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India's Diabetes Epidemic: How Colonial Food Policies and Agricultural Modernization Inadvertently Replaced Healthy Millets with High-Glycemic Rice and Wheat

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Abstract - The diabetes pandemic in India, which covers more than 77 million adults by 2025, is not just a contemporary lifestyle illness. This paper traces the origins of this health crisis by analyzing colonial-era famine management policies and post-independence agricultural modernization programs that actively displace the varieties of traditional grains in India with a rice-wheat duopoly. This paper, through the analysis of literature on the history of British famine, nutrition science, and socioeconomic statistics, demonstrates how British policies of famine management, which were influenced by administrative efficiency, but not nutrition, led to a one-hundred-year dietary revolution. The Green Revolution, which was successful in averting starvation, intensified this grain consolidation with the processes of institutional lock-in. The metabolic consequences are profound refined wheat and polished rice have glycemic indices 30-40 points higher than traditional millets (70-80 vs. 50-55), and the results directly lead to insulin resistance. The change removed the sources of dietary fiber, enhanced the deficiencies of micronutrients, and perfectly matched the metabolically susceptible Indian thin-fat phenotype. Although the thin-fat phenotype is an indicator of a population-wide tendency, there is individual variation such that not all Indians become diabetic despite being subjected to high-glycemic diets. However, population statistics indicate that the South Asians as a population group have metabolic effects of their diet choices at a lower threshold than other groups. The article is a synthesis of historical policy research, nutritional biochemistry and implementation plans, which provides evidence-based solutions to dietary paths that individuals, communities and policymakers can use to revert this trend. These results prove that the diabetic epidemic in India is not a riddle or even a fate that is destined to happen but the logical consequence of certain, fixable policy choices that focused on the ease of administration rather than on nutritional prudence.

Keywords: Diabetes epidemic India, Colonial food policies, Millet nutrition, Green Revolution impact, Glycemic index comparison, Dietary transformation, Agricultural biodiversity loss, Metabolic health outcomes.

1. METHODOLOGY

The present paper has used a multidisciplinary approach of synthesis that incorporates:

- Policy analysis of historic documents of famine management in the colonial period, and agriculture policy records in the post-independence period.
- Data on nutritional biochemistry based on peer-reviewed databases such as the USDA Food data central and the Indian food composition tables.

- Epidemiological statistics of the International Diabetes Federation, WHO and Indian Council of Medical Research.
- Indian Ministry of Agriculture and Farmers Welfare agricultural statistics.
- Socioeconomic evaluation of the records of Public Distribution System and farm subsidy program.

The analysis follows causal routes of certain policy interventions on the agricultural production, dietary transformation and finally to health outcomes which are measurable.

2. INTRODUCTION

2.1 The Hidden Architecture of a Health Crisis

India is at a dismal junction in communal health. It has the second largest population with diabetes in the world after China as more than 77 million adults have diabetes. This figure is estimated to rise to more than 134 million by 2045 assuming that the same trends will be witnessed. These statistics are not mere abstract epidemiological statistics. They indicate millions of families facing lifetime health care costs, decreased output, avoidable complications and early death.

The traditional discourse blames this outbreak to the fast urbanization process, sedentary ways of living and genetic pre-dispositions. Although these are undoubtedly playing a role, they do not imply why the prevalence rate of diabetes in India has improved so drastically in comparison with other countries with similar trends in modernization. It is necessary to note that the complexity of the diabetes epidemic in India is explained by numerous factors, such as urbanization, more sedentary lifestyles, genetic factors, increased caloric intake, and consumption of ultra-processed foods. Although these causes are widely known, the present paper dwells upon a poorly researched factor: the replacement of healthy traditional grains with high-glycemic refined grains, which started more than 150 years ago and provided the precursors of the other risk factors nowadays.

The change was not a natural or accidental one. It was spurred by the policy decisions of British colonial masters who emphasized on the efficiency of famine-relief efforts and subsequently by post-independence strategists who put emphasis on the issue of food security all without minding the long-term metabolic implications. These policies essentially changed the food that Indians consumed as an extremely diverse grain staple was substituted by 2 crops rice and wheat. This oversimplification brought efficiency in administration and, subsequently, food security. It was, however, metabolically expensive, which is today reflected in a diabetes, cardiovascular disease and metabolic syndrome epidemic.

In pre-colonial India, dozens of varieties of grains were consumed based on the local climatic conditions, soils and water. In Karnataka and Tamil Nadu Finger millet (ragi) predominated. Pearl millet (bajra) was cultivated in dry areas of Rajasthan. Maharashtra and northern Karnataka were fed on sorghum (jowar). Foxtail millet, barnyard millet, kodo millet and little millet occupied different ecological and gastronomic niches. This diversity was not just a variety of agriculture but it embodied the millennia of nutritional wisdom in the regional food cultures.

The management policies of the colonial famine, which started in the middle of the 19th century, started the process that would eventually destroy the diversity. The British administrators faced a real dilemma as to how to nourish millions of people in a geographically expansive land when famine hit the country on a regular basis. The answer was to standardize food supply on the basis of grains which could be centrally

acquired, held up in granaries, and dispensed by a system of colonial ration. These administrative needs were fulfilled by rice and wheat. Local millets, which changed after every 50 kilometers did not.

Fig –1: India's Diabetes Epidemic

Government procurement policies, ration systems and agricultural support mechanisms were designed over a hundred years, between 1850s and 1950s, to favor rice and wheat and disfavor traditional grains. Farmers acted in a rational manner to market indicators. The disadvantaged communities that relied on government food allocation were forced to adjust to their diets. Millets became linked with utter poverty, that is only taken by people who do not have access to government support.

This trend was inherited and enhanced in post-independence India. Although it averted mass starvation, the Green Revolution of the 1960s and 1970s structured whole agricultural research and support systems around high pointing varieties of rice and wheat. The Public Distribution System increased colonial ration systems, and gave subsidized rice and wheat to hundreds of millions without providing any similar aid to traditional grains. All economic incentives, institutional infrastructure and cultural perceptions were in place to solidify rice and wheat domination.

The nutritional impact of this metamorphosis can now hardly be ignored. White rice with a polish has a glycemic index of 70-80 and this results in a rapid rise of blood sugar levels, which over the decades results in insulin resistance and type 2 diabetes. Millets, which have a glycemic index of 50-55, have slow glucose release, which safeguards metabolic wellness. Rice has a low percentage of 1 percent dietary fiber. Millets contain 8-12%. Rice contains little micronutrients following polishing. Magnesium, iron, calcium and B-vitamins that are vital in the metabolic process are supplied by the millets.

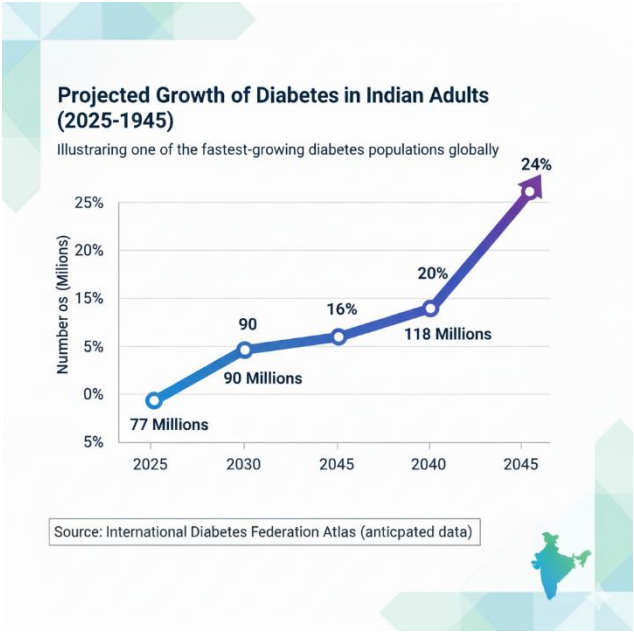

Fig -2: Projected Growth of Diabetes Prevalence in India (2025-2045).
Source: International Diabetes Federation Diabetes Atlas, 2024.

The graph illustrates the dramatic increase from 77 million adults (2025) to a projected 134 million (2045), representing one of the fastest-growing diabetes populations globally.

This change coincided with the fact that Indians became metabolically susceptible because of the thin fat phenotype in which people are normal in body mass index but are storing the harmful visceral fat. Studies have shown that South Asians would get diabetes at the 23-24BMI which is much lower than the 30+ BMI at which other groups would develop diabetes. This metabolic vulnerability is ideally used by a diet that is founded on refined high-glycemic grains.

The political and economic aspects make the health crisis more complex. The amount of water used as a result of rice production per kilogram of rice is 3,000-5,000 liters, which burdens the aquifers of Punjab and Haryana. With 250-400 liters of water, millets use more than 90 per cent less water. India is reported to spend about 30billion a year treating diabetes, and on a family-to-family basis, the lifetime expenses are about 10,000-50,000 incurred by the family of a patient. The poor are disproportionately affected by these economic burdens as a result of a disease that can be prevented to create poverty traps.

This article explores the way certain policy choices have led to the diabetes epidemic in India and more so how evidence-based interventions can turn-around the trend. The discussion takes place in various dimensions that are interrelated. To begin with, we follow the historic pathway through which the management of colonial famine and modernization of agricultural technology in post-independence achieved dietary transformation. Second, we examine nutritional biochemical associations between this dietary change with metabolic disease. Third, we look at the social, cultural, and economical forces that strengthened these changes. Lastly, we provide practical, implementable solutions to the individuals, communities, and policymakers to restore nutritionally superior traditional grains in the modern Indian diets.

The vested interest goes beyond personal well-being. All the generations brought up in monoculture of refined grains are at high risk of diabetes. The scarcity of water will result in the fact that the rice production will be impossible in numerous areas in decades. Agricultural diversity is required by climatic change, which is not present in the current systems. The ancient learning involved in the cultivation, processing and preparation of various types of grains is fading away. Action must be taken before it is too late, and it can be turned back.

3. OBJECTIVES

This paper has a number of interrelated goals that, when brought together, shed light on the connection between historical policy on food and modern day metabolic health in India. The study will further the academic knowledge on how macro-level policy choices have been transformed into macro-level health trends hence serve as a blueprint on policy analysis and formulation in the nutritional epidemiological domain.

The main aim is to develop a causal model, which will connect the British colonial policies of famine management and the post-independent policies of agricultural modernization programmes to the existing diabetes epidemic. This involves transcending correlation to show how policy intervention of a particular sort induced systematic dietary alterations which, subsequently, had foreseeable metabolic effects. The analytical approach combines the policy documents of the archives, agronomic yield statistics, nutritional biochemistry, and epidemiological surveillance information to form a logical chain of causation.

The second goal is to measure the nutritional variability of the traditional millet-based diets versus the modern day rice-wheat duopoly. The quantification is more than the traditional nutrient tables as it studies glycaemic indices, soluble fibre, insoluble fibre and micronutrient density, protein quality indices and metabolic responses. The biochemical explanation explains the significance of dietary change in diabetes prevalence especially in light of the unique metabolic nature of South Asian communities.

The third goal is to follow the social and cultural processes that supported changes that were originally promoted by policies. It was government policies which began the dietary change, but social processes maintained it and extended it. This involves the analysis of how rice and wheat came to be aspirational symbols of modernity and prosperity and millets were demonized as retrogressive. Also, it records the loss of traditional knowledge about millet cultivation, processing, and preparation and this in turn established viable obstacles to dietary diversification despite growing awareness of the benefits of a healthy diet.

The fourth goal deals with the economic and environmental aspect of grain choice. This includes estimating the actual costs of rice production, which will include water use, soil erosion, and climate risk, and will show that the process of millet production is economically viable in arid and semi-arid areas. It also examines healthcare expenditures on diabetes and the distribution of the burdens at the socioeconomic classes.

The fifth goal is practical by nature the elaboration of the strategies of diet change at the levels of individuals, communities, and policies. This goes beyond problem definition to solution design and presents tangible, tried and tested methodologies that take into consideration real obstructions whilst offering a clear sense of direction. The strategies should be scalable, culture relevant, economically viable and able to deliver quantifiable health outcomes.

Lastly, this paper will attempt to reposition the diabetes epidemic as an unavoidable, rather than a necessary, by-product of the modernization process. This retracing has both political and psychological implications. In case diabetes is caused simply by a genetic predisposition or the uncontrollable urbanization, intervention strategies seem to be few. When, on the other hand, it is a consequence of the policy choices regarding the support of agriculture, food subsidies, and nutrition education, the policy choices may cause other outcomes.

All of these aims serve a bigger thesis that India and its food system and, consequently, its metabolic health outcomes are not natural or unavoidable but are shaped by policy decisions made by them that are reproducible by other decisions. The grain variety that cushioned the metabolic health over millennium was condemned by intentional activity, but could be reinstated with intentional activity under the guidance of nutritional science, agricultural sustainability and economic justice.

4. CURRENT TRENDS

By 2025, the relationship between India and traditional grains and metabolic health can be described by a set of interconnected trends which is an indicator of both challenges and opportunities.

The most threatening tendency is the increase of the diabetes prevalence. Currently, it has been estimated that, in India, there are 77 Millon adults with diabetes which is about 11 per cent of the adult population. Nevertheless, this value covers a lot of difference. In urban areas, the prevalence rates are 14-16, and those in rural areas are 6-9. Prediabetes, which is defined by the impaired tolerance to glucose, is present in 77 million more Indians, which is a population facing the threat of developing full diabetes.

The demographics are showing alarming changes in the development of diseases. India has recorded a reduction in the average age of diabetes diagnosis, which was 50s in 2000 to 40s in 2025. Cases are on the rise in the 30s and even later 20s of age in a population that is supposed to be metabolically healthy. Early diabetes has its own importance in that, the complications of diabetes, such as cardiovascular disease, kidney failure, neuropathy are positively correlated with the time of disease and therefore increase exposure to hyper glycaemia and hasten disease complications.

The financial cost also increases. The annual expenditures on diabetes and its complications by government healthcare total up to USD>30billion and take a growing portion of the entire health budgets. Catastrophic costs are experienced in individual families. A patient with diabetes will have to take up constant medication, watch his glycaemia levels, meet with his doctor regularly, and deal with complications. During the course of the lifetime, the cost of these conditions is between USD 10,000 to USD 50,000 and above depending on the complex cases necessitating hospitalization, dialysis, or cardiovascular surgery. These costs cause catastrophic financial pressures to the families with an annual land income of USD3000-5000.

At the same time, the level of awareness of millet nutrition has grown several notches higher. The portrayal by the government of the 2023 as the International Year of Millets raised the level of awareness. The millet benefits are regularly covered by the news media and social media platforms are active communities where millet recipes are shared and information about millet is sourced. Traditional eating of grains is promoted by celebrity chefs and nutritionists. This increased awareness has been a big shift considering that ten years ago, millets were almost unfamiliar among the discourse of urban food.

The infrastructure to trade millets in the market has started to build, but it is on a very low level. Organised retail chains now have finger millet flour, pearl millet and sometimes other varieties. Online shops have an extended variety of products including exclusive millets like foxtail, barnyard and kodo. New organizations have sprung up that make convenience foods based on millet: breakfast cereals, instant mixes, ready-to-eat snacks, and even millet pasta. Although these products have high prices and target urban and educated buyers mostly, they indicate the emergence of market viability.

There are slight yet significant gains of millet production in agricultural statistics. Millet-planted area leveled off at about 2015, and has increased at an average of 35 per cent/year since 2020. This is centred on the states like Karnataka, Maharashtra and Rajasthan where millet traditions were still relatively stronger. However, the percentage of millets in total production of grain remains less than 10, against rice and wheat which have more than 85 percent.

The government policy has shown a wavering shift towards favoring the traditional grains. Some states have included millets in mid -day meal programmes and thus exposing schoolchildren to these grains. In some areas, the agencies that carry out procurement buy millets to farmers, but on comparatively small quantities to rice and wheat. Funds have been channeled to the research institutions to come up with better millet varieties and processing technologies. It has also implemented the Minimum Support Price mechanism or price floor on agriculture products, where farmers are assured of a minimum price on some of their millets in selected areas.

The benefits of millet are still recorded in nutritional research. The publications released in 2025 show that the regular intake of millet leads to the better glycaemic control in diabetic patients, decreases the cardiovascular disease biomarkers, helps to maintain the weight, and mitigates the micronutrient deficiencies. The clinical trials demonstrate that the substitution of rice with millets at least two meals a week brings significant changes in the level of HbA1c, which is the most important indicator of the diabetes process. This body of evidence supports the scientific rationale of diet diversification.

There are some interesting trends in urban-rural dynamics. As opposed to urban populations with greater prevalence of diabetes, rural populations with traditional diets (i.e. millets) have lower prevalence even though they share the same genetic background. This is a natural experiment that is giving strong arguments in support of diet as a determinant rather than genetics alone on the risk of diabetes. Ironically, the rural to urban migration tends to be associated with dietary changes in place of millets to rice and wheat, which may be the reason behind the high diagnosis of diabetes in urban areas.

Some of the traditional staples had been rice and wheat in some areas long before the intrusion of the colonialists such as rice in Bengal and Assam and wheat in Punjab and northern India. The nutritional change discussed here was felt mostly in the areas where millets had been the traditional fare, particularly the Deccan plateau, Karnataka, Maharashtra, Rajasthan, and some areas of Madhya Pradesh. It is during this homogenization of the diet that these regional patterns were superseded by a country-wide homogenous dieting of rice and wheat in the form of a duality.

The convenience food industry, nevertheless, is still dominated by rice and wheat products. Rice or wheat is used in packaged foods, restaurant meals, street food and fast food almost everywhere. Among the urban professionals who are time constrained, there is seldom a option of default food including millets, which inhibits a change in diet whether unwittingly or intentionally.

Online platforms and social media have established novel knowledge share systems. Thousands of videos on the method of cooking millet can be found on YouTube, WhatsApp chats share recipes and sourcing

data, Instagram influencers talk about the need to cook with millet. These media in part address the knowledge loss between generations that has been created by the vanishing of the millets in kitchens.

The effects of climate change make the process of cultivating rice more challenging in a number of areas. The increase in temperature, unpredictable rains and groundwater shortages have posed a danger to rice production in the conventional fields. The farmers in water-stressed areas know that rice could become non-viable in 10 years or so. This opens up possibilities of drought-resistant crops like millets, but institutional support systems are not up to date with climate reality.

There is mixed participation in educational institutions. Traditional grain nutrition is now taught on some medical and nutrition programmes, training medical practitioners to offer evidence-based nutrition advice. Still, a great number of institutions are oriented on Western nutrition models which are insufficiently concerned with Indian eating habits and metabolism.

Millets cost dynamics are complicated. Unsubsidized prices of millet are usually higher than rice prices, especially where the production of millet is low. This price difference is a manifestation of lack of agricultural subsidies, procurement guarantees and economies of scale favorable to rice and wheat. However, in areas where millet farming is practised, the price may be competitive particularly where environmental costs are internalized.

Millet promotion has started to be organised around farmer organisations and cooperatives. Through these organisations, farmers are able to access good quality seeds, knowledge in farming, pooling production to gain better markets entry and sometimes to process millets which would fetch a higher value. Although these organisations are small, they present possible economic models of millet farming.

There is increased interest among the international communities regarding millets. Climate-smart crops such as millets have also been identified as food security crops by the United Nations Food and Agriculture Organization that are important in the changing climatic conditions. The international recognition helps in the promotion of millet domestically and encourages the research funding and technical support.

All these trends are indication of a transitional system. The rice-wheat monoculture continues to dominate with the health and environmental costs. Nevertheless, the levels of awareness, market infrastructure, policy support, and agricultural interest in millets are all increasing on low levels. Its future is positive and unpredictable. The question remains open whether these nascent trends can be accelerated into any significant dietary change, based on intentional actions on several levels: individual attitude, societal response, market evolution, and policy change.

5. THE GREAT GRAIN CONSOLIDATION: COLONIAL ENGINEERING OF INDIAN DIETS

To comprehend the modern food habits in India, it is necessary to look at the historical events that have given rise to it. The duopoly of rice and wheat that now occupies Indian plates is not a natural and traditional formation. It is the result of particular policy actions that were initiated in the middle of the 19 th century and were speeded up in the 20th century.

The Indian pre-colonial period was characterized by phenomenal farming and diet variety. Food cultures of a region were developed due to the millennium-long adjustment to the environment of the region. In Karnataka and some parts of Tamil Nadu, the Karnataka staple was finger millet (ragi). The grain grew in the red soils of the area and gave it a nutritional value that kept the agricultural workers alive by engaging them in heavy labor. Pearl millet (bajra) was the most common food in western India and Rajasthan. This

was a tough grape that withstood a lot of heat and was not very sensitive to rain and thus suitable to desolate areas. Maharashtra and the north of Karnataka were dependent on sorghum (jowar) that flourished in the black cotton soil of the Deccan plateau.

In addition to these large millets, tens of smaller types occupied a local ecological niche. Foxtail millet, barnyard millet, little millet and kodo millet were used in areas that had poor soil or scarce water or unfavorable climatic conditions that could not support the growth of other crops. This did not happen by chance, as it was an expression of advanced agricultural expertise regarding which crops were appropriate in each situation. Farmers knew the soils, monsoons, how much water was needed and the resistance of pests at the granular level that even today, agronomists have only been re-discovering by scientific research.

Food variety reflected agronomical variety. The process of food preparation developed to make use of grains with the greatest nutritional value and flavor. Ragi mudde in Karnataka, bajra rotis in Rajasthan and jowar bhakri in Maharashtra, were the culinary traditions, which were constructed on the basis of local delicacies. These were neither poverty food nor poor alternatives. They were local favorite foods, which were evolved through generations to meet the local demands and nutritional requirements.

British colonial administration faced this diversity as an administrative issue in the frequent famines of the 19th and early 20th century. Famines of 1770, 1783, 1866, 1873, 1892, 1897, and 1899-1900 killed millions of people and brought about humanitarian crises that undermined the legitimacy of the colonialists. The British reaction meant that they established famine relief mechanisms that had the capacity of feeding masses of people whenever there was a crop failure.

The logistical issue was enormous. Millions of people on hundreds of thousands of square miles of 19th century transportation and storage infrastructure was incredibly hard to feed. This was exponentially increased by the variety of Indian grain consumption. In case each 50 kilometers had various staple grains, it would require a complete famine relief system to purchase, store, transport and deliver hundreds of varieties of grain. This could not be with the infrastructure that the colonial administrators had.

This was solved through systematic simplification. The British policies concentrated government procurement on only two grains which comprised of rice and wheat. These grains would be deposited in central granaries, they would be transported on the developing rail systems and would be distributed on standardized ration systems. Rice was used as the dominant commodity in eastern and southern India and wheat was used as the dominant commodity in the northern India. Local tastes determined the grain to be marketed in a particular area, but the idea was the same; the variety of local grains was substituted by homogenous staples that could be easily managed by the centralized administration.

The government procurement generated strong market pressures. The farmers were able to sell rice or wheat to government agencies at assured prices. Conventional grains did not have similar markets. Economic actors were rational and reacted in a predictable way. Farmers who had the right land went to rice or wheat production due to the fact that the produce had guaranteed income. The ancient grain production was affected because the market demand faded away.

The ration system increased these dynamics at the consumption end. The government depots provided rice or wheat to the victims during famines and times of scarcity. The recipients did not have a choice on the type of grain. Gradually, the communities that never had contact with rice or wheat got used to these products. Children were used to eating ration rice or wheat never knowing of millets that their grandparents ate. The taste preferences changed across generations.

This transformation was best felt by poor communities. The more affluent families were able to afford various foods in the personal markets. The poor were dependent on government rations. To these families, rice and wheat were not only a staple but the only grain that they regularly had access to. Milliets only remained within the poorest sections of the most discriminated agricultural regions, those who were not in any way accessible to the system of government procurement and distribution.

This stigmatization between millets and extreme poverty was permanent. Normal grains which were a staple among the classes turned into symbol of poverty. The fact that one consumed millets was an indicator of not being able to access government support which in turn was an indicator of extreme poverty. This cultural shift would turn out to be incredibly sustainable and would last long after the driving forces of the economy shifted.

This went on slowly, through a period of approximately a hundred years, between the 1850s and the 1950s. The change in the crop farmers planted and the people consumed was a gradual change each decade. By 1947 at the time of Indian independence, the diet change was at an advanced stage. Colonial system of ration had been able to make the Indian food system very simple, whereby regional foods were substituted by standardized foodstuffs.

Importantly, nutrition was never seriously taken into account in such decisions. The colonial administrators were concerned about administration efficiency in the delivery of famine relief instead of maximizing diets. The current metabolic consequences were entirely unintentional since in the 1850s-1940s no one knew that the type of grain we eat could influence the diabetes rates in 2150. They were tackling an administrative issue how to administer famine relief in an efficient manner using available resources and infrastructure. It was not expected that this solution would have metabolic implications on the future generation or not. The emphasis was on operational efficiency.

The side effect was severe and unintended. The various grains that were being taken off had a better nutritional value to metabolic health. Millets were better in terms of higher content of fiber, low glycemic rates, improved micronutrient levels, and high-quality protein compared to polished rice or refined wheat. These nutritional benefits have been developed over numerous millennia of agro selection within the Indian setting. The rejection of this nutritional wisdom in favor of administrative convenience preconditioned metabolic health problems, which would be experienced decades later.

6. THE GREEN REVOLUTION CEMENTING THE TWO-GRAIN ECONOMY

The consolidation of grain policy by the colonial rule was transferred to the independent India. In 1947, the Public Distribution System was based on colonial ration systems. The state purchasing remained centred on rice and wheat. Research institutions on agriculture, which followed the model of the Western templates, were geared towards these crops. The colonial trend carried forward to the post-independence era but is now encouraged by the Indian policy makers in search of national food security.

A watershed moment was the Green Revolution of the 1960s and 1970s that entrenched and solidified rice and wheat hegemony. To understand the reason, the desperate situation of that time needs to be looked into. India experienced real starvation by the middle of 1960s. Populometry had increased at a high rate and agricultural productivity had not increased. Food imports escalated. During the period 1965-66, the United States donated more than 10 million tons of wheat it was the PL-480 program in which approximately one-fifth of the Indian grain requirements were supplied by the United States. Such a dependency was unsustainable economically and embarrassing politically.

The Green Revolution brought salvation through technology. Developed agricultural research came with high yielding varieties of rice and wheat, which assured to increase production when used with irrigation, chemical fertilizers, and pesticides. Its technologies were work miracles. The production of wheat grew to 55 million tons in 1990 as compared to 12 million tons in 1965. Within the same time issue, rice production increased to 74 million tons as compared to 35 million tons. India became self-reliant in food production and it stopped relying on imported grains. This was a valid national victory that saved the widespread starvation.

Nevertheless, technologies of Green Revolution were crop-specific. Institutions of research came up with high yielding varieties of rice and wheat rather than millets. The resources were concentrated in the Indian Agricultural Research Institute and state agricultural universities as well as the International Rice Research Institute on the enhancement of rice and wheat. Similar studies were not subjected to finger millet, pearl millet or sorghum. The research distribution was related to the global agricultural priorities as well as the current prevalence of rice and wheat in the pattern of consumption in India.

The machineries of government policy were made to be structured based on Green Revolution crops. The Minimum Support Price regime which was intended to ensure that farmers receive minimum returns and receive incentives to produce was implemented in rice and wheat. These crops could be sold by farmers to the government procurement agencies at a guaranteed price irrespective of the market forces. Millets did not have such support. Market prices of millets varied with the weather and demand, which generated income uncertainty which the rice and wheat farmers never experienced.

Such dynamics were supported by subsidy programs. The fertilizer subsidies, which were expanding to absorb large shares of the agricultural budget, applied to all crops, but favored rice and wheat farmers more than any other farmers since they engaged in cultivation systems that were more intensive in fertilizers. Subsidies on irrigation pumps also gave preference to the cultivation of rice which is a heavily irrigated crop. Institutional lending to farmers who grow rice and wheat was offered under credit programs but those who grow millet were considered as marginal subsistence agriculturalists who were not worthy of being given formal credit.

The Public Distribution System also developed in an explosive way as it evolved into a food security program out of the rationing system developed due to the war. By 1990s, PDS had almost 300 million beneficiaries, and they distributed the subsidized wheat and rice in 500,000 fair price shops. The rice and wheat were not only made available but also artificially cheap through this system. These grains were sold to poor families at prices that were approximately half the market prices. Millets were not included under PDS so that consumers would obtain the traditional grains at full market prices and get subsidized rice and wheat.

The economic reason gave too much. A farmer in Karnataka might produce finger millet that was adapted to local soil and rainfall conditions or he could turn land under irrigated rice that was guaranteed to be purchased at Minimum Support Price. The rice choice was giving tremendously better returns. The same region might have a poor consumer who may purchase ragi at the market rate and also one who may purchase the subsidized rationed rice at a ration shop. Rice consumption was determined by economic rationality. They were not un-reasonable decisions, but it was entirely rational reactions to the incentives created by the policy.

Government agronomist advice to farmers was organized around rice and wheat that formed the basis of the agricultural extension services. The extension workers were trained on methods of growing rice and wheat, pest control, application of fertilizers and the choice of varieties. Their experience in millet farming

was low in that research institutions generated little knowledge to pass. Extension services may be able to provide advanced guidance on rice and wheat but not much on traditional grains when the farmers consulted them.

This was reflected in educational institutions. The agronomists, plant breeders and soil scientists were taught mainly on rice and wheat systems in the agricultural universities. Agribusiness generations came out with thorough knowledge of these crops and a shallow experience with millets. It formed a self-cycles mechanism: the lack of research resulted in the lack of knowledge, which resulted in the lack of educational material, which formed professionals who were not prepared to help with millet farming, which led to the disregard of research.

The effects on the millet farming were disastrous. The land area that was under millet farming has decreased steadily since the 1960s up to the 2010s. The area of finger millet reduced to an estimated 1 million hectares in 2015 as compared to an estimated 3 million hectares in the year 1960. Sorghum and pearl militant were similar. The farmers abandoned thousands of microclimate-specific and soil-specific millet varieties, which became extinct, as farmers ceased to plant them. This was a disaster in the agricultural biodiversity that had taken millennia to build.

Economies in the drylands that had been mostly led by millets remained stagnant. These regions such as much of Karnataka, Maharashtra, Rajasthan and Madhya Pradesh are typified by low rainfalls which are irregular and thus few or none of the irrigated rice crops can be grown. In the past, such conditions enabled the production of agriculture through millets. When the policy support and market demand changed to rice and wheat farmers in the dry land regions had two options either trying to produce water-intensive rice that was not suited to their location or produce millets with no policy aid.

The latter option was used by many farmers, which resulted in the massive extraction of ground water and the consequent depletion of the aquifer. Others left their rural areas and moved to the cities where they dropped farming altogether. The people who stuck to millet farming were now being left behind economically and were seeing rice and wheat farmers in the irrigated areas thrive as the government was supporting them but their own crops were not getting research efforts or buying bids.

The unequal distribution that this brought about in the region continues today. Punjab and Haryana which actively embraced the Green Revolution rice and wheat technologies realized fairly good agricultural revenues and rural wealth. Maharashtra, Karnataka and Rajasthan were dryland areas, inhabited by millets that were more suitable than wheat or rice, yet were agricultural backwaters. This difference in geographical policy of agriculture is what added to the inequality of overall development in the regions.

The green revolution was not a failure. It fulfilled its main mission to avoid mass starvation and make sure that India would be able to feed itself. The orchestrators of this change are worth commendation to prevent the apocalyptic humanitarian disaster. But the policy processes which made Green Revolution a success also fixed diets that had long-term metabolic effects. The achievement was actual and needed. The accidental health effects were also no less real and are now hard to deny.

The grain consolidation that started with the colonial policies of famine and had been fueled by modernization in Green Revolution was practically achieved by 1990s. More than 80 percent of the grain production and consumption were made up of rice and wheat. Millets survived in patches only but had been left behind economically, culturally and nutritionally. A whole generation of Indians had been raised to believe in rice and wheat as the usual rations and millets, when they knew them, as primitive residues of barbaric culture.

The institutional frameworks that underwent this trend such as research facilities, procurement infrastructures as well as PDS distribution channels were well-established. It would take a turn to challenge the strong path dependencies and vested interests. Grain traders, rice and wheat farmers, administrators of PDS, agricultural researchers, and food processing companies were interested in the status quo. The grain concentration was in full swing, the diabetes time bomb was in time mode, but the awareness of the relationship between these facts was still decades far.

It is also pertinent to mention that the visionaries of the Green Revolution such as an Indian scientist M.S. Swaminathan were literally at risk of mass starvation and were making rational decisions because of the technology and the pressing schedules that were at hand. The discussed metabolic side effects of the paper are something that the nutrition science of 1960s would not have predicted under any circumstances. They are unwanted side effects of policies that worked in the short term: in preventing famine.

7. THE METABOLIC PRICE UNDERSTANDING THE NUTRITION-DIABETES CONNECTION

The agricultural policy and food security were the main matters in the dietary change of the variety of traditional grains to the prevalence of rice-wheat. Nevertheless, it's the greatest effect is seen in the metabolism of humans and within the trends of chronic diseases. To find out why this change in diet is causing diabetes, we will have to study the biochemical differences between traditional and modern grains and how these differences affect the Indian metabolic physiology.

This analysis is initiated by the glycemic index. The glycemic index is the rate at which a carbohydrate-containing food increases the level of glucose in the blood with the use of pure glucose whose index is 100. White rice which is the variety most Indians eat is refined and it has a glycemic index of 70-80 depending on the type and how it is prepared. This implies that rice increases blood sugar almost equally fast as pure glucose. Extraction flour (maida) used in bread, biscuits and most processed foods has a GI of 65-75, which is equally troublesome to the regulation of blood sugar.

This is opposed to the traditional millets. The glucose index of finger millet is 50-55. Pearl millet ranges from 55-60. The foxtail millet is rated at about 50. The GI of barnyard millet is about 50. Little millet ranges from 50-55. Such distinctions are not insignificant. A difference of 20-30 points in the glycemic index is translated into extremely differing metabolic responses.

Blood glucose spikes faster when an individual takes high GI foods such as white rice. Pancreas reminds this by secretion of high concentration of insulin to carry glucose in blood into the cells. The result is a sudden blood sugar surge and a fall because insulin causes the glucose to drop, frequently beyond healthy levels into hypoglycemia which then causes one to eat more. This rider is repeated with every high-GI meal.

This trend impairs metabolism over years and decades. The cells that are exposed repeatedly to high doses of insulin become insulin resistant meaning that increasing doses of insulin are needed to produce glucose uptake. To counter resistance, the pancreas labors more, secretion of insulin increases. Pancreatic beta cells eventually get exhausted and incapable of producing adequate insulin. The level of blood glucose is also high. This is type 2 diabetes.

Foods with low GI such as millets have completely different metabolic effects. The glucose gets into the blood stream at a slow pace resulting in smooth fluctuations in the sugar levels of the blood instead of sharp peaks. Secretion of insulin is moderate and maintained as opposed to short-lived and voluminous.

Insulin overexposure does not result in cell insulin resistance. The pancreatic beta cells operate under sustainable levels. The roller coaster turns into a surf wave.

Glycemic response is directly related to the fiber content of grains. Fiber slows down the speed of carbohydrate digestion and glucose absorption, which in effect reduces the glycemic index of food. Depending on the type, millets are 8-12% dietary fiber. Finger millet is between 11-12% fiber. Pearl millet has 10-11%. Sorghum contains 10-13%. This is the fiber content which makes them have low glycemic indices.

White polished rice has less than 1 percent fiber. The rice polishing procedure peels off the bran layer that contains the concentration of fiber and could be left with mostly starchy endosperm. Refined wheat flour also has no fiber since the bran of wheat is removed during the milling process. Indians who changed high-fiber millets to low-fiber rice and wheat have had a significant decrease in the fiber.

This losses of fibers have implications outside of glycemic control. Fiber is also known to induce satiety making individuals feel satisfied with less energy. The Indian diet, which was composed of millet fiber in large proportions, controlled the calorie level by default. Low-fiber modern diet offers a reduced satiety per calorie which leads to over-eating, and weight gain. Fiber is also good to keep the gut healthy by nourishing good bacteria. These bacteria form short-chain fatty acids enhancing the insulin sensitivity and decreasing inflammation. The loss of fibers destabilized gut microbiome composition in manners that favor metabolic malady.

Another important difference between modern and traditional grains is the content of micronutrients. Minerals and vitamins that are not present in polished rice and refined wheat are concentrated by Millets. Of special interest to diabetes is magnesium content. Finger millet has 300-350mg of magnesium per 100 grams. The content of pearl millet is 120-140 mg the content of sorghum is 150-170mgs the content of polished white rice is 20-30mgs per 100 grams. This is a one ten-fold difference of finger millet.

Insulin requires magnesium. It is a cofactor of the glucose metabolism and insulin signaling enzymes. Deficiency of magnesium has direct negative effect of insulin sensitivity leading to a higher risk of diabetes. Studies have proved the low prevalence of diabetes among populations with sufficient magnesium intake compared to populations with insufficient magnesium intake. This replacement of magnesium rich millets by magnesium poor rice developed massive magnesium deficiency that probably leads to the high rates of diabetes in India.

The same patterns are observed with B-vitamins. Compared to polished rice, millets are much more abundant in thiamin (B1), riboflavin (B2), niacin (B3) and folate. These are essential vitamins in the metabolism of carbohydrates. Direct effects of thiamin deficiency only affect the glucose metabolism. There are insulin secretion and insulin sensitivity roles of Niacin. The dietary conversion of B-vitamins probably impaired metabolic activity on the population level.

The millets are also differentiated by the iron and calcium content as compared to rice and wheat. Finger millet is also highly nutritious with 3-4 mg of iron and 300-350mg of calcium. Rice is low in iron of less than 1mg and calcium of 10-20mg. Although the deficit of iron and calcium does not lead directly to diabetes, the deterioration of the overall metabolous condition and the presence of these elements in the range of nutrition-related chronic diseases.

The quality and quantity of the proteins are important. Protein content of millets varies depending on variety, 7-12%. Finger millet has 7-8%. Pearl millet ranges from 10-12%. Sorghum contains 9-10%. Besides, the amino acid balance of millet protein is superior to that of rice protein. Rice is also a poor source of protein

with 6-7% protein content that has a low lysine content. The mills to rice protein reduction lowered the protein consumption in populations that were already taking moderate protein diets.

Increasing the amount of protein consumed is metabolically beneficial in several ways. Protein makes one feel fuller as opposed to carbohydrates or fats and helps regulate their calorie intake. Protein is also able to retain lean muscle mass, which is vital in glucose metabolism. The first place of the insulin-mediated glucose uptake is skeletal muscle. Muscle mass loss, a condition that develops when protein consumption is inadequate and the lifestyles are sedentary, limits the glucose clearance and increases the occurrence of diabetes.

The Indian thin-fat, phenotype provides an important dimension to why dietary change affects Indians especially disastrously. Scholars have reported that the South Asians have a unique pattern of body form. Indians have more body fat, especially visceral fat on the abdominal organs compared to the Europeans who have the same body mass index. This happens even in normal levels of BMI.

Visceral fat is active tissue which releases inflammatory sub-stances and free fatty acids which disrupt the insulin sensitivity. The thin/fat complex implies that Indians get insulin resistance and diabetes at even lower levels of BMI compared to other groups. Whereas Europeans normally develop the type 2 diabetes when BMI exceeds 30, Indians normally develop diabetes when BMI ranges between 23 and 25. This metabolic weakness implies the dietary composition is of more importance to Indians as compared to those less susceptible to visceral fat build-up.

Such a diet, which is based on high-glycemic, low-fiber, nutrient-poor rice and wheat ideally plays on this weakness. The insulin resistance is facilitated by the blood sugar spikes. The deficiency of fiber does not control the number of calories that will lead to the appearance of visceral fat, even in the cases when the total BMI is normal. The micronutrient deficiencies hamper metabolic activity. The protein deficit is one of the reasons of muscle loss. All the elements of the rice-wheat diet are compatible to trigger the genetic predisposition to diabetes that is encoded on the thin-fat phenotype.

Although the thin-fat phenotype is an indicator of a population-wide tendency, there is individual variation such that not all Indians become diabetic despite being subjected to high-glycemic diets. However, population statistics indicate that the South Asians as a population group have metabolic effects of their diet choices at a lower threshold than other groups.

On the other hand, the old fashioned diets that were based on millet saved against this weakness. Reduced glycemic indices inhibited the occurrence of insulin resistance. Large fiber content impregnated fullness and good body structure. High concentration of micronutrients helped in metabolic activity. Sufficient protein maintained muscle volume. The diet which was passed down orally over the millennia was not a random survival mechanism but one which had been tailored to meet the metabolic needs of South Asian peoples.

This form of adaptation was not in the conscious sense of scientific knowledge. Glycemic indices and insulin resistance were unknown in the traditional communities. They however, were aware by experience that some foods offered sustained energy, warded off hunger and was healthy. Societies that ate millets flourished and reproduced. Individuals who had a diet that could not sustain metabolic health experienced greater disease burden and reduced fitness. In thousands of years, this pressure of selection narrowed down diets that were considered to work well in the Indian metabolic physiology.

This fitness was disrupted by the nutritional revolution. The change in foods which preserved metabolic health to those foods which capitalized on metabolic vulnerability occurred within two or three generations. The effects were not direct and instant. The development of diabetes takes decades. The initial generation that mainly ate rice and wheat did not experience anything dramatic of a change to health. The second generation had high yet average diabetes rates. The fourth and fifth generations, completely oriented on high-glycemic diets since their childhood, experience the entire disastrous manifestation: diabetes at the age of 30s and 40s, not 60s and 70s.

This late presentation blurred the cause and effect relationship between eating policy and health outcomes. With the increase in prevalence of diabetes in 1990s and 2000s, the change of diet was final and taken as normal. Rice and wheat were not perceived as new foodstuffs that have possible health effects because they were considered as traditional foodstuffs. The real traditional foods; millets, were lost or discarded as primitive. This historical forgetting did not allow one to realize that the epidemiology of diabetes was the direct result of grain policy decisions made decades ago.

8. LIMITATIONS AND FUTURE RESEARCH

There are a number of limitations in this analysis. First, it puts more emphasis on grain selection and does not exhaustively discuss other dietary modifications including more sugar intake, ultra-processed foods, and changes in cooking oil that, also, cause the risk of diabetes. Second, the historical analysis is based on the existing policy documents, and it might not be able to capture the regional differences in implementation. Third, although biochemical pathways between high-glycemic diets and diabetes are well-known, the exact quantitative role of grain choice versus other factors is subject to future epidemiological studies, which would utilize and control dietary manipulation.

Future research should examine:

- There was a correlation between the prevalence of diabetes and the patterns of millet consumption by the region.
- Long-term research on metabolic performance of reintroduction programs of millet.
- Dietary diversification economic model of healthcare savings.
- Food diversity, cooking and identity formation Cultural anthropology of food choices and identity formation around grains.

9. CONCLUSION

The diabetes epidemic in India is not just a modern day societal health issue. It represents the metabolic long-term effects of the historical choices that radically changed the diet of Indians. This article has followed how the British colonial policies on famine management launched a planned grain concentration, where extraordinary dietary variety was substituted with rice and wheat supremacy. Although successful in terms of food security, modernization of agriculture after independence increased the transformation of agriculture institutions who marginalized the traditional grains. The consequences of this dietary change on metabolism are metabolically far-reaching and quantifiable. The white rice and refined wheat, which has been refined, have a glycemic index that is 30-40 times greater than that of the traditional millets, which is a direct cause of insulin resistance that is the hallmark of type 2 diabetes. The starch wastages which came with the grain consolidation interfered with the regulation of satiety and the well-being of the

gut microbiomes. Metabolic dysfunction was due to micronutrient deficiencies especially magnesium depletion. These biochemical alterations were combined with the thin-fat Indian phenotype which was genetically determined to produce a perfect storm of diabetes risk.

The existing trends demonstrate some challenges and opportunities. Prevalence of diabetes is on the steadily increasing but the onset age is dropping at a rate that makes the years of disease burden unending to the victims. The cost of healthcare is increasing at unsustainable rates, which results in poverty traps of the afflicted families. The consciousness of millet nutrition has however increased tremendously. Infrastructure in the market is growing. Policy support in spite of the limited one is positive. According to statistics on agriculture, there are slight growths in millet production following decades of its decline. The avenues of approach are on multiple levels. The action of individual persons, by little adjustments in their diet, such as the substitution of two meals per week by millet-based preparations, can lead to quantifiable health gains. Cooking workshops and purchasing cooperatives are community-level programs that overcome practical obstacles to achieve social momentum. Systemic incentives beyond the current favoritism of metabolically problematic foods can be moved by policy interventions, such as provision of millets in the Public Distribution System or Minimum Support Prices on traditional grains.

There are stakes beyond personal health which include water security, climate resilience, agricultural sustainability, and economic justice. The rice farming exploits aquifers in a manner that ensures occurrence of water crisis in future. The current patterns of cultivating rice will become unsustainable in most areas due to climate change. This system of agricultural assistance continues to create inequalities among regions where the drylands where millets are best adapted are marginalized. These are environmental and economic dimensions to support health arguments to change the diet. To address this challenge, one needs to be aware of history, knowledgeable on nutrition, and have practical implementation skills. Indians need to be made aware that the modern dietary trends are not traditional or deterministic but they are the result state of particular, reversible policy choices. Diversity of grains that secured metabolic health over millennia can be regained by equally conscious actions on individual, community and policy levels.

The last lesson is that it is not a secret or a genetic predisposition to empower the epidemic of diabetes in India. It is a product of dietary change which is designed by the policy. Various policies will have diverse effects. It has been demonstrated that the diversification of the grains, particularly the introduction of the millets into the rice-wheat blend, is a tested, feasible method of reducing the chances of diabetes, saving water, and minimizing climate exposure. A combination of the nutritionally better grain with the present day ones, especially the rice varieties, is a viable, achievable approach to not only reversing the trend of metabolic diseases but also to alleviating shortages of water and exposure to climate conditions and impoverishment of rural regions.

The time to act is now. All generations brought up on cultural monoculture of refined grains are at risk of diabetes. The ancient information concerning the millet farming and cooking are being lost. The current systems are lacking in agricultural diversity that would be required by climate change. Nevertheless, there are emerging tendencies of increased awareness and a new infrastructure. The diet revolution that accumulated in 150 years can be undone in the next generation with a conscious decision informed by historical knowledge and nutritional science. The personal decisions are summed up into cultural change. Systemic incentives are moved about by policy interventions. The plate decisions that are currently implemented define the health consequences over decades. Choose accordingly.

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