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The Triumphant Cassava Chronicled by Foresight, Political Will and Accountability

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Abstract

In terms of production, area planted and more importantly, the number of dependent families, cassava is one of the most important crops in the contemporary world, probably next only to the prominent three food crops, rice, wheat and maize. The fact that cassava attained the greatest leap in production and the area harvested and one of the highest yield improvement among the world's major food crops in the last 30 years suggests the great potential of cassava for future as well. In a worldwide comparison among the three major root crops, i.e. potato, sweet potato and cassava, cassava is now the first in total area harvested, production (calorie basis) and yield (calorie basis). In the last 30 years, the area planted with potato and sweet potato actually decreased and the yield mostly stagnated. In contrast, during the same period, cassava production more than doubled in Africa and Asia, in the former mainly due to the increase in area and in the latter, very dominantly due to the improvement in yield. The inherent strength of cassava in producing robust yields even under harsh conditions may be the main reason for cassava's success in Africa. The introduction of new high yielding, high starch varieties may be the major driving force for the great yield improvement in Asia.

Despite all these successes and the undeniable importance, cassava is only remotely recognized worldwide even nowadays. It was nearly a totally neglected commodity until recently. Yet, there were nameless pioneers who had domesticated wild plants to be a great crop of future, the cassava. There were men of scope who recognized not only the incumbent importance but also the untapped potential of this crop more than 40 years ago. There were men of determination who paved the way to bring cassava to the international research attention. It was extremely fortunate for researchers to follow cassava breeding based on excellent genetic material under a nearly ideal institutional arrangement provided by these pioneers of foresight and political will. A detailed account of the cassava development, particularly the varietal improvement and trends in area, production and productivity in the recent years, the political will and foresight of the pioneers in cassava development and the accountability of researchers are discussed in this paper.

Key words: Cassava, CIAT, foresight, accountability, varietal improvement

Cassava – a conspicuously unrecognized, yet significant crop

In the recent issue of the most influential popular scientific journal in the world, Scientific American, an article captioned "The 3rd important calorie producing crop in the world" (Nassar and Ortiz, 2010) appeared, describing cassava as an important crop providing daily staple for more than 800 million people, argued for recognizing its significance and potential. However, at the same time, in the encyclopedic book "World History of Varietal Improvement – Crops" (Ukai and Osawa, 2010) published in Japanese featuring 21 representative crops, it was surprising to note that there was no mention of cassava, while seemingly less weighty crops such as buckwheat or sugar beet were included in the list. This is a clear indication of the stereotype understanding on world crops in Japan and probably in many parts of the world as well. Then, the somewhat zealous description of cassava as the 3rd most important crop of the world in Scientific American and the total disregard of this crop in the list of "representative crops that have been sustaining the human society" in World History of Varietal Improvement - Crops do not go together. This is indeed a remarkable contrast. Against this background, based on macro statistics on world crop production and also using micro data gained from experiences, the present status of cassava as a world crop and the progress made in recent years is detailed below.

Historical perspective

Cassava has been deeply involved in the history of human beings, originally in the American Continents, later in Africa and more recently in Asia. While it can tolerate dry climates and poor, acid soils, it is susceptible to excessive moisture and cold temperature, limiting the cultivation of this crop to the tropics and subtropics. Even in tropical countries, cassava has been regarded as a crop grown in marginal lands by small farmers and consumed by poor people. This and the absence of production in developed countries are the reason why cassava has seldom attracted research attention in the past. However, cassava is a great crop as indicated by every statistical hard data shown later. Being utilized worldwide for human foods (roughly 60%), food and industrial starch (20%) and animal feeds (20%), cassava is a multi-purpose crop containing the elements of rice, maize and soybean, all together.

The origin of cassava in the South American Continent is believed to go back to some 7000 BC. But because of the soft tissue nature of its root and stem there was no conclusive material remain of cassava from the ancient times and it is difficult to accurately estimate the exact date of domestication and the beginning of cultivation (Hershey, 1987). Earthen vessels (huacos) modelling after cassava roots are commonly excavated from the remains of the pre-Inca civilization of Chimu Dynasty (850 -1470 AD); hence, cassava must have been a well established crop in the Andean/Amazonian areas by that time (Fig. 1). Since most cultures of the American Continents before the Conquistadores era had no habit of recording events with letters, there was little literary descriptions of cassava until recently. It was actually Charles Darwin, a traveller from outside, who made a vivid account of cassava and its highly versatile uses in his book "The Voyage of the Beagles" (Darwin, 1839). It described that Mandioca or cassava was cultivated in great quantity and every part of this plant was useful: the leaves and stalks were eaten by the horses and the roots were ground into a pulp, which, when pressed dried and baked, formed the farinha, the principle article of sustenance in Brazil.

Fig. 1. Earthen vessel (Huaco) of Chimu Dynasty, Peru, modelled after cassava roots

In spite of its versatility, cassava had to wait another 140 years before it began to attract worldwide research attention, until a comprehensive cassava research program with world mandate was established in CIAT (Centro Internacional de Agricultura Tropical) in Colombia in the Continent of the origin and diversification of this crop and another international cassava research program in IITA (International Institute of Tropical Agriculture) was established in Nigeria, in the Continent of acute importance of this crop in the early 1970s.

During 1974, when initial evaluation of the vast germplasm of cassava and start of the breeding programme was in operation at CIAT, Jack R. Harlan, representing the 20th Century American Agronomy visited and was exposed to every corner of the more than 2000 entries of cassava collection, with a passionate desire to convince him of the importance of cassava and its great genetic potential. This meeting resulted in a catalytic effect, with him describing cassava at length in his monumental book, 'Crops and Man', in the revised edition (Harlan, 1992) from the original edition (Harlan, 1975). Later, the cover article on the potential of cassava that appeared in one of the 1982 issues of Science written by James H. Cock, the then CIAT Cassava Program leader, may probably be the first occasion when cassava's potential was given a spot light in a major scientific journal (Cock, 1982). It is worthy to mention that the actual cassava development since then has far indeed outpaced what was predicted in that article. By this time, cassava as a crop of great potential had been gradually recognized and nearly every text book published thereafter in the USA and Europe dealing with representative crops of the world could not do without featuring cassava (ASA and CSA, 1980; Maxwell and Jennings, 1980; IRRI, 1983; OECD, 1993).

Accordingly, cassava's role in human society was increasingly calling the attention of world celebrities who were not researchers. For example, Bill Gates took a notice of African Mosaic Virus of cassava as one of the most devastating crop diseases in the world and suggested that it would be a historic contribution if this disease could be eradicated with the help of biotechnology (Gates, 2000). Jared Diamond once remarked that as the much reputed biotechnology was a technology mostly for large enterprises and rich farmers so far, if it were truly aiming at the welfare of human kind, it should solve the problems of crops grown by small, poor farmers such as cassava (Diamond, 2005).

During the past 30 years, cassava nearly completely converted its image from a traditional food crop to a major source of food and industrial starch and feed in many parts of Asia, especially in Thailand and Vietnam, where the cassava production and processing evolved into a giant export-oriented industry. Yet, the actual cultivation of the crop is still nearly entirely left to the millions of small farmers who bring their products to the factories for cash income (Fig. 2). In Africa, cassava is supporting the ever increasing population as a basic daily staple. There is ample potential for further improvement in yield and utilization in that Continent. Cassava's importance would never dwindle in future Africa.

Fig. 2. Cassava starch factory in Tayninh, Vietnam in 2009. Small farmers bring in their harvest here to get cash income. Processed starch is sold mostly to China. This type of starch factories mushroomed in many parts of Asia

Trends in area, production and productivity

According to Food and Agriculture Organization (FAO, 2011), wheat, rice and maize take a prominent status because of their predominantly large area harvested. This given, when we consider the increase or decrease in the past 30 years from 1979 to 2009 (the most recent year in which the data are available), cassava occupies the first place in nearly every important statistics (Table 1). Among the nine most important food crops of the world (harvested area more than 10 million ha), cassava is the only crop, which more than doubled the production during the 30 years and among the only three crops (others are maize and rice) that increased the total area harvested in the same period, cassava being the distinct first (+43.9%) among the three. Cassava's mean yield (t ha^{-1}) increased by 40.3% during the same 30 years largely at par with the other three prominent crops. Thus, the designation of cassava as the third most important food crop by the Scientific American article may not be an outright exaggeration, especially when the future potential is taken into account. On the other hand, the omission of this crop from the list of 21 important crops of the world in World History of Varietal Improvement - Crops is a downright mystery, nearly an equivalent of writing the history of Soccer World Cup without mentioning Brazil.

Table 1. World's 10 most important food crops[1] in the order of the change in total production in the past 30 years to 2009[2]

Crops	Total production		Harvested area		Mean yield	
	Change in 30 years to 2009 (%)	In 2009 (million ton)	Change in 30 years to 2009 (%)	In 2009 (million ha)	Change in 30 years to 2009 (%)	In 2009 (t ha-1)
Cassava	+101.1	240.9	+43.9	19.0	+40.3	12.64
Maize	+95.3	816.8	+29.0	159.5	+51.5	5.12
Rice	+80.6	677.9	+14.4	161.4	+59.9	4.20
Wheat	+61.1	680.8	-1.4	225.4	+63.2	3.02
Millet	+31.5	31.9	-5.0	35.4	+38.5	0.90
Potato	+10.0	329.5	-4.6	18.3	+11.5	17.98
Barley	-3.2	149.9	-35.3	54.1	+47.9	2.77
Sorghum	-5.3	62.1	-1.3	43.7	-4.1	1.42
Sweet potato	-21.9	107.6	-26.6	8.5	+6.4	12.60
Oats	-45.3	23.0	-60.3	10.3	+37.9	2.25

1. Harvested in more than 10 million ha (except for sweet potato) in 2009. In addition to these important food crops, soybean, sugar cane, rape seed and coconut must be counted as world's important crops
2. FAO/STAT 2011

The predominance of cassava becomes even more apparent when we compare the recent history of three basic root crops, potato, sweet potato and cassava. Sweet potato decreased its harvested area drastically (-26.6%) and potato did the same significantly (-4.6%) during the recent 30 years, while cassava greatly increased its harvested area in the same period (+43.9%). It also improved its yield highly successfully during the same period (+40.3%), while potato and sweet potato did the same only modestly (+11.5% and +6.4%, respectively). Accordingly, the total production of cassava had a phenomenal increase (+101.1%) while that of potato increased only modestly (+10.0%) and that of sweet potato decreased very significantly (-21.9%). Considering the much higher root dry matter content of cassava than potato (nearly twice on an average), the worldwide calorie production and the calorie yield of cassava exceeded that of potato and the difference would further widen in future. It is nearly a monopoly of triumph by cassava.

An intercontinental comparison of cassava production figures also leads to an interesting insight (Table 2). Now, slightly more than half (51.5%) of cassava is produced in Africa and its increase in the past 30 years is amazing (+157.4%), of which the increase in harvested area (+77.2%) is the primary cause followed by the yield improvement (+45.3%). Virtually all the cassava produced in Africa is consumed as human food either

Table 2. Cassava production figures and the change in the last 30 years to 2009 in three continents

Continents	Total production		Harvested area		Mean yield	
	Change in 30 years to 2009 (%)	In 2009 (million ton)	Change in 30 years to 2009 (%)	In 2009 (million ha)	Change in 30 years to 2009 (%)	In 2009 (t ha-1)
Africa	+157.4	124.6	+77.2	12.33	+45.3	10.1
Asia	+101.7	81.5	+13.0	4.04	+78.8	20.2
America	+12.7	34.7	-3.1	2.67	+16.1	13.0

directly or after light processing. Asia now produces some 33.7% of world cassava and the increase in the past 30 years is also impressive (+101.7%), of which the improvement in yield (+78.8%) is clearly the dominant factor. This increased cassava production in Asia is used almost entirely for processing into food and industrial starch and animal feeds. In the American Continent, the production and yield showed some increase and the harvested area slightly decreased during the same period.

Cassava production figures in major cassava producing countries in Asia give a diversity of developmental processes in different countries (Table 3). In Thailand where the production increase during the past 30 years was the highest (+171.0%), the increase has been brought about equally by the increase in harvested area (+66.9%) and improved yield (t ha^{-1}) (+62.3%). The increased acreage was mainly induced by the increased demand for cassava product for export and the improved yield was caused primarily by the new high yielding, high starch varieties which had nearly completely replaced the traditional varieties and secondly by the improved cultural practices.

Vietnam accomplished an equally impressive production increase during the same period (+150.1%), but this was nearly entirely due to the improved yield (+127.0%) brought about by the new high yielding, high starch varieties which had replaced the traditional varieties in more than 70% of the national acreage.

Indonesia too achieved a significant production increase (+60.3%) but its cassava acreage actually declined (-18.3%) during the same period, thus, its production increase was solely due to the improved yield (+96.3%). This progress in production efficiency was much due to the new high yielding, high starch varieties and improved agronomic practices in Sumatra, the center of cassava production for processing in this country.

India also attained a very impressive production increase in the last 30 years (+59.1%) while its acreage decreased significantly (-22.5%), indicating that its successful production increase was solely due to the enhanced production efficiency (yield, +105.3%). Besides, India boasts the highest yield in the world (34.4 t ha^{-1}). This great yield improvement was achieved through an entirely different pathway from other countries. While cassava's most distinct advantage is its ability to give yield more than reasonably well under dry conditions on nutritionally poor soils where most other crops fail, it was experimentally proven that cassava could produce one of the highest yield (in the order of 79 t fresh root ha^{-1} year^{-1} or 28 t dry root ha $^{-1}$ year^{-1}) under favorable water availability on fertile soils (CIAT, 1978; 1980). India had developed a highly successful cassava production scheme with irrigation and adequate fertilizer application for factory starch processing, supported by a good selection of varieties and cultural practices, thus pushing India to a world unique position in cassava production efficiency.

China also has increased its cassava production significantly during the same period (+49.1%) through corresponding increase in harvested area (+26.0%) and yield improvement (+18.3%). Its yield improvement was partially successful due to the introduction of new

Table 3. Cassava production figures and the change in the last 30 years to 2009 in major cassava producing countries in Asia

Countries	Total production		Harvested area		Mean yield	
	Change in 30 years to 2009 (%)	In 2009 (million ton)	Change in 30 years to 2009 (%)	In 2009 (million ha)	Change in 30 years to 2009 (%)	In 2009 (t ha^{-1})
Thailand	+171.0	30.09	+66.9	1.327	+62.3	22.68
Vietnam	+150.1	8.56	+10.3	0.509	+127.0	16.82
Indonesia	+60.3	22.04	-18.3	1.176	+96.3	18.75
India	+59.1	9.62	-22.5	0.280	+105.3	34.37
China	+49.1	4.51	+26.0	0.270	+18.3	16.67
Philippines	+0.2	2.04	12.2	0.216	-10.7	9.47

varieties, however, it is not as spectacular as in the previously described four countries, probably due to the comparative difficulty or limitation (short growing period) of growing cassava in subtropical environment.

The Philippines is the only country where the cassava production did not increase in any appreciable degree and the yield actually decreased significantly (-10.7%) during the past 30 years. Many new varieties have been named, but the absence of effective technology transfer scheme and the lost opportunity for establishing the processing industry for capturing the growing market were the reasons for the slumping cassava production in this country. Once renowned as a rising star of Asia 50 years ago, the Philippines has stagnated in social development as indicated by such public measures as the number of hospital beds per population, infant mortality rate, disparity between the poor and the rich or GNP per capita in recent years. A humble process such as cassava development could not escape from this larger scale slump of society at large.

CIAT germplasm and varietal improvement

The monumental production increase of cassava in Asia during the past 30 years has been accomplished predominantly through the improvement in yield. The introduction of new high yielding, high starch varieties were the major factor for this yield improvement. During this period, a total of 52 CIAT-related new varieties have been officially released in seven countries in Asia, except India, and by 2008, virtually all the new cassava varieties were adopted by the farmers except in India, accounting for 51% of the total cassava area in Asia in 2008 (Howeler, 2008; Rojanaridpiched, et al., 2008; Kim et al., 2008). It leaves little doubt that the CIAT-related varieties have been the basic driving force for the great cassava production success in Asia.

The breeding scheme that produced these varieties started in January 1973 under the Cassava Varietal Improvement Programme. It started with the evaluation of the vast cassava germplasm comprising more than 2000 accessions collected throughout the center of origin and diversification of this crop (Kawano et al., 1978a), soon followed by the establishment of basic breeding methodology (Kawano et al., 1978b). As such a comprehensive varietal improvement program, based on virtually the total genetic variability the species *Manihot esculenta* possessed, proceeded with ample human and institutional supports (Fig. 3), tens of thousands of new genotypes were produced annually and thousands of clones were passing through the pipelines of selection every year. The whole scale upgrading of basic yielding ability by improving the harvest index (ratio of root weight to the total plant weight) of the breeding population, the tolerance to dry climate, the adaptation to poor, acid soils and the resistance to diseases, mainly Cassava Bacterial Blight, were the major progress made during the first 10 years of breeding operation at CIAT, Colombia

Fig. 3. F1 selection at CIAT, Colombia in 1976. With 2000 accessions from the centre of origin and diversification, 20 ha of field space for experimentation and 20-strong field hands, it was a good beginning

Subsequently, taking clue from the advice of Peter R. Jennings, the founder of the Varietal Improvement Department at IRRI (International Rice Research Institute, Philippines) then stationed at CIAT, who advocated the grand theory of crop production likely to have greater success outside the center of origin of the crop (Jennings and Cock, 1977), the CIAT Asian Cassava Varietal Improvement Program was started in April 1983 in a joint operation with the Department of Agriculture in Thailand and in close cooperation with agricultural research institutions in the Philippines, Indonesia, Malaysia, China and Vietnam (Fig. 4). The breeding program based on the hybridization between Thai and CIAT/Latin American material have been a great success especially in combining high yielding capacity with high root starch content. During the 15 years since 1983,

Fig. 4. F1 selection of the CIAT/Thai collaborative program at the Rayong Field Crops Research Centre, Thailand in 1997. This particular operation was assisted by some 70 people; all but one (the author) were employees or workers provided by the Thai Department of Agriculture. Many successful varieties in Thailand and other Asian countries originated here

some 6,00,000 genotypes have been introduced from CIAT/Colombia and CIAT/Thai program to other Asian national programs (mostly in the form of F1 hybrid seeds and a few hundreds clones).

The varieties selected from these sources and officially released have been quickly adopted by the farmers and are very successful especially in Thailand, Vietnam and Indonesia. The additional economic gain generated by the adoption of these new CIAT-related varieties was estimated to be more than one billion US dollar accumulated till 2000 and in recent years that amount increased annually (Kim et al., 2001; Howeler, 2008). It should be noteworthy that a large portion of this additional economic effect has entered and is entering the household income of the millions of small, many of them actually poor, farmers. In many rural places where cassava is grown for sale to factories, we can meet many small farmers one after another, who very willingly testify that their lives are better now. Thanks to the additional cash income brought about by the new high yielding cassava varieties.

The domestication of crop plants is nearly synonymous to the invention of agriculture that introduced a drastic change to human society. As wealth accumulated, culture and civilization flourished, but the magnitude of exploitation, discrimination and mass murdering had also escalated. Human civilization is a crop breeding civilization. It can be considered as the greatest scientific event in human history even comparable with the later industrial revolution or the present information revolution. Breeding is one of the most interesting human undertakings even in our times.

Foresight and political will

The very basis of the progress in cassava development can be traced back to the foresight and political will of the leading figures who had identified cassava's future potential, led the way of taking this crop to get major international research attention and organized the international collection of cassava germplasm more than 40 years ago. The decision to engage CIAT to start a comprehensive cassava research program is believed to be initiated by a highly reputed Canadian research leader, Joseph Hulse, the then Director of IDRC (International Development Research Centre, the Canadian Government channel for international research cooperation), who later became Deputy Director General and in the end, Chairman of the Board. He deputed his disciples as the founding board members of CIAT to establish a cassava research program with world mandate and secured Canadian Government funds for this. Eduardo Alvarez-Luna, the founding Deputy Director General of CIAT, was well aware that genetic variability was crucial for the success of the CIAT Cassava Program. As if to anticipate the days of intellectual property right on genetic resources 30 years later, Alvarez-Luna gave freedom to collect cassava land races from every cassava growing country in Latin America, on a gentleman agreement that the collected germplasm would be used only for the common good of human beings without seeking any monetary profit and the advanced breeding material generated from these germplasm would be returned to the country of origin without any conditions. Ampol Senanarong was Director General of the Department of Agriculture (later Minister of Agriculture and Cooperatives), Thailand, when the collaborative breeding program based on the hybridization between Latin American germplasm and Thai varieties was starting to produce promising results. Senanarong in his address at the annual conference of the Department of Agriculture opined that genetic resource was a touchy issue in the present day context. Nevertheless, Thailand was the primary country to receive the benefits from the broad genetic material brought in by CIAT and the advanced varieties selected from the hybrids between Thai material and these materials, he added. Hence, it should be recognized that CIAT brought out these materials produced in Thailand based on their own and Latin American material to other Asian countries for fairness. While Thailand was the most advanced in terms of cassava production, processing and export at that time, it was obvious that other countries, especially Vietnam and Indonesia, would soon be strong competitors. This broad-mindedness should be profoundly appreciated.

Foresight is based on wide vision and deep insight. Political will is defined by the power to carry out the foresight and the ability to negotiate. While one should be greatly thankful to these leading figures for cassava improvement, it may not be an overstatement that the Asian cassava, if not the world cassava, is much indebted to the foresight and political will of these great luminaries.

Accountability

The concept of accountability seldom comes to consideration in most Asian countries. Even in Japan where the history of science and its social engagement is comparatively long, the consciousness of Scientists rarely goes beyond their immediate day to day responsibility. In CIAT Cassava Program, the research target was a typical small farmers' crop, cassava; hence, every one was firmly convinced, ever since the beginning, that if agricultural research or technology did not reach the neediest people, it was not of any use and a wasteful exercise. In the case of varietal improvement, since the work relied on genetic resources, a common human heritage, one was held accountable for a wider social engagement. It was very fortunate in having been able to carry on the breeding career with limitless genetic material, abundant budget and plenty of man power. As such in retrospect, one has been conscious of accountability at three phases, i.e., with respect to (1) research and technology, (2) social engagement and (3) history.

At the research and technology phase, the original breeding and selection scheme set up in the beginning years at CIAT, Colombia had been unshakable and defined the basic structure of varietal improvement for many years to come (CIAT, 1973; 1974). The first major action was the comprehensive evaluation of germplasm material (Kawano et al., 1978b; Hershey and Kawano, 1982) followed by the definition of breeding methodology on handling genetic materials (Kawano et al., 1978a; Kawano, 1980), on yielding ability (Kawano and Thung, 1982; Kawano et al., 1998) and on broad adaptability (Irikura et al., 1979; Kawano, 1990). There were ample opportunities to experience specific undertakings such as chemical component of breeding (Gomez et al., 1980; Kawano et al., 1987), disease resistance breeding (Umemura and Kawano, 1983; Kawano et al., 1983) or insect resistance breeding (Bellotti and Kawano, 1980). By recording all these processes in scientific articles, there was fulfillment of an important part of responsibility by the researcher. Yet, the most crucial responsibility of a breeder or researcher is the generation of useful breeding material and the delivery of recommendable varieties. In this respect too, by transferring tens of thousands of new genotypes to national programs and sending many useful new varieties to the production fields, this criteria had been satisfactorily fulfilled (Kawano, 1995; 1998; 2003).

At the social engagement phase, convincing data on the dissemination of new varieties and the economic effects they generate and its distribution to the neediest strata of society are necessary. Fortunately, there have been many third parties and occasions that conducted the collection of the data (Kim et al., 2001; Howeler, 2008), which conclusively proved the above assumptions. Since the primary and principle recipients of technology, new improved varieties in this case, are small farmers, the original promise of delivering new technology to those who were most anxiously waiting for it to improve their humble lots had also been fulfilled. Nevertheless, the social responsibility of the breeders expands to the whole environmental issue beyond the conventional domain of mere varietal improvement. Cassava has the reputation of being a crop of ruining soils, for which chemical (soil nutrient degradation) and physical (soil erosion) processes are traditionally attributed. While the former is largely unfounded (Howler, 1991), the latter is a fate of upland crops; cassava being one of the most vulnerable. Some measures to minimize erosion with cassava have been developed (Howler, 1995; Watana et al., 2008); however, there is no panacea for all the situations. In places such as Vietnam, where the adoption and expansion of new high yielding varieties took place rapidly, one can observe both the negative side of cassava expanding into erosion-prone sloppy areas driven by the new economic opportunity and the positive side of enhanced awareness for soil conservation induced by the additional value attached to the farm land. Hence, accountability of an Agricultural Scientist expands to such environmental issues also.

With respect to history, it is believed that by producing useful varieties utilizing cassava germplasm collection and making them available to more people, rich tributes have been paid to the people in the centre of cassava origin and diversification who had been preserving their own land races and their ancestors who had domesticated wild cassava to the present cultivated one. To those countries that had allowed CIAT to freely collect cassava germplasm in their lands; this friendly gesture had been at least partly reciprocated by returning the improved germplasm to them. Behind all these, there has been a firm consideration that crop genetic resources were a common human heritage and it was the duty of Agricultural Scientists to utilize these resources for the welfare of the people who have been most acutely waiting for the useful technology.

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