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Preface

Despite aggregate rise in agriculture growth and self-sufficiency in food production, the reality of India’s food policy programme is that it has failed to address the underlying problem of malnutrition or hidden hunger, which has persisted despite rising levels of calorie intake. This report investigates policies that have led to designing and delivering of a set of skewed agriculture growth practices and food distribution programmes, which have done little to alleviate the problems of undernutrition in the country. Our examination of extant food policy programme and agriculture growth strategies in India is motivated by the concern that changes in current patterns of food production and distribution can plausibly lead to better health and nutritional outcomes. We posit that incorporation of nutri-cereals within the public distribution system or PDS - which currently distributes mostly rice and wheat - can to an extent contribute to alleviation of problems of micronutrient deficiency, with specific reference to scheduled areas in Maharashtra.

Through the course of our analysis, we illustrate that agriculture production and investment policies ushered during the Green Revolution era were biased towards wheat and rice. This was accompanied by government procurement policies that led to selective incorporation of wheat and rice within the state nutrition programmes, and this occurred at the cost of exclusion of other grains such as millets crops. We illustrate that outcome of such a policy was that slowly and subsequently, both food production and consumption patterns in India shifted heavily towards two core cereals, specifically wheat and rice, which in general have lower micronutrient component compared to other cereal groups such as nutri-cereals. The rise in production and consumption of nutri-cereals was accompanied by a simultaneous decline in both area under cultivation for production for nutri-cereals as well as their consumption. We then demonstrate that proportionate increase in rise in consumption of core-cereals over nutri-cereals could be one of the causes for rising levels of malnutrition amongst the Indian population. This is followed by the development of the argument in favour of promoting production of nutri-cereals within Maharashtra.

To this end, we compare levels of production, procurement, consumption and distribution of core cereals and nutri-cereals within Maharashtra. By developing a utility model driven by preferences of representative households in the state, we calculate estimates of quantities and corresponding investment that would be required in the state for introduction of nutri-cereals. The analysis is
limited to nutri-cereals *jowar* (sorghum), *bajra* (pearl millet), and *ragi* or finger millet. We conclude the report by case analysis of introduction nutri-cereals within the PDS in Karnataka and infer lessons that can serve as precursors for future policy initiatives in other states of India, including Maharashtra.
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IV. List of abbreviations

AAV  Antyodaya Anna Yojana
APY  Area, Production and Yield
BMI  Body Mass Index
FAO  Food and Agriculture Organization
FPS  Fair Price Shops
ICDS Integrated Child Development Services
IDA  Iron Deficiency Anaemia
IDD  Iodine Deficiency Disorders
IIPS International Institute for Population Sciences
KAPRICOM Karnataka Agricultural Price Commission
KMS  Kharif Marketing Season
MDMS Mid-day Meal Scheme
MGNREGS Mahatma Gandhi National Rural Employment Guarantee Scheme
MoCAF&PD Ministry of Consumer Affairs, Food & Public Distribution
MoH&FW Ministry of Health and Family Welfare
MoRD Ministry of Rural Development
MoUD Ministry of Urban Development
MSP Minimum Support Price
MWCD Ministry of Women and Child Development
NFHS National Family Health Survey
NITI National Institution for Transforming India
NNM National Nutrition Mission
NNMB National Nutrition Monitoring Bureau
NNP National Nutrition Policy
NPAN National Plan of Action on Nutrition
NSS National Sample Survey
PDS Public Distribution System
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>PEM</td>
<td>Protein Energy Malnutrition</td>
</tr>
<tr>
<td>RDA</td>
<td>Recommended Dietary Allowance</td>
</tr>
<tr>
<td>RMS</td>
<td>Rabi Marketing Season</td>
</tr>
<tr>
<td>SC</td>
<td>Scheduled Castes</td>
</tr>
<tr>
<td>ST</td>
<td>Scheduled Tribes</td>
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<tr>
<td>VAD</td>
<td>Vitamin A Deficiency</td>
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1. Introduction

India faces an acute crisis of malnutrition. According to the Global Nutrition Report 2018, India tops the chart of countries with children who are stunted, approximately 46.6 million of them. The problem of malnutrition in the country persists despite aggregate rise in food production and even a steady increase in aggregate consumption of calories at household level (Radhakrishna & Ravi, 2004; Pingali, Mittra, & Rahman, 2017; National Nutrition Policy, 1993). The contrast between India’s status of a country as largely self-sufficient in food production and its staggering rates of malnutrition can be understood as an outcome of a disjunctive food policy process that has its genesis in the Green Revolution era of late 1960s. The start of Green Revolution in India prompted investments in new technologies of agriculture production, which assuredly averted the threat of chronic hunger that the country was faced with at that time (Golait & Pradhan, 2006; Pingali, 2012). However, the policies of Green Revolution primarily laid stress on gaining food self-sufficiency and elimination of hunger primarily through promotion of wheat and rice; and, this occurred at the cost of relative decline in production and consumption of other coarse cereal grains, such as sorghum and millets (Davis, et al., 2018; Nagaraj, Basavaraj, Rao, Bantilan, & Haldar, 2013). Simultaneously, while India has gained self-sufficiency in food grain production and consumption along with modest levels of rise in calorie intake, the health-related problems related to malnutrition or deficiency in intake of essential nutrient components such as vitamins and minerals have only aggravated.

In the context, this study report is motivated by the concern if nutri-cereals can play a role in addressing dismal levels of malnutrition in India. Nutri-cereals, a new reference term for coarse cereals grains or millets, have for long been locally produced and consumed by a substantial number of Indian populations. Major millet crops grown in India include Jowar or Sorghum (Sorghum Bicolor), bajra or pearl millet (Pennisetum typhoides), ragi or finger millet (Eleusine corcana), and then there are other small millets such as kangni or foxtail millet (Setaria italica), kutki or little millet (Panicum miliare), kodo millet (Paspalum scrobilculatum), jhangora or barnyard millet (Echinochloa frumentacea), cheena or proso millet (Panicum miliaceum), and Korale or brown top millet (Brachiria ramosum) (Rao, Bhat, & Tonapi, 2018). However, the shifts in agriculture policies over the past few decades, and crop procurement and state sponsored food

---

1 https://globalnutritionreport.org/
distribution programmes have impacted both production and consumption patterns of nutri-cereals in India.

In general, for both production and consumption patterns of food grains, a shift away from nutri-cereals and in favour of finer cereals (wheat and rice) has been observed. The grain policies of subsidies, price support programs, and crop-specific input supply and credit programs, which are mainly geared towards wheat and rice, have crowded out investments from other food grains, including nutri-cereals and also pulses, even from traditional areas where they were earlier grown (Pingali & Sunder, 2017; Pingali, 2012; Pingali, Mittra, & Rahman, 2017). The consequence of such a policy has been that India’s food policy has been targeted to meet food security through enhanced calorie intake from cereal based sources rather than attainment of nutrition security through micronutrient rich food sources.

In addition to policy constraints, there are also political economy challenges when it comes to improving nutrition levels amongst the poor in India. Accessibility and affordability are two major factors that govern availability of nutritious food to the poor. The poor are often deprived of nutrition rich food variety due to lack of availability of such food items in areas where poor either work or reside. Similarly, the pricing of food items also matters. Restrictive pricing of food items that are beyond the means of the poor groups again hampers the consumption of nutrition rich food amongst the poor. Nutrition specific interventions, thus, need to calibrate both these factors in their design. There are other factors such as disagreements over strategies and interventions, politics amongst politicians and high administrative levels, levels of political commitment to nutrition that determine effective implementation of nutrition sensitive programmes (Pelletier, Menon, Ngo, Frongillo, & Frongillo, 2011).

In the context, the public distribution system (PDS) in India has been illustrative of a mechanism of distributing food to the large number of poor people in India at a subsidized price and across urban and rural hinterlands. The PDS in India is the world’s largest food based social safety net program that operates through a network of more than 500,000 fair-price shops (FPS) spread throughout the country (Chakrabarti, Kishore, & Roy, 2018). The PDS is jointly managed by the central and state governments (ibid). The central government is responsible for procurement, storage, transportation, and the bulk allocation of food grains to the state governments.
Identification of eligible families, issuance of ration cards, distribution of subsidized goods and supervision of the functioning of FPS lie with the state governments (ibid). The central government subsidizes only rice, wheat, sugar, and kerosene oil. State governments can add other items to the basket of goods to be sold through the PDS, but they must pay for subsidizing these additional items from their own resources (ibid).

The PDS has had its share of critics (for risks of creating dependency, financial burden on the public exchequer, inefficiency in distribution, poor targeting and corruption in the scheme) and its proponents, but on the whole the PDS has proven to be an effective pathway to reduce undernutrition, when financing is available (Maestre & Parasar, 2017; Jha & Ramaswami, 2010; Nandakumar, Ganguly, Sharma, & Gulati, 2010; Rahman, 2014; Rahman, 2016). Moreover, where political will and effective administrative and community organization backing has been there, PDS has functioned well to minimize leakages and serve its purpose (Khera, 2011; Rahman, 2014).

However, the PDS in its current form desires much diversity in the diet it offers and a vast share of the PDS procurement system constitutes of rice and wheat (Nandakumar, Ganguly, Sharma, & Gulati, 2010; Desai & Vanneman, 2015), but then this may be subject to state level variation as some states have included items such as pulses, millets, black gram and iodized salt in their schemes. In addition to the PDS, there are two other extensive government interventions aimed at enhancing nutrition levels in India, namely the Integrated Child Development Services (ICDS) and Midday Meal Scheme (MDMS). But again, both ICDS and MDMS have mostly been limited to procurement of wheat and rice and have done little to contribute to nutritional outcomes through balanced diet food provisions in accordance to local tastes and preferences (Pingali, Mittra, & Rahman, 2017).

Apart from the policy bias in food production directed towards wheat and rice, there is also a political nexus that operates between the powerful farm lobby of rice and wheat suppliers and the parastatals responsible for procurement of grains to various safety net programmes, - including the PDS, the ICDS and the MDMS - which benefit from procurement policies favoring wheat and rice (ibid). Lastly, the expansion and diversification of food basket through inclusion of nutri-cereals within the food distribution system is further constrained by the fact there has not been any major technological innovation in boosting the agriculture production of nutri-cereals (Swaminathan &
Thus, any talk of diversification of food distribution system through inclusion of nutri-cereals has to be accompanied by investments in research and development for expansion of agriculture production of these grains.

Moreover, recognition of nutrition as a problem distinct from food security within the policy context predominantly occurred only in the last two decades. A significant step in the direction was the formulation of the National Nutrition Policy or NNP in 1993 under the auspices of the Department of Women and Child Development. The NNP set out for a multi-sectoral strategy for alleviating the problem of malnutrition and for achieving the optimal levels of nutrition for the people, through close collaboration between the Food Policy, the Agriculture Policy, the Health Policy, the Education Policy, the Rural Development Programme and the Nutrition Policy as each complements each other (National Nutrition Policy, 1993). The formulation of NNP in 1993 was also a response to other significant global developments in the field of nutrition earmarked by the International Conference on Nutrition convened at the headquarters of Food and Agriculture Organization (FAO) in Rome in December 1992. The formulation of NNP was followed by the development of the National Plan of Action on Nutrition (NPAN) with the intention of operationalizing the objectives enshrined in the NNP. Subsequently, the demand for nutrition interventions at various levels have echoed once a while.

In the aforementioned context of rising levels of undernutrition in India and a policy environment characterized by food bias towards two staple cereal grains (wheat and rice) that operates to impact all levels of food system beginning from production to consumption, this study report employs a nutrition sensitive approach to address the dismal status of health and nutritional outcomes in Scheduled Areas of Maharashtra. The report begins with the premise that nutritional and health outcomes depend on the availability of nutrition rich food as well as its accessibility to the poor. To address these two-pronged challenges, the report aims to assess if incorporation of nutri-cereals in the food system (production, procurement, distribution and consumption) can potentially contribute to improve levels of nutrition and health outcomes in Scheduled Areas of Maharashtra, and that if the extant PDS in the state can be utilized to make these grains available to the poor at affordable prices. For the purpose of this report, we will confine ourselves to three main types of nutri-cereals, namely sorghum (*jowar*), pearl millet (*bajra*) and finger millet (*ragi*).
To establish its claims, the report substantiates its findings based on data on current patterns of cereal consumption, production, procurement and distribution and their relation to food preferences and nutritional status in Scheduled Areas of Maharashtra. The report simultaneously attempts to understand if public investments, in the production and consumption of nutri-cereals, can potentially contribute to improve health and nutritional outcomes. Alongside these major assessments, the report also aims to assess if production and consumption of nutri-cereals can accrue other benefits to the backward regions of Maharashtra such as improving water-use efficiency, climate vulnerability, carbon emissions and food security, and if there are lessons to be drawn from other states of India in improving food system in Maharashtra.

The report arrives at a critical juncture when the National Nutrition Mission (NNM) (or the POSHAN Abhiyan) has been commissioned by the government of India with a three-year budget of Rs. 9046.17 crore commencing from 2017-18. The NNM envisages reduction in malnutrition through convergence of various nutrition related schemes - such as Aanganwadi Services, Pradhan Mantri Matru Vandana Yojana, Scheme for Adolescent Girls of MWCD; Janani Suraksha Yojana, National Health Mission of MoH&FW; Swachh Bharat Mission of Ministry of Drinking Water & Sanitation; Public Distribution System (PDS) of Ministry of Consumer Affairs, Food & Public Distribution (MCAF&PD); Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) of Ministry of Rural Development (MoRD); Drinking Water & Toilets with Ministry of Panchayati Raj and Urban Local Bodies through Ministry of Urban Development (MoUD) - to develop a comprehensive and targeted monitoring and evaluation framework to tackle malnutrition, and by mobilizing participation at all levels, that is, state, district and aangadwadi levels (National Nutrition Mission: Administrative Guidelines, 2017). In line with the NNM, this study report is a recognition that health and nutritional outcomes can better be addressed as aspects of the wider social, economic and environmental factors.

A note on terminology: For the sake of convenience, we use the term ‘core cereals’ to designate the two crops, wheat and rice. The term ‘nutri-cereals’ has been used to designate millet group crops. The term ‘cereal’ has been used to refer the entire group of cereal food grains, both core

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2 http://pib.nic.in/newsite/PrintRelease.aspx?relid=177166
3 Aanganwadi is a form of basic health care service in India, which were started by the Government of India in 1975 as part of the Integrated Child Development Services Program to combat child hunger and malnutrition (https://en.wikipedia.org/wiki/Anganwadi)
cereals and nutri-cereals. At all other places, where reference to particular crops has been made, they have been specified so.

2. Policy context and nutrition status in India

As indicated earlier, during the decades following independence the dominant concern of the food policy programme of India was mainly elimination of hunger and attainment of self-sufficiency in food production. Subsequently, the Green Revolution was ushered with the twin aim of achieving both these goals. But the Green Revolution’s heavy bias towards cereal production, mainly wheat and rice, had significant adverse impact on nutritional outcomes and dietary diversification of the Indian population (Chakrabarti, Kishore, & Roy, 2018; Desai & Vanneman, 2015; Pingali, Mittra, & Rahman, 2017).

For instance, to take the case of pulses, which constitutes of the primary source of plant protein and complex carbohydrates for vast majority of Indian population, there was a registered decline in their consumption post 1950s (Joshi, Kishore, & Roy, 2016). The excessive emphasis laid by the Green Revolution on core cereal grains resulted in a near stagnation in growth of pulses over the years, and in general the availability of pulses in India has not kept pace with its rising demand (ibid). Consequently, the prices of pulses, which were lower than core cereals prior to Green Revolution, have risen significantly post the Green revolution (Joshi, Kishore, & Roy, 2016; Chakrabarti, Kishore, & Roy, 2018). In addition to the rising prices of the pulses, the poor coverage of pulses by the PDS compared to wheat and rice seem to have further contributed to the decline in their consumption. More or less the same has been the case with nutri-cereals.

While there has been an increase in overall cereal production over the past decades in India, there has been a general decline in both production and consumption of nutri-cereals in India between 1960s and 2000s (Davis, et al., 2018; Swaminathan & Bhavani, 2013; Goyal & Singh, 2002). In other words, the share of nutri-cereals as part of the total production of cereals has seen a decline over the past few decades (Davis, et al., 2018; Swaminathan & Bhavani, 2013; Goyal & Singh, 2002). According to the estimates of Swaminathan and Bhavani (2013) the growth rate in area of total coarse cereals comprising jowar (sorghum), bajra (pearl millet), ragi (finger millet), maize, small millets and barley, was negative in all the three periods 1980-1981 to 1989-1990, 1990-1991 to 1999-2000 and 2000-2001 to 2011-2012. According the same estimates, rice and wheat together
constituted about 78 per cent of total food grain production in 2009-2010 (Swaminathan & Bhavani, 2013).

Moreover, contrary to the case of core cereals, there has been no major research investments and technical innovations for production of nutri-cereals (Nagaraj, Basavaraj, Rao, Bantilan, & Haldar, 2013; Swaminathan & Bhavani, 2013). The production of nutri-cereals has further suffered a setback as about 50 per cent of area under cultivation for millets has been diverted largely to soybean, maize, cotton, sugarcane and sunflower (National Academy of Agriculture Sciences, 2013). For Maharashtra specifically, there has been an overall decline of 38 per cent in area under cultivation for nutri-cereals; 84 per cent decline in area under cultivation for kharif Jowar, 53 per cent decline in area under cultivation for rabi jowar; 58 per cent decline in area under cultivation for kharif bajra; 28 per cent decline in area under cultivation for ragi (Figure 1). Despite decline in area, productivity of nutri-cereals in the state has increased; productivity of kharif jowar increased by 17 per cent and rabi jowar by 70 per cent, and productivity of bajra has almost doubled (Figure 2).

Source: (Ghawate, 2018)⁴

Figure 1: Decadal changes in area under cultivation for nutri-cereals in Maharashtra

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The reported changes in production patterns of cereals in India have had a concomitant impact on food consumption patterns, and subsequently, on the nutritional intake of the subcontinent population. As also mentioned earlier, in addition to production outputs, government procurement policies of food grains in India with guaranteed minimum support price for wheat and rice further perpetuated the bias inherent in the production system. Simultaneously, the three large flagship food entitlement programmes of the government of India, the PDS, the ICDS and MDMS have ensured an assured supply of core cereals to consumers at subsidized prices. Desai & Vanneman (2015) in their study of the role of PDS in shaping food consumption patterns document that PDS users are substantially more likely to consume core cereals, as many PDS users seem to skew their consumption towards items they are able to purchase cheaply, primarily wheat and rice, while reducing consumption of other forms of cereals (also see, Deaton & Dreze, 2009; Davis, et al., 2018). Davis et al. (2018) observe that the proportion of nutri-cereals to total cereals consumed.
declined from 35 per cent to 5 per cent and 17 per cent to 3 per cent in rural and urban areas, respectively, between 1961 and 2011.

The shift in diet patterns, with predominance in consumption of (core) cereal-based diet has not been without consequences; this is particularly true for the levels of micronutrient intake in the Indian population. The overall increase in cereal production in India, with characteristic heavy bias towards wheat and rice, has persisted alongside severe levels of undernutrition or ‘hidden hunger’. Hidden hunger, as opposed to (raw) hunger that is the state of being underfed or the need felt to fill the belly, is characterized by deficiency of micronutrients that are required only in small amounts but their deficiency results in ailments and/or mental and physical infirmities (Gopaldas, 2006). Micronutrient deficiency in India can be attributed to cereal based Indian diets, predominantly wheat and rice, which are qualitatively deficient in micronutrients particularly iron, vitamin A and riboflavin (Sangeetha, Sharma, Burman, & Lenin, 2013; DeFries, et al., 2018; Rao, et al., 2018). Micronutrient deficiencies can persist despite high calorie intake. As Deaton & Dreze (2009) argue there is no tight link between the number of calories consumed and nutritional or health status. In fact, a set of surveys carried out by National Nutrition Monitoring Bureau (NNMB)\(^5\) reported decline in micronutrient intake in some states despite increase in levels of calorie intake (National Nutrition Monitoring Bureau, 2009; Radhakrishna & Ravi, 2004).

The NNMB further identifies three forms of significant micronutrient deficiencies in India. These are: vitamin 'A' deficiency (VAD), iron deficiency anaemia (IDA) and iodine deficiency disorders (IDD) (National Nutrition Monitoring Bureau, 1993). These micronutrient deficiencies persist alongside the other prevalent form of undernutrition in India that is the protein energy malnutrition (PEM), which is reflected by the growth indicated by height and weight of children and adults in comparison to the established standards (ibid). However, again the deficiency of the aforementioned micronutrients has no relevance to the calorie and protein levels in the individual diets (National Nutrition Policy, 1993). In addition to the three identified micronutrient deficiencies (VAD, IDA and IDD), there are other micronutrient components that are essential for

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\(^5\) The National Nutrition Monitoring Bureau or NNMB was established in the year 1972 under the aegis of the Indian Council of Medical Research (ICMR) in the states of Andhra Pradesh, Gujarat, Karnataka, Kerala, Madhya Pradesh, Orissa, Tamil Nadu, Maharashtra, Uttar Pradesh and West Bengal, has been carrying out regularly, since its inception, annual surveys on diet and nutritional status of the population and the results have been published in the form of technical reports.
health growth such as zinc, calcium, thiamine, riboflavin, niacin and folic acid (Vir, Sreenath, Bose, Mathur, & Menon, 2014).

For almost 70 per cent of the Indian population, the intake of micronutrients in their diet is less than 50 per cent of the recommended dietary allowance (RDA)\(^6\) (Kotecha, 2008). As per National Family Health Survey-4 (NFHS-4) 2015-16 nearly every third child in India is undernourished – underweight (35.7 per cent) or stunted (38.4 per cent) and 21 per cent of children under five years are wasted (NITI Aayog). VAD is a well-known cause of morbidity and mortality, particularly among young children and pregnant women in India (NITI Aayog). VAD inhibits the growth of young children, weakens their immunity and in cases of acute deficiency, it leads to blindness and to increased mortality (ibid). VAD along with zinc deficiency leads to weakening of the immune system and increases susceptibility to infections such as diarrhea disease and pneumonia (NITI Aayog; Vir, Sreenath, Bose, Mathur, & Menon, 2014).

Iron deficiency induced anaemia is again a cause of concern. According to an estimate of NITI Aayog, anaemia has been considerably higher in rural areas than urban areas, for disadvantaged groups (particularly scheduled tribes) and for children and women in households in the lower wealth quintiles. According to a Planning Commission report, every second woman in India is anaemic (55.3 per cent) (Planning Commission, Government of India, 2010). Approximately 22,000 people, mainly pregnant women, die every year in India from severe anemia (Kotecha, 2008). IDA amongst pregnant women has an intergenerational effect as it increases the risk of low birth weight or premature delivery, peri-natal and neonatal mortality, inadequate iron stores for the new-born, lowered physical activity, fatigue and increased risk of maternal morbidity (NITI Aayog).

Low iron intake, coupled with hookworm infestation and infections, further aggravates the problem (Vir, Sreenath, Bose, Mathur, & Menon, 2014). Anaemia prevalence in young children, under 3 years has increased from 74 per cent to 79 per cent between NFHS 2 (1998-99) & NFHS 3 (2005-06) (Planning Commission, Government of India, 2010). Similarly, IDD and folic acid

\(^6\) Recommended Dietary Allowance or RDA is a system of nutrition recommendation from the Institute of Medicine of the National Academies (United States) that specifies the amount of nutrient and calorie intake per day considered necessary for maintenance of good health.
deficiencies lead to severe impairments amongst young children in India (Kotecha, 2008). Approximately, 6.6 million children are born mentally impaired every year in India due to iodine deficiency, and about 200,000 babies are born every year with neural tube defects in India due to folic acid deficiency (ibid).

According to a report by International Institute of Population Sciences (IIPS), in Maharashtra itself 23 per cent of children 0-23 months of age were stunted of which 8 per cent were severely stunted and approximately 23 per cent were underweight, of which 7 per cent were severely underweight (Unisa, Chattopadhyay, Fulpagare, & Sinha, 2016). About 59 per cent of pre-school children, 61 per cent of adolescent girls, 76 per cent of pregnant women and 73 per cent of lactating mothers in the state suffer from anemia (Arlappa, et al., 2014). More children in the rural than urban areas were stunted (26 per cent versus 21 per cent) and underweight (26 per cent versus 20 per cent) (Unisa, Chattopadhyay, Fulpagare, & Sinha, 2016). Furthermore, the percentage of anaemic women and children, and women with low body mass index is higher for scheduled areas of the state than for non-scheduled areas (Fig. 1.1, 1.2, 1.3 & 1.4).

Figure 3: Percentage of anemic women as per NFHS, 2015-2016
Figure 4: Percentage of anemic children as per NFHS 2015-2016

Figure 5: Average anaemia percentages (schedule versus non-schedule districts)
In sum, the emphatic concern for food self-sufficiency and hunger elimination through expansion of core cereal food basket seems to have adversely affected the availability of other cereal groups in India. Consequently, while India’s food policy has addressed the problem of calorie insufficiency, it has done little to alleviate the problem of micronutrient deficiency or the problem of ‘hidden hunger’ that continues to persist in India (Pingali, Mittra, & Rahman, 2017). Taking cognizance of these issues, some research studies have suggested of diversification of the food grain basket provided by the PDS (Chakrabarti, Kishore, & Roy, 2018; Sangeetha, Sharma, Burman, & Lenin, 2013), that is away from core cereals to nutri-cereals. Consequently, in recent times some states have included pulses and nutri-cereals in their PDS scheme. There are others who contend that these inclusions in the PDS have worked mainly as an income transfer program and not so much as a nutritional intervention (Chakrabarti, Kishore, & Roy, 2018).
3. Addressing malnutrition through food basket diversification

In this section we explore if and to what extent changes in dietary consumption patterns, particularly a shift away from wheat and rice-based diet and towards inclusion of nutri-cereals can potentially contribute to enhancement of nutrition levels in Scheduled Areas of Maharashtra and plausibly in the overall context of India. To reiterate, we are mainly concerned with three kinds of nutri cereals- *jowar* (sorghum), *bajra* (pearl millet), and *ragi* (finger millet). We posit that the decline in production of these nutri-cereals is directly related to the decline in intake of micronutrients, and consequently focusing on policy measures directed at inclusion of these cereal grains, that is nutri-cereals, within PDS of the state can lead to positive nutritional and health outcomes.

Prior to this we look at some of the claims regarding the nutrition component of nutri-cereals compared to other cereals. The nutri-cereals under consideration in general have higher micronutrient content than cereals, that is, wheat and rice (Davis, et al., 2018; DeFries, et al., 2015; Rao, et al., 2018). Rao et al. (2018) note that rice is less nutritious than wheat (including refined flour), with respect to protein, iron and zinc content, while millets such as pearl millet are more nutritious than wheat. Davis et al. (2018) observe that despite the decline in relative share of nutri-cereals in overall supply of cereals, between 1966 and 2009, nutri-cereals have disproportionately accounted for the supply of protein, iron, and zinc among *kharif* crops (Davis, et al., 2018). Additionally, nutri-cereals are a rich source of iron, zinc, calcium and other vitamins required for healthy growth of individuals. However, regardless of potential health and nutritional benefits, in the current scenario nutri-cereals are largely consumed where they are grown (Rao, et al., 2018), and much remains to be done to incorporate these grains within the food procurement and the distribution system.

---

7 Crops that are sown in rainy season from June to September are defined as *kharif* crops
Table 1: Nutrition content of nutri-cereals and other cereals (wheat and rice) per 100 grams of edible portion

Protein and Fiber content
(All values are expressed g/100g edible portion; All blank space in the table represent below detectable limit)

<table>
<thead>
<tr>
<th>Food Name</th>
<th>Moisture</th>
<th>Protein</th>
<th>Ash</th>
<th>Total Fat</th>
<th>Total Dietary Fiber</th>
<th>Insoluble Dietary Fiber</th>
<th>Soluble Dietary Fiber</th>
<th>Carbohydrate</th>
<th>Energy KJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bajra (Pennisetum typhoideum)</td>
<td>8.97 ±0.60</td>
<td>10.96 ±0.26</td>
<td>1.37 ±0.17</td>
<td>5.43 ±0.64</td>
<td>11.49 ±0.62</td>
<td>9.14 ±0.58</td>
<td>2.34 ±0.42</td>
<td>61.78 ±0.85</td>
<td>1456 ±18</td>
</tr>
<tr>
<td>Barley (Hordeum vulgare)</td>
<td>9.77 ±0.38</td>
<td>10.94 ±0.51</td>
<td>1.06 ±0.22</td>
<td>1.30 ±0.20</td>
<td>15.64 ±0.64</td>
<td>9.98 ±0.62</td>
<td>5.66 ±0.68</td>
<td>61.29 ±0.77</td>
<td>1321 ±19</td>
</tr>
<tr>
<td>Jowar (Sorghum vulgare)</td>
<td>9.01 ±0.77</td>
<td>9.97 ±0.43</td>
<td>1.39 ±0.34</td>
<td>1.73 ±0.31</td>
<td>10.22 ±0.49</td>
<td>8.49 ±0.40</td>
<td>1.73 ±0.40</td>
<td>67.68 ±1.03</td>
<td>1398 ±13</td>
</tr>
<tr>
<td>Ragi (Eleusine coracana)</td>
<td>10.89 ±0.61</td>
<td>7.16 ±0.63</td>
<td>2.04 ±0.34</td>
<td>1.92 ±0.31</td>
<td>11.18 ±1.14</td>
<td>9.51 ±0.65</td>
<td>1.67 ±0.55</td>
<td>66.82 ±0.73</td>
<td>1342 ±10</td>
</tr>
<tr>
<td>Samai (Panicum miliare)</td>
<td>11.36 ±0.19</td>
<td>10.13 ±0.45</td>
<td>1.34 ±0.16</td>
<td>3.89 ±0.35</td>
<td>7.72 ±0.92</td>
<td>5.45 ±0.48</td>
<td>2.27 ±0.52</td>
<td>65.55 ±1.29</td>
<td>1449 ±19</td>
</tr>
<tr>
<td>Varagu (Setaria italica)</td>
<td>14.23 ±0.45</td>
<td>8.92 ±1.09</td>
<td>1.72 ±0.27</td>
<td>2.55 ±0.13</td>
<td>6.39 ±0.60</td>
<td>4.29 ±0.82</td>
<td>2.11 ±0.34</td>
<td>66.19 ±1.19</td>
<td>1388 ±10</td>
</tr>
<tr>
<td>Rice, raw, milled (Oryza sativa)</td>
<td>9.93 ±0.75</td>
<td>7.94 ±0.58</td>
<td>0.56 ±0.08</td>
<td>0.52 ±0.05</td>
<td>2.81 ±0.42</td>
<td>1.99 ±0.39</td>
<td>0.82 ±0.22</td>
<td>78.24 ±1.07</td>
<td>1491 ±15</td>
</tr>
<tr>
<td>Wheat, whole (Triticum aestivum)</td>
<td>10.58 ±1.11</td>
<td>10.59 ±0.60</td>
<td>1.42 ±0.19</td>
<td>1.47 ±0.05</td>
<td>11.23 ±0.77</td>
<td>9.63 ±0.19</td>
<td>1.60 ±0.75</td>
<td>64.72 ±1.74</td>
<td>1347 ±23</td>
</tr>
</tbody>
</table>

Source: (Hemalatha, 2018)
Table 2: Nutrition content of nutri-cereals and other cereals (wheat and rice) per 100 grams of edible portion

**Iron and calcium content**
(All values are expressed mg/100g edible portion; All blank space in the table represent below detectable limit)

<table>
<thead>
<tr>
<th>Food Name</th>
<th>Iron (Fe)</th>
<th>Zinc (Zn)</th>
<th>Copper (Cu)</th>
<th>Manganese (Mn)</th>
<th>Potassium (K)</th>
<th>Magnesium (Mg)</th>
<th>Phosphorus (P)</th>
<th>Sodium (Na)</th>
<th>Calcium (Ca)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bajra</td>
<td>6.42 ±1.04</td>
<td>2.76 ±0.36</td>
<td>0.54 ±0.11</td>
<td>1.12 ±0.17</td>
<td>365 ±18.0</td>
<td>124 ±19.5</td>
<td>289 ±25.3</td>
<td>4.11 ±0.09</td>
<td>27.35 ±2.16</td>
</tr>
<tr>
<td>Barley</td>
<td>1.56 ±0.15</td>
<td>1.50 ±0.27</td>
<td>0.43 ±0.17</td>
<td>1.24 ±0.11</td>
<td>268 ±20.4</td>
<td>48.97 ±6.1</td>
<td>178 ±26.8</td>
<td>7.56 ±1.52</td>
<td>28.64 ±3.49</td>
</tr>
<tr>
<td>Jowar</td>
<td>3.95 ±0.94</td>
<td>1.96 ±0.31</td>
<td>0.45 ±0.11</td>
<td>1.19 ±0.11</td>
<td>328 ±25.1</td>
<td>133 ±14.8</td>
<td>274 ±35.7</td>
<td>5.42 ±0.21</td>
<td>27.60 ±3.71</td>
</tr>
<tr>
<td>Ragi</td>
<td>4.62 ±0.36</td>
<td>2.53 ±0.51</td>
<td>0.67 ±0.22</td>
<td>3.19 ±0.88</td>
<td>443 ±59.6</td>
<td>146 ±10.7</td>
<td>210 ±58.4</td>
<td>4.75 ±0.14</td>
<td>364 ±58.0</td>
</tr>
<tr>
<td>Samai</td>
<td>1.26 ±0.44</td>
<td>1.82 ±0.14</td>
<td>0.34 ±0.08</td>
<td>0.23 ±0.08</td>
<td>105 ±15.7</td>
<td>91.41 ±12.63</td>
<td>130 ±27.5</td>
<td>4.77 ±0.14</td>
<td>16.06 ±1.54</td>
</tr>
<tr>
<td>Varagu</td>
<td>2.34 ±0.46</td>
<td>1.65 ±0.18</td>
<td>0.26 ±0.05</td>
<td>0.33 ±0.05</td>
<td>94 ±10.7</td>
<td>122 ±5.9</td>
<td>101 ±5.2</td>
<td>3.35 ±0.04</td>
<td>15.27 ±1.28</td>
</tr>
<tr>
<td>Rice, raw, milled</td>
<td>0.65 ±0.11</td>
<td>1.21 ±0.17</td>
<td>0.23 ±0.06</td>
<td>0.63 ±0.22</td>
<td>108 ±10.9</td>
<td>15.30 ±6.99</td>
<td>96 ±16.30</td>
<td>2.34 ±0.28</td>
<td>7.49 ±1.26</td>
</tr>
<tr>
<td>Wheat, whole</td>
<td>3.97 ±0.78</td>
<td>2.85 ±0.65</td>
<td>0.49 ±0.12</td>
<td>3.19 ±0.59</td>
<td>366 ±59.6</td>
<td>125 ±14.8</td>
<td>315 ±41.8</td>
<td>2.50 ±0.20</td>
<td>39.36 ±5.65</td>
</tr>
</tbody>
</table>

Source: (Hemalatha, 2018)
4. Environmental impact of cultivation of Wheat and Rice: Rationale for promoting cultivation of nutri-cereals

In addition to the declining nutritional levels, the shift towards rice and wheat-based food consumption patterns have also had adverse environmental impact. Already many states in India are facing severe water shortages, with the country being projected as standing on the brink of a severe water crisis (Rodell, Velicogna, & Famiglietti, 2009). Furthermore, the intensification of agriculture has led to increase in energy input for pumping of water for irrigation (Shah, Giordano, & Mukherji, 2012; Patle, Singh, Sarangi, & Khanna, 2016). Davis et al. (2018) indicate that in aggregate rice and wheat rely far more than other cereals on irrigation, namely for 65 per cent and 86 per cent of cultivated area respectively, while nutri or coarse cereals are mostly rain fed. Davis et al. (2018) also posit that replacing rice areas with alternative cereals such as millets and sorghum will lead to decline in levels of water consumption required for irrigation. Millets are also less affected by diseases and pests and hence, also do not need synthetic fertilizers or pesticides and can mostly be grown with organic inputs (Behera, 2017).

In case of Maharashtra, the problem of water scarcity has been aggravated by the fact that: although the state is one of the worst affected regions by water shortages, the land area under sugarcane cultivation in Maharashtra has gone up from 167,000 hectares in 1970-71 to 1,022,000 ha in 2011-12 (Qazi, 2017). Sugarcane again is a water-intensive crop. Along with water, a significant amount of fertilizers is also required in order to grow sugarcane.

We establish the rationale for promoting the cultivation of nutri-cereals in Maharashtra by spatially looking at three factors that cumulatively convey the environmental stress created through existing cropping pattern across the state. As the figure(s) below demonstrate, the districts that have maximum production of sugarcane, are also the ones which have seen substantial decline in water levels and high consumption of fertilizers reflected through average sales. Therefore, immediate steps leading to shifts in cropping pattern are need of the hour to avert any future crises of water scarcity and other negative consequences of climate change such as increased carbon emissions.
Figure 7: Dominant Crops, Average Fertilizer Sales and Post-Monsoon Depth to Water Level Trends in Maharashtra

Source:
Dominant Crops: Department of Agriculture, Government of Maharashtra
Average Fertilizer Sales: Department of Fertilizers, Ministry of Chemicals and Fertilizers, Government of India
Post-Monsoon Water Depth: Ministry of Water Resources, Government of India
5. Current patterns of cereal production, procurement, distribution and consumption in Maharashtra

Maharashtra is one of the largest producers of nutri-cereals in India. For the year 2016-17, total nutri-cereals production in Maharashtra was about 3.7 million tonnes compared to production of core-cereals which stood at 5.8 million. Compared to the production of core cereals, in the year 2017-2018, the sale of core-cereals through PDS was 3.75 million tonnes; 2.11 million tonnes of wheat and 1.64 million tonnes of rice (see, Figure 9).

Figure 8: Production of Cereals in Maharashtra

*Data Source: Directorate of Economics and Statistics, Department of Agriculture, Maharashtra State*
At the state level in Maharashtra, there is almost no procurement of nutri-cereals. However, this is in contrast to the central level procurement trends. Maharashtra is a major source of procurement of nutri-cereals at the central level. Figure 10 shows the total procurement of nutri-cereals at the central level. Maharashtra and Haryana are the two major players, with Maharashtra contributing to almost 37 per cent of the total procurement.

After procurement, we compare the allocation, off-take and distribution of cereals in Maharashtra and across different schemes under which the PDS beneficiaries are classified.
Lastly, we look at the consumption of nutri-cereals at the household and individual level with the help of the National Sample Survey Data for Maharashtra. The majority portion of nutri-cereals are consumed from market sources (50.61 per cent) (See Figure 12). Alternatively, we can also look at the consumption of nutri-cereals from a comparative standpoint between non-scheduled and scheduled areas. There is only a marginal difference between the patterns of consumption, which points towards a homogeneous consumption pattern across non-scheduled and scheduled areas in Maharashtra (See Figure 12).

We can further breakdown the percentage of nutri-cereals consumption from market sources to investigate the need for introducing nutri-cereals in PDS. As Figure 13 shows, out of the 50.61 per cent of households consuming nutri-cereals from the market, 82 per cent possess ration cards while 17.64 per cent do not. This goes to reiterate the thesis there is a need for introducing nutri-cereals as a large proportion of the intended beneficiaries of the policy currently rely on the market for their consumption.
Percentage of Households Consuming Nutricereals in Scheduled Areas of Maharashtra (2011-2012)

- Consuming only from Market: 48.54%
- No consumption: 17%
- Only Home Grown Consumption: 33.16%
- Consuming from Market and Home: 1.30%

Percentage of Households Consuming Nutricereals in Non-Scheduled Areas of Maharashtra (2011-2012)

- Consuming only from Market: 53.29%
- No consumption: 16.61%
- Only Home Grown Consumption: 28.93%
- Consuming from Market and Home: 1.16%
Figure 12: Consumption of nutri-cereals at household level for Maharashtra (state level) and for Schedule and non-Schedule areas of the state.

Data source: National Sample Survey, 2011-12

Figure 13: Breakdown of Market Consumption of nutri-cereals in Households of Maharashtra

Data source: National Sample Survey, 2011-12
6. Preferences and Consumption of nutri-cereals

Given the need for introduction of nutri-cereals in Maharashtra, we now aim to develop a model with the aim of proposing estimates of public investments that would be required in introducing nutri-cereals in the PDS system in Maharashtra. We rely on secondary data sources, such as the National Sample Survey and data collected from Government of Maharashtra to shed light on the preferences of consumption of nutri-cereals and then discuss the possible consequences of introduction of nutri-cereals in the PDS.

The fundamental concerns we seek to answer are the following: If the government distributes nutri-cereals through PDS, would people consume it? And if yes, how much would the potential beneficiaries consume? Answering these questions would help in guiding the scale at which the intervention should be pursued.

Methodology

In our conception of the problem of preferences of nutri-cereals, we have identified two channels to think about the dynamics between PDS policy and consumption basket of households. These channels have been visualized in Figure 14 and explained below.

![Figure 14: Short term and Long-term effects: Conception of Preference and Consumption problem](image)

Firstly, the historical policy of distributing wheat and rice at subsidized rates may have over a period of time reduced the prevalence of nutri-cereals in the consumption basket while increasing that of wheat and rice. Figure 13 shows us that consumption of nutri-cereals has consistently gone down across the different occupation classes. The trends are consistent with cited literature.
Secondly, the high consumption of wheat and rice could be also be solely because of subsidized rates (the standard price effect) and if nutri-cereals are provided at a subsidized rate, one would expect to see large positive consumption effects for them as well.

Please note that in Figure 14, we have not attempted to establish causal relationships between the short-term and long-term effects. We assume these effects are independent, though in reality we suspect they are not.

From the point of view of policy, it is difficult to reverse or control the first effect that has already taken place. But should this lead us to the pessimistic view that nobody wants to consume nutri-cereals and that there is no scope for this policy? We think the answer to that is no, primarily because of the second channel pointed out above. Even if there has been a historical restructuring of preferences in favor of wheat and rice, as is seen through the work (Sangeetha, 2018), there are still price effects to contend with that would allow us to push the consumption of nutri-cereals.

Given this background our next task is to estimate how much quantity will households consume at different arbitrary prices. With these estimates we can inform on the scale of this policy and eventually estimate the amount of public investment needed to achieve these outcomes. As shown in Figure 15, we can visualize this methodology as mapping of independent vectors starting from prices to public investment.

Figure 15: Average Daily Consumption of nutri-cereals across various occupation classes in India (in grams)
We use the latest round of NSS data on household consumption expenditure (2011-12). NSS has data on consumption of various goods, specifically on cereals (wheat, rice, maize, 
ragi, jowar, bajra and some other cereals) for our interest for a sample of about 8000 households in Maharashtra. See Appendix for detailed specifications of the model.

Results
The statistical analysis yields the following estimates of expenditure shares for nutri-cereals:

<table>
<thead>
<tr>
<th>Nutricereals</th>
<th>Expenditure shares*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jowar(c)</td>
<td>19.37%</td>
</tr>
<tr>
<td>Bajra (d)</td>
<td>11.26%</td>
</tr>
<tr>
<td>Ragi (e)</td>
<td>10.46%</td>
</tr>
</tbody>
</table>

* Estimates calculated using wheat & rice benchmarks; reported estimates are least of the two to be on the conservative side. Please see appendix for detailed computations and data surveys from NSS.

These preference constants or expenditure shares help us get the actual expenditure on these cereals by all households in Maharashtra at the state level as well as district level. To do this, we have calculated the total expenditure on cereals using NSS data and compiled them district-wise for Maharashtra. We assume that these expenditures would be constant even if nutri-cereals are introduced in the PDS. This expenditure is calculated for only households that can avail cereals from PDS. Expenditure on nutri-cereals by these “PDS households” is 24 per cent of total cereal expenditure in Maharashtra. Using the expenditure shares, we calculate the district wise quantity
of nutri-cereals that would be required for distribution at PDS shops. Detailed calculations have been provided in the Appendix section. The quantities are calculated for different prices of *ragi*, *bajra* and *jowar* and are summarized in Table 4.

The primary observation from these quantities is that less quantity of nutri-cereals would be required if they are priced higher. This is consistent with the assumptions of our model. Secondly, we observe that quantities required for nutri-cereals follows the same preference trend; *jowar* > *bajra* > *ragi*.

Based on the estimates of quantity, we also provide an aggressive estimate of monthly loss that would need to be borne by the public exchequer in order to introduce nutri-cereals in PDS. In order to do so, we use the Average Annual Modal Price of nutri-cereals. The justification for choosing the Modal Price has been provided in the Appendix.

The figures in Table 5 suggest that at slightly higher prices than are those currently prescribed under various schemes, nutri-cereals can introduce into the PDS system. The cost of this introduction is significant. This loss is accountable as the loss that the state has to bear due to difference in the cost of food grain procurement and sale price. As the central government provides assistance in the form of food subsidy to the State to bear this loss, we can compare the computed estimates of loss to the food subsidy provided over the same time period. For price trends used in the analysis, the percentage of food subsidy that would need to be used for the introduction of nutri-cereals ranges between 50 per cent to 80 per cent.

With the help of Table 4 and Table 5, we are able to simultaneously give estimates of quantities that would be needed for distribution at a certain choice of price, while also looking at the loss that would be adjusted as food subsidy. This helps in determining the scale at which the policy of introducing nutri-cereals in PDS should be pursued.

We conclude this section by proposing further analysis that can be undertaken in order to get more insights into potential investment scenarios for the government. Firstly, one can provide a range of investment options based on accurate demand for nutri-cereals across different districts. Secondly, we have not assumed an upper bound of entitlement for nutri-cereals for households. This can be addressed by developing a scheme wise matrix of entitlements. Lastly, the analysis can be extended to include nutrition values that are present in each cereal and we can then estimate the nutritional impact of introducing nutri-cereals into PDS.
Table 4: District wise Quantities needed for Distribution at Different PDS Prices (’000 Tonnes/month)

Source: National Sample Survey (NSS) 68th round; Household Consumer Expenditure; MSAMB, Government of Maharashtra, Department of Food and Civil Supplies, Government of Maharashtra

<table>
<thead>
<tr>
<th>District</th>
<th>PDS Distribution Prices (’000 Tonnes/Month)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>₹1/Kg</td>
</tr>
<tr>
<td>Ragi</td>
<td>Bajra</td>
</tr>
<tr>
<td>Ahmednagar</td>
<td>16.70</td>
</tr>
<tr>
<td>Amravati</td>
<td>12.30</td>
</tr>
<tr>
<td>Ch浦rapur</td>
<td>11.70</td>
</tr>
<tr>
<td>Dhule</td>
<td>9.74</td>
</tr>
<tr>
<td>Gadchiroli</td>
<td>7.51</td>
</tr>
<tr>
<td>Jalgaon</td>
<td>17.10</td>
</tr>
<tr>
<td>Nanded</td>
<td>12.80</td>
</tr>
<tr>
<td>Nandurbar</td>
<td>9.10</td>
</tr>
<tr>
<td>Nashik</td>
<td>19.10</td>
</tr>
<tr>
<td>Pune</td>
<td>21.30</td>
</tr>
<tr>
<td>Thane</td>
<td>24.00</td>
</tr>
<tr>
<td>Yavatmal</td>
<td>12.30</td>
</tr>
</tbody>
</table>

Total for Scheduled Areas

| 173.66 | 321.50 | 182.37 | 34.73 | 36.47 | 64.30 | 17.37 | 18.24 | 32.15 | 11.58 | 12.16 | 21.43 |

Scheduled Districts

<table>
<thead>
<tr>
<th>₹36/Kg</th>
<th>₹7.90</th>
<th>₹4.76</th>
<th>₹4.26</th>
<th>₹4.12</th>
<th>₹3.16</th>
<th>₹1.80</th>
<th>₹3.09</th>
</tr>
</thead>
<tbody>
<tr>
<td>₹10/Kg</td>
<td>₹4.76</td>
<td>₹2.13</td>
<td>₹2.13</td>
<td>₹2.13</td>
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<td>₹2.13</td>
<td>₹2.13</td>
</tr>
<tr>
<td>₹15/Kg</td>
<td>₹4.45</td>
<td>₹4.45</td>
<td>₹4.45</td>
<td>₹4.45</td>
<td>₹4.45</td>
<td>₹4.45</td>
<td>₹4.45</td>
</tr>
</tbody>
</table>

36
Table 5: Estimated Minimum Monthly Loss to the Exchequer (Crore ₹)

<table>
<thead>
<tr>
<th>Reference Year</th>
<th>PDS Price (₹/Kg)</th>
<th>All Districts</th>
<th>Scheduled Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ragi</td>
<td>Bajra</td>
<td>Jowar</td>
</tr>
<tr>
<td>2014-2015</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>372.0</td>
<td>207.0</td>
<td>452.9</td>
</tr>
<tr>
<td>5</td>
<td>164.1</td>
<td>80.5</td>
<td>185.9</td>
</tr>
<tr>
<td>7.5</td>
<td>94.8</td>
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<tr>
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<td>2015-2016</td>
<td></td>
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<tr>
<td>2.5</td>
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<td>256.8</td>
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<td>52.3</td>
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<td>62.3</td>
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<tr>
<td>20</td>
<td>4.2</td>
<td>&lt; 0</td>
<td>&lt; 0</td>
</tr>
</tbody>
</table>

Reference Year: Average Modal Price is used for the corresponding year

The district Palghar is not a part of these calculations

Values <0 indicate negative public investment, which is not relevant.
In the last section, we have looked at the potential investment that would be required in introducing nutri-cereals in PDS. In this section, we look at other experiences across Indian states where this policy has been introduced.

The government of Karnataka has been one of the first states to initiate procurement of millets (finger millet / *ragi* in south Karnataka and sorghum / *jowar* in north Karnataka) from farmers and distribution through PDS (Rajshekar & Raju, 2017). The scheme was introduced in 2013-14 under the name ‘*Anna bhagyadinda Krishi bhagya*’ (Farmer welfare through food welfare) with only limited success, and subsequently, based on a study conducted by the Karnataka Agricultural Price Commission (KAPRICOM) further improvements were incorporated within the scheme. KAPRICOM in their assessment of inclusion of millets in PDS in Karnataka suggested: (a) to increase the minimum support price (MSP) to *ragi* and *jowar* to provide at least 20 to 30 per cent mark-up over cultivation as estimated by KAPRICOM; (b) reduce incentives being given to maize and cotton, which were the chief competitors to *ragi* and *jowar*; (c) aggressively promote millets as an appropriate crop to adapt to changing climatic situation in the state, and; (d) invest in carrying out research to produce new varieties that will provide high yields, thus making it attractive to farmers to grow the crops (ibid). Post these recommendations the MSP for the both the crops were increased in 2015-16, which resulted in increased procurement of these grains.

Rajshekar & Raju (2017) in their study of introduction of millets in PDS in Karnataka report some of the issues related to production, procurement, storage, pricing, and consumer preference that have surfaced in the course of implementing the scheme. They identify that a major issue related with introduction of millets in the PDS is the lack of sufficient quantity of produce in the area; there has been a steady decline in area under cultivation for *jowar* and *ragi*, ceding to maize and cotton. In their assessment of experiences of farmers when selling their produce in open market versus selling to the government under the MSP procurement system, Rajshekar & Raju (2017) report that while the price for millets which the farmers received under the MSP procurement was higher than the open market, the delays in receiving the payment under the MSP procurement
system was a cause of dissatisfaction amongst the farmers. Repeated paper works were also cited as a factor that deterred the farmers from selling their produce to the government.

In addition to problems of procurement, consumer behaviour of farmers was also cited as a factor that deterred procurement of millets. Millets are largely grown for food and fodder, unlike other commercial crops that intended for sale in the market. Millets also have storage value as they can last for longer duration compared to other crops, and farmers tend to stock up these grains and may sell them from time to time to fulfil cash requirements to buy inputs for other crops. Shorter procurement windows, ill-equipped staff at procurements agencies, lack of storage space, political pressure to procure lower quality grains etc. were some of the other challenges encountered when it came to procurement of millets in Karnataka. When it comes to consumer taste preferences, Rajeshekar & Raju (2017) report that while *ragi* and *jowar* form a major part of the food basket for the consumers in Karnataka, the demand as well as the preference for rice clearly surpassed all other grains, including *jowar, ragi* and wheat; more than 70 per cent of the respondents surveyed by them asserted that they did not want the proportion of millets to be increased while decreasing the quantum of rice.

Looking at our model from the previous section along with the experience of Karnataka, we can draw two major lessons to develop the concerned policy in Maharashtra. Firstly, if nutri-cereals are introduced in Maharashtra, there will be a need of a greater food subsidy allocation from the central level as the introduction of nutri-cereals cannot be at the expense of the core-cereals as the Karnataka experience suggests. Secondly, the policy would be more effective if it is introduced as a separate, parallel scheme to the existing policies such as AAY and *Annapurna*, as opposed to merely introducing and increasing nutri-cereals entitlement within existing schemes.

---

*Is there a way forward...?*

Recently, state governments in India have come forward to channelize efforts to address problems of malnutrition through inclusion of nutri-cereals in state nutrition programmes, and also by expanding area under cultivation for nutri-cereals and through establishment of improved market linkages that can possibly provide favourably remunerative prices for these grains. The government of Odisha under *Millet mission programme* has partnered with civil society and academia to design and implement policies to create and sustain an effective system of production, processing, marketing and consumption
of nutri-cereals in the state (Government of Odisha, 2018). In Andhra Pradesh millets are being promoted through intercropping with pulses (Department of Agriculture, Government of Andhra Pradesh, 2018). Apart from inclusion in PDS and state nutrition scheme, local procurement practices and distribution strategies have also been experimented with. In 2009, WASSAN organized procurement and distribution of millets through self-help groups (SHGs) in few villages of Anantapur district of Andhra Pradesh (Rajshekar & Raju, 2017). Similarly, Deccan Development Society (DDS) worked with groups of Dalit women and other marginalized communities to bring in fallow land under cultivation for millets and redistribute it to the poor (ibid). However, it is yet to be seen if such decentralized models can be sustained over long term and at a larger scale.

8. Conclusion

The report highlights that selective targeting of certain crops, primarily of cereals such as wheat and rice, through favourable agriculture investment and government procurement policies has led to decline in production as well as consumption of other nutrition rich food grains such as sorghum and millets. Through the course of our analysis, we have illustrated that the decline in levels of consumption of nutri-cereals is linked to declining levels of consumption of certain essential micronutrients required for healthy growth and development of physical and mental cognitive abilities of individuals. The adverse effect of consumption of food grains lacking in essential micro-nutrients is particularly manifested in women and children of growing age. Lastly, rather than growing crops that are leading to an increase in the environmental distress of the state, the rationale for agriculture development should be grounded in mitigation of adverse environmental impacts which are being felt in Maharashtra over the last few years.

Our report further delves into current patterns of production, distribution and consumption of cereal production in Maharashtra. In the current scenario, there is hardly any presence of nutri-cereals in the public distribution system of the state. We, thus, suggest that there are likely scenarios in which nutri-cereals can be introduced into the PDS system in Maharashtra. We present estimates of quantities that would be ideally required to distribute nutri-cereals across districts in Maharashtra. We also present possible investment scenarios dependent on the price at which the nutri-cereals would be introduced in PDS. Our estimates are preliminary but significantly robust and can be used to inform decisions in this matter.
Lastly, we have undertaken a case study of initiatives that have been taken within other states of India to promote both cultivation and consumption of nutri-cereals. These are important lessons that could serve as precursors to any future policy initiatives. We, therefore, urge the government of Maharashtra to channelize funds, and to initiate agriculture production and procurement policy measures to realize the successful incorporation of nutri-cereals within the state. This, as has been emphasized in the report, is likely to contribute to improvement in levels nutrition and health outcomes within the state of Maharashtra.

References


9. Appendix

Tables of Visualizations

Figure 1:

<table>
<thead>
<tr>
<th>Year/Productivity in kg/ha</th>
<th>Rb. Jowar</th>
<th>Bajra</th>
<th>Ragi</th>
<th>Other Cereals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960-61</td>
<td>37.36</td>
<td>16.35</td>
<td></td>
<td>4.79</td>
</tr>
<tr>
<td>1980-81</td>
<td>34.98</td>
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<td>1990-91</td>
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<td>4.31</td>
</tr>
<tr>
<td>2000-01</td>
<td>31.84</td>
<td>18</td>
<td></td>
<td>6.65</td>
</tr>
<tr>
<td>2010-11</td>
<td>30.28</td>
<td>10.35</td>
<td>1.2</td>
<td>0.59</td>
</tr>
<tr>
<td>2016-17</td>
<td>30.12</td>
<td>8.37</td>
<td>0.93</td>
<td>0.84</td>
</tr>
<tr>
<td>2017-18</td>
<td>17.59</td>
<td>6.8</td>
<td>0.86</td>
<td>0.66</td>
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Figure 2:

<table>
<thead>
<tr>
<th>Year/Productivity in kg/ha</th>
<th>Rb. Jowar</th>
<th>Bajra</th>
<th>Ragi</th>
<th>Other Cereals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960-61</td>
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<td>570</td>
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<tr>
<td>1970-71</td>
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<td>404</td>
<td></td>
<td>611</td>
</tr>
<tr>
<td>1980-81</td>
<td>448</td>
<td>454</td>
<td></td>
<td>754</td>
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<td>1990-91</td>
<td>598</td>
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<td></td>
<td>1027</td>
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<td>2000-01</td>
<td>499</td>
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<tr>
<td>2010-11</td>
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<td>1085</td>
<td>975</td>
<td>508</td>
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<td>2016-17</td>
<td>322</td>
<td>416</td>
<td>1011</td>
<td>390</td>
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<td>2017-18</td>
<td>920</td>
<td>903</td>
<td>1093</td>
<td>805</td>
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Figure 5:

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<tr>
<th>Percent Anaemic</th>
<th>Non-Schedule Areas</th>
<th>Schedule Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>44.385</td>
<td>50.445</td>
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<tr>
<td>Children</td>
<td>50.630</td>
<td>58.518</td>
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### Figure 8:

<table>
<thead>
<tr>
<th>Type of Nutri Cereal</th>
<th>Production in Million Tonnes in Maharashtra</th>
<th>Production in Million Tonnes in Scheduled Areas of Maharashtra (2016-17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jowar</td>
<td>2.5</td>
<td>0.75</td>
</tr>
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<td>Bajra</td>
<td>1.1</td>
<td>0.58</td>
</tr>
<tr>
<td>Ragi</td>
<td>0.1</td>
<td>0.04</td>
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<tr>
<td><strong>Total Production of Nutri-Cereals</strong></td>
<td><strong>3.7</strong></td>
<td><strong>1.37</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Core Cereal</th>
<th>Production in Million Tonnes in Maharashtra</th>
<th>Production in Million Tonnes at Scheduled Areas of Maharashtra (2016-17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>2.2</td>
<td>0.99</td>
</tr>
<tr>
<td>Rice</td>
<td>3.6</td>
<td>1.24</td>
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<td><strong>Total Production of Core-Cereals</strong></td>
<td><strong>5.8</strong></td>
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### Total PDS Sales in Million Tonnes (2017-2018)

<table>
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<tr>
<th>Grain</th>
<th>Total PDS Sales (In Tonnes)</th>
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<tr>
<td>Wheat</td>
<td>2.12</td>
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<td>Rice</td>
<td>1.64</td>
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### Figure 10:

<table>
<thead>
<tr>
<th>Cereal</th>
<th>Maharashtra</th>
<th>Haryana</th>
</tr>
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<tbody>
<tr>
<td>Jowar (KMS 16-17)</td>
<td>3733</td>
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</tr>
<tr>
<td>Bajra (KMS 16-17)</td>
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<td>6371</td>
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</table>
Figure 11:

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<tr>
<th>Scheme</th>
<th>Cereal</th>
<th>Allotment by Government of India (in Lakh Tonnes)</th>
<th>Off-take by Government of Maharashtra (in Lakh Tonnes)</th>
<th>Distribution to FPS (in Lakh Tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPS for establishments (Non-NFSA)</td>
<td>Wheat</td>
<td>0.27</td>
<td>0.1608</td>
<td>0.1331</td>
</tr>
<tr>
<td></td>
<td>Rice</td>
<td>0.114</td>
<td>0.075</td>
<td>0.07</td>
</tr>
<tr>
<td>FPS for Saffron Card Holders and APL Farmers (Non-NFSA)</td>
<td>Rice</td>
<td>1.35</td>
<td>1.24</td>
<td>1.21</td>
</tr>
<tr>
<td></td>
<td>Wheat</td>
<td>2.16</td>
<td>2.02</td>
<td>1.92</td>
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<tr>
<td>FPS for NFSA (PH)</td>
<td>Rice</td>
<td>15.17</td>
<td>14.18</td>
<td>14.11</td>
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<td></td>
<td>Wheat</td>
<td>20.36</td>
<td>19.04</td>
<td>18.95</td>
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<td>FPS for NFSA (AAY)</td>
<td>Rice</td>
<td>5.04</td>
<td>4.87</td>
<td>4.83</td>
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<td></td>
<td>Wheat</td>
<td>5.48</td>
<td>5.22</td>
<td>5.21</td>
</tr>
<tr>
<td>FPS for NFSA (Coarse Grains)</td>
<td>Jowar</td>
<td>0.01657</td>
<td>0.01427</td>
<td>0.01403</td>
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Figure 12:

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<th>Sources</th>
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<th>Non schedule areas</th>
<th>Schedule areas</th>
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<tr>
<td>No consumption</td>
<td>31.32</td>
<td>33.16%</td>
<td>28.93%</td>
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<tr>
<td>Consuming only from Market</td>
<td>50.61</td>
<td>48.54%</td>
<td>53.29%</td>
</tr>
<tr>
<td>Only Home Grown Consumption</td>
<td>16.83</td>
<td>17%</td>
<td>16.61%</td>
</tr>
<tr>
<td>Consuming from Market and Home</td>
<td>1.24</td>
<td>1.30%</td>
<td>1.16%</td>
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</table>

Figure 13:

<table>
<thead>
<tr>
<th>Ration Card</th>
<th>Percentage of Households</th>
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<td>Yes</td>
<td>82.36</td>
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<tr>
<td>No</td>
<td>17.64</td>
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Figure 15:

<table>
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<tr>
<th>Occupation Class</th>
<th>1996-97</th>
<th>2011-12</th>
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<tr>
<td>Labor</td>
<td>94.5</td>
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<tr>
<td>Agriculture</td>
<td>147.4</td>
<td>67.5</td>
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<tr>
<td>Service + Business</td>
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<td>20.9</td>
</tr>
<tr>
<td>Other Occupations</td>
<td>112.9</td>
<td>15.8</td>
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<tr>
<td>Pooled</td>
<td>107.3</td>
<td>36.3</td>
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</table>

Tables/Data used in Models:

1. Minimum Support Price for Commodities in Maharashtra

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<th></th>
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</thead>
<tbody>
<tr>
<td>Paddy-Common</td>
<td>1080</td>
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<td>1310</td>
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<td>1470</td>
<td>1550</td>
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<td>Paddy-Grade ‘A’</td>
<td>1110</td>
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<td>1345</td>
<td>1400</td>
<td>1450</td>
<td>1510</td>
<td>1590</td>
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<tr>
<td>Jowar-Hybrid</td>
<td>980</td>
<td>1500</td>
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<td>1530</td>
<td>1570</td>
<td>1625</td>
<td>1700</td>
</tr>
<tr>
<td>Jowar-Maldandi</td>
<td>1000</td>
<td>1520</td>
<td>-</td>
<td>1550</td>
<td>1590</td>
<td>1650</td>
<td>1725</td>
</tr>
<tr>
<td>Bajra</td>
<td>980</td>
<td>1175</td>
<td>1310</td>
<td>1250</td>
<td>1275</td>
<td>1330</td>
<td>1425</td>
</tr>
<tr>
<td>Maize</td>
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<td>1175</td>
<td>1310</td>
<td>1310</td>
<td>1325</td>
<td>1365</td>
<td>1425</td>
</tr>
<tr>
<td>Ragi</td>
<td>1050</td>
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<td>1500</td>
<td>1550</td>
<td>1650</td>
<td>1725</td>
<td>1900</td>
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<td>Wheat</td>
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<td>1525</td>
<td>1625</td>
<td>1735</td>
</tr>
<tr>
<td>Barley</td>
<td>980</td>
<td>980</td>
<td>1100</td>
<td>1150</td>
<td>1225</td>
<td>1325</td>
<td>1410</td>
</tr>
</tbody>
</table>
Model for Analysis

We use standard consumption model to calculate expenditure shares of each of the concerned nutri-cereals in the consumption basket. In this model, we assume that households are going to spend their entire budget allocation on cereals and their preferences are determined by this utility function:

\[ U = W^a \times R^b \times B^c \times J^d \times R^a \]

Here, the multiplicative components together represent the consumption basket that varies across households.

W: Wheat
R: Rice
B: Bajra
J: Jowar
Ra: Ragi

Further, the superscripts for each cereal represent the preferences of each cereal in the consumption basket for each household. Therefore, \(a, b, c, d\) and \(e\) are the preferences of each cereal in the consumption basket. Technically these equivalent to the shares of expenditure on corresponding cereal in the consumption basket. For example, if a household is going to spend ₹100 on cereals it will spend \(a\)% on wheat, \(b\)% on rice and so on and so forth. Please note that these superscripts are constants i.e. that they are same for all households in Maharashtra. This is a purely statistical assumption to help us calculate average estimates.
According to the aforementioned model, we derive the following equilibrium conditions that will form the basis for the statistical analysis that will lead us to extract the preference constants mentioned above. Following are the equilibrium conditions:

\[
P_w \times W = \frac{a}{a + b + c + d + e} E
\]

\[
P_R \times R = \frac{b}{a + b + c + d + e} E
\]

\[
P_B \times B = \frac{c}{a + b + c + d + e} E
\]

\[
P_J \times J = \frac{d}{a + b + c + d + e} E
\]

\[
P_{Ra} \times Ra = \frac{e}{a + b + c + d + e} E
\]

Here \( E \) is the total expenditure by a household on all cereals. It can be interpreted as budgetary allocation by households on cereal expenditure. We first compute these expenditure shares and use them to calculate the quantities of consumption for various PDS prices. In order to do so, we run econometric regressions on the NSS data.

The Tobit model concerns censoring at zero (which is without loss of generality) and consists of two core assumptions:

1. \( y_i = \max (0, X_i \beta + u_i) \)
2. \( u_i \sim N (0, \sigma^2) \)

This is also be expressed in the terminology of latent \( y^*_1 \) as

\( y^*_1 = X_i \beta + u_i \) and \( y_i = \max (0, y^*_1) \).

We use this specification of Tobit model in our analysis as this one kind of a limited outcome model. We prefer it over the standard regression model as there is a significant amount of censoring in the NSS data. This censoring is assumed to be caused by no supply of some cereals where those households are situated. In other words, although some households would optimally want to consume positive quantities of any nutri-cereals, their consumption in the data is 0 because there is no supply of that specific nutri-cereals in that area. This is a reasonable assumption as there is very unequal production of nutri-cereals in Maharashtra (see Figure below) and the total production itself is very low.
We next calculate the Quantity that would be required for distribution at PDS shops for the computed preferences or expenditure shares. This follows from:

\[ \text{Price} \times \text{Quantity} = \text{Expenditure}, \text{Therefore, Quantity (} Q_n \text{)} = \frac{\text{Expenditure}}{\text{Price}} \]

We thus develop the matrix for quantities; Varying the price across cereals, we generate Table 4 for observation.

In order to calculate the investment that would be required for the introduction of Nutricereals in PDS, we need to first understand the various prices associated with PDS.

We observe the following relationship between the various prices;
Market price > Procurement Price > MSP >> FPS Price, where

MSP = Price set by govt. as a support to avoid distressed sale and provide security to the producer.

Procurement Price = Price at which the Government (State or Central) procures various
FPS Price = Price at which cereal is sold to ration card holders
We choose the Average Modal Price to compute the various investment scenarios for this policy at different PDS prices. The choice of Average Modal Price is justified as follows:

Typically, the modal price can be assumed to be representative of the most common type of quality of the agriculture produce available at the market at any time. Thus, we choose this price using the main equation for these estimations as:

\[ I = (AMP - P_{PDS}) \times Q_n, \]

where notation is as follows:

- \( I \) is the funds needed/investment required
- \( AMP \) is the average modal price for each year at which the gov. will procure these grains
- \( P_{PDS} \) price is the price which is charged for the grain at the FPS shop
- \( Q_n \) is the quantity of each grain that is allocated for distribution

This is followed by a computational task across different price vectors, PDS prices and Q to give Table 5.

**Code for Analysis**

The code was run on a Licensed Stata System.

```
cd "C:\Users\31237\Downloads\NSS_Data"
clear
set more off
use "lev5"
edit
gen state_code = substr(commonid, 16, 2 )
keep if state_code == "27"
drop okstamp filler blank
destring itemcode hpqty hpval totalqty totalval mlt state_code nss nsc, replace
drop if itemcode > 129
tab itemcode
gen hh_id = substr(commonid, 9, 27)
sort hh_id
```
order hh_id, after(commonid)
drop commonid

gen weight = mlt/100 if nss == nsc
replace weight = mlt/200 if weight == .
drop nss nsc mlt

reshape wide hpqty hpval totalqty totalval sourcecode weight, i(hh_id) j(itemcode)
tab totalval121

replace totalval101 = 0 if totalval101 == .
replace totalval102 = 0 if totalval102 == .
replace totalval107 = 0 if totalval107 == .
replace totalval108 = 0 if totalval108 == .

/////Generating district codes and district names/////
gen dc = substr(hh_id, 11, 2)
order dc, after(hh_id)
sort dc
encode hh_id, gen(hh_num)
destring dc, replace
gen district = "nandurbar" if dc == 1
order district, after(dc)

replace district = "dhule" if dc == 2
replace district = "jalgaon" if dc == 3
replace district = "buldana" if dc == 4
replace district = "akola" if dc == 5
replace district = "washim" if dc == 6
replace district = "amravati" if dc == 7
replace district = "wardha" if dc == 8
replace district = "nagpur" if dc == 9
replace district = "bhandara" if dc == 10
replace district = "gondiya" if dc == 11
replace district = "gadchiroli" if dc == 12
replace district = "chandrapur" if dc == 13
replace district = "yavatmal" if dc == 14
replace district = "nanded" if dc == 15
replace district = "hingoli" if dc == 16
replace district = "parbhani" if dc == 17
replace district = "jalna" if dc == 18
replace district = "aurangabad" if dc == 19
replace district = "nashik" if dc == 20
replace district = "thane" if dc == 21
replace district = "mumbai suburban" if dc == 22
replace district = "raigarh" if dc == 24
replace district = "pune" if dc == 25
replace district = "ahmadnagar" if dc == 26
replace district = "bid" if dc == 27
replace district = "latur" if dc == 28
replace district = "osmanabad" if dc == 29
replace district = "solapur" if dc == 30
replace district = "satara" if dc == 31
replace district = "ratnagiri" if dc == 32
replace district = "sindhudurg" if dc == 33
replace district = "kolhapur" if dc == 34
replace district = "sangli" if dc == 35

/////////////////////////////////////

gen rice_value = totalval101 + totalval102
gen rice_qty = totalqty102 + totalqty101
gen wheat\_value = totalval108 + totalval107

\[ \text{gen wheat} \_\text{qty} = \text{totalqty108 + totalqty107} \]

egen total\_exp\_cereals = sum(weight129*totalval129)

egen total\_households = sum(weight129)

sort dc

class: egen districtwise\_exp\_cereals = sum(weight129*totalval129)
class: sum(weight129)

regress wheat\_value totalval129, noconstant vce(bootstrap)

\\\[a = .3688///OBS = 7798///\\

replace totalval121 = 0 if totalval121 == .

capture program drop mytobit

program define mytobit

args \lnf\ xb

local y "$\_ML\_y1"

quietly replace \`\lnf\' = 0.5 if \`y\'==0

quietly replace \`\lnf\' = \ln((1/20)*\normalden((\`y\' - \`xb')/20)) if \`y\'>0

end

ml model lf mytobit (totalval121 = rice\_value, nocons)

ml maximize

drop _ML\_tua1

tobit totalval121 wheat\_value, ll(9) vce(bootstrap)

\\\[c/a = .28376///\\

//Therefore \(c\) (RAGI SUBSTITUTION)= .1046///OBS = 125///

regress rice\_value totalval129, noconstant vce(bootstrap)

\\\[b = .3512///OBS = 7798///\]
tobit totalval121 rice_value, noconstant vce(bootstrap)
///c/b = .30261//
//Therefore c (RAGI SUBSTITUTION) = .1062///OBS = 125///

tobit totalval115 wheat_value, noconstant vce(bootstrap)
///d/a = .5253//
//Therefore d (JOWAR SUBSTITUTION) = .1937///OBS = 3520///
tobit totalval115 rice_value, noconstant vce(bootstrap)
///d/b = .671766//
//Therefore d (JOWAR SUBSTITUTION) = .2359///OBS = 3520///

tobit totalval116 wheat_value, noconstant vce(bootstrap)
///e/a = .30541//
//Therefore e (BAJRA SUBSTITUTION) = .1126///OBS = 1392///
tobit totalval116 rice_value, noconstant vce(bootstrap)
///e/b = .35082//
//Therefore e (BAJRA SUBSTITUTION) = .1232///OBS = 1392///

tobit totalval117 wheat_value, noconstant vce(bootstrap)
///f/a = .1680//
//Therefore f (MAIZE SUBSTITUTION) = .0619///OBS = 60///
tobit totalval117 rice_value, noconstant vce(bootstrap)
///f/b = .26851//
//Therefore f (MAIZE SUBSTITUTION) = .0943///OBS = 60///

gen ragi_exp = .1046*total_exp_cereals

gen jowar_exp = .1937*total_exp_cereals

gen bajra_exp = .11*total_exp_cereals
gen maize_exp = .06*total_exp_cereals

gen ragi_exp_districtwise = .1046*districtwise_exp_cereals

gen jowar_exp_districtwise = .1937*districtwise_exp_cereals

gen bajra_exp_districtwise = .11*districtwise_exp_cereals

gen maize_exp_districtwise = .06*districtwise_exp_cereals

order district, before(total_exp_cereals)

*******************************************
/////////working with production data/////////
/////to characterise the supply side distribution of crops////
*******************************************

cd "C:\Users\31237\Downloads"
set more off

clear

//Importing production data from apy and cleaning it for maharashtra district wise
//to calculate total nutri cereals production.;////
//Please NOTE THAT THIS PRODUCTION DATA IS IN TONNES//
import delimited "APY_1997_2018"
edit
keep if state == "Maharashtra"
keep if crop == "Maize"|crop == "Ragi"|crop == "Jowar"|crop == "Bajra"

destring(production), replace
sort statecropdistrict year
rename statecropdistrict District
replace District = lower(District)
replace District = "mumbai" if District == "mumbai suburban"
keep if crop == "Ragi"
cumul production, gen(probR)
line probR production, sort
gen year_from = substr(year, 1, 4)
order year_from, after(year)
gen year_to = substr(year, 6, 7)
order year_to, after(year_from)
destring(year_from), replace
drop if year_from < 2008

cumul production, gen(probR_08)
line probR_08 production, sort
///The above sum of nutri cereals produce does not include Maize///
order Nutricereals_except_Maize, before(total_nutri)

********************************************************************************

///////////THE END FOR PRODUCTION////////

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About ISB

ISB is a premier management institution established in 2001, in association with Kellogg School of Management, The Wharton School and the London Business School. In just a few years, ISB has successfully pioneered several new trends in management education in India, and has established itself as a leading B-school across the world. ISB has a strong pool of research-oriented resident faculty and invites high calibre international faculty from reputed B-schools to teach in its Post Graduate Programme in Management, Executive Education Programmes, Post Graduate Programme in Management for Senior Executives, and also to participate in collaborative research with the resident faculty.