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Traditional Crops in Modern Food Systems: Preserving Heritage and Promoting Nutrition

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Introduction

«Dis-moi ce que tu manges, je te dirai ce que tu es.»

"Tell me what you eat and I will tell you what you are." - Anthelme Brillat-Savarin, Physiologie du Gout, ou Meditations de Gastronomie Transcendante (1826)[1]

We live in a unique period of human history. On one hand, we are producing more food than ever before for our entire species[2,3]; this is enabling food consumption at unprecedented levels. By 2030, over 1 billion people are estimated to be clinically obese[4,5]. At the same time, food shortages and malnutrition is also increasing sharply[6,7]. Despite global targets to eliminate hunger and malnutrition by 2030, over 349 million people currently face acute food shortages[8]. This dichotomy has become evident over the past three years. On one hand, countries with high rates of obesity have consistently shown high rates of mortality due to COVID-19 complications[9]. On the other hand, disruptions in international food supply, such as the war in Ukraine, have caused major food crises even in distant places across the world[10]. Coupled with human-induced climate change, such situations are likely to get worse[11].

Some of these problems have come from recent history. Over the past few generations, almost all societies across the planet have drastically changed their approaches to agriculture, food preferences and eating habits. Traditional systems of food and agriculture prevailing before this had many flaws: they were prone to low yields, droughts, famines, short shelf-life of supplies etc. Radical changes in global agriculture over the

20th century, particularly during the period of the Green Revolution, averted major famines and lifted billions of people out of hunger and poverty[12]. In a period of rapidly growing populations, these changes greatly increased yields[3] and helped avoid Malthus' apocalyptic predictions of a global societal collapse driven by food shortages[13]. However, these changes made many food systems across the world less suited to their populations and geographic context, causing unique problems to human health, society and the environment. These range across obesity[12,14] increased meat consumption[14], deficiency of micronutrients and vitamins[12,14,15], loss of biodiversity[14], climate change[16] and many others. Such radical changes to agriculture have also driven human choices regarding food, making most diets across the world increasingly similar and vulnerable to similar systemic problems[17,18].

Despite such disruption, some cultures have preserved their balanced heritage in food habits and preferences. Generations of shared experiences and learnings have helped people from such cultures sustainably nurture crops for both human and environmental wellbeing. Their choices and preferences have stood ground against detrimental changes emerging from rapid disruption of 20th century agriculture. This essay will focus on the importance of traditional varieties of rice and wheat and indigenous cereals such as millets. It will discuss their displacement from modern agriculture and its consequences. Lastly, it will also outline some actionable steps to preserve and sustainably promote this heritage for a positive impact on human society.

Food, food everywhere: Replacement of indigenous crops during the Green Revolution

The Green Revolution of the 20th century was instrumental in avoiding famines and averting poverty by combining large public investments and institutional efforts into crop research and infrastructure Page 2 of 9 development. A major component of this involved the introduction of high yield varieties (HYV) of certain cereals, most notably rice, wheat and corn[12,15,19]. For instance, the IR8 variety of rice helped increase rice yields across many developing Asian countries by over three times between 1960s and 2010s[3,20,21]. Combined with governmental support for favourable input subsidies (fertilizers, insecticides etc) and intensive infrastructure spending, these varieties changed global agriculture on an unprecedented scale and helped most countries in Asia and Latin America achieve food security[12,15]. However, these disruptive changes also made food systems far too reliant on select variants of a few favoured crops. Today, almost 50% of all calories consumed by humans come from rice, wheat or corn[18]. This has come at the cost of other traditionally grown foods.

Excessive monoculture, incentivised by preferential agricultural regimes, has displaced indigenous crops and cereals from agricultural fields. For instance, wild leafy vegetables and fish harvested from rice paddies in Philippines have lost place due to the Green Revolution[12]. In South Asia, the Green Revolution has transformed the Indo-Gangetic plain stretching across Pakistan, India and Bangladesh into a single water-intensive rice-wheat cropping system. This has caused crop displacement and price instability of legumes, which are also a major component of staple diets in this

region[12,15,22]. Such rapid disruption of food has increased calorie consumption but decreased both the availability of dietary micronutrients and the overall biodiversity of crops. Associated deficiencies and other health problems have also increased among affected populations globally[3,12,23]. Such problems have brought a renewed focus to traditional crops that have long been cherished from heritage.

Hidden gems: Unique cultural importance and scientific value of millets

Crops such as millets have some of the oldest traditions of cereal consumption by humans to their claim. While consumption of wild millet grains stretch back to over 100,000 years[24], the earliest instance of their domestication extends to almost 10,000 years ago[25]. In many regions around the world, these grains were domesticated before wheat or rice and thus formed an essential part of cultural and culinary heritage with ancient roots[26].

Scientifically, most millets feature a C4 photosynthesis carbon cycle[26,27]. In comparison to other crops, which feature a C3 photosynthesis cycle, millets perform slower photosynthesis under regular conditions. However, they are more efficient in conditions involving high temperatures and low availability of water and nitrogen[28,29]. Hence, despite normally offering lesser yields than rice, wheat or corn, millets are more resilient and better suited for newly cultivated semi-arid and arid lands with low soil fertility. On these lines, millets are also be better suited for present-day ecosystems that are stressed by human-induced climate change[26].

Despite this, their displacement from farms has been most noticeable. Globally the area under cultivation of sorghum and other millets has declined over the past 50 years[3]. Compared to vegetables, fruits and legumes, such crops are easier to replace with rice, wheat and corn HYVs due to their similarity as a staple carbohydrate base. Apart from causing loss of heritage, this displacement has also altered the dietary intake of people, thus affecting their nutrition and health.

Compared to rice, wheat and corn HYVs, most common millets have fewer macronutrients (carbohydrates, proteins), greater amounts of fats and lower calorific values. However, they have substantially greater amounts of micronutrients (calcium, iron, phosphorus, thiamine etc) and crude fibre[30]. Millets also have gluten-free proteins, lower glycaemic indices and greater availability of other bioactive compounds[31]. This makes them better suited for nutritionally balanced diets to prevent chronic health problems. For instance, finger millets have a high content of dietary fibre[32] and resistant starch that metabolises into short fatty acids33; this is important in regulating and reducing risks of colon cancer[33]. Replacing such cereals with rice, wheat and corn exclusively has thus caused nutritional deficiencies. However, due to the promotion of HYVs, these deficiencies have become even more pronounced.

Old crops, new problems: Problems with High Yield Variants

Despite intending to improve on the world's most grown crops[3], high yield varieties from the Green Revolution have caused numerous unintended problems. In case of wheat, to support higher yields modern cultivars have smaller plant

height and spike density. However, they also have much higher content of gluten than traditional varieties[34]. This has caused greater incidence of celiac disease, non-celiac gluten sensitivity and irritable bowel syndrome, most noticeably in the high-wheat consuming countries of the Western world[34–36]. These high yield wheat cultivars also have lower contents of minerals in comparison to older traditional varieties; this has increased risks of other health problems associated with their deficiencies[34,37].

Similarly, modern cultivars of rice have a higher glycaemic index than traditional varieties; this is associated with an increased risk of type II diabetes[38]. This is worsened by the increased consumption of white rice, which is more polished, refined and less nutritious than brown rice38,39. Cultivar replacement and the subsequent creation of new food supply chain infrastructure during the Green Revolution favoured white rice of HYVs over others because it is easier to store and transport[39]. Such a systemic preference for cultivation and supply of high yield variety rice has also driven populations to alter habits and consume more white rice, thus increasing incidence of diabetes across high-rice consuming countries of Asia[39].

Subsequently, this preference for HYVs has also endangered and caused the extinction of many traditional rice varieties. On one hand, institutional preference from governments have made such varieties unprofitable. On the other hand, changing consumer habits due to the abundance of high yield cultivars has diminished demand and culinary use of such varieties[40–42]. Apart from their culinary heritage and unique taste, such varieties also had unique nutritional offerings that have since disappeared from affected diets[43].

Actionable solutions: Governmental measures and international steps

Unlike the early years of the Green Revolution, present-day agriculture does not suffer from insufficient food production. Instead, more systemic problems regarding nutrition of food, its distribution and its adaptability to changing climate conditions[26,44] require more urgent attention. Traditional crops and varieties can offer important solutions for this. At a fundamental level, traditional crops need to become as viable as HYVs of rice, wheat and corn for farming. Since an overwhelming share of human calorie consumption comes from an unprecedentedly few number of crops[18], it is likely that supply side intervention will affect consumption more than consumer habits and market trends. To realise this, governments need to take calculated steps to support sustainable farming of these grains.

Countries that benefitted the most from the Green Revolution (India, Mexico, Philippines etc) invested heavily in developing irrigation systems, input subsidies, procurement infrastructure and global trade provisions to secure export markets for their newly planted HYVs[12,19]. Despite causing long-term problems, these steps were urgent measures that brought much needed food security in their time. In comparison to this, traditional food crops and varieties can flourish even with less disruptive and more sustainable measures. Simple steps such as reforming outdated HYV-specific subsidy and procurement provisions[40] could go a long way. Among other steps, from promotion of resilient millets to preservation of native varieties, targeted governmental initiatives have an important role to play in this revival.

However, governmental initiatives cannot succeed without international cooperation and structural support. Current WTO rules regulate agricultural exports and subsidies largely invariant to specific crops. The rationale behind this is to limit market dumping of subsidy-driven overproduction by resource-rich countries and thus de-risk others from cheap food imports[45]. This approach discourages most developing countries with small non-corporate farmers from promoting crops that were displaced by the Green Revolution. For instance, in India, since governments have already maximised the 10% WTO blue box subsidy limit to support wheat and rice[15,45,46], traditional crops would require Page 4 of 9 greater support from the government to revive cultivation. Revamping such regulations and reforming them to be more crop and region specific will help governments produce more nutritious and diverse foods without causing global trade imbalances. This will also help bring reduce global poverty through targeted and sustainable agriculture improvements. Outreach initiatives, such as the International Year of Millets[47], can also be very helpful. However, to bring a meaningful impact, the agriculture of these crops will need both international structural changes and governmental institutional reforms simultaneously.

Grains for gains: Problems with market-driven solutions and conclusion

Some traditional crops have succeeded in reversing trends of displacement from the Green Revolution. A notable example of this quinoa. Once a unique pseudograin limited to communities of the Andes, quinoa is now a highly prized nutrition-rich global superfood. Its reputation has brought prosperity to many impoverished traditional farmers[48–50]. However, this has also produced unintended consequences. Extreme price volatility and proliferation of high-yield low-nutrition varieties grown in other regions[49,50] has disrupted traditional livelihoods, quinoa-rich diets and biodiversity of the crop itself across the Andes itself[48–50]. Similarly, traditional farmers of Ethiopian Teff are also facing economic and legal competition from farmers in richer countries[44,51] due to rising global interest[52]. These examples show that without well-planned supply-side initiatives, consumer preferences and market trends alone cannot promote traditional foods sustainably.

Agriculture in its present form has many other systemic problems whose discussion goes beyond the scope of this essay. For instance, despite a decreasing trend, the portion of crops grown specifically to feed livestock is unsustainably high[3,54]. Much like the growth of soya bean, there is a possibility that traditional crops and revived traditional varieties could make affordable livestock feed and further contributing to this problem[30,51]. Despite this, the possible benefits of supporting traditional crops and varieties outweigh a few such risks. Their unique history and nutritional value can smoothly harmonise heritage of the past and food security of the present to create better shared opportunities for the future.

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