BIOTECHNOLOGY IN ANIMAL AGRICULTURE AND POVERTY ALLEVIATION: AN NGO PERSPECTIVE

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ABSTRACT

Biotechnology has only a very limited potential to alleviate poverty in rural Africa, because it does not address the main reasons for poverty, such as weak infrastructure, bad governance and unfavourable terms of trade. Looking at the main characteristics of the predominantly small-scale animal farming in Africa, the potentials and limitations for biotechnological applications in food processing, forage improvement, animal breeding and animal health are discussed. Indigenous biotechnology under the control of livestock farmers can be beneficial, whereas – with the exception of some animal health technologies – large-scale and "high-tech" applications of biotechnology have shown little potential to alleviate poverty. Indeed, these applications can have the opposite effect. Rather than pouring an undue amount of human and financial resources into further refinement of advanced biotechnology, African livestock researchers should develop their own research agenda that addresses the real problems of small-scale livestock keepers and poverty alleviation.

Key words: livestock systems, indigenous knowledge, food processing, animal breeding, animal health, research prioritisation

INTRODUCTION

In recent years, biotechnology – especially gene technology – has greatly altered agricultural production in industrialised countries. Some biotechnology advocates also claim that these new technologies have a great potential to alleviate hunger and poverty. This is open to debate. Here, we examine these claims with respect to animal agriculture in Africa. After outlining the main reasons for poverty, we broadly characterise smallholder and pastoral livestock-keeping. We then consider which biotechnology options in animal agriculture can contribute to alleviating poverty and who controls them. Finally, we indicate alternative research priorities in animal agriculture to contribute to poverty alleviation.

REASONS FOR POVERTY IN AFRICA

Although statistics have their pitfalls, two things are clear: in Africa, poverty is widespread and is largely rural. It is therefore understandable that many people think agricultural production must be increased in order to alleviate poverty. However, a closer look reveals that poverty and famine are rarely due to insufficient production but rather to:

- insufficient access to land and other productive resources
- unfavourable terms of trade for food products, especially for animal products
- remoteness and weak infrastructure (roads, markets, health services, schooling etc)
- poor health of farmers (HIV/AIDS, malaria etc)
- civil or international war or conflicts between groups
- external shocks, such as drought
- bad governance, including corruption
- disregard for indigenous knowledge (IK) and local agricultural resource management.

Moreover, female-headed households are much more likely to be poor that male-headed ones. Can biotechnology in animal agriculture help alleviate these reasons for poverty?

CROP AND LIVESTOCK FARMING IN AFRICA: MAIN CHARACTERISTICS.

In contrast to industrialised countries, where farmers are now a small minority – in the European Union 4.5% and in the USA a mere 0.7% (CIA, 2005) – farmers make up the vast majority of the workforce in most African countries: 80% in Tanzania, 75% in Kenya, 70% in Nigeria, and even in the industrial giant on the continent**,** South Africa, 30% of the people live from farming. African farmers are not only the majority of the labour force; they are also the majority of consumers. They could be called "market-oriented subsistence" farmers.

African farms are generally small, labour-intensive operations in which animals serve multiple functions: providing food and raw materials (hides, skins, horns, wool), a savings account, an investment, a means to accumulate capital. If banks are few and far between, how can money best be stored – under the bed where it may be eaten by rats or termites, or as a productive investment, e.g. in livestock?

Most African farmers still depend primarily on their local knowledge, and this is dynamic. Within their economic possibilities, they are innovators. If they see opportunities, they venture into new enterprises, such as more intensive goat-keeping in parts of Kenya or pig-keeping in parts of southern Nigeria. They do this if the circumstances are right – but, in many cases, it makes economic sense to keep livestock more extensively. Whereas price ratios between meat (beef, mutton) and grain in the North are often more than 10:1, studies in sub-Saharan Africa found that the average price ratio of the cheapest grain to liveweight is 1:5.6 (McIntyre *et al*., 1992). Today, in parts of Ethiopia, the price of a kg liveweight of sheep is almost at par with a kg of grain. Under these economic conditions, there are few "paying" technical options to "improve" in terms of intensifying husbandry – whether through biotechnological or other means – also because external pressures such as drought or disease are common and beyond the control of poor livestock-keepers.

BIOTECHNOLOGY TO ALLEVIATE POVERTY?

Agricultural biotechnology is a loosely-used term that includes a wide range of processes that change raw material into something edible or longer-lasting. In a broad sense, the use of biotechnology in animal agriculture can be differentiated into four groups:

- food processing, such as fermenting milk and making cheese
- forage additives or fermentation (silage making)
- animal breeding, such as artificial insemination (AI) or embryo transplantation (ET)
- producing drugs and vaccines.

Many African societies have long used biotechnology in food processing, especially fermentation. As the souring process weakens pathogens of tuberculosis and brucellosis, consuming sour milk products is safer than consuming fresh non-pasteurised milk. Although men may often do the milking, the women usually control milk processing and marketing. In Nigeria, Waters-Bayer (1988) found that particularly the poorer women (from households with few or no cattle) benefited from their application of biotechnology, as women from richer households sold unprocessed milk to poorer women who, in turn, fermented the milk and sold it at a profit in a popular mixture with cooked millet (*fura da nono*).

Drying or smoking of meat and fish – which may or may not be called biotechnology – also contributes to household income. Meat processed in this way comes from not only domestic but also wild animals. As food processing – including meat processing – is often women's work,

these practices can strengthen the position of women, and projects building on these practices have indeed helped to alleviate poverty (e.g. Lemunyete, 2002).

Larger-scale processing of milk using standardised cultures, e.g. to produce yoghurt or cheese, often relies on reconstituted milk and the products may compete with indigenous products. Large-scale drying and spicing of venison as *biltong* in southern Africa caters primarily for the urban and tourist markets. These larger enterprises create some employment but their contribution to poverty alleviation is minimal.

BIOTECHNOLOGY FOR FORAGE TREATMENT

Forage conservation includes drying (hay-making), fermentation (silage-making) and feed additives, e.g. urea treatment of straw. In general, if forage can grow year-round, this will be of better quality, making forage conservation superfluous. Where forage growth is highly seasonal, forage conservation can offer a way to balance forage supply to animals, but moderate weight losses during a dry season are quickly regained through compensatory growth in the next wet season. Hay can be useful for animal survival during a drought, as an extra ratio for sick animals and in urban farming when forage has to be transported to the animals. But in many other smallholder systems, forage conservation is simply not economic, so biotechnology to improve the processes will not benefit them.

Whereas haymaking can make sense for very small animal holdings, silage making and treatment with urea depends on scale. Wetter material is not easy to store; it needs to be covered and kept under anaerobic conditions. Larger units have less waste than smaller pits. Silage and urea-treated straw are better suited for medium-sized or large animal holdings. The biotechnology in these techniques will make little contribution to alleviating poverty among smallholders. Silage and urea-treated straw have a shorter storage life than hay and, because wet material cannot be transported as easily as can dry material, their use is also less flexible.

BIOTECHNOLOGY FOR ANIMAL BREEDING

Biotechnology in animal breeding includes AI and ET in practical breeding, as well as DNA analyses for breed characterisation. There are certainly merits for these techniques. AI was initially developed to reduce the incidence of venereal disease in animals, but now allows the use of superior male animals on a larger scale than possible with natural service. If breeding or AI centres are available, smallholders – who often prefer keeping female animals – may no longer have to keep entire males. ET makes it easier to introduce exotic animals into countries that have strict quarantine requirements.

There are, however, a number of prerequisites for successful use of AI. Farmers need to recognise whether an animal is in heat; semen and insemination technicians must be within easy reach; liquid nitrogen has to be available etc. This infrastructure is lacking in large parts of Africa, and experience with AI has often been disappointing. Even where it seems to work well, there are some dangers. In most cases, the semen is from animals of potentially high production in meat (rapid growth) or milk. High production and resistance to environmental stress are antagonists, i.e. high-yielding animals are less resistant to disease, more prone to heat stress, require more water than indigenous breeds, and need good-quality feed to achieve their production potential. For a dairy cow that produces 6000 or 8000 l of milk per lactation, straw with a digestibility of 50–55% is not good forage, whereas indigenous breeds that need only to survive as a savings account can manage with it.

AI can also lead to loss in biodiversity. AI bulls can become semen millionaires, which may be good for the breeders and the AI businesses, but has disastrous impact on genetic variability

within a breed. For example: Holstein Friesian (HF) is the most widely kept dairy cow in the world – currently at least 50 million cows. If present breeding practices continue, the HF population in the USA will consist of only 60 genotypes by the year 2015 (de Haan *et al*., 1997). There are currently about 8.5 million HF cows in the USA (WHFF, 2005). The push for maximum production means that many bulls are closely related. This leads to an international uniformity among HF dairy cattle. ET will further accelerate this dangerous trend towards uniformity among dairy cattle.

These trends fly in the face of the need to conserve animal genetic diversity. The poorer livestock-keepers in Africa have to cope with a great variability in ecological conditions and need animals adapted to the local environments. Uniform animals cannot serve this purpose. Indigenous animal genetic resources are needed for that purpose (Vilakate et al 2003)

There are exceptions to using biotechnology only for high-yielding breeds. Nguni cattle semen and embryos are sold in South Africa. The Nguni are known to be well adapted to a harsh environment, can cope with low-quality forage, are fairly tick resistant and tolerate a range of diseases (Bester *et al*., 2003). However, the number of donor animals does not reflect the variability of types found in the larger Nguni cattle population. And this use of biotechnology raises another difficult issue: the Nguni were originally selected by Zulu cattle breeders, but the South African Government successfully discouraged the Zulu from keeping Nguni, so white commercial farmers were the ones who conserved Nguni cattle and brought them back to fame. If the Nguni continue to be commercially successful, who should benefit?

The importance of indigenous animals was also highlighted in research in Ethiopia, which assigned economic values to the multi-functionality of goats, including their insurance value. The findings suggest that indigenous goats under improved management practices give higher total benefits to the poorer livestock-keeping households than do crossbred goats, even though the crossbred goats produce more milk (Workneh Aleyew, 2000).

Thus, it is unlikely that AI and ET can contribute greatly to poverty alleviation in Africa. Both techniques are presently used mainly for high-yielding animals with high demands with respect to feed quality, sanitation and hygiene. These high-input animals are kept on large farms, which can out-compete small farms, e.g. in South Africa. If these large farms operate in a labour-intensive way, on-farm employment may contribute to poverty reduction, but this is not always the case. Another consideration is that breeding with the help of advanced biotechnology such as AI and ET takes the control over the breeding process out of the hands of livestock-keepers and puts it into the hands of commercial breeders/firms and breed societies. These modern breeding institutions cater primarily for large farms and generally disregard the specific requirements of small-scale farmers and pastoralists.

A further application of biotechnology is the gene sequencing and modern genetic analysis of livestock genotypes such as recently done for African cattle by ILRI. Findings that prove the high value of indigenous breeds can be a source of pride for poor livestock farmers, but this still does not improve their economic situation.

BIOTECHNOLOGY FOR ANIMAL HEALTH

Modern biotechnology can be used for diagnosis (e.g. to differentiate closely related disease agents) and to prepare veterinary medicines and vaccines. Ethno-biotechnology in veterinary medicine involves various types of preparations of leaves, bark, roots etc. The recipes for traditional medicines are often not in the public domain; they are the exclusive knowledge of traditional healers, who charge for their services. The process of developing and producing

modern drugs and vaccines is not under the control of small-scale farmers or pastoralists – it is a service from outside, also provided against payment. Experience has shown that, if vaccination can prevent the loss of animals, using these outside services is an investment which also small-scale livestock-keepers and pastoralists are willing to make.

To control disease in many parts of Africa, however, the problem is not how to develop new, more effective diagnostic methods, vaccines or drugs. Rather, it is their availability of local level. For this, more effective organisational structures of veterinary services are more important than further refinement of diagnostic methods or better vaccines. More effective services also include community-based animal health workers, who live in the livestock-keeping communities and provide the local animals with inexpensive "first aid".

THE WAY FORWARD

Biotechnology has only limited potential to alleviate poverty, because it cannot remove the main reasons for poverty: political instability, bad governance, insufficient infrastructure and services, disregard of IK, and insufficient recognition by government and researchers that smallholder and pastoral farming is a necessary and valuable part of animal agriculture. Research efforts therefore should be directed into: 1) better understanding the existing animal agriculture systems and IK; 2) developing necessary infrastructure; and 3) improving services, rather than into biotechnology developments that require a sophisticated infrastructure (Waters-Bayer and Bayer, 2004). The challenge is to find better ways to address the problems of the vast majority of African livestock-keepers and to help develop their potentials to respond to opportunities and adapt to change. This is the real scientific revolution that African livestock keepers – and scientists – need. And this is the revolution that many non-governmental organisations working in Africa are seeking to bring about.

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