4.2.	Dietary reduction of N and P excretion (ruminants and monogastric)
NPA Location Finland, Northern Ireland, Republic of Ireland, Scotland	**Description and Purpose:** Adjust the composition of livestock diets to reduce the total intake of N and P per unit of production. Recent research has shown that animal feed can be formulated to reduce nitrogen (N) and phosphorus (P) excretion without reducing animal performance (Utah State University Cooperative Extension, 2010; Shields and Orme-Evans, 2015) . The ideal protein concept is a feeding method in which crude protein levels are reduced and amino acids are supplemented in order to reduce N excretion. For reduction of P excretion, adding phytase to the diet has been shown to increase P availability to hogs and chickens. According to the European Commission Guidelines for BEMPs (2018), there is a close relationship between the excretion of N and P by dairy cattle and the amounts consumed with feed. The guide highlights that nutritional measures are good options to reduce N and P excretion by animals. However, the EC (2008) underlined that in the western and eastern-southern type of dairy production in Europe, cow diets already have moderate N contents so that it is not realistic to reduce the N supply further without impairing the milk yield. Furthermore they highlighted that it is unrealistic to reduce the dietary N in beef systems given that beef fattening units tend to have optimised N supply, whilst for grazing animals (suckler herds and steers) small amounts of complementary protein rich feed is provided. The two main imports of P are through feed and mineral fertiliser. However, one must take into account the negative effects of diet changes on cattle, pigs and other livestock. These have been described in detail by Shields and Orme-Evans (2015).
	Nutrients Reduction (Effectiveness): Data are fairly limited. One study from the Netherlands in 2010 showed that agreement between farmers and the feed sector was reached to reduce P in feed by 10% which led to a reduction from 179 Mkg P_2O_5 to 161 Mkg P_2O_5.This was driven by informed farmers seeing the need to reduce P in feed as the only course of action once they stopped applying P fertiliser. European Commission (2018) cited research stating that for typical Danish (Northern Europe) pig production, the N excretion per pig could be reduced from 5.3 kg N per pig

	produced to 3.9 kg N, by using two feed mixtures for sows (differing in N content) and reducing the N concentration in slaughter-pig feed by 5 % and instead adding synthetic amino acids. They further underlined that this measure alone would reduce ammonia emission by 22 %, i.e. from the current 1.26 kg ammonia to 0.98 kg. For all pig farming systems, implementation of optimised feeding is expected to reduce the overall N excretion in manure by 32 %. The EC (2008) stated that in the UK dairy systems, an optimised feeding (going from 17 % crude protein in dry matter to 14 %) in the relevant systems could reduce the overall N excretion from the cattle by approximately 48 kg per cow and year. Maguire et al (2005) reviewed dietary strategies for reduced P excretion and improved water quality. They stated that reduction of P overfeeding, use of feed additives to enhance dietary P utilization, and development of high available phosphorus (HAP) grains are successful measures to decrease fecal P excretion without impairing animal performance.
	Recycling/Recovery: The information is limited. In general there is not much interest in nutrients recovery from agricultural activities (Drizo, 2019).
	Climate Change Mitigation: Given that feed production accounts for about 47% of livestock emissions it is a key target for mitigation. Nousiainen et al. (2004) showed that ammonia emissions from all farm sources may decrease by 5-15% (average 10%) from a reduction in mean protein content by 10 g per kg in the diet. Low-protein feeds is one of the most cost-effective and strategic ways to reduce NH_3 emissions. Oenema et al. (2012) stated that low-protein animal feeding also decreases N_2O emissions and increases the efficiency of N use in animal production but is only really applicable to housed animals. Swensson (2003) (cited in European Commission, 2018) observed that a 25 % lowered N supply to dairy cows did not impact milk yield, and reduced ammonia emission in the stable by over 65%.
	Operation and Maintenance (O & M): The EC Guide (2018) provides operational data for Dietary reduction of N and P excretion. The guide underlines that energy (as metabolisable energy, ME) and protein (crude protein, CP) are the critical nutrients for practical rationing on farm as these are the most costly nutrients to supply. CP is a simple measurement of N content of feed (assumed 16% N for budgeting purposes). Recommended CP and ME requirements for livestock are available in farm reference documents and websites e.g. Tried & Tested (2019).
	Cost: Schulte et al. (2012) (cited in EC, 2018) estimated that reduced fertiliser N usage rates per kg produce use (i.e. improved NUE) can result in an abatement potential 0.080 Mt CO_2eq for Ireland, with an associated cost saving of M€ 28.9.