ORF ISSUE BRIEF
SEPTEMBER 2016
ISSUE NO. 157

Climate Change and Food Security in India

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ABSTRACT Climate change has added to the enormity of India's food-security challenges. While the relationship between climate change and food security is complex, most studies focus on one dimension of food security, i.e., food availability. This paper provides an overview of the impact of climate change on India's food security, keeping in mind three dimensions — availability, access, and absorption. It finds that ensuring food security in the face of climate change will be a formidable challenge and recommends, among others, the adoption of sustainable agricultural practices, greater emphasis on urban food security and public health, provision of livelihood security, and long-term relief measures in the event of natural disasters.

INTRODUCTION

At the heart of the Sustainable Development Goals (SDGs) are targets to end hunger, achieve food security, and improve nutrition. For India, food security continues to be high on its list of development priorities because the country's relatively high rates of economic growth have not led to a reduction in hunger and undernutrition. India's gross domestic product at factor cost and per capita income grew at seven percent and five percent per annum, respectively, from 1990-91 to 2013-14.[1] However, the incidence of undernutrition has dropped only marginally from 210.1 million in 1990 to 194.6 million in 2014,[2] and India has failed to meet the Millennium Development Goal of halving the proportion of people who suffer from hunger. About 12 Indian states fall under the 'alarming' category of the Global Hunger Index. According to the National Family Health Survey 2015-16, the proportion of children under five years who are underweight is significantly high in states such as Bihar (43.9 percent), Madhya Pradesh (42.8 percent) and Andhra Pradesh (31.9 percent).[3]

While large sections of the Indian population suffer from acute undernutrition, rising incomes and growing urbanisation are rapidly changing the composition of the food basket—away from cereals to high-value agricultural commodities such as fish and meat.[4, 5] As a result, the total demand for foodgrains is projected to be higher in the future due to an increase in population as well as a growing indirect demand from the feed. Mittal (2008) has made long-term projections of India's food demand and supply up to 2026. According to her, the increase in total food demand is mainly due to growth in population and per capita income while production is likely to be severely constrained by low yield growth.[6] Moreover, it will be difficult to meet India's long-term food requirements with domestic production alone.[7] Kumar et al (2009) also find that with current production trends, meeting future demand for foodgrains through domestic production will be difficult.[8]

One of the biggest issues confronting Indian agriculture is low productivity. India's cereal yields are drastically lower than those of developed regions such as North America (6,671 kg per ha), East Asia and the Pacific (5,184 kg per ha), and the Euro area (5,855.4 kg per ha) (see Table 1). Moreover, Table 2 shows that yield per hectare of foodgrains has stagnated in India since the 1980s.

Table 1: Cereal yields (kg per ha, 2013)

Country/ Region	Kg per hectare
East Asia & Pacific (developing only)	5,184.0
Central Europe and the Baltics	4,131.1
Sub-Saharan Africa	1,433.5
Europe & Central Asia (all income levels)	3,661.6
Euro area	5,855.4
North America	6,671.0
India	2,961.6
World	3,851.3

Source: World Bank Database, http://data.worldbank.org/indicator/AG.YLD.CREL.KG/countries?display=default

Table 2: Growth rate of yield per hectare (%) of foodgrains

	Rice	Wheat	Coarse Cereals	Pulses	Total Foodgrains
1980-81 to 1990-91	2.7	3.4	2.6	2.0	3.0
1990-91 to 2000-01	0.9	1.7	1.3	-0.6	1.7
2000-01 to 2010-11	1.6	1.0	4.1	2.4	1.7
2010-11 to 2014-15	1.6	-1.0	3.1	1.9	1.8

Source: Reserve Bank of India database, https://www.rbi.org.in/Scripts/PublicationsView.aspx?id=16463

HOW DOES CLIMATE CHANGE AFFECT FOOD SECURITY?

The World Food Summit in 1996 defined food security thus: "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life."[9] According to this definition, there are three main dimensions to food security: food availability, access to food, and food absorption. Thus, adequate food production alone is not a sufficient condition for a country's food security.

Food security is one of the leading concerns associated with climate change.[10] Climate change affects food security in complex ways. It impacts crops, livestock, forestry, fisheries and aquaculture, and can cause grave social and economic consequences in the form of reduced incomes, eroded livelihoods, trade disruption and adverse health impacts. However, it is important to note that the net impact of climate change depends not only on the extent of the climatic shock but also on the underlying vulnerabilities. According to the Food and Agriculture Organization (2016), both biophysical and social vulnerabilities determine the net impact of climate change on food security.[11]

Much of the literature on the impact of climate change on food security, however, has focused on just one dimension of food security, i.e., food production. The impact of climate change on the other dimensions of food security – access and utilisation – have received little scholarly attention. This paper explores the impact of climate change on India's food security by considering all these dimensions of food security.

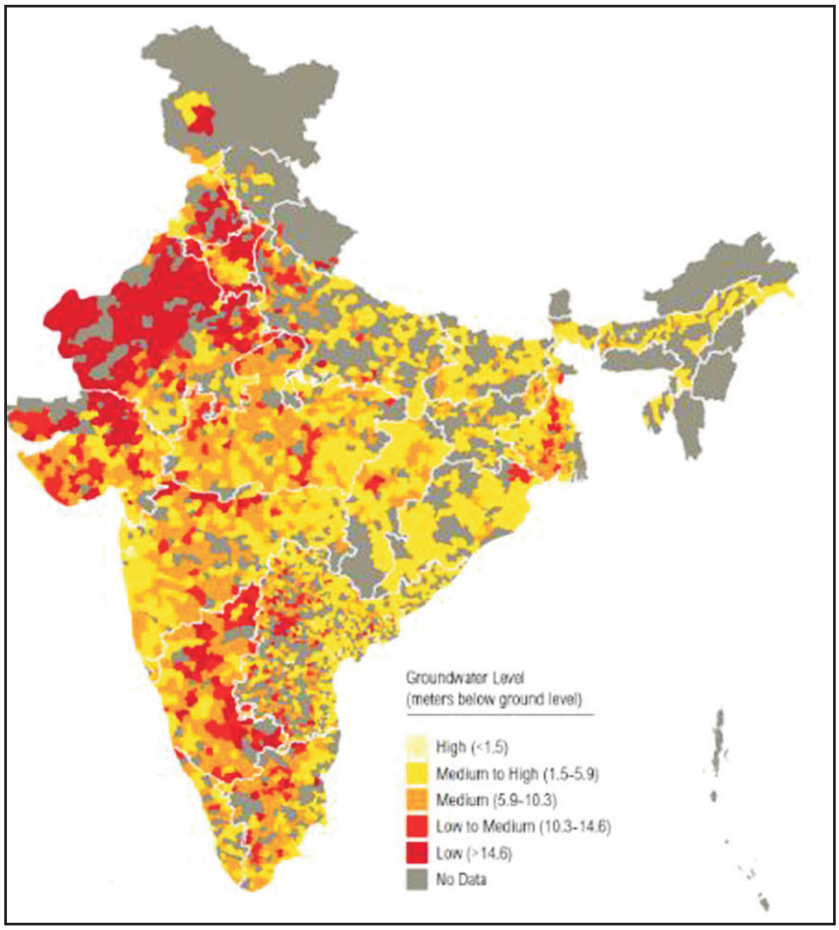
Food production

Climate change presents an additional stress on India's long-term food security challenges as it affects food production in many ways. For one, it may cause significant increases in inter-annual and intra-seasonal variability of monsoon rainfall. According to World Bank estimates, based on the International Energy Agency's current policy scenario and other energy sector economic models, for a global mean warming of 4°C, there will be a 10-percent increase in annual mean monsoon intensity and a 15-percent increase in year-to-year variability in monsoon precipitation.[12] The World Bank (2013) also predicts that droughts will pose an increasing risk in the north-western part of India while southern India will experience an increase in wetness.[13]

The impact of climate change on water availability will be particularly severe for India because large parts of the country already suffer from water scarcity, to begin with, and largely depend on groundwater for irrigation. According to Cruz et al. (2007), the decline in precipitation and droughts in India has led to the drying up of wetlands and severe degradation of ecosystems.[14] About 54 percent of India faces high to extremely high water stress.[15] Large parts of north-western India, notably the states of Punjab and Haryana, which account for the bulk of the country's rice and wheat output, are extremely water-stressed.[16] Figure 1 shows that groundwater levels are declining across India. About 54 percent of India's groundwater wells are decreasing, with 16 percent of them decreasing by more than one meter per year.[17] North-western India again stands out as highly vulnerable; of the 550 wells studied in the region, 58 percent had declining groundwater levels. With increased periods of low precipitation and dry spells due to climate

change, India's groundwater resources will become even more important for irrigation, leading to greater pressure on water resources. According to the World Bank projections, with a global mean warming of 2°C above pre-industrial levels, food water requirements in India will exceed green water availability.[18] The mismatch between demand and supply of water is likely to have far-reaching implications on foodgrain production and India's food security.

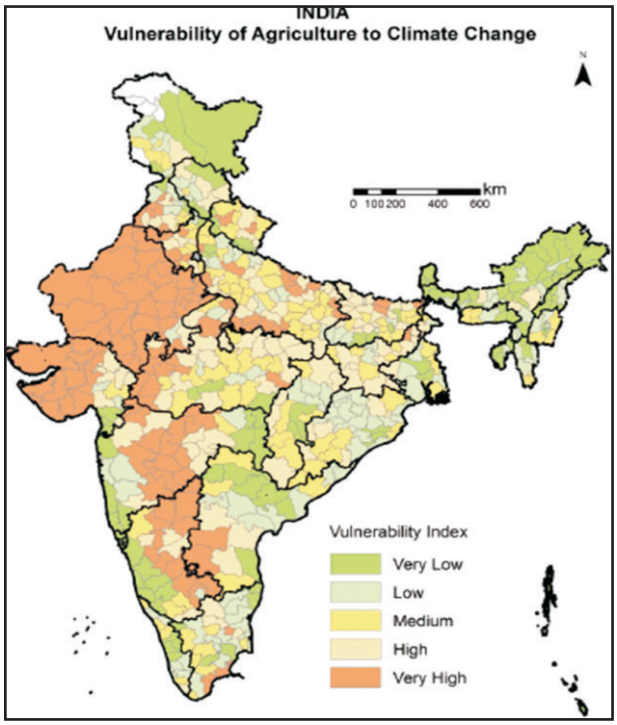
Figure 1: Groundwater level in India (meters below the ground level)



Source: World Resources Institute, http://www.wri.org/blog/2015/02/3-maps-explain-india%E2%80%99s-growing-water-risks

Indian agriculture, and thereby India's food production, is highly vulnerable to climate change largely because the sector continues to be highly sensitive to monsoon variability. After all, about 65 percent of India's cropped area is rain-fed. Figure 2 shows that most districts with very high and high vulnerability to climate change are in Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Karnataka and Uttar Pradesh. Wheat and rice, two crops central to nutrition in India, have been found to be particularly sensitive to climate change. Lobell et al (2012) found that wheat growth in northern India is highly sensitive to temperatures greater than 34°C.[19] The Intergovernmental Panel on Climate Change (IPCC) report of 2007 echoed similar concerns on wheat yield: a 0.5°C rise in winter temperature is likely to reduce wheat yield by 0.45 tonnes per hectare in India.[20] Acute water shortage conditions, together with thermal stress, will affect rice productivity even more severely.[21]

Figure 2: Vulnerability of Indian agriculture to Climate Change (2021-2050)



Source: CA Rama Rao et al (2013)[22]

Food access

While there has been considerable progress in understanding the sensitivities of crop production to yield, there are relatively few models which assess the impact of climate change on access to food. According to the Fourth Assessment Report of the IPCC, depending on the climate change scenario, 200 to 600 million more people globally could suffer from hunger by 2080 (Yohe et al., 2007).[23] Lloyd et al (2011) also make the projection that climate change will have significant effects on future undernutrition, even when the beneficial effects of economic growth are taken into account.[24] According to their model predictions, there will be a 62-percent increase in severe stunting in South Asia and a 55-percent increase in east and south sub-Saharan Africa by 2050.[25]

It is more difficult to find similar, modelling-based studies on the impact of climate change on food access and nutrition specifically focusing on India. However, noted experts like Nira Ramachandran have underscored the importance of factoring climate change in the discourse on nutrition in the country. Ramachandran warns that climate change can slow down, and even drastically reduce, the improvements in food security and nutrition that India has managed to achieve so far.[26]

Climate change amplifies the economic drivers of food insecurity. Variation in the length of the crop growing season and higher frequency of extreme events due to climate change and the consequent growth of output adversely affect the farmer's net income. India is particularly vulnerable because its rural areas are home to small and marginal farmers who rely on rain-fed monocropping, which provides barely a few months of food security in a normal year.[27] According to Ramachandran (2014), food stocks begin to run out three or four months after harvest, farm jobs are unavailable and by the next monsoon/sowing season, food

shortages peak to hunger.[28] Climate change will also have an adverse impact on the livelihoods of fishers and forest-dependent people. Landless agricultural labourers wholly dependent on agricultural wages are at the highest risk of losing their access to food.[29,30]

In regions with high food insecurity and inequality, increased frequency of droughts and floods will affect children more, given their vulnerability. Vedeld et al (2014) conducted a survey of nine villages in the drought-prone Jalna district of Maharashtra and found that local crop yields and annual incomes of farmers dropped by about 60 percent in the drought of 2012-13.[31] Such a large fall in income is likely to have a huge impact on child nutrition because poor households typically spend the bulk of their earnings on food. In another study based on 14 flooded and 18 non-flooded villages of Jagatsinghpur district in Orissa, Rodriguez-Llanes et al (2011) found that exposure to floods is associated with long-term malnutrition.[32] According to their study, children exposed to floods during their first year of life presented higher levels of chronic malnutrition.[33]

Yet the impact of climate change on food access is not limited to rural areas. Urban food insecurity is also a critical issue because poor households from rural and coastal regions typically migrate to urban areas for livelihood options. Ramachandran observes that hunger often triggers off a wave of migration towards cities, relocating entire families to urban slums.[34] These migrants mostly join the ranks of poorly paid workers in the urban informal sector, where there is no security of tenure and wages fall below the legal minimum. India's urban food insecurity indicators present an alarming picture. For example, over 30 percent of children below five years are underweight in urban Bihar, Madhya Pradesh and Karnataka (See Table 3). The proportion of urban children who are stunted and wasted is high even in Karnataka and Maharashtra, which are relatively prosperous states.

Table 3: Child nutritional status in urban India (2014-15)

	Proportion of children under 5 who are stunted (%)	Proportion of children under 5 who are underweight (%)	Proportion of children under 5 who are wasted (%)
Andhra Pradesh	28.3	28.4	15.5
Assam	22.3	21.4	13.2
Bihar	39.8	37.5	21.3
Goa	18.3	25.3	27.7
Haryana	33.4	28.5	21
Karnataka	32.6	31.5	24.8
Maharashtra	29.3	30.7	24.9
Manipur	24.1	13.1	6.4
Meghalaya	36.5	22.9	13.7
Madhya Pradesh	37.5	36.5	22
Puducherry	24.7	23.3	26.1
Sikkim	22.9	12	13.2
Telangana	20.9	22.2	14.6
Tamil Nadu	25.5	21.5	19
Tripura	17.2	21.7	13.4
Uttarakhand	32.5	25.6	18.6
West Bengal	28.5	26.2	16.7

Source: Compiled from National Family Health Survey – 4 Database[35]

Climate change will exacerbate India's existing problems of urban food insecurity. The highest risks related to climate change are likely to be concentrated among the low-income groups residing in informal settlements which are often located in areas exposed to floods and landslides and where housing is especially vulnerable to extreme weather events such as wind and water hazards.[36] Mumbai and Chennai are especially prone to bear the brunt of climate change.[37] Dasgupta et al (2012) add Kolkata to the list of cities that are particularly vulnerable to climatic risks,[38] as climate change is likely to intensify the frequent flooding in the Hooghly river during monsoon.[39] The poor inhabitants of Kolkata are most vulnerable as their homes are located in low-lying areas or wetlands that are particularly prone to tidal and storm surges.[40]

Given that food is the single largest expenditure for poor urban households, displacement, loss of livelihood or damage to productive assets due to any such extreme weather event will have a direct impact on household food security.[41] The urban poor has also been identified as the group most vulnerable to increases in food prices following production shocks and declines that are projected under future climate change.[42]

Food absorption

There are many potential impacts of climate change on food absorption but there is a dearth of quantitative studies on the subject which focus on India. Overall, the global threat is that climate change could lead to a reduction of production and consumption of certain foods that play a critical role in the diets of poor rural and indigenous populations such as fish, fruits and vegetables, and wild foods.[43] Change in climatic conditions could lead to a reduction in the nutritional quality of foods (reduced concentration in proteins and minerals like zinc and iron) due to elevated carbon dioxide levels.[44] In India, where legumes (pulses) rather than meat are the main source of proteins, such changes in the quality of food crops will accelerate the largely neglected epidemic known as "hidden hunger" or micronutrient deficiency.[45] Phalkey et al (2015) argue that micronutrient deficiencies increase the risk of acquiring an infectious disease which in turn worsens the problem of undernutrition, creating a vicious circle.[46] Evidence from Botswana suggest that changes in climate that lead to an increase in temperature and a decrease in precipitation are associated with an increase in diarrhoeal disease in children.[47] In India, children living in poor rural areas and urban slums are at higher risk of morbidity and mortality from diarrhoeal diseases. Projections made by Moors E. et al. (2013) say that climate change will lead to an average increase of about 13.1 percent in diarrhoea in the Ganga basin.[48] Ramachandran (2014) also argues that climate change could lead to a reversal of India's achievements in reducing diarrhoea-related deaths.[49]

The impact of climate change on vector-borne diseases is fairly well documented. Climate change will lead to the emergence of new patterns of pests and diseases which will affect human health and lower the capacity to utilise food effectively, thereby posing new risks for food security. For instance, more people will be exposed to vector-borne diseases such as malaria, dengue and chikungunya. According to Dhara, Schramm and Luber (2013), the entire population of India except those living in areas above 1700m above sea level are at risk of contracting malaria.[50] The arboviral diseases chikungunya and dengue may also be influenced by climate as both are transmitted by the common vector Aedes aegypti.[51] The urban poor living in informal settlements are particularly vulnerable, absent the basic facilities such as

piped water, sanitation, clean drinking water, drainage systems, and heath facilities. High incidence of undernutrition due to poverty exposes the urban poor to diseases linked to climate impacts, which in turn aggravates undernutrition and ill-health and reduces the ability to adapt and build resilience to climate change.[52] Adverse effects of malaria, diarrhoea and undernutrition have been found to be concentrated among children due to physiological susceptibility.[53] Children have been found to be at greater risk when food supplies are restricted.[54]

WAY FORWARD: RECOMMENDATIONS

Adoption of sustainable agricultural practices

The main problem of Indian agriculture is low productivity. To meet India's growing food demand, there is an acute need for increasing productivity in all segments of agriculture. But given the vulnerability of Indian agriculture to climate change, farm practices need to be reoriented to provide better climate resilience. India needs to step up public investment in development and dissemination of crop varieties which are more tolerant of temperature and precipitation fluctuations and are more water- and nutrient-efficient. Agricultural policy should focus on improving crop productivity and developing safety nets to cope with the risks of climate change.

Better management of water resources must be a key feature of sustainable agriculture. Water supply management options such as new storages and water harvesting are important, especially in the water-stressed regions of north-western India. Water use efficiency in agriculture needs to be enhanced. India's irrigation infrastructure needs to be upgraded; particular attention needs to be given to north-western India, the country's food basket that is prone to climate-induced droughts. Despite the benefits of drip irrigation, it is still largely adopted for high-value horticultural crops. To enhance the area under micro and drip irrigation, the government should redirect the subsidy on electricity for drawing water for irrigation purposes, which has been a major contributor to declining groundwater levels, towards the adoption of drip irrigation techniques.

A four-pronged strategy is recommended for the water sector:

- Increase irrigation efficiency
- Promote micro irrigation in water-deficient areas
- Better water resource infrastructure planning
- Restoration of water bodies in rural areas

Stronger emphasis on public health

India has historically had a poor record in public health. With the worsening challenges of climate change, the country's policymakers have also paid little attention to its impacts on health. Despite the fact that the disease burden from vector-borne and diarrhoeal diseases is very high in urban slums and tribal areas of India, this area was overlooked when the original National Action Plan for Climate Change (NAPCC) was formulated. The Ministry of Health is currently formulating a National Mission for Health under the ambit of NAPCC but given the close relationship between climate change, infectious diseases and food absorption, public expenditure on health needs to be stepped up drastically.

Enhance livelihood security

Achieving food security in the context of climate change calls for an improvement in the

livelihoods of the poor and food-insecure to not only help them escape poverty and hunger but also withstand, recover from, and adapt to the climate risks they are exposed to. India's National Rural Employment Guarantee Act (NREGA) of 2005 marked a global milestone in the history of poverty alleviation. NREGA has had several positive effects: increasing rural wages, reducing gender wage gaps, enabling better access to food, and reducing distress migration from rural areas. NREGA has also made an important contribution to child well-being, through the reduction of hunger and improvement of health and education.[55] Moreover, the scheme contributes to ecological restoration and natural resource regeneration in dry regions. Water conservation accounted for about half of the total projects supported by NREGA from 2006 to 2008, with 850,000 completed works.[56] Although some gaps have been observed in the implementation of NREGA, the scheme has various benefits for the rural poor, particularly the marginalised sections, women, scheduled castes and scheduled tribes. Therefore, funding allocations for NREGA should be maintained and efforts should be made to more effectively streamline the funds to plug existing leakages.

Given the level of urban poverty, undernutrition, and lack of remunerative employment, there is a strong case for providing guaranteed employment on the lines of NREGA in urban areas as well. Such a scheme should be tailored to not only provide livelihood security to the urban poor but also create climate-resilient urban infrastructure in Indian cities. Additional efforts are required for the vulnerable populations residing in the ecologically fragile coastal and forest regions.

Greater emphasis on urban food insecurity

Urban India is not only an important contributor to global greenhouse gas emissions but also a victim of climate change as poor people account for the bulk of its population. As observed earlier, climate change will have an enormous impact on urban food insecurity. Therefore, urban food insecurity deserves serious attention. The approach towards tackling urban food insecurity must take into account both the access and absorption dimensions of food insecurity. To improve access to healthy food, effective public distribution systems need to be put in place. Efforts must be made to learn from states such as Tamil Nadu which has an effective public distribution system and has better nutritional outcomes.[57] To improve food absorption, living conditions in urban informal settlements need to be upgraded. The Swachh Bharat Mission, which aims to construct 10.4 million individual toilets and 0.5 million public toilets and adopt scientific solid waste management in 4,041 towns, may be regarded as a step in the right direction.

Indian cities have an extremely poor record in disaster management. Therefore, public investment in climate-resilient infrastructure should be enhanced. In India, flood control efforts, sanitation infrastructure and surveillance activities are not very effective. Better infrastructure in urban areas will minimise the disease risks caused by flooding.

Long-term relief measures in the event of natural disasters

India's disaster-management strategies are mostly inadequate, short-lived and poorly conceived. Also, much of the emphasis is laid on providing quick relief to the affected households as opposed to developing long-term adaptation strategies. Little effort is made towards addressing the long-term impacts of natural disasters on agricultural productivity and undernutrition. A recent report by NITI Aayog

suggests that "the government should transfer a minimum specified sum of cash to affected farmers and landless workers as an instant relief".[58] For richer farmers who may want insurance above this relief, the report recommends a separate commercially viable crop insurance programme.[59]

Given the vulnerability of Indian agriculture to climate-induced natural disasters and their long-term impacts on agricultural output, livelihoods and nutrition, such a short-sighted approach towards disaster relief will only prove inadequate. The government needs to take a long-term view of disaster relief. Moreover, given the adverse impacts of natural disasters on child nutrition, long-term undernutrition prevention programmes must be implemented in disaster-affected regions. Additional efforts must be directed towards reducing the risk in agriculture. Such schemes should be specially targeted towards small farmers.

Need for more impact assessment studies

To develop climate-resilient strategies and make adequate policy interventions, there is a need for an integrated assessment of the impact of climate change on India's food security. So far, there are fewer studies on the impact of climate change on other dimensions of food security besides production. Research efforts should be directed towards assessing and quantifying where possible the impact of climate change on undernutrition and food absorption. ORF

(This paper has been prepared under a project on 'Urbanising India', funded by the Research Council of Norway and jointly undertaken by the Observer Research Foundation, Delhi and the Peace Research Institute, Oslo.)

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