Asian Journal of Crop Science

ISSN 1994-7879

science alert
http://www.scialert.net

ANSInet
an open access publisher
http://ansinet.com

Asian Journal of Crop Science 4 (4): 122-126, 2012
ISSN 1994-7879 / DOI: 10.3923/ajcs.2012.122.126

Bio-approaches and Technologies for Improved Crop Production in Northern Nigeria: A Review

A.M. Gumi and A.A. Aliero
Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria

Corresponding Author: A.M. Gumi, Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria Tel: +2348065974255

ABSTRACT

Poverty in Nigeria has been on the increase with rural populace (predominantly farmers) most affected, living on less than 1 USD a day. The country is now ranked among the poorest nations in the world. Increased crop productivity and yields through sustainable agriculture is considered vital to any poverty alleviation strategies. With the current expanding populations in these regions, farmers faces tremendous challenges such as environmental sustainability, crop improvement through genetic engineering (genomics), biotic constraint and diseases coupled with local expertise and participations. New bio-approaches and technologies such as effective irrigation methods, proteomics technology, bio-control approaches and solar energy with storage techniques will offer hope to crop producers in northern Nigeria and at the same time resuscitating sustainable agriculture. System wide adoption and implementation of these new technologies will leads to the attainment of sustainable agriculture in Nigeria within the next few years. The involvement of commercial partners (stakeholders), to actively adopt and implement these new technologies is recommended.

Key words: Poverty, crop production, emerging technologies, sustainable agriculture, Northern Nigeria

INTRODUCTION

Human beings are totally dependent on agriculture for food, which is essential for their survival and livelihood (Atkinson *et al*., 2007). Farmers in northern Nigeria currently experience yields in crop production that are far below world average and are too low to support the expanding populations in these regions. Concerns are also growing on long term sustainability of agriculture in Nigeria. Moreover, new technologies such as genetically engineered crops are not expected to be a major factor in increasing food production in developing countries during the next two decades (Hazelle, 1995).

CHALLENGES FACING CROP PRODUCERS IN NORTHERN NIGERIA

Sustainable crop production will offer promising hope and increase the Gross Domestic Product (GDP) of Nigeria in its quest to restore its ambition of being one of the 20 leading economy in the world. However, farmers in northern Nigeria face tremendous challenges in improving crop production in order to attain this long term sustainable yield. The most serious constraints that hinder sustainable crop productions in these regions are:

- Natural resources management (primarily soil and water); these include soil fertility and degradation, insufficient water coupled with inefficient irrigation techniques, lack of fertilizer, invasive weeds species, climate changes, desertification and drought
- Crop improvements; this among others include genetically engineered crops that will target traits such as- architecture (height, leaves and seed size, root length etc.), stress tolerant, herbivores deterrence, Biosynthesis of key metabolites, resistance to weeds and the herbicide that controls them, water use efficiency, flowering time and photoperiod response (Miflin, 2000)
- Biotic constraints; perspective from scientist globally have shown that disease and insect pests rob the world of more than 40% of the attainable yield of eight most important food crops (NRC, 2008). Among the biotic constraints facing crop production in northern Nigeria includes; plant diseases susceptibility, arthropods vectors, invasive species that threatens crop biodiversity
- Energy production and storage techniques; crop production in Nigeria is operated under energy limited system. Factors limiting energy rich agriculture include rural access to electricity, mechanised agriculture and solar energy techniques with storage batteries
- Local expertise and participation is among the stepping stone towards increased crop production in northern Nigeria. All trials should focus on locally grown crops under local environmental conditions

EMERGING ISSUES AND TECHNOLOGIES TO IMPROVED CROP PRODUCTION

The scientific and technological advances of the past century have greatly expanded the breadth and power of agricultural innovations. There now exist a remarkable array of technologies to improve crop production and many of them are now on practice, which include the following:

Technologies for natural resources management: The future of sustainable agriculture in Nigeria depends largely on proper management of natural resources, primarily soil and water. More than two third of agricultural land in northern Nigeria is considered to be degraded and the situation is equally alarming (FAO, 1992). Irrigated and dry land salinity also imposes serious threats to cropping lands in these as a result of poor water management. The technologies include.

Soil management techniques: Application of organic manure and mulching with green plants, controlled overgrazing and bio-solids integrations are among the promising techniques towards successful soil management practice (Chrispeel and Sadava, 1994).

Water management techniques: Effective and efficient irrigation methods, on site storage tanks to capture and store water in fields so as to minimize runoff water are among the techniques that could help address water challenges (IFAP, 2005).

Technologies for crop improvements: Crop performance is affected by a combination of many factors among which is the collection of genes that provide the plant with the potential for high yield in a farming environment (Abbott, 1999). It takes years to develop high performing plants and efforts in Nigeria have fallen behind though new tools and techniques are emerging that can speed improvements of local crops. The techniques are as follows:

Annotated crop genome sequencing: This technique helps to establish and find out the genetic sequence and individual gene function of local crops own by farmers. Documenting these genes sequence and functions will help in speeding crop breeding for sustained productivity (Miflin, 2000). Efforts are well underway to sequence the complete genome of *Arabidopsis*, rice and maize with the complete sequence of chromosome 2 and 4 been recently published (Lin *et al*., 1999; Mayer *et al*., 1999). Cook (1998) has outlined some of the methods that are being developed for collaborative crop plants project. The first approach is usually to search for homology with other known genes. Another approach to understanding the function of specific sequence is to observe their expression under a range of defined conditions using micro array technology (Ruan *et al*., 1998). Gong *et al*. (2011) established the sequence of a small heat shock protein (sHSP) gene using homology based gene candidate method and rapid amplification of cDNA ends (RACE). The cDNA sequence of this gene is 920 bp in size (GenBank: HM132040) and contains an open reading frame (ORF) of 636 bp, which was predicted to encode a protein with 211 amino acid residues. These studies and those in other species, show this has considerable potential as a powerful tool for plant gene discovery and functional analysis as well as aiding the understanding of genetic regulatory networks and gene interaction.

Germplasm techniques: Novel genes for improving a crop can come from plant, animal, or bacterial species and molecular techniques are used to introduce them into a candidate crop. Once they are introduced into a plant, conventional plant breeding approaches are used to incorporate them into the local, elite germplasm (Chrispeel and Sadava, 1994).

Biochemical engineering: Biochemical studies of plant metabolism have identified proteins crucial in the functioning of most pathways. Many key genes have been isolated by purifying and (partially) sequencing the proteins and then finding the corresponding cDNA and/or their genomic sequences. Knowledge of the changes in a specific plant function induced by different treatments has led to the development of methods to isolate genes involved in the metabolic pathways or their associated physiology (Miflin, 2000). Frequently studied pathways include Osmolyte production in plants under abiotic stress conditions; OA results in a number of benefits that sustain cell and tissue activity under stress conditions and as such proposed as an effective tolerance mechanism for abiotic stress (Sinclair and Muchow, 2001; Serraj and Sinclair, 2002).

Technologies to overcome biotic constraint: Among the technologies emerging that can effectively overcome biotic constraints (weeds, disease pathogens and pest) so as to ensure sustainable yield are:

Plant mediated gene silencing approach: This technique is used to induce plants to transfer pieces of genetic materials to other organisms, targeting and interfering with the interaction between the plants and the organisms at genetic level. This approach takes the advantage of the recently discovered powerful molecules known as small RNA, which play a role in plant development and resistance to stress. Plant-mediated gene silencing has shown promise for the control of viruses, nematodes and certain insects (NAS, 2009).

Bio-pesticides and Bio-control approach: This approach focuses on natural means of fighting biotic constraints of crop rather than synthetic chemicals in order to avoid environmental

degradation and pollution. Bio pesticides involve release of pest specific natural enemy to control its population and some allelopathic plants that can inhibit the growth of specific weeds while promoting that of agricultural crops (Bunza, 2010).

Disease suppressive soils: The use of disease-suppressive soils involves management practices that encourage crop-associated microbial communities that naturally reduce plant diseases and pests. These practices might include manipulating carbon inputs, using crop rotation sequences that increase the presence of beneficial organisms, or inoculating soils with disease-suppressive microorganisms (NAS, 2009).

Technologies for energy production and storage: Considering the weather types and temperature range in these regions (Northern Nigeria), solar energy technology will offer reliable energy needed for crop production due to its nature of being potentially scalable and in expensive to operate. Also, photosynthetic micro-base fuel produced from algae and cyanobacteria will excel well in these regions due to prevailing light and temperature of these locations (Singh and Gu, 2010).

Local expertise and participation: The emerging issues and technologies listed are interdependent. For a successful crop production, a system wide approach of all the techniques have to be implemented at local environmental conditions. Farmers need an opportunity to provide input and acquire information. These tasks require a committed, trained, local workforce-a workforce of extension agents, scientists and engineers that must be built with national efforts and international help (NAS, 2009).

CONCLUSION

A system wide adoption and implementation of these approaches and technologies will no doubt increase crop productivity and offer hope to poor communities in Nigeria on their quest for food security strategies and economic development within the next few years.

REFERENCES

Abbott, A., 1999. A post-genomic challenge: Learning to read patterns of protein synthesis. Nature, 402: 715-720.

Atkinson, G., S. Dietz and E. Neumayer, 2007. Handbook of sustainable development. Edward Algar Publishers, UK, ISBN 9781843765776, pp: 362-375.

Bunza, M.D.A., 2010. Biological Control: A Modern Approach to Disease, Pest and Weed Control. Pyla-Mak Publishers, Kaduna, Nigeria, pp: 7-9.

Chrispeel, M.J. and D.E. Sadava, 1994. Plants, Genes and Agriculture. Jones and Bartlett Publishers, USA., pp: 72-76.

Cook, R.J., 1998. Toward a successful multinational crop plant genome initiative. Proc. Natl. Acad. Sci. USA., 95: 1993-1995.

FAO, 1992. Sustainable Development and the Environment. Food and Agricultural Organization of the United Nations, Rome, Italy.

Gong, Z., W. Zhu, M. Lu and R. Chen, 2011. Cloning and expression of a small heat shock protein gene CaHSP24 from pepper under abiotic stress. Afr. J. Biotechnol., 10: 4968-4976.

Hazelle, P., 1995. Technology`s contribution to feeding the world in 2020. Proceedings of the Speeches Made at an International Conference, June 13-15, 1995, International Food Policy Research Institute, Washington, DC., USA.

IFAP, 2005. Good practices in agricultural water managements: Case studies from farmers worldwide. FIPA, International Federation of Agricultural Producers (IFAP), Paris, France. http://www.ifap.org/fileadmin/user_upload/ifap/items/WaterAuditsUnitedKingdom.pdf

Lin, X.Y., S.S. Kaul, S. Rounsley, T.P. Shea and M.I. Benito *et al*., 1999. Sequence and analysis of chromosome 2 of the plant *Arabidopsis thaliana*. Nature, 402: 761-768.

Mayer, K., C. Schuller, R. Wambutt, G. Murphy and G. Volckaert *et al*., 1999. Sequence and analysis of chromosome 4 of the plant *Arabidopsis thaliana*. Nature, 402: 769-777.

Miflin, B.J., 2000. Crop improvement in the 21st century. J. Exp. Bot., 51: 1-8.

NAS, 2009. Agricultural technologies to reduce poverty. Board on Agriculture and Natural Resources, The National Academies Press, Washington, DC., USA. http://dels-old.nas.edu/ag_technologies/biotic_constraints.shtml

NRC, 2008. Emerging technologies to benefit farmers in Sub-Saharan Africa and South Asia. Committee on a Study of Technologies to Benefit Farmers in Africa and South Asia, The National Academies Press, Washington, DC., USA., pp: 19-24. http://www. nap. edu/catalog/12455.html

Ruan, Y., J. Gilmore and T. Conner, 1998. Towards *Arabidopsis* genome analysis: Monitoring expression profiles of 1400 genes using cDNA microarrays. Plant J., 15: 821-833.

Serraj, R. and T.R. Sinclair, 2002. Osmolyte accumulation: Can it really help increase crop yield under drought conditions. Plant Cell Environ., 25: 333-341.

Sinclair, T.R. and R.C. Muchow, 2001. System analysis of plant traits to increase grain yield on limited water supplies. Agron. J., 93: 263-270.

Singh, J. and S. Gu, 2010. Commercialization potential of microalgae for biofuels production. Renewable Sustainable Energy Rev., 14: 2596-2610.