

MATCHING LIVESTOCK SYSTEMS WITH AVAILABLE RESOURCES

by

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DEVELOPMENT MODELS

The Third World

In the tropical regions of the Third World in general and specifically at the level of the small farm, livestock production is in crisis. This crisis is closely related with the production models which were implanted in Third World countries during the post-war period and were intensified in the decades of the 60's and 70's. In order to introduce these new technologies, many Third World countries established credit mechanisms, agricultural research programmes, rural extension schemes, and training programmes aimed at increasing production by promoting an increase in the productivity of crops and animals.

The model that was advocated for the agronomic sector aimed to bring about a "green revolution", specifically in cereal grain production, that would solve the nutritional problems and hunger suffered by millions of people in the Third World. "Improved" production systems were promoted, based on high performance germ plasm, monocultural practices and the intensive use of capital, machinery, and costly imported inputs such as fertilizers, pesticides and herbicides.

In the livestock field, priority was given almost exclusively to the introduction of systems, the technical and economic bases of which were derived from experiences in the temperate, "industrialised" countries, where emphasis had been on low labour inputs, high use of capital, and intensive specialised production methods aimed at market expansion. For example:

- Cattle production systems were based on the American and Australian models that employed extensive grazing on pastures established in regions previously in natural forest. The result has been an alarming increase in erosion and destruction of ecosystems and watersheds.
- Pig, poultry and milk production systems were based on "economy of scale", involving an ever increasing dependence on "imported" inputs (feed grains and protein meals, germ plasm, drugs, equipment and fossil-derived fuel), and an overall negative effect on employment opportunities, especially in rural areas.

The result of these activities has been an increasing dependence on imported inputs, increased costs of production, reduced rural employment, contamination of the environment and destruction of ecosystems, deforestation and under-utilization of available resources.

The industrialised countries

The transfer of livestock technologies from industrialised to developing countries, has obviously been largely unsuccessful. Quite apart from the reasons for such failures, it is relevant to question the basic concepts governing the models currently employed in the industrialised countries. For, contrary to what is so often assumed, it may not be desirable - even if it were technically and economically feasible - to attempt to achieve in Third World countries the styles and standards of living currently "enjoyed" (??) in the industrialised countries. Leaving aside the social issues, an assessment of the present agricultural situation in most industrialised countries shows that:

- agricultural products - especially those of animal origin - are expensive to produce and to buy,
- present production systems are wasteful and cause considerable ecological damage,
- the systems of production and the products that are produced are frequently associated with stress both for animals and humans, and
- the dependence on, and excessive use of, fossil fuel based inputs is causing an alarming increase in atmospheric carbon dioxide concentrations, which is the main contributor to the warming of the earth's atmosphere - the "greenhouse effect."

It hardly seems sensible to encourage the developing countries to commit their scarce economic resources to livestock production programmes which may eventually arrive at the same inappropriate endpoint.

Eco-development and self-reliance

The concept of eco-development has been proposed by Third World economists as an alternative to the classical development models derived from the industrialised countries, which have proved to be unsustainable when introduced into developing countries. The basic feature of eco-development is that the means of improving the quality of life of a community should be sought within a framework bounded by the limitations - environmental, social and economic - governing the activities of the community. The means of achieving such aims should

Experience has shown quite clearly that it is counter-productive in developing countries to base these activities on the models that have been, or are currently being, applied in the industrialised countries. The conclusions of a recent evaluation report on Dutch assistance to the livestock sector in Third World countries (Netherlands Development Cooperation, 1987) reveal how much time and effort have been wasted in these endeavours:

..."The animals (Dutch dairy cattle) were generally unable to adjust to local conditions; climate, feed and management systems all posed problems. The cattle were unsuited to small farmers' needs; they could not be used as draught animals and often suffered from disease stress, leg problems and infertility"

...."the experience of twenty years revealed that the route (intensive livestock projects) had been ill-chosen".

THE "GREENHOUSE EFFECT"

Discussing the issues of the world food crisis, population growth and renewable energy, Dumont (1989) stated:

"..Now an even more formidable threat has appeared on the horizon. Until recently, all forecasts (of crop yields) were based on the virtually certain knowledge that the world's various climates were invulnerable to major meteorological upheavals. That last lingering certainty has passed.....

....it is now established beyond the slightest doubt that increased carbon dioxide levels in the air as a result of an excessively rapid increase in the use of fossil fuels, among other things, has caused the world's climate to warm up since the beginning of the 70s.

....The warming-up process will raise the level of the sea and threaten the existence of all the great river deltas, especially those in Asia..

...Increased temperatures have aggravated droughts and thus reduced the flow of the world's great rivers...

...Since the last ice age 18,000 years ago, the world temperature has risen by only four degrees. It is now feared that by the year 2050, only 61 years from now, the temperature increase could be between two and six degrees."

TOWARDS A NEW STRATEGY FOR SUSTAINABLE RURAL DEVELOPMENT

Matching production systems with available resources

The situation that has been described makes it obligatory to reorientate present production systems and to develop a new agricultural policy based on optimal use (instead of misuse) of the earth's natural resources. Such a policy must be rural, rather than urban, orientated and a notable feature of it will be the economic strengthening and increased independence of the small-scale farmer.

It has been proposed (Preston and Leng, 1987) that such a strategy be based on the development of agricultural systems which integrate production of food, fuel and fertilisers, and diverse livestock species, with emphasis on the utilization of:

- Existing under-utilised local resources and wastes (e.g., crop residues, livestock excreta and agroindustrial byproducts)
- New resources derived from more efficient agronomic systems based on improved utilization of solar energy, soil, water, genetic diversity and people - which are the natural resources of the tropics. Specific reference is made here to the use of sugar cane and forage trees and shrubs as the principal elements in such a scheme.

In the long and short term, it is hypothesised that the alternative to fossil fuel is in biomass derived from solar energy capture and that this is more viable and desirable than energy from nuclear sources, especially when environmental and social issues are taken into account. Furthermore, it is proposed that there need be no conflict, indeed the prospects are for complementarity, in the use of biomass to satisfy both food and fuel needs.

Such a policy presupposes a series of conditions, principal among which are the following:

- crops and cropping systems must be chosen which permit maximum capture of solar energy and its conversion into biomass;
- optimum fixation of atmospheric nitrogen in relation to the nutrient needs of the selected crops and associated livestock systems;
- fractionation of the crops to satisfy dual needs of food/feed and fuel;
- the livestock components of the system should address the complementary needs of monogastric and herbivorous animal species.

- The overall system should:
 - be at least self-sufficient in, and preferably a net exporter of, energy,
 - not contaminate the environment,
 - not destroy natural ecosystems,
 - optimise employment opportunities, and
 - promote a maximum degree of self-reliance.

MEASURES THAT CAN BE TAKEN TO REDUCE EMISSIONS OF CARBON DIOXIDE AND METHANE

To the general policy described above, there must now be added a series of additional recommendations in order to address the specific problem of the "greenhouse effect". The following measures can be expected to lead to reduced emissions of methane and carbon dioxide. Not all are immediately executable, but they indicate what should be the long term goals in order to attain and maintain a balance between sources and sinks of carbon dioxide and methane.

- Giving priority to the growing of crops which are most efficient in fixing carbon dioxide into biomass (eg: perennial tropical forage crops and trees).
- Encouraging agricultural production in the tropics of the Third World, instead of promoting self sufficiency in industrialised temperate countries. This is because food production systems in industrialised countries are highly dependent on fossil fuel-derived inputs. By contrast, most Third World tropical country systems employ animal and human power, rather than machinery, and they have a much greater potential for developing biomass-derived fuels. Means to this end would be the elimination of tariffs on food imports from the tropics, and of subsidies to farmers in the industrialised countries, and by applying an environmental tax to the use of fossil fuel since this is the main cause of the "greenhouse effect".
- In the tropical countries, wetland rice should be discouraged and more emphasis given to dryland cereal production for human consumption. Cereal growing for animal consumption in tropical countries should be actively discouraged, and emphasis given to perennial forage crops and forage trees as the basis of intensive animal production.

- Grazing systems in the tropics should be actively discouraged, in favour of complete or semi-confinement of animals. This will permit planting of existing grazing lands with forests (especially multipurpose forage trees) and favour the greater use of crop residues as animal feed (instead of burning them).
- A massive programme is needed to promote strategic supplementation of ruminant diets in Third World countries in order to optimise rumen function (which leads to reduced methane and CO₂ production). This will also lead to increased production of food, or the keeping of fewer animals.
- Non-ruminant species (especially pigs, poultry, rabbits) should be favoured over ruminants as meat producers, since they produce less methane and carbon dioxide per unit of product.
- Low-cost biogas digestors must be an essential element in all units where livestock are confined.
- Human organic food waste must be recycled through pigs, and/or earth worms, instead of being allowed to ferment in land fills (giving rise to methane) or to be incinerated (producing carbon dioxide).
- Maximum support should be given to research and development efforts which will enable fossil-derived fuels to be replaced by biomass-derived fuels. Gasification of biomass to produce hydrogen and carbon monoxide (can be used directly as fuel or as substrates for chemical industry) would appear to be the most appropriate technology to promote.

REQUIRED INFRASTRUCTURE

Political or Technological Reform?

It is usually assumed that the first constraint to rural development is the need for reform of land tenure. However, it is becoming increasingly apparent that, with or without agrarian reform, there is no way that farming systems can absorb the "landless" labour force that exists in rural areas in most of the Third World. New solutions are needed and these must be based on proposals for technological as well as political change.

Tropical countries offer exciting possibilities for technological reform, because of the largely untapped potential for biomass production in regions blessed with abundant supplies of solar energy, high mean temperatures and rainfall. However, the realization of such potential will require an original approach not only to the growing of the biomass but also its utilization.

Energy (with food as a byproduct) will be the key to such schemes, and the utilization of biomass as feedstock for a chemical industry will be as important as providing a substitute for present fossil-based liquid fuels. Rural industries based on "biomass refineries" promise to solve problems which are immediate, such as increasing rural employment, and of longer term, as is the prospect of developing a viable and safe alternative to non-renewable energy sources, both fossil and nuclear.

The need to reverse the greenhouse effect, coupled with the concern about the risks and the environmental contamination associated with the nuclear option, is a golden opportunity for the tropical regions to exploit their largely untapped resources inherent in the opportunity to use solar energy throughout the year. Existing rates of photosynthesis permit the capture of 10 times more energy than is presently consumed as fossil fuel (Hall, 1984: personal communication). This is being achieved with an overall global efficiency of only 0.2%. By contrast, a perennial tropical crop such as sugar cane fixes solar energy at 10 times this rate (2% annually) (Bassham, 1978). Tropical trees are almost as efficient and most have the added virtue of being able to fix ambient nitrogen in their root system.

STRATEGIES FOR MILK PRODUCTION SYSTEMS IN THE TROPICS

Where, in the above scheme, does tropical milk production fit and what strategy should be followed in establishing this kind of activity? The starting point must be an analysis of the actually and potentially available resources. There are no specialised tropical dairy animal breeds, other than the Riverine type of buffalo. Furthermore attempts to create them have not proved to be sustainable. The impact of the Australian Milking Zebu and of the Jamaica Hope, for example, has been minimal outside the immediate areas where they were developed.

The immediately available and numerically important cattle resources in the tropics are *Bos taurus* beef cattle. There are many advantages from using these as a basis for milk production through crossbreeding, foremost among which is the increase in productivity and in biological efficiency that results when milk and beef production are combined in the same animal. Converting existing extensive beef cattle systems in tropical countries into dual purpose milk-beef enterprises will increase their productivity and biological and economic efficiency. In ecological terms, this means a global reduction in methane production per unit of animal product, and the possibility of reducing total animal numbers (fewer, more productive animals consuming the same basic feed resources).

From the nutritional standpoint, the increase in productivity required in a dual purpose, as opposed to a specialised beef animal,

does not entail substitution of local feed resources by exotic (usually grain-based) "balanced dairy feeds" as is the case when specialised dairy breeds and systems are introduced (Netherlands Development Corporation 1987). What is needed is strategic supplementation with rumen activators and bypass nutrients, which can be met by judicious use of mostly locally available tropical agroindustrial byproducts (e.g., multi-nutritional blocks from molasses and urea, rumen micro-nutrients and bypass macro-nutrients from oilseed cakes and tree foliages (see paper by Leng, this conference)).

CONCLUSIONS

A new era is dawning in development strategy. Participation is mandatory in the setting of goals and identification of means. It is also becoming apparent that, because both the goals and the means are not the same, the initiatives taken by developing countries in establishing their own development strategies must not only be respected, but may also serve as stimuli for more effective cooperation between developed and developing countries.

Inadequate human nutrition is still the most immediate problem in most developing countries. But it is now being realised that the solution is not simply to increase productivity but to tackle more fundamental issues, foremost among which is the warming of the earth's atmosphere, caused by increased ambient concentration of carbon dioxide (mainly due to increased use of fossil fuels). This threatens, in the shorter term, to reduce crop yields and, in the longer term, heralds unmitigated disaster through flooding of river deltas.

Reversing the "greenhouse effect" will require promotion of solar efficient perennial crops, and forage trees, which simulate forest ecosystems and provide a sink for carbon dioxide. The biomass from these crops should lend itself to fractionation into low and high fibre components, the former being the basis of intensive confinement production of monogastric animals, while the latter can be converted into versatile energy-yielding substrates suitable either as ruminant feeds or, through the process of gasification, as the basis of a chemical industry (hydrogen and carbon monoxide). Liquid and solid wastes can be recycled through biodigesters and earthworms with much reduced emissions of methane and carbon dioxide, compared with processing them through conventional oxidation lagoons and land fills.

In the field of livestock production, increasing emphasis must be given to systems which reduce methane emissions per unit of livestock product, at the same time permitting greater use of locally and potentially available resources. In this respect the two major approaches are: giving greater emphasis to monogastric species (especially pigs) as meat producers, and adapting presently inefficient extensive beef operations into dual purpose milk-beef systems.

These technologies, which are now being developed in Third World countries, will lead to more sustainable systems of livestock production, to employment generation, to increased availability of renewable energy and - most importantly - to a reversing of the "greenhouse effect". The challenge facing governments of industrialised and Third World countries alike is to be able to accept that development without either fossil or nuclear fuels is not only technically feasible but will bring with it much needed sociological and ecological benefits through the greater role that will be given to rural areas as the future source of both feed and fuel.

The implementation of these new strategies will require a greater appreciation of:

- Communication as a means of promoting:
 - understanding of changing priorities,
 - awareness of common problems and the means of overcoming these, and
- Relationships founded on technological support rather than economic dominance.
- The concepts of ecodevelopment and self-reliance when designing and implementing technologies.

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