semi-arid, and sub-humid land—is drought-prone (Reserve Bank of India 2013). Irrigated agriculture is no different because most irrigation systems rely on surface water, so they are also linked to precipitation. With the reality of climate change, rainfall is predicted to become more variable in India and dry regions are expected to become drier; extreme and intense droughts are expected at higher frequencies in the coming years.

The impact of droughts appears to be increasing in developing and developed countries alike, which is a clear sign of the unsustainable use of, and growing pressures on, natural resources (Wilhite et al 2014). Like all natural hazards, drought has natural and social dimensions. Different types of droughts have varying economic, environmental, and social impacts; it is the social dimension that turns a hazard into a disaster.

The risk associated with drought in any region is a product of both, the region's exposure to the event (for example, the probability of occurrence at various severity levels) and the vulnerability of society to the event (Blaikie et al 1994). Vulnerability is determined by social factors such as population changes, population shifts (regional and rural to urban), demographic characteristics, technological advancement, government policies, environmental awareness and degradation, water use trends, and social behaviour. These factors change over time and, thus, vulnerability is likely to vary in response to these changes.

Human adaptation and response to drought is primarily through evasion or endurance, which are defined on temporal and spatial scales. Drought resilience is an outcome of social and political support, cultural means and dependence, ecological stability and biodiversity, livelihood diversification, and food security. Therefore, the ability to adapt to droughts is determined by the interplay of multiple aspects.

The Making of a Drought: The Human Influence

While drought is a natural "phenomenon," a combination of factors makes it a "disaster" or matter of concern. Even though droughts can be predicted, their intensity and duration remain elusive. While a lack of rainfall is the underlying cause for drought, diverse socio-economic, biological, and agricultural factors determine the severity of its impact (Wilhite and Glantz 1985). Without denying the occurrence of extreme and perennial droughts, the effects of which may be disconnected from anthropological factors, it cannot be denied that human activities play a crucial role in influencing the severity of droughts. To understand and manage droughts, it is necessary to accept that human influence is as integral to drought as climate variability (Van Loon et al 2016).

Poor selection of crops (for example, sugar cane), inefficient methods of irrigation, and the imbalanced use of ground and stored water also lead to what is now commonly known as "man-made drought." Maharashtra has faced man-made droughts since 2012. Irrigation projects in the state are plagued with delays, cost overruns, and implementation irregularities.

Premised on an acceptance that drought will remain a feature of Indian agriculture in this profoundly human-influenced Anthropocene era, this paper attempts to explore if the impact of drought can be minimised on agriculture, food production, rural India, and importantly, on the millions of small farmers who are most affected by it. More particularly, it seeks to examine whether such vulnerabilities have been accentuated of late as a result of development. Skewed development has a generic effect and also an influence on the agricultural sector, particularly on policies, research, extension, and markets. The article discusses some traditional practices that are gradually dying out, and how they are being reconsidered in future drought management policies.

Current Drought Management: A Reactive Approach

The government's response to droughts and related practices is more reactive than planned. Therefore, the response is to treat the effects of drought rather than the underlying causes and associated vulnerabilities. The typical government approach is to "wait till it rains" and provide some emergency assistance to affected localities and hope that a catastrophe can be avoided. For many years, drought programmes have been enacted too late to augment water supplies. Moreover, these programmes are usually inconsistent and inequitable and are implemented in a confusing manner.

At the local level, drought planning in many areas is given low priority because of the randomness of droughts, the limitedness of planning resources and jurisdiction, and the ineffectiveness of federal government disaster relief programmes. As a result, local governments are encouraged to accept the implicit policy of acting only after a crisis has occurred. A recent example is the 2017 drought in Tamil Nadu, where government action began much too late. The state declared that it was drought-hit on 10 January 2017 only after around 40 farmers protested outside the Tiruchirapalli collector's office on the premise that 47 farmers in the state had committed suicide in the previous two months. A farmer suicide study in Odisha shows that 30% of farmers commit suicide due to crop loss and 87% of crop loss is caused by droughts. Coping mechanisms used earlier have diminished over time and adjustment and adaptation require more time and resources.

Despite attempts to design cost-effective measures to support people at key points in the drought cycle (for pastoral livelihoods), the backbone of international drought management is direct food aid and labour-intensive public works projects. Even during an impending crisis, there is great reluctance to impose water conservation measures. Decision-makers are faced with a dilemma as to when they must halt or reduce industrial activity, curtail domestic water use, or prohibit non-essential services. As a result, timely action is rarely achieved (Vlachos 1982).

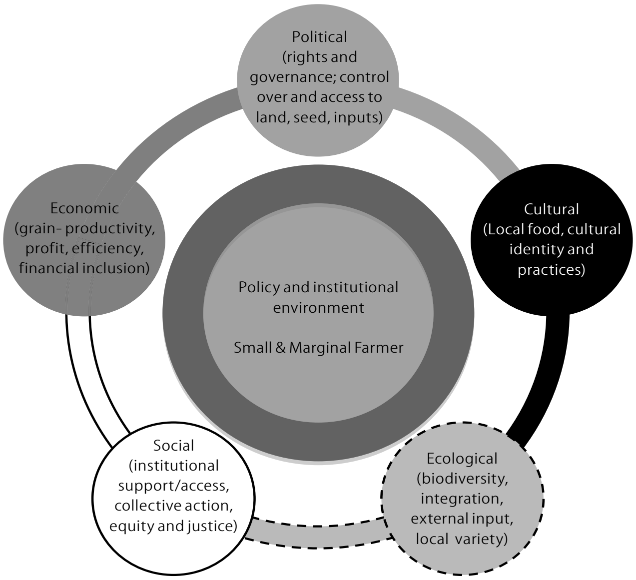
Understanding Drought: Proposing a Multidimensional Framework

While it is difficult to mark the onset and end of a drought, its impacts can be severe and can affect the poorest and most deprived sections of society (NRSC 2008). Keeping the millions of farmers who bear the brunt of drought at the forefront, this paper adopts a human angle to propose a comprehensive "ecosystem of drought" framework to understand and analyse the drought vulnerabilities of the poor—especially the small and marginal farmers in the Indian context. As drought is most easily characterised by its impact on the poor farming community and their realities, the ecosystem of drought framework can aid in better appreciating the impact of drought.

The "ecosystem of drought framework" attempts to understand the small farmer's environment from a holistic and multidisciplinary perspective. The framework analyses how the social, economical, and ecological environments of farmers have changed with the recent political and cultural churn and whether the changes have led to increased vulnerability.

A multidimensional diagnostic tool (as shown in Figure 1, p 43) helps drought stakeholders better appreciate vulnerabilities and act accordingly to address issues. This can help to build a long-term perspective and strengthen drought preparedness and adaptation, and to augment the resilience of small and marginal farmers while also providing a holistic perspective on

Figure 1: Ecosystem of Drought in the Context of Small Farmers to Determine Their Vulnerability



responding to drought in the post-drought period. The ecosystem of drought captures different components associated with drought. The word "ecosystem" encompasses the interactions between the biotic and abiotic components and integrates them into a complete system. Similarly, the ecosystem of drought talks about social, economic, ecological, political, and cultural dimensions and how their interactions affect humans to holistically understand droughts; the framework allows one to visualise droughts as more than the mere deficiency of rainfall. Droughts are complex interfaces of various dimensions and their effects. When studied in their entirety, these dimensions explain the interconnectedness of farming and the impact of droughts.

This paper analyses and contrasts developmental paradigms and agricultural practices across five ecosystem dimensions to provide a holistic understanding of drought impact and the ensuing vulnerabilities. Considering the limitations of this paper, we deal with a few aspects and examples in each dimension. By no means must the examples, references, and anecdotes presented be treated as a comprehensive unpacking of elements in each dimension. The comparisons of the development paradigms are made primarily to discuss potentially better systems for drought preparedness, adaptation, and mitigation, and are not aimed at derogating present practices. Present development paradigms have multidimensional elements—decentralised local governance, access to IT-enabled services, scope of insurance, and a growing preference for cultural and natural food—which enhance the ability to live with droughts. However, these developmental elements have limited accessibility, affordability, and scope.

From Living with Drought to Dying of Drought

Droughts have accompanied agriculture since the latter's inception and farmers have been ingenuously adapting to climatic variability through the manipulation of biodiversity, natural resource management, and agronomical practices. Traditional systems of cropping and crop management have evolved around local agro-ecological strengths and limitations. These agroecosystems are of global importance to food and agriculture and are based on cultivating diverse crops in varying time and space; these cultivation systems have allowed traditional farmers to mitigate risks and maximise harvest security in uncertain and marginal environments, with minimal technology and limited environmental impact. Campbell (1999) notes that despite increased diversification of livelihood sources in Southeast Kajiado after the 1972–76 drought, the region saw an expansion of rain-fed agriculture, horticulture, and tourism. During the 1994–95 droughts, traditional strategies of herd movement and use of wild fruits were applied. Without romanticising the past and ancient traditions, we attempt to see whether logical practices were adopted in the past to cope with drought and whether the changes brought in at a faster pace over the last few years have made us more vulnerable.

Market-led and growth-led agricultural research tend to aim to aggressively defeat nature by imposing and manipulating agriculture systems through specific crop choices, input, and technology. This has often negatively impacted small farmers, by either marginalising or weakening them or making them vulnerable in both ways.

In the past, communities in developing countries have shown the greatest resilience to droughts, floods, and other catastrophes. For example, pastoralists in the West African Sahel were able to cope with decreased rainfall by 25%–33% in the 20th century, while contrasting resilience in the face of changing climates has been documented in smallholder farmers in Bangladesh and Vietnam, and indigenous hunting communities in the Canadian Arctic (Cross and Barker 1992; Mortimore 1998; Huq et al 1999; Huq 2001; Berkes and Jolly 2001; Adger et al 2001; Roncoli et al 2001). Although these systems evolved in very different times and geographical areas, they share structural and functional commonalities (Beets 1990; Marten 1986)—a combination of species and structural diversity in time and space, high biodiversity, maintaining cycles of materials and waste through effective recycling, a reliance on local resources, and cultivating a variety of crops.

Increased External Dependence

The ecosystems that provide resilience to marginal farmers have lost their capacity as a result of many decades of unsustainable development practices. Changes have been observed in the way food used to be sourced and grown. Biodiversity was nurtured and relied upon; land, soil, and water were managed effectively; and most importantly, communities accepted, respected, and adapted to nature, its limitations, and geoclimatic variations. Changes in the management of natural elements have affected the resilience of ecosystems and have implications for the adaptability and vulnerability of small farmers.

Sourcing food from non-agricultural lands (uncultivated systems such as forests, wetlands, pastures, etc) in addition to agricultural land enables a systemic approach to food consumption. It allows rural and tribal communities to sustain themselves for the whole year and steer clear of natural disasters and season-induced shortfalls of agricultural food. Since the productivity of trees is often more resilient to adverse weather conditions than that of annual crops, forest foods often provide a safety net during periods of food shortages caused by crop failure; forest foods also make important contributions during seasonal crop production gaps (Blackie et al 2014; Keller et al 2006; Shackleton and Shackleton 2004).

Farmers in rain-fed areas and in tougher agroecosystems (mountains, uplands, arid conditions, etc) have evolved unique spatial and temporal mixes of crops according to monsoon rain patterns and other physical limitations. Sensitivity to droughts is minimised by reducing dependence on vulnerable systems by diversifying food production and moving away from drought-prone crops (Adger et al 2003). In response to climatic and physical risks, they also reorient their dietary intake to include more diversity to ensure food and nutritional security.

Adaptive elements to climate change, including diversification, low external input/energy use, weather forecasting/adjusting, traditional natural resource management (moisture, nutrition, and pest management), cropping practices (mixed/inter/relay cropping, crop rotation, etc), and collective food and seed storage and distribution are inherent to small farmer agriculture. Research confirms that such adaptations are more pronounced in marginal and remote ecosystems, which demonstrates their potential in augmenting local food and nutritional security.

Food production in these farms has undergone tremendous change over the last two decades with respect to crops, varieties, cropping patterns, and crop management. This change is in response to the external market, research, and stimuli of extension programmes. Most of these changes have occurred without taking into account the potential of traditional farming systems, which have emerged over years by using limited local resources and which have evolved through cultural linkages. The new technologies that have crept into these rain-fed small farms have not always been designed for such situations and are often ill-equipped to withstand disasters of increasing intensity. As a result, the vulnerability of small and marginal farmers is increasing with increased external dependence on markets and technologies and reduced internal control and adaptation.

The agriculture developmental approach that focuses on breeding, the use of agrochemicals, and irrigation-based high input technologies for select food crops has been quite successful in ensuring national food security and in augmenting the income of many farmers. However, it has also resulted in the narrowing of crop diversity, which had earlier been evolved in response to local geo-climatic variations, in the deterioration of soil health and water holding capacity, negative changes in water regimes (groundwater depletion and salt accumulation), and has made farms more vulnerable to droughts.

Reducing the Scope for Local Collective Action and Control

There have been many changes in the way water, seed, food, and feed is stocked, conserved, harvested, and shared within communities. Transformations in agricultural gender roles and in the scope for collective action in farming have impacts on the safety nets of small and marginal farmers.

Shared and adaptive water management and governance systems, particularly in water-scarce and deficit ecosystems, have evolved over the years through discipline, restraint, and community-led control. These evolutionary governance systems have recently been eroded and replaced by external dependence, exploitative free-rider use, and a lack of local initiatives to conserve and harvest water. Efforts around participatory watershed development and water-harvesting initiatives have shown results but have remained largely driven by external factors and funds. Instances of elite capture and the incurring of negative externalities that marginalise the poor, landless, and tribal people are frequent.

There are informal seed supply and distribution systems comprised of seed production and management systems controlled by farmers. These are based on indigenous knowledge and local diffusion mechanisms. These systems include retaining seeds on the farm from previous harvests to plant the following season and farmer-to-farmer seed exchange networks. There has been little or no emphasis on the informal seed supply sector.[1]

Despite evidence that gender-informed approaches are required to bolster the role of women, productivity, and farm resilience, such approaches are not yet common in agriculture. Women's involvement in agro-biodiversity preservation, livestock care, genetic improvement, food and seed storage, and processing are no longer promoted or practised, except in some areas where the feminisation of agriculture is taking place due to increased male migration. Women play a critical role in helping families adapt to drought by foraging for food, sharing saved resources, and taking care of the family while also contributing to the family income.

Traditional instances of collective action in adapting to drought by small and marginal farmers and rural communities in vulnerable ecosystems exist but have not been emphasised in mainstream drought management. At present, relief from external institutions dominates drought management. This is still happening to a great extent; different forms of collective action by microcredit groups, self-help groups (SHGs), farmers' field schools (FFSs), area/user groups (in watershed projects), farmers' interest groups (FIGs), farmers' clubs, farmers' cooperatives, producer companies, etc, are able to achieve the desired development objective with mainstream and alternative development support.

Apart from involving farmers, these collective action initiatives have the potential to include other stakeholders like researchers, development specialists, extension workers, and corporate and social entrepreneurs in a collaborative platform with a common objective. While most existing initiatives[2] are meant to connect small farmers with the market by promoting commercial/enterprising agriculture, collective action in the direction of adaptive food security is limited to institutions around production (FFSs, area/user groups, etc) and distribution (seed/grain banks).

Therefore, the role of collective action in facilitating adaptation is where lessons can be applied from political ecology and other theoretical insights for present-day adaptation processes.

With green revolution technology, the costs of cultivation and risks of crop failure are so high that, often, small farmers do not recover the money spent. Between 1990–91 and 1995–96 in India, chemical fertiliser costs increased by 113% and pesticides by 90%, while the wholesale price of wheat went up only by 58%.[3] In 2015, the sum of fertiliser, pesticide, and seed costs was 48% of crop revenue, which was much higher than the 36% average from 1990 to 2006.[4] A sharp rise in international cereal prices between 2007–08 also had a profound impact on food security and vulnerabilities of the poor in South Asian countries.[5]

A focus on economic efficiency and productivity enhancement, of both food and cash crops at the cost of feed reduction,[6] diversity loss, and soil and water degradation, has led to food surplus and a commercialised agriculture economy that compromises substantially on resilience. The market-led paradigm of industrial agriculture converts diversity to monocultures by focusing on the external input of chemicals and on generating uniform monoculture commodities. Taking into account all output, chemical-intensive monocultures produce less food per acre than ecological farms high in biodiversity (Shiva 2016).

Most of these economic gains of the present agricultural paradigm are calculated while discounting environmental and social costs and inherently linked future vulnerabilities. While this approach achieves overall national food security and appreciable agricultural growth, the issues of equity and sustainability of farm production, local food, and nutritional security often get compromised. In spite of this growth and development, the Indian economy still succumbs during poor monsoons, which reveals the weaknesses in the present agricultural paradigm and the vulnerability of millions of poor farmers.

Searching for Local Identity in a Globalised Market

Traditional cultural practices and food systems have evolved and adapted to regional ecosystems; they are positively related and mutually supportive. Biodiversity, food diversity, and cultural diversity go hand in hand. Tribes in the heartland of India have evolved 2,00,000 rice varieties from one wild grass, the *Oryza sativa* (Shiva 2016). Our culture is linked to and has evolved with agriculture; therefore, agriculture that is culturally relevant—and vice versa—is fundamental for food security, sustainable livelihoods, and well-being. Many traditional societies adapt to food and water scarcity during droughts by relying on alternate systems, including forest food and cultural water endowments.

However, development interventions and global trends of increased industrialised agriculture, monoculture, and the market economy have a negative, and in some cases, a devastating impact on traditional food systems, subsistence-based economies, and agro-ecological systems that indigenous people depend on for survival.[7] Crop diversity, landscape management, and season-specific crops lead to greater resilience.

Losing Local Control

An increased and intensive support of green revolution areas and farmers also leads to less focus on rain-fed areas and small farmers. With shifts in agricultural research funding from the public to private sector, there is more interest in biotechnology. This change is reportedly disadvantageous to small farmers because private research companies lack the incentive to address the concerns of small farmers (Pingali and Traxler 2002). An analysis of the establishment and outcome of agricultural research in India reveals a lack of public-oriented research and support of rain-fed small farms and their crops (millets, tubers, vegetables, etc), agricultural biodiversity (indigenous varieties and landraces of paddy), and cropping practices. The brown revolution, which aimed at increasing the productivity of arid areas in India, was always treated as subordinate to the green revolution and the promotion of irrigation. This bias is evident in how the green revolution was extended to Eastern India—Bringing Green Revolution to Eastern India (BGREI)—even after documented limitations of the same movement in Punjab.

Out of 138.35 million operational holdings in India with an average size of 1.15 hectares, 85% are marginal and small farms of less than 2 hectares. According to the agriculture minister, "These small farms, though operating only on 44% of land under cultivation, are the main providers of food and nutritional security to the nation, but have limited access to technology, inputs, credit, capital[,] and markets."[8] Most small and marginal farmers are concealed sharecroppers and tenants with unrecorded rights. Their access to formal credit, insurance, and compensation continues to be denied, which increases their vulnerabilities. A lack of formal contracts also discourages tenants from investing, while also restricting their access to the support price market. The land record management system is archaic and records are not updated, which also prevents farmers from accessing support. Small and marginal farmers also bear the brunt of land acquisition, land-use change, and loss of commons.

In the wake of increased privatisation, access to the forest and common food systems has decreased, which has reduced the availability of natural and wider food baskets on which communities are dependent. This compels them to depend more on purchased food to meet their minimum survival needs. These communities are most affected during droughts because they lose their field crops and their ability to purchase food is limited.

Conclusions

The gradual marginalisation and limited voice of small farmers have held decision-makers, researchers, and extension agents from appreciating small farm ecosystems in their entirety. Instead of appreciating their eco-friendly, biodiverse food production and sourcing systems which have low footprints/net handprints and high energy efficiency, present policy paradigms dub them as inefficient farmers who must leave agriculture to contribute to urban and industrial development. While the lack of appreciation and promotion of their ecosystems hits them hard, the impact of droughts makes them sink further in the vicious downward spiral of poverty, forcing them to work as cheap labour to serve mainstream development; they lose the battle either way.

Farmers living in harsh environments in Africa, Asia, and Latin America have developed and/or inherited complex farming systems that have the potential to solve many uncertainties facing humanity in the era of climate change. These systems have been managed in ingenious ways, allowing small farming families to meet their subsistence needs in light of environmental variability without depending much on modern agricultural technologies (Denevan 1995). Wilken (1987) is of the opinion that the persistence of millions of hectares of traditional farming is proof of a successful indigenous agriculture strategy and a tribute to small farmers throughout the developing world.

There is a compelling need to re-examine the present paradigm of agricultural development and its implications for small farmers. The proposed "ecosystem of drought framework" has a systemic, multidimensional human approach to improve the resilience of small and marginal farmers by minimising their vulnerability to drought. Since droughts cannot be predicted, there must be a constant effort through all the dimensions discussed. Further delay may be costly; we may lose the opportunity to save small farmers and small-farm agriculture, and the ecological, social, cultural, economic, and political advantages that accompany them. For better financial stability, farming strategies need to take note of the constraints imposed by the climate and aim to establish systems that are economically and environmentally sustainable.

NOTES

1 "Seed Policy and Programmes for Asia and the Pacific," *Proceedings of the Regional Technical Meeting on Seed Policy and Programmes for Asia and the Pacific*, Bangkok, Thailand, 2–6 May 1999, Issue 160, http://books.google.co.in/books?q=+bibliogroup:%22Seed+Policy+and+Programmes+for+Asia+and+the+Pacific:+Proceedings+of+the+Regional+Technical+Meeting+on+Seed+Policy+and+Programmes+for+Asia+and+the+Pacific+%3B+Bangkok,+Thailand,+2-6+May+1999%22&source=gbs_metadata_r&cad=5.

2 The Himalayan Action Research Center (HARC) in Uttarakhand has organised contracts for small farmers for vegetable farming with networks like SAFAL. The JRD Technology Centre has started eco-enterprises, Biomarts, that produce the biological inputs required for the implementation environment-friendly agronomic practices, and which are run by self-help groups (SHGs). Tata Chemicals in Noida has successfully incorporated five producer companies of vegetable growers as part of the new institutional arrangements between corporates and farmers. In the North Eastern Community Resource Management Project (NERCOMP) in the West Garo Hills, more than 500 tea farmers joined to establish a tea factory. In Ri-Bhoi and the East Garo Hills districts of Mizoram, Zopar Exports Limited has been successful in establishing contact farming with crops like anthurium, strawberry, and gerbera. Ginger Farmers Cooperative Marketing Federation Limited (Gin-Fed Ltd) in Karbi Anglong is making an effort to market ginger in the Korean market through tie-ups with private firms (http://www.solutionexchange-un.net.in/en/index.php?option=com_docman&task=doc_download&gid=1224&Itemid=78).

3 DPH (2009): "Agriculture, Food and Small Farmers in India," DPH, http://base.d-p-h.info/en/fiches/dph/fiche-dph-8104.html.

4 Gary Schnitkey and Sarah Sellars (2016): "Growth Rates of Fertilizer, Pesticides, and Seed Costs Increase Over Time," *Corn + Soybean Digest*, 13 July, http://cornandsoybeandigest.com/marketing/growth-rates-fertilizer-pesticide-and-seed-costs-increase-over-time.

5 International Society for Plant Pathology (2009): "One Billion Hungry People: Multiple Causes of Food Insecurity Considered," *Science Daily*, 14 July, http://www.sciencedaily.com/releases/2009/06/090625113857.htm.

6 A result of changed straw-to-grain ratios and increased replacement of coarse cereals in arid ecosystems.

7 http://www.fao.org/sard/en/init/964/2687/2453/index.html.

8 http://timesofindia.indiatimes.com/india/91-land-holding-would-belong-to-small-farmers-by-2030-Agriculture-minister/articleshow/50-977867.cms.

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