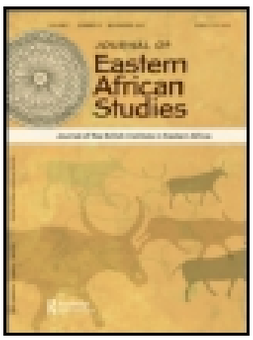

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Culturing Development: Bananas, Petri Dishes and 'Mad Science'

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ABSTRACT *This paper analyses a biotechnology-focused project which aims to promote the development and adoption of tissue culture bananas by small-scale farmers in Kenya. The paper highlights the generation of several important narratives that are used to justify the development and dissemination of this technology. First, a disaster narrative, a series of claims regarding rural livelihoods and banana production in Kenya, is generated. This creates a political and technical space for the creation of a new science that can solve these problems. Finally a series of claims regarding the efficacy of the technology in alleviating poverty are made. The project wields these various constructs to create a particular projection of rural Kenya and banana production, deploying data, statistics, economics and 'facts' in order to continually redefine the project as a success. The project can, through a process of defining its own boundaries and limits, justify a technology-led solution to a complex and nuanced set of problems – the biological subsuming the political. The project thus succeeds as a generator of discourses as much as a generator of technologies.*

Introduction

> The project Biotechnology to Benefit Small-Scale Banana Producers in Kenya was developed in response to the rapid decline in banana production over the last 20 years. This decline was due to widespread soil degradation and the infestation of the nation's banana orchards with pests and diseases, problems further aggravated by the common practice of propagating new banana plants using infected suckers. The situation was threatening food security, employment, and incomes in banana-producing areas.[1]

The creation and adoption of agricultural biotechnologies has become possibly the most publicised and contested rural development issue in the developing world. Even fundamental analyses concerned with exploring the root causes of food security and famine have been buried by debates about whether biotechnology can or cannot make developing countries food secure. The debate about the appropriateness of agricultural biotechnology has become increasingly divisive and divided. At one end of the spectrum, international non-governmental organisations (NGOs) like Action Aid argue there are potentially no material benefits, only risks, to be gained from agricultural biotechnologies in their current form.[2] At the other end of the spectrum, scientists like Dr Florence

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Wambugu formerly of the International Service for the Acquisition of Agri-biotech Applications (ISAAA) and now of Africa Harvest make bold claims: 'in Africa GM [genetically modified] food could almost literally weed out poverty'.[3] More recently, these discussions have become as important as life itself as genetically modified maize as part of World Food Programme food aid packages directed to the southern African food shortages of 2001/02 was first rejected, then accepted by Zimbabwe and Malawi (and Zambia continues to reject GM maize), causing long delays in providing food aid in the most affected areas. It is important, too, to flag the role of the development community in this debate as European development agencies and USAID provided advice on these issues that reflected their own contemporary domestic policies and future international trade priorities.[4] Agricultural biotechnology in Africa, then, appears to have taken root in highly contested terrain.

Kenya, by contrast, is fertile ground. Agricultural biotechnology is heavily evidenced in the public research sector, the non-governmental sector, the private sector and the media. The share of total agricultural gross domestic product that Kenya invests in agricultural research (known in the lexicon as the investment intensity ratio) was 2.6 per cent in 2000, as high as some developed countries and perhaps more illuminatingly over three times the sub-Saharan African average. Around 30 development agencies are engaged in agricultural research and development in Kenya. The Kenyan Agricultural Research Institute (KARI) has been heavily funded by international donors for two decades, is spread over 25 campuses, and employs approaching 500 full-time equivalent researchers. There are two major Consultative Group on International Agricultural Research campuses and another international agricultural research centre based in the country. In 1999, total spending on agricultural research reached 3.3 billion Kenyan shillings (at current exchange rates around US$45 million).[5] Kenya has received heavy investments in its national agricultural innovation system. More recently, there has been an increasing shift towards biotechnological research, underscored by the announcement in autumn 2003 of the development of a New Partnership for Africa's Development-sponsored centre of Bioscientific Excellence for Eastern and Central Africa (BECA), which will seemingly focus purely on biotechnological agricultural research.[6] Indeed, in some respects the production of agricultural biotechnology appears to be a synonym of rural development broadly defined in Kenya. The macroscopic horizons of traditional agricultural science and extension are being reduced to the laboratory, the test tube and the gene. There are undoubtedly exciting developments in agricultural biotechnology and huge potential, but is there a risk in channelling increasingly large amounts of development funding into what remains an inherently more risky, costly, specialised and so far slightly disappointing branch of agricultural research and development? Why has development funding-driven research and development specialised and chased risks, rather than seeking diversification and wider-ranging solutions? It is clearly not in the best traditions of development discourses that revolve diversifying activities to build resilience to shocks and stresses.

The answer lies in another set of development discourses. The development process of identifying and constructing a problem, and then solving that problem, is a core characteristic of the agricultural biotechnology filiére in Kenya. An ever-expanding litany of diseases, pests and pathogens seem to threaten almost every aspect of Kenyan agriculture. These threats are mapped – in biotechnological terms often quite literally molecularly – and measured: research and developmental priorities are then set.[7] The

solution lies in the technology. Has Kenya become a developing-country sized laboratory for biotechnological innovation?

This article explores the reasons why biotechnological research and applications appear to have diffused throughout Kenya's research and development institutions in such an unproblematic, systematic and increasingly powerful way. The focus of study is one particular biotechnological commodity, tissue culture (TC) bananas (Musa spp.), and a particular project that produces knowledge of the technology through research and development and seeks to distribute the commodity. The pithily titled: 'The Benefits of Biotechnology for Small-Scale Banana Producers in Kenya', was initiated by KARI and ISAAA and funded by the Rockefeller Foundation and the International Development Research Centre (IDRC) of the Canadian Government (this particular project is now housed under the banner of 'Africa Harvest' or 'A Harvest', but similar projects continue in both KARI, ISAA and several other NGOs). The argument here will draw upon two main bodies of work: first, post-development theory and development anthropology focusing on the way in which development is presented as an edifice to construct its own artifices; and second, the sociology of scientific knowledge, that seeks to understand the politics, contexts and ideas that drive the evolution – the social construction – of scientific knowledge in particular directions.[8] The anthropological focus on the language, practice and motifs of development initiatives and scientific discovery provides a useful means to interrogate the making of a Kenyan development-oriented biotechnological banana industry.

There has been much recent debate around postmodernist critiques of development.[9] Perhaps the critique most pertinent for biotechnological development in Africa is the assertion that post development theory is bound up in the creation of its own meta-narratives and homogenised, romanticised, neo-luddite and relativist notions of the Third World, and this ignores, and patronises and simplifies, the wants and needs of 'the people'. To put this in generalised terms, Kenya's small-scale farmers are not remotely interested in the ideology or laboratory science of biotechnology; rather, they have concerns about the cost, the utility and the distribution of biotechnology – not whether it represents anything more sinister. We do not then need to focus upon value judgements of the technology itself, but instead upon the mechanisms invoked by the project itself to create an environment in which the technology cannot fail. The critique offered here thus lies within the tautologies of the 'project' and the construction of narratives that surround, underpin and embed the project and the technology.

Projects and Projections

Bruno Latour, in his study of a failed Parisian rapid transport system, stated that '[b]y definition, a technological project is a fiction, since at the outset it does not exist, and there is no way it can exist yet as it is in the project phase'.[10] Latour shows how a technological project is framed in time by those who instigate it, map it, and translate it; but it is also framed in context: 'a technological project is not in a context; it gives itself a context, or sometimes does not give itself one'.[11] Latour here is primarily talking about the context in terms of the network of support needed to force or ease a technology into existence, although I think different contextualisations are apparent even if the overall aim remains to make a technology real. Latour argues it is not useful to replace a project in the proper context to understand it; which with African technological development

might amount to little more than complaining that technologies are simply transposed into Africa with little or no thought with monotonous regularity. Rather, it is important to study the way in which a project is contextualised or decontextualised. It is within these sociologies that we can begin to unpick what drives particular ideas, developments, or particular technologies.

David Mosse draws on some of Latour's ideas in his study of agricultural projects and policymaking in India.[12] He interrogates the relationship between a development project and the language and practice that bookend it; in justification and in search of policy discourses:

> Moreover, a development project cannot in any definitive way proclaim its own reality; this is always contingent upon outside judgements. Project reality has to be determined through the interpretive work of experts who discern meaning from events by connecting them to policy ideas and texts – logframes, project documents (and vice versa).[13]

Arturo Escobar identified – or at least named – two important processes within the creation of policy discourses: 'institutionalisation' and 'professionalisation'.[14] The invention of institutions that, and the training of practitioners who, generate, transmit, stabilise and reproduce development 'truths' and policy priorities are key to the development process, and to understanding that issues of knowledge and power are central in the shaping of process of contextualisation and decontextualisation.[15] Professionalisation is the production of a set of techniques and disciplinary practices through which knowledges are organised and disseminated, and institutionalisation is the creation of institutions in which discourses are produced, recorded and implemented. For the former, the creation of new disciplines, such as development economics, and the training of local development experts are key. Professionalisation is the creation of epistemic communities within the field of development. For the latter, a vast array of institutional mechanisms have come into being, from the international remit of global regulatory agencies, to the myriad of small non-governmental agencies that operate 'on the ground'.[16] The introduction to this paper alludes to the manifestations of these processes in Kenya; 30 development agencies, over 500 researchers dedicated to agricultural biotechnological research in Kenya. Indeed, Kenya-based NGOs like the African Biotechnology Stakeholders Forum (ABSF), ISAAA and Africa Harvest exist purely to promote biotechnological uptake amongst policymakers and small-scale farmers. There are many more. Local journalists have received specialist training in writing about agricultural biotechnology. And international NGOs like Action Aid have moved their headquarters to Nairobi partly in response to the biotechnological gravity exerted by Kenya. The 'project', then, does not exist in a vacuum, it may be studied in a vacuum à la Latour, or its own internal machinations may appear to the critique to work in a vacuum, but as Mosse argues, lessons for policy and practice, data, results, outcomes are articulated and re-articulated through the project to create an environment in which the project can gestate and grow.

Professionalisation and institutionalisation intersect in the production of new types of knowledge and in the instigation of new types of activities. Knowledge based on data that has been mapped, measured and analysed is therefore conceived of as 'objective', 'rational' and 'apolitical'. This is the type of knowledge needed to make external judgements on

projects, to shape project realities. This 'pure' production of knowledge has important implications for the development process, as this 'objectivity' generates the authority that permits particular kinds of development intervention, which tend to subjugate the experiences of the beneficiaries of the process within a matrix of bureaucracies, processes, techniques and objectives:[17]

> The thoughts and actions of 'development' bureaucrats are powerfully shaped by the world of accepted statements and utterances within which they live: and what they do and do not do is a product not only of the interests of various nations, classes, or international agencies, but also, and at the same time, of a working out of this complex structure of knowledge.[18]

Development practitioners make decisions through their own disciplinary lens and from within their own milieu of language and practice, a process which is concurrently shaped by the very process of development itself. Thus, development remains an external process in terms of both values and interventions, despite the creation of mechanisms of participation and democracy that support it. Indeed, 'development' must to an extent remain external to itself in order to perpetuate policy and projects, ideas and activities. If there is no external element – in the form of consultants, partners, even beneficiaries – it cannot shape its own perpetuation as Mosse shows.[19]

James Ferguson,[20] in his study of the World Bank's construction of Lesotho as a development object and a dissection of why that development ultimately did not succeed as hoped remains a useful place to begin. Ferguson showed that the development process in Lesotho began by creating a particular set of 'truths' about Lesotho: it was reliant on agriculture; agriculture was in decline, and institutions were too weak to provide suitable interventions. These truths were backed up by an array of statistics, calculations and 'facts'. The construction of a target for development as 'backward' and 'in decline' is central to the full acknowledgement that development is the process that bridges the gap between the First and the Third Worlds. This sets the scene for the construction of development narratives, of particular trajectories that must be modelled. The focus is on identifying deficits that must be overcome, gaps that must be filled. This is not too dissimilar from the way the generation of technologies is understood; scientists (and this is an enormous generalisation) despite often not really noticing that people exist during their research, are quick to politically embed their research when it becomes a technology.[21] It is at this moment, not before, when the true act of contextualisation begins.

Thus, scientific and technological narratives are intimately tied up with development narratives. Traditional culture, and the activities culture encompasses, are painted as static and never changing, as 'preserved in the timeless aspic of tradition and custom'.[22] Meanwhile, in 1980, the Brandt Report stated, 'The sharing of technology is a world-wide concern . . . But clearly it is most important to the developing countries, and it can even be argued that their principal weakness is the lack of access to technology, or of command of it'.[23] Nearly a quarter of a century later, Gordon Brown expressed similar sentiments: 'In the nineteenth century you could say that it was inadequate science, technology and knowledge that prevented us saving lives. Now, with the science, technology and knowledge available, we must face the truth that the real barrier is indifference'.[24] Scientific and technological application, then, is a pre- and co-requisite for development.

The present is defined by technological research and development, and the future will be shaped by the possibilities of these new knowledges.

In sum, we can identify three ways in which contextualisation can operate with regard to technology and development. First, there are processes of decontextualisation (and even re-contextualisation) in the creation of a technology, in the framing of a project; science in becoming a technology tends not to be demand-led. Rather it is through projects, policy and donors (and at this point we should remember the externalities of expert knowledge needed to justify all) that technologies are generated. Second, there are processes of contextualisation, contextualising the project within networks of experts and institutions, within the political, in order to push the idea forward, to keep it moving: 'contextualization is fabricated and negotiated like everything else: by tying bigger and bigger pots and pans, and more of them, to the project's tail'.[25] Third, there is a process of contextual transposition that ferments in the background, underpinning both decontextualisation through the idea that to not have technology is to be deficient in technology, and through contextualisation, where development imperatives and the development apparatus, drive the extension and filamentation of the networks needed to make a technology exist, and commit a policy to paper. The Kenyan case study illustrates some of the steps walked to contextualise and decontextualise, and make a technology real.

Networks and Development Partnerships in Kenya

Kenya is relatively well served in terms of agricultural research capacity and infrastructure. Complex relational networks exist between many of the institutions engaged in agricultural research and development there. Indeed, the notion of partnership is very important to the process of producing scientific knowledge in Kenya. The idea of partnerships in relation to biotechnology in Kenya are codified in three separate ways. Within development theory, the notion of partnership has many meanings, but despite this theoretic diffusion the ideal of partnerships have become embedded in what modern development is, and ought to be. Evolutionary economists have argued that partnerships, too, are extremely important within agricultural innovation systems, partnerships and the knowledge they share and communicate have been the driving force behind a shift from exogenous to endogenous technological development. Indeed, partnerships literally are the innovation system: '[a national system of innovation] is a system or network or private and public sector organisations whose interactions produce, diffuse and use economically useful knowledge'.[26] Partnerships – or rather networks in the language of science studies – make a technology real. Without a network of support (of 'pots and pans') a technology can quickly die. The filaments of the network, for myriad reasons chose to conduct information, or insulate information, within the network. It is within this network that the impetus to drive a technology must come. If this network can drive the technology, and meet other ideals of participation and needs of partnerships, so much the better. But the primary, and most hidden, objective is to drive the technology.

Partnerships can encompass many transactions: knowledge, advice, funding, resources, political will and advocacy. Partnerships are fundamental for development yet remain poorly defined. It is perhaps easier to define partnerships by what they are not, by what they are a rejection of: a shift away from 'old-fashioned' models of development, a move away from 'top–down' approaches, a move towards accepting 'alternative viewpoints'

and systems of knowledge and understanding.[27] Partnerships are a twenty-first-century way of doing things. According to the Organization for Economic Cooperation and Development:

> Acceptance of the partnership model, with greater clarity of the roles of partners, is one of the most positive changes we are proposing in the framework for development co-operation. In a partnership, development co-operation does not try to do things for developing countries and their people, but with them.[28]

Functioning partnerships are therefore prized above almost all else in development communities. The existence of relationships with southern partners is obligatory for northern NGOs if they are to seek legitimacy and, most importantly, funding.[29] It is problematic to consider partnerships as real co-operation between equals given other development agendas of good governance and aid conditionality, and these development thrusts are likely to become more powerful in the near future. Power relations within partnerships are amplified by the increasingly important role played by the private sector in providing funding. NGOs, and researchers, have to market themselves as partners willing to fit into bilateral donors' development agendas and the private sector's corporate agenda. Within this context, development partnerships can be understood as resource transactions between unequal partners. Institutions are created in response to the vagaries of development policy and funding, and this is particularly clear in the biotechnology sector in Kenya. Partnerships are inherently contradictory: marketed as impartial, yet often highly political; superficially equal, yet bound up in power relations; co-ordinated by definition, yet in reality often highly fragmented; ostensibly bottom–up, but often driven by funding priorities.

The many institutions concerned with agricultural research and biotechnology in Kenya inevitably form complex partnerships given the prioritisation of partnerships by donor agencies. Partnerships also arise for another reason; they are a particularly important articulation within agricultural research and development. Experience suggests that innovation most commonly takes place at the interface of research and production 'institutions' in developing countries. A wide set of actors and institutions are involved in innovation processes, and productive relationships between these actors create linkages between formal research and the use of knowledge in economic production. Traditionally, public sector agricultural research has produced little innovation in developing countries because it was relatively isolated from economic agency.[30] In Kenya, for example, KARI has enjoyed relatively little success in converting research into 'products'. This realisation has resulted in KARI re-orienting its research agenda and actively pursuing partnerships across both the public and private sector.[31] The increasing importance of public–private partnerships, in particular, is shaping the institutional landscape quite radically.

'The Benefits of Biotechnology for Small-Scale Banana Producers in Kenya' is an example of a partnership-oriented project. Table 1 illustrates the complexity of the range of partnerships that contribute to the project. Project documentation notes:

> A major strength of the project was the formation of partnerships with both public- and private-sector institutions, which helped to promote a sustainable system of technology development and dissemination. Collaboration at a local level was greatly enhanced by Kenya's strong network of NGOs, such as church and women's

Table 1. Summary of the main institutions involved in *The Benefits of Biotechnology for Small-Scale Banana Producers in* project adapted after Wambugu and Kiome, 2001, 9)

Objective	Institutions	Main Output	Requirements
TC Production	GTL, KARI, DuRoi Laboratories (South Africa)	Selection of varieties, TC production, quality control and assurance, training in nursery management	Enhanced public–private collaboration, stringent quality control
Strategic/Adaptive Research	KARI, ATPS, ISAAA, Farmer groups	On-station trials, varietal comparisions, spacing, agronomy, TC versus sucker comparisons, intercropping, training, demonstrations, technology diffusion	Appropriate infrastructure and policy framework
Distribution	KARI, ISAAA, CBOs, Farmer groups	Distribution mechanism channels – schools, churches, on-farm trials, markets, village leaders, farmers	Well-designed marketing plan, entrepreneurial skills, and willingness to participate
Links with Farmers	KARI, STPS, ISAAA	Needs assessments through PRA, varietal choices, orchard management, access to TC plantlets, on-farm trials, training, large and small-scale farm demonstrations, financing	Participatory approach geared towards meeting farmer expectations and aspirations
Marketing	KARI, ATPS, ISAAA, ZEF (Germany), farmer groups	Socio-economics: pricing, quality control, distribution and training	Market structure establishment, post-harvest handling/ packaging standards
Expansion	Micro-entrepreneurs, NGOs	Manure application, micro-irrigation, Banana Grower's Association, private investments (e.g. banana-related businesses and export markets)	Political and economic stability, entrepreneurial skills for identification of business opportunities
Technical Backstopping	ITSC (South Africa), John Innes Centre (UK), DuRoi Laboratories (South Africa	Designing appropriate field management packages, commercialisa tion strategy, virus disease diagnostics, training	Public–private collaboration, networking, experience sharing

Key: CBOs – community-based organisations; PRA – Participatory rural appraisal; ATPS – African Technology Policy Series; GTL – Genetic Technologies Limited; ZEF – Zentrum für Entwicklungsforshung (Centre for Development Research); ITSC – Institute for Tropical and Subtropical Crop.

> groups. The Kenyan tradition of harambee, or pulling together, helped farmers and researchers work together to evaluate the TC technology.[32]

Partnerships are in some respects a nexus for theories of development and of innovation, they are part of the dominant theoretical rationale of development, providing a warm sense of unproblematic consensus, legitimacy and a sense of co-operation, and they are an important component of new understandings of how to build agricultural research and innovation systems in developing countries.

In terms of agricultural research, partnerships lubricate the institutional landscape of Kenya at three levels, they provide the concrete range of skills necessary to produce and disseminate tissue culture bananas at one level, at another level they provide a sense of bottom–up development, of responding to farmers' needs, and of properly prioritised research. Finally, they create the network, or filiére, needed to contextualise the technology. The subsequent sections will explore how valid the second and third implications are in respect to tissue culture bananas.

Constructing a Kenyan Banana Industry

> Bananas and plantains, which are starchy cooking bananas, are widely grown across the world's tropical regions. They are major food crops in developing countries, and bananas are also an important export crop to industrial countries . . . They are particularly important in East Africa where they constitute the main staple food for about 50% of the population. In this part of the world the annual consumption reaches over 400 kg per person.[33]

According to Wambugu and Kiome, in their overview of 'The Benefits of Biotechnology for Small-Scale Banana Producers in Kenya' project, Africa is a major producer of bananas, contributing 35 per cent of world production.[34] East Africa produces over half of Africa's banana crop and it '[provides] a staple food and source of income for an estimated 20 million people'.[35] Two per cent of Kenya's land used for crop production is under cover of banana, an area equivalent to 80,000 hectares, predominantly under the management of small-scale farmers, who have an average banana holding of 0.3 hectares. Traditionally, banana has provided a source of income and sustenance for rural and urban populations, and 24 per cent of banana production is still used purely on a subsistence basis.[36] Bananas are grown over a wide range of agro-ecosystems, from sea level up to around 1,800 metres, generally in areas of high rainfall ($>$1000 mm per annum). Production is generally rain-fed, as smallholders tend not to have the resources to implement systematic irrigation. Hence, drought is often a key limiting factor for production.

Banana are identified as an attractive crop for smallholder farmers for a number of reasons:[37] Banana is a popular food and a good source of carbohydrates, vitamins and minerals; surplus production provides a reliable source of income – contributing to household security; once a crop is established, harvesting is essentially continuous throughout the year; under optimum conditions, banana can outperform many other crops in terms of yield per hectare; banana is suitable for intercropping and provides soil stability and shelter for other plants. Yet, despite the many advantages of banana

production, the majority of rural households only cultivate very few banana plants. Banana is almost never the primary crop and, in fact, agriculture as a whole is usually only one of several livelihood activities that a household engages in. However, Matin Qaim, in his socio-economic assessment of banana biotechnology, which formed part of the project, notes that his household survey data indicates that 90 per cent of households mentioned they are active in at least ten different enterprises, he lists the production of different grains, starchy root crops, fruits, vegetables and livestock keeping as some of these activities. It is interesting Qaim chooses only to list on-farm activities, and does not mention remittances, labour and micro-enterprises as key activities. A Department for International Development (DfID) study of ten deep rural villages in western Kenya shows that agricultural activities contributed a mean of only 32.2 per cent in terms of overall household income. Even in the poorest income quartile agriculture only 64.8 per cent of income was derived from agriculture.[38] This rural income pattern has been observed across Kenya for at least the past ten years.[39] Empirical evidence shows that the notion of Kenyan rural households relying purely on agricultural production is outmoded. To emphasise the reliance of rural households on agriculture is one of the central tenets of development. Ferguson showed in his Lesotho case study how the World Bank chose to present Lesotho as a 'traditional subsistence peasant economy' when this was clearly not the case, it did however provide justification for the implementation of the World Bank's array of rural development initiatives.[40]

Even if one accepts the 'undue rural reliance on agriculture' thesis, it is clear the banana is not an important crop within the majority of agricultural systems. Far from 'constituting the main staple food for about 50% of the [East African] population' as the International Institute of Tropical Agriculture (IITA) suggests,[41] data from the Food and Agriculture Organisation of the United Nations (FAO) indicates that the mean nutritional contribution of bananas in Kenya has been in the order of 11–12 calories per capita per day over the past 25 years (Figure 1). Furthermore, mean consumption per capita in East Africa is less than a tenth of what the IITA suggests. Qaim implicitly hints at this more realistic figure himself when he indicates that: 'nearly every rural household has a couple of banana plants'.[42] It is likely that the poorest percentiles of rural households

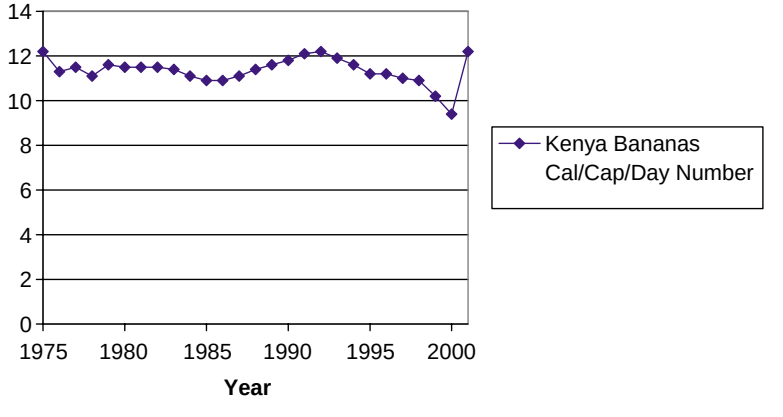

Figure 1. Banana consumption in Kenya, 1975–2001 (calories/per capita/per day)(FAOSTAT data, 2003).

consume proportionately more bananas than the FAO figure, but it appears highly unlikely that the banana forms the main component of either their diet or their income.

It seems that the project's premise that the banana is an important crop for rural development, food security and income generation in Kenya appears to be based on poor data. There is little or no evidence from either empirical or statistical data that: first, the banana is a staple crop: second, that is provides a cash income for small-scale producers: and third, that is provides an important calorific contributions to rural peoples' diets in Kenya. It appears much more thorough preliminary research should have been conducted to identify the scope, nature and importance of the banana to small-scale households in Kenya. The data as presented significantly and systematically overstates the importance the banana to rural livelihoods in Kenya. This has serious implications for the relevance of, and impacts of, the biotechnology banana innovation system in Kenya.

Having constructed the Kenyan banana sector as fundamental to food security, rural livelihoods and poverty alleviation the next stage of the development discourse of the banana in Kenya is to create a 'crisis narrative', a situation that is inexorable, inevitable and above all cannot be managed with the existing portfolio of development interventions. In East Africa, the narrative suggests that banana production has declined over the past twenty years. Wambugu and Kiome state: 'But the decline in the production of the banana over the past twenty years has had a major impact on food security, particularly for subsistence farmers, and bananas have become an expensive item that many low-income groups can no longer afford.'[43] This narrative prevails in a whole range of literature supporting biotechnological development in Africa. DeVries and Toenniessen, for example, highlight sharp yield declines in Rwanda and Uganda over the past 17 years, indicating that mean annual yields have decreased from 11 t ha^{-1} in 1970 to less than 6 t ha^{-1} in 1997 in Rwanda, and 8 t ha^{-1} in 1970 to less than 6 t ha^{-1} in 1997 in Uganda. These data are not sourced.[44] There is indeed a gamut of literature referring to progressive banana yield declines in East Africa, all cited by biotechnologists.[45] Figure 2

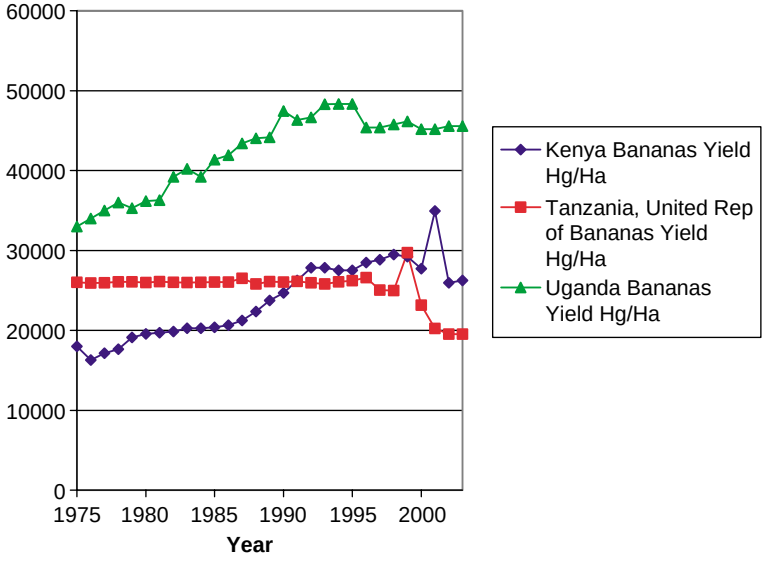

Figure 2. Hg/Ha yields of bananas in selected east African countries, 1975–2003.

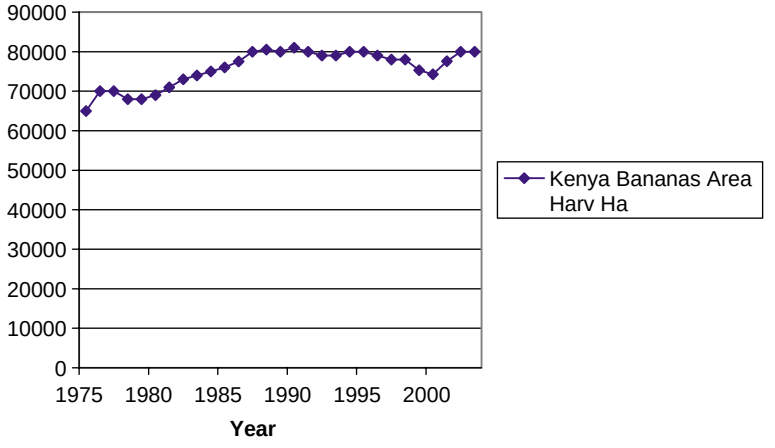

Figure 3. Area of harvested bananas in Kenya (Ha), 1975–2003 (FAOSTAT data, 2004).

indicates FAO time series data of mean annual yields for Kenya, Uganda and Tanzania between 1975 and 2003. It is clear there is no discernible decrease in banana yields over the past 20 years, except possibly in Tanzania. In fact, if anything, there has been a significant increase in yields in Kenya and Uganda over that period.[46]

It appears the progressive yield declines, which are not measured, referenced or sourced in any of the literature concerning the project, or any of the other biotechnology banana initiatives in Kenya, have little or no statistical or empirical basis. Furthermore, the 'decline' in banana yields in Kenya does not appear to have created the stagnation in banana production that has led to higher urban prices that the literature suggests.[47] Figure 3 suggests that the amount of land covered by banana production has remained constant or even increased over the last 25 years. It appears the crisis narrative of rapidly decreasing banana yields, brought about by the 'infestation of the nation's banana orchards with pests and diseases' is not as serious an issue as the data would suggest.[48] Nevertheless, the data presented by the researchers behind the projects – and other similar projects – had the veneer needed to gain access to the development funding necessary to run the project. It is at this point the commonalties behind the development apparatus and the innovation system become most apparent. The creation of a particular narrative banana production in Kenya and East Africa, backed up by the products of the scientist, statistician and the economist was attractive enough to interest development agencies such as the Rockefeller Foundation and the IDRC. A concrete problem had been identified mapped and measured, and a technical solution was offered. The data had created a partnership between the development agency and the scientist. An innovation system was the result.

Tissue Culture Bananas in Kenya

The narrative of decline in banana production discussed above has been attributed to a number of factors. According to Wambugu and Kiome these include:[49] lack of clean planting material; pests and diseases; lack of awareness amongst farmers of the technology available to improve yields and control pests and diseases; low levels of management; and

Table 2. Principal pests and diseases affecting Kenya's banana orchards (after Wambugu and Kiome, 2001)

Pests	Diseases
Weevils *Cosmopolites sordidus*	Fusarium wilt (Panama disease) *Fusarium oxysporum f. sp. Cubense*
Nematodes *Radopholus similes Pratylenchus goodeyi*	Cigar-end rot *Verticillum theobromae* *Trachysphaera fructigena* Black sigatoka leaf spot *Mycosphaerella fijiensis* Yellow sigatoka leaf spot *Mycosphaerella musicola*

decline in soil fertility. Wambugu and Kiome then assert that the recent decline in yields can largely be attributed to the infestation of Kenya banana orchards by pests and diseases (see Table 2). They provide no empirical evidence for this assertion. They state that disease infestations are perpetuated by small-scale farmers' practice of using suckers from existing plants to grow new ones.[50] The existing plants may be possibly diseased and new stems will be affected by these diseases as they mature. A more systematic analysis of why banana yields are poor should probably have focused on a broader range of issues. For example, only 51 per cent of small-scale farmers provide any inputs at all, despite the fact the use of irrigation and manure are widely acknowledged as crucial to maintaining optimum yields.[51] Some reasons why inputs are not more widespread are highlighted, focusing in particular on a lack of farmers' knowledge in using farm chemicals and superstitious beliefs about the use of fertilisers on banana plants. Reference is also made to farmers 'liquidity constraints', presumably meaning they cannot afford, or do not believe the benefits outweigh the costs of, utilising more sophisticated management techniques. Possibly some households just like having a few banana plants nearby for occasional consumption.

Disregarding a more detailed analysis of constraints on banana production, the project focuses on a lack of clean planting material, pests and diseases, and a 'lack of awareness amongst farmers of the technology available to improve yields and control pests and diseases'. [52] The use of tissue culture techniques to produce banana plantlets operates on the premise that Kenyan farmers' practice of using disease-infected sucker material for propagation is the main constraint for improving crop's yield performance. Laboratory-based micropropagation techniques provide disease-free planting material. This results in increased banana productivity. One of the advantages of tissue culture is that it is a relatively simple biotechnological technique. Table 4 highlights some of the advantages and disadvantages of tissue culture technologies and their application to bananas. It has been used since the 1980s in South Africa, for example. Jomo Kenyatta University of Agriculture and Technology began the micropropagation of banana in Kenya in 1995, with the help of World Bank funding. The aim of the project analysed in this paper is to scale up this production to provide large amounts of tissue culture plantlets to small-scale farmers. It aims to do this by building and upgrading national banana tissue culture capacity and establishing viable biotechnology distribution channels. Several international donors, development agencies, Kenyan universities, NGOs and parastatals are involved in projects of this type in Kenya. For widespread technology adoption to occur –

especially amongst small-scale producers – the project envisaged the creation of institutions and capacity building for technology dissemination. There are further plans to extend the technology to Uganda and Tanzania, where it is claimed similar problems with the banana sector exist.

It is important to closely examine the advantages and disadvantages of tissue culture banana technologies given the large amount of resources deployed, and the plans to increase capacity across the East African sub-region. It is clear that the technology helps to eliminate the passing on of pathogens from one generation to the next by eliminating unclean planting material as the main vector. The issue regarding the improved yields of tissue culture banana over traditional sucker material is not quite so clear-cut, however.[53] A South African study from the early 1990s indicates that TC material boasts a yield advantage of around 20 per cent in the first year, then decreases yearly though still boasting measurable greater yields after the third year.[54] These yield increases appear similar to a range of other studies.[55] Perhaps surprisingly, given the aims of the project, there is only one mention in all the documentation of results of a comparison of tissue culture versus conventional sucker banana. The yield difference at one of the field test sites owned by KARI was 19 per cent greater in the tissue culture banana over one growing season (Table 3). It is a pity that several years into the project there is not more published data on yield comparisons, from field trials or from on-farm studies.

The issue of good quality data on yields is fundamental for any assessment of the utility and appropriateness of tissue culture banana production. Tissue culture banana plantlets are relatively expensive (about US$1.50 per plantlet at the time of writing) and have to compete with traditional suckers that are obviously free. Therefore, tissue culture banana technologies need to conclusively prove they are worth investing in. The available data do indicate that tissue culture bananas at least initially outperform conventional suckers. There has been, however, little attempt to assess the on-farm realities of tissue culture banana adoption and production.[56]

Despite little dissemination of post ante data, given the fact most tissue culture projects – including the project under analysis – are in preliminary scaling-up phases where the aim is to attract extra funding to multiply production and dissemination of the technologies, significant attention was paid to constructing forward-looking ex ante studies of socio-economic benefits of tissue culture technologies. Qaim's assessment of the impact of banana biotechnology in Kenya, in particular, focused on ex ante analyses of the socio-economic impacts of tissue culture technologies for small-scale farmers.[57] Qaim acknowledges that small-scale farmers are unlikely to be willing or able to adopt the full range of management instruments needed to fully realise the extra productive potential of tissue culture banana plants. Experience shows that small-scale farmers tend to be selective about the array of management options they use when they adopt new technologies.[58] It does not appear possible to unproblematically juxtapose the results from Kenyan optimised field trials into analyses of small-scale farmer benefits. Therefore,

Table 3. Comparison of TC versus conventional sucker at National Horicultural Research Centre – Thika, central Kenya. (after Wambugu and Kiome, 2001).

	Days to harvest	Yield (t/ha/year)
Tissue culture	341	49.9
Conventional suckers	414	41.9

Table 4. Advantages and disadvantages of tissue culture bananas

Advantages	Disadvantages
TC plantlets are free of most of the pests and diseases that exist in Kenya, notably weevils, nematodes and fungi.	TC planting material has a higher price compared to conventional suckers. This implies a high cash outlay for the adoption of the technology.
Yield performance of TC plantlets is superior to clean conventional sucker material. According to a South African study yields are 20 per cent higher in the first year, then slightly decreasing, but still measurable after the third year.	TC plants require more care and improved management. TC plants have no nutrient reserves when planted and external stress is particularly harmful. Fertilisation, weeding and sufficient water supply are crucial to TC plants.
In vitro plantlets are uniform and this may simply orchard management compared to conventional material. However, uniformity decreases over time, meaning this is not a long-term advantage.	Tissue culture procedures remove most pathogens, but not viruses.
Experience with TC techniques and the establishment of efficient germplasm distribution channels are also preconditions for progression to more advanced biotechnologies. For example, transgenic banana varieties.	There is an increased risk of mutant with TC bananas. Mutations such as dwarfing or other undesired morphological features decrease yields. Mutation rates can reach 50 per cent.

it is surprising to examine the results of Qaim's ex ante analysis (Figure 4). The analysis segregates the mean annual yields into three classifications of farm size: small-scale (<0.5 acres), medium-scale (between 0.5 and 2 acres of bananas), and large-scale (plantations bigger than 2 acres). The analysis assumes all the recommended management techniques are adopted.[59] Table 5 illustrates the conclusions from the ex ante analysis. Small-scale producers appear to increase their yield by 150 per cent, medium-scale producers by 132 per cent, and large-scale producers by 93 per cent. Given the only published data on tissue culture versus traditional suckers is from a one-year field trial held at a research station in South Africa that showed a 19 per cent increase in yield which is likely to decrease from the third year onwards, the optimism embodied in Qaim's ex ante analysis appears unduly optimistic. The analysis ignores not only the available data but also empirical experience that suggests small-scale farmers do not adopt whole packages of technologies. This oversight circumvents the need to acknowledge that the project has only assessed tissue culture yields in optimum conditions.

In one further respect one might argue that the analysis is rather more than simply optimistic. When one unpicks what is meant by optimum management conditions one realises that this includes planting twice as many TC plantlets per hectare than one would plant traditional plantlets. This is not clearly stated in the document. The rationale for this is that TC plantlets are more prone to suffering from environmental stress as they develop and increasing planting density provides some collective protection from the elements. This also, of course, serves to automatically double TC banana yields per hectare which does make the optimistic projections regarding yield increases described above less optimistic and certainly does the promotion of the project and the technology no harm at all. Increasing planting density also serves to place increasing pressure on land and labour, two 'externalities' not considered in the analysis.

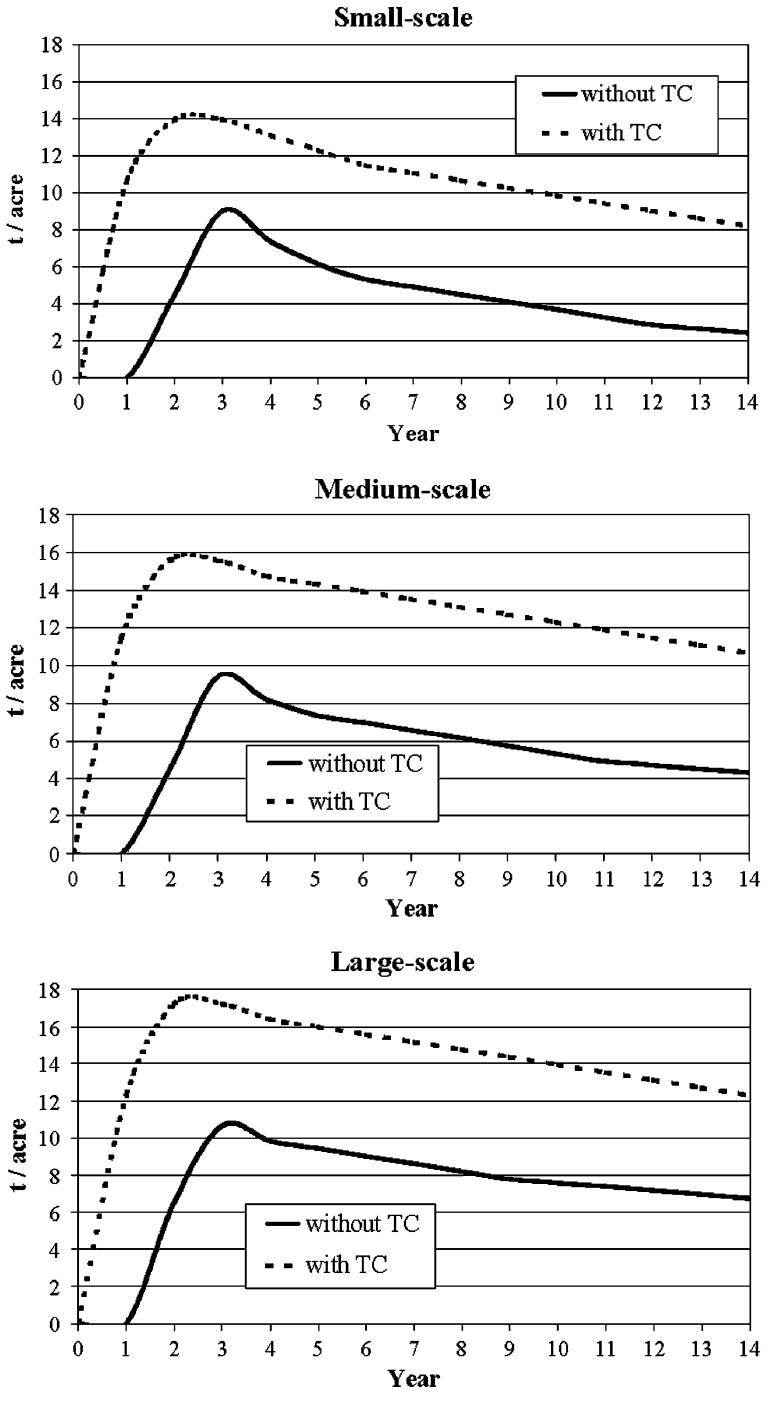

Figure 4. Estimated banana yield curves over a 14-year plantation cycle without and with the use of TC technologies (after Qaim, 1999).

Table 5. Average banana cost and income figures without and with the use of TC technology (per acre) (after Qaim, 1999, 17)

	Small-scale		Medium-scale		Large-scale	
	Without	With	Without	With	Without	With
Cost Annuity (Ksh)	5 996	13 815	7 258	15 774	9 992	19 159
Average Yield (t)	4.35	10.89	5.62	13.03	7.57	14.61
Income Annuity (Ksh)	23 774	60 853	29 312	71 744	38 002	78 388
Return per labour-day (Ksh)	929	1 251	904	1 271	858	1 211
Per unit cost (Ksh/t)	1 313	1 206	1 292	1 175	1 357	1 280

Source: Author's calculations based on the interview survey (1998).

This ex ante study forms an important part of the overall project and has been influential in 'proving' that small-scale farmers can in fact benefit from 'biotechnological' products.[60] The use of ex ante studies without the application of post ante studies to test the analysis seems to be a fundamental omission in the data analysis of 'The Benefits of Biotechnology for Small-Scale Banana Producers in Kenya' project. It is an omission that allows the tacit creation, publication and dissemination of overly optimistic data on the positive impacts of the technology. Indeed, it appears that whenever there was a choice to be made about how to analyse, present and describe data a course of action was chosen that would present the TC banana in the best light. For example, increasing yields due to TC banana production will lower prices in urban markets easing food insecurity, yet when it comes to analysing the benefits of increased production for producers no attempt is made to factor in the impacts of increased supply on prices and consequently profits. This would seem to serve the interests of the scientist and the project, not necessarily the needs of the small-scale farmer or urban consumer. There are several other examples of similar instances but this example is illustrative, I think.

Contexts, Realities, Networks

'The Benefits of Biotechnology to Benefit Small-Scale Banana Producers in Kenya' project is about momentum; the technology must be cajoled into existence, inertia must be overcome, innovation must be smoothed. 'Technological projects become reversible or irreversible in relation to the work of contextualisation'.[61] Contextualisation shapes realities and forms networks that voice a demand, a need, for the technology. Meanwhile, the project, beholden only to its own criteria of success and failure, becomes a tautological object that can only be unlocked by experts. Momentum is generated in matrices of contextualisation and decontextualisation, framing and interpreting.

The case study of tissue culture bananas in Kenya is illuminating at a number of levels. Superficially, it represents a typical development narrative in terms of the ways in which a development object is created and de-politicised through the deployment of 'facts', creating the space for a particular intervention and creating a technological momentum. The case study displays traits of subduing culture and place within its analysis, of using data and knowledge of varying quality, and presenting science and technology as value free and the only way to solve the presented problem. Processes of professionalisation and institutionalisation are inherent within the project; indeed we can see the results

occurring before our eyes across Kenya, within institutions, projects, activities and policies. The tissue culture banana product is a pilot, the aim of which is to attract funding to create 'new institutions' such as regional training centres that upgrade tissue culture banana capacity, establish distribution channels, and promote technological awareness across East Africa.[62] Professionalisation is inherent in the ways in which data is created, presented and analysed, or sometimes not presented. The most striking example of this is the deployment of questionable economic instruments such as the ex ante studies of the socio-economic benefit of tissue culture technologies for small-scale producers. The project shapes how it will be pigeonholed as a success or failure.

It would be remiss not to acknowledge that another more explicit process than interpretation has been occurring in the project, however. The tissue culture project is an example of an innovation system, a kind of metaphor for the networks necessary to create technologies and get people to use them. In some ways it is a successful one. The project has been successful in taking new knowledge and producing and packaging it for economic development. The technology is not without merit. Aside from critiques of the conception of the project, the projections the project makes and the contexts it shapes, partnerships from the public and the private sector, from the state and civil society, and from several African countries have been successful in managing knowledge in a sufficiently coherent way to produce banana plantlets for small-scale farmers. The banana plantlets exist in very many orchards. Indeed, the project has been the recipient of international recognition for the successful management of complex partnerships. The technology of tissue culture is not at issue in this paper. Studies have shown tissue culture banana plants have both advantages and disadvantages; moreover it is clear that these advantages and disadvantages are not fully understood in the context of small-scale farm production in developing countries. Rather, at issue is the way in which the technology has been brought into existence.

It has been argued that technology is often valued according to whom it is associated with, rather than by its utility.[63] The discourse of the network of partners, of the innovation system, evidences this; it is an African project designed to help poor, rural Africans. Its perceived utility – its success even – is congruent with the partners of the project, not the technology itself. Partnerships, then, provide an abiding rationale for the rationality of the technology. The network distributes the context across the continent, while rooting itself firmly within the continent.

Meanwhile, the project is a lens through which realities are generated and interpreted. Narratives of the decline in banana yields, and of threats to the economy, to livelihoods and to food security create an internal momentum within the networks of experts; development practitioners, donors, scientists and policymakers, who help the technology become a reality, and the project become a necessity. A network of Promethean desire – the feeling that technology should be transferred because it can be, that technology ought to be created because it can be created – generates a sort of heat that makes networks fluid and that promotes motion within those networks. This impulse towards the modern shapes development, shapes policy and shapes the way scientists think: 'with biotechnology we can literally weed out poverty' and contextualised thus does not sound such an outrageous claim. Donors such as the Rockefeller Foundation want to fund technological projects; they want to fund 'African' solutions. African scientists want to develop technological solutions, everyone wants quick fixes to problems, everyone wants projects to succeed. These wants – perfectly rational in their own right – accrete

and shape interpretative abilities perhaps as much as PhDs do. It is in the moments when a technology barely exists, where a 'puff of air could wipe it out',[64] that interpretations tie the technology into many contexts; within the largesse of donors, the labs of scientists, the desks of policymakers and the fields of farmers. Actors have to 'want' the technology to exist, and in the case of tissue culture bananas then it does exist, alongside the paraphernalia of project yields, cumulative profits and pathways out of poverty. Of course, many people want TC bananas to exist not because of what they represent as a technology but because they represent the real, live promise of a future of African-developed biotechnologies growing in African fields. They represent a vision.

The implications are clear. The innovation of context shapes priorities, drives change and promotes projects. The investment in TC bananas, regardless of their utility or appropriateness, runs into millions of dollars so far. Tissue culture bananas are frequently touted as the success story in African biotechnological development. The success or failure of the technology ends up not mattering. It does not seem to matter that tissue culture techniques are not technically even considered very 'biotechnological', certainly no genetic modification takes place, and no particularly innovative processes or procedures are involved.

Farmers who spoke of the technology complained of the risk of debt to acquire the technology, the effort needed to provide irrigation, the lack of markets for banana. The project buries these issues. No measured increases in yields have been published. The project focuses on the promise of the future. The success of the project is very much the project itself – the circling of the narrative of the product. Despite this, the production of project narratives can be considered neither facts nor fictions, just as a technology is neither 'good' nor 'bad'. The enveloping of science within the veil of the 'project' underlines this. Suitably historicised, even the most neutral scientific domains become narrative. As Escobar reminds us, to treat science as a narrative, as a result of context, as an element of a project, is not to dismiss a technology, but rather it is to treat science properly, without succumbing to its 'mystification', creation of 'the truth', or overreaching promises on the one hand, or to ironic scepticism, fear, or outright ideological dismissal on the other.[65] Science, projects and expert discourses produce powerful truths, and ways of interpreting and intervening in the world, in the present and in the future. Biotechnological science, in particular, has the potential of suturing together many different understandings of nature and capital and how they intersect in profound new ways, especially in Africa and other developing regions. The tissue culture banana case study in Kenya shows above all else that technology is neither 'good' nor 'bad'. Rather it exists or it does not. It is precisely because science is important and technology is so relied upon that how a technology comes to exist, as much as what a technology can do or what it represents is worthy of our attention.

Notes

[1] Wambugu and Kiome, 'The Benefits of Biotechnology', vii.
[2] Action Aid, 'GM Crops'.
[3] New Scientist, 'Feeding Africa'.
[4] Smith, 'Povertà, potere e resistenza', 158–72.
[5] Bientema, Murithi and Mwangi, 'Agricultural Science and Technology Indicators'.
[6] ILRI, *New Biosciences Facility*.
[7] ASARECA, 'Development of a Long Term Strategic Plan'.

[8] See work of Escobar, Kothari, Power and Ferguson,. or Latour or Woolger.
[9] Escobar, 'Beyond the Search for a Paradigm?', 11–14.
[10] Latour, *Aramis*, 23.
[11] Ibid., 133.
[12] Mosse, *Cultivating Development.*
[13] Ibid., 157.
[14] Escobar ,'Beyond the Search for a Paradigm?'
[15] Foucault, *Archaeology of Knowledge.*
[16] Watts, 'Development I'.
[17] Escobar, 'Beyond the Search for a Paradigm?'
[18] Ferguson 1990, 18.
[19] Mosse, *Cultivating Development.*
[20] Ferguson 1990.
[21] Sturgis, 'Science in Society'.
[22] Kirk, 'Pottering with Incorporation', 32.
[23] Brandt, *North–South*, 193.
[24] Brown, 'Making Globalisation Work for All'.
[25] Latour, *Aramis*, 143.
[26] Clark *et al.*, 'Research Capacity Building'.
[27] Chambers, *Challenging the Professions.*
[28] OECD, *Shaping the 21st Century*, 13.
[29] Fowler, 'Building Partnerships'.
[30] Clark, 'Innovation Systems'.
[31] Kiome, 'Development and Application of Science'.
[32] Wambugu and Kiome, 'The Benefits of Biotechnology', 7.
[33] International Institute of Tropical Agriculture.
[34] Wambugu and Kiome, 'The Benefits of Biotechnology'.
[35] INIBAP, *Regional Network for Eastern Africa.*
[36] Qaim, *Assessing the Impact of Banana Biotechnology.*
[37] Wambugu and Kiome, 'The Benefits of Biotechnology'.
[38] Freeman, Ellis, and Allison, 'Livelihoods and Rural Poverty Reduction'.
[39] Evans and Ngau, 'Rural–urban Relations'; Daniels and Mead, 'The Contribution of Small Enterprises'.
[40] Ferguson, 1990.
[41] IITA.
[42] Qaim, *Assessing the Impact of Banana Biotechnology*, 5.
[43] Wambugu and Kiome, 'The Benefits of Biotechnology', ii.
[44] Frisson *et al.*, *Mobilizing IPM.*
[45] See Robinson *et al.*, 1993; Robinson and Anderson, 1992; Qaim, 1999, 2000; Wambugu *et al.*, 2000.
[46] As far as I am aware the FAO datasets are the only reasonably accurate, systematic analyses of agricultural production and human consumption in Africa. As far as banana yields are concerned, no FAO datasets exist.
[47] Qaim, *Assessing the Impact of Banana Biotechnology*; Wambugu and Kiome, 'The Benefits of Biotechnology'.
[48] Wambugu and Kiome, 2001., vii.
[49] Wambugu and Kiome, 2001., 3.
[50] Bananas are unusual in that they are propagated only from suckers from a 'parent' plant and not from seed.
[51] Davies, 'Banana and Plantain'.
[52] Qaim, *Assessing the Impact of Banana Biotechnology.*
[53] The issue is further muddied by the almost mystical 'potential' yield of 60 t ha^{-1} that is often quoted. This is a yield not achieved anywhere in the world, yet it is often quoted as evidence that the growth of traditional suckers is being constrained due to disease.
[54] Robinson, Fraser and Eckstein, 'A Field Comparison', 831–36.
[55] Prof. Esther Kahangi, the principal investigator for a Jomo Kenyatta University tissue culture project, reported increased yields of three to four times in favour of tissue culture bananas in an interview at Jomo Kenyatta University of Agriculture and Technology, 30 October 2003.
[56] During a study visit with Prof. Ester Kahangi, I was surprised that these questions were not addressed as part of her tissue culture projects *post ante* socio-economic survey. Indeed, her sociological research appeared to

focus purely on why farmers were sometimes resistant to the new technology. In particular, it was a surprise that no assessment of tissue culture yields in an on-farm resource-poor setting was made.

[57] Qaim, *Assessing the Impact of Banana Biotechnology*.

[58] Parton, 'Household Goals', 327–28.

[59] Which, tellingly, includes the recommended plant spacing for tissue culture bananas in Kenya of 3×4 metres, 450 plants per acre, which is more than double the amount of mats per unit area compared to traditional plant spacing. This in effect doubles TC yields automatically.

[60] Qaim's study has been cited frequently by biotechnology institutions such as ISAAA, BioEarn, AfriBio and the World Bank amongst others as powerful evidence of the applicability of biotechnology to small-scale African farmers.

[61] Latour, *Aramis*, 142.

[62] Wambugu and Kiome, 'The Benefits of Biotechnology'.

[63] Smith, 'Context-bound Knowledge Production'.

[64] Latour, *Aramis*, 142.

[65] Escobar, 'Beyond the Search for a Paradigm?'

References

Action Aid. "GM Crops – Going Against the Grain." Available from www.actionaid.org; INTERNET.

Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). "Development of a Long Term Strategic Plan for Regional Agricultural Research in the Eastern, and Central African Sub-Region." September 1997.

Bientema, N., F. Murithi, and P. Mwangi. "Agricultural Science and Technology Indicators: Kenya." International Service for National Agricultural Research (ISNAR). Available from www.asti.cgiar.org/countries/kenya.aspx; INTERNET.

Brandt, W., *et al. North–South: A Programme for Survival: A Report on the Independent Committee on International Development*. London: Pan, 1980.

Brown, G. "Making Globalisation Work for All – The Challenge of Delivering the Monterrey Consensus." Speech delivered 16 February 2004, London.

Chambers, R. *Challenging the Professions: Frontiers for Rural Development*. London: ITDG Publishing, 1993.

Clark, N. "Innovation Systems, Institutional Changes and the New Knowledge Market: Implications for Third World Agricultural Development." *Economics of Innovation and New Technologies* 11, no. 4 (2002): 353–68.

Clark, N., A. Hall, R. Sulaiman and G. Naik. "Research Capacity Building: The Case of an NGO Facilitated Post-Harvest Innovation System for the Himalayan Hills." *World Development*. 31, no. 11 (2003): 1845–63.

Daniels, L., and D. Mead. "The Contribution of Small Enterprises to Household and National Income in Kenya". *Economic Development and Cultural Change* 47, no. 1 (1998): 45–71.

Davies, G. "Banana and Plantain in the East African Highlands." In *Bananas and Plantains,* edited by S. Gowen. London: Chapman and Hall, 1995.

Escobar, A. "Beyond the Search for a Paradigm? Post-development and Beyond." *Development* 43, no. 4 (2000): 11–4.

Evans, H., and P. Ngau. "Rural–Urban Relations, Household Income Diversification and Agricultural Productivity." *Development and Change* 22 (1991): 519–45.

Ferguson, J. *The Anti-Politics Machine: 'Development', Depoliticization and Bureaucratic Power in Lesotho*. Cambridge: Cambridge University Press, 1990.

Foucault, M. *The Archaeology of Knowledge*. New York: Vintage, 1971.

Fowler, A. "Building Partnerships between Northern and Southern NGOs: Some Issues for the Nineties." *Development* 1 (1992): 16–23.

Freeman, H. A., F. Ellis and E. Allison. "Livelihoods and Rural Poverty Reduction in Kenya." *Development Policy Review* 22, no. 2 (2004): 147–71.

Frisson, E., C. Gold, E. Karamura, and R. Sikora. *Mobilizing IPM for Sustainable Banana Production in Africa*. Proceedings of a workshop on banana IPM held in Nelspruit, South Africa, 23–28 November 1998.

International Institute of Tropical Agriculture (IITA). 2003. Available from www.iita.org/crop/plantain.htm; INTERNET.

International Livestock Research Institute (ILRI). *New Biosciences Facility for East and Central Africa*. Nairobi: NEPAD, 2003.

International Network for the Improvement of Banana and Plantain (INIBAP). *Regional Network for Eastern Africa.* Montpellier: INIBAP, 1991.

Kiome, R. "Development and Application of Science and Technology in Agricultural Production: Kenya Case Study." Paper presented at the East and Central Africa workshop of the Inter-Academy Council Study on Science and Technology Strategies for Improved Agricultural Productivity and Food Security in Africa, Nairobi, 31 January–2 February, 2003.

Kirk, C. "Pottering with Incorporation: Social Change and the Sinhalese Potters of Ratmalagahwewa." In *Incorporation and Rural Development,* edited by H. Heringa, U. Perera and A. Weeramunda. Colombo: University of Colombo, 1983.

Latour, B. *Aramis, or the Love of Technology.* Cambridge, MA: Harvard University Press, 1996.

Mosse, D. *Cultivating Development: An Ethnography of Aid Policy and Practice.* London: Zed Books, 2004.

New Scientist, "Feeding Africa." 27 May 2000.

Operation for Economic Co-operation and Development (OECD). *Shaping the 21st Century: The Contribution of Development Cooperation.* Paris: OECD, 1996.

Parton, K. "Household Goals and Technology Adoption of Smallholders in Eastern Kenya". *Review of Marketing and Agricultural Economics* 61, no. 2 (1993): 327–8.

Qaim, M. *Assessing the Impact of Banana Biotechnology in Kenya.* Brief no. 10. New York: ISAAA, 1999.

Robinson, J. and Anderson, T. "Advantages of Tissue Cultured Bananas in the Plant Crop, Confirmed." *Banana Newsletter (AUS)*, 15 (1992): 14–15.

Robinson, J., C. Fraser, K. and Eckstein. "A Field Comparison of Conventional Suckers with Tissue Culture Banana Planting Material over Three Crop Cycles." *Journal of Horticultural Science* 68, no. 6 (1993): 831–36.

Smith, J. "Context-Bound Knowledge Production, Capacity Building and New Product Networks." *Journal of International Development* 17, no. 5 (2005): 647–59.

——— "Povertà, Potere e Resistenza: Sicurezza Alimentare e Sovranita." *Africa Australe, Afriche e Orienti: Rivista di Studi ai Confini tra Africa Mediterraneo e Medio Oriente* [Bologna], 2 (2003): 158–72.

Sturgis, P. "Science in Society: Re-Evaluating the Deficit Model of Public Attitudes." *Public Understanding of Science* 13, no. 1 (2004): 55–74.

Wambugu, F., and R. Kiome. "The Benefits of Biotechnology for Small-Scale Producers in Kenya." Brief no. 22. International Service for the Acquisition of Agri-Biotech Applications (ISAAA), 2001.

Wambugu, F., Karembu, M., Njuguna, M., and Wanyangu, S. "Biotechnology to Benefit Small-Scale Banana Producers in Kenya." ISAAA working paper, 2000.

Watts, M. "Development I: Power, Knowledge, Discursive Practice." *Progress in Human Geography* 17, no. 2 (1993): 257–72.