HOW CAN ANIMAL SCIENCE AND TECHNOLOGICAL INNOVATIONS HELP US TO MEET THE TARGETS DEFINED BY PNG VISION 2050?

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Abstract

Two innovations in animal feed science and technology have the potential to revolutionize PNG’s smallholder and subsistence agricultural systems by enhancing the income earning ability of rural farmers and enabling them to respond in a resilient manner to local and global economic developments and climatic change. Improved feeding systems for pig and poultry, namely, ensiling sweet potato for storage and feeding to pigs and low/high energy broiler feed formulations, combining sweet potato and cassava with protein concentrate provided by Niugini TableBirds, led to marked cost-benefit gains and animal performance. Future prospects are set to explode augmented by the mineral resources boom and increasingly affluent urban populations demanding more animal protein as meat, milk and eggs and thereby creating opportunities for growing localized primary production. The commercial monogastric industry and smallholder livestock sector are faced with common challenges and hence shared objectives that may be achieved by greater collaboration rather than competition and this will bode well for at least 580,000 small-scale pig and poultry farmers and a further three to six million household members who are supported by rural farming activities. Therefore, to work realistically towards achieving the PNG Vision 2050 targets we should return our attention to agricultural production.

Keywords: Pig, poultry, feeding systems, low energy concentrate, high energy concentrate, sweet potato, cassava, ensiling.

Introduction

Subsistence and smallholder agricultural production in Papua New Guinea, practiced by some six million people living in rural communities, consists of mixed crop-livestock systems where, particularly for pigs and poultry, supplementary feeding is very common at village level to small-scale semi-intensive commercial farms. These traditional low-input systems can be relatively flexible to household demands, based on the capacity of family members to provide the needed labour input for farming available land.

On the other hand, the smallholder farming sector is growing rapidly, in line with resource developments and an ever increasing population, and despite a dwindling availability of arable land at household level, environmental challenges and local and global economic
changes. In addition, the promising semi-intensive farming tends to remain sufficiently integrated within economical, environmental and cultural contexts.

The livestock sub-sector could contribute to the agriculture sector in moving the smallholder farmers, 85% of population, into the next level of development status, meaningfully participating in the development of the PNG agriculture economy (Moat, 2012).

However, there is a recognized shortfall in the supply of meat, milk and eggs to the country for both urban and rural populations. Hence, PNG is a net importer of meat, milk and eggs. In particular, pig and poultry are the two most popular meat proteins in the diets of most urban and rural people and the demand for pork and chicken meat and eggs in the country is growing faster than local commercial farms can cater to. This scenario contributes further to the country’s import bill, but also provides an opportunity for PNG’s smallholder livestock farmers, who remain poised to capitalize on the growth in demand for these livestock products. In order to succeed in gaining a greater slice of the growing local market the smallholder livestock sector requires the timely and well placed intervention of agricultural technologies.

While PNG Vision 2050 recognizes that subsistence agriculture ventures play a critical role in enhancing rural livelihoods and the cultural lives of many, and that opportunities exist in food production, namely vegetables and fresh meat, for the domestic market (NSPTF, 2009), it also admits that how to do this remains a challenge (Dom and Pandi, 2011).

This paper presents two livestock feeding technologies for pigs and poultry, released by the National Agricultural Research Institute (NARI), that have the potential to revitalize PNG’s smallholder and subsistence agricultural systems by enhancing the income earning ability of rural farmers and enabling them to respond in a resilient manner to local and global economic developments and climate change. The major challenge of farming pigs and poultry at any level is providing animals with the appropriate nutritional feed that enables them to perform effectively enough to sustain their economic productivity. The two innovative feeding technologies for livestock farming in PNG are resource efficient and cost effective means of improving productivity of small-scale, semi-commercial farms and even commercial.

**What are the targets defined by Vision 2050?**

Agriculture contribution to achieving PNG Vision 2050 comes under the four pillars, of which the primary concern is wealth creation (Figure 1). The agriculture sector directly impacts through food security, income generation, gainful employment, and sustainable resource use. Within the framework of Vision 2050 the National Agriculture Development Plan defines the government’s sectoral priorities for agriculture (Moat, 2012). The vision of NADP is sustainable transformation of the country’s agriculture sector into a vibrant and productive economic sector that contributes to economic growth, social wellbeing, national food security and poverty alleviation (MoAL, 2009). The targets in this area are defined by real per capita gross domestic product and an improvement in the Human Development Index (NSPTF, 2010; Table 1).
What is the role of livestock research and development?
The goal of livestock development is to revitalize and expand the livestock and apiculture industries to improve the welfare and livelihood of the rural communities and to contribute to the general economy of the country (MoAL, 2009). As the mandated research organization for smallholder agriculture NARI contributes directly towards achieving the second objective of the NADP which is to improve livestock production, processing and marketing (MoAL, 2009; p40).

![Vision 2050: A Smart, Wise, Fair, Healthy & Happy Society](image)

Figure 1: Linkage for agriculture plan to National Vision 2050 (Adapted from Omuru, EE et al, 2011) Source: Moat (2012).

Table 1: Table 2.2 Strategic target goals for Vision 2050 (Source: NSPTF, 2010; p28)

<table>
<thead>
<tr>
<th>Year</th>
<th>Human Development Index (HDI) (out of 182 listed countries)</th>
<th>Life Expectancy (years)</th>
<th>Real per Capita GDP (Kina)</th>
<th>Adult Literacy Rate (percent of 15 years and older)</th>
<th>Basic Education Gross Enrolment (pre-Gr. 8, 6 – 14 year pop.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>148</td>
<td>58.0</td>
<td>1 919.8</td>
<td>58</td>
<td>85.5</td>
</tr>
<tr>
<td>2020</td>
<td>123</td>
<td>63.0</td>
<td>2 744.4</td>
<td>70</td>
<td>90.0</td>
</tr>
<tr>
<td>2030</td>
<td>98</td>
<td>68.0</td>
<td>3 663.5</td>
<td>80</td>
<td>96.5</td>
</tr>
<tr>
<td>2040</td>
<td>73</td>
<td>72.0</td>
<td>6 178.6</td>
<td>90</td>
<td>98.0</td>
</tr>
<tr>
<td>2050</td>
<td>50</td>
<td>77.0</td>
<td>10 420.5</td>
<td>100</td>
<td>100.0</td>
</tr>
</tbody>
</table>
**How do we achieve the targets through livestock production?**

NARI’s strategic objective is enhancing productivity, efficiency and stability of agricultural systems (NARI AIP, 2011). Under the sub-programme objective of effectively integrated crops, livestock and aquaculture for smallholder farmers, two major research projects have delivered improved feeding systems for pigs and poultry in 2010 and 2011 respectively. These two feeding technologies make full use of sweet potato and cassava as a major component of feed for pigs and poultry, replacing commercial feeds and thereby lowering costs of feed at the farm level.

Pig and poultry are by far the most favoured meat protein sources in PNG, while recent demands for fish from inland fish farming is also on the rise. Total livestock production in PNG is estimated at some 57,000 tons per year (Bourke and Harwood, 2009) where pig and poultry products make up 95% of domestic production. Based on indicative figures of the 2000 PNG National Census data (NSO, 2002), half of the rural households and 10% of urban households in PNG are engaged in some kind of livestock production; which includes about 360,000 pig farmers, 220,000 poultry farmers and about 20,000 fish farmers (Ayalew, 2011).

Gibson (2001) estimated the total value of household agricultural production in PNG was almost Kina1.3 to 1.6 billion per annum. And this local food produce provides 80 percent of available calories, where sweet potato is the major contributor at 65% of total calorie intake. Pigs and poultry contribute at least 3% of the total calorie intake in PNG, but this figure may be very inaccurate for the lack of updated economic and nutritional values (Gibson, 2001). Quartermain (2001) foresees growth at 5% per annum for production of meat for household consumption commensurate with a population growth of 2.0-2.5% per year and continued increasing affluence. But with the recent explosion of resource development in PNG this estimate requires urgent review.

Expansion and sustainability of the smallholder livestock farming sub-sector is dependent on encouraging more people to go into broiler bird and grower pig production, by supporting with critical inputs, such as lowered feed cost, animal health services and regular extension contact, thereby making it attractive and profitable (Dom and Pandi, 2011).

**Technological innovations: Improved pig and poultry feeding systems**

In a paper presented at the Food Security Policy Conference on High Food Prices in PNG, Ayalew (2011) pointed out that improved pig and poultry technological innovations contribute to improved food security at household level by:

1) Enhancing extensive use of local feed resources as partial substitutes to imported grains thereby significantly reducing the cost of feeding;

2) Opening up viable value addition opportunities to garden produce, as sweet potato and cassava can also be marketed to support market-oriented livestock production;

3) Encouraging localized marketing of forage and fodder for livestock feed as is already prevalent, at least in the highlands.
4) Creating gainful employment opportunities for available household labor, as they can work part or even full time preparing these local feeds for livestock feeding, and

5) Enhancing farm integration towards greater total farm production. Manure is an efficient organic fertilizer to return nutrients back to the soil.

Sweet potato silage for feeding pigs and High and Low energy poultry concentrates were two livestock feeding technologies delivered to the public at the annual Agricultural Innovations Show hosted by NARI. The improved feed technologies have had great appeal to many individual farmers and farming communities in different rural settings across the country, with different project activities, including on-station and on-farm research trials, out-grower feeding trials, mini-mill development and training and technology demonstrations taking place in Morobe, Eastern Highlands, Jiwaka, Western Highlands, Western, and East New Britain Provinces.

A brief description of the improved animal feed technologies

1. **Sweet potato silage for storing and feeding to pigs**

Smallholder and village farmers predominantly maintain their pigs on supplements of sweet potato and cassava, both of which are very suitable source of dietary energy in animal feed, provided that the starchy roots are cooked (Dom and Pandi, 2011). Ensiled sweet potato forage was tested as a feed preservation technique that provided nutritious, highly digestible (fermented) feed, maximized the use of tuber and vine, reduced the need for labour in daily pig feeding chores (especially for women) and eliminated the use of cooking fuel (Dom and Ayalew, 2009).

Table 2: Growth performance, carcass measures and economic returns for grower pigs fed three test diets in low and high altitude locations at Labu Station Morobe and Tumbul District respectively (Adapted from Dom and Ayalew, 2010)

<table>
<thead>
<tr>
<th>Diets</th>
<th>DMI (g/day)</th>
<th>ADG (g/day)</th>
<th>FCR</th>
<th>Carcass weight (kg)</th>
<th>Carcass percent (%)</th>
<th>Back-fat depth (mm)</th>
<th>Sale value (Kina)*</th>
<th>Unit price on live weight (Kina/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STD</td>
<td>1694</td>
<td>730</td>
<td>2.33</td>
<td>48</td>
<td>70.6</td>
<td>22.28</td>
<td>322</td>
<td>4.74</td>
</tr>
<tr>
<td>SPCtfv</td>
<td>1553</td>
<td>502</td>
<td>3.09</td>
<td>37</td>
<td>72.5</td>
<td>13.19</td>
<td>259</td>
<td>5.08</td>
</tr>
<tr>
<td>SPS</td>
<td>1190</td>
<td>540</td>
<td>2.21</td>
<td>45</td>
<td>76.3</td>
<td>10.2</td>
<td>315</td>
<td>5.34</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STD</td>
<td>1886</td>
<td>592</td>
<td>3.18</td>
<td>50</td>
<td>66.7</td>
<td>30.0</td>
<td>350</td>
<td>4.67</td>
</tr>
<tr>
<td>FFO</td>
<td>1145</td>
<td>368</td>
<td>3.10</td>
<td>48</td>
<td>77.4</td>
<td>24.7</td>
<td>336</td>
<td>5.42</td>
</tr>
<tr>
<td>SPS</td>
<td>1329</td>
<td>398</td>
<td>3.33</td>
<td>48</td>
<td>78.7</td>
<td>15.7</td>
<td>336</td>
<td>5.51</td>
</tr>
</tbody>
</table>

STD is standard pig grower diet; SP is sweet potato; ct is cooked tubers; fv is fresh vine; S is sweet potato silage; SPS is sweet potato silage; SPS and SPctfv were test diets were mixed rations with pig grower; DMI is dry matter intake; ADG is average daily gain; FCR is feed conversion ratio.

*Based on a wholesale/abattoir price of Kina7.00 per kilogram of frozen fresh carcass.
Dom and Ayalew (2010) concluded that while the growth performances of crossbred pigs on mixed sweet potato silage diets were significantly lower than those on the sole fed grower pig ration in daily gain and body weight gain, the sweet potato silage made on-site from forage sourced locally resulted in improved unit carcass sale prices in both the formal and informal market (Table 2). They further pointed out that the improved carcass quality delivers a premium price on pork meat cuts (Dom and Ayalew, 2010). More importantly unit price on live weight gain offered incrementally improved returns on costs of raising growing pigs to slaughter weight.

2. **High and Low energy broiler concentrate feeds**

Sweet potato and cassava were combined with broiler finisher concentrates as complementary energy sources of higher and lower energy respectively. The formulated diets met the critical dietary requirement of high metabolizable energy providing values as high as 15.39 MJ/Kg and 15.87 MJ/kg, for sweet potato and cassava respectively, which were higher than the standard commercial finisher diet which in this case was 11.30 MJ/Kg (Dom and Pandi, 2011). As a result, broiler bird performances on the sweet potato and cassava diets showed daily were not significantly different to those on the standard finisher ration (Dom and Pandi, 2011; Table 3). Furthermore, farmer evaluation trials showed that overall performance of broilers on the cassava/high energy diet and sweet potato/low energy diet were very good as birds were able to attain target market weight of over 2 kg from week 5 (Pandi et al, 2011).

A very important outcome of this research was providing proof that sweet potato/low energy diet compared very well with the commercial finisher pellet and this led to the participation of Niugini Tablebirds to manufacture two protein concentrate mixtures, for blending with either sweet potato or cassava, to provide an energetically and nutritionally effective finisher ration (Dom and Pandi, 2011). Additionally, the broiler concentrate is appropriate for feeding pigs and fish in appropriately formulated rations and is another outcome being investigated in this ongoing research.

Table 3: Summary of production of broiler birds from day 21 to 28 collated from three AME bioassay in 2003 (Glatz, 2007).

<table>
<thead>
<tr>
<th>Feed sources</th>
<th>Weight gain/bird/day (g)</th>
<th>Daily intake/bird (g)</th>
<th>Feed conversion ratio (FCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet potato tuber</td>
<td>38.1d</td>
<td>82.4bc</td>
<td>2.2c</td>
</tr>
<tr>
<td>Cassava root</td>
<td>41.4cd</td>
<td>79.5c</td>
<td>2.0cd</td>
</tr>
<tr>
<td>Sago</td>
<td>34.1d</td>
<td>76.1c</td>
<td>2.3c</td>
</tr>
<tr>
<td>Wheat</td>
<td>53.0bc</td>
<td>87.6b</td>
<td>1.7d</td>
</tr>
<tr>
<td>Sorghum</td>
<td>48.0c</td>
<td>85.0b</td>
<td>1.8d</td>
</tr>
<tr>
<td>Soya bean</td>
<td>54.0bc</td>
<td>83.3bc</td>
<td>1.5dc</td>
</tr>
<tr>
<td>Copra meal</td>
<td>36.5d</td>
<td>76.6c</td>
<td>2.2c</td>
</tr>
<tr>
<td>Pyrethrum marc</td>
<td>35.5d</td>
<td>75.4c</td>
<td>2.2c</td>
</tr>
<tr>
<td>Flame broiler starter</td>
<td>39.0d</td>
<td>92.6b</td>
<td>2.0cd</td>
</tr>
<tr>
<td>Flame broiler finisher</td>
<td>44.3cd</td>
<td>85.4b</td>
<td>1.7d</td>
</tr>
</tbody>
</table>

Means with the same superscript are not significantly different (P>0.05) from each other.
Final remarks: Are the Vision 2050 targets for livestock production really achievable?
Livestock contribute around 12.9 percent of global calories and 27.9 percent of protein directly through provision of meat, milk, eggs and offal, and also contribute to crop production through the provision of transport and manure (FAO, 2011). In addition, livestock contribute to farmer wealth and in many countries including PNG animals serve the socio-cultural needs of farming communities. The FAO reports that driven exclusively by gains in poultry and pig meat production, global meat output is set to expand by nearly 2 percent to 302 million tonnes in 2012 and most of the sector growth is likely to originate in developing countries. This global trend has implications on PNG’s food security and income generation by subsistence farmers and smallholders.

Put simply, food security is about people having enough nutritious food to eat on a day-to-day basis; particularly important is having adequate protein in the diet. Today the population of Papua New Guinea is over 7 million people, and with an average annual growth rate of 3.2% per annum (NSO, 2002), there is an urgent need to enhance the productivity and resilience of our agricultural systems if we intend to feed an additional eight million mouths by 2050. It is unrealistic to assume that the traditional Melanesian safety net of village life and subsistence agriculture will continue to provide sufficiently for both the household income and food security needs of these future Papua New Guineans.

The Vision 2050 targets are to more than double the GDP per capita by 2030 and 2050 and to move PNG up the HDI from 148 in 2010 to 98 by 2030 and 50 by 2050 (Table 1). These are stretching targets. But with current and future gas and mineral resource developments bringing in much needed revenues there is great potential for these targets to be achieved.

The Medium Term Development Strategy envisions ‘a world class agricultural sector that is responsive, to international and domestic market for a diverse range of products and provides the best available income and job opportunities’ providing “High Quality of Life for all Papua New Guineans” and for “PNG to be a Prosperous Middle Income Earning Country”.

By current the estimate 600,000 farmers are actively involved in smallholder livestock production in PNG and they continue to operate in challenging business environments despite their potential for expansion. By the current population growth rate and demand from more affluent consumers, livestock production may at least need to triple to meet the established targets. Increased importation of meat and eggs may not be a viable option and indeed this option is rejected by major stakeholders in the livestock sector. Therefore, the authors advocate the need for PNG to be more proactive in developing the smallholder agriculture and livestock sector, by taking advantage of outputs from research and development and by creating and/or implementing the appropriate enabling policies and national development plans that for the most part have remained as routine rhetoric, while tangible benefits are yet to be felt at the grassroots.

While NARI and other agriculture stakeholders will continue their efforts at contributing towards the defined targets of Vision 2050, through the respective sector plans, it is
paramount that future government budgets are focused at enabling the most productive use of limited land, available labour and local business interests for developing smallholder agriculture and livestock industries to continue to contribute in the fundamental development aspirations of all Papua New Guinean farmers and non-farmers alike.

It is our firm belief that with the appropriate support and incentive, smallholder agriculture can become a vehicle for moving PNG towards achieving real development impacts, through science and technological innovations. This potential has been demonstrated in part by the reported improved animal feed technologies that have proven potential at small-scale level in a number of rural communities to revitalise livestock production.

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