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Ewe size and nutrition during pregnancy

Effects on metabolic and productive performance of the offspring

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ABSTRACT

Exposure of the fetus to adverse conditions *in utero* may result in developmental adaptations that alter metabolism and postnatal growth of the offspring. This thesis investigated the effects of dam size and nutrition during pregnancy on growth, metabolic function and lactational and productive performance of the female offspring to two years of age. Four-hundred and fifty heavy ($60.8 \text{ kg} \pm 0.18$) and 450 light ($42.5 \text{ kg} \pm 0.17$) dams were randomly allocated to *ad libitum* or maintenance nutritional regimens from days 21 - 140 of pregnancy, under pastoral grazing conditions. From one week prior to lambing, all dams were fed *ad libitum* until weaning. After weaning, female progeny were managed and fed under pastoral conditions as one group. Maternal nutrition during pregnancy affected lamb growth to weaning, however, after weaning lamb growth was affected by dam size. Dam size had no effect on glucose metabolism, adrenal function or fat metabolism in 16-month-old female twin offspring. Dam nutrition during pregnancy had a minor effect on glucose metabolism and no effect on adrenal function or lipolysis, however, it did possibly affect gluconeogenesis and/or glycogenolysis, with increased glucose production in ewes born to maintenance-fed dams. Ewes born to dams fed maintenance showed greater milk production, lactose percentage, lactose and crude protein yield. Ewes born to heavy dams showed greater milk production and lactose yield. Dam size had no effect on reproductive performance of the female offspring. Being born to a larger dam showed no advantages over being born to smaller dams, for number of lambs born and weight of lambs at birth and weaning. 'Grand'dam maintenance nutrition increased lamb birth and weaning weight and lamb growth rates of the 'grand'offspring. Ewes born to maintenance-fed dams could have an advantage over ewes born to *ad libitum*-fed dams in physiological stressful situations in life as their liver may be able to supply more glucose to support their growing conceptus and milk production to increase the chances of survival of their offspring. These results indicate that it is possible to programme the offspring by feeding their dams differently during pregnancy under grazing conditions. With a better understanding of how offspring can

be programmed through different maternal nutritional regimens, it may be possible to significantly increase the production potential of the New Zealand ewe population.

SAMENVATTING

Blootstelling van een ongeboren jong aan ongunstige omstandigheden *in utero* (baarmoeder), kan resulteren in veranderingen in de ontwikkeling van het metabolisme en de groei van het nageslacht. In dit proefschrift worden de effecten beschreven van het gewicht en het voedingsniveau van de Nieuwe Zeelandse ooi tijdens de dracht op de groei, het metabolisme, de lactatie en het productie vermogen van haar vrouwelijke nageslacht tot twee-jarige leeftijd. Vierhonderdvijftig zware ($60.8 \text{ kg} \pm 0.18$) en 450 lichte ($42.5 \text{ kg} \pm 0.17$) ooiën waren *ad random* verdeeld over twee groepen: een groep had toegang tot *ad libitum* gras en een groep werd gegraasd op onderhouds-niveau van dag 21 – 140 van de dracht. Alle ooiën werden gehouden onder graas omstandigheden. Vanaf één week voor het lammeren, alle ooiën hadden toegang tot *ad libitum* gras tot aan het spenen. Hierna werd het vrouwelijke nageslacht als één groep gemanaged en hadden *ad libitum* gras beschikbaar. Het voer niveau van de ooi tijdens de dracht beïnvloedde de groei van het nageslacht tot aan het spenen. Het gewicht van de moeder beïnvloedde de groei van de lammeren na het spenen, maar dit had geen effect op het functioneren van het glucose metabolisme, de bijniëren (adrenal) en ook niet op het vet weefsel metabolisme op een leeftijd van 16 maanden. Het voer niveau van de ooi tijdens de dracht had ook geen effect op het functioneren van het glucose metabolisme, de bijniëren en lipolyse (vetafbraak), maar het had mogelijk wel een positief effect op het proces van gluconeogenese (opnieuw vormen van glucose) en/of glycogenolyse (het proces waarbij glycogeen wordt afgebroken en omgezet in glucose). Vrouwelijk nageslacht van ooiën die op het onderhouds-niveau gevoerd werden, hadden een grotere glucose produktie. Nageslacht van ooiën die onderhouds-niveau gevoerd werden, produceerden meer melk, lactose en eiwitten en hadden hogere lactose percentages in de melk. Nageslacht van zware ooiën produceerden meer melk en lactose. Het gewicht van de ooi had geen effect op het reproductie vermogen van het nageslacht. Er waren geen verschillen gevonden tussen de zware en lichte groep in het aantal geboren lammeren (tweede generatie) en het gewicht van deze lammeren zowel bij de geboorte als bij

het spenen. Voeren van het onderhouds-niveau aan de (groot)moeder verhoogde het geboorte en speen gewicht en ook de groei van de tweede generatie lammeren. Vergeleken met het nageslacht van oaien die *ad libitum* gevoerd werden, had het nageslacht van oaien die het onderhouds-niveau gevoerd kregen een voordeel in fysiologische stressvolle situaties. Omdat hun lever mogelijk meer glucose kan produceren en waardoor er meer glucose beschikbaar is voor het groeiende jong tijdens de dracht en voor de daarop volgende melk productie is de overlevingskans voor dit nageslacht groter. De resultaten in dit proefschrift laten zien dat het mogelijk is om het nageslacht te ‘programmeren’ door de moeder verschillende niveaus te voeren tijdens de dracht. Door meer inzicht in het ‘programmeren’ van het nageslacht te krijgen, door middel van verschillende voer niveaus tijdens en na de dracht, is het mogelijk om het productie vermogen van de Nieuw Zeelandse schapen te vergroten.

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