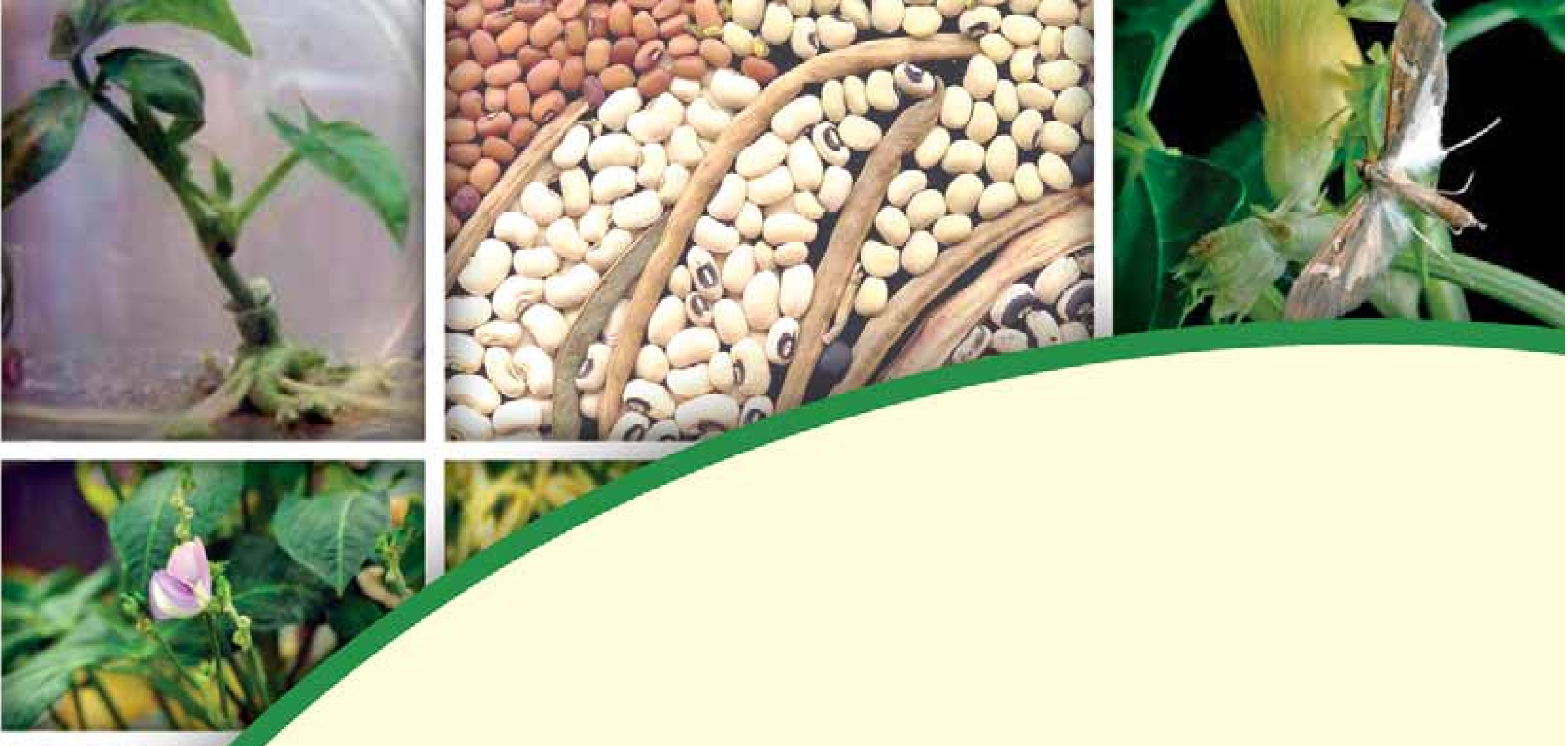

Development, testing, regulation and deployment of transgenic cowpea in Africa

Proceedings of a Cowpea Project Review and Planning Meeting

21 March 2007
Accra, Ghana

AFRICAN AGRICULTURAL TECHNOLOGY FOUNDATION
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Contents

Acronyms and abbreviations

AATF	African Agricultural Technology Foundation
ARIs	Advanced Research Institutes
AU	African Union
Bt	*Bacillus thuringiensis*
CBD	Convention on Biological Diversity
CBI	Crop Biotechnology Initiatives
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
ECOWAS	Economic Community of West African States
EFSA	European Food Safety Authority
EU	European Union
FAO	Food and Agriculture Organisation
FTO	Freedom to Operate
GM	Genetically Modified
GMOs	Genetically Modified Organisms
IAR	Institute for Agricultural Research [Zaria, Nigeria]
IITA	International Institute of Tropical Agriculture
FTO	Freedom to Operate
KT	Kirkhouse Trust
MPB	*Maruca* pod borer
NARS	National Agricultural Research Systems
NABDA	National Biotechnology Development Agency
NBFs	National Biosafety Frameworks
NGICA	Network for Genetic Improvement of Cowpea in Africa
NGOs	Non-Governmental Organisations
SSA	Sub-Saharan Africa
USAID	United States Agency for International Development
ABS	Africa Bio-fortified Sorghum

Background

Cowpea *(Vigna unguiculata),* whose global annual production stands at 7.6 million tonnes, is one of the most important food grain legumes in the tropics including Africa, which accounts for 64 percent of the world production (Mbene et al, 2000). The major cowpea producing countries in Africa are Nigeria, Niger, Mali, Senegal, Burkina Faso and Ghana with modest amounts emanating from the east African countries of Uganda, Mozambique, Tanzania, and to some extent, Ethiopia (Mbene et al, 2000). While cowpea leaves, green pods and green peas are consumed as human food, it is the protein-rich grains, prepared in different forms in different parts of the continent, that constitute the main food product of the crop. Dry haulms are often fed to livestock, particularly in the dry season, when animal feed is scarce making the crop an essential and integral component of sustainable crop-livestock farming systems in the semi-arid and arid regions of Sub-Saharan Africa (Ortiz and Crouch, 2001).

In spite of the significance of cowpea as a food crop to millions of people on the continent, grain yields today remain low averaging 0.3 tonnes/ha due to several biotic and abiotic factors. The adverse effects of some of these yield-limiting factors could be ameliorated through cultural practices, while others require genetic manipulation through breeding. For instance, modest levels of insect resistance have been developed in cowpea varieties against some of the damaging insect pests. However, while some sources of insect resistance have been reported in wild cowpea relatives (*Vigna* spp.) as well as other non-*Vigna* legumes such as African yam bean (*Sphenostylis stenocarpa*), none of these can inter-cross with cowpea via conventional breeding approaches (Machuka, 2002).

Yet losses due to insect pests alone have been documented to frequently exceed 90 percent (Murdock et al, 2001). While modest levels of insect resistance have been developed in cowpea varieties against some of the insect pests, there is virtually none with demonstrable resistance against *Maruca* pod borer (MPB), a serious field pest of cowpea in the cultivated cowpea genome (Machuka, 2002). However, it is known that insect pests, especially lepidopterans, can be controlled by *Bacillus thuringiensis* (*Bt*) – an ubiquitous, soil-dwelling, spore-forming bacterium – when applied topically on crops as spore formulations. Unfortunately, *Bt* sprays are often washed away by rain, degrade under solar ultra violet radiation and are not optimally targeted against certain insect pests that live within plant tissues. The limitations associated with the use of conventional methods in effectively dealing with cowpea's pest problem makes the application of biotechnological procedures for overcoming the constraints to cowpea production particularly attractive. With advances in molecular and cellular biology, it is now possible to engineer into plant genomes the genes that encode expression of crystal proteins, thus providing to the plant built-in protection against lepidopterans such as MPB. This effort is currently under exploration by a coalition of institutions to reduce grain yield losses in cowpea in Africa. If the *Bt* gene, which confers resistance to the pod borer, is transferred into improved cowpea varieties, the need for insecticide sprays to control the pod borer will be eliminated and smallholder farmers can substantially increase their yields and greatly enhance their nutritional and economic status.

However, experience with transgenic crops elsewhere (Canada, Australia, Brazil and Argentina) suggests that economic, marketing and consumer preferences as well as food, feed and environmental safety aspects be given early and full consideration. This is to ensure smooth progress in developing a transgenic crop variety and ease of delivery of the product to end users. In addition, it safeguards against potential technology backlash as has been demonstrated in some parts of the world where some consumers have reacted negatively to products from genetically modified (GM) plants that have occasioned blocking of GM grains and oilseeds from certain markets.

Furthermore, noting that once transformed, transgenic cowpea will be handled, tested and deployed as a regulated product, there is need to review regulatory and biosafety requirements essential for safely developing, testing and deploying high quality insect resistant cowpea varieties for utilisation by smallholder farmers in Sub-Saharan Africa (SSA). Clearly, any effort to genetically modify a crop like cowpea with the eventual goal of producing food and disseminating seed containing novel genes ought to be made in the context of social, economic and political considerations of the new technology and proceed in a safe and highly responsible manner (Murdock et al, 2001). FAO (2004) also supports a science based safety evaluation system that objectively characterises the benefits and risks of transgenic crops on a cautious and case-by-case basis.

To this end, the African Agricultural Technology Foundation (AATF) brought together partners and stakeholders from west Africa to examine progress so far made regarding cowpea improvement via genetic transformation and plan for additional work during the coming year. The overall objective of the meeting was to review the progress made in research, synthesise the results for the past year and focus on what needs to be done in the coming years. Specifically, the meeting focussed on aspects of product development (transformation and introgression), regulatory and biosafety issues, and how to deal with the general area of *Bt* cowpea technology acceptance to ensure full scale utilisation of GM technology in Africa. In addition, the requisite governance structure for the project was also discussed in order to shed light on the roles and responsibilities of partners engaged in this initiative.

Genetic transformation of cowpea

Progress

The need to develop an efficient and reproducible transformation system for cowpea was considered critical for the introduction of insect resistant genes into cowpea germplasm thereby complementing the ongoing efforts of conventional approaches to cowpea breeding in Africa.

Cowpea transformation based on Agrobacterium mediated system aided by an antibiotic selectable marker (*nptII*) has been developed at the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia (Popelka et al 2006). The choice of the system was based on freedom to operate (FTO) and the fact that *nptII* allows useful differentiation between transformed and untransformed tissue. The use of *nptII* with geneticin selection has increased efficiency of transformation.

The selection of the *Cry1ab* gene, provided by Monsanto through AATF's facilitation, has been instrumental in the synthesis and reconstruction of a new binary vector. This was done using the *nptII* gene linked to the *Bt* gene equipped with genetic promoters that regulate expression of *Cry1ab* gene in young green organs of the plant. In addition, the gene has been transferred to cowpea and resulted in the production of transformation events (using the IT86D-1010 line), five of which have produced seed and shown transmission of the *Bt* gene to the next generation. The *Cry1ab* protein can easily be detected using ELISA and Western blot techniques.

Although there is currently no *Maruca* in Australia due to extreme drought conditions, initial insect bioassays are under way using *Helicoverpa armigera*, an equally rapacious pest of cowpea. The results indicate that two lines, 356 and 81, have 100% protection against *Helicoverpa armigera*.

The challenge therefore for the continuation of the work remains obtaining the FTO from consumers and producers regarding the presence of *nptII* antibiotic marker, adherence to biosafety regulations in target countries, gene introgression, and the need to communicate the technology to the community at large. Specifically, priority areas in transformation work were highlighted as:

- production of large numbers of primary transgenics with *Bt* gene
- screening for high expressors for lines that transmit the gene and eventual segregation
- the urgent need to commission efficacy tests based on *Maruca*.

Issues of discussion and way forward

Gene expression

The meeting noted that gene expression of *Cry1ab* is rather widespread in most plant tissues including pollen and may become a concern for biosafety. This may not be peculiar to cowpea but other transformation work as well. Experience has shown that even though there are many strategies of transformation that avoid this, it is preferable not to have expression in pollen. But when this does happen, there may be need for an evaluation of the effects of such occurrence through biosafety experiments. It was agreed that the concern regarding expression of *Cry1ab* in pollen is important due to potential non-target effects of this gene on other insect pests, which if not considered may slow down public acceptance efforts.

Testing against *Maruca*

The urgency for testing the *Bt* cowpea against *Maruca* for meaningful continuation of the project was noted. The meeting was called upon to consider the following options, as currently permission to bring in *Maruca* for testing has not been granted in Australia:

- consideration for testing to be done in west Africa as soon as conditions allow (this would be the ideal option) or
- consideration for testing to be done at Purdue University, USA (could involve collection of strains from west Africa by Prof Larry Murdock).

Since sufficient seeds have been produced, the meeting resolved to look at the options and consider which institutions and what countries could kick start efficacy testing of transformed cowpea as a critical next step for the project.

Additional genes

Regarding consideration for additional genes as a way of mitigating against resistance build-up, the meeting resolved that although there are other options worth exploring, the project needs to focus on:

- the need to proceed systematically with the current gene and acquire a second or third gene when it becomes available
- the work of breeders under the Kirkhouse programme be seen as an invaluable input, for instance following up on drought tolerant genes
- consideration of the results of other transformation work being carried out in China with a view of learning lessons from elsewhere.

Allergenicity tests

The meeting resolved that for regulatory purposes, tests on animals will be carried out using appropriate procedures in recognised facilities.

Status of biosafety regulations

The meeting agreed that there was need to determine the status of biosafety regulations in west Africa and whether these can in the immediate future allow for the importation of *Bt* cowpea for testing purposes.

Marker free event

It transpired during the meeting that the *Bt* cowpea under development would contain the antibiotic selectable marker, *nptII*. The segregation of the marker as earlier anticipated was not achieved owing to a low level of co-transformation of the selectable and *Bt* genes. However since *nptII* is deregulated in many regulating authorities including those in the European Union (EU), a decision was jointly reached with AATF to proceed with the current protocol that contains the antibiotic resistance selectable marker. It was also noted that it is advisable to begin with a large number of events from which selection can then be made. AATF was called upon to facilitate access to use of *nptII* through CSIRO.

Scheme for introgression of *Bt* genes into cowpea

Background

The importance of adherence to specific characterisation aspects of a single copy (the donor parent) including the efficacy against *Maruca*, absence of backbone, expression stability by T4 generation and good agronomic characteristics is the key to effective introgression.

The process of introgression also involves a careful selection of the African variety; ideally, varieties that are of preference to both consumers and farmers; have high and stable yield potential; have other resistance capability against insects and diseases and can adapt to other ecological zones.

Although the conventional process of introgression takes 4 to 5 years, the marker assisted backcrossing of the donor plant (T4) with an African variety should take a maximum of 16 months subject to availability of human, material and financial resources.

Issues of discussion and way forward

Discussions on the donor parent status, selection of germplasm, breeding method and cost implications resolved the following:

1. that since respective countries have breeders, they should, through a committee, identify varieties that are acceptable in their setting;
2. that formation of a committee to search and select varieties (and lead plants) be based on available resources and be complementary to efforts by the Kirkhouse Trust (KT) progress and should take into account other traits such as *Striga*, aphid and drought resistance;
3. that assistance be sought from institutions like Monsanto and Syngenta in the selection of the lead event;
4. that determination of facilities for carrying out the work with respect to environmental conditions and requisite containment and confinement regulations be made;
5. that a preliminary field trial be considered to unequivocally establish 'true to typeness' of the phenotype of transformed cassava; and
6. breeders to consider several approaches to obtain a marker free event if this proves necessary regardless of the decision by European Food Safety Authority (EFSA) that *nptII* is considered safe.

Biosafety and regulatory compliance

Background

It was emphasised during the meeting that once transformed, the transgenic *Bt* cowpea will be handled, tested and deployed for utilisation by smallholder farmers as a regulated product. Thus, its safety will be evaluated based on current scientific knowledge taking into account the context of social, economic and political considerations of the GM technology. GM crops or products are regulated articles that cannot be released into the environment or used as food before being assessed and found to be safe. It is always the responsibility of the developer of such products to generate and assemble safety information upon which regulatory decisions are based (biosafety dossier).

The safety of GM technology is traced back to the relevant provisions in the Convention on Biological Diversity and the Cartagena Protocol on Biosafety. In both cases, the potential of modern biotechnology in promotion of human well being and the attendant needs for food, agriculture and health care is emphasised just as the need to ensure development of appropriate procedures to enhance the safety of biotechnology by minimising potential threats to biological diversity taking also into account risks to human health. Towards this end most countries in Africa have acceded to the Cartagena Protocol on Biosafety that requires '*Each contracting party to necessary and appropriate legal, administrative and other measures to implement its obligations under this protocol*', that is the need to develop National Biosafety Frameworks (NBFs). However, although notable efforts have been taken towards developing NBFs in Africa, the process is yet to be completed in many countries and what exists currently are what may be termed as interim structures for handling biosafety. It is hoped that the current momentum for developing NBFs can be sustained over the coming few years to create fully developed, staffed and functional mechanisms to provide oversight over GM crops including *Bt* cowpea.

An outline of regulatory issues that were cited worthy considering in developing a regulatory road map for *Bt* cowpea were tabled for deliberations at the meeting and they comprised:

1. critical examination of the status of biosafety and regulatory frameworks in pilot countries;
2. the need for the project to embrace biosafety assessment leading to generating a biosafety dossier;
3. consideration for regulatory file management leading to the application and procurement of permits from regulatory authorities;
4. the need for the project to invest in regulatory/biosafety skills development; and
5. consideration for stewardship and contingency plans.

Issues of discussion and way forward

Status of the legal framework in target countries

1. The meeting noted that even though the regulatory frameworks in the target countries are not yet fully developed, it is possible in the short term to use the existing interim guidelines such as the quarantine frameworks to facilitate the testing of *Bt* cowpea. Such regulations and guidelines allow for confined tests as long as no material is released into the public domain. To date Burkina Faso, Cameroon and Mali have completed the process of enactment of laws on biosafety while Nigeria and Ghana have so far made good progress.
2. The meeting resolved that there is need to look into efforts by bodies like the African Union (AU) and the Economic Community of West African States (ECOWAS) in regard to influencing the harmonisation of legal frameworks on the continent.
3. In regard to fast tracking testing, the meeting determined that an institution(s) be urgently identified to apply for the importation of material from Australia for testing in Africa.

Importation and containment of *Bt* cowpea

In terms of the lead institutions and which countries should consider beginning the testing of *Bt* cowpea, considerations were made for the involvement of the Institute for Agricultural Research (IAR) in Zaria, Nigeria, the International Institute of Tropical Agriculture (IITA), the National Biotechnology Development Agency (NABDA) and other collaboration between institutions in Nigeria. The meeting advised that this needed further deliberation to be firmed up in another forum.

Although the need to work with marker free products is not written into law, the meeting identified the requirement that any GM food crop being developed should be free from selectable markers. This will be crucial for the team working on biosafety and eventually public acceptance as in some countries such as Burkina Faso.

Biosafety dossier and risk assessment

The meeting advised that since Australia will be delivering the critical research material for this project, some of which could be the end product, the creation of a regulatory archive (lab notes, photos and other information) should be commissioned for future use. It was noted that successful application and consideration for regulatory approval was dependant on the adequate compilation of the project's biosafety dossier. This process should start right away.

Capacity building

The key constraints were enumerated as lack of and or inadequate facilities for introgression and containment and training of personnel. It was clarified that existing infrastructure in most institutions require renovation. The bottom line was the urgent need for enhancement of national capacities in biosafety issues in the countries targeted for deployment of *Bt* cowpea.

Stewardship planning

The key to successful implementation of the cowpea project is early planning especially in matters of biosafety. The meeting resolved to urgently develop a project policy manual that would encompass project procedures to be used by all partners. This will ensure that safety issues are adhered to right from transformation, handling of the transgenic cowpea, testing and deployment for eventual utilisation by smallholder farmers in Sub-Saharan Africa (SSA) and therefore determine eventual acceptance of the product by both producers and consumers. This was noted as being crucial in the indemnification of Monsanto and AATF from liability.

Towards public acceptance of *Bt* cowpea

Background

Farmer and consumer perceptions

Since 1999, per capita food production has been decreasing in SSA amidst rising demand. There is therefore need to increase domestic food production through expansion of the area under cultivation and or increasing agricultural productivity. In recent times, the feasible and innovative way of increasing agricultural productivity has been through modern biotechnology.

Research findings indicate that eventual acceptance of a product is dependent on the perceived benefits of the product. In the case of *Bt* cowpea, AATF initiated a project that facilitates access by farmers to improved cowpea. Specifically it is expected that *Bt* cowpea will be a cheaper and more sustainable option that will result in increased production and income, improved nutrition, enhanced soil fertility, increased storability, and improved health due to decreased pesticide use.

In terms of economic benefits, the adoption of *Bt* cowpea in the Nigerian Cowpea Grain shed (Burkina Faso, Cameroon, Ghana, Niger, Benin, Chad, Cote d'Ivoire, Gabon, Mali, Nigeria and Togo) is likely to increase gains from 6.3 billion to 10 billion dollars (Langyintuo et al, 2003).

The issue, however, remains the ability to amplify on one hand the positive aspects associated with the adoption of *Bt* cowpea and on the other hand to diminish the negative aspects herein embalmed in the existing challenges. Specifically, due reflection should be made to increase the visibility of the benefits (to both consumers and producers) in terms of savings in pesticide costs at farm level, lower pollution, safety in both human and animal consumption and economical cooking. In addition, there is need to vigilantly tackle evolving issues to do with knowledge on potential risks for human health in the future, availability of information on GM crops and misinformation on GM foods by raising awareness levels.

Public acceptance of *Bt* cowpea for Sub-Saharan Africa

Public acceptance has to do with empowerment of target group (community, etc) to make informed decisions on controversial issues through the provision of balanced factual information on the benefits and risks of a technology/product within defined boundaries at the right time, to the right audience and through the right channels that will enhance understanding and support the realisation of an enabling environment.
In the case of *Bt* cowpea, the effective management of the reputation of *Bt* cowpea in order to increase the probability for its acceptance and use will be important.

Successful public acceptance efforts emanate from an enhanced understanding of the issues and the existence of an enabling environment in the target countries. Since people's decisions (and actions) are informed by their perceptions and attitudes towards a technology/product influenced by the existing environment, the successful introduction of *Bt* cowpea in Africa will rely on winning the support of policy actors and decision makers at all levels (political and consumer) through allaying fears and assuring of safety through proper communication.

This also requires a thorough understanding of the public acceptance chain link, which requires that project actors identify the key issues and blind spots – the fears and the whys (and therefore key messages); the mechanisms for addressing them and the key players. Specifically these include:

1. **Key issues:** benefits (economic and social), risks (safety) and sensitivities (cultural and regulatory) of the technology.
2. **Mechanisms:** training (of risk communication team), education (of policy and decision makers), campaigns and the identification of third party endorsers.
3. **Key players:** project communication team or implementers and target audience such as policy makers, donors, investors and scientists.

The cornerstone of effective communication concerning the acceptance of *Bt* cowpea is the quality of the messages passed across. These should focus on the product and its potential returns and why transformation is the best for overcoming the *Maruca* constraint.

Issues of discussion and way forward

Controversial issues and key messages

Lack of understanding: It was noted that since it is very easy to accuse industry of wanting to make money, there is need to introduce and educate the public on the new issues. This will require heavy investment akin to that of the mainstream biotechnology industry.

Seed markets: The meeting cautioned that ownership of the seeds and the availability of markets were important factors that would influence public acceptance. The information on seed ownership and markets is often used to mislead decision makers into forming opinions against a technology.

Trends monitoring: The meeting advised the project actors not to ignore debates going on in the media especially print, and to proactively participate through the help of institutions such as the International Institute of Tropical Agriculture (IITA).

Benefits and risks: The communication team was challenged to constantly juxtapose cost and benefits in their messages. This is because the project activities (such as regulatory issues) are expensive but the eventual economic benefits are higher.

Targets

The meeting resolved that it is important to start early and earmark some Non-Governmental Organisations (NGOs) as allies and reach them before the anti-GM campaigners do. A case in point was given as Burkina Faso, where NGOs are already misinforming the community that *Bt* cowpea has been introduced. This will complement the direct efforts to reach the farmers (producers) and consumers, other industry players and policy makers.

Communication strategy

Profiles: The need to profile respondents from the cowpea perception study was highlighted. This would form an important segment in dissemination of other information.

Industry involvement: the meeting agreed that involving industry in the promotion of biotechnology was strategic in terms of future activities akin to the Crop Biotechnology Initiatives (CBI) now active in Asia, South America and India due to the size of their markets.

Resource mobilisation: The meeting proposed a change in the way public acceptance work is looked at, specifically for the project. The need to mobilise and allocate additional resources with the help of the other institutions was proposed.

Early start: Project partners were advised to take advantage of the available information and start information campaigns on *Bt* cowpea in their respective institutions as able and confident spokespersons.

Public acceptance and communication committee: It was concluded that there was need for a team to spearhead an assessment of the communication needs and channels and develop the project's public acceptance and communication strategy.

Management of the project

Background

The transformation of cowpea has proved that it might be possible to transform other difficult (African) food crops. Although there was no system of transformation of cowpea, this initiative has in a short time achieved many things. The gene has been provided through successful negotiations with Monsanto and Kirkhouse Trust is funding another project that will increase capacity for introgression by nationals of west African states. This will eventually complement AATF efforts.

In the meantime, AATF has received technical assistance from the Network for Genetic Improvement of Cowpea in Africa (NGICA) and national institutions, and the project implementation framework so far is clear. The proposed project management structure will have at the top a project executive committee with the responsibility of advising on the overall implementation of the project. Currently AATF has used volunteers and its core funds (along with USAID and Rockefeller funding) to jumpstart the project. The necessary funds for implementing the project, estimated at US$ 20m with the regulation costs standing at US$ 9m are being sought. The critical aspect thus remains securing funding in order to proceed with planned project activities.

Issues of discussion and way forward

Funding

The meeting resolved the following**:**

1. Assistance to be sought from industry (for example Syngenta, Monsanto) since cowpea is an important crop. Industry consideration for support would go a long way in opening doors for other crops.
2. The Africa Bio-fortified Sorghum (ABS) strategy – funded by the Gates Foundation – to be used as a learning case.
3. Target country policies governing revenue collection (proceeds from seeds) be examined with a view to encouraging governments to make commitments for annual contributions to AATF.

Management

The meeting resolved the following:

1. Inclusion of persons from the civil society and private companies in the executive committee be considered.
2. A different business model be adopted: there is need to start thinking as a commercial venture and not an NGO and capture the anticipated benefits from the project.

3. A search for models on overcoming the current challenge of moving the project from the proof of concept to the delivery of the product to the farm be carried out and the arising issues of stewardship be identified.
4. Finalisation of the business plan
    a. The project advisory committee to be mandated with overall oversight and guidance of the project to avoid preventable mistakes.
    b. Country-by-country issues to be captured to leverage product testings, deployment and commercial seed marketing.

Recommendations

The meeting resolved that the project should begin to address biosafety and regulatory compliance as well as the public acceptance issues in readiness for the testing of material in west Africa late in 2007 or early 2008. Specifically, the meeting recommended as part of the strategy:

1. The establishment of public acceptance and communications committee to take the lead role in raising awareness in target countries.
2. The establishment of biosafety assessment and regulatory compliance working group to take the lead role on matters of regulatory review, applications and approvals.
3. The formation of a committee (of breeders with the help of KT) to identify and select priority crop varieties with assistance from private sector partners such as Monsanto and Syngenta).
4. The identification of lead institutions to fast track testing. These will facilitate The application of permits for the importation of material to west Africa.
5. Capacity building:
    a. to expedite the audit of existing facilities, improvement and provision of equipment in target countries; and
    b. human resources: skills development in biosafety and regulatory compliance, introgression and backcrossing, and risk communication in target countries.
6. The setting up of country coordination committees as well as step-up efforts for resource mobilisation from donors and the private sector.

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Appendices

Appendix I: Key note address

AB Salifu
Director, Council for Scientific and Industrial Research – Savanna Agricultural Research Institute on behalf of:
Professor Emmanuel Owusu-Bennoah
Director General, Council for Scientific and Industrial Research

Mr Chairman
Colleague Scientists
Distinguished Invited Guests
The Press
Ladies and Gentlemen:

It gives me great pleasure to welcome all of you to today's review and planning meeting. I am doing this on behalf of Professor Emmanuel Owusu-Bennoah, Director General of the Council for Scientific and Industrial Research (CSIR). The Director General will most certainly have been here personally to welcome and also open the meeting but he had to attend to an equally important assignment that coincided with this one. I am therefore conveying his apologies and good wishes to all of you.

Today's meeting is significant for two main reasons: first it is taking place during the period slated for celebrating Ghana's 50th Independence Anniversary dubbed Ghana@50. Secondly, today's meeting heralds some good news from science with respect to the long search for resistance to one of cowpea's notorious and devastating insect pest, *Maruca vitrata.*

Ladies and Gentlemen:

Cowpea still ranks as a major food source for the poor in Africa. Its cultivation stretches from Sub-Saharan west Africa to eastern and southern eastern Africa. Much of the production of cowpea in Africa is concentrated in central and west Africa which together account for over 64% of the area devoted to production of the crop in the tropics.

Throughout Africa the diet of populations is based on the consumption of a cereal grain and a food legume; cowpea being the common legume fitting this combination. Combined with cereals in the diet, lysine-rich cowpea complements the lysine/tryptophan-poor cereals, while the cereals supply the sulphur-containing amino acids needed for a balanced amino acid intake. Cowpea has also become important as a weaning food for babies and is an invaluable source of nutrition for young children and nursing mothers. The sale of cowpea grain is an important source of income for most subsistence-level farm families, especially in west Africa.

Despite the significant progress made by research in improving cowpea over the last decades, insect pests remain the most important constraint to production, particularly in west Africa. The economic significance of insects on cowpea has been documented over the years; most of us in this meeting are very familiar with data that capture the significance of the various insects attacking cowpea. The bottom line is that cowpea cannot be produced economically without recourse to controlling and/or managing its numerous insect pests.

Maruca and flower thrips stand out as the most important pests of cowpea for which the development of resistant genotypes will bring the greatest benefit to farmers in Sub-Saharan Africa. Insecticide use has been promoted by most extension systems in Africa as the technology of choice for coping with cowpea pest problems. This technology of choice, however, brings in its wake challenges with respect to cost, availability, farmers' capacity for judicious use and the risk of not making a profit even if a particular farmer was barely able to purchase insecticide.

The deployment of resistant cowpea varieties in any strategy for managing its pest complex would make the greatest impact in sustainable production of the crop. Increased field resistance to any one of the major flowering and post-flowering pests will greatly reduce cost of production and increase farm-level yields. Unfortunately, the search for adequate levels of resistance through conventional methods has been an arduous task for some time now, as it appeared that the genome of cowpea was devoid of the necessary resistance genes to the major insect pests.

Today's review and planning meeting will bring to the fore sustained efforts by cowpea scientists in deploying new technology to cope with what is agreeably an important pre-flowering, flowering and indeed post-flowering pest of cowpea, *Maruca vitrata*. The progress that you will discuss will be one of many such useful strides that have been made in modern agriculture through the process of biotechnology.

Recent indications are that today there have been more than 15,000 field trials of transgenic crops, about one billion hectares of farmland under such crops and that an estimated 8 million farmers in 17 countries are growing GM crops. A number of these transgenic crops have resistance to insects through the transfer of the gene encoding *Bacillus thuringiensis* (*Bt*) delta-endotoxins to confer the resistance. For us scientists, this is progress worthy of commendation.

However, the advent of biotechnology and particularly its deployment in agriculture, health and environment has brought in its wake a heated debate across the continents as to its advantages and disadvantages. Concerns have been raised about the safety of food and animal products collectively described under the generic acronym GMOs (genetically modified organisms). Similar concerns have been raised about the consequences of growing genetically altered crop commodities in natural ecosystems vis-à-vis the sanctity of the genetic diversity.

Critics fear that a genetically enhanced gene for agricultural use could 'escape' from a farmer's field and breed with a wild relative to create a 'super weed' that could overwhelm the natural environment and curtail genetic diversity. Those who speak in favour (like me) on the other hand say that the productivity gains of genetically enhanced (not 'genetically modified') crops allow more food to grow on existing farmland, which then curtails the need to open up more land under the plow to feed a growing population. Furthermore, pollen flow between plants is a natural phenomenon that has been occurring for thousands of years.

Ladies and Gentlemen:

These statements sound familiar to a number of us gathered herein, and are just a miniscule reflection of the wider albeit heated debate on issues of biotechnology and its effects. For me the argument is no longer the science; for that has been well grounded. Instead, what currently is at the core of the new technology is the issue of public perception of the concept and its deployment in agriculture, health and environment.

Therefore, as we prepare to deploy the first transgenic cowpea in African farmlands, there is the need to win the public debate as to its appropriateness and sustainability for smallholder agriculture. Having been personally involved with the initial studies and efforts in the cowpea transformation component research of the Bean/Cowpea Collaborative Research Support Program, I know for sure that a lot of background research had been done prior to and alongside the transformation research itself. But then the issue as I have already stated, is not with us the scientists; it is the producers, consumers and the public at large that need to be brought along. We should bear this in mind.

Similarly, while we engage ourselves in looking at the progress in developing the first transgenic cowpea, field-testing and deployment for African agriculture, we should not lose sight of the relevant personnel and infrastructure that are needed to handle the would-be regulated product, particularly in the key cowpea producing countries in west Africa. Even more important should be a key consideration for making it possible for researchers in the countries where the product will be tested and/or deployed, to get adequately informed on biosafety issues, with an ultimate objective of enhancing their capacities to use such products to develop varieties that meet local demands through marker-assisted selection.

Ladies and Gentlemen:

Ghana has put in place the National Biosafety Framework, with draft bills on Biosafety and Plant Varieties awaiting parliamentary ratification respectively. The Biosafety Bill provides procedures for handling of request for approvals, inspection, reviews, and appeals, among others. The Plant Varieties Bill provides protection for new plant varieties released by researchers, farmers and the community at large. These are modest developments and serious commitments to ensuring that an enabling environment exists for extending the frontiers of the scientific endeavour in Ghana.

Ladies and Gentlemen:

Pest problems on cowpea persist because of lack of diversity in research approaches. The scope of research approaches appears to have now widened and today we have the opportunity for a truly *Maruca*-resistant transgenic cowpea. I have the singular honour on behalf of the Director General of the CSIR to declare the Review and Planning Meeting on Development, Testing, Regulation and Deployment of Transgenic Cowpea in Africa duly opened. Welcome to Ghana and please remember to celebrate Ghana@50 with us in your own ways. Thank you very much.

Appendix II: List of participants

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