“COMMUNITY EMPOWERMENT AND TROPICAL ANIMAL INDUSTRY”

PROCEEDINGS

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Community Empowerment and Tropical Animal Industry

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PREFACE

The Faculty of Animal Science, Universitas Gadjah Mada, is pleased to have The 5th International Seminar on Tropical Animal Production, held at our campus in Yogyakarta, on October 19-22, 2010. The previous seminar has been successes in discussing various issues at that time. Agriculture is the mainstay of the people of most tropical countries, where billion of people live. Within agriculture, a high priority is placed on animal rearing, since farm animals play important roles in the economies of the countries. The present seminar on ‘Community Empowerment and Tropical Animal Industry’ follows on in a series on tropical animal production.

The conference was aimed to gather educators, academics, researchers, industry practitioners, representatives of professional industry associations and non-government organizations in the field of animal science, to discuss issues and concerns confronting the various stakeholders in responding to the community empowerment and tropical animal industry. The conference further aimed to provide an interdisciplinary forum to facilitate the exchange of information through research and networking amongst the conference participants to foster collaborative research and academic exchanges.

The conference featured more than 200 panel, paper and poster presentations, and attendees, by animal science academics and practitioners from more than 20 countries. All the full papers and abstracts in these proceedings have been subjected to a double blind refereeing process coordinated by selected academics. The success of an international seminar with published proceedings depends on the collective team efforts of many people. We owe a significant debt of gratitude to many individuals. We wish to take this opportunity to thank these individuals who have contributed to the success of this conference. First, we would like to thank the paper and panel presenters as well as the conference session chairs for their contribution of expertise, time and efforts. We would also like to extend special thanks to the Paper Reviewers and Editors who have spared their precious time and efforts to review and edit the papers. The names of the Paper Editors are listed on the following page. The review and editing process has been a complex one given the fact that English is not the native language of many of the delegates who submitted papers for this seminar. With a number of papers it has been necessary to focus, at times, more upon intent and meaning than grammatical correctness.

We also commend the hard work done by the conference steering and organizing committees composed of the academic, administrative staff and students of the Faculty of Animal Science, Universitas Gadjah Mada.

Prof. Dr. Krishna Agung Santosa
Editor in Chief
REPORT OF ORGANIZING COMMITTEE

Good Day,
His excellency, Minister of Agriculture, Republic of Indonesia
The honourable Rector of Universitas Gadjah Mada,
Distinguish guests, participants, ladies and gentlemen,

On behalf of the organizing committee, I would like to extend our warmest welcome all supporters, presenters, and participants to the Fifth International Seminar on Tropical Animal Production 2010 in Yogyakarta, Indonesia, and indeed it is a great pleasure to see you all in our campus of Universitas Gadjah Mada, Yogyakarta.

This is a very special international event that held by Faculty of Animal Science, Universitas Gadja Mada, Indonesia. The International Seminar on Tropical Animal Production (ISTAP) is conducted every four years. The first, second, third and fourth were conducted in 1994, 1998, 2002, and 2006, respectively. The theme of this year 2010, the 5th ISTAP is “Community Empowerment and Tropical Animal Industry”.

This forum is attended by more than 200 delegates representing 23 countries (Australia, Cameroon, Denmark, Ethiopia, India, Iran, Japan, Kuwait, Malaysia, Pakistan, Philippines, The Netherlands, Timor Leste, Nepal, Sri Lanka, Nigeria, Bhutan, Scotland, Thailand, USA, and Indonesia. There were over 170 abstracts submissions and 150 papers were accepted and will be presented at the forum. We are confident that the 5th ISTAP will be an excellent opportunity for all participants to share and learn from each other. We hope that this ISTAP will be a success and that your stay in Indonesia will be a pleasant one.

I would like to express my sincere appreciation to the keynote speaker His excellency Ir. Suswono, MMA, Minister of Agriculture, Republic of Indonesia, and the invited speakers, Prof. Dr. Dale R. ZoBell, Prof Dr. E.R. Orskov, Prof. Dr. Mogens Lund, Dr. Henning Otte Hansen, Ms. Fokje Steenstra, Mr. Vinod Ahuja, Dr. Yanin Opatpatanakit, Prof Dr. Ryo Akashi, Prof. Dr. Michio Muguruma, Prof. Dr. Tohru Suzuki and Dr. Ferry Purnama.

Furthermore, my great thanks go to the sponsors of the conference, i.e. Bank Indonesia, Bank Negara Indonesia, Bank Rakyat Indonesia Syariah, PT. Jackson Niagatama, PT. Peksi Guna Raharja, CV. Restu Bumi, Livestockreview.com, PT. Nasmoco and Murni Bakery.

I would also like to acknowledge the support in the organization of the conference of ABAD Entertainment. Similarly, I also express my sincere gratitude for the hard work and dedication displayed by our paper reviewers, editors, committee and students of Universitas Gadjah Mada.

Again, we would like to welcome you all to the Fifth ISTAP for Participants, Delegates, and Special Guests in Yogyakarta, Indonesia
Thank you.

Dr. Budi Guntoro
Chairman
WELCOME ADDRESS
DEAN OF FACULTY OF ANIMAL SCIENCE, UNIVERSITAS GADJAH MADA

Assalamu’alaikum warahmatullahi wabarakaatuh,

Honorable the Minister of Agriculture, Republic of Indonesia.

Your excellency Rector of Universitas Gadjah Mada

Distinguish guests, ladies and gentlemen

Let us thank full God almighty, that because of his amazing grace, we are all able to meet together at this Internationnal Seminar. On behalf of the Faculty of Animal Science, Universitas Gadjah Mada, it is my great privilege and pleasure to have you in Universitas Gadjah Mada.

Faculty of Animal Science, one among of 18 faculties in UGM, has been recognized as the prime educational institution in Indonesia, providing teaching, research and extension programs in science and animal industry including animal nutrition, animal production, technology of animal products and livestock social economics.

This is the fifth International Seminar on Tropical Animal Production (5th ISTAP), and the like the first until the fourth ISTAP, is the agenda of own faculty to be conducted once after every four years. The aim of this respective will contemplate in-depth community empowerment and animal industry problem in the tropical developing countries. The big problem which are constituting a challenge in tropical developing countries, particularly in Indonesia, among other things are the economic transformation and the trend of economic globality.

Finally, on behalf of the Faculty, I extend my sincere gratitude to honorables Minister of Agriculture the Republic of Indonesia, for your kind and generosity to include this event on your busy time schedule and be with us to give keynote speech and talk policy matters. We have proud and full of honourable to have invited speakers from all around the world as well as all participants derived from many universities, research institutes, related governmental offices and industries in Indonesia. Four-day conference hopefully would yield valuable solution and discussion in livestock production with holistic management of local resources could be successfully. By this opportunity, I would like to thank all parties and members of both Steering and Organizing Committees, who have devoted their time to make this seminar success. Allow me for this event, to request Prof. Dr. Sudjarwadi to officially open this seminar. Thank you.

Wassalamu’alaikum warahmatullaahi wabarakaatuh.

Prof. Dr. Tri Yuwanta
Dean
OPENING REMARKS
RECTOR OF UNIVERSITAS GADJAH MADA

Assalaamu’alaikum warahmatullaahi wabarakaatuh

The honorable Ministry of Agriculture Republic of Indonesia
Distinguished Guests, Participants of the seminar, and Ladies and Gentlemen.

It is my pleasure to welcome all of you to the campus of Universitas Gadjah Mada to attend the 5th international Seminar on Tropical Animal Production. This seminar is more or less a respond to the recommendation forwarded at the 4th International Seminar on Tropical Animal Production held in 2006.

Ladies and Gentlemen

Universitas Gadjah Mada on behalf of Faculty of Animal Science is very delightful to host this fourth yearly seminar. First of all, I would like to thank and express my appreciation to the Dean of Faculty of Animal Science and all members of the committee of the seminar who have been working very hard to make the seminar successful.

The large numbers of representative we have here from all around the world indacate that the interest generated in animal production is real and trying to affect the resources of rich and poor nations.

Secondly, on this significant occasion I would like to express as well sincere gratitude to the Minister of Agriculture, Ir. Suswono, MMA for your special speech.

The theme of fifth International Seminar on Tropical Animal Production is “Community Empowerment and Tropical Animal Industry”. Since animal production in the tropics has been developed rapidly in order to provide high quality food, however it still very much depends on science, technology, and resources from developed countries. Overseas depending resources make agriculture development difficult to be sustainable. It is urgent to concern and take responsibility for sustainable development of agriculture which integrates three main goals: environmental health, economic profitability and social economic equity.

This seminar will be hopefully being continued as a forum of researchers, specialists in animal science and technology for tropical countries. In our constant effort to improve the food production and technology for tropical countries, we very much depend on cooperatives efforts of scientists who have already improved livestock production in the region.

Finally, I do hope you enjoy very much this seminar and your stay in Yogyakarta. Thank you very much.

Wasslaamu’alaikum warahmatullaahi wabarakaatuh.

Prof. Dr. Sudjarwadi
Rector
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**INSTRUCTIONS TO AUTHORS**
Asian Livestock: Opportunities, challenges and the response

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Consumption of livestock products in developing countries in general and Asia in particular has shown a remarkable upward trend since the early 1980s. Delgado et al. (1990) were among the first to call attention to these trends and characterized the phenomenon as a revolution of sorts. Although some debate has arisen recently on the use of the term ‘livestock revolution’ assigned by them (Pica-Cimara and Otte, 2009.), there is little doubt that Asian livestock sector growth over the past nearly four decades has been extraordinary. While global meat consumption recorded a compound annual growth of a little over 2.5 percent between 1980 and 2007, Asian consumption grew at the rate of 5.2%, thus more than doubling the share of Asia in global meat consumption. Comparable figures for milk consumption were 1.4 percent and 4.4 percent (Table 1). To be sure, there were considerable variations both across countries and time with the growth being much more rapid during the decades of 1970s, 1980s and 1990s (Figures 1 and 2). Although, at the global and regional level some slow down is predicted in future growth in the sector, general expectations are that the demand for animal source foods will continue to grow at a reasonable pace creating diverse opportunities within and across livestock producing regions including Asia

| Table 1. Total consumption of meat and milk: Asia and the World (million tones) |
|-----------------------------|----------|----------|----------|----------|
| World          | 134.0  | 266.0  | 455.4  | 669.3  |
| Asia           | 29.1(21.7)** | 112.8(42.4) | 78.1(17.1) | 250.0(37.4) |
| East Asia      | 19.1(14.3) | 80.7(30.3) | 13.1(2.87) | 54.3(8.10) |
| China          | 14.7(11.0) | 71.5(26.9) | 3.6(0.80) | 41.1(6.14) |
| South East Asia| 3.49(2.60) | 14.0(5.26) | 3.6(0.80) | 9.5(1.42) |
| South Asia     | 4.49(3.35) | 9.49(3.56) | 47.3(10.4) | 147.8(22.1) |
| India          | 2.57(1.91) | 3.80(1.42) | 31.9(7.00) | 102.2(15.3) |
| Rest of Asia   | 2.02(1.51) | 8.61(3.23) | 14.1(3.10) | 38.4(5.73) |

* Excluding butter. ** Figures in parentheses are percentages to World total.
Source: FAO Statistics.

Production has responded to the growing demand capitalizing on low labor costs, technology transfer and structural changes that facilitated private investment in poultry production and public investment in dairy related institutional development. In Asia’s meat sector, more recent growth seems to be emanating from pork sector led by China and Vietnam and spurring similar structural changes in pork industry as occurred in broiler and egg production. The demand for milk is also expanding rapidly in East Asia, led by China, and South East Asia, led by Vietnam. Although still modest in magnitude when compared to South Asia, China’s emergence as a major dairy producer is certainly challenging the reputation of South Asia as the traditional dairy producer within Asia. Trade in animal products has grown even more rapidly even though, as a proportion of total consumption, trade in livestock products remained small. More significantly, however, Asia is emerging as a large importer of concentrate feed for poultry and pig production.

Data on production and trade of feed is not as readily available as meat and milk but statistics from International Feed Industry Federation (IFIF) place global compound feed production at over 700 million tonnes. Actual production is however expected to be significantly higher than that since IFIF numbers are derived from feed production surveys in plants producing over 2,500 mt per year and do not include feed production in smaller commercial plants or on-the-farm production. According to some estimates actual global production of feed is expected to be as high as twice the IFIF figures.
The 5th International Seminar on Tropical Animal Production
Community Empowerment and Tropical Animal Industry
October 19-22, 2010, Yogyakarta, Indonesia

Growth of milk consumption per capita across Asian countries

Figure 1. Growth of meat consumption per capita across of Asia

Growth of milk consumption per capita across Asian countries

Figure 2. Growth of milk consumption per capita across of Asia countries

Table 2. Total production of meat and milk: Asia and the World

<table>
<thead>
<tr>
<th>Region</th>
<th>Meat</th>
<th>Milk*</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>136.0</td>
<td>272.0</td>
</tr>
<tr>
<td>Asia</td>
<td>28.6 (21.0)</td>
<td>109.4 (40.2)</td>
</tr>
<tr>
<td>East Asia</td>
<td>18.8 (13.8)</td>
<td>75.9 (27.9)</td>
</tr>
<tr>
<td>China</td>
<td>14.8 (10.9)</td>
<td>70.4 (24.1)</td>
</tr>
<tr>
<td>South East Asia</td>
<td>3.63 (2.67)</td>
<td>13.8 (5.10)</td>
</tr>
<tr>
<td>South Asia</td>
<td>4.61 (3.38)</td>
<td>12.4 (4.55)</td>
</tr>
<tr>
<td>India</td>
<td>2.62 (1.93)</td>
<td>6.55 (2.41)</td>
</tr>
<tr>
<td>Rest of Asia</td>
<td>1.56 (1.15)</td>
<td>7.30 (2.68)</td>
</tr>
</tbody>
</table>

* Excluding butter.
** Figures in parentheses are percentages to World total. Source: FAO Statistics
many Asian countries feed manufacturers have shifted production from poultry into pigs due to softening demand for poultry feed in the wake of recent HPAI outbreaks. This is likely to spur structural changes in the pork industry, especially in China and Vietnam. Indeed, given the likely limits to technical change in broiler production, swine industry in Asia could emerge as a key competitor to poultry competing heavily for compound feed and ingredients—corn, soybean and fats. According to IFPRI IMPACT forecasts, China is expected to double its corn production between 1997 and 2025 and yet import approximately 40 million tonnes of corn to meet the growing demand. This could put upwards pressure in corn prices especially as the demand also intensifies in the US for ethanol production. This could also mean other cereals—wheat, for example, being utilized as feed (Falcon, 2008). How that affects the competitiveness and political economy of Asia’s agriculture and livestock sector is anybody’s conjecture at this point.

### Table 3. Projections on maize production and trade

<table>
<thead>
<tr>
<th>Country</th>
<th>1997</th>
<th>2025</th>
<th>Annual growth, %</th>
<th>1997</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>121.9</td>
<td>230.6</td>
<td>2.3</td>
<td>-1.9</td>
<td>-39.8</td>
</tr>
<tr>
<td>India</td>
<td>10.33</td>
<td>14.4</td>
<td>1.2</td>
<td>0.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Indonesia</td>
<td>9.40</td>
<td>14.1</td>
<td>1.5</td>
<td>-0.5</td>
<td>-0.2</td>
</tr>
<tr>
<td>Japan</td>
<td>0.00</td>
<td>0.00</td>
<td>0.0</td>
<td>-16.3</td>
<td>-15.4</td>
</tr>
<tr>
<td>South Korea</td>
<td>0.08</td>
<td>0.14</td>
<td>2.0</td>
<td>-8.1</td>
<td>-12.7</td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.05</td>
<td>0.07</td>
<td>1.3</td>
<td>-2.3</td>
<td>-3.9</td>
</tr>
<tr>
<td>Myanmar</td>
<td>0.30</td>
<td>0.54</td>
<td>2.1</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Pakistan</td>
<td>1.27</td>
<td>2.39</td>
<td>2.3</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Philippines</td>
<td>4.17</td>
<td>8.46</td>
<td>2.6</td>
<td>-0.4</td>
<td>-1.9</td>
</tr>
<tr>
<td>Thailand</td>
<td>4.45</td>
<td>8.05</td>
<td>2.1</td>
<td>-0.2</td>
<td>-1.3</td>
</tr>
<tr>
<td>Vietnam</td>
<td>1.60</td>
<td>2.78</td>
<td>2.0</td>
<td>0.1</td>
<td>-0.7</td>
</tr>
</tbody>
</table>


Recently released State of Food and Agriculture (SOFA) report by FAO has presented global analysis of the livestock sector and it highlighted three overarching messages that merit discussion in the context of Asia.

Firstly, livestock products make important contributions to food security and poverty reduction for many low-income rural families in Asia. Livestock rearing is a key livelihood and risk mitigation strategy for small and marginal farmers and its share in the total value of agriculture and allied activities has been growing in a number of Asian countries. It is widely recognized that relatively more equal distribution of livestock assets (compared to land) makes poor far more important in livestock production than crop production and hence investments in livestock can have more direct and immediate impact on poverty reduction. Livestock is also one of the most important productive assets in rural areas and serves as a critical store of wealth for farm families and as an insurance mechanism for coping with household-related crises. Further, livestock rearing at the household level is largely a women-led activity, and therefore income from livestock rearing and decisions related to use of livestock related within the household are taken by women. Interventions in a number of countries have demonstrated that support for livestock rearing can potentially contribute significantly to the empowerment of women and an increasing role in decision making at both the household and community level.

Growing demand for livestock products and technological changes along the food chain have led to major structural changes in livestock production and marketing systems. For dairy and small ruminant production, the production costs on small farms are often comparable with those of large scale enterprises. However, in a number of countries in Asia, high transactions costs along the value chains impose disproportionate burden on small producers in accessing expanding markets. Similarly, smallholder swine-pig meat producers in Asia face numerous challenges related to market evolution resulting from rapid intensification of pig production by large integrated firms and increasing cross-border trade in live pigs and pig-meat. Smallholder producers have the potential to overcome these challenges but need support from collective organizations and support networks. One element of the future action agenda in smallholder livestock development in Asia must therefore focus on creating
innovative institutional arrangements that are efficient, competitive, sustainable and inclusive and enable small producers enter into supply arrangements with large processors. This requires concerted public action in support of small farmer enterprise development, including cooperatives, and development of participatory decision-making mechanisms that enable dialogue and collaboration between small producers, service providers and decision makers.

The region has produced a number of successful models to demonstrate the potential of livestock sector in empowering rural poor and generating poverty alleviating growth but much work still remains to be done to fully capitalize the potential of livestock sector in support of poor peoples’ livelihoods. In this context, the SOFA report argues that it is important to focus future livestock development agenda on the institutional reforms and public and private investments that consider three objectives: (i) to enhance the ability of smallholders to take advantage of the opportunities offered by growth in the sector; (ii) to protect the poorest households for whom livestock serve as a crucial safety net; and (iii) to enact broader rural development policies to ease the transition of many rural households out of the sector.

The second key message of the report is that livestock production is placing increasing pressures on natural resources and the environment and corrective action is needed to encourage the provision of public goods such as ecosystem services and environmental protection. This requires addressing policy and market failures and developing appropriate incentives including market-based policies, such as taxes and fees for natural-resource use which would motivate producers to internalize the negative externalities associated with livestock production (FAO, 2010).

The report notes that livestock contribute to and are victims of climate change. But, at the same time, the sector has enormous potential to contribute to climate change mitigation. Realizing this potential will however require new and extensive initiatives at the national and international levels, including: the promotion of research on and development of new mitigation technologies; effective and enhanced means for financing livestock activities, developing and transferring technologies to mitigate greenhouse gas emissions. Some negative environmental consequences from livestock production stem from problems associated with open-access common property resources. Clarifying property rights and promoting mechanisms for their enforcement would contribute towards sustainable management of these resources. On the technology side, promotion of technologies such as animal genetic improvement, animal feeding, improved grazing-land management, and silvo-pastoralism can mitigate the negative effects of livestock production on natural resources and the environment (FAO, 2010).

Thirdly, in view of the widespread prevalence of a number of production limiting and trade preventing diseases in the region and growing health concerns resulting from zoonotic and food-borne diseases, support for the development of policies and delivery systems for enhancing food safety and minimizing the animal disease burden is another area that deserves focused attention. Animal health services face new challenges of battling animal diseases that cause mortality, reduce animal productivity and harm human health because of the risk of animal to human disease transmission. In a number of countries, animal health systems suffer from institutional weaknesses that lead to poor delivery of animal health services and higher risks to livelihoods and human health. The SOFA report warns however that the poor face different risks and have different incentives and capacities to respond than intensive commercial farmers. Therefore, animal health service providers have the additional challenge of recognizing the differences between their stakeholders and developing mechanisms to reach them all. An effective solution to addressing this challenge will require that producers at every level, including poor livestock keepers, are engaged in the development of animal disease and food-safety programmes.

Finally, it is important to recognize that addressing the issues confronting the sector, action is required at all levels, from the local level, through the regional and national levels to the international level. The challenges of mobilizing adequate public and private investment and enhancing the quality of sector governance can’t be solved by individual actors. They require integrated efforts by a wide range of stakeholders to capitalize on the strength of livestock production systems in Asia and the need to tackle those root causes with potential negative impact on further rapid livestock sector development. It is also imperative that such efforts be realistic, equitable, and conscious of region’s socio-economic and cultural dimensions. Developing an agenda for action supported by governments,
international institutions, multilateral and bilateral donors and civil-society stakeholders is a crucial first step towards a livestock sector characterized by: better governance; a more inclusive development process; levels of investment commensurate with the importance of the sector and the challenges it faces; and improved international cooperation.

LITERATURE CITED


Cattle extension programs and research for tropical agriculture

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INTRODUCTION

Successful Extension programs must be useful and practical in order for participants to gain information that can be readily adopted. Seaman Knapp, one of Extension’s most influential pioneers in the USA stated, “What a man hears, he may doubt. What he sees, he may possibly doubt. But what he does himself, he cannot doubt (Seevers et al., 1997).”

Indonesian agriculture has come a long way over the past decade. However, subsistence agriculture is still prevalent and there is much that can be done to increase productivity and economic viability. The challenge is to develop extension programs that are timely and relevant. Cooperation from all sides of agriculture will make this possible. This would include collaboration with private industry, federal and provincial government’s right down to the grass roots producers themselves. There must be a commitment particularly from the government agencies to devote the resources necessary to develop programs and be a presence in the rural areas of Indonesia.

We know there is a common framework of successful agricultural extension based on five principles (Killough):
1. A sound agricultural policy is indispensable
2. Extension consists of “facilitation” as much if not more than “technology transfer”
3. Producers are clients, sponsors and stakeholders, rather than beneficiaries of agricultural extension
4. Market demands create an impetus for a new relationship between farmers and private suppliers of goods and services
5. New perspectives are needed regarding public funding and private sectors

However, the environment of agricultural extension is changing in the following ways:

1. The aims of official development assistance are becoming more focused. This means reducing poverty and social inequalities, the sustainable use of natural resources, and participatory development, are overall objectives to which extension policies can make a significant contribution. People are leaving the country for the cities but at the same time the rural population is expanding rapidly and has limited access to health and education services.

Food security is often a problem for the rural poor, a large proportion of whom live only by agriculture. Food security in towns and the sustainable management of natural resources hinges on farmers’ work. By helping to improve farming and farm yields, agricultural extension can be a very powerful tool for empowerment and support to community livelihoods. These objectives highlight the fact that extension systems must be accessible and useful to the poorest, and address the special concerns of women farmers and young farmers.

2. Changes are happening in Indonesia as there is increased economic liberalization, decentralization and privatization. The standard of living has been slow to increase but there is in fact a trend forward. This is resulting in urban families having more disposable income which trickles down to the farmers as the price of agricultural products slowly rises and the demand for more products are required and value-added opportunities arise.

3. New opportunities for collaboration with industry in extension activities are being developed. These include: Input suppliers (seeds, fertilizer, animal/crop health products, farm equipment, etc.) include advice and training as part of marketing their products. Additionally, purchasers of agricultural products advise, train, and recommend techniques to ensure supplies of guaranteed quantity and quality. This leads to private trainer-advisor-outreach agencies emerging in response to the demand from public agencies and professional organizations. Farmer organizations (trade unions,
associations, cooperatives and others) may offer a range of service provisions such as inputs and product marketing, loan facilities, training, information, facilitation and extension services.

4. Public spending on extension is shrinking as policies to bring down public deficits in most developing countries have led to expenditure ceilings on agricultural extension and the introduction of fee-based schemes. In some ways, this is a positive development. Users can dictate, or at least influence, the type and quality of the services they buy. On the other hand, it may put some of these services beyond the reach of the poorest.

According to the Swiss Center for Agricultural Extension, a new approach to extension is needed to accommodate the developments and trends described. But it must emerge from an analysis of the successes and failures of existing operations. The reason is that the success of extension programs must be gauged over the long term. The main benchmarks must be their impacts on agricultural output, the welfare of rural communities and environmental sustainability, but consumers’ interests must not be left out of the equation. It has proven difficult to assess these objectives in practice. While indicators for monitoring outreach activities are often available, final impacts are rarely assessed and are not strictly comparable between different types of interventions and contexts.

These constraints notwithstanding, the following six principles can be said to form the basis of an extension policy.

1. A sound agricultural policy is indispensable. An agricultural extension program is more likely to succeed if the conditions for growth in agriculture and related industries are in place. Extension is only one aspect of agricultural policy.

2. Extension consists of “facilitation” as much if not more than “technology transfer”. Extension is too often merely seen as a vehicle for spreading scientific and technical progress and technology transfer. But this is a narrow and highly unsatisfactory definition.

The dissemination of knowledge is not a one-way street from scientists to producers. Farmers’ own knowledge must be collected, analyzed, capitalized on, propagated and disseminated.

Producers need more than just technical information. There is rarely a “one size fits all” solution to address the mix of technical, economic, commercial, social and environmental aspects that farming problems consist of. Farmers need information on markets, credit facilities and consumer demand. But simply making information more readily available is not enough to ensure that it is used effectively. On the various levels of their activities (farm, local community, industry subsector), producers must themselves be able to analyze the constraints, seek out and test solutions, and make choices from an array of existing service providers.

Extension professionals must be adept in participatory techniques, and resourceful in drawing on a mix of communication methods and technologies. They must think in terms of market opportunities, increasing producer incomes and total farm management.

3. Ensure that all extension activities are supported for agricultural training, farmer organizations and agricultural research. Human and financial resources must be balanced among all the elements which help take agricultural knowledge forward: education, training, research, extension and professional organizations. Targeting all available resources on extension alone is not effective.

TECHNOLOGY TRANSFER

Burton E. Swanson, Professor Emeritus of Rural Development University of Illinois at Urbana-Champaign examined the technology transfer function and concluded that this activity will become increasingly privatized as technologies become progressively more proprietary and as farmers become more commercialized. As this transition occurs, more and more of the cost of providing technical advisory services to farmers will be recovered through the sale of production inputs and services. However, in most developing countries, there can and should be closer cooperation between the public and private sectors because many input suppliers do not have technically competent sales personnel who can give correct technical advice to farmers. Therefore, rather than public extension personnel viewing the private sector as competitors, they should develop public–private partnerships with input supply dealers because these firms provide most of the one-on-one technical advisory services, especially to large commercial farmers and, to a lesser extent, to small-scale farmers unless they are organized into producer groups.
As an example of this concept I was involved in a research and extension project in collaboration with the private sector. The objective of which was to determine the effect on digestibility and production of protein and energy supplementation of stocker cattle on intensively-managed grass flood-meadow pastures.

In Utah retained ownership of calves beyond weaning is very low. This may be due to factors such as cash flow but also increased financial risk and the potential for negative or low value-added opportunities. Pastures could provide for increased value-added and retained ownership opportunities through stocker cattle (yearlings on grass) on irrigated and intensively-managed pastures.

Flood meadows are predominant in many of the valleys and normally constitute grasses and sedges with moderate energy levels and relatively low protein values. These pastures are typically allowed to grow to mid-season and then hayed and stock-piled for winter cow feed supplies. Grazing of flood meadow pastures by growing cattle is carried out but production is limited due to nutrient constraints (primarily protein) to maximize growth resulting in marginally competitive costs of gain. Intensive management (use of electric fence and grazing pressure) is now common among stocker operations utilizing tame grass pastures. This provides the opportunity to incorporate supplemental feeding strategies with a higher degree of control than was formerly possible when cattle were extensively grazed.

High protein products generally increase weight gains of cattle grazing moderate to low quality forage by increasing forage intake and digestibility. High bypass protein feeds such as corn gluten feed have been successfully used as a protein and energy supplement for growing beef cattle grazing forage in the summer. These high bypass products are particularly valuable where the forage is rapidly degraded such as lush grass or irrigated pastures.

Soy Best, an extruded soybean product, has 42 percent protein and 86 percent TDN with 60 percent of the protein as bypass or Undergraded Intake Protein (UIP). By-pass is a term which implies that the protein within the feed is not degraded in the rumen but escapes this environment and is available for absorption in the small intestine. This can be advantageous, particularly if the protein in the feed is already of high quality.

We cooperated with a company that produced the Soy Best product and carried out the study. In the end we were able to determine that supplementation of protein does provide a production advantage but not necessarily an economic advantage. We developed an extension fact sheet and spoke at a number of producer meetings about protein supplementation.

**Examples of Extension Programs in the USA for Beef Cattle**

1. I have been involved in a number of successful extension programs in the USA and Canada as I have worked as an extension beef specialist. One of these programs we called Intermountain Beef 3910 which took participants through a number of learning exercises, which increased their knowledge in beef grading, price discovery and certain aspects of production, and animal husbandry. This two day workshop was developed in collaboration with industry partners including major sponsorship from the Utah Cattlemen’s Association, Global Animal Management and Utah State University Extension. Logistical support was provided by JBS, in the form of facilities and personnel. Each workshop was limited to 20 participants and there have now been twelve workshops to date. The objectives of the workshop were to provide participants with a basic understanding of the beef grading system and Beef Quality Assurance (BQA) to demonstrate how these principles relate to them and the entire beef industry. This is a hands on program and extremely well received by beef producers, industry and university faculty. The reason for the success of the program has been because of the collaboration of all involved with a common objective and support from government, university, industry and the beef producers themselves.

2. Another example of extension programs in the area of beef cattle that has worked is illustrated below. Researchers in the western USA determined that supplementation of beef cattle on western ranges was necessary and would lead to increased productivity and financial gain.

Ruminants are often unable to consume enough nutrients from pasture forage to fulfill requirements. During such situations supplemental feeding is necessary to meet production goals. There are numerous commercial feed supplements available to producers, and an unlimited number of...
options for the development of custom supplements. It may be difficult to decide which supplement type (i.e., energy, protein, etc.) best fits the goals of the livestock production system. A fundamental understanding of ruminant nutrition is helpful in making these decisions. It is also important to choose a delivery method that provides the targeted amount of desired nutrients to each animal in the herd and minimizes input costs.

Supplemental feeds for livestock are often classified as energy or protein supplements by considering the percentage protein alone. This is because the primary protein and energy feedstuffs used in supplements are generally between 75 and 90 percent TDN, yet the protein content of the high protein feedstuffs, like cottonseed meal or soybean meal, are three to five-fold higher than grains like corn and milo. Because of this relationship, the primary difference in nutrient content of a 20 percent and 40 percent protein supplement is the protein concentration, not energy. Thus, supplements are often categorized as protein or energy supplements based on the protein content alone.

Developing a cost-effective supplementation program is dependent upon identifying the nutrient most limiting to productivity and providing the limiting nutrient(s) at the lowest cost. If protein is deficient (i.e., < 7 percent crude protein), supplements should be evaluated based on cost per pound of protein. Similarly, if forage supply is limited and energy is deficient, supplements should be evaluated based on cost per pound of TDN (energy). Sometimes both energy and protein are limiting, so a balanced approach to provide supplemental protein and energy is recommended.

Generally, high protein feedstuffs are more expensive than grains or energy byproducts. Since high protein feedstuffs are more expensive per ton, high protein supplements are more expensive than low protein supplements. However, it is critically important to evaluate potential supplements based on cost per unit of nutrient needed.

A fact sheet was developed with the objective to aid producers in determining the supplement type needed for grazing beef cattle and to describe the characteristics of supplement delivery methods. The format of the fact sheet was to explain supplemental feeding and provide research findings to validate the reasons for supplementation.

1. In one area of Utah we were interested in developing a mineral nutrition program with ranchers. Beef cattle require a number of dietary mineral elements for normal bodily maintenance, growth, and reproduction. Minerals that are required in relatively large amounts are called major or macro elements. Those needed in small amounts are classified as micro, minor, or trace minerals. The major minerals include calcium, phosphorus, magnesium, potassium, sodium, chlorine and sulfur. Among those needed in trace amounts are iron, zinc, manganese, copper, iodine, cobalt and selenium. Samples were taken from feed supplies and pasture over a period of 6 months on each ranch that cooperated. Nutrient analysis determined the levels of each mineral using mass spectroscopy. Results were tabulated and developed into a fact sheet. Additionally we held a series of producer meetings to explain the results.

2. The final example is “The Cow-Calf Management Guide & Cattle Producer's Library” which is an educational resource for cattle producers and educators prepared by the Western Beef Resource Committee. The committee consists of extension specialists in 12 western states. Historically, the Library has only been distributed in printed form. In 1999 a CD-ROM version was added. The Library contains approximately 250 factsheets in sections on quality assurance, nutrition, reproduction, range and pasture, animal health, management, marketing, finance, genetics, and drought and other natural disasters. The Library is revised annually by WBRC.

The Library has been a tremendous resource for beef cattle producers throughout the USA. Thousands of the books and CDs have been distributed over the past 20 years.

Presently I am involved in a project to develop something of a similar nature for third world countries but in areas such as animal husbandry, human nutrition, water development, irrigation, agronomics and other areas related to rural living and agriculture. I am working with private industry on this venture which will include visits and training to a number of countries, the first of which are Peru and Ecuador next spring. The fact sheets and resources produced will be tailored for any type of situation such as tropical, arid, semi-arid etc.
CONCLUSIONS

Any one of the examples used in this paper could be implemented in Indonesia in any area of agriculture. The point is, information needs to be developed based on sound principles and practices which are formulated from available research or knowledge. From here extension programs, fact sheets or other resources can be developed in cooperation with industry, government, agricultural producers etc. There is no end to the opportunities and resources available if everyone works together for the greater good.

Agricultural extension systems, especially in developing countries such as Indonesia, are in a process of change as the national focus shifts from national food security to improving rural livelihoods, including food security at the household level and, increasingly, working to achieve sustainable natural resource management. At the same time, while the world’s supply of staple food crops will continue to increase, the increasing demand among many industrialized nations for biofuels is rapidly increasing worldwide prices for many staple food crops. The immediate and long-term impact on food consumption and human nutrition among the poor and ultra-poor is uncertain but appears to be serious. The impact on small-scale farmers will likely differ from country to country, depending on government price, import and export policies and what it will do to enhance their ability to seize opportunities offered by the market (Swanson).

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The revolving fund system in sustainable community development

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ABSTRACT: Revolving funds have been used as a means of providing a sustainable source of capital investment for many decades. There are many examples of their use at a regional, national and global scale. Revolving funds have also been implemented at a community and individual scale as a means of driving rural development in many countries. Perhaps the best known examples of these are the thriving micro-credit schemes that operate in many developing countries. Despite their many successes there have been some criticisms of micro-credit schemes, particularly in relation to their strict regulatory and bureaucratic nature and the fact that in many cases the poorest members of many societies are excluded from the cash economy. For these reasons the Ørskov Foundation, a rural development charity based in Scotland, has built on and utilised an adaptation of the revolving fund paradigm so that any initial capital investment it makes in community development projects takes the form of tangible investments, such as livestock, that rural people are familiar with. The return on the initial investment takes the form of offspring from the original livestock provided and these in turn help the benefits to spread to other people in a system that can potentially “revolve” indefinitely. Examples of projects from a number of countries where revolving funds have been used in this way are described.

INTRODUCTION

In its strictest economic definition, a revolving fund is often established with capital that does not need to be repaid, but can be replenished through charges made for the goods and services produced as a result of the initial capital.

Historically, there are examples of revolving funds having been used as early as 1910 by the Oklahoma State Legislature (Franklin and Douglas, 2003). The distinguished English Economist John Maynard Keynes also discussed the use of revolving funds in arguing that a constant stream of investment can be financed by a fixed pool of money, which turns over continuously (Keynes 1937).

“If investment is proceeding at a steady rate, the finance (or the commitments to finance) required can be supplied from a revolving fund of a more or less constant amount, one entrepreneur having his finance replenished for the purpose of a projected investment as another exhausts his on paying for his completed investment.”

Revolving funds, as instruments of capital investment, have been used at a range of scales. Globally, the United Nations set up a revolving fund in 1973 to provide financial assistance to support the production and discovery of mineral deposits and geothermal energy resources in developing nations. The scale of this fund was commensurate with its aims, with a reported US$62million invested from the fund (Tomita and Nichol, 1988). Regionally, the Pan American Health Organisation (part of the WHO) established a revolving fund for vaccine procurement in 1979 and more recently, in 2000, set up a strategic fund to deal with HIV/AIDS, TB and malaria (PAHO, 2003). Nationally, the US Federal Government introduced Revolving Loan Funds in the 1970s to offset reductions in direct government support for rural businesses, particularly those involved in agriculture (USDA, 1996).

Revolving Funds as Used by the Ørskov Foundation

The first experience in setting up a community project based on a revolving fund system was in Indonesia, in the village of Kwarasan. It was carried out in 2001 in collaboration with Gadjah Mada University and funded by the Rotary Club. The village women’s group were given 50 female goats and 2 males. Each family was given two pregnant goats and undertook to “repay” half of the first 2 pregnancies back to the group who together decided whether to increase group membership or set up another village group on the same principle. By 2006 the initial 52 goats had increased to 477. Since
then, 4 more similar projects with goats, funded mainly by rotary clubs have been set up around Yogyakarta with similar success.

In 2002, based on the success in Indonesia, two community projects in Vietnam near to the city of Hue, were set up again with University staff participating in the projects funded by the Rotary Club. In Vietnam the projects were set up with local pigs (Mangkai) instead of goats. The system was similar, with a number of piglets given back to the Village Women’s Union to distribute to other members.

In 2004 2 projects were set up in Kenya, near to Nakuru in the Rift Valley, in collaboration with Egerton University. This project was based on lactating goats. The village collaborate in selecting goats for high milk production but the revolving fund system is generating. In Kenya there is a high demand for goat milk as it is believed to be beneficial for HIV/AIDS patients.

Following the success of these community projects funded by the Rotary Club, the Ørskov Foundation was set up, with the specific aim of building on these successes by providing a dedicated source of funding to enable revolving-fund projects to be set up to help in the alleviation of poverty amongst rural communities in developing countries.

**Ørskov Foundation Case Studies**

**Indonesia (2007/2008)**

In September 2007 the Ørskov Foundation established seven projects in collaboration with Gadjah Mada University (GMU), Yogyakarta in Central Java, the Faculty of Agriculture Technology - University of Jember (UNEJ), East Java and with the Development Unit of the Mataram local government (DUM) on Lombok Island.

Each project had a livestock focus. Each of the livestock species provided by the projects were location-specific and driven by the needs and wishes of the communities involved. Four of the projects focused on goat production, two involved the production of eggs, meat and breeding stock from ducks and one project supported the production of fresh water fish.

The projects placed an emphasis on community income generation and self-sufficiency as one of their key outcomes. Through links between the Ørskov Foundation and the three partner organisations in Indonesia, there were also extensive opportunities for the integration and exchange of knowledge and expertise between university students studying agricultural sciences and community members, leading to enhanced long-term environmental protection and sustainable development and a greater understanding between students and small farmers.

The following is a list of planned outcomes envisaged for the projects:

- Improved livelihood opportunities amongst community participants.
- Providing communities with a means to meet their immediate needs but also allowing them to invest accrued benefits from the sale of excess livestock in a community managed fund as a sustainable way to mitigate against future environmental shocks and vulnerability.
- The project provides communities with access to an affordable form of credit to purchase items deemed essential for improved livelihoods.
- The revolving-fund principle empowers community groups to take control of decision making processes related to their own livelihood needs.
- The community fund derived from revolving-fund repayments can also if decided by the community provide scope for non-agricultural income generation to be derived from micro-credit loans provided by the community for the benefit of community members.
- Improved education and training in knowledge of animal feed, health and husbandry amongst participating community group members.

In total, across all seven projects funded, an initial 158 households benefited. The initial number of goats provided to the four projects was 241 and at the end July 2008 that number had risen to 310. A second group of beneficiary households in Banyu Soca Village were identified and a further 30 households benefited from the offspring of the initial project in this village before the end of 2008.
Eight households from Girikerto Village, Sukorejo also received financial assistance to build staged goat pens as the existing housing they had for their goats was not deemed suitable at the time when the animals were being provided to the families.

From the initial 810 ducks provided to the 27 households in Rowosari and Barat Sawah the total number of adult ducks more than doubled to August 2008 to 1,840. In addition, the ducks also produced a total of 12,462 eggs to August 2008. At a sale price of 600 Rupiah the value of these eggs to the households was 7,477,200 Rupiah, or approximately $700 (2008 prices). At the end of July 2008 a further 15 households received 30 ducks each, passed on from the Bintang Tani farmer group from Rowosari village. This exemplifies the benefits of the revolving-fund system, with initial seed-funding providing sustainable opportunities for livelihoods development.

The fish cage project in Lombok was initiated in April 2008. The first harvest of adult fish was expected to take place in October 2008 with an estimated 400 – 450 kg of adult fish produced from each of the cages provided to the initial 15 household recipients.

**Malawi (2007 – 2010)**

The Ørskov Foundation has been actively funding community projects in Malawi since 2007. The first project was the Lilongwe District Goat project. This project targeted smallholder farmers from Nsundwe and Nkhoma areas that were interested in goat production but have limited resources. Vulnerable households with malnourished under-five aged children and those looking after orphans and/or people living with HIV and AIDS were given special consideration in this project.

The project promoted sustainable goat production through supplying households with an initial stock of local female goats and improved exotic bucks. Farmers were organised into groups of 15 members, assisted to construct appropriate housing and supplied with local does and either a dairy or meat breed buck depending on preference. The buck was jointly managed by each group whilst the does were allocated to individual household members, who were required to pass on two female offspring to members of new groups.

Group members were provided with training in goat management by staff from Bunda College, University of Malawi. Research carried out from 1992 to 2004 by the University of Malawi showed that goat milk is ideal for combating malnutrition and supplementing the diets of those with HIV and AIDS, which are prevalent in Nsundwe and Nkhoma. Dairy goat crosses are also in high demand locally, selling at double the price of local meat goats.

The project aims to directly benefit up to 60 households initially, through:

- Increased goat ownership
- Newly acquired goat management and marketing skills
- Improved nutritional status as a direct result of access to meat and milk, or indirectly from sales enabling households to purchase other food items
- Reduced exploitation from traders following training in marketing techniques
- Nutrient cycling through the use of goat manure for crop production
- Reduction in crop damage and environmental degradation through improved housing and husbandry

During evaluation of this project in 2009 a number of issues of concern were raised as to the effectiveness of the implementation and perceived lack of ownership of the project by the community participants.

In particular, some of the beneficiary households were not aware that they owned the goats and were, therefore, able to derive benefits from that ownership. There seemed to be conflicting information being given to the households by local Agricultural Extension Officers that was often in conflict with the initial capacity building undertaken at the start of the project. This led to confusion and a lack of understanding over ownership amongst the community which resulted in the revolving fund aspect of the project was not able to be implemented.

These issues have subsequently been addressed, but they highlight the potential pitfalls in the use of revolving funds when used in a rural development context (see Milligan, 1987).
Since 2009, M-Livestock Consultants have been conducting a pilot phase of Malawi’s Responsive Village Egg Model at Geni Village, Mchinji District, Malawi. This is a community revolving system of poultry rearing that initially provided 10 households each as an effective means of providing income and food security. The model has since been scaled up to improve accessibility of fertile eggs of the ‘Tombi Village Layer 2010’ breed to all villagers. It is envisaged that in 3 years the number of beneficiaries will have grown to around 750 households.

Currently, the model beneficiaries are passing on the gift of fertile eggs to 72 Households of people living with HIV/AIDS in Gumulira Millennium Village. These are eggs from crossing Black Australorp and Hyline Commercial Layer. The breeding program is carried out by village breeders. Each pass-on beneficiary household receives a gift of 14 fertile eggs for hatching with local hens to produce Tombi Village Layer 2010 Chicks.

Another project funded the purchase and manufacture of solar drying cabinets for villagers in Nyanggu in Chikwawa District. Entech, an environmental technology company that is working with the Macaulay Institute on the JANEEMO project in Malawi, received funding to manufacture solar drying cabinets. These will be owned by a community association group and used to dry the leaves of the Moringa tree (*Moringa oleifera*), which has exceptional nutritional qualities and will be used to supplement the diets of communities in the Lower Shire District. Payment for the use of the solar driers will be made “in-kind” by villagers supplying an excess of leaves for drying. This excess powder will be sold in local markets and the profits passed to the community association to re-invest in other micro-enterprise activities linked to the JANEEMO project. A total of 2,000 people are expected to benefit directly from this project.

In 2010 we funded a second project in Chikwawa District that will provide appropriate solar energy technology in the form of photovoltaic solar panels to members of the Chikwawa Cotton Growers Association in collaboration with Seeds of Opportunity, a Malawian NGO.

Rural life in Malawi is characterized by a narrow economic base, over-dependency on rain-fed agriculture and biomass for household energy. This situation is exacerbated by increasing poverty among communities, increasing population pressure on a limited land resource base, land degradation arising from agricultural expansion and the cultivation of marginal lands, and increasing deforestation to meet the increasing demands for energy, food and construction purposes.

This project seeks to abate deforestation, soil erosion and a loss of habitat/biodiversity by promoting the use of solar photovoltaic systems that will reduce dependence on firewood and kerosene for energy. Seeds Of Opportunity will be working in collaboration with Chikwawa Cotton Growers Association to increase the livelihood opportunities of people in Chikwawa by improving the accessibility of solar photovoltaic systems in order to reduce deforestation and land degradation arising from domestic energy demands. Chikwawa Cotton Growers Association is a local farmer organisation aiming at developing cotton production in Chikwawa.

The association aims at assisting farmers in the procurement of inputs and marketing of cotton. The project will assist in increasing forest conservation efforts in the area and raise an awareness of issues of protecting the environment in order to reduce poverty arising from an unsustainable use of the available forest resources.

The project will initially benefit 30 households (about 180 people). The implementation strategy will be to organise the beneficiaries and assist them to form a committee that will establish and manage a fund where they will make monthly contributions. In due course money from the fund will be used to procure more solar photovoltaic systems to be distributed to other people in the community so as to increase the scope of the project.

The direct beneficiaries will assist other people in their communities by providing energy services from solar photovoltaic products/systems- e.g. charging mobile phones to facilitate communication and information dissemination. It is anticipated that farm productivity and incomes for the poor will be boosted whilst safeguarding the natural environment as this project will facilitate improved access to ICT, access information on markets and contact with far off suppliers/buyers for the communities produce.
Cameroon (2008)

Recent transformation in Cameroon's economy has profoundly changed the parameters of social development. One significant trend has been the increased burden of poverty on women, which accounts for the feminisation of poverty in the country, both in qualitative and quantitative terms.

The goal of a project funded by the Ørskov Foundation was to assist vulnerable women’s groups from Bokwaongo village in the Southwest Province of Cameroon to generate significant household income and improve their socio-economic status and living conditions. The project identified four women’s self-help and common initiative groups and trained them in pig rearing and on strategies to boost their household incomes through marketing.

Sri Lanka (2008)

Small-scale fisheries in reservoirs have played an important role in the subsistence economy in Sri Lanka, but some reservoirs have been declared as sanctuaries for the protection of biodiversity. However, the need to provide livelihoods for the people living in these areas has risen in order to alleviate poverty and to gain their support for conservation.

In a project funded by the Ørskov Foundation the Annaiwilundawa sanctuary, a seasonal dry zone wetland, was stocked with suitable fish species by local communities who will be given technical support from staff at Wayamba University. A revolving-fund was established from which an agreed proportion of the income from the sale of fish re-invested in order to purchase fingerlings, nets, etc. and extend the benefits to more community group members. This community-based fishery management system was developed to enable sustainable utilisation of fish whilst at the same time safeguarding the avian biodiversity of a one of only three recognised RAMSAR wetland sites of international importance in Sri Lanka.

Kenya (2009-2010)

The Chyulu Hills Bee Keeping Mothers project seeks to create alternative and environmentally friendly sources of income for women living on the slopes of Chyulu Hills. The project is managed by the Sikizana Trust who work with 9 self-help groups spread along the hills. The Trust also runs a rescue centre for abandoned and vulnerable children in the same area. The project will supply each of the groups and the rescue centre with modern beehives, fencing and training on bee keeping and marketing skills. Savings from the sales will be utilised to give members income and to increase the number of beehives available.

In the Uholo West revolving commercial farming project the University of Nairobi provided a package of assistance to 450 farmers through the provision of a mixed commercial farming system comprising dairy goats, fish ponds, beekeeping and bananas. The funding provided by the Ørskov Foundation helped to support the dairy goat beekeeping elements of the proposed system.

The Kisumu Initiative for Positive Empowerment in Kisumi initiated a project to enhance food security for vulnerable people living with HIV/AIDS in Nyanza Province, through community-based dairy goat and local poultry farming. Following implementation of this project it is anticipated that the initial beneficiaries from this project could number up to 800 people.

Vietnam (2007)

In cooperation with the local Women’s Union of Dau Kenh Village, Quangtri province, central Vietnam a project with local cattle was established. The project will also provide farmers with knowledge on the improvement and use of underutilised crops such as rice straw, groundnut vines and other locally available plant material, through the active participation in the project by staff from Hue University of Agriculture and Forestry.

This project builds on existing, successfully implemented, revolving fund projects that provided community members with local pig breeds. Members of the Women's Union expressed an interest in expanding their livestock enterprises into cattle and sought the funding for this project to achieve this.
**Nepal (2008)**

This project aims to support resource-poor tribal Kumal women in the Gaikhur and Chyangli Village Development Committees of Gorkha District by providing knowledge, skills and seed funding for goat farming that ultimately helps in improving their livelihoods by ensuring sustainable income opportunities. The specific objectives of the project were to:

- train the tribal Kumal women groups on conservation farming methods, sustainable agroforestry management, fodder and forage management, goat farming and effective marketing so that they can sustain their livelihoods using locally available resources
- develop an effective microenterprise model based on goat farming and agroforestry using the revolving-fund approach for its implementation amongst the community groups
- create employment opportunities at a local level and develop linkages with markets to raise incomes


The Ørskov Foundation has supported three groups; Mon-Bunyu, Oryang Ojuma Women project and Giligili Women beekeepers. These groups with over 80 members have over 150 local and wooden beehives. They have been collaborating with different institutions and organisations and as a result they have demonstrated great success in terms of increased honey production, knowledge acquisition and overall poverty alleviation. Since inceptions, the 3 groups have earned over 3.5 million Ugandan Shillings (approximately £1,100) from the sale of honey and other bee products. As a result, poverty amongst rural beekeepers has reduced and their living conditions and livelihood status improved.

More importantly, members of these 3 project groups came together and founded the Acholi Beekeepers Cooperative Society. This will help them and other beekeepers work together, enhance their capacity, improve the marketing of honey and other bee products and assist in certifying their bee products with fair trade organisations. This Cooperative is registered and plans are underway to affiliate it to the national Beekeepers body. Beekeepers in other villages are also being mobilised to access membership.

During January 2010, these groups pulled their resources and with funding support from another donor conducted 3 days residential training for over 178 beekeepers from the whole Kitgum region. Among the topics conducted were; cost benefit analysis, book keeping, honey bees, the colony, bee behaviour, apiary management, hive colonization methods, the enemies of bees and pest management, how to construct protective equipment, using locally available materials, honey harvesting and hive inspection, honey processing and marketing.

Community managed revolving fund/micro-credit schemes were established from honey sales and these are providing micro-credit loans to the farmers to expand on their entrepreneurial activities. This revolving fund will adopt effective micro-finance facilities for the beekeepers in 2010.

**Democratic Republic of Congo (2008)**

Annual production of meat (domestic and wild meat) in the Democratic Republic of Congo (DRC) covers only 11% of protein food needs of the population. Many people in towns as well as in rural areas can rarely afford to buy meat. This situation induces malnutrition, precarious health, reduced endurance for working, poor resistance to diseases and shortened longevity.

Farming *Cricetomys* (giant pouched rats of sub-Saharan Africa) on a large scale could be a quick and cheap way to enhance the production of meat in the country. The project funded by the Ørskov Foundation aimed to improve the established Cricetoma farming methods and techniques, to adapt that husbandry in different places to improve productivity and to disseminate *Cricetomys* as a viable alternative minilivestock species in Kinshasa and elsewhere in the DRC. Grant you need to explain more what is Cricetomis.

Ten Cricetoma farmers, who were members of the Association of Wild Animal Farmers (AWAF) group, along with another 10 Cricetoma farmers in Kinshasa and 3 provinces of DRC at Butembo
(Province of Nord-Kivu), Lubumbashi (Province of Katanga) and Luki(Boma) (Province of Bas Congo) each received 200 breeding animals and appropriate cages. This first group of 20 farmers will serve as model systems to disseminate the husbandry practices required for *Cricetomys* production.


In 2007 a project funded by the Ørskov Foundation sought to empower local communities with skills and resources to domesticate Grasscutter rats (*Thryonomys swinderianus*) and increase the production of their meat for local markets. This has dual significance in that it serves both as a source of income for local people but also as a conservation strategy for wild Grasscutter populations.

Grasscutters are the most preferred bushmeat species in Ghana and the most important throughout West Africa in terms of volume of trade and preference. This project promoted the production of Grasscutters by rural communities through husbandry training by staff from the Kwame Nkrumah University of Science and Technology and by providing them with the initial stock of animals to begin their own farming enterprises.

The project was expected to provide employment and supplementary income, reduce pressure on wild Grasscutter populations and directly reduce the incidence of wildfires - the most common mode of capture for wild animals.

In 2009 the Animal Research Institute in Accra, in association with the Ghana Society of Animal Production and the Canadian Society of Animal Production (GSAP-CSAS), received funding for a revolving goat project as economic support to rural women involved in the Shea nut industry in northern Ghana. The project provided breeding herds of goats to women groups in 10 communities in northern Ghana, helping to support the livelihoods of 340 women in the first year.

**CONCLUSIONS**

The conclusion from the projects funded so far is that they have had a very positive impact on poverty alleviation where they projects have been implemented with a fully operational revolving fund structure. We believe that the secret of the success was to let the village groups participate in how they were going to manage the revolving fund system. This provided early ownership of the project and its outcomes amongst the beneficiaries. Involving university departments/NGOs in the implementation and management at the initial stages of project implementation have also had unexpected advantages in that their students/staff have gained an insight into their client’s needs. Several research programmes and other initiatives have been initiated and carried out in conjunction with the community projects with participation of the village groups, good for the students and the villages. Where some problems occurred, as described in Malawi, the reason was simply lack of participation by the community to set up the project which ensures commitment to a successful project.

**LITERATURE CITED**

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Intensification of smallholder livestock production, is it sustainable?

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ABSTRACT: This paper discusses sustainability perspectives of intensification of different types of smallholder livestock production. A main sustainability issue of intensification is its contribution to household incomes. Smallholder dairying substantially increases incomes, despite pressing technical sustainability issues. Trade-offs are that it is not an option for the really resource-poor households, and its impact on different environmental and societal sustainability issues. Intensification of small animal systems appears to have a low potential to substantially increase incomes. Livestock intensification strategies have to meet the environmental and societal demands.

Key words: intensification, livestock, smallholders, sustainability, livelihoods, environment

INTRODUCTION

Worldwide, livestock production systems are rapidly changing. The increasing demand for animal source food is a major driving force for these changes. The growth in consumption of animal products in emerging and developing countries will remain strong, despite the present economic crisis. In these countries, increases in livestock production occur mainly outside the traditional rural sector (FAO, 2005), at the same time, large numbers of smallholders keep livestock in support of their livelihoods. Many countries promote the intensification of livestock production to meet the increasing demands and to reduce imports of livestock commodities. Countries are not only supposed to be concerned about the increased demands of the wealthier consumers of animal foods, they are expected to remain committed to poverty alleviation too. It is expected that the increase in demand for animal foods can help smallholder crop-livestock farmers to engage in market-oriented economic activities and that this can help them to improve their livelihoods (Delgado et al., 2001).

Intensification, the increased use of inputs and services to increase the output quantity and/or value per unit input, requires cash inputs. This does not fit the risk avoidance strategy of smallholders. It requires that smallholders have to become more market-oriented. This will lead to increased competition with other smallholders and with large-scale operators. Is it feasible for the poorer households to invest their scarce resources in more intensive livestock systems?

Livestock intensification is also promoted to reduce the environmental burden of livestock production (Steinfeld et al., 2006). Environmental challenges vary from exhaustion of resources to environmental pollution. At present, the impact of livestock on climate change is widely discussed. Steinfeld et al. (2006) state that reducing animal numbers, improving feed quality and increasing production levels are needed to mitigate detrimental effects of livestock on the environment. Reducing animal numbers interferes with the multiple objectives of smallholder livestock keeping. Livestock do not only produce food, they provide manure and draught power to support crop production, and they are a capital asset, in particular in areas lacking reliable financial institutions.

The potential benefits and trade-offs of livestock intensification place livestock on the sustainability agenda. Sustainability is defined in many different ways. In short, sustainable agricultural production has to be economically viable, ecologically sound and socially just, at farm, regional and global system levels. This paper discusses the sustainability perspectives of the current changes in smallholder livestock production. It draws on the results of case-studies on village poultry, integrated agriculture-aquaculture systems, small ruminants and dairy cattle in Ethiopia, Vietnam, Indonesia, India, Bhutan, and Kenya, respectively.
CASE STUDIES

Village Poultry

The majority of rural households keep poultry in their farmyard. In Tigray, Northern Ethiopia, Aklilu (2007) explored the role of village poultry, their marketing and consumption, and possibilities for their improvement. The main benefits derived from village poultry were income from sale of eggs and sale of birds, followed by egg and meat consumption in the family, and strengthened social relationships. Poultry were seen as a very important resource for the very poor. Female-headed households often only kept poultry, whereas male-headed households had a wider range of opportunities for earning income. Poultry development programmes generally focus on health interventions, housing, feed supplementation and crossbreeding. Households, however, are not adopting intensifying technologies widely. Innovations in village poultry can only be successful if they fit the limited physical and economic resources of the farming households (Aklilu, 2007).

In poultry, an alternative to village poultry is to apply industrial poultry keeping methods. In almost every country there are small- and medium-scale poultry units involving commercial hybrids, compound feeds and industrial poultry housing methods. Industrial poultry keeping systems have to be completely market-oriented. They are very vulnerable to macro-economic disturbances.

Integrated Agriculture-Aquaculture

SE Asia has a long tradition of integrated farming. The Mekong River Delta in Vietnam is an example of a region where many farmers have integrated rice with fruits, vegetables, pigs, poultry and fish in Integrated Agriculture Aquaculture (IAA) systems. Bosma (2007) and Phong (2010) studied production performances, ecological sustainability, and decision making on diversification in rice-based high input fish, rice-based medium input fish and orchard-based low input fish farms. Nutrient balances and Life Cycle Assessment (LCA) were used to quantify the environmental impact of farms and their components (Phong et al., 2010).

Economic liberalisation in 1986, the introduction of modern rice varieties, big floods, and increasing market demands were driving forces for agricultural diversification and intensification (Phong et al., 2007). Whether or not an individual household practised a specific component and integrated different components depended on, in decreasing order, available family labour, wealth status, land area, family situation and market prices (Bosma, 2007). Intensification of the different IAA components was based mainly on the use of external inputs. In particular, farmers with sufficient capital tended to intensify their farming practices. The use of inorganic fertilizers was the main intensification strategy for the crop components. The use of concentrates and hybrid pigs were major tools in intensification of pig production. The intensification level of the fish component differed between areas. The use of concentrates and culture of catfish were the intensification strategies for fish in areas with access to urban and international markets.

Small Ruminants

Small ruminant keepers often are among the poorer groups in society. Budisatria (2006) studied the dynamics of small ruminant production systems in Central Java, an area in Indonesia renowned for the quality of its small ruminants. Farmers referred to their small ruminants as a saving that provides security and helps to accumulate capital. Manure was the second reason for keeping small ruminants. Drivers of change in small ruminant systems acted at national, regional, agro-ecosystem and household levels (Budisatria et al., 2007a). Over a period of 80 years of small ruminant development, the number of small ruminants increased seven-fold. Intensification of small ruminants implied changes in breeds kept and in management systems. The intensification of land use resulted in declining grazing areas and less family members available for herding small ruminant flocks. The majority of small ruminants are now kept in confinement, or in a combination of grazing and confinement. Household resources, i.e. family labour, time and capital availability, were the major factors determining whether farmers kept small ruminants or not (Budisatria et al., 2007a).
Dairying

Crossbreeding for dairying is a major tool in intensification of cattle production. Samdup (1997) and Patil (2006) evaluated the impact of crossbreeding in mixed farming systems in Bhutan and Gujarat (India), respectively, by collecting data on household resources, inputs, outputs and internal resource flows of households with and without crossbred cattle. In India, governmental and non-governmental institutions promote dairy development to contribute to poverty alleviation. This started with the introduction of Jersey and Friesian crossbreds through artificial insemination, as well as training in feeding and management. In Gujarat, crossbreeding for dairying was introduced in 1985. In Bhutan, crossbreeding was stimulated by the 1985 breeding policy which promoted crossbreeding with Brown Swiss in high altitude areas and with Jersey in areas with relatively good market access, and using local breeds in remote areas that have harsh environmental conditions (Samdup et al., 2010).

Kenya is prominent for integrating dairying into smallholder farming systems, particularly in the highlands, where farmers mainly use European dairy breeds: Friesians, Ayrshires, Jerseys, and Guernseys. Bebe (2003) studied the consequences of intensification of smallholder dairying in the Kenya highlands. Here, about 60% of the rural households have integrated dairy in their mixed farming systems. Major drivers were colonial history, favourable agro-ecology, supportive agricultural policies, and the traditional value of milk in people’s diet (Bebe et al., 2002). Farmers intensify their farming practices by shifting from free-grazing to semi-zero- or zero-grazing (stall feeding). The semi-zero- and zero-grazing farms already comprise over three-quarters of all smallholder dairy farms.

SUSTAINABILITY

Concept

In 1987, the World Commission on Environment and Development published Our Common Future, in which sustainable development is defined as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’. Thereafter, many different definitions and interpretations of the concept of sustainability have been published. The interpretation of sustainable development also depends on the hierarchical level and the stakeholders involved. There is a strong pressure from society to adopt the concept. It has become a core element in government policies, development plans, corporate strategies and even research programs.

The definition of sustainable agriculture, agriculture that is economically viable, ecologically sound and socially just at different hierarchical levels, implies that there are three major dimensions of sustainable development: economic, ecological and societal. Sustainable agricultural development evokes concern that current farming practices endanger the continuity of agricultural production systems, the rural areas, and the planet as a whole. At the global level, it addresses global public goods such as greenhouse gas mitigation, biodiversity conservation, and poverty reduction. At regional and agro-ecosystem level, farmers provide products and services to meet the food, ecological and society demands. At farm level, however, farmers’ main interest is securing their own livelihoods. Conflicting interests among public and private interests are a typical problem in developing sustainable development strategies.

Assessment of Sustainability

Sustainability is not a measurable entity in itself, most studies use sustainability indicators to characterize sustainable development. Cornelissen (2003) developed a stepwise approach to implement sustainability, including: delineation of the system or innovation concerned; identification of Ecological, Economic, and Societal (EES) issues; translating EES issues into measurable sustainability indicators; assessing the contribution of sustainability indicators to sustainable development; communication of results. This approach assumes stakeholder engagement in identifying the issues to be addressed. The use of relevant indicators and their data sources is a key aspect in assessing sustainable development. A sustainability indicator measures the current status of an EES issue for a production system or innovation. The contribution of a sustainability indicator to sustainable development is often subjective. Sometimes the estimate of an indicator is compared with a target value and results are presented graphically. There is no one sustainability indicator set that fits all agricultural production systems; what is and what is not
sustainable depends on the agro-ecosystem and the social, cultural and political context. The sections below discuss economic, ecological, and societal issues and indicators of livestock intensification as experienced in the different case-study areas.

**ECONOMIC ISSUES**

Estimates of contributions of livestock to livelihoods in the case-study areas were based on the indicator ‘value added’ (revenues minus variable costs) plus estimates of ‘additional’ benefits (Bosman et al., 1997; Moll et al., 2007). Revenues included the value of marketed products and the opportunity values of home consumption, manure, and draught power. Additional benefits represent the money saved by a household in a herd or a flock as guarantee that future requirements can be met, equivalent to an insurance premium not required, and the expenses avoided by selling animals for urgent cash needs, i.e. saving of financing expenses incurred by engaging formal or informal agents.

The case-studies are not directly comparable with regard to the economic benefits of different livestock types, but they confirmed that there was a livestock ladder with the smallest economic benefits from village poultry, followed by small ruminants, pigs, fish, local cattle, and the largest benefits from dairy cattle. For Tigray, the benefits from sales and home consumption of poultry were estimated at around 70 US$ y\(^{-1}\) per household (for 2003-04). Modelling of the impact of innovations showed that New Castle Disease (NCD) vaccination could double these benefits (Aklilu, 2007). The modelling showed that housing and supplementary feeding each could have a positive effect on technical parameters, but a highly negative impact on economic benefits. Crossbreeding had a negative effect on technical as well as economic results. Value added estimates for the IAA farms were on average, 900 and 1240 US$ y\(^{-1}\) for 2002 and 2004, respectively. The share of farm income was highest for rice (42 and 48%), followed by fruits (19 and 29%), fish (25 and 9%), pigs (8 and 17%), cash crops (4 and 10%) and poultry (2 and -8%) (Phong et al., 2007). In 2004, the returns for poultry were negative, due to the Avian Influenza (AI) outbreaks in 2003 and 2004. AI caused a considerable decrease in demand and in the prices for poultry products, whereas the demand and prices for fish and pork increased. The farmers showed their resilience by intensifying the aquaculture component and pig production. The AI outbreaks very much affected farmers that had specialised in poultry production. In Indonesia, the economic benefits from sheep and goats were small: 120-165 US$ y\(^{-1}\). Exploration of innovation scenarios indicated that if farmers can specialise in sheep fattening on the basis of rice bran supplementation or in goat breeding the technical and economic performance can be improved 1.3-2.2 times relative to current production systems (Budisatria et al., 2008). In both Gujarat and Bhutan, farms with crossbred cows used more external inputs for cattle and had higher outputs than farms without crossbred cows (Patil and Udo, 1997; Samdup, 1997). Consequently, in Gujarat estimates of value added by cattle were 1.6 times higher in households with crossbreds compared to households with local cattle (400 vs 243 US$ y\(^{-1}\)), whereas, in Bhutan, crossbreeding had an even bigger influence on milk production and estimates of value added by cattle were 10 times higher in farms with crossbreds compared to farms with local cattle (1030 vs 107 US$ y\(^{-1}\)). Bebe et al. (2002) estimated that the total benefits of dairying were, on average, 1073 US$ y\(^{-1}\) per farm in the Kenya highlands, of which 56% was from non-market (home consumption, manure, and insurance and financing) benefits.

Labour productivity, the economic returns per unit of family labour, is another economic indicator. It reflects how efficient family labour is used for livestock. The case-study results showed that labour productivity of dairying, using European or crossbred stock, was higher than for crops or wage labour (Moll et al., 2007). Smallholder dairying is also competitive with large-scale dairy farms, as it uses family labour and has no high requirements for investments. The returns per unit of family labour from small animals were below the minimum labour wage. Some innovations in small animals showed potential to increase economic benefits, however, the returns to labour remained below the minimum labour wage. Farmers with sufficient household labour, however, do not consider the use of family labour as a production cost, because alternative employment opportunities are limited.

Another important economic issue for intensification of livestock production is to increase local production and to reduce imports of livestock commodities. In Kenya, the success of smallholder dairying is shown by the fact that dairy production has become the main farm income source for over 600,000 mixed crop-livestock farming households. The smallholders produce about 70 percent of the...
total milk production, and imports are decreasing (Noah and Waithaka, 2005). In Bhutan, however, the implementation of crossbreeding policies with smallholder farmers has not been able to reduce the gap between supply and demand for dairy products. Imports come from India, the country with 70 million smallholder dairy producers. In India, as in many other developing countries, the informal milk market has about 80% of the market share (Patil, 2006). This is the most economical way of milk marketing.

The conclusion that smallholder dairying has brought economic gains for the households involved does not mean that there are no constraints. The major technical sustainability issue is lack of good quality feed. Farmers usually mention this to be their major constraint. Population increases are causing intensification of land use, disappearing grazing areas and shrinking farm sizes, as a result ruminants have to rely more on crop residues and forage from road sides or other marginal lands. In Bhutan, India and Kenya, milk production levels were around 5-6 kg per lactation day (Samdup et al., 2010; Patil and Udo, 1997; Bebe, 2003). It seems that the feed resources available on smallholder mixed farms (some grazing in communal areas, crop residues from the farm and small amounts of local concentrates) can only support such production levels. In the Kenya highlands, the size of farms has decreased by more than half over the past two decades, mainly because of subdivision through family inheritance. This shrinking of land holdings is a major concern with regard to the continuation of current farming practices. The free-grazing farms are disappearing, but these farms produced replacement stock needed for the semi-zero- and zero-grazing, as these farms were unable to produce sufficient heifers for replacement, because of low calving rates and high calf mortalities. The availability of replacement stock is a general problem in smallholder dairying.

**ECOLOGICAL ISSUES**

Livestock can be a major stress factor on the environment: land degradation, soil mining and overgrazing in semi-arid areas, deforestation and loss of biodiversity in rainforest frontiers, involution of mixed farming systems in densely populated areas, and pollution of water, air and soils in industrial livestock systems. Soil nutrient balances are widely used as sustainability indicators. Industrial livestock systems usually show large nutrient surpluses, whereas, e.g. studies in Sub-Saharan Africa show alarming nutrient depletion rates (Stoorvogel, 2007). Livestock usually have a positive effect on nutrient balances and resulting crop production. They collect, through feed purchases and collection of roadside forages, convert and deposit nutrients, but manure alone is not sufficient to restore nutrient deficits. In Asia, fertilizer use seems to be higher than in Africa. The IAA farms in the Mekong River Delta showed substantial N (84 kg ha⁻¹) and P (73 kg ha⁻¹) surpluses, indicating that intensification of rice, fruit trees and vegetables resulted in accumulation of nutrients in soil pools (Phong, 2010). The crop-livestock farms in Bhutan also showed relatively large N and P surpluses (Samdup, personal communication).

In the discussion about greenhouse gas emissions by livestock it is suggested that intensification of the livestock sector will help to mitigate greenhouse gas emissions, as less greenhouse gas is produced per kg of intensively-produced animal product than per kg of product from an extensive production system (Steinfeld et al., 2006). The LCA of the IAA farms showed that the relation between livestock and the environment is complex. In the Mekong River Delta, the major tools for intensification are the use of fertilizers and concentrates. The fish component of IAA farms in the research areas differed in intensification level. The LCA results indicated that the environmental indicators land use, energy use, global warming potential, eutrophication potential, and acidification potential per kg fish were higher in the low input fish system than in the medium and high input fish systems, due to the small fish yields in the former. The differences in intensification level between the high and medium input fish systems, however, did not result in differences in environmental impacts per kg of fish produced. The medium input fish ponds were better integrated with the other farm components than the intensively managed fish ponds (Phong, 2010). The average global warming potential per kg protein was higher for pigs and poultry than from fish. Overall, rice (0.8 ha paddy per farm) and pigs (11 pigs per farm) were the biggest contributors to the environmental impact of food production in the Mekong River Delta. This was mainly due to excessive use of fertilizers and methane emission from the paddy fields and the off-farm impact of the production of concentrates or pigs (Phong et al., 2010). The contributions of pigs and poultry to land use, global warming potential, acidification potential and eutrophication potential per kg product were within or slightly larger than the ranges found in the literature for industrial pig and poultry keeping (Phong et al., 2010). The energy use per kg pig or
poultry was relatively low compared to industrial systems. It was concluded that to reduce impacts per kg pig and poultry, pig and poultry production should become more productive. However, if this is achieved by feeding more concentrates, the off-farm impacts of growing and producing the feed ingredients will increase the environmental impacts again.

Intensification generally increases pollution per unit area. An example of pollution per unit area is the finding that in Central Java, the housing of small ruminants close to the family quarters resulted in very high levels of drinking-water contamination with faecal bacteria (Budisatria et al., 2007b).

Reduction of biodiversity and domestic animal diversity are also issues of environmental impact of livestock production. There is a wide range of biodiversity, c.q. agro-diversity, indicators at the levels of genes, species and ecosystems. This will not be discussed here. Domestic animal diversity is a subset of agro-diversity. Intensification often starts with replacing local breeds by crossbreds or European breeds. Crossbreeding can also have a positive effect on biodiversity. In Bhutan, one of the policy objectives of promoting keeping fewer but more productive crossbred cattle was to reduce grazing in forest areas. This has been successful to some extent, as crossbred cows are milked every day and graze less in the forest than local cattle (Samdup et al., 2010).

SOCIETAL ISSUES

In developed countries major societal issues are welfare and health of animals, zoonoses, and food safety. These issues determine very much the public debate and acceptance of current animal production systems in society. These issues will not transfer easily to animal production in developing countries. In these countries, a major social issue is that only a part of the smallholder mixed farmers, in particular the better-off farmers, is able to take advantage of the increased demands for livestock products. The social, cultural and capital asset functions of livestock will remain important for the poor households. So, many of the poorer households are likely to be excluded from the increased market opportunities. This will result in a reduction of the number of smallholder livestock farmers. Whether or not smallholder mixed farmers will opt out from livestock production will also depend on the opportunities for employment in other sectors.

In the Mekong River Delta, farmers were asked about their most pressing sustainability issues. Farmers scored societal issues more often than economic and ecological issues. Education of their children was the main social issue. Farmers did not want their children to become farmers. From investment in education they expected a good job opportunities for their children (Phong, 2010).

Intensification, through crossbreeding, can also have an effect on cultural practices. In Indonesia, Madura cattle are used in the Karapan, a famous traditional bull race in Madura Island, and Sonok, a contest of harmonious walking of two cows or heifers with accompanying traditional music, events. Since 2001, crossbreeding is allowed in Madura. Farmers in districts where the cultural events are still of importance are not motivated to start crossbreeding. In other districts crossbreeding with Limousin is introduced and a new cultural practice, judging the physical appearance of crossbred bulls, is replacing the traditional cultural events (Schultinga, 2010). Another example of the resilience of smallholders.

DISCUSSION

Sustainability assessments are used to compare different products or production systems, or to estimate the impact of specific technologies, so providing information about success or failure of innovation or intensification strategies. The main issue of intensification of smallholder livestock production is its contribution to household incomes. Smallholder dairying with European or crossbred stock increased household incomes. The introduction of dairying also creates job opportunities along the dairy chain.

In an FAO (2010) study on greenhouse gas emissions from the global dairy sector it is concluded that in industrialised countries the emissions per kg milk are much lower than in developing regions, due to lower production levels and less efficient milk production in developing countries. This study allocates all emissions to milk production and neglects other functions of cattle in smallholder systems. In the Kenya highlands the other functions comprised more than half of the cattle benefits. The total emissions per animal are much lower in smallholder crop-livestock farms than in industrial livestock farms. Nevertheless, the smallholder sector contributes significantly to global greenhouse
gas emissions due to their large number of animals. But, this contribution is much less than in developed countries. Herrero et al. (2008) calculated that all of Africa’s ruminants contribute about ten per cent of global livestock methane emissions.

Increase in milk production should preferably be the result of better feeding and management practices and not an increase in the number of animals. In Gujarat, modelling studies and field trials indicated that feeding more locally available supplements could increase milk yields at the most by about 20% (Patil, 2006). Increases in production have to come from concentrates and using European dairy breeds or crossbreds. The off-farm impacts of growing and producing the feed ingredients will increase greenhouse gas emissions on a global scale.

Growing and producing feed ingredients and cattle keeping also have a big impact on biodiversity in rainforest frontiers (Steinfeld et al., 2006). Kaimowitz and Angelsen (2010) argue that livestock intensification is not the answer to save tropical forests. Ranchers will only be willing to adopt land-saving practices when land has become scarce and most of the forest has gone.

The use of European dairy breeds or crossbreds is a major trade-off between poverty alleviation through dairying and preservation of domestic animal diversity. Farmers are the main actors in maintaining breeds, but we cannot hold them responsible for maintaining domestic animal diversity. In developed countries, public institutions and hobby farmers are major actors in breed conservation. Farmers need incentives to maintain local breeds. This can be economic incentives to produce niche products, or the recognition that local breeds are well adapted to local diseases or other harsh environmental conditions.

Another trade-off is the conclusion that dairying is not an option for the really resource-poor farming households. In the Kenya highlands, households with dairy cattle had about twice as much land as households without dairy cattle. Resource-poor farmers are more likely to own poultry, pigs, or small ruminants than large stock. Small animals better fit the farming conditions of the very poor, but their contributions to household incomes were small, and the productivity of the family labour invested in small animal was low. The potential of innovations in small animal systems to substantially increase incomes of rural households was low. Micro-credit and passing-on-the-gift programmes are needed to help poor households to invest in livestock and intensifying technologies. Small animals are more suitable for micro-credit and livestock loans-in-kind programmes than large ruminants. It usually takes a too long time before large ruminants can be reared.

The impact of village poultry and small ruminants on the environment was small, except for groundwater pollution of housing small ruminants close to the family. In Vietnam, the main intensification strategy for pigs was the use of hybrid pigs and consequently the use of concentrates. This resulted in a relatively high environmental impact of pigs (e.g. pigs contributed 35% of global warming potential of the farms), due mainly to the impact of off-farm processes (Phong et al., 2010).

The market for milk is the major pull factor for smallholder dairying, and in countries such as India, Bhutan, and Kenya, it produces the majority of the milk of the country. In other sectors, large-scale industrial production accounts for the major part of the increases in livestock production. Nevertheless, the increasing demands influence the non-dairy farmers too, e.g. in Ethiopia, prices of village poultry and eggs had more than doubled over the last ten years due to the increase in number of consumers and the introduction of chicken on menus in local restaurants. The increasing demands can also have a negative impact on local production. In West Africa, the increasing demand for poultry products has a negative effect on local industrial poultry production, as the poultry meat demands are increasingly met by imports of whole chickens or inferior cuts (Dieye et al., 2007). Local poultry meat from small- or large-scale industrial units costs more than imported chicken products as a consequence of the higher production costs of feed and chicks.

Livestock production will continue to intensify. Often, livestock intensification policies focus on the economic dimension of sustainability. They tend to neglect the environmental and societal dimensions. Livestock development strategies need to include a sustainability analysis to assess the impact of intensifying technologies at different levels. Without development policies that deliberately consider the opportunities and threats faced by crop-livestock farming households, many of these households are likely to be excluded from the increased market opportunities.
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The development of Danish agriculture and agribusiness: Lessons to be learned in a global perspective

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ABSTRACT: The agri and food industry is a major industrial sector in Denmark. Around 20% of total industrial turnover still comes from the food industry and that places the sector in a remarkable position seen from a global perspective. Compared to other countries on a similar level of economic development Denmark has an extremely important agriculture and agribusiness sector. Danish agri and food cooperatives seem to have been successful in obtaining international competitiveness. The transformation and the structural development of the cooperative sector has more or less been completed. In Denmark, cooperatives play a major role in the agri and food industry - especially in sectors close to the farmers in the food chain. Cooperatives have succeeded in building up greater market power to strengthen the marketing of farmers’ products. The development of the industrial structure among Danish agri-cooperatives has been very rapid during the latest decades. Through mergers and acquisitions the number of firms has fallen dramatically, and the result has been increasing concentration ratios in almost all groups of the food industry. Structural development, concentration and globalisation in recent decades have resulted in the agri and food companies now being among the largest in Europe. To a large extent, agriculture all over the world faces similar problems and challenges. For this reason, it is essential that know-how, experiences and lessons can be transferred and adopted by agriculture in other countries around the world. In many ways, the experience and the success behind Danish agriculture and agribusiness can be transferred to other countries. However, profound studies of specific needs and conditions are necessary. The transfer of knowledge from Danish agri and food businesses can take place through joint-ventures or foreign investments, in which mutual and equal benefit is obvious. However, the transfer of knowledge can also be facilitated by development assistance from industrialised countries.

INTRODUCTION

For decades, Danish agriculture and agribusiness have been characterised by a high market share for cooperatives and strong international competitiveness. The structure of companies in the sector has, to a high degree, been export and globally oriented. Also, in a global perspective, the world market shares, the competitive strengths and the size of cooperative food companies etc. in Denmark is remarkable.

Cooperatives have succeeded in building up more market power to strengthen the marketing of farmers’ products. By pooling products in larger and larger cooperatives, the market position has improved, and managing the globalization process has been facilitated. Barriers to globalisation have been avoided as the big cooperatives had resources and products to invest in international marketing.

Cooperatives are recognised as being structurally robust in many areas. Vertical integration, traceability, supply management etc., give cooperatives a competitive advantage. Many cooperatives have proved to be extremely competitive having a high quality management and business administration.

Financially, cooperatives have a unique construction: Cooperatives are owned by the members - by the farmers - but the financial contribution is rather limited. Because farmers agree to deliver their production to the cooperative, the need for capital in the cooperative is reduced. In a way, the farmers’ commitment to deliver their production to the cooperative is the major contribution and support from the farmers, and indeed a stable supply from the farmers, is a very important asset for any company. In this way cooperatives need less capital, and the farmers can be owners of their own cooperative company without adding huge capital input.

The lessons learned by Danish agriculture and cooperatives might benefit farmers and cooperatives in foreign countries - in several ways.
First of all, the cooperative movement is based on the principle of supporting one another and other cooperatives. The transfer of knowledge and support to build up new cooperatives in e.g. developing countries is completely in line with the values and ideas of the cooperative movement.

Secondly, Danish cooperatives take part in the globalisation process through export and increasingly also through foreign direct investment, global strategic alliances, foreign joint-ventures etc. Partnerships with companies or group of farmers in foreign countries are common, and the concept of such cooperation is that all partners are supposed to benefit.

Thirdly, Danish cooperatives and Danish agribusiness have developed and strengthened their structure, competitiveness and market power in many decades, and farmers from other countries - whose agribusiness sector is less developed - can copy or learn from the Danish experiences. The process of developing agribusiness often has to go through similar stages, so companies at an early stage are more or less able to learn from the experiences of companies at a later stage.

Fourthly, the combination of a highly competitive agribusiness and a dominance of cooperatives is a unique case, from which lessons from successes and failures can be learned. Researchers, consultants and farmers from many countries study the Danish cooperatives in agribusiness in order to learn and copy from the Danish experiences.

THE PROCESS OF DEVELOPMENT OF STRUCTURE AND COMPETITIVENESS

The process of globalisation, structuring and creating competitiveness has developed over many decades. Cooperatives were established in the 1880s, and the transformation from domestic orientation to export orientation started in the same period. The major stages in the globalisation and structure/competitiveness of Danish cooperatives are shown in figure 1.

![Diagram of Globalisation and Structure/Competitiveness](image)

Source: Own presentation

**Figure 1.** Stages in the globalisation and development of the structure/competitiveness of Danish cooperatives

The globalisation and industrialisation of Danish agriculture and agribusiness started gradually as early as the end of the 19th Century. Increasing international competition and price pressure on the international grain markets were drivers of a significant transformation, in which the production and export of animal products such as butter, eggs and meat increased. In later stages of the globalisation process, the diversification of export markets and the export of goods to more distinct markets have characterised the development, indicating a more advanced stage of the globalisation process.
Recently, foreign direct investment, global strategic alliances and production abroad have also been major elements in the globalisation process.

Since the beginning of the transformation process at the end of the 19th Century, the Danish agricultural sector has focused on cooperatives as a main driver for development and globalisation. The overall aim was to ensure farmers’ market power in the marketing chain through the establishment of cooperatives in most agricultural sectors, both up-stream and down-stream. The market share of cooperatives increased, and during the last decades a remarkable wave of mergers among agribusiness companies, and especially cooperatives, has occurred. Structural development through consolidation and concentration has dramatically increased the competitiveness of companies.

THE GLOBAL STATUS OF AGRICULTURAL COOPERATIVES

Cooperatives play a significant role for many farmers around the world. The importance of cooperatives varies from country to country, although there is no clear pattern regarding the importance and development from a global perspective. Generally, cooperatives in agriculture are most prevalent in northern Europe. Prevalence varies from sector to sector with cooperatives having a large market share within the milk and meat sectors.

Viewed over a long time scale, there is evidence to suggest that cooperatives in the EU have gained a greater market share (e.g. Bekkum, and van Dijk, 1997; Hansen, 2005).

In the EU, agricultural cooperatives have a 50 % share of the supply of agricultural inputs and more than a 60 % share in the collection, processing and marketing of agricultural products (COPA-COGECA, 2010).

In the U.S., the number of cooperative dairies fell by almost 70 % in the period 1973-2002, but during the same period their share of total milk sales increased from 76 to 86 % (USDA, 2005). Generally, the market share of cooperative dairies has been increasing in both the U.S. and the EU-15 in recent decades.

In general, the market share of cooperatives is rather high when it comes to businesses close to the farmers in the value chain. Cooperatives also play a relatively important role within segments, in which the farm value share of total expenditures is high (Rogers, 2000). Farmers’ incentive to establish and maintain cooperatives is stronger when it comes to companies that directly trade with farmers, and where it is most critical for the farmers to have access to a reliable supplier and buyer. For this reason, cooperatives play a minor role within sectors such as breweries, bakeries, food service etc.

THE DEVELOPMENT OF COOPERATIVE INDUSTRIES

The development of the industrial structure among Danish agri-cooperatives has been very rapid during recent decades. The number of firms has decreased dramatically and today only a few firms survive. The result has been increasing concentration ratios in almost all groups of the food industry. Recently, foreign direct investment and production abroad have increased significantly (see figure 2-5).

In general, the number of cooperatives and other companies in the agri and food industry increased until the mid-1900s, and has since declined. Since 1960, the number of companies has fallen by more than 90 %, mostly due to mergers and acquisitions. In the same period, the average size of a company has increased from index 100 to index 4.500 - here measured by production in volume terms.

Concentration has increased tremendously since the mid-1980s. Merger waves have resulted in the establishment of larger cooperatives, which have increased their market share significantly. Also, a shift in focus from export to globalisation through investment and production in foreign countries, has appeared.

Increasing market power and increasing international competitiveness have been the major drivers behind this structural development in the Danish agri and food industry.
Note: Data from 10 sectors within Danish agri and food industry
Source: Own calculations based on annual reports and company information

**Figure 2.** Number of companies in Danish agri and food industry

![Number of companies chart](chart1.png)

Note: Size = Production (volume) per company
Source: Own calculations based on annual reports and company information

**Figure 3.** Average size of companies in Danish agri and food industry 1960 = 100

![Average size chart](chart2.png)

Source: Own calculations based on annual reports and company information

**Figure 4.** Concentration (HHI-index) in selected sectors within Danish agri and food industry

![Concentration chart](chart3.png)
The 5th International Seminar on Tropical Animal Production
Community Empowerment and Tropical Animal Industry
October 19-22, 2010, Yogyakarta, Indonesia

![Graph showing export and production abroad from Danish agri and food industry]

**Note:** Selected agri-cooperatives.
**Source:** Own calculations based on annual reports and company information

**Figure 5.** Export and production etc. abroad from Danish agri and food industry

**COOPERATIVES’ MARKET SHARE**

In general, during the 19th Century, Danish agri and food cooperatives increased their market share. Within the dairy and pork industries, market share increased from zero to 80-90 % within a few decades following the establishment of cooperatives in the 1880s. For other sectors, cooperatives were established at a later stage, but in most cases their market share rose year on year (see figure 6).

![Graph showing market share of cooperatives in the Danish agri and food industry]

**Source:** Own calculations based on information from companies and organisations.

**Figure 6.** Market share of cooperatives in the Danish agri and food industry.

The increasing market share of cooperatives in the Danish agri and food industry is due to organic growth and acquisitions of capital owned companies.

**AGRICULTURAL COOPERATIVES TODAY**

In Denmark, cooperatives are completely dominant when it comes to pork, dairy products, grass seed, fur, grain and feedstuff. In other areas - such as sugar and poultry - cooperatives have completely disappeared and their business has been taken over by capital owned companies. The present market share of Danish cooperatives is shown in table 1.
The pattern of market shares - going from zero to almost 100 - can be explained by several different factors. In sectors such as dairy and pork, farmers must rely on daily deliveries from the farm to processing companies, and therefore cooperatives give farmers some kind of assurance and trust. This explains the large market share of cooperatives within the milk and pork processing industries. Transaction costs, and the farmers’ share of total marketing costs, also explain a part of the market share. In other sectors, the success or failure of cooperatives can be explained by managerial competence.

According to Hansen (2009), Danish cooperatives are expected to at least maintain their market share in the coming years. In general, the fundamental concept of the cooperative will remain unchanged. Cooperatives regard globalisation as a positive challenge with some seeing cooperative ownership as an advantage during globalisation.

Finally, it should be stressed that cooperatives operate mainly in the supply and processing industries. When it comes to farms and primary agricultural production, cooperatives do not play any role at all.

**Table 1. Market share (%) for cooperatives in Denmark, 2008**

<table>
<thead>
<tr>
<th>Business</th>
<th>Market share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pig slaughtering</td>
<td>86</td>
</tr>
<tr>
<td>Pig production</td>
<td>68</td>
</tr>
<tr>
<td>Beef slaughtering</td>
<td>57</td>
</tr>
<tr>
<td>Meat processing</td>
<td>52</td>
</tr>
<tr>
<td>Dairies</td>
<td></td>
</tr>
<tr>
<td>- milk intake</td>
<td>94</td>
</tr>
<tr>
<td>- milk, consumption</td>
<td>96</td>
</tr>
<tr>
<td>- butter</td>
<td>99</td>
</tr>
<tr>
<td>- cheese</td>
<td>89</td>
</tr>
<tr>
<td>Fur</td>
<td>95</td>
</tr>
<tr>
<td>Sugar</td>
<td>0</td>
</tr>
<tr>
<td>Poultry</td>
<td>0</td>
</tr>
<tr>
<td>Agri. machinery</td>
<td>0</td>
</tr>
<tr>
<td>Feed, fertiliser etc.</td>
<td>80</td>
</tr>
<tr>
<td>Eggs</td>
<td>58</td>
</tr>
<tr>
<td>Grass seed</td>
<td>73</td>
</tr>
<tr>
<td>Potato starch etc.</td>
<td>77</td>
</tr>
</tbody>
</table>

Source: Own calculations based on information from companies and organisations.

**DANISH AGRICULTURE AND AGRIBUSINESS AT A GLANCE**

The agri and food industry is a major industrial sector in Denmark. Though the relative share is decreasing over time, around 20 % of the total industrial turnover still comes from the food industry, which places the sector in a remarkable position seen from a global perspective. Compared to other countries on a similar level of economic development, Denmark has an extremely important agriculture and agribusiness sector.

The Danish food industry is dominated by two major branches – the dairy and meat industries - which account for more than 50 % of the turnover for the sector. The export orientation has been high for many years, almost dating back to the beginning of the 20th Century. In general, about 60-70 % of agricultural production is exported, which indicates strong international competitiveness.

Structural development, concentration and globalisation in recent decades have resulted in the agri and food companies now being among the largest in Europe. Today, Danish companies are in the top 3 in several important sectors in the agri and food business in Europe (see table 2).

The figures are remarkable considering that Denmark accounts for less than 0.5 % of the total economically active population within agriculture in Europe, and less than 0.7 % of the total agricultural land in Europe.

In the dairy, pork and fur sectors, Danish companies are in the top 2 in Europe, with all three companies being cooperatives.
Cooperatives have been a major driver in the development of Danish agriculture. Cooperatives were definitely an indispensable catalyst in the transition from a self-sufficient and protected agriculture, to an industrialised, globally-oriented, highly competitive and vertically integrated agribusiness sector.

The international competitiveness of Danish agri and food business is reflected in the fact that their world market shares are remarkably high. Despite the fact that resources in Danish agriculture are rather limited, the sector plays an important role on the global market, as export, in several cases, has a high share of total international trade and is even more or less dominant in some important cases (see table 3).

### Table 2. Danish food companies by rank in Europe (2008)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Rank</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pork*</td>
<td>2</td>
<td>Danish Crown</td>
</tr>
<tr>
<td>Beef*</td>
<td>7</td>
<td>Danish Crown</td>
</tr>
<tr>
<td>Dairy*</td>
<td>2</td>
<td>Arla</td>
</tr>
<tr>
<td>Feed industry*</td>
<td>3-4</td>
<td>DLG</td>
</tr>
<tr>
<td>Grass seed*</td>
<td>1</td>
<td>DLF-TRIFOLIUM</td>
</tr>
<tr>
<td>Fur trade*</td>
<td>1</td>
<td>Kopenhagen Fur</td>
</tr>
<tr>
<td>Brewery</td>
<td>3</td>
<td>Carlsberg</td>
</tr>
<tr>
<td>Pot plants (trade)</td>
<td>7</td>
<td>Gasa Group</td>
</tr>
<tr>
<td>Potato seed*</td>
<td>8</td>
<td>Danespo</td>
</tr>
</tbody>
</table>

* Means that cooperatives dominate the sector (see table 1).

Source: Own calculations based on information from companies and from national and international organisations

### Table 3. World market share (export) of selected Danish agri and food products (2008)

<table>
<thead>
<tr>
<th>Products</th>
<th>World market share, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass seed</td>
<td>32</td>
</tr>
<tr>
<td>Mink skin</td>
<td>30</td>
</tr>
<tr>
<td>Pork</td>
<td>29</td>
</tr>
<tr>
<td>Processed pork</td>
<td>14</td>
</tr>
<tr>
<td>Cheese, processed</td>
<td>12</td>
</tr>
<tr>
<td>Bacon and ham</td>
<td>11</td>
</tr>
<tr>
<td>Hides and skin</td>
<td>9</td>
</tr>
<tr>
<td>Cheese</td>
<td>8</td>
</tr>
<tr>
<td>Butter</td>
<td>6</td>
</tr>
</tbody>
</table>

Source: Own calculations based on FAO (2010)

The export of machinery from the Danish agri and food sector now accounts for a greater share of the total export from the sector. This export of capital goods also leads to a potential transfer of knowledge.

During recent decades, Danish cooperative agri and food companies have increased their foreign direct investment significantly. Production, processing, innovation etc. in foreign subsidiaries or joint-ventures now play an increasing role, and this step further step in the globalisation process will also lead to the transfer of knowledge to foreign countries. Foreign direct investments from Danish agri and food cooperatives have taken place in all regions of the world.

### CATTLE BASED AGRICULTURE AND AGribUSINESS

Cooperatives play a major role in the dairy and beef sectors. Farmers producing milk and beef are often heavily dependent on daily access to markets, and cooperatives give farmers an easy, cheap and reliable marketing channel. Transaction costs are reduced, and an optimal price for milk and meat is given to the farmers, as no owners other than the farmers need to be paid. Live cattle markets, which
hardly exist anymore in Denmark, were also organised by farmers themselves. Furthermore, cattle farmers also depend on access to feed stuffs and other inputs such as veterinary medicine, and these suppliers now mostly come from farmer owned cooperatives.

Arla, the Danish-Swedish cooperative dairy, intends to invest in a biogas plant based on manure from Danish farms. The idea is to solve an environmental and economic problem for farmers and at the same time to produce carbon neutral energy for Arla’s milk powder factory.

All the above illustrates that cattle-based agriculture and agribusiness is heavily integrated, and that farmers can benefit from cooperation and cooperatives.

**KEY SUCCESS FACTORS**

Lessons from cooperative development cannot be fully learned by other countries without considering the different situation that exists in these countries. The lessons from the Danish agricultural and food cooperatives must be targeted at the specific country or region, in which a new cooperative system is to be implemented. From that point of view, some key success factors based on positive and negative experiences from Danish cooperatives can be presented:

1. Farmers must be able to understand the advantages of a cooperative - and to obtain concrete economic benefits in the short or longer run.
2. Farmers must be committed to work for the cooperative, and to follow the rules and principles.
3. A certain level of social competence, mutual trust and credibility among the cooperative members is necessary in order to strengthen cooperation.
4. In a cooperative, the individual farmers or members should regard each other as colleagues and not as competitors.
5. Cooperatives must fulfill a role in society. The role may be to increase the market power of farmers or to reduce transaction costs - aiming at giving the members an economic advantage.
6. Cooperatives must be willing to cooperate with each other - nationally and internationally - in order to strengthen their market position, and in order to obtain mutual benefit.
7. Farmers themselves - and not governmental institutions or companies - must be the main drivers behind the establishment of new cooperatives. Governments, other institutions or companies may facilitate and support establishment, but farmers must be the major players.
8. Cooperatives must be managed as profit companies with the overall goal of maximising the economic benefits for the owners in the long run. Specific political or social goals, which do not add any economic benefit, should be downgraded.
9. Access to capital, investments and funding are potential problems for cooperatives. However, farmers’ obligation to deliver their products to the cooperative will reduce the demand for capital. In a joint-venture with a partner, members’ supply of agricultural products will be a valuable asset, which to some degree, will eliminate the need for capital from the members.

**CONCLUSIONS**

To a large extent, agriculture in South East Asia faces the same fundamental challenges and problems as those faced, and more or less solved, by Danish farmers in recent decades: An agricultural sector with many small farmers who have to cooperate in order to increase their market power in the food chain. Furthermore, they have to cooperate to benefit from the potential advantages of economies of scale, which small individual farmers operating alone cannot exploit.

Danish agricultural and food cooperatives seem to have been successful in obtaining international competitiveness. Also, the transformation and the structural development of the cooperative sector seems to have succeeded.

In several cases, other countries or organisations have tried to copy and to implement the Danish cooperative system with limited success. Several key success factors and lessons must be considered carefully.

Successful cooperatives provide farmers with significant advantages. However, the task of establishing successful cooperatives is not easy, and farmers must be committed and have a strong incentive.
Based on Danish experiences, and based on the specific regional conditions, further development of agri and food cooperatives in South East Asia might succeed. Such a scenario presupposes the following major fundamental conditions and perspectives:

- Local farmers must be committed and must be the main drivers of the cooperative process.
- Governmental authorities or institutions are important stakeholders and they should support or facilitate the process.
- The establishment of cooperatives will definitely be an appropriate tool to ensure the long-term reduction of poverty among rural populations. Also, cooperatives in the agri-environmental business sector focused on sustainable energy production from manure are highly relevant.
- The transfer of knowledge from Danish agri and food businesses can take place through joint-ventures or foreign investments, in which mutual and equal benefit is obvious.
- The transfer of knowledge may also be facilitated by development assistance from industrialised countries. Danish assistance policy towards developing and transition countries is changing, so that agriculture, the food supply chain and partnerships with agricultural businesses seem to be more in focus.

**LITERATURE CITED**

Hansen Henning Otte. 2009. Survey about Danish agro and food industry.
Genome research of gut bacteria, how to analyze and how to apply?

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ABSTRACT: After development of new generation DNA sequencers, the analyses of bacterial genome have been easy and familiar to microbiologist. However, to utilize vast amounts of data, it need bioinformatics and reverse-genetics, including transformation of plasmid DNA into target bacterium and gene knockout technique using homologous recombination. The authors proposed novel transformation technique to control restriction enzyme reaction using plasmid artificial modification (PAM). For the knockout gene, an error prone PCR has been employed to construct temperature sensitive plasmid. Using this plasmid the knockout technique become extremely easier, than conventional method.

INTRODUCTION

Recent innovation of DNA sequencing technology makes radical change of biological research, not only human medical but also animal, plant, microbiological science. The whole genome sequencing of bacterium is now very easily and quickly obtained using new-generation genome sequencers. In the case of human gut microbial society (so called ‘microflora’), more than 200 species of symbiotic and commensals bacteria have been sequenced.

However, the species number of gut microflora has estimated over 1000. To understand, relationship between each bacterium of microflora and host animal gut intestinal tract and also between bacterium and bacterium.

The microflora of animal GIT gives many effect on host health, prevents pathogenic infection, immunological reaction, such as preventing or enhancing allergic responses, obesity, arterial sclerosis and hypertension, mental condition such as depressive symptomatology. Tessier found Bifidobacterium from human infant feces and its assist human health, now the Bifidobacterial species are major in human large intestine and many species are found from other animals. It is thought Bifidobacterium act many good effects on human health.

From the unrecorded history, people take many fermentation foods, such as pickles and yogurt, fermented fish, ‘Sushi’ etc. Some lactic acid bacteria, eg. Lactococcus, and fungi, eg. Aspergillus oryzae, are used in the key-process of fermentation foods. They have assist human nutrition and health controlling. Now, these microorganism are actively taken as probiotics.

I will show recent progress of genome biology in microbiology and its impact on animal science and production.

GENOME SEQUENCER

When the human genome project was reported by two groups, HUGO and Celera Genomics in 2004. The sequence analyses were performed using capillary electrophoresis based automated sequencer, which enable 96 electrophoresis at once, which greatly improved the sequencing speed, then s slab gel based automated DNA sequencer.

October 2005, 454 released the Genome Sequencer 20, the first next-generation sequencing system on the market. In this sequencer, Template DNA fragment are attached on Beads on which surface are coated with a Primer DNA. Then the PCR reactions are performed on the beads in oil emulsions. The amplification is proceed clonally in each emulsion. After the PCR, beads are put on micro honeycomb plate (PicoTiterPlate), sequencing chemistry is based on pyrosequencing PCR. During elongation of DNA polymerase released pyrophosphate is chaptured by sulfurylase and luciferase. The luminescence of million beads is detected by CCD camera. The newest Genome Sequencer FLX Titanium, released in October 2008, featuring 1 million reads at 400 base pairs in length.
Two other next generation sequencing systems are available now. SOLiD, provided by ABI is using immobilized PCR and repeated ligation reaction. Illumina also using immobilized PCR. Amplified templates are sequenced using a robust four-color DNA sequencing-by-synthesis technology that employs reversible terminators with removable fluorescent dyes.

These high throughput DNA sequencer enabled human genome (3 x 10^9 bp) re-sequencing during single running of the system. The sizes of bacterial genome are 2 x 10^6 –8 x 10^6, several hundred of bacterial genome is able to analyze using the 2nd generation genome sequencer.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Read Length</th>
<th>Run Time</th>
<th>Throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>454 FLX Titanium</td>
<td>400 bp</td>
<td>10 hours</td>
<td>600 Mb</td>
</tr>
<tr>
<td>ABI SOLiD</td>
<td>2x 150 bp</td>
<td>~14 days</td>
<td>85-95 Gb</td>
</tr>
<tr>
<td>Illumina HiSeq2000</td>
<td>2 x 100 bp</td>
<td>~8 days</td>
<td>150-200 Gb</td>
</tr>
</tbody>
</table>

Thus, bacterial genome sequencing is now not difficult and not need big money. To obtain bacterial draft genome sequence it need only $1500 and 1 days. (However, to finish genome sequencing is much more difficult because, usually assembled data still have several hundred of unreaded regions. It needs manual amplification and sequencing to close the missing zones). It is much easy and lower cost to identify bacterial strain, than that using growing ability on selective medium set and chemical and biochemical characterization. In this point (Sep, 2010) 1371 strains have been finished and 4941 strains are on going.

**REVERSE GENETICS**

As described above, vast amount of the genome sequence have been available today. However, much of the data has been used inefficiently in molecular biological studies since reverse genetic tools, such as convenient shuttle vectors, an efficient transformation method, gene knockout and random mutagenesis techniques, etc., have not been available. Accordingly, we have been working towards developing simple methods that would establish transformation techniques for bacteria for which the genome sequence is available.

![Figure 1. The reverse genetics tool for bacterial research. Transformation (A), single crossover recombination (B), double crossover recombination for gene knockout (C), double crossover recombination for gene knockout using temperature sensitive plasmid (D).](image-url)
PLASMID ARTIFICIAL MODIFICATION (PAM) TO IMPROVE TRANSFORMATION EFFICIENCY

Transformation is essential to develop molecular biological techniques of each bacterium. However, restriction-modification (R-M) systems prevent efficient shuttle vector plasmid introduction into target bacterium. Recently, the whole genome DNA sequences of many bacteria have been reported. Using homology and motif analyses, possible R-M genes are able to find from genome sequence. By introducing DNA methyltransferase genes into E.coli cell, the plasmids will modified by these enzymes.

After propagation of the shuttle vector between E.coli–target bacterium in the PAM host, the plasmid will protected from the digestion by restriction enzyme of target bacterium during transformation, and gives higher efficiency. We propose to designate this method Plasmid artificial modification (PAM).

Here, we described the method of transformation with Bifidobacterium adolescentis ATCC15703, using PAM method and electroporation, in which the efficiency was improved 10^5 times by introducing 2 genes encoding the modification enzymes (Fig. 2).

Figure 2. The PAM concept. Panel A: The conventional method for the transformation of bacteria.

The introduced shuttle vector is degraded by a restriction enzyme of the target bacterium. A small amount of vector survives and replicates in the target bacterium. Panel B: A PAM plasmid expressed by E. coli (the PAM host) carries all of the modification methylase genes expressed by the target bacterium. A shuttle vector plasmid is introduced into the PAM host and is methylated by the appropriate modification enzymes. The shuttle vector then is isolated and introduced into the target host by electroporation. The vector plasmid is protected from host restriction enzymes and yields a higher transformation efficiency. Panel C: The R-M system is a complicated structure composed of a gene cluster that may include subunits or unknown accessory genes. The PAM plasmid, containing the known modification gene(s) as well as the uncharacterized components, is introduced into an E. coli transformant harboring a shuttle vector. Restriction enzyme digestion occurs, but some copies of the plasmid survive in the PAM host. The plasmid is then isolated and introduced into the target bacterium. (Reproduced from ref.4 with permission from Oxford Journals).
and right arm. Clones that showed Spr and Cms phenotype were selected as candidates of gene disruptant.

Table 2. Comparison of Electroporation Efficiency in *Bifidobacteria* using PAM

<table>
<thead>
<tr>
<th>Donor host</th>
<th>Recipient</th>
<th>Efficiency (CFU/µg DNA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOP10</td>
<td>B. adolescentis ATCC15703</td>
<td>$1 - 3 \times 10^4$</td>
</tr>
<tr>
<td>TOP10 /pPAM1233</td>
<td>B. adolescentis ATCC15703</td>
<td>$4 - 6 \times 10^4$</td>
</tr>
<tr>
<td>TOP10 /pPAM1283</td>
<td>B. adolescentis ATCC15703</td>
<td>$1 - 2 \times 10^4$</td>
</tr>
<tr>
<td>TOP10 /pPAM1233-1283</td>
<td>B. adolescentis ATCC15703</td>
<td>$0.9 - 4 \times 10^4$</td>
</tr>
<tr>
<td>B. adolescentis ATCC15703</td>
<td>B. adolescentis ATCC15703</td>
<td>$9 \times 10^4$</td>
</tr>
<tr>
<td>TOP10</td>
<td>B. longum 105-A</td>
<td>$1.5 \times 10^3 - 5 \times 10^3$</td>
</tr>
<tr>
<td>B. longum 105-A</td>
<td>B. adolescentis ATCC15703</td>
<td>$6 \times 10^3 - 8 \times 10^3$</td>
</tr>
</tbody>
</table>

*After electroporation, the cells were diluted $\times 1$ or $\times 100$ with MRS, plated on MRS-AC agar, supplemented with 150 µg/ml spectinomycin, then incubated at 37°C under anaerobic condition.

Next to transformation, the site directed mutagenesis is important to construct site directed mutagenesis (so called ‘Knock Out’ technique. It has been widely applied in the molecular genetics, of Bacteria (*E. coli, Bacillus subtilis*), Plant (*Arabidopsis thaliana* etc.) and animal (mouse). Knocked out organisms gave direct evidences of physiological functions of the deleted genes. In the conventional genetics, firstly obtain some mutants, which showed specific ‘phenotype’ such as nutritional requirement, morphological disorder, conditional lethality or immortality. Then, perform mapping the position on the genome, cloning and sequencing. In the genome-sequenced organism, all sequence data have been already obtained, and the research strategy will completely be changed from the conventional genetics. Pick up candidates genes, which may be responsible to a specific biological phenomenon. Computer based bioinformatics, including homology analyses are used in this step. Then cloning the candidate genes and express in the other host, such as *E. coli* etc. In the case of simple enzyme, such as hydorogenase, it is enough to understand the function of the gene. If the biological event occurred by multi-gene cooperation, the ‘Knock-out’ technique is effective to study the mechanism. Using homologous recombination, it is possible to knock out some genes (Fig. 3).

![Figure 3](image_url)

**Figure 3.** Scheme of homologous recombination with Ts plasmid. Homologous recombination event, screened at 42°C with Spectinomycin (Sp) and Choramphenicol (Cm), occurred by double crossover at left arm and right arm. Clones that showed Sp' and Cm' phenotype were selected as candidates of gene disruptant.
LITERATURE CITED


Animal production in Thailand: Challenges and potentials in global market

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ABSTRACT: This article is an overview of animal production in Thailand based on statistics and reviews. These include agricultural economics, population of domestic animal, production, consumption and export value of important animal such as poultry, swine and cattle. Export to global market and challenges of livestock business has also discussed.

Key words: production, consumption, global market, export value, Thailand

INTRODUCTION

The opportunities of international food trade are attractive and help create international food businesses that operate at various levels along the food chain. Global businesses are active in feed production and animal farming, for example of poultry and pigs. Experience has shown that the practical conduct of multi-country risk assessments is challenging because surveillance data are required along with detailed information on production systems, food handling practices and food consumption data, all of which can vary in availability and quality between countries. In addition to the challenges related to food safety in international markets, new problems keep emerging and new technologies are being developed. Also, the world population keeps growing, and there has been a steep increase in food prices as a result of higher demand for animal protein. At the same time, there is reduced land availability due to climate change and urbanization. Food security has become a focus of interest rather than food safety. However, the two issues are closely linked as food security considers not only the availability an access to affordable but also safe food. Food security also covers the resilience of food systems against disruption, and food safety scares can be a key reason for import bans. Global food systems are a reality and consumers expect the food originating from such systems to be as safe as locally produced food.

Overview of Agricultural Economics

Thailand with total land area of 513,155 km² is situated on the Indo-China Peninsula in the tropical region. The climate is classified into three seasons as followed: 1) hot and dry from February to May with average temperature 34 ºC and 75% humidity, 2) rainy from June to October with average temperature 29 ºC and 87% humidity, and 3) cool from November to January with temperatures range from below 20 ºC to 32 ºC with a drop in humidity. The annual rainfall averages 1,200 mm. With the human population of 63 million, 75% are farmers who live in the rural area where agriculture plays an important role in income and livelihood. Animal production is an integral part of Thai agriculture which main crops are rice, cassava, corn soybean including rubber trees and oil palm.

The OAE (2009) has estimated at agricultural economics contracted by 0.23% in 2009 primarily due to impacts of the global economic recession. As a consequence, demand for agricultural commodities dropped and their exports decline by 24.90%. This situation led to a drop in farm production. Nonetheless, farm prices of main products including rice and oil palm were favorable even though they were lower than those of 2008 which were extraordinary high. Hence, farm price index in 2009 fell by 11.19% and production index declined by 0.33%. However the government has launched several significant programs and measures to stabilize and maintain agricultural product prices. Livestock subsector is predicted to rise by 2.26% as a result of well management in controlling production of broilers, swine and laying hens. Prices of livestock product are satisfied. It is forecasted by OAE (2009) that agricultural economics will likely to show a positive growth rate due to the recovery of the world and Thai economy. Meanwhile the continuation of government’s supporting programs will still be carried on to stimulate farm income. However, there might be some negative factors that can hamper agricultural growth such as oil price fluctuation and baht appreciation.
Therefore, agricultural sector is anticipated to expand in the range of 1.6-2.6% while livestock subsector is predicted to increase within the range of 2.2-2.3%. As the economics recovery and a better price will induce producers to expand their production whereas several government schemes implemented such as extending of export quota to EU and initiating of trace back system are expected to show positive results in 2010.

Population of Domestic Animals in Thailand

Domestic animals which play important role in Thailand are including cattle, buffalo, swine, goat, sheep, duck and chicken. During 1999-2009, animal populations had increased excluding buffalo population which had decreased by 22.8% as shown in Table 1. The highest increase in goat population is possibly that the policy of Thai government aims to promote goat production in the southern region especially 3 provinces closed to the Malaysian border. Swine population increased by 15.0% from 7.4 million in 1999 to 8.5 million in 2009.

According to the official statistics, beef cattle population in Thailand had an estimated 8.6 million heads in 2009 which had been reported that native cattle was the major breed of beef cattle which comprised 5.4 million heads or approximately 63% of the total population that were raised extensively by 1 million farmers (DLD, 2010). Buffalo population had declined due to high slaughter rates, scarcity of farm labour and grazing area, the increasing use of small tractors and low market prices (Na-Chiangmai, 2002).

Table 1 Livestock populations in Thailand during 1999-2009 (reported on 1st January each year) unit: head

<table>
<thead>
<tr>
<th>Year</th>
<th>Cattle</th>
<th>Buffalo</th>
<th>Swine</th>
<th>Goat</th>
<th>Sheep</th>
<th>Duck</th>
<th>Chicken</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>5,208,541</td>
<td>1,702,223</td>
<td>7,761,056</td>
<td>144,227</td>
<td>37,312</td>
<td>27,884,041</td>
<td>189,341,110</td>
</tr>
<tr>
<td>2001</td>
<td>5,571,283</td>
<td>1,710,095</td>
<td>8,203,270</td>
<td>188,497</td>
<td>42,720</td>
<td>28,448,399</td>
<td>214,979,081</td>
</tr>
<tr>
<td>2002</td>
<td>5,908,625</td>
<td>1,617,358</td>
<td>6,989,152</td>
<td>177,944</td>
<td>39,326</td>
<td>25,034,011</td>
<td>228,760,326</td>
</tr>
<tr>
<td>2003</td>
<td>5,916,323</td>
<td>1,632,706</td>
<td>7,815,534</td>
<td>213,917</td>
<td>42,883</td>
<td>23,800,092</td>
<td>252,718,883</td>
</tr>
<tr>
<td>2004</td>
<td>6,668,332</td>
<td>1,494,238</td>
<td>6,285,603</td>
<td>250,076</td>
<td>47,811</td>
<td>15,648,538</td>
<td>179,738,810</td>
</tr>
<tr>
<td>2005</td>
<td>8,275,108</td>
<td>1,624,919</td>
<td>8,174,526</td>
<td>338,355</td>
<td>50,779</td>
<td>21,540,345</td>
<td>254,204,068</td>
</tr>
<tr>
<td>2006</td>
<td>8,036,057</td>
<td>1,351,851</td>
<td>7,153,784</td>
<td>324,150</td>
<td>51,151</td>
<td>20,843,553</td>
<td>184,326,752</td>
</tr>
<tr>
<td>2007</td>
<td>9,337,985</td>
<td>1,577,798</td>
<td>9,300,073</td>
<td>444,774</td>
<td>50,963</td>
<td>24,952,809</td>
<td>283,126,151</td>
</tr>
<tr>
<td>2008</td>
<td>9,582,030</td>
<td>1,359,807</td>
<td>7,740,575</td>
<td>374,029</td>
<td>43,738</td>
<td>22,722,647</td>
<td>235,599,566</td>
</tr>
<tr>
<td>2009</td>
<td>9,079,327</td>
<td>1,388,685</td>
<td>8,537,703</td>
<td>383,796</td>
<td>40,269</td>
<td>27,565,231</td>
<td>281,672,304</td>
</tr>
<tr>
<td>% change</td>
<td>84.60</td>
<td>-22.83</td>
<td>15.02</td>
<td>188.91</td>
<td>1.99</td>
<td>23.44</td>
<td>66.05</td>
</tr>
</tbody>
</table>

Source: DLD (2010)
Production and Consumption in Thailand

In this article, it will be emphasis on main important animal production in Thailand which are poultry, swine and cattle.

Poultry

The industries’ big step forward was taken in 1973 when the Charoen Pokphand Company (CP) exported the first lot of chickens to Japan. High chicken price was perhaps the strongest incentive for private firms to invest in this new and promising agro-based industry. The CP was the first to correctly foresee high profits and to establish the first modern chicken slaughterhouse in order to process frozen chicken for export market. Then in 1977, the Bangkok Livestock Trading Company, which is as a subsidiary firm of CP, initiated a contract farming system in Sri Racha. Since then, slaughterhouses were established by other five firms and contract farming has become very popular. Since 1973, the broiler farm size has been expanding rapidly, particularly in the major chicken-raising provinces of Nakhon Pathom, Chachoengsao, Chon Buri, and Thonburi. The role of the small middleman in marketing, hence, has been continuously declining. Finally, since the late 1970s’ all major feed mill companies, which also operate under a complete vertical integration system, have established their own slaughterhouses. The structure of the industry, therefore, has now become highly concentrated in the hands of a few leading integrated firms. Thai broiler industry’s farm facilities, breeding farms and broiler farms in particular, expanded substantially in early 2002-2003, shortly before Thailand was hit by High Pathogenic Avian Influenza (HPAI), H5N1 type, in January 2004. The disease incidence caused both export demand and domestic consumption to plunge in 2004. After demand recovered in 2005, independent chick producers and broiler integrators have monitored the market closely and cautiously adjusted their production to reflect the actual demand. As a result, broiler production has fluctuated in a lesser degree in recent years than in the past.

In addition to supply management, the Thai broiler industry has successfully improved farming systems to encounter animal health and food safety challenges. All integrated producers are currently strictly implementing biosecurity measures across the board, from the farm level to the processing level. Nearly all broiler houses of integrated producers are laid out in an evaporative cooling system which lead to higher productivity and reduced disease exposure and mortality rates. In addition, Thai chick producers have continued to improve genetics in broiler breeding stocks so that average meat yields per bird have increased in recent years. Technological advances and strong demand have driven the growth of production and export. Integrated producers have also invested money to introduce or improve their broiler meat processing facilities from slaughtering to cooking processes. Accordingly, Thailand is currently considered one of the premium suppliers for cooked chicken meat products to Japanese and EU customers. Chicken meat is by far the most popular meat product among consumers because it is cheaper than other meats and easy to prepare. Problems of BSE and FMD within other meats have also made poultry a more attractive alternative.

Table 2. Production, consumption and export of chicken meat during 2005-2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
<th>Consumption</th>
<th>Export (*1,000 tons)</th>
<th>Value for export, Million USD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mill. heads</td>
<td>*1,000 tons</td>
<td>Kg/h/y</td>
<td>Frozen meat</td>
</tr>
<tr>
<td>2005</td>
<td>787</td>
<td>1,117</td>
<td>872</td>
<td>13.97</td>
</tr>
<tr>
<td>2006</td>
<td>874</td>
<td>1,269</td>
<td>982</td>
<td>14.84</td>
</tr>
<tr>
<td>2007</td>
<td>840</td>
<td>1,183</td>
<td>883</td>
<td>14.76</td>
</tr>
<tr>
<td>2008</td>
<td>920</td>
<td>1,360</td>
<td>959</td>
<td>14.76</td>
</tr>
<tr>
<td>2009</td>
<td>937</td>
<td>1,384</td>
<td>990</td>
<td>15.18</td>
</tr>
<tr>
<td>% change</td>
<td>19.06</td>
<td>23.90</td>
<td>13.53</td>
<td>8.66</td>
</tr>
<tr>
<td>2010 (f)</td>
<td>960</td>
<td>1,419</td>
<td>1,019</td>
<td>15.49</td>
</tr>
</tbody>
</table>

(f) forecast
Source: Thai Broiler Processing Exporters Association (2010)
During 2005-2009, broiler production has increased by 19.06% which produced 1.38 million tons in 2009. As broiler industry has the highest value in Thailand, the market share are consisting of Charoen Pokkapan (CP) 29%, Sunvalley Ltd. 22%, Betagro 14%, Saha Farm 14% and others. Domestic consumption of chicken meat is 0.99 million tons or 71.5% of total production which is estimated around 15.18 kilograms per annum as shown in Table 2.

Egg production has expanded by 26.75% during 2005-2009, which production yield about 9,902 million eggs in 2009. High increasing rate has been occured after avian influenza outbreak in 2004 because government under operations of DLD had restricted control for poultry production included applying evaporative cooling system. Domestic consumption of chicken meat is 9,499 million eggs or 96% of total production which is estimated around 142 eggs per annum as shown in Table 3. Rate of consumption is relatively small compared to other Asian countries such as China, Japan and Taiwan because cholesterol content in egg yolk concerns consumers. Therefore, government has promoted to increase consumption rate by educating on nutritive value of egg and setting up “School egg project” for each pupil to consume 3 eggs per week. These will be leading to enhancement of egg consumption to be 200 eggs per annum in 2012.

### Table 3. Production, consumption and export of hen egg during 2005-2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Production, Million eggs</th>
<th>Consumption, Million eggs</th>
<th>Eggs/h/y</th>
<th>Export, Million eggs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>7,812</td>
<td>7,645</td>
<td>118</td>
<td>167</td>
</tr>
<tr>
<td>2006</td>
<td>8,555</td>
<td>8,296</td>
<td>127</td>
<td>259</td>
</tr>
<tr>
<td>2007</td>
<td>8,990</td>
<td>8,682</td>
<td>132</td>
<td>308</td>
</tr>
<tr>
<td>2008</td>
<td>9,424</td>
<td>8,949</td>
<td>135</td>
<td>475</td>
</tr>
<tr>
<td>2009</td>
<td>9,902</td>
<td>9,499</td>
<td>142</td>
<td>403</td>
</tr>
<tr>
<td>% change</td>
<td>26.75</td>
<td>24.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: OAE (2010)

### Swine

Production has moved from a system dominated by small growers to larger-scale commercial operations. Around 80% of total production takes place on large farms and feed mill companies. More than half the production is on farms with over 100 pigs. The collapse in production in 1998 had a significant impact on small farms. Low prices and high cost of production forced many small farms out of business. Commercial pig raising farms have gradually been developed in provinces around Bangkok mainly due to a rapid increase in urban demand for pork. These commercial farms use intensive fattening operations with high quality swine catering to more discerning markets in the cities. The important commercial-pig-raising areas are Nakhon Pathom, Chachoengsao, Chon Buri, Ratchaburi and Suphan Buri. This development has been made possible by a few feed mill companies which are responsible for providing piglets, animal feeds, drugs as well as veterinarian services and farm management know-how.

### Table 4. Swine production, consumption and export of pork during 2005-2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Production, Million heads</th>
<th>Consumption, (*1,000 tons)</th>
<th>Export, Value for export (Million USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9.83</td>
<td>744.13</td>
<td>12.17 57.42</td>
</tr>
<tr>
<td>2006</td>
<td>10.40</td>
<td>787.28</td>
<td>11.01 46.64</td>
</tr>
<tr>
<td>2007</td>
<td>11.62</td>
<td>879.63</td>
<td>10.19 43.48</td>
</tr>
<tr>
<td>2008</td>
<td>10.50</td>
<td>794.85</td>
<td>12.28 52.70</td>
</tr>
<tr>
<td>2009</td>
<td>10.20</td>
<td>772.14</td>
<td>11.00 61.06</td>
</tr>
<tr>
<td>% change</td>
<td>3.76</td>
<td>3.76</td>
<td>2.13 6.33</td>
</tr>
<tr>
<td>2010 (f)</td>
<td>11.20</td>
<td>847.84</td>
<td>13.00 72.30</td>
</tr>
</tbody>
</table>

(f) forecast

Source: Swine Producers and Processors for Exporting Association (2010)
In 2009, swine production was 10.20 million heads which was decreased by 2.8% compared to the previous year due to high price of feedstuffs, leading to high cost of production started from the end of 2007 until the first half of 2008. These results had a significant impact on small and medium scale farms which were lost their business. Total pork supply in 2009 reached 772 million tons, of which 98.6% were produced for local consumption and the remaining 1.4% was exported. Pork consumption was declined in 2009 due to economic recession associated with high price of pork. Consumption per capita was approximated 12.0 kilograms per annum in 2009 which had increased by 2.13% compared to year 2005. However, pork is still a traditional and popular Thai food which demand has been mostly for domestic consumption.

### Cattle

There are several beef production systems in Thailand depending on investment and potential of producers. However, beef market plays important role in types of production system which can be classified into 3 systems as following 1) to produce for high quality markets which market share is only 1%. European crossbred steers are fattened for 10 to 14 mo and reached BW between 550 and 600 kg. Beef is tender due to high marbling which has high quality as imported meat; 2) to produce for medium quality markets is that high Brahman crossbred bulls were fattened for 3 to 4 mo in order to increase body muscle and fat; and 3) to produce for opened markets which meat is from native cattle, low Brahman crossbred bulls, culled and old cattle that are grazed in communal land without supplementation. Thai native cattle had been classified as *Bos indicus* and used as draught animal in the past.

In 2009, beef production was 1.17 million heads which was calculated as 168,050 tons of carcass weight and has been increased by around 6% compared to year 2005 (Table 5). There has been a modest growth in beef production due to not due to lower price of live beef cattle, leading to giving up their business by smallholders. There has been no growth in beef consumption due to economic recession associated with high price of beef. Consumption per capita was approximated 2.86 kilograms per annum in 2009.

### Milk Production

Milk production is dominated by small dairy farms which typically have 5-10 milking cows and around 28% of farmers have more than 20 heads of dairy cattle. Therefore, smallholders account for most of milk production in Thailand. There are often problems such as low productivity, infertility and mastitis in dairy cows. Poor quality feed is a major problem, leading to poor quality in raw milk production. The government has heavily promoted dairy production to improve income distribution. This has encouraged a switch from rice production to dairy production. Promotion of milk production occurs through price guarantees for raw milk.

In 2009, milk production was 840,000 tons from 293,000 lactating cows (Table 6) and milk consumption per capita was approximated 14 litres per annum. School milk project subsidies account for 50% of milk consumption. A local content requirement policy requires firms which import skim powdered milk to buy local raw milk from farmers via dairy cooperatives.

### Table 5. Production, consumption and export of beef during 2005-2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
<th>Consumption</th>
<th>Export</th>
<th>Import</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Million heads</td>
<td>*1,000 tons of carcass</td>
<td>Million heads</td>
<td>(*1,000 tons)</td>
</tr>
<tr>
<td>2005</td>
<td>1.10</td>
<td>158.80</td>
<td>1.24</td>
<td>178.85</td>
</tr>
<tr>
<td>2006</td>
<td>1.17</td>
<td>162.92</td>
<td>1.24</td>
<td>179.28</td>
</tr>
<tr>
<td>2007</td>
<td>1.20</td>
<td>172.41</td>
<td>1.25</td>
<td>179.57</td>
</tr>
<tr>
<td>2008</td>
<td>1.19</td>
<td>170.93</td>
<td>1.25</td>
<td>180.00</td>
</tr>
<tr>
<td>2009</td>
<td>1.17</td>
<td>168.05</td>
<td>1.25</td>
<td>180.29</td>
</tr>
<tr>
<td>% change</td>
<td>6.36</td>
<td>5.82</td>
<td>0.81</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Source: OAE (2010)
Table 6. Dairy production, consumption and export of milk and milk products during 2005-2009
Source: OAE (2010)

<table>
<thead>
<tr>
<th>Year</th>
<th>Dairy cattle (*1,000 heads)</th>
<th>Dairy lactating cows (*1,000 heads)</th>
<th>Production (*1,000 tons)</th>
<th>Consumption (*1,000 tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>493</td>
<td>296</td>
<td>843</td>
<td>799</td>
</tr>
<tr>
<td>2006</td>
<td>518</td>
<td>310</td>
<td>888</td>
<td>856</td>
</tr>
<tr>
<td>2007</td>
<td>495</td>
<td>292</td>
<td>822</td>
<td>917</td>
</tr>
<tr>
<td>2008</td>
<td>491</td>
<td>291</td>
<td>786</td>
<td>825</td>
</tr>
<tr>
<td>2009</td>
<td>498</td>
<td>293</td>
<td>840</td>
<td>908</td>
</tr>
<tr>
<td>% change</td>
<td>1.01</td>
<td>-1.01</td>
<td>-0.36</td>
<td>13.64</td>
</tr>
</tbody>
</table>

Export to Global Market

In 2008, Thailand exported in the rank 13th in the world, valued 23,864 million US dollars (approximately, 800,000 million Baht which is accounted of 2.4% of the total world food export). Meat export from Thailand has been in the rank 18th of the world, valued 1,855 million USD or 2% world market share which the composition of market consists of chicken (90.6%), duck (5.0%), pork (3.1%) and beef (1.3%).

During 2005-2009, exports of chicken meat and product had a trend to increase average 14.46% per annum. Due to avian influenza outbreak in 2004, there has been changed in pattern of export from fresh meat to processed meat. Export of chicken meat has been reported around 397,000 tons with export value of 1,600 million USD in 2009 which is in the world rank 4th with 5% market share (Laurujisawat, 2010). The main importers for Thai chicken meat are Japan (43.70%), EU (46.35%) including England, Netherlands, Germany and Ireland and others (9.95%) including Vietnam, Singapore, South Korea and Hong Kong in 2009. Chicken meat exports (both cooked and uncooked) in 2009 reportedly dropped by 1% from 397,000 tons to 401,000 tons in 2008. Thailand’s exports of cooked chicken meat are forecast to grow by 7-8 percent in 2010 due to an anticipated recovery in the economy of importing countries, especially EU and Japan. In addition, China, a major competitor in Japanese market, is likely to lose its competitiveness with Thailand due to growing domestic consumption and increased concerns from trading partners about the safety of Chinese food products associated with result from reduction of import tariff according to Japan Thailand Economic Partnership Agreement (JTEPA). However, it has been believed that the prospect of Thai exports would be brighter if EU increases its import quota of cooked meat and if both EU and Japan agreed to accept uncooked product under Thailand's proposed compartmentalization scheme.

Regarding the total export market, duck has been the second with estimated market value of 84 million USD. For the export of duck meat to global market, the major importers for cooked product, about 8,984 tons with value of 71 million USD, are European countries such as England 45.9%, Germany 35.1%, Netherlands 11.2%, Ireland 2.3%, and others 6.2% while Vietnam is the only main market for frozen duck meat with 3,068 tons and a value of 13 million USD. For duck meat export, Thailand is in the world rank 4th with 8% market share.

Thirdly, the exports of pork to global market, the major importers were mainly in Asia which total market value was 61 million USD in 2009. There are 2 types of export products as frozen or chilled pork and cooked pork. In 2009, the export for raw pork approximated 784 tons with a value of 2 million USD which the main markets were Hong Kong (94.7%), Cambodia (4.2%) and Vietnam (1.1%). For cooked pork, the export value was 59 million USD with around 10,000 tons which the major markets are for instance Japan 97.0%, Hong Kong 1.5% and Singapore 1.2%. For market of frozen pork in Hong Kong, China is the significant competitor due to lower cost of production and transportation associated with new regulation in allowance of fresh pork display for sale which had directly benefit to China who export fresh pork compared to Thai frozen pork, leading to decrease Thai export of frozen pork.

Lastly, the export of beef to global market was estimated about 242,450 USD in 2008. The major importers were Japan 98.4% and USA 1.6%.

Apart from meat export, several animal and animal products have been exported such as hen egg, live animals, hides, and others. The export value of hen egg estimated about 28 million USD with
403 million eggs which the main markets were Hong Kong (79.2%), China (15.4%), Jordan (3.2%) and others (2.3%) in 2008. For live animals including chicken, cattle and pig, they were exported to neighboring countries such as Malaysia, Laos, Cambodia and Myanmar with the export value of 48.2 million USD in 2008. Cattle were mainly exported to Malaysia (19.8 million USD) and others (2.4 million USD) including Laos, Cambodia and Myanmar. Cambodia and Laos were the major importers of pig with the export values of 17.7 and 3.2 million USD, respectively. For buffalo export, the main importers were Myanmar and Laos with the values of 2.6 and 1.2 million USD, respectively. The main markets for export of native chicken, broiler and laying hen were Laos (147 thousand USD), Cambodia (117 thousand USD) and Myanmar (38 thousand USD).

Challenges of Livestock Business

In the future, livestock business, especially commercial production for export, has focused on not only high productive efficiency but also consideration of main factors affecting livestock business. Important factors which had impacted on global market of animal and their products are new laws or regulations for import and export, epidemic spread of disease, baht appreciation and global economic crisis which will be described as following:

1. Trade Laws and Regulations

   Laws or Regulations Concerning Food Safety. Food safety has been mentioned broadly especially in developed countries and utilized for trade negotiation such as product quality with no chemical residue, production process which had environmental friendly, hygienic raising, post-harvest process. There will be more competitiveness when free trade agreement has been negotiated. For example, Japanese government pay attention to consumers concerned their health by the basic law on food, agriculture and rural areas. This law aimed to set up security and stability of food supply, multifunctional agriculture including rural sustainability, environment, food security, geographic importance, food quality and safety, and animal welfare. Thai export company has to monitor and adapt to problem of residue in animal goods according to specifications and standards for foods, food additives, etc. under the Food Sanitation Act 2008 by Japan External Trade Organization issued on January 2009. In addition, the European Commission has been responsible for food safety by using Rapid Alert System for Food Products which has been reported about risk or hazard of goods by EU members as well as by consumers directly. Goods have been guaranteed by producers and entrepreneurs to ensure that it is no health hazard for consumers or be reported immediately if hazard is detected. Moreover, EU has a system for management of food safety to take care of safety through the supply chain of food as well as to be traced back.

   Thailand has also focused on food safety and established government’s organization, named “Thai Agricultural Commodity and Food Standard” which had responsibility for food standard, laws and regulations concerning food safety, and coordination with foreign countries in order to build up agreement, measures of standards and food safety, and controls of import-export of food and agriculture. Since 1994, Thailand has became one of the 80 members of World Trade Organization (WTO), there are several agreements which country members have to proceed according to WTO especially Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) and Agreement on Technical Barrier to Trade (TBT).

   Import Quota Administration. Administration of import quota is aimed to control for import and limit quantity of imported goods for example EU import quota for chicken meat. Import of chicken meat to EU has been classified as frozen fresh meat, salted meat and cooked meat with tariff rates of 53, 15.4 and 10.9%, respectively. The EU control amount of salted meat and cooked meat imports by limiting import quantity. Under the agreement, Thailand received 92,610 tons, out of a total quota of 264,245 tons, for salted chicken meat but could not export due to avian influenza outbreak. Quota for cooked chicken meat for Thailand was 160,033 tons, out of a total quota of 50,953 tons. The EU recently notified WTO of its plan to raise import tariff on 8 items of poultry meat products. These include uncooked chicken meat products containing more than 57% chicken meat, cooked chicken meat products containing 25-57% chicken meat, and containing less than 25% chicken meat which these products are currently not under the EU tariff-rate-quota. Additionally, Thai exporters have
requested the Department of Trade Negotiations (DTN) of the Thai government to discuss with the EU a possible increase in current quota ceiling and import tariffs in 2009 (Preechajarn, 2009).

**Laws or Regulations Concerning Environment.** Pollution from animal production has partly caused environmental impact which is increasingly important issue for international trade negotiations. It is stated that animal production or animal goods should not generate environmental pollution. The major environmental threats of intensive livestock production are deteriorating water quality, spreading of disease and pathogens, accumulation of nutrients and heavy metal, odour, volatilisation of ammonia, emissions of methane and nitrous oxide, etc. Moreover, animal industry involves upstream, midstream and downstream industries which have participatory prevent and solve the environmental problems. More effective technologies are needed to meet new regulations and compliance measures for pollution control which would cause an increase in cost of animal production.

2. **Disease Problem**

Problems of diseases and pathogens has been seriously affected on both domestic and international markets of animals and their products, leading to consequent impact on animal production. For new disease information, there is an international organization named “World Organisation for Animal Health (OIE)” who currently monitor and inform movement of animal disease. In recent, the major disease that clearly affected on animal industry is avian influenza because its impact on human health and death as well as on economic aspect by causing farmers out of business and exporters stop export of fresh chicken meat. Because of avian influenza outbreak, the Royal Thai Government (RTG) launched several measures to support the poultry industry, from small-scale farmers to integrated poultry processors. These measures include the avian influenza Stamping-Out Campaign on poultry farms/areas, a compensation scheme for disease-affected farmers, fee exemptions for chicken slaughterhouses, and outreach to help unemployed workers/operators. In addition, foot and mouth disease has also impacted on exports of fresh pork and beef to international market.

3. **Economic Crisis**

Problems about Thai currency crisis and global economic recession significantly affect on a decrease in consumers’ power of payment. The global financial crisis of 2008-09 severely impacted on Thailand's exports, however, with most sectors experiencing double-digit drops. In 2009, the economy contracted about 3.5%, mainly due to lower exports as a result of the global economic crisis. The Thai government is focusing on financing domestic infrastructure projects and stimulus programs to revive the economy, as external trade remains weak and the persistent internal political crisis dampens foreign direct investment prospects.

**CONCLUSIONS**

For developing countries including Thailand to become significant exporters of livestock products, they would need to achieve productivity gains in livestock production. This might be enough to generate exports to other developing countries, but also to develop markets in other industrial countries, it would be needed to put in place much higher food safety and quality standards, together with trace-back facilities and information systems about livestock diseases and control mechanisms, to satisfy the very high consumer standards in industrial country markets. Thai major food exporters have expanded their production capacity through new machinery purchases or upgrades to meet demand for a variety of products in the major markets and to satisfy international quality standards including HACCP and ISO. Therefore, Thai food strategy towards safety and quality foods increase export value of products and also strengthen good image of Thai foods which altogether lead to total better country’s economy.
LITERATURE CITED

Improvement of forage quality by means of molecular breeding in tropical grasses

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SUMMARY

Many important warm-season perennial grasses multiply either by vegetative propagation, or form their seeds by an asexual mode of reproduction called apomixes. Possibility of improving of these plants by conventional breeding method depends on availability of natural genetic variation and its manipulation through breeding and selection. However, there are naturally not many genetic variations in apomictic grasses to generate new genetic variation. Plant tissue culture techniques have complemented conventional plant breeding programs. The author established a system for plant regeneration from in vitro-cultured calluses, suspension cells and protoplasts in some tropical grass species including apomictic species. In addition, we focus on describing current and future applications and impact of genetic transformation in tropical grasses.

INTRODUCTION

Forage grasses can be grouped into two large categories; warm- and cool-season grasses. Warm-season grasses produce most of their growth during the warmer periods of the growing season, while the opposite is true for cool-season species. These grasses are utilized in many different agricultural production systems with greatest value as feeds for livestock. They are also useful for preventing soil erosion and maintaining soil fertility. A species may be grown alone, or in mixtures with other grasses or legumes at high or low levels of soil fertility. They may be grazed, or made into hay or silage for conservation.

Many important warm-season perennial grasses multiply either by vegetative propagation, or form their seeds by an asexual mode of reproduction called apomixes. Possibility of improving of these plants by conventional breeding method depends on availability of natural genetic variation and its manipulation through breeding and selection. However, there are naturally not many genetic variations in apomictic grasses to generate new genetic variation.

Recently, plant tissue culture techniques have complemented conventional plant breeding programs (Akashi 1991, Akashi and Adachi 1994, Akashi et al. 1994, Akashi and Kawamura 1998, Akashi et al. 2002). Major categories of these methods can be summarized as induction and screening of desirable mutants at cellular and tissue level, somatic hybridization between remotely related species, induction of haploid plants as breeding materials, and direct transformation in protoplasts, as well as micropropagation of unique genotypes.

Tissue culture methods ordinarily consist of two phases; firstly, initiation of callus and secondly, regeneration of plants from the callus. Many plant cells have been proved as totipotent, that is, for example, a non-embryogenic cell has the potential to differentiate into an embryogenic cell and then to develop into an entirely new plant. However, the requirements of each species for growth and regeneration are still unclear. Therefore, to make practical use of tissue culture, the ability to regenerate plants from callus and protoplast should be demonstrated in each appropriate species. The author established a system for plant regeneration from in vitro-cultured calluses, suspension cells and protoplasts in some tropical grass species including apomictic species. In addition, we focus on describing current and future applications and impact of genetic transformation in tropical grasses.

Plant Regeneration System from Embryogenic Callus and Cell Suspension in Some Tropical Grasses

Embryogenic callus was initiated from immature embryos on Murashige and Skoog (MS) medium (Murashige and Skoog 1962) supplemented with 10 mg/L 2,4-D, 10% coconut water and Solidified
with 0.8% agar in guineagrass (*Panicum maximum* Jacq). Initially various types of callus were obtained and embryogenic responses were found to be correlated with the genotypes investigated (Fig.1a-1-a-5). For somatic embryos germination and plant formation MS medium supplemented with 1.0 mg/L GA3 and 1.0 mg/L kinetin was used. The twelve genotypes analyzed can be classified into three groups by the frequency of somatic embryo formation and degree of apomixes. One of group consists of highly apomictic genotypes with a high embryogenic capacity (Akashi and Adachi 1991).

Plant regeneration from cultured immature inflorescences of dallisgrass (*Paspalum dilatatum* Poir.) was obtained by somatic embryogenesis. Embryogenic callus was initiated from immature inflorescences on MS medium supplemented with 10 mg/L 2,4-D and solidified with 0.2% Gellan Gum (Fig.1b-1). Somatic embryos developed and germinated precociously when embryogenic calli were transferred to a medium contained 1.0 mg/L each of kinetin and GA3 (Fig.1b-2). All regenerants were successfully grown to maturity (Akashi and Adachi 1992a). The respective suspension cultures were initiated from immature inflorescence-derived embryogenic callus (Fig.1f-1). The suspension cells could be classified into small, starch-containing embryogenic cells with dense cytoplasm and large, vacuolated, non-embryogenic cells. Plant regenerated from cell suspensions were produced after 5 months of culture when 2-3 mL of pellets of centrifuged suspension cells were cultured on solid MS medium with 1.0 mg/L NAA and 0.2 mg/L BAP (Akashi and Adachi 1992b).

We have established a high-frequency plant regeneration system via somatic embryogenesis from seed-derived callus and cell suspension cultures in six genotypes of bahiagrass (*Paspalum notatum*). Embryogenic callus was initiated from mature seeds on MS medium supplemented with 2.0 mg/L 2,4-D, 3.0% sucrose and 0.3% Gellan Gum in the dark. Culture response was found to be correlated with genotype. “Pensacola” had the best response in embryogenic callus formation (Fig.1c-1-c-4), and 74% of the calli regenerated plants (Fig.1c-5, c-6). The suspension was composed of compact cell clustered. When smaller clusters were transferred to solid MS medium without hormones, plant regeneration was initiated at high frequency (28.6%). Morphological evidence is provided that regeneration of suspension cells occurred via embryogenesis (Akashi et al. 1993).

**Protoplast Cultures in Some Tropical Grasses**

Protoplasts were isolated from embryogenic suspension cells of apomictic dallisgrass. The respective suspension cultures were initiated from immature inflorescence-derived embryogenic callus (Akashi and Adachi 1992). Previous to protoplast isolation, suspension cells were treated with MS liquid medium without sucrose and hormones. Due to this pretreatment protoplast yield and viability were dramatically increased. A maximum protoplast yield of 5 x 10⁷/g fresh weight was obtained (Fig.1f-2). Cell division and colony formation from pretreated protoplasts were found to be best in an agarose solidified KM8p medium (Kao 1975). The plating efficiency, based on colony formation after 2 weeks of culture, was 0.5-0.8% (Fig.1f-3-f-6). Protoplast-derived colonies were transferred to a solidified MS medium containing 1.0 mg/L 2,4-D for callus proliferation. The calli formed embryonic structures which gave rise to green plants in 0.2% (w/v) Gellan Gum solidified MS medium with 1.0 mg/L NAA and 0.2 mg/L BAP (Fig.1f-7). The regenerated plants were transferred to 1/2 MS hormone-free medium for further growth and root formation. Rooted plants could be transferred to soil (Akashi and Adachi 1992a).

In apomictic guineagrass the suspension culture used as donor material was originally initiated from immature embryo-derived embryogenic callus. Prior to protoplast isolation, suspension cells were conditioned with MS liquid medium without sucrose and growth regulators. This pretreatment lead to a dramatic increase in protoplast yield and colony formation. Cell division and colony formation from such pretreated protoplasts were found to be best in agarose-solidified modified KM8p medium. Protoplast derived colonies developed into callus on solidified MS medium supplemented with 1.0 mg/l 2,4-D. After 2 months in culture, calli formed compact somatic embryos. Although some of the somatic embryos developed small leafy structures, whole plants could not be regenerated (Akashi et al. 1995).
Genetic Transformation in Tropical Grasses

A simple and inexpensive, self-built particle acceleration apparatus is described, and the special features of the device are emphasized (Fig.1g-1). We have employed this easy-to-use gene gun for efficient direct delivery of DNA to cultured cells of an important monocotyledonous forage crop, dallisgrass. High levels of transient expression of the β-glucuronidase gene were obtained following bombardment of suspension cells. Furthermore, stable transformed cells of this grass have been obtained after intrusion of the bar (bialaphos resistance) gene at optimized delivery conditions. Tentative transgenic calli were selected on solidified medium, and one of these calli, after transfer to liquid selection medium, gave a stable suspension culture tolerant at 1.0 mg/L bialaphos. Integration of the transgene in suspended cells was confirmed by PCR amplification analysis (Akashi et al. 2002).

We have established a reproducible particle bombardment transformation protocol for bahiagrass. The improved culture system, embryogenic callus formed frequently and produced highly regenerative tissues (Fig.1d-1-d-6). These tissues were formed from embryogenic callus on MS medium containing 2.0mg/L 2,4-D, 0.1mg/L BAP and 50 mM copper sulfate at 31±1°C under dim light conditions and used as transformation targets. This modified culture minimized the problems with loss of regenerability and increases in albinism that frequently occur for requiring transformed plants (Fig.1e-1-e-6). Many of green transformants were obtained under 3.0 mg/L bialaphos selection pressure, and this frequency was 2.2% (8 transgenic lines/320 pieces of target tissue) (Fig.1g-2-g-7). Integrated transgenes (GUS and bar gene) were confirmed by PCR amplification analysis. Transgenes were stable transmitted to T1 progenies (Fig.1g-8), and localized expression of GUS gene was analyzed by histochemical assay (Gondo et al. 2003).

On the other hand, luminescent proteins, such as the green fluorescent protein (GFP) from the jellyfish (*Aequorea victoria*), have proven to be powerful tools in plant genetic transformation and gene expression studies due to their excellent sensitivity and rapid response. GFP has also the significant advantage that it does not require a substrate, and its expression can be detected in real time in living cells by light excitation. Therefore, GFP has been used as a reliable reporter for plant transformation. In this study, the plasmid modified pBI221 (pBI0809) containing the gfp reporter gene under control of the cauliflower mosaic virus (CaMV) 35S promoter was introduced into mature seed-derived embryogenic calli by particle bombardment. Sectors containing embryogenic calli with strong GFP fluorescence were identified using a fluorescence viewing system. Cell- and tissue-specific expressions of the gfp gene were also investigated in transgenic plants, and stable GFP expression was observed in transgenic calli (Fig. 2a-d). As a result of GFP selection, the total time required to produce transgenic calli was reduced by approximately 14 days compared to the time needed when selective agents such as the bar gene are used (50–60 days). Three months after bombardment, regenerated transformants were potted in soil, acclimatized and transferred to the greenhouse (Fig. 2o). A 480-bp fragment was amplified and identified as the gfp gene by polymerase chain reaction (Fig. 2m). The presence of the gfp gene in genomic DNA of three out of nine transgenic bahiagrass lines was confirmed by DNA gel blot hybridization analysis (Fig. 2n). Transformants showed hybridization patterns suggesting that the gfp gene was present in three copies per regenerant. The GFP expression could be visually detected in all tissues such as leaves, leaf sheaths, anthers and pollen (Fig. 2e-l). Overall, the gfp gene can be utilized not only as a reporter gene, but also as a visual selectable marker for bahiagrass transformation.

Prospect

*Brachiaria* is tropical forage grasses, which has been cultivated in tropical and subtropical region as pasture mainly. At present, *B. brizantha* (A. Rich.) Stapf, *B. decumbens* Stapf and *B. ruziziensis* Germain & Evrard have been important commercially because these species have many positive attributes, e.g., tolerance to acid soil, high productivity and high quality forage. Thus, these cultivars are also important as breeding material for development of *Brachiaria* breeding. In *Brachiaria* breeding, besides productivity and digestibility, persistence, adaptation to infertile acid soil and antibiotic resistance to spittlebugs are also important breeding objectives. However, it is very difficult to develop a *Brachiaria* breeding program through a traditional hybridization approach because
Figure 1. Tissue culture and genetic transformation in some warm season grasses. a) Embryogenic callus formation from immature embryos in guineagrass. 1) Immature embryo. 2) Embryogenic callus. 3-5) SEM of somatic embryos at different stages of development. b) Embryogenic callus formation from immature inflorescences and plant regeneration in dallisgrass. 1) Embryogenic callus. 2) Plant regeneration from somatic embryos. c) Embryogenic callus formation from mature seeds and plant regeneration in bahiagrass. 1) Primary callus after 14 days of culture. 2, 3) Embryogenic callus after 28 days of culture. 4) A subcultured micro-callus after 60 days culture. 5, 6) Plant regeneration from micro-callus. d) Developmental stages of seed-derived embryogenic callus and plant regeneration. 1-3) Embryogenic callus formation after 7 (1), 14 (2) and 21 (3) days of culture. 4) Somatic embryos formation. 5) Maturation of somatic embryos. 6) Germination of somatic embryos and plant regeneration. e) Developmental stages of highly regenerative embryogenic callus cultured on CuSO₄ additional medium and plant regeneration. 1-3) Embryogenic callus cultured after 0 (1), 3 (2) and 14 (3) days on CuSO₄ additional medium. 4, 5) Shoot germination with scutellum formation. 6) Elongation of germinated shoot. f) Cell colony formation and plant regeneration from suspension protoplasts of dallisgrass. 1) Typical suspension cells. 2) Isolated protoplasts from suspension cells. 3-5) Cell division and cell colony formation from protoplasts after 5 (3), 7 (4) and 10 (5) days of culture. 6) Colonies formed from protoplasts after 20 days of culture. 7) Shoot formation from protoplast-derived callus. g) Stable transformation of bahiagrass mediated by particle inflow gun. 1) A simple self-built particle inflow gun. 2) Selection culture of bialaphos resistant callus. 3) Transient GUS expression 16 hours after bombardment. 4) Bialaphos resistant callus. 5) Stable GUS expression on bialaphos resistant callus. 6, 7) Plant regeneration from transformed callus. 8) Transgenic plants with setting seeds.
Figure 2. Expression of gfp gene in transgenic bahiagrass. (a) Transient green fluorescent protein (GFP) expression 16 h after bombardment. (b,c) GFP expressing callus 14 days after bombardment. (d,e) GFP expression from transformed callus to plant regeneration. (f–h) GFP expression of regenerated plant in vitro (f, leaf blade; g, tiller; h, underground part). (i–l) GFP expression in each tissue of a transgenic plant (i, leaf; j, leaf sheath; k, anther; l, pollen). (m) Detection of gfp gene in transgenic plants by polymerase chain reaction (M, marker; P, plasmid pBI221; Co., non-transformed plant; TP, transformed plant). (n) The number of transgenes in transgenic plants by DNA gel blot analysis (P, 5 pg Hind III-digested plasmid pBI221; Co., nontransformed plant; TP, transgenic plant). (o) Potted transgenic plants (Co., non-transformed plant; TP, transgenic plant).

almost all species are predominantly facultative apomictic tetraploids. Therefore, it is proposed that *B. ruziziensis* (ruzigrass) should be useful for *Brachiaria* breeding programs based on tissue culture system because this species has sexuality. We have established an effective method for plant regeneration through multiple-shoot formation or somatic embryogenesis from seed-derived shoot apical meristems of diploid ruzigrass firstly (Ishigaki et al. 2009a). Subsequently, tetraploid ruzigrass were produced by *in vitro*-colchicine treatment with multiple-shoot clumps or seedlings. The availability of these tetraploid ruzigrass individuals will likely also expand the breeding potential of the *Brachiaria* genus (Ishigaki et al. 2009b). Additionally, the author attempted to establish a particle inflow gun-mediated transformation protocol for ruzigrass using multiple-shoot clumps and embryogenic calli. This transformation system should be a valuable tool for use in *Brachiaria* breeding programs. These results can be applied to develop *Brachiaria* breeding programs in Japan.

*Pennisetum purpureum* is popular grass in tropical or subtropical area. This grass contains several positive characters, which are beneficial for animal feeding. They can be grown for years, having high yield, highly nutritious, selectively chosen as feed by animals, and can growth on a wide range of soil condition, drained soils, to some extent, drought tolerant of the deep root system. Napier grass does not tolerant flooding, but grows best in areas with high rainfall in excess of 1,500 mm per year. However, there are negative properties, which prevent this grass to develop as planed. First of all, their flowers are very small while the pollens are short-lived which result in low level of seed formation. Moreover, the flowering period of each type of napier grass is different making it more difficult and consuming to have them cross-pollinated. Because of a synchrony of male and female flower parts, the plant relies on cross-pollination by wind (Pongtongkam et al. 2006). This grass is an inconsistent seed producer and rarely develops seeds in some habitats, when seeds are produced, they are often of low viability. Dwarf napier grass, more leafier and higher nutrient contain than normal napier grass. These grass have high potential as forage in grazing area.
Recently, plant biotechnology and molecular biology have created unprecedented opportunities and promises in the field of agriculture. Methods have been developed for the propagation of genotype, more and efficient regeneration through micro-propagation (Ali et al. 2008). In our present research work was undertaken by keeping in view the importance of tissue culture technology in dwarf napier grass improvement and establishment of efficient protocols for mass scale propagation of healthy, disease free and premium quality planting material through micro-propagation.

LITERATURE CITED


Ishigaki G, Gondo T, Suenaga K, Akashi R (2009b) Induction of tetraploid ruzigrass (*Brachiaria ruziizensis*)
Advance research in functional and healthy food from animal products: Antihypertensive peptides derived from meat protein hydrolysates

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ABSTRACT: Meat is a good source of effective peptides in preventing and reducing chronic lifestyle-related disease (CLSRDs) such as hypertension. Lack in crucial nutrients consumption such as protein of plant or animal origin along with abnormalities in carbohydrate and fat metabolism may underlie the aetiology of the clinical course of hypertension. Functional food derived from meat rich in those nutrients may utilize physiological function of peptides as well as improve digestion and metabolism carbohydrate and fats, thus lowering blood pressure and normalize associated biochemical and histopathological changes in man body. Edible meat comes in top of the most valuable animal products that the proteolytic action of meat muscle tremendously generates a profound number of multi-amino acid peptides, some of them with a strong relevant antihypertensive activity.

INTRODUCTION

The nutritional and functional properties of food proteins have been investigated for many years. The nutritional quality of a protein depends on its amino acid content and on the physiological utilization of specific amino acids after digestion and absorption (Friedman 1996).

Bioactive peptides have been detected in many different food source, with milk protein being the most commonly known source (Jelen, & Lutz, 1998). Among the different classes of bioactive peptides, the antihypertensive peptide are the best known (Clare, & Swaisgood, 2000). The main group of the antihypertensive peptides corresponds to the inhibitors of angiotensin I-converting enzyme (ACE).

Recently, specific peptides are considered as inhibitors of ACE, which are potentially used as pharmaceuticals to treat hypertension (Vercruysse et al., 2005). Many ACE inhibitory peptides from foods have been reported (Arihara et al. 2001, Kawamura et al. 1992), but rarely have the inhibitory mechanisms of these peptides been examined. Fujita et al. (2000) and Yokoyama et al. (1992) reported the ACE resistance of ACE inhibitory peptides from the enzymatic digests of chicken breast muscle and ovalbumin.

They tentatively classified these peptides into three categories: inhibitory peptides type, substrate peptides type and pro-drug peptides type. In all of the reports described above, it was emphasized that the resistance of the ACE inhibitory peptide against ACE itself, or against digestive enzymes, was a prerequisite for their action in vivo. Substrate type peptides are those which show a decrease in ACE inhibitory activity after being cleaved by ACE. The inhibitory activity of the inhibitor type peptide is not significantly affected by ACE cleavage. The pro-drug type peptides are those which show an increase in ACE inhibitory activity after ACE cleavage. It has also been reported that the substrate type peptides do not affect the blood pressure of spontaneously hypertensive rat (SHR) but the inhibitor and pro-drug type peptides produce a reduction in blood pressure values (Muguruma, Ahhmed, & Kawahara, 2008). Also in the same study, on the basis of this classification, we discovered a peptide named A5, which was also defined as a substrate type and another peptide was identified as pro-drug type named M6, where they also suggested that M6 has greater antihypertensive activity than A5 in vivo (Muguruma et al., 2009).

The aim of this article is to present the possible functions of some peptides sourced from animal meat on blood pressure.
ANGIOTENSIN CONVERTING ENZYME MECHANISM AND BLOOD PRESSURE

Angiotensin converting enzyme (ACE) is a dipeptidyl peptidase transmembrane bound enzyme. A soluble form of ACE in plasma is derived from the plasma membrane-bound form by proteolytic cleavage of its COOH-terminal domain. Mainly angiotensin converting enzyme is a tool degrades bradykinin and has the potential to cut any available peptides, a potent vasodilator, and other vasoactive peptides (angiotensin-I). It is a circulating enzyme that participates in the renin-angiotensin system, by cutting tow amino acids of the substrate (angiotensin-I). That action of this enzyme goes beyond liberating angiotensin-II from angiotensin-I or inactivating bradykinin (Ervin, 1990) (Fig. 1). The function of angiotensin-II is to cause constriction of arteries, thereby elevating blood pressure as blood flows in a narrower paths bloodstream. ACE inhibitors lower blood pressure by inhibiting the formation of angiotensin-II, thus relaxing the arteries.

![Diagram of Renin-angiotensin system for blood pressure regulation]

**Figure 1.** Renin-angiotensin system for blood pressure regulation

As the roles of biologically active peptides of meat being absorbed in man body, start to be active, they meet competitively (depends of their types) with ACE, in which they block and inactivate ACE. Inactivation of ACE generates stability for the angiotensin-I, the more angiotensin-I stable, the more the blood pressure normal. The peptides that play inhibitor roles compete with ACE to interlock in the same place that ACE cleave the angiotensin. As the competition is high, the ACE contents the condition whereas the arteries would not be shrinkage.

**PROCEDURE TO EXAMINE ACE INHIBITORY ACTIVITY**

With slight improvement in the procedure that we used in previous studies (Katayama et al., 2003a; 2003b, 2004; 2007; 2008; Muguruma et al., 2009), ACE inhibitory activity was measured according to the method of Cushman and Cheung (1971). The mechanism of such reaction in that protocol is counted on liberation of hippuric acid from hippuryl-L-Histidyl-L-Lucine (His-His-Leu) that basically stimulated by ACE.

A filtered sample contained biologically active peptides (6µl) is mixed with 50µl of 7.6mM His-His Leu as substrate contains 100 mM sodium borate buffer (pH 8.3) and 608 mM NaCl and then pre-incubated at 37°C for 5 min. With view to initiate the reaction, a 20µl of ACE (60 miliunits/ml of rabbit lung) must be added in a buffer contains 0.25M sodium borate buffer (pH 8.3) followed by
incubation the mixture at 37 °C for 30 min. The reaction always terminated by adding 554µl of 0.1N HCl except in the case of blank samples, that have always to be treated with the same amount of HCl but before the pre-incubation step. Then the Hippuric acid liberates by ACE is always extracted by adding 1.5ml of ethyl acetate followed by vigorous shaking of the mixture for 2 min. After centrifugation at 3,000 rpm for 20 min, the process is then followed by collecting 1 ml ethyl acetate (upper layer). The collected layer of ethyl acetate was then evaporated at 100°C for 10 min. The hippuric acid was then dissolved in 1 ml of 1 M NaCl and its concentration determined by photometric instrument at 228nm. The concentration of ACE inhibitors required to inhibit 50% of ACE activity is defined as the actual value of IC\textsubscript{50}.

**MEAT PROTEIN AND HYPERTENSION**

Meat contains bioactive proteins and peptides that play important role in prevention CLSRD such as blood pressure. In essential hypertension there is a metabolic defect where glucose metabolism is altered due to insulin resistance, resulting in increased tissue levels of aldehydes and oxygen-free radicals and hypertension. This metabolic defect can be corrected nutritionally by vitamin E, vitamin C, vitamin B6 or a diet rich in protein-containing cysteine (Vasdev, Lognerich, Sinal, 2002). We have collectively tried to explore and categorize all the important peptides that recently were identified and their amino acid sequences as well as functions were discovered. Table 1 shows the overall crucial peptides of meat and other food stuff associated with IC\textsubscript{50} values (ACE inhibitors). It is obviously clear that IC\textsubscript{50} of those products was great and have the potential to lower blood pressure, IC\textsubscript{50} defined as the appropriate concentration of protein or peptide to inhibit 50% of the action of ACE in vivo. We got the lower IC\textsubscript{50} and the greater peptides in which the highest reduction in blood pressure.

**EVIDENCES OF MEAT PROTEINS IN REDUCING HYPERTENSION**

It was reported that the proteolytic action of pork muscle DPP typically generates a good number of dipeptides, some of them with a relevant ACE inhibitory activity (Sentandreu & Toldra, 2007). Most proteins contain bioactive sequences, but those sequences are inactive within the parent proteins.
Active peptides fragments are released from native proteins only via proteolytic digestion. Once such peptides are liberated, they can act as regulatory compounds and inhibitory nutraceuticals (Arihara, 2006). Recently, many bio-functional peptides, antihypertensives, antioxidants, antimicrobials, and antithrombotic and immunomodulatory peptides have been isolated in foods. Among these, antihypertensive peptides (ACE inhibitors) are of particular interest for prevention and treatment of hypertension (Kobayashi et al., 2008).

As many scientists purified numerous meat peptides that play nutria-functional roles, in our laboratory, we have been trying in last decade to value some meat peptides of local animals (beef, pork and chicken). We obtained some crucial peptides from muscle protein hydrolysates: porcine crude myosin (Katayama et al., 2003a); porcine skeletal muscle protein (Katayama et al., 2003b); porcine troponin C (Katayama et al., 2003c; Katayama et al., 2004); porcine skeletal muscle myosin (Katayama et al., 2007); porcine skeletal muscle troponin (Katayama et al., 2008); porcine myosin B (Muguruma et al., 2009). All the purified peptides showed a great effect on blood pressure of spontaneously hypertensive rats (SHR). The in vitro IC$_{50}$ of meat peptides was very low, which means even little consumption of amount of such food, interestingly that little amount lead to inhibition 50% of ACE activity. IC$_{50}$ defined as reading of protein concentration that always has to be calculated by certain equation to inhibit 50% of the ACE activity.

Table 1 shows some of the valuable peptides that sourced from pork, chicken, sardine, tuna and salmon. Other researchers obtained ACE inhibitory peptides from different products includes marine products and meat species such as beef (Jang et al., 2005; 2007; 2008); chicken collagen (Iwai et al., 2009); tuna (Lee et al., 2010); fugu muscle (Nagai et al., 2008); salmon (Nou et al., 2008); sardine (Otani et al., 2009); chicken bone (Nakade et al., 2008); oyster (Wang et al., 2008); sardine by-products (Bougatet et al., 2008); also porcine skeletal muscle (Arihara et al., 2001); chicken (Fujita et al., 2000).

Figure 2-A shows the effects of nonapeptide on the blood pressure of SHR. SHR fed orally by nonapeptide, the quantity of this peptide was 10mg per 1kg of rat’s weight. This peptide showed a significant effect, specially after 3 hours, the blood pressure was decreased by a rat of 35mmHg. This nanopeptide is quite unique, because it could stabilize the blood pressure and the blood pressure contentiously remained low for almost 6 hours, from 3 to 9 hours. And at 24 hours when it compared
to the water samples it slightly decreased the blood pressure, even though we consider this peptide that it has a good ability in maintaining the blood pressure of SHR. The stability in this peptide coincide with its IC\textsubscript{50}, the more ACE cut this peptide the more it become competitive, it is clear that this peptide had resisted the ACE activity inhibiting angiotensin-I from being converted to angiotensin-II. Also in a study conducted by Ahmmed et al. (2009), showed that after administration of the meat hydrolyzate, the SBP decreased by 6 mmHg in 3 h and 13 mmHg in 6 h, as meat hydrolyzate has a considerable blood pressure-lowering effect (Fig. 2-B).

The concentration of angiotensin II was measured in the meat and meat hydrolyzate groups of rats, and comparison of the results showed that the meat hydrolyzate had a considerable effect on the angiotensin II concentration after rats were fed a diet containing 5\% meat hydrolyzate for 2 weeks (Ahmed, & Muguruma, 2010).

The results indicate that meat hydrolyzate may contains some peptides that function as nutraceuticals and could lower the blood pressure. Administration of meat hydrolyzate led to blood-pressure-lowering effects similar to those observed in previous reports that concern about animal origin products. We monitored the blood pressure and found that it could be reduced in both the short-term and long-term perspectives by feeding rats with a diet containing meat hydrolyzate.

In hypertension, as in other progressive, CLSRDs with high mortality rates, the functional food approach offers major advantages over models with prevention tool, inhibiting rather than reducing disease and provide appropriate implementation of palliative strategies and program of medical and emotional care for the terminally ill. To determine whether a peptide is a long-term ACE inhibitor requires further investigation. This research may provide adequate evidence that meats contain a considerable number of constituents that could be utilized as functional food and nutraceuticals.

CONCLUSIONS

Results of our research along with many dozens of studies provide a body of evidence that meats possess variety of proteins consisted from large number of peptides in which showing great effect on CLSRDs. We maintain meat consumption due to recommended daily allowance, the better the health care we provide. However, excessive consumption of meats, by not follow the regular basis of consumption, may lead to unprofitable results that affect mechanisms of man body such as increasing uric acid which puts strain on the kidneys, dyspepsia and also helps obesity to be occurred. Meat hydrolyzate may also contain other constituents as a result in which gives it the opportunity to be utilized as a functional food and nutraceutical. From the collected data of animal experiments fresh meat products would have to be considered to contain compounds that play temporally immunopharmacological role.

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Diversity on the exterior performance of crossbred cattle kept by farmers in Central Java

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ABSTRACT: In Java, starting in the 1980’s, exotic germplasms have been used to increase the productivity of Ongole Grade cattle, which is considered as native cattle. However, due to uncontrolled breeding system and poor pedigree record by the farmers, nowadays, many different types of cattle exist in Indonesia. This study was aimed to investigate the diversity on the exterior performance and body size of crossbred cattle. This study was carried out in Central Java and Yogyakarta Provinces. In total 160 heads of female Simmental crossbred female cattle, with age more than 2 years were observed for their exterior performances. Survey and direct measurement on the exterior performances of cattle were applied to collect all parameters required. The results indicated that most predominant body colour was brown-red (59.38 %), followed by red and white (14.38% and 11.88%), respectively. The colour of the head were mostly white (72.50%), some were brown (17.50%). The noses were varied from black (53.75 %) and pink (41.25 %). Most of the cattle have small and medium dewlap (46.25 % and 43.13% respectively). The shape of horns are mostly curved inward (35.00 %) and slightly upward (32.50%). The cattle are mostly humpless (72.50%) and few of them have small hump (25%). The colour of tails’ hair is varied from brown (66%) and black (48%). The colour of the vulva was mostly pink (55.00%) and blackish pink (23.13%). The heterogeneity of Simmental crossbred cattle is caused by unplanned crossbreeding systems, yet, their genotypes are not well indentified. There is a need to plan an appropriate crossbreeding program.

Key words: diversity, crossbred cattle, exterior performance, uncontrolled breeding system

INTRODUCTION

Indonesia is a country with a growing human population and a developing economy, drive to increasing the demand of meat, especially beef meat. To fulfill the increase in demand for beef in Indonesia, the government has been promoting the crossing between exotic breed cattle with local / indigenous cattle. From the 1980’s onwards, the government has been promoting artificial insemination, using exotic breeds from temperate regions, such as Simmental, Limousine and Aberdeen Angus, to improve the local beef cattle performance. As a result, domestic beef production comes from various distinct beef cattle populations, which were formed from the native and imported genetic resources. As other tropics countries, upgrading with temperate breeds in crossbreeding is a main attempt to improve livestock.

The genotype and performances of crossbred cattle were not well identified. Beside of poor recording system, there is lack of plans on how to maintain a sustainable level of ‘upgrading’ or how to maintain the pure breeds for future use in crossbreeding, contribute to non-sustainability (Philipsson et.al.2006). Phenotypic variation within breeds can be large, moreover in composite breeds and indiscriminate crossbreds.

Currently, beef cattle population in Indonesia is around 12.5 million heads, comprised of local cattle such as Bali, Madura, Ongole Grade (OG), Brahman Grade, Hissar, Pesisir and Javanese; crossbreds and imported cattle from Australia. There is no exact data of the number of crossbreds cattle, but it is increasing year by year.

This study was aimed to investigate the diversity on the exterior performance and body size of crossbred cattle.
History of Crossbreeding

Martojo (2005) stated that in the 19th century, local breeds were upgraded using Ongole bulls from India. Then Ongole bulls and small sized local Java-breeds were crossed in East Java. Further importation of the Indian *Bos indicus* such as Ongole, Hissar and other zebu cattle occurred in early 20th century. The purpose of the importation was to provide Java with strong draught cattle to pull carts for the sugar industry. According to Barwegen (2004), East Javanese initially disliked the Ongole breed, because they could not work in forests as the Javanese cattle could.

The male and female Ongole cattle were bought from areas surrounding Madras India. The pure Ongole was brought to Sumba Island and became the Sumba-Ongole. In Java, the Sumba-Ongole were crossed with Javanese cattle (*Bos javanicus*) and formed the Ongole-grade (in Indonesia called Peranakan Ongole). As mentioned by Maule (1990), that Ongole cattle in Indonesia become established on a large scale, after its introduction in 1906 until around 1980’s. The characteristics of the Ongole and OG cattle are: a big body, strong power, docile and a quiet temperament, good heat tolerance and ability to live at minimum feed conditions. This makes them good animals for draught.

The coat colour of Ongole is glossy white but some males have a grey markings on the back quarters have grey markings on their hump. Ongole cattle grows faster than Madura or Bali cattle and have a better feed conversion ratio and less fat in the carcass. However, they are less fertile than original Javanese cattle (Barwegen, 2002), and Madura and Bali cattle as well (Maule, 1990). Widi et al. (2006) showed that the reproduction performance of Javanese cattle was higher than that of the OG. In 2003, the population was estimated at about 4.4 million or 41 % of total cattle population in Indonesia. About 90 % of them are on Java (Directorate General of Livestock Service, 2003). Their numbers are, however, rapidly decreasing.

**Figure 1.** Crossbreeding in beef cattle by farmers through artificial insemination (Source: Widi et al. 2008)
In 1980’s, the government introduced exotic breeds such as Simmental, Limousine, and Aberdeen Angus through artificial insemination. The purpose of this program was to increase the productivity of local cattle in terms of their growth to fulfill the national meat demand. Figure 1 shows how in Yogyakarta Province crossbreeding with exotic breeds has been implemented. Currently, more than 80% of the cattle in this province are exotic crossbreds (Widi et al. 2008).

Simmental is the most favourite breed for farmers in Central Java and Yogyakarta Provinces. For example, in 2007, in a district of Yogyakarta Province, the utilization of Simmental semen reached 71%, compared to other breeds like Limousine and Ongole Grade / Brahman, which were only 6 and 23% respectively (Widi et al., 2008).

Simmental. The ancestor of today’s Simmental was the Brenese, a local breed found in the Simme Valley. Its colours included black-and-white or red-and-white pied and sometimes solid red. Until the middle of the nineteenth century the cattle were often run in mixed herds, though the red-and-whites (which were usually blond-and-white) substantially outnumbered the taller, more robust black-and-whites which were kept mainly in the Frinbourg canton. After about 1870, however the establishment of ‘pure’ breeds became the fashion and the two types were separated according to colour (Porter, 1991). Furthermore Porter (1991) stated that the red—and—white type Simmental was carefully bred as a triple—purpose breed and selected for a yellowish-red and white coat with a white face, legs, and tail. In crossbreeding all around the world, the Simmental is highly preferred, since it provides good growth, a large frame and thus a better beef yield to its crossbred progeny. It improves the quality of the meat with white fat and excellent marbling. It improves the milk yield, resulting in strong development of the calves in suckler herds.

Limousine. The Limousine is a heavily muscled animal renewed for its excellent carcass qualities, the yield of meat being exceptionally high, with a minimum of fat. The limousine is a rich gold colour, with lighter circles around the eye and muzzle, and shading to a lighter colour on the legs. The majority of animals are horned although a poled strain has been developed. (Anonimus, 2000).

MATERIAL AND METHODS

Study Areas

This study was conducted in the Central Java and Yogyakarta Province which are sources of beef cattle in Java Island. Three Districts with 6 sub districts within, represent 3 agro ecological zones, namely dry upland, wet upland and wet lowland, were used in this study. Dry upland areas were located in Gunung Kidul District. Wet upland areas were located in Sleman District, and wet lowland areas were located in Sleman and Kebumen Districts.

Methods

In total 160 heads of female Simmental crossbred female cattle, with age more than 2 years were observed and measured for their exterior performances. Age of cattle was measured by determining their teeth. The exterior characteristics observed were colour of body, face, nose, leg, around eyes, tail’s hair and vulva; size of dewlap and hump, existence of back line, shapes of horn, thickness of body’s and head’s hair. While, body size measured are girth of chest, height at withers, length of body, height at the hip, wide of hip, length of head, wide of head, head index, body weight and body score condition (BSC). Body size were measured using a tape FH brand with 1 cm precision figures and the measuring ruler FHK brand with 0.2 cm accuracy.

Exterior characteristics were calculated by using percentage of their existence. While vital statistics were calculated for their means and standard deviation.

RESULTS AND DISCUSSION

Most of farmers in Central Java and Yogyakarta provinces keep cattle for breeding purposes, producing calves and usually selling them after weaning or pre-yearling period. Female / cows cattle are dominated the cattle population. The farmers applied artificial insemination to mate their cattle,
<table>
<thead>
<tr>
<th>Exterior characteristics (%)</th>
<th>Percentage based on age group (%)</th>
<th>Average (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-3 year (N=57)</td>
<td>3-5 year (N=42)</td>
</tr>
<tr>
<td>Body colour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>19.30</td>
<td>14.29</td>
</tr>
<tr>
<td>Cream</td>
<td>7.02</td>
<td>7.14</td>
</tr>
<tr>
<td>Brown-red</td>
<td>52.63</td>
<td>54.76</td>
</tr>
<tr>
<td>Red</td>
<td>15.79</td>
<td>19.05</td>
</tr>
<tr>
<td>Grey</td>
<td>1.75</td>
<td>0.00</td>
</tr>
<tr>
<td>Black</td>
<td>1.75</td>
<td>2.38</td>
</tr>
<tr>
<td>Undefined (mixed)</td>
<td>1.75</td>
<td>2.38</td>
</tr>
<tr>
<td>Face colour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>80.70</td>
<td>73.81</td>
</tr>
<tr>
<td>Cream</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Brown</td>
<td>7.02</td>
<td>16.67</td>
</tr>
<tr>
<td>Red</td>
<td>7.02</td>
<td>7.14</td>
</tr>
<tr>
<td>Black</td>
<td>5.26</td>
<td>2.38</td>
</tr>
<tr>
<td>Nose colour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Cream</td>
<td>1.75</td>
<td>0.00</td>
</tr>
<tr>
<td>Pink</td>
<td>43.86</td>
<td>40.48</td>
</tr>
<tr>
<td>Black</td>
<td>50.88</td>
<td>57.14</td>
</tr>
<tr>
<td>Spotted</td>
<td>3.51</td>
<td>2.38</td>
</tr>
<tr>
<td>Leg colour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>40.35</td>
<td>47.62</td>
</tr>
<tr>
<td>Brown</td>
<td>45.61</td>
<td>40.48</td>
</tr>
<tr>
<td>Red</td>
<td>14.04</td>
<td>11.90</td>
</tr>
<tr>
<td>Size of dewlap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>61.40</td>
<td>42.86</td>
</tr>
<tr>
<td>Medium</td>
<td>31.58</td>
<td>47.62</td>
</tr>
<tr>
<td>Big</td>
<td>7.02</td>
<td>9.52</td>
</tr>
<tr>
<td>Back line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exist</td>
<td>5.26</td>
<td>14.29</td>
</tr>
<tr>
<td>Not exist</td>
<td>94.74</td>
<td>85.71</td>
</tr>
<tr>
<td>Horn shapes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not exist</td>
<td>1.75</td>
<td>7.14</td>
</tr>
<tr>
<td>Straight up</td>
<td>10.53</td>
<td>16.67</td>
</tr>
<tr>
<td>Slightly upward</td>
<td>26.32</td>
<td>30.95</td>
</tr>
<tr>
<td>Curve inward</td>
<td>43.86</td>
<td>23.81</td>
</tr>
<tr>
<td>Curve outward</td>
<td>3.51</td>
<td>9.52</td>
</tr>
<tr>
<td>Hanging down</td>
<td>5.26</td>
<td>2.38</td>
</tr>
<tr>
<td>Small</td>
<td>8.77</td>
<td>9.52</td>
</tr>
<tr>
<td>Asymmetries</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Hump size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not exist</td>
<td>77.19</td>
<td>66.67</td>
</tr>
<tr>
<td>Small</td>
<td>21.05</td>
<td>30.95</td>
</tr>
<tr>
<td>Medium</td>
<td>0.00</td>
<td>2.38</td>
</tr>
<tr>
<td>Big</td>
<td>1.75</td>
<td>0.00</td>
</tr>
<tr>
<td>Colour around eyes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cream</td>
<td>5.26</td>
<td>2.38</td>
</tr>
<tr>
<td>Brown</td>
<td>5.26</td>
<td>9.52</td>
</tr>
<tr>
<td>Red</td>
<td>40.35</td>
<td>30.95</td>
</tr>
<tr>
<td>Black</td>
<td>49.12</td>
<td>57.14</td>
</tr>
<tr>
<td>Thickness of head’s hair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>70.18</td>
<td>76.19</td>
</tr>
<tr>
<td>Medium</td>
<td>28.07</td>
<td>19.05</td>
</tr>
<tr>
<td>High</td>
<td>1.75</td>
<td>4.76</td>
</tr>
</tbody>
</table>
Table 1. The exterior characteristics of crossbred cattle (continuation)

<table>
<thead>
<tr>
<th>Exterior characteristics</th>
<th>Percentage based on age group (%)</th>
<th>Average (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-3 year (N=57)</td>
<td>3-5 year (N=42)</td>
</tr>
<tr>
<td>Thickness of body’s hair</td>
<td>Low</td>
<td>84.21</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>15.79</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.00</td>
</tr>
<tr>
<td>Colour of tail’s hair</td>
<td>Creamy white</td>
<td>7.02</td>
</tr>
<tr>
<td></td>
<td>Brown</td>
<td>35.09</td>
</tr>
<tr>
<td></td>
<td>Red</td>
<td>28.07</td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>29.82</td>
</tr>
<tr>
<td>Colour of vulva</td>
<td>Pink</td>
<td>56.14</td>
</tr>
<tr>
<td></td>
<td>Pinky brown</td>
<td>5.26</td>
</tr>
<tr>
<td></td>
<td>Pinky black</td>
<td>17.54</td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>21.08</td>
</tr>
</tbody>
</table>

using the most preferred exotic breeds semen, Simmental and Limousine. They only use OG / Brahman semen for OG or Brahman heifer which are in the first mating.

Some farmers still believe that the reproductive performance of F1 of Sim-OG or Lim-OG cows are better compared to the further backcross generation crossbreds cows, so that they prefer to keep the F1 crossbreds cows to be bred (personal communication, 2009) and this fact was proved by Putro (2009), who said that the reproductive performances of further backcross generation of crossbreds cows were slightly decreasing compared to F1. However currently, farmers also breed further backcross generation cattle, which resulted cattle with composition of Bos Taurus blood until 87.5 %, even more. The exterior characteristics of crossbreds cattle were shown in Table 1.

**Exterior Characteristics**

Exterior characteristic should be known for the introduction of cattle breed are colour of body, tail’s hair, the shape of horns, hump, dewlap, specific colours on the body, characteristic of the head, ears and neck (Supiyono, 1998).

Seven and five pattern variations on body and face colour have been observed in this study. The dominant body colour was brown-red, while colour of face was white. The dominant colour of legs were white and brown. As mentioned by Porter (1991), pure Simmental with colour of yellowish-red with white face and legs were preferred to be bred. Besides the dominant colours, there were some other colours existing on those crossbred cattle. Since there were no sufficient recording system done by farmers, so the breed of the cattle progeny could not be certainly known. However, in Central Java, the most preferred exotic cattle breed are Simmental. Limousine is only famous in few areas.

Based on the colour of the coat, face and legs, performed by observed cattle, the crossbreds cattle in Central Java were Simmental crossed. However, they might be results of crossing with other breeds like Limousine, Angus, OG or Brahman. The exploration of genetic introgression of exotic to local / indigenous breeds cattle can be done by molecular work, but it is expensive, and yet, the level of upgrading is still missing.

Uncontrolled crossbreeding, unplanned breeding program and poor recording systems done by farmers, resulted various phenotypic performances and unknown upgrading level. Low awareness among farmers about benefit of recording is a limiting factor in many developing countries.

**Body Vital Statistics**

Body vital statistics of crossbred cattle were shown in Table 2.
Table 2. Body vital statistic of crossbred cattle

<table>
<thead>
<tr>
<th>Body vital statistics</th>
<th>Average based on groups (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-3 year (N=57)</td>
</tr>
<tr>
<td>Girth of chest (cm)</td>
<td>172.89 ± 13.56</td>
</tr>
<tr>
<td>Height at the withers (cm)</td>
<td>126.28 ± 6.08</td>
</tr>
<tr>
<td>Length of the body (cm)</td>
<td>119.60 ± 14.54</td>
</tr>
<tr>
<td>Height at the hip (cm)</td>
<td>132.63 ± 6.20</td>
</tr>
<tr>
<td>Wide of hip (cm)</td>
<td>47.25 ± 5.03</td>
</tr>
<tr>
<td>Length of head (cm)</td>
<td>50.05 ± 4.12</td>
</tr>
<tr>
<td>Wide of head (cm)</td>
<td>21.98 ± 1.83</td>
</tr>
<tr>
<td>Head Index</td>
<td>44.08 ± 3.36</td>
</tr>
<tr>
<td>Body Weight estimation (kg)</td>
<td>402.05 ± 95.12</td>
</tr>
<tr>
<td>BSC</td>
<td>3.29 ± 0.55</td>
</tr>
</tbody>
</table>

Comparing to the results of Widi et al (2006), the girth of chest, height at withers, length of the body and estimation of body weight of female OG with age of over 4 years, in Central Java, were 154.69 ± 1.12 cms; 123.56 ± 1.36 cms; 130.19 ± 1.91 cms; 298.75 ± 5.79 kg, respectively, so that crossbred cattle were much bigger than Ongole Grade.

According to Sudardjat and Pambudy (2003), the average of height at wither of male Ongole Grade was 140-160 cms and that of female OG was 130-140 cms and their body weight can reach until 400 – 600 kg. It means that in the past, when the population of OG was still high, the body size of those cattle were more less similar with crossbreds cattle. However, since the preference of farmers was shifted to crossbreds cattle, the population of OG cattle decreased rapidly. During colonial period, OG were strongly used for draught animals, and the breeding and selection program at that time resulted big animals which were appropriate to pull carts or plough lands. However, due to the demand of meat which has been increasing, following the increasing of human population, OG, including the big ones, shifted to meat producers. Nowadays, the remaining OG are smaller and the reason for small number of farmers to stay keeping OG was less capital needed (Widi et al., 2006).

The average of cattle ownership is 4.6 heads / farmer and the average of cows ownership is 1-2 heads / farmer (Widi et al., 2008). With the small number of cattle ownership, farmers are not be able to select and retain keeping the good cattle / cows. Urgent need drives farmers to sell their cattle without any selection for breeding.

CONCLUSIONS

A lot of variation in exterior performances, found in crossbreds cattle in Central Java. It was resulted from indiscriminate crossbreeding with exotic breeds. Uncontrolled crossbreeding, unplanned breeding program and poor recording systems done by farmers, resulted various phenotypic performances and unknown upgrading level.

It is strongly recommended to plan an appropriate breeding program which emphasising on selection scheme, recording and evaluation of the cattle.

LITERATURE CITED


Certificate

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