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ISAAA

The International Service for the Acquisition of Agri-biotech Applications

# ENHANCING THE DIFFUSION OF TISSUE CULTURE BANANA TO SMALL-SCALE FARMERS IN KENYA

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**About ISAAA**

The International Service for the Acquisition of Agri-biotech Applications (ISAAA) is a not-for-profit international network founded in 1990 to facilitate the acquisition and transfer of agricultural biotechnology applications for the benefit of resource-poor farmers in the developing world. ISAAA has three network centers namely: AfriCenter in Nairobi, Kenya; the SEAsia Center in Los Banos, Philippines and AmeriCenter in Cornell University, Ithaca, New York. ISAAA's activities are guided by an international Board of Directors that oversees programmatic, organizational, and policy strategies. One of her principal strategy is to share knowledge and experiences on all aspects of crop biotechnology by establishing a network of Biotechnology Information Centers (BICs). These Centers facilitate sound decision-making relating to biotech crops and their real and potential contribution to food security, poverty reduction and environmental conservation. The AfriCenter office is located at the International Livestock Research Institute (ILRI) campus.

***Mission and Vision Statement***

ISAAA's mission is to contribute to poverty alleviation in developing countries by increasing crop productivity and income, particularly among resource-poor farmers, and to bring about a safer environment and more sustainable agricultural development. It is based on a novel new vision of technology transfer that treats North and South as equal partners in projects that offer gains to both sides. ISAAA believes that this mission can be best achieved through strengthening the capacity of national programmes to evaluate, regulate and deploy new technology in a safe and responsible way.

***Goals***

ISAAA aims to transfer and deliver appropriate biotechnology applications and information to developing countries, that ultimately will improve food security, increase incomes and generate employment in rural and urban areas.

## Introduction

A review of the world banana economy shows that banana is one of the most important staple crops in tropical countries. Production of the fruit for sale in local markets is among the few agricultural activities that provide households, especially the rural poor, with regular income throughout the year. In 2005, the area under bananas in Kenya was 83,687 hectares (MoA, 2006). The crop is predominantly grown by small-scale farmers both as a source of income and as a household food security crop. The main banana producing regions are Nyanza, Central, Eastern, and Western Provinces. While the foregoing scenario depicts the economic and food security potential of banana, the production and marketing of the crop in Kenya takes place in a context characterized by lack of a supportive policy environment and institutional arrangements to optimise outputs.

One of the problems affecting production of banana as a potentially reliable food and commercial crop is the high infestation with various pests and diseases. The condition is aggrevated by traditional practices of exchanging planting materials. In this way pests and diseases are easily transmitted from one farm to another, and this has been observed to reduce banana yields up to 90% (Mbogoh et al., 2002). As a result, food security, employment opportunities and household incomes in the banana producing areas of the country have been threatened.

This policy brief focuses on the broader context of the widely celebrated project; *Banana Biotechnology to Benefit Small-scale Banana Growers in Kenya*. The project was initiated by the International Service for Acquisition of Agri-biotech Applications (ISAAA) and the Kenya Agricultural Research Institute (KARI) with the principal goal of introducing tissue culture (TC) technology into the national banana sub-sector to mitigate production constraints associated with lack of disease-free planting material. Tissue culture is a biotechnological tool for multiplying disease-free planting material. Small plant parts, tissues or cells obtained from a desirable variety are grown under laboratory conditions to produce numerous tiny plantlets. In six months, up to 2, 000 banana plantlets can be produced from a single shoot. With non-TC conventional methods, only 10 suckers can be produced from one plant in the same amount of time (ISAAA, 2001). The process does not embrace genetic engineering or genetic modification. In this respect, TC bananas are excluded from the category of genetically modified crops.

The brief has been specifically prepared to contribute to a better understanding of the role of emerging technologies in enhancing food security, economic development and poverty alleviation. The brief also seeks to solicit the requisite policy support for up-scaling the benefits of TC technology to other high potential banana growing areas in the country.

The brief reflects on the process of transferring the TC technology to small-scale farmers in Kenya. A synopsis of the achievements, impacts and outcomes that the project has generated is given. Lessons learnt, challenges encountered and opportunities for up-scaling the technology are highlighted. In terms of future outlook and prospects, emphasis is placed on the kind of enabling policy environment that would facilitate growth and development of a technology driven banana sub-sector in Kenya.

## Background

The origin of the TC banana project can be traced back to 1996 when ISAAA secured funding from the International Development Research Center (IDRC) and the Rockefeller Foundation (RF) to address problems related to a drastic decline in banana production due to pests and diseases. At 14 tonnes per hectare (on average), farmers in Kenya achieve less than a third of the global potential banana yields. The economically most important banana pests and diseases impacting on banana production in the country are; nematodes and weevils and fusarium wilt (panama disease). The pathogens are spread through infected banana suckers that farmers use for banana propagation, due to lack of clean planting material (Qaim, 1999).

Tissue culture technology was found to be the most appropriate tool to mitigate the aforementioned problems, reverse the declining trend in banana production and enhance farmers' access to clean planting materials. Consequently, the TC banana project was initiated in 1997 and facilitated by ISAAA in collaboration with strategic partners and the intended beneficiaries (farmers). The project came as a response to pronounced demand at farmers' level in the major banana growing areas. The focal areas of the project have been Maragua, Murang'a and Kirinyaga Districts in Central Kenya, Kisii, Gucha and Nyamira Districts in Nyanza and Kwale District at the Coast (ISAAA Briefs, 2001).

The project was designed to address the following objectives:

(i) To develop on-station and on-farm activities linked with farmers, extension services, NGOs and other end users to ensure tissue culture bananas were evaluated, distributed, marketed and utilized by farmers.
(ii) To extend the benefits of tissue culture banana production in rural communities through acquisition of planting materials adequate for establishing viable commercial units of orchards.
(iii) To increase household incomes arising out of the sale of banana fruit and exploitation of entrepreneurial opportunities created by large-scale adoption of the technology such as hardening and distribution of plantlets, marketing and post-harvest utilisation of the banana fruit.
(iv) To create a model project to show successful application of biotechnology for bananas and other commodity crops in Kenya, and also regionally.

The implementation of the TC banana project has taken place in three distinct phases. Phase I (1997-2000) entailed technology acquisition and testing. Horizontal up scaling was done in phase II (2000-2003). In the third phase (2003 and beyond) the main focus has been regionalization and enhancing the quality and commercial potential of banana products through diversification of utilisation and value addition. Strengthening of linkages among the service providers in the technology value chain is also being undertaken.

## Implementation process: strategic approaches and institutional mechanisms

The process of transferring and deploying the tissue culture banana technology to small-scale farmers in Kenya was inclusive, participatory and interactive. The main methodological approaches employed were the Farmer Field Schools (FFS) and the value chain analysis concept. The FFS approach originated from the Food and Agricultural Organization (FAO) of the United Nations. It is a participatory approach to extension, which gives the farmer an opportunity to make a choice in methods of production through discovery (Karembu, 2002). Training methodology is learning by doing, which promotes discovery, comparison and interactive relationship among learners and trainers. The FFS approach was applied in the project to enhance learning, familiarization and diffusion of the new technology that involved a change of practice from use of traditional suckers to tissue culture plantlets. From the onset, farmers were involved in the identification and testing of the most popular varieties through Participatory Rural Appraisals (PRAs), to inform the scientists on the preferred varieties to source for multiplication. The capacity of farmers to manage banana orchards in line with sound agronomic practices was built. The value chain analysis (VCA) was applied to identify different links and critical elements for successful technology diffusion. VCA is a systematic approach used at the project identification stage to determine entry points for different interventions, justification for interventions and implementation strategies.

The implementation process followed key stages outlined below:

⇔ Conducting participatory rural appraisals (PRAs) to identify banana production constraints, major cultivars farmed, marketing channels and improvement opportunities.
⇔ Conducting on-station trials at KARI's regional centres in the main banana growing areas to generate

information on cultivar performances and agronomic production packages under optimum conditions.

- ⇔ Conducting on-farm trials in major banana growing areas to evaluate TC banana performance under farmer conditions.
- ⇔ Conducting technology diffusion research to identify technology adoption issues.
- ⇔ Conducting socio-economic and market studies to understand the social dynamics in growing and marketing bananas.
- ⇔ Initiating a pilot micro-credit scheme to help farmers establish viable commercial units.
- ⇔ Formation of a banana growers association to coordinate operations and provide services to farmers once the project funds and support come to an end.
- ⇔ Diversification of markets and utilization of banana products through value addition.

In terms of institutional arrangements for implementation, the project provided a broad platform for forging of public-private partnerships. It is a typical example of how convergence of a wide range of institutions with mutually reinforcing competitive advantages can foster delivery and adoption of a new technology. ISAAA as the lead implementing agency identified KARI as a suitable collaborator and strategic partner to host the project based on a number of reasons among them; the nationwide network of research centers that KARI has and the capacity to conduct agronomic studies.

To ensure a reliable and sustained supply of high quality planting materials, two private companies involved in production of tissue culture materials were brought on board. ISAAA undertook the initial technology brokering and transfer of the technology from South Africa to Kenya. The South African based DuRoi laboratories, a private company with long experience in tissue culture multiplication was engaged to supply the initial TC materials. A local private company in Kenya, Genetic Technologies International Limited (GTIL) was identified to handle the materials imported from South Africa and to eventually undertake mass propagation of local desired varieties for farmers in Kenya. Technical backstopping based on the South African experience was provided by the Institute of Tropical and Sub-Tropical Crops (ITSC). Further technical backstopping to investigate the incidence and diagnosis of viral diseases in Kenya was undertaken by a consultant from UK's John Innes Centre. Technology diffusion research to identify constraints to adoption was supported by the African Technology Policy Studies (ATPS) Network. An ex-ante study to assess the potential impact of the intervention was carried out by a reknown socio-economist from ZEF-University of Bonn. Ex-post analysis has been on-going to document the socio-economic impacts and outcomes of the project.

Establishment of a revolving micro-credit fund is one of the core institutional mechanisms attributed to successful implementation of the project. Studies conducted on technology adoption rates revealed that farmers were constrained by lack of capital and the cost of plantlets could drastically limit diffusion. On realizing this, the ISAAA Board initiated a US $ 15, 000 pilot TC banana micro-credit revolving fund, primarily to enable farmers to acquire plantlets and other essential inputs. The micro-credit facility was based on the Grameen Bank group-lending model. This model relies on "peer-group monitoring" which reduces lending risks. Banana farmers were facilitated to form friendship groups of about 30-50 members. Each group was ultimately responsible for repayment in case of individual defaults. BEAM Business Options Ltd, a private company with expertise in community mobilization, group organization and capacity building, was contracted to implement the pilot micro-credit revolving fund which was later rolled to the K-Rep Development Agency. The success of the revolving fund in Central Kenya was replicated by K-Rep in Kisii region with additional support from Maendeleo Agricultural Technology Fund (MATF) of FARM Africa.

## Impacts and outcomes

Significant impacts and positive outcomes have stemmed from the TC banana project. Farmers in the project focal areas have been the primary beneficiaries. Yield losses caused by pests and diseases at farm level have reduced substantially. The technology has made it possible for more than 5, 000 farmers to access large quantities of superior disease-free plantlets with early maturity traits (12-16 months compared to the conventional banana of 2-3 years), bigger bunch weights (30-45 kg compared to the 10-15kg from conventional material) and higher annual yield per unit of land (40-60 tonnes per hectare against 15-20 tonnes previously realized with conventional material) have been recorded. The technology also ensures uniform maturity and fruiting and this has often enabled organized marketing.

One of the conspicuous performance indicators of the project is the extent to which the livelihoods of the community have been transformed. Household incomes of participating farmers have risen by 38% from banana sales resulting to decreased poverty levels and improved livelihoods. Increase in yields has also translated to enhanced food security and improved health of the households.

While studies have demonstrated that investing in TC banana production is relatively more capital intensive than non-TC banana, the returns are significant. Ultimately, TC banana production offers relatively much higher financial returns than non-TC banana to offset the initial investment costs. The estimated average total cost of establishing and operating a TC banana orchard is Kshs 229, 500 (USD 3280) per hectare in year 1. The cost reduces to an operating cost of about Kshs 68,

### A case study of a successful TC banana farmer

John Matara Orina is one of the many banana farmers, who have benefited from the tissue culture (TC) banana project. He comes from Isecha village, Marani division of Kisii District, Nyanza Province. He ventured in TC banana farming in 2003 though he was a long-time farmer of traditional banana. He started with 50 plantlets but later expanded his orchard with additional 350 plantlets to make a total of 400 plantlets. With facilitation from ISAAA AfriCenter, who introduced the technology to farmers, he sourced the 400 plantlets from KARI-Kisii. ISAAA also linked the farmers to credit service providers. Through the arrangement, Orina received a total of Kshs 36, 000 (USD 514) as loan, all of which he has repaid to K-Rep Development Agency, the micro-credit provider.

"Being a member of Omokonge farmer group, I have benefited from intensive training in; orchard management, farming as a business, banana value addition, micro-credit management and collective/group operations. I have also been involved in several farmer exchange visits and also got a rare opportunity of being part of a traveling workshop that toured Kenya and Tanzania with representation from the three East African countries. The tour enabled me to interact with other farmers and key players in the banana value chain", Mr. Orina proudly narrates.

In order to fetch better prices for his produce, Orina has ventured into banana value addition activities. Currently, he has constructed two ripening chambers, which he uses to ripen his bananas. This takes him a relatively shorter duration, 3-4 days as compared to 6-7 days when he was using the traditional ripening methods. He sells the fruit in the local markets in Kisii and also in Nairobi and Nakuru.

"To date, I have reaped significant benefits from investing in TC banana farming. I have sold over 600 banana bunches at an average price of Kshs 200". With a smile, Mr. Orina reveals that he has on average made a profit of 80,000 Kshs per year in a span of three years. "From the banana income, I have used Kshs 35,000 to pay school fees for my children, and managed to acquire a grade cow at a cost of Kshs 20,000. "The welfare of my family has greatly improved". The farmer appreciates the social and economic benefits that he has derived from the TC banana investment. (1USD=70Kshs)

***Pioneer tissue culture banana farmers***

200 (USD 975) in year 2 and subsequent years after the establishment of the orchard. The analysis shows that farmers make a profit of about Kshs 36, 000 (USD 515) per hectare by end of the year 1. The profit level in year 2 and subsequent years after orchard establishment actually rises to about Kshs 462, 800 (USD 6612) per hectare per annum (Mbogoh, et al. 2002).

The gender dimensions of the project are worthy of notice. Improved banana production has enhanced household welfare and contributed to both economic and social empowerment of women and children. Access and control of income from banana sales reveal 85% control by women.

The project has contributed to building of social capital and cohesion at farmers' level based on trust and collective action. This is an important asset that new development projects introduced in the same focal areas have taken advantage of.

The multiplier effect of the project is substantive. New business and employment opportunities have sprouted along the banana value chain, particularly at production, transportation, value addition and marketing. Opportunities for investing in banana hardening nurseries have also emerged as illustrated in table 1.

## Achievements

Remarkable achievements have been realised from the banana project. The most outstanding ones relates to increased food supply at household level, and, building and strengthening the capacity of farmers to produce and market banana as a commercial crop. Sustainability and ownership of the project by farmers has been realized through training on adoption of good agronomic practices from planting to harvesting. Successful setting up of a micro-

**Table 1: Estimated cost of running a hardening nursery**

| Size of hardening nursery – 8m x 10m (capacity: 3,000-5,000 plantlets) | | |
|---|---|---|
| **Item** | **Cost (US$)** | **Cost (Kshs)** |
| Structure | 750 | 41, 600 |
| Soil mixture | 150 | 8, 330 |
| In-vitro materials @ US$0.6 x 4,000 plantlets | 2,400 | 133, 300 |
| 6 months Maintenance (labour + inputs) | 280 | 16, 000 |
| Total | 3,580 | 198, 900 |

NB: cost estimations were arrived at after consultation with KARI-Kenya and Agro-Genetic Technologies (AGT) in Uganda

Profit margin analysis for 4,000 plantlets
Sale price @ US$1 per plantlet – US$4,000
Purchase price @ US$0.6 per plantlet – US$2,400
Production cost – US$280 + US$150 + US$375 (50% structure cost) = US$805
Sale price – (purchase price + production cost) = US$795
Profit margin = 795 / (4,000+750) x100 = 17%

NB: cost of land is not factored in.

credit revolving fund in Central and Nyanza provinces to enable more farmers establish viable commercial units of orchards is commendable.

Production and marketing linkages have been strengthened through the formation of a banana growers association – the Highridge Banana Growers and Marketing Association (HBGMA). The association is supporting farmers to tap the benefits of collective bargaining and economies of scale. Collective marketing has minimized exploitation from middlemen enabling farmers to fetch better prices. In addition, farmers have been linked to the Kenya Gatsby Trust (KGT), a local NGO that conducts market research and disseminates information to farmers on fair trade, pricing and international marketing trends and opportunities.

The project has also attracted recognition at various levels. In 2000, the project was declared winner of the First Place Medal in the Global Development Network (GDN) Awards for Science and Technology for Development, an initiative of the World Bank and Government of Japan. In 2006, the third phase of the project was declared the 1st best project during the 10th KARI Scientific Biennial Conference.

Notably, neighbouring countries have adopted the TC banana model as evidenced by successful replication of the same in Tanzania and Uganda. As well, several organisations in Kenya have ventured in horizontal up scaling using similar approach.

## Challenges

Development and transfer of any technology is often a learning experience. No technology comes along with universal solutions to multi-faceted problems facing the target end-users. For the case of TC banana, challenges encountered were:

- Limited established distribution and marketing systems for the plantlets. Planting material is transported in potted form which limits wider reach to remote rural areas.
- Relatively higher cost of TC plantlets compared to conventional suckers.
- Limited access to micro credit.
- Higher requirement of TC banana for labour and inputs such as manure and water.
- Mixing of banana varieties in the laboratories which has been widely reported.
- Limited value-addition.
- Land degradation and the need for integrated pest and crop management (IPM).
- Managing partnerships' diverse expectations and institutional dynamics.

## Lessons

A number of issues were carefully observed and analyzed at the various stages of adopting and adapting the TC banana technology. The specific lessons learnt provide an informed basis for replicating the technology transfer process elsewhere. The generic ones can inform the delivery of similar and advanced agricultural technologies such as genetically modified crops. Key lessons are:

- Participatory approaches in problem identification and technology delivery yields high levels of success. Involving target beneficiaries in introducing new technologies ensures information, knowledge and skills are impacted in a most cost effective way that promotes technology uptake and sustainability.
- Public- private partnerships and complementary are fundamental in the dissemination of beneficial technologies to resource-constrained farmers.
- Availing farmers with their

preferred banana varieties enhances technology uptake
- Effective repayment of loans is not only dependent on frequent follow up but also on performance of overall farm enterprise.
- Training in credit management is important and should embrace social aspects such as HIV/AIDS and business development.
- Collective action by farmers is essential since it increases farmers' bargaining power. Farmers are also able to learn from each other, and the level of community cohesiveness is enhanced.
- Linking production to value addition and understanding the market is crucial for farmers to maximize benefits from any agricultural technology.
- Using a value chain approach when introducing a new technology effectively catalyzes technology uptake.
- Reaching out to the poorest of the poor even with a credit scheme is not easy. This is because credit repayment requires diverse sources, which this category of farmers may not have. A kind of voucher system complemented with 50% grant system may be more effective.
- With increased adoption and opening up of more distribution and hardening nurseries, the need for disease diagnostics and virus indexing facility is crucial.

## Opportunities and potential for scaling-up

Opportunities for scaling-up benefits of the TC technology to other banana growing areas in Kenya exist at various levels. Bananas perform well in most agroecological zones in the country especially the highlands. Out of the eight provinces in Kenya, at least four are high potential areas for banana production. In-built markets studies have demonstrated that local market demand for banana is much higher than what farmers are currently producing. In 1992, the World Bank estimated that the need in Kenya alone was 30 million banana suckers/seedlings over a 10 year period (Biosafety News, 2003). The high demand for clean plantlets present a window of opportunity that can be tapped by existing companies or new ones intending to venture into the banana subsector. Evaluation of the costs and benefits for TC banana production over a 10 year period gives a cost-benefit ratio of about 4.8, which reflects a fairly attractive rate of return on investment.

Exploiting production, value addition and marketing linkages present opportunities for products' diversification into banana juice, banana flour, banana wine and banana fibre artefacts. In this regard, farmers stand a high chance of exploiting niche markets from processed banana and value added products compared to the fresh form. Being a highly nutritious fruit, market diversification and value addition places farmers at a vantage position to exploit other niche markets. Promising ones that would greatly benefit from banana fortified flour, banana instant soups, and confectionaries include: hospitals, educational institutions food aid organisations, homes for the aged and refugee camps. Banana is a highly perishable commodity. Processing would prolong shelflife, giving farmers the flexibility to sell when prices are favourable and caution against glut periods.

The TC banana project has laid a strong foundation and created avenues for applying advanced biotechnology tools such as genetic engineering. The tools could for instance entail introduction of diverse banana varieties or genes for disease resistance or controlled ripening (for longer shelf life).

Researchers and development partners can easily introduce other technologies using institutional linkages that have been established.

## Policy recommendations

It is evident that efforts to promote TC banana production are justifiable from both food security and economic perspectives. However, it should be noted that promoting banana production as a commercial venture can only be possible if players in the subsector are adequately supported in terms of an enabling policy, legal and institutional frameworks.

1. To address the problem of limited distribution of plantlets, mechanisms of establishing hardening nurseries and village laboratories in close proximity to farmers should receive high priority. It is envisaged that this would reduce the cost and losses incurred transporting already hardened plants. Greater regulatory oversight by quality assurance from the Kenya Plant Health Inspectorate Services (KEPHIS) would assist in developing standards of operations.

2. Quality control at laboratory level is vital to prevent mixing of varieties and minimizing production of off-type plantlets. Such mechanisms would also ensure that all materials produced in the labs meet phytosanitary requirements. A supportive policy environment for the banana sub-sector is therefore required to facilitate such institutional and regulatory arrangements.

3. Standards for all the players along the value chain need to be formalized. These include quality standards on TC plantlets, unit of trade for the fruit and acceptable processed products. This will entail setting up a code of conduct/practice that clearly shows whole process from lab to table.

4. The relatively high cost of plantlets is one of the constraints hindering wider diffusion. ISAAA is working closely with several interest groups to help establish

low-cost village labs and satellite nurseries in the project focal areas. Lowering of power tariffs and zero rating of taxes levied on laboratory equipment and chemicals is a policy measure that can substantially reduce the cost of plantlets.

5. Enhancing access to micro credit is another key area that requires attention and policy support. The microfinance Bill that was passed recently should be operationalized in a manner that provides conducive policy, legal and institutional framework for promoting viable and sustainable microfinance options in the agricultural sector including the banana sub-sector. This would attract an increased number of microfinance institutions targeting small-scale farmers. ISAAA will concentrate on developing model micro-credit packages that such institutions could adopt or adapt.

6. One avenue through which the government can leverage production of banana as a high value crop is through introduction of incentive measures and fiscal instruments to facilitate small cottage industries. The government can intervene through provision of rural electricity, market outlets and favourable investment environment.

7. To supplement traditional staple food crops such as maize, the government and interested partners should mount sensitization campaigns aimed at promoting banana as a highly valuable and nutritious crop with high returns. Emphasis should be placed on promoting banana eating culture and official recognition of banana as a national food security crop.

8. To foster marketing channels, the banana growers associations should be linked to private sector institutions such as the Fresh Produce Exporters' Association of Kenya (FPEAK). Such connections would improve market access and make it possible for farmers to tap both local and international markets especially in areas where demand for bananas is high and supply is low or non-existent. Currently traders (middlemen) are playing a pivotal role in terms of bridging farmers' access to distant markets. While appreciating their contribution, regulations that minimize the number of middlemen along the value chain would protect farmers from excessive exploitation.

9. Capacity building programmes that enable banana producers exploit the existing opportunities in organic banana processed products for the European market should be organized. This will involve training farmers in good agricultural practices that enable them to ensure integrity, transparency and harmonization of global agricultural standards and attain the EUREPGAP requirements of food safety and environmental compliance.

10. An important input by government would be support for a disease diagnostics and a virus indexing system to serve existing and on-going distribution nurseries and tc labs. This is vital and absolutely needed.

*The Ministries of Agriculture and Trade and Industry are the relevant institutions that should spearhead policy formulation and provide leadership in appropriate institutional arrangements for sustainability of the banana sub-sector and economic growth.*

## Conclusion

The TC banana project clearly demonstrates that a wide range of actors and institutions are involved in innovation processes. Sustained linkages between these actors create a facilitative environment for the acquisition and application of new technologies in agricultural production. Primarily, forging of partnerships and networking is a pivotal factor. Effective participation of farmer groups and other stakeholders in identifying, testing, dissemination, monitoring and evaluation of the technology enhances the level of success. The TC banana project reinforces growing evidence on the potential of biotechnology in enhancing food security and alleviating poverty among small-scale farmers. The challenges the project encountered imply that useful and viable technology require supportive technology transfer mechanisms at all levels. Structural constraints must be addressed for farmers to optimally harness the benefits of the technology.

## Policy Implications

This brief has observed that banana production is taking place in a policy vacuum. A national policy to nurture the growth and development of the sub-sector is needed. The government has a crucial role to play in supporting and regulating the banana sub-sector through development of a comprehensive policy instrument to address critical areas in the supply of clean planting materials, production, value addition and marketing.

However, it is good news that over the past five years the Ministry of Agriculture has undertaken reviews of various policies and legal frameworks with the aim of creating a conducive environment for private sector investment. The Strategy for Revitalising Agriculture (SRA) that was officially launched in March 2004 has been shaping policy adjustments for agricultural sector development. Based on this policy initiative, we strongly recommend that banana sub-sector should be given urgent consideration due to its importance as a food security crop and its evident high rate of return as a cash crop.

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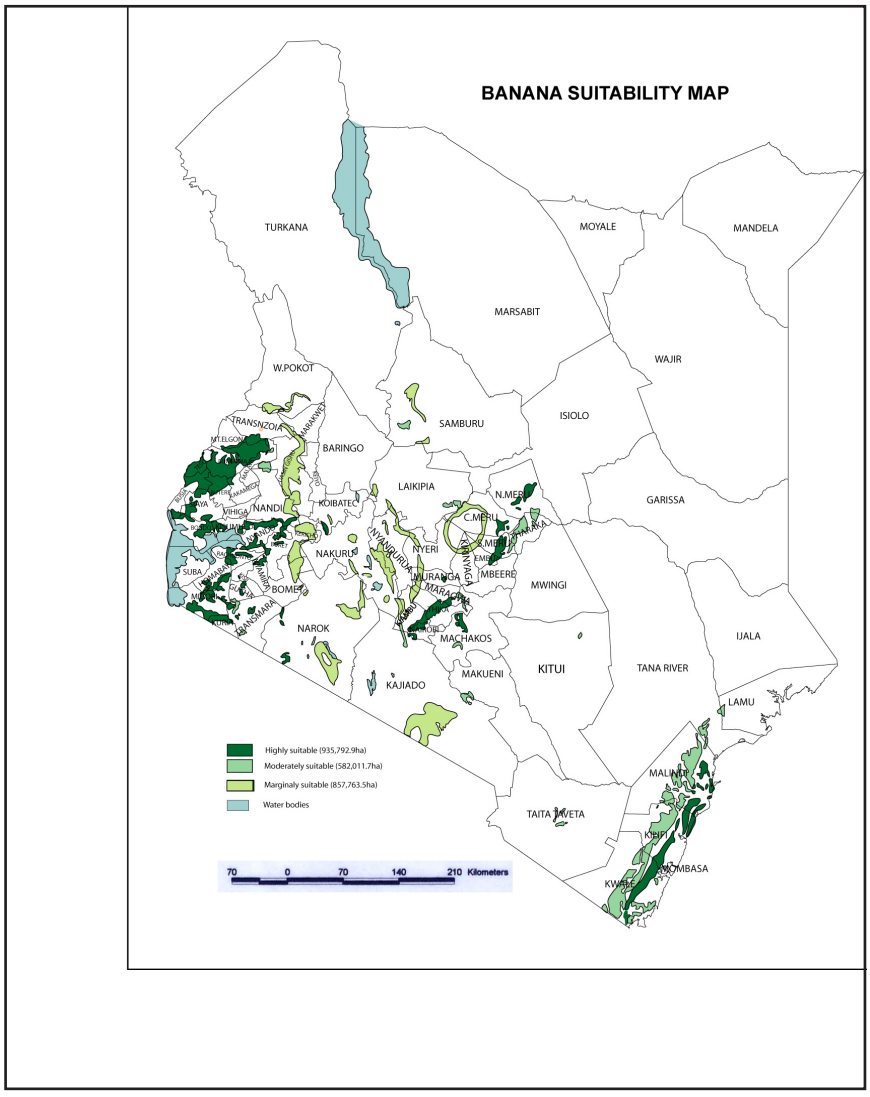



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