Practical use of seaweed as a farm input

While there is considerable variation between different species, seaweeds are generally a good source of macro and micronutrients, rich in protein, carbohydrates, fibre, fatty acids and macro and micro minerals. Seaweeds have been assessed as being 10-20 times richer in minerals than terrestrial plants, with ingredients including iodine, calcium, phosphorous, magnesium, iron, sodium, potassium and chlorine, as well as trace minerals zinc, copper, manganese and selenium.

The potential to cultivate seaweeds or harvest them from the wild is therefore of considerable economic interest. Use of seaweed in agriculture has to compete with the financial returns from a range of other uses, including in high-value pharmaceutical and nutraceutical products. However, a number of agricultural uses appear to offer cost-effective benefits for farmers.

Biostimulants

Seaweeds generally lack the appropriate chemical composition to be classified as fertilisers, although sometimes seaweed extracts are blended with other fertiliser compounds. Otherwise, seaweed products are classed as biostimulants as they contain plant hormones, which enhance biological activity in plants. This can increase productivity and/or product quality, with additional benefits including reduced plant stress due to environmental factors (e.g. drought, heat, disease). These outcomes are such that seaweed can be used to replace synthetic fertilisers.

Most seaweed biostimulants on the market are wild harvested, processed by alkaline liquid extraction from fresh seaweed, or by grinding dried material. Typical prices worldwide are $10-30 per litre for seaweed extracts and $500-800 per tonne for dried product, depending on the seaweed species processed. These materials are mainly used in horticulture. There is a lack of standardisation leading to variable product, making it difficult for farmers to be confident about the effectiveness and return on investment from broadacre application. However, as new standards are introduced, and as alternatives to synthetic fertilisers are more eagerly sought, demand may increase.

Soil amendments

Research into compost made from seaweed indicates this can be a very effective soil amendment, increasing plant health and productivity. There is currently no seaweed compost produced commercially, but the option to add seaweed to on-farm composting processes may be attractive to farmers who can source fresh supplies. There does not appear to be a need to wash salt off the seaweed before processing, but the seaweed needs to be mixed with high-carbon materials, such as straw or sawdust, to achieve the optimal carbon:nitrogen (C:N) ratio for decomposition.

Livestock fodder

While seaweeds in general offer a wide range of nutrients, there can be problems of palatability, digestibility and adverse impacts from particular seaweed ingredients when using specific seaweeds. For example, digestibility has been estimated to range from 15-94%. The most problematic ingredient is iodine, and seaweed intake limits are often recommended with this in mind. As a result, seaweeds are usually considered appropriate for use as fodder supplements rather than bulk feeds. For ruminants, the recommended limit is commonly 2% of total feed dry weight, but about 10% is suggested for poultry, and less than 0.5% for pigs. While systematic research into the benefits of using these fodder supplements is limited, there is substantial empirical evidence that their inclusion can substantially increase animal health and productivity. This requires that the appropriate seaweed species be selected on the basis of digestibility as well as nutrient value.

There is some evidence that ensiling seaweed can increase its digestibility and moderate the iodine content, enabling larger quantities to be included in feed rations (e.g. 2-5% in pigs). However, as there is no commercial production of seaweed silage, farmers would need to source their own fresh seaweed supplies. Recent trials conducted with AgriFutures Australia's support suggest the labour involved to successfully prepare and ensile seaweed means this is not likely to be an attractive proposition for farmers.

Seaweed has considerable potential as a source of aquaculture feed, with preparation involving simple drying and milling processes. It appears to be an appropriate substitution for more expensive feeds for finfish, abalone, sea cucumber, sea urchins and prawns, where the cost of conventional feed can be as high as 50% of the cost of production. Co-production of seaweed with aquaculture may provide significant cost savings in feed production, as well as improve water quality, and there is particular interest in this among salmon farmers.

Methane suppressants

There is increasing focus on using feed supplements to reduce methane emissions from ruminant livestock, as part of strategies to reduce greenhouse gas emissions from farms. Methane emissions are significant among dairy and beef cattle, as well as sheep. As an example, the methane emissions from a single cow have been calculated as equivalent to 2.5 tonnes of CO_2 per year. If these emissions could be halved in ways that made the farmer eligible for carbon credits, the benefits could be monetised – about $150,000 per year for a herd of 200 cattle, or about 20 cents per head per day. Given that the co-benefits from reducing methane emissions are increased efficiency of feed conversion in the rumen (often estimated as about 10% or more), it may eventually be cost effective to spend this amount on proven methane-reduction strategies. However, there is much more work to be done to prove the efficacy of seaweed products or other feed additives in methane suppression.

There is particular interest in the potential use of *Asparagopsis* seaweed, which has a high level of bromoform. This is the ingredient considered most effective as a methane suppressant, though it may compromise animal health if fed in large quantities. The production of *Asparagopsis* in commercial quantities as a fodder supplement may be challenging, and processing it to retain the highly volatile bromoform content may be expensive. Levels of methane reduction are reported to be 50-90%, with the greatest reduction in confined livestock with a high grain content in their diet. The results for pasture-fed livestock suggest a lower level of effectiveness.

Producing an *Asparagopsis* supplement from farmed seaweed may ultimately be more expensive than producing bromoform ingredients synthetically. Trials of this production method are already being undertaken, with a target price of 20 cents per cow per day. Currently, available supplies of *Asparagopsis* cost about $1 per cow per day to administer, though it is hoped the cost may reduce to 30 cents per day in time. *Asparagopsis* will need to complete with other methane-suppressant fodder supplements, such as the European product Bovaer®, as well as locally available biochar, aiming for a price point of 15 cents per cow per day. While the levels of methane suppression may be less than those achieved through use of *Asparagopsis* (e.g. 20-40%), assessment of these alternatives needs to take into account the likely additional co-benefits of improved animal health, feed conversion, productivity and product quality. Future alternatives could include other seaweed species, such as kelps, which contain lesser quantities of bromoform but are easier and cheaper to produce in commercial quantities, and offer better nutritional benefits.

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Australian sources of seaweed

The seaweed products available to Australian farmers are largely derived from imported goods. Those priced at an affordable level for farmers are often of variable performance, with a lack of information on the species used and the resulting properties. Some products are derived from wild-harvested seaweeds, with farmed seaweeds largely being directed to more lucrative markets, such as pharmaceuticals and nutraceuticals. Using the by-products from pharmaceutical and nutraceutical production as agricultural inputs, such as livestock feed, may be possible, but the available quantities would be small.

Currently, in Australia, there is very little seaweed farming, with considerable regulatory hurdles for this type of enterprise. There are plans to farm *Asparagopsis* for its methane-suppressing properties, with parallel initiatives in New Zealand, but the long-term viability of this is unproven. There are a few pilot operations involving different seaweed species, but these have not reached commercial scale.

Wild harvesting, largely based on collection of beach wrack, is licensed in some areas, but this is very limited. The cost of processing beach wrack is such that it is not viable to direct the end product for agricultural use; the retail price of kelp has been quoted as $6,000 per tonne, with labour comprising about 50% of the production cost. Processing may involve species separation, collection, washing, shredding and preserving the seaweed in oil.

Co-production of seaweed with aquaculture is likely to increase in the future, taking advantage of the benefits of seaweed absorbing discharged nutrients, which would otherwise pollute the surrounding waters, as well as being a substitute for conventional aquaculture feed.

The recognised pollution-mitigating benefits of seaweed could also lead to future opportunities for harvesting the increasing volumes of seaweed growing in some Australian estuaries. Seaweed blooms are seen in many localities in response to increased nutrient pollution of waterways due to human activity. Evidence is emerging from other parts of the world that managed harvesting of these seaweeds can have environmental benefits and create opportunities for recycling the nutrients within agricultural systems. Composting appears to offer the immediate low-cost solution for Australian farmers, but if economies of scale can be established, there may be other product possibilities.

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