E

March 2012

منظمة الأغذية والزراعة للأمم المتحدة | 联合国粮食及农业组织 | Food and Agriculture Organization of the United Nations | Organisation des Nations Unies pour l'alimentation et l'agriculture | Продовольственная и сельскохозяйственная организация Объединенных Наций | Organización de las Naciones Unidas para la Alimentación y la Agricultura

COMMITTEE ON AGRICULTURE

Twenty-third Session

Rome, 21 - 25 May 2012

Crop Improvement for the 21st Century

Introduction

1. Current crop production systems could not feed the projected global population of over 9 billion by 2050. A significant increase in global food production will be required[1]. This increase must be achieved in the face of challenges that include increasing competition for arable land and water, urbanization, changing diets and climate change. A central question is how to realign crop improvement, the scientific alteration of the genetic patterns of crops in order to increase their value, so that the world can have the suitable crop varieties that enable the sustainable intensification of food production to meet increasing demands while reducing agriculture's adverse effects on the environment.

2. The *Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture* agreed by the Thirteenth Regular Session of the Commission on Genetic Resources for Food and Agriculture and adopted by the FAO Council in 2011, lays out priorities for managing, safeguarding and using plant diversity to address the generational challenges of food insecurity. Towards this end, crop improvement has to be reoriented to produce the "smart" crop varieties that yield more with fewer inputs. Innovation and efficiency will be key in achieving this aim. Four considerations for reorienting crop improvement strategies for the challenges of the 21st century are proposed.

Developing "smart" crop varieties for a wide range of agro-ecosystems

3. The full range of the heritable diversity of plant genetic resources for food and agriculture (PGRFA), including those of underutilized crops[2] and neglected species, that are conserved ex-situ, on-farm and in situ, must be accessed in order to discover beneficial traits and combine them into the "smart" crop varieties which are adapted to changing climatic conditions in line with FAO's work on Sustainable Crop Production Intensification (SCPI)[3]. FAO's publication, *Save and Grow*, posits that "*a genetically diverse portfolio of improved crop varieties, suited to a range of agroecosystems and farming practices, and resilient to climate change*"[4] is key to sustainable production intensification. Deploying the widest possible genetic diversity, including crop wild relatives and better genetic

[1] FAO. 2009. *How to Feed the World in 2050*.
[2] Crops such as sorghum, millets, pulses, roots, tubers, vegetables and oilseeds
[3] COAG/2012/5- Sustainable Crop Production Intensification
[4] FAO. 2011. *Save and Grow – a policy makers guide to the sustainable intensification of smallholder crop production* .

understanding of local pest, disease and weed populations, in crop improvement is indispensable for attaining this goal. Pre-breeding, whereby germplasm curators and plant breeders work together to use heritable variations from non-traditional gene donors to produce populations of intermediate materials that can then be used in breeding, is increasingly important in achieving this diversification. Recently, a well-received e-learning course on pre-breeding[5] has been developed by FAO and partners.

Innovations for realigning plant breeding programmes

4. Crop improvements through plant breeding has accounted for more than 50 percent of increases in yield[6]. The increased rice production in sub-Saharan Africa due to the development and wide dissemination of the New Rice for Africa (NERICA) is a good example. To re-enact such gains routinely, the current yield-centric breeding practices, with their objectives often conceived solely by the plant breeders for ideal, research station conditions, must evolve into participatory, multi-disciplinary and demand-driven programs that leverage suitable scientific and technological tools to harness the potentials of PGRFA. In addition to high yields, new elite varieties must be adapted to extreme weather conditions, including the evolving new biotypes of pests and diseases, and prevailing farming conditions; make more efficient use of inputs, and have improved nutritional qualities.

5. Innovations in biotechnological tools, bioinformatics, information technology infrastructure and high throughput assay platforms that allow precise genotyping and phenotypic evaluations must be used more widely and routinely in breeding programs. For instance, molecular breeding techniques demonstrably facilitate increased efficiency in sourcing and deploying genes from novel sources[7] but its use has been for too long largely restricted to multinational plant breeding and seed companies. Better networking and links among the global range of national and international plant breeding and research institutions, deploying modern Information and Communication Technologies will further accelerate progress.

Strengthening the 'Crop Improvement to Seed Delivery Continuum'

6. Maximizing the benefits from PGRFA sustainably requires the comprehensive strengthening of, and forging of linkages between, the three components of its value chain: i) conservation, ii) plant breeding, and iii) the delivery of well-adapted, high quality seeds and planting materials to growers. This "PGRFA continuum[8]" underpins the successful implementation of the *Second Global Plan of Action* as well as the International Treaty on PGRFA. Well-characterized crop germplasm are required for plant breeding just as an effective mechanism is needed for delivering seeds and planting materials of improved varieties to the growers. Any weakness in this continuum truncates the value chain and effectively scuttles all the efforts to grow the most suitable crop varieties. National PGRFA strategies that institutionalize the continuum approach are being developed and promoted in countries.

Winning partnerships, networks and institutional capacities

7. Reorienting crop improvement for sustainable food production will require a broad range of partnerships. A partnership that integrates local knowledge and brings together relevant private and public sector entities including National Agricultural Research Systems, centres of the Consultative Group on International Agricultural Research, and regional research and development networks is imperative for success. Multi-national and local seed companies are increasingly partnering with the public sector where markets, enabling policy environments and legal frameworks that stimulate investments are available. As public investment in crop breeding programs is shrinking, the development and deployment of elite varieties of crops not handled by the private sector is largely neglected to the detriment of food security. These new dynamics must be factored into the devising of policies and the fostering of institutional collaborations and partnerships. In order to have the critical

[5] Pre-breeding e-learning course at http://km.fao.org/gipb/
[6] Fernandez-Cornejo J. 2004. The Seed Industry in US Agriculture. AIB 786. USDA, USA.
[7] Strengthening Plant Breeding Capacities: CGRFA/WG-PGR-5/11/Inf.4
[8] Mba *et al.* 2011. *PGR.* doi:10.1017/S1479262111000943

mass of adequately skilled personnel driving this envisaged re-orientation, related education curricula in universities need thorough revisions in order to incorporate innovative efficiency-enhancing scientific and technological methodologies, policy and legal issues and PGRFA-related norms into the training programs for the 21st century plant breeders.

Perspectives on way forward

8. There is a compelling urgency to develop and deliver suitable crop varieties. To achieve this, the major bottlenecks – inadequate investments and human resources, weak institutions and lack of enabling policy environment in most developing countries[9] [10] – must be addressed immediately. Concerted efforts are required to support ongoing activities on:

- The assemblage and translation of relevant crop improvement related best practices into a toolbox of actionable policy interventions.
- The development of national strategies for the PGRFA management continuum as contribution to the implementation of the *Second Global Plan of Action*.
- Strengthening of national capacities for developing and implementing relevant regulatory frameworks and national legislations in line with global instruments such as the International Treaty.

9. The FAO-led Global Partnership Initiative for Plant Breeding Capacity Building[11] is contributing to the enhancement of capacities, the fostering of partnerships and the provision of policy assistance for result-oriented crop improvement programs. There is a need for sustained support to this multi-stakeholder platform in order to scale up its activities that contribute to global efforts for reorienting crop improvement for the food security of our changing world.

[9] Repinski *et al*. 2011. Crop Sci. 51:2325–2336.
[10] FAO. 2010. *The Second Report on the State of the World's PGRFA*.
[11] GIPB: http://km.fao.org/gipb/