Considerations of Feed Demand and Supply for the Evolution and Expansion of Beef Cattle Farming in Sabah, East Malaysia

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Abstract

To develop a plan for the expansion and evolution of the beef industry in Sabah, it was decided to apply relevant farming information and technology from New Zealand pastoral systems. Based on expert recommendation in New Zealand, metabolic energy budgeting (MEB) was chosen as the vehicle for technology transfer, rather than a direct translocation of elements of farm practice between these two countries of vastly different climate. In Phase 1 of the study, farm system evolution in New Zealand over the last two and half decades was evaluated by modelling past systems from historic records for the author to gain experience of New Zealand pastoral systems and to develop MEB spreadsheet tools to identify principles of system improvement; and in Phase 2, the tools developed in New Zealand were applied for evaluation of opportunities for farm system improvement in Sabah.

In Phase 1, an evaluation was carried out of cumulative changes on New Zealand lower North Island sheep and beef cattle farms from 1980–81/1985–86 to 2010–2011. Herbage harvested on the farms studied, as determined by MEB, was 7.43 t DM ha^{-1} yr^{-1} in 1980–81 and only 5.76 t DM ha^{-1} yr^{-1} in 2010–11. Also herbage supply (based on GROW model calculations using weather data) had decreased from 9.64 t DM ha^{-1} yr^{-1} to 8.70 t DM ha^{-1} yr^{-1} (partly due to an apparent climate change effect). However, with the evolution of farm system configurations over the past quarter century focusing on efficiency gain, the feed conversion efficiency (based on national data) improved from 25 kg feed consumed per kg lamb weaned in 1980–81/1985–86 to 19 kg feed consumed per kg lamb weaned in 2010/2011 and the corresponding increases in meat production from 1980–81/1985–86 to 2010/2011 were a rise from 137 kg to 147 kg total beef and lamb carcass per ha per year. Two major drivers of the higher meat production were an increase in lambing percentage, and an increase in weight of lambs and bulls at sale.

In Phase 2, a first study in Sabah using the MEB tools developed in New Zealand involved three cut-and-carry feedlots (Brahman, Bali and Droughtmaster cattle), and utilised 5,981 monthly liveweight records of 485 cattle farmed in this system for the period 2008–2013. A second study in Sabah involved five grazing units (Brahman cow-calf, Bali cow-calf, Droughtmaster cow-calf, and Heifer and Brahman bull Units), and included 30,166 monthly liveweight records for 1353 cattle farmed in this system during the same period. A third study involved three oil-palm-integrated cattle (OPIC) farms (two in 9 yr old plantations and one in a 12 yr old plantation) and 600–700 cattle farmed in this system in 2013 and 2014. In this study, animal growth rates were assumed based on records from the nearest government farm with

animals of similar breed. For the three systems, herbage-cutting experiments were carried out in August–October 2014 to estimate herbage growth and nutritive value (metabolisable energy and protein contents), and soil samples collected to describe the soil nutrient content. In the cut-and-carry feedlot and grazing cattle farming systems, the herbage harvested, as indicated by the modelling in these systems, was lower (3.74–7.16 t DM ha^{-1} yr^{-1} herbage eaten) than the potential yield of the herbage extrapolated from the cutting experiments (6.9–21.3 t DM ha^{-1} yr^{-1}). In the OPIC farming system, the modelled herbage harvested in 9 yr old plantations was 2.0–2.4 t DM ha^{-1} yr^{-1} and that of 12 yr old plantation was 1.4–1.7 t DM ha^{-1} yr^{-1}. These values are higher than values for potential herbage supply (0.4–0.8 t DM ha^{-1} yr^{-1}) reported in literature for plantations of similar ages. In all three systems, herbage nutritive value was low (7.0–8.9 MJ ME kg DM^{-1}; 9%–14% CP), calving percentage was low (33%–47%); soil was acidic and soil nutrient content was low; while invasion of non-sown species (native grass) was high. The best average feed conversion efficiencies (FCE) for these systems were 21.3 kg DM kg LWG^{-1} (cut-and-carry feedlot), 40.2 kg DM kg LWG^{-1} (grazing), and 32.2 kg DM kg LWG^{-1} (OPIC). FCE was found to improve with application of N fertiliser and was not necessarily high when feed consumption was intensified (or at high system feed demand). A key statistic defining the stock-configuration in an efficient system for the cut-and-carry feedlot cattle farming system was 994 kg animal LWT ha^{-1}, or a comparative stocking rate (CSR) of 96 kg animal liveweight per tonne feed consumed. For the grazing cattle farming system, the observed optimum was 506 kg animal LWT ha^{-1}, or a CSR of 94 kg LWT t DM^{-1}. The identification of an optimal CSR for the OPIC farming system was limited (by the data supplied by the farms), but the available data indicated that for 9OP1 the CSR was 89 kg LWT t DM^{-1}, or approximately 231 kg animal LWT ha^{-1}.

From the series of studies in Sabah, it is concluded that the future focus of the beef industry to expand and improve the productivity should be first to adjust the farm system configuration especially the stocking rate for optimal FCE under the present forage supply regime (and for that purpose a-CSR type of statistics would be useful to determine the appropriate stocking rate), and only then, to develop a pasture husbandry and fertiliser recommendations aimed at improving herbage dry matter harvested towards a target of 14–20 t DM ha^{-1} yr^{-1}, with ME of 9–10 MJ kg DM^{-1}, and CP of 14%–16% at harvesting or grazing. The herbage production target for the OPIC farming system, however, cannot be determined until the time trajectory of the decreasing system herbage productivity with decreasing oil palm age is fully understood. The use of supplement in the three systems is optional, but if it is used, it should be targeted tactically to reduce liveweight loss and enhance cow reproductive performance.

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List of Abbreviations

Abbreviations	Descriptions	Units
ADG	Average Daily Gain	g hd^{-1} d^{-1}
AFRC	Agriculture and Food Research Council	
AFZ	Association Française de Zootechnie	
ARC	Agriculture Research Council	
Ca	Calcium	
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement	
cm	Centimetre	cm
CP	Crude protein	% of kg DM
CSIRO	Commonwealth Scientific and Industrial Research Organisation	
CSR	Comparative Stocking Rate	
CV	Coefficient of Variation	%
d	Day	
DM	Dry matter	
DOA	Department of Agriculture (Sabah)	
DSM	Department of Statistics (Malaysia)	
DSSM	Department of Statistics of Sabah Malaysia	
DVS	Department of Veterinary Services (West Malaysia)	
DVSAI	Department of Veterinary Services and Animal Industries (Sabah)	
ENSO	El ñino-Southern Oscillation	
FAO	Food and Agriculture Organisation	
FCE	Feed conversion efficiency	kg DM kg LWG^{-1}
g	Gram	g
ha	Hectare	ha
hd	Head	
H_{km}	Horizontal distance walked a day	
INRA	Institut National de la Recherche Agronomique	
K	Pottasium	
kg	Kilogram	kg
k_g	Coefficient of use of ME for liveweight gain	
k_l	Coefficient of use of ME for lactation	
km	Kilometre	
k_m	Coefficient of use of ME for body maintenance	
k_p	Coefficient of use of ME for pregnancy	
LWG	Liveweight gain	kg d^{-1}
LWL	Liveweight loss	kg d^{-1}
LWT	Liveweight	kg
m^2	Square metre	
MAFF	Ministry of Agriculture, Fisheries and Food	
ME or M/D	Metabolisable energy	MJ ME kg DM^{-1}
MEB	Metabolic energy budgeting	
ME_{LWL}	Mobilised body energy from liveweight loss	MJ ME d^{-1}
meq	Mili-equivalent	
Mg	Magnesium	
MJ	Megajoules	
mm	Millimetre	mm
mo	Month	
MPOB	Malaysian Palm Oil Board	
NASEM	National Academies of Sciences, Engineering, and Medicine	
N	Nitrogen	
NEM	North East Monsoon	
NEMI	National Enteric Methane Inventory	
NZ	New Zealand	
ºC	Degree Celsius	

OP	Oil palm
OPIC	Oil Palm Integrated Cattle
P	Phosphorus
P	Statistical probability
PKC	Palm Kernel Cake
PMLD	Pusat Menternak Lembu Dara (Centre for Heifer Rearing)
ppm	Parts per million
PPT	Pusat Pembanyakan Ternakan (Centre for Livestock Production)
R	Pearson's correlation coefficienct
RM	Ringgit Malaysia
SCA	Standing Committee on Agriculture
SKSB	Sawit Kinabalu Sendirian Berhad
SOA	Sulphate of Ammonia
SPT	Stesen Pembiakan Ternakan (Station for Livestock Breeding)
SRW	Standard Reference Weight
SU	Stock Unit
SWM	South West Monsoon
t	Tonne
V_{km}	Vertical distance distance walked per day
yr	Year

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