

Fostering international collaboration for food security and sustainable development: a personal perspective of M. S. Swaminathan's vision, impact and legacy for humanity

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Arguably, no living person has done more than M. S. Swaminathan to improve the lives of the poor and the marginalized. His monumental contributions to India's Green Revolution are documented elsewhere. In this paper, I focus sharply on two little-chronicled bodies of his work: (1) the IRRI Cambodia programme which guided and supported that conflict-affected country to achieve rice self-sufficiency and exporter status; and (2) the United Nations Hunger Task Force which fundamentally changed global thinking about hunger and food security by going beyond productivity improvement to include nutrition, social safety nets, natural resource management, and an enabling policy environment. Both cases illustrate the power of international collaboration and a commitment to inclusive and sustainable development. The Sustainable Development Goals will carry these principles forward for humanity as an enduring legacy of Swaminathan's vision and life achievement.

Keywords: Cambodia, rice, international collaboration, sustainable development, Swaminathan.

'There are uncommon opportunities now to harness the power of synergy between science and public policy to address contemporary development issues such as the growing divide between rich and poor, the feminization of poverty, the dearth of jobs, overpopulation, climate change, and the loss of forests and biodiversity.'

Introduction

THE above quote might have been extracted from the global declaration of the Sustainable Development Goals (SDGs). Instead, these are the words of M. S. Swaminathan, written in 2000, for an editorial in the journal *Science* entitled 'Science in response to basic human needs'¹. Twelve years earlier, he established the M.S. Swaminathan Research Foundation (MSSRF) to 'apply science and technology to address problems faced by

rural populations creating change in their lives in the spheres of natural resource management, agriculture, food and nutrition'². Through MSSRF, he has applied a lifetime of learning, research and practice in the service of rural communities in India, while serving untiringly as a global thought and practice leader in sustainable development. Throughout his career, Swaminathan has championed a profoundly ethical approach to development and has urged researchers, policy makers and practitioners alike to take actions that are 'pro-poor', 'pro-women' and 'pro-nature'³.

In this personal perspective, I will document and reflect on just a few of Swaminathan's contributions and achievements, beginning in 1982, when he assumed the role of Director General of the International Rice Research Institute (IRRI), a position that he held for six years. His monumental contributions to India's Green Revolution are documented elsewhere. In this paper, I will focus sharply on two bodies of work with which I was closely associated, and therefore can best appreciate and convey Swaminathan's unique vision, impact and legacy: the IRRI Cambodia programme and the United Nations Hunger Task Force. These cases illustrate the power of international collaboration and a commitment to inclusive and sustainable development. I hope that both of these examples also express a unique 'Swaminathan touch' – a sense of vision, inspiration, humility, compassion, and humanity – that his colleagues, mentees and other admirers believe has made him worthy of a Nobel Peace Prize. Arguably, no living person has done more than Swaminathan to improve the lives of the poor and the marginalized. And, as a true leader, he has achieved this impact and ensured a legacy through example and encouragement.

I will begin with an initiative, conceived and guided by Swaminathan, whereby IRRI helped to restore rice farming in Cambodia after years of conflict, dislocation and destruction. This little-known case chronicles the experience of a country that emerged from starvation and food aid dependency to become a significant rice exporter. The second example will be the United Nations Hunger Task Force (HTF), established in 2002 by then UN Secretary

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General Kofi Annan. As part of the UN Millennium Project, the HTF was co-chaired by Swaminathan and Pedro Sanchez, renowned soil scientist and fellow World Food Prize laureate (2002). The HTF report has shaped programmes and investments in agriculture and food security for the past decade, especially in Sub-Saharan Africa. In conclusion, I will briefly outline Swaminathan's less direct, but potentially even more strategic, contribution to advancing sustainability through a new holistic set of global development goals: the SDGs.

Cambodia: from killing fields to sustainable food security

In the twentieth century, few countries experienced the levels of social disruption, human carnage and physical destruction that befell Cambodia. As the Vietnam War spilled into Cambodia⁴, the country was bombed ferociously between 1969 and 1973; during that period, the United States flew over 200,000 sorties and dropped 2.75 million tonnes of munitions on Cambodia⁵. Despite this extreme use of force, on 17 April 1975, the capital Phnom Penh fell to forces of the Communist Party of Kampuchea, known widely as the Khmer Rouge. By then, the population of Phnom Penh had risen from less than a million to 2 million people as the rural population fled the bombing and the advance of the rebel forces.

Within weeks of overthrowing the Lon Nol Government, the Khmer Rouge emptied the capital and other cities, relocating the population to all parts of the country, separating families, and creating organized labour and production brigades. Recognizing the symbolism of empowering rural people, the Khmer Rouge leader, Pol Pot, immediately placed a high priority on increasing rice production. He established an ambitious national target of 3 MT/ha, that was likely modelled on a similar campaign instituted in China by Hua Guofeng⁶. As early as May 1975, Radio Phnom Penh pronounced: 'If we have rice, we have everything'⁶. Although Cambodia was a significant rice exporter in the early 1960s, average national yields were in the range of 1.0 to 1.4 MT/ha, the lowest in Asia⁷. To more than double rice production, without external inputs like fertilizer and well-adapted seeds, would be a formidable and ultimately an unrealistic task⁶.

Between 1975 and 1978, the Khmer Rouge instituted some extraordinarily draconian and ill-conceived agricultural policies⁸. Within the context of a 4-year plan to build socialism in agriculture and other sectors, and to achieve the 3 MT/ha target, the government moved to replace Cambodia's traditional rainfed rice with high-yielding irrigated rice systems that would, in principle, rapidly increase production. Irrigation canals were constructed on 1 km square grids by deploying forced labourers, many of whom had been relocated from Phnom Penh and other cities. Within these irrigation grids, one

hectare plots were designed from existing parcels and farmed by communal production groups. New rice varieties of Chinese origin were introduced and promoted by Chinese agricultural advisers. However, the infrastructure was poorly designed and hastily constructed without consideration of water requirements and stream capacities and flows⁸. This caused flooding and required frequent major repairs⁸. Throughout the Khmer Rouge period, production stagnated at around 1 MT/ha or less⁷, and the country plunged into deep food deficits and widespread starvation.

The Khmer Rouge rejected what they considered to be modern technology (notwithstanding the introduction of rice varieties from China) as illustrated by the following quote attributed to a Khmer Rouge leader when emphasizing the overriding importance of their unique brand of Cambodia's socialist revolutionary movement (cited by Himmel⁸): '*...because technology is not the decisive factor; the determining factors of a revolution are politics, revolutionary people, and revolutionary methods.*'

Under the Khmer Rouge leadership, the country, then called 'Democratic Kampuchea', experienced almost four years of genocide and crimes against humanity, while launching periodic attacks against Thailand and Vietnam⁹. While estimates vary, noted Yale University expert on the Cambodia genocide, Ben Kiernan, estimates that the Khmer Rouge was responsible for the deaths of about 1.7 million people: an extraordinary 21% of the population⁹.

In December 1978, Vietnam invaded Cambodia and, by January 1979, had removed the Khmer Rouge leadership from Phnom Penh⁹. What followed was an extended period of slow recovery supported by the governments of Vietnam, the Soviet Union, Eastern European Soviet bloc nations, Cuba and India, and a number of humanitarian non-government organizations (NGOs). Because of Vietnam's role in the overthrow of the government, the United Nations – in particular China, the United States and the United Kingdom – refused to recognize the new Vietnamese-supported government, known as the People's Republic of Kampuchea. For more than a decade, civil war continued and Cambodia remained internationally isolated by an official UN doctrine that rejected the nature of non-democratic regime change, despite the clear, albeit delayed, acknowledgment of the genocidal actions of the Khmer Rouge.

It was within this complex, bloody and tragic historical setting that, in 1985, Swaminathan initiated a programme of international cooperation with Cambodia that would serve as the country's primary source of scientific and technical support to the agriculture sector for more than 15 years. With his deep knowledge of Indian agricultural research as a scientist and as an administrator, he appreciated the necessity of a strong national research infrastructure. He argued that 'only a strong national research system could take advantage of advances in international research' and indeed pointed to the ease with which India

embraced and deployed new wheat and rice varieties that launched his country's Green Revolution³.

Several years before joining IRRI, Swaminathan had supported the Government of Vietnam to establish the Cuu Long (Mekong Delta) Rice Research Institute (CLRRI), which was instrumental in introducing, adapting and developing new rice varieties suitable for the Mekong Delta¹⁰. That programme included much needed infrastructure development, the long-term appointment of Indian scientists and the training of Vietnamese scientists in India. Partnership to build national institutional capacity became one of the hallmarks of his tenure at IRRI. His experience with CLRRI served as an inspiration for the IRRI Cambodia programme.

In the first decade after the overthrow of the Khmer Rouge, international NGOs played a major role in connecting Cambodia's development needs with relevant information, technologies and expertise, supplementing the technical cooperation and training provided by then pro-Soviet countries represented in Phnom Penh. One such NGO, the Mennonite Central Committee (MCC), reached out to Swaminathan in early 1985 to propose and offer to facilitate a programme of cooperation with IRRI¹¹. However, adhering to his principle of local ownership and leadership, Swaminathan insisted that a request for such cooperation and assistance must come from the Cambodian Government, not from an international NGO.

After several months of exchanging letters and telexes, and following a visit to IRRI by two Cambodian agricultural officials, the then Agriculture Minister and Deputy Prime Minister, Kong Som Ol, formally approved a mission to Cambodia by a team of three IRRI scientists¹¹. With arrangements made by UNICEF, one of the few international organizations allowed to operate in Phnom Penh, IRRI's first post-war mission to Cambodia took place in January 1986. The team comprised Gurdev Khush (renowned IRRI rice breeder and World Food Prize laureate, 1996), Don Puckridge (IRRI agronomist and representative in Thailand) and the present author (then an associate scientist assigned by Swaminathan to support the establishment of new IRRI country programmes).

Mobilization of funds to support the IRRI Cambodia programme presented unusual challenges. Without diplomatic recognition of the Cambodian Government outside of the Soviet-bloc countries and India, IRRI's traditional donors were reluctant to contribute. However, upon my suggestion, Swaminathan approached the Government of Australia, recognizing its geopolitical interests in the region. I was aware that the then Australian Foreign Minister, Bill Hayden, had a strong personal interest in supporting the people of Cambodia and reengaging the Government of Cambodia, a position that was strongly opposed by the United States¹². Through a series of discreet meetings and correspondence with Australian officials in Canberra and Manila, including a 10-minute

discussion between Swaminathan and Prime Minister Bob Hawke during the latter's visit to Manila³ in May 1986, agreement was reached to establish an 'IRRI-Indochina Programme' that would include Cambodia, along with Vietnam and Lao PDR. Later this programme would become more transparently the Cambodia-IRRI-Australia Project (CIAP), while separate country-focused projects continued in Vietnam and Lao PDR. Between 1987 and 2001, Australia contributed about US\$ 25 million to support Cambodia through CIAP¹³.

The first decade of IRRI's programme of research cooperation in Cambodia was comprehensively documented in Harry Nesbitt's *Rice Production in Cambodia*¹⁴. This volume highlighted some of the unique challenges encountered in improving production in a country dominated by diverse rainfed rice ecosystems. Major areas of emphasis included rice varietal improvement, soil fertility management, farming systems research, integrated pest management, mechanization and post-harvest improvement^{13,14}. A richly detailed, anecdotal history of the IRRI Cambodia programme, entitled *The Burning of the Rice*¹¹ was published in 2004.

Under Swaminathan's guidance, IRRI's collaborative programme in Cambodia embraced the importance of local ownership and leadership as the foundation of sustainable capacity development. To that end, two critical programmatic priorities were established at a very early stage: a massive training of Cambodian agricultural scientists and practitioners; and the establishment of a national research institute to be known as the Cambodian Agricultural Research and Development Institute (CARDI).

The report of the IRRI mission in January 1986 noted 'the biggest constraint facing the country is the shortage of trained manpower' and that local capacity development should be given the highest priority¹⁵. The team noted that only 20 of the 300 graduates of the pre-war University of Agriculture remained in the country; the rest had died or had fled. Later, CIAP Team Leader Harry Nesbitt estimated that only 40 of the 400 qualified agriculturalists remained in Cambodia immediately after the war¹³. Through a variety of capacity building opportunities, ranging from short in-country training, to international courses at IRRI and elsewhere in the region, to masters and Ph D programmes in several countries, including Australia, Cambodia rapidly built its capacity in rice research and extension. By 2001, a total of 1,700 Cambodians had been trained in over 7,000 training opportunities with IRRI's support since the inception of the programme¹³.

The IRRI mission also observed 'there are no facilities for development and evaluation of technology (in Cambodia)'. Most of the infrastructure had been destroyed¹³. The IRRI mission conveyed a request from the Ministry of Agriculture to assist in establishing a rice research and training centre¹⁵. Following an evaluation of different

sites, complex and difficult negotiations with land owners, the Government and donors, and many years of functioning as the *de facto* national rice research institute, CARDI was formally established in 1999 and inaugurated by Prime Minister Hun Sen in 2000 (ref. 11). Fully consistent with Swaminathan's vision of the critical role of a national institution, Hun Sen stated in his inauguration speech¹⁶: 'CARDI should also have an important role to play in networking with regional and international research institutes and centers to strengthen the cooperation in research and exchange of experiences, outcomes and technical information of scientific value.'

Swaminathan had a unique perspective of having served as leader in both a *national* agricultural research institution – the Indian Council of Agricultural Research – and an *international* agricultural research center – IRRI. He appreciated that a strong national research institution is a pre-requisite for international collaboration. In his own words³: '...if we wish developing countries to progress in agriculture, we must help them to build strong National Agricultural Research Systems. The stronger the NARS, the greater is the benefit of the International Agricultural Research Centres.' Swaminathan added that, 'this will confer long-term benefits and also help strengthen the morale and capability of national scientists, working on national salaries.'

Perhaps the most striking example of international cooperation under this programme was in the area of germplasm conservation. As in many IRRI programmes, rice germplasm was a strategically important component of IRRI's work in Cambodia. Swaminathan had long advocated the importance of germplasm conservation. While serving as Independent Chairman of the United Nations Food and Agriculture Organization Council from 1980 to 1985, he played a crucial role in establishing the Commission on Genetic Resources for Food and Agriculture. Soon after joining IRRI, he convened a rice germplasm conservation workshop which heralded major commitments on collaboration at the national, regional and global levels to advance the collection, conservation, and utilization of crop germplasm¹⁷.

The experience of Cambodia brought the need for effective germplasm conservation sharply into focus. The massive dislocation of people, disruption of farming, and distortion of policies left Cambodia's farmers with only remnants of their diverse, uniquely adapted, traditional rice varieties after the Khmer Rouge period. The Ministry of Agriculture and NGOs approached IRRI for assistance in locating their 'lost' traditional varieties. In response, IRRI was able to repatriate over 750 traditional varieties that had been collected in December 1972 and January 1973, and safely stored in the International Rice Genebank at IRRI headquarters in the Philippines¹⁸. IRRI and Cambodian scientists purified, evaluated and reintroduced many of these varieties to meet the needs of Cambodia's diverse rainfed conditions, where modern

varieties developed elsewhere for more favourable environments were found to be poorly adapted. One Cambodian variety, *Phka Rumduol*, was chosen as the 'World's Best Rice' at three consecutive *The Rice Trader* World Rice Conferences (2012, 2013 and 2014). *Phka Rumduol* was developed and released by CARDI in 1999 with the support of the Cambodia–IRRI Australia Project. This important task of conserving Cambodia's rice varieties continues under CARDI's leadership, in cooperation with IRRI. As of January 2015, 4,677 types of rice seed from Cambodia were held in trust at the International Rice Genebank¹⁸.

The long-term impact of IRRI's cooperation with Cambodia is difficult to quantify, in part because of a deliberate institutional commitment to Swaminathan's ideals of personal humility and local ownership. Nevertheless, it is appropriate, in the light of the preceding historical sketch, to at least reflect on the pattern of rice production in Cambodia from 1961 to the near present (Figure 1)⁷. From a pre-war production level of almost 4 million MT, annual rice production fell to around 1 million MT immediately before and during the Khmer Rouge period, as a result of the flawed policies and technologies described above. By 1985, six years after the Khmer Rouge was removed from Phnom Penh, the country's rice production had recovered to about 2 million MT per annum, primarily through a three-fold expansion of planted area. From just 2 million MT in 1985, production has increased to over 9 million MT per annum in 2013 (a more than 6% annual growth rate), through a combination of further doubling of the harvested area and a more than doubling of yield per hectare to 3 MT/ha – ironically, the elusive target of the Khmer Rouge. Today, Cambodia is again a significant rice exporter, with exports averaging close to 1 million MT milled rice over the past six years⁷.

I am confident that Swaminathan would urge us to conclude that the extraordinary trajectory of growth since 1985 is the collective impact of four factors: the application of science and technology; the contribution of national institutional and human resource capacity; the power of international collaboration; and the ingenuity and resilience of the Cambodian rice farmer.

In this section, I have chosen to focus on Swaminathan's role in initiating and guiding IRRI's highly successful programme of collaboration and support in Cambodia. Aside from Cambodia, he championed and supported the establishment of national rice research institutions in Egypt, China, the Philippines, Lao PDR, Bhutan, and Madagascar, while supporting the strengthening of existing institutions in several other rice-growing countries, including several in Africa¹⁹.

I will elaborate on just one of these additional examples: Egypt. In contrast to Cambodia, all of Egypt's rice is grown under irrigated conditions. The partnership with Egypt was one of IRRI's first and most productive on the

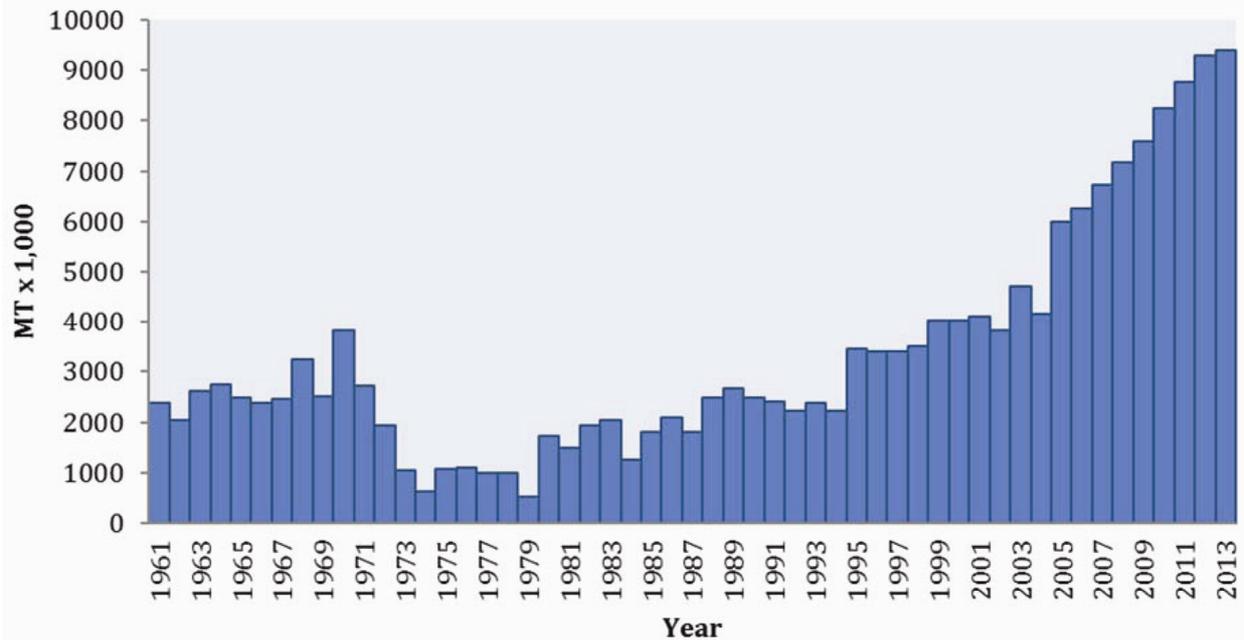


Figure 1. Rice production in Cambodia, 1961–2013 (in MT rough rice). Source: FAOSTAT: <http://faostat3.fao.org/browse/Q/QC/E>.

African continent. Egypt was one of the first *japonica*-rice growing countries to successfully introduce modern semi-dwarf varieties developed at IRRI. Collaboration intensified in 1976 with Egypt's participation in the International Rice Testing Programme and was further strengthened during the 1980s by a major USAID-funded rice project implemented in partnership with the University of California at Davis²⁰.

Despite this long, productive relationship with IRRI, Swaminathan recognized that Egypt needed its own world-class research and training facilities in order to lead national rice farming improvements and to enable stronger international collaboration. As a result, with IRRI's scientific and technical support and with funding from USAID, Egypt established the Rice Research and Training Center (RRTC) in January 1987 at Sakha, located in the heart of the country's rice growing Nile delta. The RRTC mandate included research, training, extension and seed production²⁰. After a decade of yield stagnation, this revitalized partnership with IRRI through RRTC enabled Egypt to boost its national yield from 6 MT/ha to almost 8 MT/ha, one of the highest levels in the world²¹.

Tackling global hunger: a holistic, human-centered approach to meeting humanity's most basic need

At the Millennium Summit in September 2000, world leaders adopted the UN Millennium Declaration (UN General Assembly Resolution A/RES/55/2), a commitment to end extreme poverty by 2015. The Millennium

Summit was attended by 149 Heads of State and Government and high-ranking officials from more than 40 other countries. The Millennium Declaration resolved to 'spare no effort to free our fellow men, women and children from the abject and dehumanizing conditions of extreme poverty, to which more than a billion of them are currently subjected'²². Emerging from the Summit was a set of time-bound goals and related targets that became known as the Millennium Development Goals: the MDGs.

In 2002, the UN Millennium Project was commissioned by then United Nations Secretary-General Kofi Annan to recommend a concrete action plan for achieving the MDGs. Headed by Jeffrey Sachs, the Millennium Project served as an independent advisory body and presented its final report to the Secretary-General in January 2005 (ref. 23). The work of the UN Millennium Project was undertaken by 10 thematic Task Forces, one of which was the Hunger Task Force (HTF), which Swaminathan co-chaired. Task force members were drawn from governments, UN agencies, international research institutions, private sector, civil society, and academia. The work of the HTF was completed in 2004 and the final report was published in 2005 (refs 24, 25). Drawing on independent expert analysis, stakeholder consultations, and field visits to Asia and Africa, the HTF presented seven core recommendations for ending hunger summarized below²⁵. Five of those recommendations called for action at the community level in 'hunger hotspots'. The HTF recommended that these local actions should be complemented by simultaneous action at the national and global levels.

Synergistic community-level actions in hunger hot-spots:

- Increase the agricultural productivity of food-insecure farmers
- Improve nutrition for chronically hungry and vulnerable groups
- Reduce vulnerability of the acutely hungry through productive safety nets
- Increase incomes and make markets work for the poor
- Restore and conserve the natural resources essential for food security²⁵.

Complementary higher level actions:

- Move from political commitment to action
- Reform policy and create an enabling environment²⁵.

Even before their formal release, the HTF recommendations were highlighted by Secretary General Kofi Annan in his historic African Green Revolution speech in Addis Ababa on 5 July 2004 at a ‘High Level Seminar on Innovative Approaches to Meet the Hunger Millennium Development Goal in Africa’²⁶. In launching what he called ‘a uniquely African green revolution’, the Secretary General referred to the HTF’s recommendations as ‘far reaching and refreshingly concrete’. His speech drew attention to an approach to agricultural development that incorporated soil health and improved water management, and the need for complementary investments in roads, electrification, mobile phones, public health and social safety nets²⁶.

All of the above recommendations reflect principles and positions that Swaminathan had expressed for decades and continues to articulate in his publications, speeches and interviews around the world. Since the earliest days of the Asian Green Revolution, he has recognized and, more importantly, has *applied* modern science and technology to improve agricultural productivity for small-scale, food insecure farmers. Working closely with Norman Borlaug, he introduced and developed wheat varieties to India that would transform the country. He also advanced the concept of an ‘Evergreen Revolution’²⁷ which he defines as ‘increasing productivity in perpetuity without associated ecological harm’²⁸, while not backing away from the role of modern science and technology, including biotechnology. These ideas profoundly shaped the HTF report.

In an article in *Science* in 1982, Swaminathan identified the challenge to agriculture as being ‘continuous improvement in the productivity of major farming systems per unit of land, water, time, and energy without detriment to the long-term production potential of soil’²⁹. He argued that biotechnology, including genetic engineering, could help with that task. Indeed, under his tenure as IRRI Director General, the Rockefeller Foundation initi-

ated the first international research programme on rice biotechnology in 1985 (ref. 30). Modern scientific approaches to rice improvement, including but not limited to genetic engineering, became central to IRRI’s success in improving rice productivity in subsequent decades³¹.

By highlighting the importance of nutrition, the HTF went beyond many earlier ‘calls for action’ that had focused on ‘food security’ and, for the most part, relied on cereal production and caloric intake as the primary solutions to hunger. Indeed, the two official indicators of MDG Target 1.C – prevalence of underweight children under-five years of age and the proportion of population below a minimum level of dietary energy consumption – are now considered inadequate measures of broader nutritional impact³². Expressing this concern, Swaminathan has long argued that nutrition should be part of broader ‘symphony approach’ to rural development that includes employment, income generation and education³. He recently reiterated this point, calling for a shift in tackling global hunger from a ‘food security’ focus to a ‘nutrition security’ approach^{33,34}. He argued that nutritional criteria should be mainstreamed into agricultural planning through nutrition-sensitive agriculture, including greater use of biofortification. He illustrated the potential of biofortification through Golden Rice: a product of IRRI’s biotechnology programme started by Swaminathan 30 years ago. With high levels of beta-carotene, Golden Rice has the potential to reduce vitamin A deficiency among millions of low-income rice consumers who cannot access or afford alternatives³⁵.

Throughout his career, Swaminathan has consistently encouraged a more holistic view of the world. Just as we need to consider a broader notion of ‘hunger’ that includes improved diets and nutrition, he has drawn attention to critical cross-cutting issues such as gender, employment and income generation. Early in his time at IRRI, Swaminathan initiated path-breaking gender initiatives that would draw greater attention to the roles, contributions and needs of women in farming, including establishment of a regional network to advance gender-related research and training³. He argued that women should be relieved of the drudgery of weeding and transplanting rice and be provided opportunities and be trained in higher-income post-harvest enterprises³⁶.

In September 1983, IRRI convened an international conference on women in rice farming. In a paper for the Consultative Group on International Agricultural Research (CGIAR) on the role of gender in agricultural development, Susan Poats noted that the conference monograph, *Women in Rice Farming*³⁷ ‘set an example for national and international agricultural research institutions to begin exploring the relationship between specific production systems and women farmers’³⁸. Aside from mainstreaming gender into rice research, not only at IRRI but in national programmes, Swaminathan’s vision led to a Rockefeller Foundation-supported Bellagio Conference

in March 1985 that was considered to be a turning point towards gender awareness and action for the international agricultural research community^{19,38}.

Swaminathan has consistently acknowledged and honored the contributions of farmers. He argued: 'We often forget that we live in this world as guests of green plants that tap sunlight and of farm families who convert plants into products for our consumption'³⁹.

On the occasion of IRRI's 25th anniversary in 1985, Swaminathan invited 14 outstanding rice farmers from 10 countries to join scientists and political leaders at IRRI's headquarters. Working with IRRI scholars and scientists, Mina B. Swaminathan interviewed these farmers over 4 days to capture their experience, insights and perspectives. The findings highlighted the emerging importance of income generation and employment³⁹. As yields increased and productivity improved in Asia over the previous 15 years, real rice prices declined⁴⁰. While this was a boon for consumers, small-scale farmers were increasingly looking for ways to augment their incomes.

Drawing on these insights, Swaminathan wanted to address in practical ways the need to diversify and increase employment and income opportunities for small-scale rice farmers. To this end, he launched the Prosperity through Rice Project, in partnership with the University of the Philippines, and with financial support from the Asian Development Bank³⁶. The project was undertaken with partners in Bangladesh, Indonesia, Sri Lanka, and Thailand and had three components: increased input use efficiency; greater enterprise diversification; and improved rice by-product utilization. Prosperity through Rice was yet another example of his ability to think laterally and beyond the present, and to prepare for the changes ahead.

Through *pro-poor* crop varietal improvements, *pro-women* diversification of income and employment, and *pro-nature* 'Evergreen Revolution' approaches, Swaminathan has helped guide the agricultural development community towards envisioning and enabling a more equitable and more sustainable future: the core principles of the new SDGs. His impact on reducing global hunger was evident before he joined IRRI and long before he co-chaired the UN HTF. But he did not rest on his laurels. At IRRI, he fundamentally changed the direction of the Asian Green Revolution with his emphasis on equity, sustainability and partnership. Through the HTF, in collaboration with Pedro Sanchez, he fundamentally changed global thinking about hunger and food security with his focus on nutrition, social safety nets, natural resource management, and an enabling policy environment. Indeed, according to Sanchez (pers. commun.), MSSRF's holistic, eco-village approach provided inspiration for the African Millennium Villages Project, a multi-sector, rural development initiative of Columbia University's Earth Institute operating across more than a dozen Sub-Saharan African nations⁴¹.

MDG Target 1.C (in earlier documentation referred to as 'Target 2') resolved to 'halve, between 1990 and 2015, the proportion of people who suffer from hunger'. FAO's recently released 'The State of Food Insecurity in the World 2015' reports that, for the developing regions, the share of undernourished people in the total population has decreased from 23.3% in 1990–92 to 12.9% in 2014–16 (ref. 42). While this figure falls just short of the MDG Target 1.C, the gains are impressive and a source of inspiration for individuals and organizations working to end hunger. FAO further reports that 72 developing countries out of 129, or more than half the countries monitored, achieved the MDG 1.C hunger target, reinforcing the HTF's 2005 conclusion that: 'It can be done'²⁵. The challenge going forward is to redouble efforts to further reduce and effectively eliminate hunger, especially in Sub-Saharan Africa and South Asia. To this end, Goal 2 of the new SDGs explicitly seeks to 'end hunger' by 2030 (ref. 43).

As in the specific case of rice production in Cambodia described above, it is unrealistic to attempt to attribute a portion of this progress to any one person or organization. There is more than sufficient evidence – in the form of dozens of awards, prizes, and honorary degrees, and thousands of publicly available publications and testimonials – that Swaminathan has inspired actions of individuals and institutions that have led to reduced hunger and greater dignity for millions of people around the world. His unwavering humility and personal integrity have engendered to his colleagues, mentees and followers a deeply held value of respecting and acknowledging the contributions of others.

Concluding remarks: the road to dignity

In the opening paragraph of this paper, I alluded to the convergence of Swaminathan's vision of development with the post-2015 development agenda and the emergence of a new set of global development goals: the SDGs. The SDGs have been formulated as a universal call to action drawing on the conclusions of the Rio+20 Conference held in June 2012. Not unlike the opening quote that I extracted from his 2000 paper in *Science*, the following 49 words from the Rio+20 outcome document, *The Future We Want*, illuminate Swaminathan's vision and core values⁴⁴: 'We recognize that people are at the centre of sustainable development and, in this regard, we strive for a world that is just, equitable and inclusive, and we commit to work together to promote sustained and inclusive economic growth, social development and environment protection and thereby to benefit all.'

In December 2014, UN Secretary General Ban Ki-moon produced a synthesis report for the post-2015 agenda: 'The Road to Dignity by 2030: Ending Poverty, Transforming All Lives and Protecting the Planet'⁴⁵. Throughout this report, we see the impact and legacy of

Swaminathan's work. One area in particular stands out as emblematic of the man and his work, a mere sliver of which I have described in this paper:

In section 4.2 on 'Technology, Science and Innovation for a Sustainable Future' (paragraph 119), the Secretary General expresses concern that 'access to vital and environmentally sound technologies is today unevenly spread, both within and between countries, with the poor and many developing countries essentially locked out' and that 'we have a long way to go to reach the necessary level of participation of women and girls in science, technology (including ICTs), engineering, and mathematics for the world in the 21st century'⁴⁵.

These are issues that Swaminathan has championed relentlessly at IRRI and MSSRF for more than 30 years. And in keeping with his orientation towards action and echoing the approach that underpinned the Cambodia programme outlined above, the Secretary General advocated (paragraph 121) for 'support that will allow (developing countries) to benefit from enhanced access to these technologies, and, ultimately, to expand domestic innovation and the development of *their own* technological solutions'⁴⁵. Towards this end, the Secretary General urged UN Member States to establish a 'Technology Bank' that would serve as 'Science, Technology, and Innovation Capacity Building Mechanism' for developing countries (paragraph 126). The latter proposal is remarkably similar to Swaminathan's proposal 32 years earlier for what he called 'international and regional brain banks' from which countries could receive 'objective and up-to-date advice on technology choice and transfer'²⁹.

Commitment to human dignity has unquestionably been a core value that has driven the life and work of Swaminathan. *The Road to Dignity*, so eloquently laid out by Secretary General Ban Ki-moon, is rich with ambition and good intentions. Yet experience tells us that ambition and good intentions are not sufficient for creating lasting impact. Among Swaminathan's many valuable lessons was to distinguish between 'know how' and 'do how'³. As we embark on the post-2015 development agenda, it is important that we understand the importance of translating 'know how' into practice through 'do how' in the service of the poor and marginalized. In so doing, in the words of the Secretary General, we may indeed achieve 'a life of dignity for all, leaving no one behind'. For us all to commit to this vision would be M. S. Swaminathan's enduring legacy for humanity.

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