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# Sustainable Piggery Effluent Utilisation in Australian Farming Systems

Case studies on the development and implementation of Nutrient Management Plans at ten Australian piggeries

**2011**




CARING
FOR
OUR
COUNTRY

This project was partially funded through Australian Pork Limited and the Australian Government's Caring for our Country initiative

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# Table of Contents

# Foreword

The Australian pork industry is dedicated to producing environmentally sustainable pork, which involves fostering a long term competitive industry in Australia.

As well as producing a safe and tasty protein, the pork industry must also be responsible in managing its environmental impact in ways that continually underpin value in the final product. By becoming better environmental stewards, the pork industry can create new sources of value and economic opportunities for everyone in the supply chain.

Australian Pork Limited (APL) has a vision of a sustainable, competitive Australian pork industry that actively integrates sound environmental practices throughout the entire supply chain, from piggeries to abattoirs, boning rooms and processors.

APL has developed two significant documents to assist with this vision: the *National Environmental Sustainability Strategy for the Pork Industry 2010–2015,* and the *National Environmental Guidelines for Piggeries (2nd Edition Revised, 2010).*

The following case studies record the development and implementation of "Nutrient Management Plans" at 10 piggeries across Australia; four in Queensland, three in Victoria, two in Tasmania and one in South Australia. The farms selected were a mix of key stakeholders including large vertically integrated producers as well as smaller family owned farms.

The Nutrient Management Plans (NMPs) were formulated for each individual site and included nutrient management principles, farm nutrient status and assessment, nutrient management options (including a risk assessment and recommendations) and management plans. The NMPs identified capital and management practices required to implement the plan.

This applied demonstration and ultimately the adoption of sustainable effluent management practices has enabled the participating producers to undertake long term changes and improvements in nutrient management practices and champion the concept to encourage adoption by the wider pork industry.

This project was partially funded through the Australian Government's Caring for our Country initiative, for the development of the NMPs, and APL, for the preparation of case studies and promotion of the project outcomes to industry.

# Acknowledgments

Australian Pork Limited (APL) would like to thank the farmers and farm managers who devoted considerable time to the development and formulation of Nutrient Management Plans (NMPs) and subsequent response to the actions and recommendations in the plans. Their efforts in contributing to improved environmental practices in the pork industry are to be applauded.

APL acknowledges the detailed work by FSA Consulting in preparing the NMPs; Stephen Wiedemann, the Principal Investigator with Naomi Zadow, Robyn Tucker, Eugene McGahan and Michael O'Keefe.

APL also acknowledges Dr Rob Wilson, Rob Wilson Consulting, for collating this case study report.

The support of the Australian Government through the Caring for our Country initiative is gratefully acknowledged.

# Introduction[1]

Piggeries are net accumulators of nutrients as most of the nutrients brought onto the farm in the form of feed, bedding and other on-farm inputs such as fertiliser, are not removed when the pigs are sold. Most of the nutrients contained in feed end up in the piggery manure as solids, sludge, spent litter or effluent. Most piggeries store and use by-products they produce on-farm for growing pasture or crops. However, in most cases by-product application rates or plant removal rates are not calculated or estimated, especially for nitrogen and phosphorus, leading to potential nutrient overloading of soils and the potential risk of nutrient loss to the environment.

> "The pork industry produces by-products (in the form of effluent and manure) that are rich in nutrients and valuable to the enterprise, provided they can be managed well. If these by-products are not managed correctly, an environmental problem can exist because the nutrients can contaminate soil and water. By managing these nutrients, the potential environmental problem is turned into a benefit to the farm." *FARM B*

On-farm management of by-products is therefore an important component of sustainable piggery management practices.

Nutrient Management Plans (NMPs) assist in quantifying the mass balance of nutrients produced and utilised on-farm, and in identifying potential risks of nutrient losses to surface water, waterways or groundwater. By outlining current management practices and potential environmental risks, an action plan can be developed with the aim of adjusting management practices or improving infrastructure. This will ultimately improve nutrient use efficiency and reduce the risk of losing nutrients to the environment.

Poor nutrient management can lead to soil structure decline, nutrient overload, poor crop/pasture performance, leaf burn, compaction layers, erosion from bare batches, excessive weed growth, leaching and run-off into waterways. The benefits of good nutrient management can include cost savings by utilising a valuable fertiliser source and soil conditioner (organic matter), reduced use of synthetic fertiliser, improved soil structure and better infiltration.

[1]Adapted from Zadow, EN, Tucker, RW, McGahan, EJ, O'Keefe, MO and Wiedemann, DG, 2010. 'Caring for our Country – Nutrient Management Plan Development (Summary Report)', Final report prepared for Australian Pork Limited, APL Project No. 2262.02.

# Study Method[1]

The Nutrient Management Plans (NMPs) were developed through site visits, various tests, ie. soil, and modelled estimations.

The piggery nutrient balance was determined by using ether *PigBal* (QPIF 2004) or the *Piggery Assessment Spreadsheet* (Skerman 2003) to estimate the total volume of nutrients that exits the piggery in the form of solids, effluent and sludge using herd data and default diets. This process models the predicted effluent output and the amount of nitrogen, phosphorus, potassium and salts produced in piggery by-products. *PigBal* also estimates the volumes of nitrogen, phosphorus and potassium using a mass balance equation based on feed intake and pig production.

Most piggeries spread manure by-products in some form onto paddocks to grow crops or pastures. The sustainability of the by-product reuse practices was modelled using paddock nutrient budgets. Inputs into the paddock nutrient budget were either calculated from analysis results collected during site visits, industry average values, or values derived from *PigBal*. Plant or livestock removal rates were calculated using expected dry matter yields and textbook nutrient contents. Soil reserves of nutrients were derived from the analysis results from the soil, water, effluent, manure and compost samples collected during the site visits.

> "The pig industry always needs to gain knowledge of the benefits and problems with effluent management. We need to know a base point of our nutrient levels now and what we should be achieving." *FARM D*

A nutrient risk assessment based on the *National Environmental Guidelines for Piggeries (2nd Edition Revised, 2010)* (Tucker, McGahan, Galloway & O'Keefe 2010) was completed.

Based on information collected on the site visit, the outcomes of paddock nutrient budgets, and the environmental risk assessment, recommendations were given on different options for improving nutrient management on each farm. An action plan was then developed in conjunction with the piggery owners and managers after they had reviewed the draft NMPs. Each action plan detailed the requirements for each recommendation, a timeline for completing the improvements and the person responsible.

> "This project benefitted our operation by helping turn a potential environmental risk into a benefit to the farm. In the long term, this will help our business to be sustainable and allow ongoing pork production. This benefits the whole industry." *FARM B*

The following case studies were developed from this body of information.

[1] Adapted from Zadow, EN, Tucker, RW, McGahan, EJ, O'Keefe, MO and Wiedemann, DG, 2010. 'Caring for our Country – Nutrient Management Plan Development (Summary Report)', Final report prepared for Australian Pork Limited, APL Project No. 2262.02.

# Farm A

1800 SOW FREE RANGE BREEDER UNIT, SOUTHERN AUSTRALIA

## Farm Description

This piggery is an 1800 sow rotational outdoor breeder piggery located in Southern Australia. The piggery has been operating since 1997 and commenced as a 400 sow outdoor unit. The property's soils are brown volcanic clays showing nutrient levels generally sufficient to sustain crops.

The property is managed using a 12 year rotation involving three years of pig use, followed by nine years of alternative use; a rotation of wheat or barley, canola and livestock grazing of pasture or cereal stubble. Following the three year pig phase, the paddocks are remediated by levelling, refilling the wallows and ploughing twice before direct drilling with broad leafed crops.

The piggery design consists of three separate production units of 450 sows and piglets to three to four weeks of age, and a gilt training and isolation area containing approximately 335 gilts at any one time. The areas used by pigs are established as paddocks radiating from a central handling area, with each of the units having a farrowing and dry sow area.

The farrowing area typically consists of 20 pens with six sows kept in each paddock with straw-bedded farrowing huts. The dry sow unit consists of 15 pens radiating from a central handling area with straw-bedded huts for shelter.

Photo: Aerial view of the site showing crop growing on land that has had pigs on it for three years

## Farm Management Objectives

The farm management practices are designed to limit the build up of nutrients across the farm in conjunction with the 12 year rotational system. This involves moving the dry sows within each paddock every six months and the farrowing sows every four weeks, with self-feeders moved every 20 days.

The 12 year rotation incorporates:

- Three years of pig production;
- Three years of wheat or barley with fertiliser applied to each crop;
- Three years of canola with fertiliser application; and
- Three years of livestock grazing on pasture or cereal stubble with no fertiliser application.

Crops and grazing may however occur in annual cycles in order to improve cereal management, yields and/or to reduce crop disease and herbicide resistance.

## Issues Identified

The manure (nutrient) deposition rate will vary between the dry sow and farrowing areas due to differences in diets fed, production and stocking density. Favouring of dunging areas by pigs would unevenly distribute manure on a paddock scale.

*PigBal* was used to estimate the theoretical annual nutrient mass balance for the piggery phase of the paddock rotation. In the three years the pigs are kept in an area of 125 hectares, the total nutrients applied to this area is 525 kg N/ha, 330 kg P/ha and 261 kg K/ha.

Using historical crop performance and fertiliser application data for the 12 year rotation period, an annual nutrient budget indicated that significantly more nutrients were added to the land than removed through the rotation.

Given the clay content of the soils, soil compaction was also identified as a possible factor responsible for some of the agronomic issues experienced at times during the cropping rotations. Compaction of the wallow areas occurred resulting from wet soils being constantly filled, levelled and used.

## Risk Assessment

A nutrient risk assessment was completed which indicated that while the soils used for the piggery are suitable for growing crops, yields may be limited by depth, stoniness and marginal sodicity in some paddocks.

Overall the assessment showed that there is a need for improved management of the nutrients deposited during the pig rotational phase, including the amount of nutrients deposited and the distribution within the paddock.

## Action Plans and Recommendations

There is little research, and consequently a lack of specific Australian published advice, to address the soil and environmental issues arising from outdoor pig production. Therefore the action plan for this Nutrient Management Plan (NMP) includes the collection of updated information to assist any future management decisions.

Concerns about the level of nutrients applied by the pigs and the nutrient distribution within the paddocks may be addressed by:

- Reducing the length of the pig phase and/or pig numbers;
- Reducing the pig phase to two years in the rotation and still utilising the same cropping and grazing removals from a nine year phase would result in a much reduced nutrient surplus; and
- Promoting a more even manure disposal across the paddocks by more frequent relocation of huts, feed troughs and self feeders.

Soil compaction following the three year pig phase and of the wallow areas may be remediated by:

- Moving pigs to new areas more frequently, though this will increase costs and involve logistical challenges;
- Growing pasture ley crops (ungrazed), adding gypsum, cultivating the soil when dry or deep ripping after the pig phase;
- Allowing the wallows to dry before remediation;
- Ripping wallow areas and adding gypsum; and
- Using paddock soil to fill and level the surface.

## Implementation

Activities undertaken since the NMP was developed included alterations to the rotation sequence from a three year pig phase to a two year phase. In addition, management practices have been altered to increase the frequency of sow movements within the two year pig phase. Both these practices will greatly improve the distribution of manure application within the paddocks, reduce the overall loading rates and hence improve the difference between nutrient application and removal through the cropping phases.

> "The importance to the 'outdoor' sector of the Australian pig industry of this type and frequency of rotation is crucial to the long term sustainability of this sector. The extra cost (of recommended practices) is substantial as we run a number of units. But if the company did not implement these new procedures it may not be pig farming in the future."

The other significant change has been the removal of a 'unit' (470 sows and gilts) from a 32 hectare area, which has occupied this area for two years. This effectively changes the overall design to a 'five unit' operation from the original 'three units'. This in itself improves the rotational frequency between the pig and crop rotational phases and hence the overall nutrient management of the property.

# Farm B

2250 SOW FARROW TO WEANER UNIT, NORTHERN AUSTRALIA

## Farm Description

This property in Northern Australia operates a 2250 sow breeder unit producing weaners which are transferred to another grow-out site; the piggery has been operating for approximately 25 years. The 179 hectare property comprises undulating soils of moderately weathered sedimentary rock or old alluvia.

The pig sheds are of traditional design with the manure flushed from the sheds regularly using treated effluent. The effluent is collected in a sump and then flows to a series of four ponds for treatment; an anaerobic, facultative anaerobic, aerobic and finally a storage pond. The ponds have a total capacity of 40 ML. Approximately one half of this volume needs to be removed annually to maintain capacity in the pond system.

No effluent or piggery solids are spread on the property, although the farm licence includes an irrigation area which has not been developed. All solids are composted at an adjacent facility and taken off-site; treated liquid effluent is used for flushing sheds and on the compost windrows.

## Farm Management Objectives

The composting operation has experienced difficulties in sourcing enough bulking carbon sources to utilise all the liquid effluent from the ponds and as a consequence is utilising less than the 20 ML required to maintain capacity in the ponds. It has been estimated that the long term availability of a bulking source will restrict the use of effluent to about 10 ML per year.

The owners have proposed that an irrigation area of approximately 40 hectares be developed to irrigate the excess effluent not required for composting. This will reduce the likelihood of the ponds overtopping and make better use of a valuable nutrient source. They propose to grow a mix of perennial pastures and graze cattle on the irrigated area.

## Issues Identified

*PigBal* estimates have indicated that the piggery produces annually a total of 49.2 t N, 17 t P and 12.5 t K of which 12.3 t/yr N, 16.5 t/y P and 0.6 t/yr K is available in the sludge for composting. The remaining 12.9 t/yr N, 0.5 t/yr P and 11.2 t/yr K should be available for reuse.

It has been estimated that approximately 10 ML/yr will be available for irrigation and if this treated effluent is applied at a rate of 0.25 ML/ha/yr over the 40 hectares, then 81 kg N/ha, 3 kg P/ha and 105 kg K/ha will be applied annually to the soil.

Soil testing of the proposed irrigation area showed that soil fertility was reasonable, although soil N and S levels are low. There was a high level of background P in one paddock, but this is not likely to restrict irrigation application rates. Conductivity and sodicity levels are both low at all sites. Provided that nutrient deficiencies are amended and P levels monitored, the area is suitable for effluent irrigation.

Only grazing cattle on perennial pastures will not remove sufficient N, which could potentially be lost in run-off or by leaching into groundwater.

Photo: High yielding perennial pasture under irrigation

## Risk Assessment

A nutrient risk assessment was conducted and overall the property has a low environmental risk profile, however the mortality carcass and effluent treatment areas require attention due to the close vicinity of a fresh water bore.

The carcass burial pits are sited in an area where soil permeability may increase the risk of nutrient leaching. Surface water ponding around the burial site may also occur.

## Action Plans and Recommendations

Difficulty in sourcing sufficient bulking material for the compost operation to utilise all the treated liquid effluent will necessitate the development of a 40 hectare irrigation area. A farm monitoring plan should be developed to include all sampling requirements stated in the piggery's current licence. Both effluent and soil nutrient analysis will validate that the application rates are sustainable and that excess nutrients are not leaching below the plant root zone.

Improved pastures are to be established and cutting a pasture hay crop to remove nutrients is recommended in conjunction with grazing cattle. Growing a forage sorghum crop for hay would also be a good option to use in the rotation if a higher rate of effluent application is needed. This would assist in removing excess N and K if soil monitoring results indicate that levels are becoming too high.

It is also recommended to upgrade the existing carcass composting facilities by lining new or emptied pits with a thick layer of sawdust and diverting surface water run-off around the pits by installing a drain.

Photo: Contrast in perennial pasture under irrigation versus unirrigated

## Implementation

The activities undertaken as a result of the Nutrient Management Plan (NMP) have been to purchase and install an irrigator which can spread effluent across the 40 hectare area to be used for improved pasture hay production and cattle grazing. This has reduced the likelihood of the ponds overtopping if usage in the compost operation is further reduced.

> "The project has resulted in better utilisation of the effluent on-farm. We are now able to irrigate the nutrients in the piggery effluent over a larger area of land, where it can benefit the pasture and provide for cattle grazing and hay production."

Photo: The new irrigator can spread effluent over large areas

These improvements have assisted to overcome any adverse issues that may arise with effluent management on the property and has given the owner another sustainable option for using the effluent, in addition to the composting operation.

> "Since installing the irrigator, we have been able to distribute the nutrients over a much larger amount of land than could be done previously. The dual reel system gives us absolute flexibility to irrigate the correct amount of nutrient on the areas as required."

Photo: Flexible irrigation options are key to the system's success

# Farm C

330 SOW OUTDOOR-FARROW TO SHED-FINISH UNIT, SOUTHERN AUSTRALIA

## Farm Description

This mixed enterprise on 480 hectare property of medium, brown clay loam in Southern Australia operates a 330 sow farrow to finish unit with breeding and farrowing outdoors, and the post-wean growing stock housed in verandah type sheds. The design incorporates a radial paddock system rotated around the property.

The system incorporates a nine year land use rotation with pigs kept on a 10 hectare paddock for a year followed by eight years of cropping and pastures, hay or seed production. A new site for the breeding stock is selected each year. The crop/pasture rotation usually occurs in annual cycles, eg. wheat, legumes, and then pasture.

The sheds are hosed clean between batches of pigs and the effluent collected in pits at the end of the sheds. Effluent from these pits is pumped to a main storage/drainage pit with a storage capacity for four to five months, depending on rainfall.

Effluent is drawn directly from the storage pits for spreading on the property every two to three weeks using a vacuum tanker.

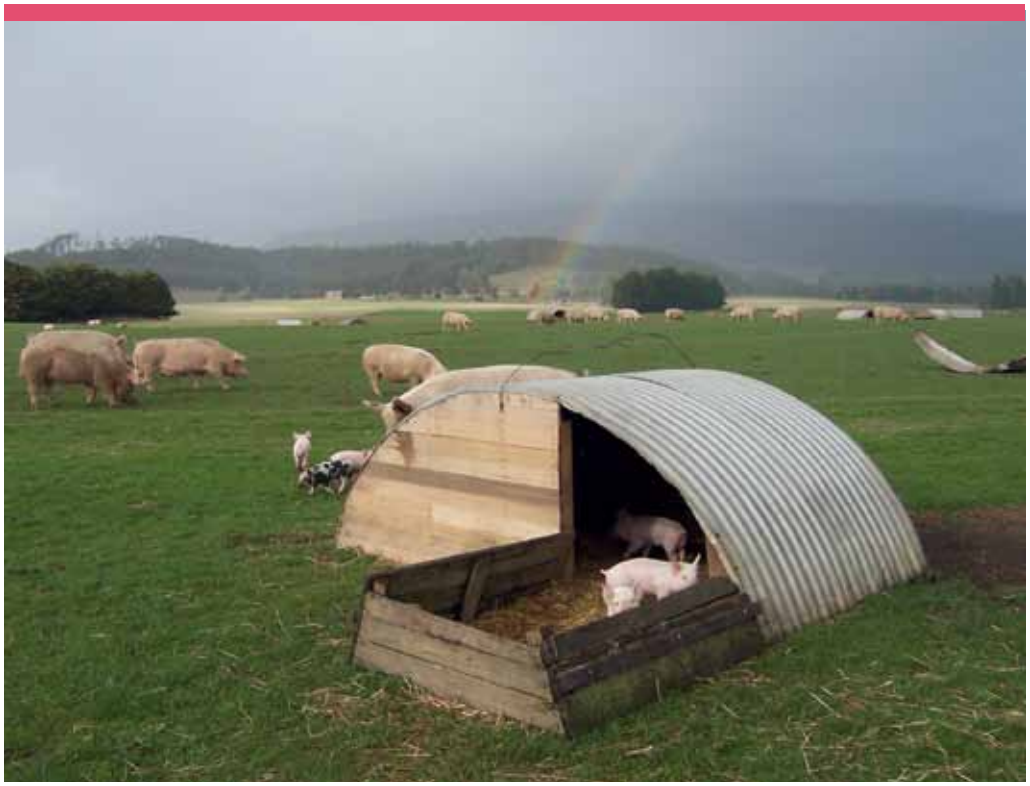

Photo: Sows are bred and farrowed outdoors

## Farm Management Objectives

The management of this business is conscious of the environmental responsibilities of operating a diversified farming enterprise that will utilise the piggery's effluent stream efficiently. A nine year pig and crop/pasture rotational strategy exemplifies this recognition for environmental sustainability.

Effluent is not spread within 20 metres of any watercourses, a 20 metre wide buffer is always maintained between an existing creek and areas used to run the outdoor pigs, and the sheds are located approximately 10 metres from this creek.

The crop, pasture and seed production rotations are designed to improve crop yields, assist weed management, reduce the likelihood of crop disease transfer and reduce herbicide resistance. Crop performance data and fertiliser application rates are recorded to help manage this process.

The need to utilise the piggery effluent more effectively has been identified, not only for agronomic reasons, but also to save labour, machinery time and soil compaction from using the vacuum tanker to spread effluent.

## Issues Identified

*PigBal* was used to produce a nutrient mass balance for the 10 hectare outdoor rotational piggery. The annual nutrient output over the pig site was calculated to be 580 kg N/ha, 360 kg P/ha and 260 kg K/ha. The 4 ML of liquid effluent spread annually over 200 hectares of land available for reuse would contribute 16 kg N/ha, 4 kg P/ha and 7 kg K/ha; a low average annual nutrient application rate.

Soil analysis from a number of sites across the property showed that the topsoil levels of N, P and K were generally high to very high, with soil acidity a concern in a number of paddocks.

The nutrient budget suggests that the current nine year rotation is not sufficient to remove the nutrients applied from the pig effluent and from the inorganic fertiliser additions as well.

## Risk Assessment

An environmental risk assessment matrix indicated that by-product reuse could be improved by correcting the balance between nutrient inputs through the anticipated removal by the crop and pasture rotation, through soil nutrient storage, and the strategic irrigating of effluent (taking into account seasonal and weather conditions).

Surface water could be vulnerable as the sheds and pig sites are located close to a water course, even though buffer distances are maintained. Other identified risks included a potential risk of an effluent spill from the storage pits and that the effluent is not regularly analysed, although records of reuse are undertaken.

## Action Plans and Recommendations

An important recommendation was to develop a sustainable rotation plan for the outdoor piggery sites, together with a formal environmental monitoring plan. This would determine alternate or improved land uses to follow the pig phase to better match nutrient inputs and removal rates. Options include:

- Reducing inorganic applications;
- Growing crops with a high nutrient removal rate; or
- Lengthening the rotation intervals, ie. extending the cropping phase.

Effluent management reuse and costs could be improved by installing an agitator, pump, pipe work and travelling irrigator to spread the liquid effluent rather than using a vacuum tanker. The monitoring plan would include regular effluent and soil testing in all reuse and pig site areas.

Photo: A travelling irrigator is now used to spread effluent

## Implementation

In order to meet these recommendations a new effluent irrigation system has been installed on the property. This includes the installation of a new suction line to the largest of the effluent holding pits and extensive underground pipe work for connection to a travelling irrigator for spreading over a larger area. The sprinkler will travel approximately 200 metres at each cycle and be able to cover two hectares each month, taking into account seasonal and weather conditions.

Photo: Pasture under irrigation

This land will be cropped with wheat and, at an estimated yield of 6 t/ha, will likely remove approximately 144 kg N and 24 kg P from each crop. A soil monitoring program has also been instigated.

> "We are conscious of the environmental needs of farming and this utilisation of the waste is a way we saw to assist with the environmental impact on the land from the piggery effluent."

The implementation of the improved irrigation and cropping program is expected to be shown as an example of best practice for the wider farming community in the area, as well as yielding an immediate return through reducing running costs and increased crop yields.

Photo: Crops are benefitting from the new irrigation system

# Farm D

530 SOW FARROW TO FINISH UNIT, SOUTHERN AUSTRALIA

## Farm Description

This piggery is situated in Southern Australia on a 450 hectare property of undulating loam and clay-loams soils. The piggery has been operating since the mid 1970s.

The piggery generates approximately 470 000 L of effluent per week from conventional sheds designed with flush drains and pull-plug systems. The raw effluent from sheds gravitates to an in-ground concrete tank, agitated and periodically pumped over a static run-down screen which removes approximately 17 $m^3$ of wet solids per week.

Separated liquid effluent gravitates to an anaerobic pond and then to a winter storage pond prior to being irrigated. A third pond is available for storage if required. The separated solids are stockpiled on a concrete drying pad for approximately two to four weeks and then either spread on the farm or used as starter compost material for the mortality composting process. Some solid material is sold off-farm.

Approximately 420 hectares of land is available for effective grazing or cropping and 120 hectares can be irrigated with effluent. The remaining land, approximately 290 hectares, can be used for solids spreading. A further 160 hectares off-farm is also available for spreading solids.

The main method of nutrient removal from the property is through live weight of cattle grazed on the irrigated pastures or from grain and forage production.

## Farm Management Objectives

The owner has expressed an interest in developing a sustainable Nutrient Management Plan (NMP) for budgeting nutrient applications based on efficient use of the piggery's by-products and the strategic use of artificial fertilisers. Silage has previously been produced and fed to cattle, but this has become an expensive practice and hard to justify when cattle returns are low. Low rainfall seasons also reduce the potential for fodder yields.

It is also intended to investigate the potential to increase the composting operations utilising mortalities, screened solids and a carbon source to develop and maintain a regular market for the compost. Advice will be required on the composting process and the potential value of the product to justify further investment in composting infrastructure and equipment.

> "The pig industry produces manure which should be used to improve production of the surrounding land."

It is expected that these activities, together with a cropping program, will achieve the sustainable use and removal of nutrients across the whole property.

## Issues Identified

The NMP utilised whole farm nutrient assessment using *PigBal* to predict effluent output and nutrients produced in the by-products. Paddock nutrient assessment and budgeting was undertaken to account for nutrient movements at the paddock level and to record the efficiency of nutrient use.

It was determined that spreading the screened solids at 3.6 t/ha over the 290 hectares of land suitable for spreading, would supply approximately 10 kg N/ha, 3 kg P/ha and 3 kg K/ha.

Application of liquid effluent at a rate of 0.19 ML/ha over the 126 hectares available for irrigation would distribute annually 98 kg N/ha, 6 kg P/ha and 142 kg K/ha.

Soil testing at the 0-10 cm levels showed that all paddocks have high levels of P and K, though N was below the normal baseline level for crop and pasture production. This indicated that there would be adequate P and K reserves for cropping without further application of effluent, compost or artificial fertilisers. Nitrogen would however need to be applied to meet expected crop requirements.

Deep soil testing (50-60 cm) has shown significantly lower levels for N and P, indicating that nutrients have not leached beyond the root zone. Soil and plant nutrient budgeting did indicate that all crops, including grazing of post crop removal, has the potential to remove the nutrients supplied by the effluent.

To ensure the long term sustainability of effluent reuse on the property, nutrient application needs to be better matched to crop nutrient removal rates and existing soil reserves.

> "As a start we need to know a base point of what our nutrient levels are now and what we should be aiming for."

## Risk Assessment

An environment risk assessment matrix indicated that the operation and management of the property will not impose any risks to the surrounding amenity and environment. The improvements identified relate to effluent nutrient composition and subsequent reuse on the property, utilising soil and crop nutrient removal budgeting.

## Action Plans And Recommendations

Activities have been identified around paddock scale nutrient budgeting, deep soil sampling, sampling and analysis of by-products prior to land application and surface soil nutrient analysis, to assist with nutrient budgeting. Specifically, the recommendations include:

- Development of an annual nutrient budget in collaboration with agronomic advice on an annual cropping program, as well as the existing grazing and hay/silage operations, to maximise the specific nutrient requirements for crops and pastures. This needs to also make recommendations for the strategic use of artificial fertilisers;

- Identification of paddocks that have high concentrations of nutrients and undertake further deep soil nutrient testing to assess any leaching of nutrients beyond the root zone; and
- Advice on the siting, design and operation of a compost operation be sought to minimise any impacts on surface and groundwater. Locations adjacent to the existing effluent ponds should be considered for the diversion and capture of compost pad water run-off into the ponds. Composting of all screened solids should be undertaken to reduce the amount of nutrients that require on-farm spreading.

Photo: A windrow turner makes an expanded compost operation easier to manage

## Implementation

Since the piggery's NMP and recommendations, the owner has carried out excavations for the installation of an increased and improved network of underground pipes, with risers at specific positions, for connection to a travelling irrigator. This has meant that irrigation of effluent can now be applied over a larger area of the farm than previously had occurred and with improved efficiency of operation and application.

> "The result is that we have made it quicker and more efficient to move the irrigator, plus given enough water pressure to extend the line areas that traditionally haven't been irrigated with manure. This allows less concentration of manure and reduced nutrient build up per hectare."

A monitoring program has been developed and instigated that includes sampling and analysing of treated effluent, solids and soils of the reuse areas, to ensure improvements to the overall nutrient management of the farm.

# Farm E

2000 SOW FARROW TO FINISH UNIT, SOUTHERN AUSTRALIA

## Farm Description

This farm is a 2000 sow conventionally designed breeding and finishing farm on 440 hectares of slightly undulating reddish brown or brown clays, situated in Southern Australia.

The piggery operates an integrated waste management and treatment system producing liquid effluent for on-farm irrigation and separated solids for compost manufacture. Compost is spread on the property and also sold for horticulture and domestic garden products.

Approximately 357 hectares can be irrigated with liquid treated effluent; spray irrigation over 320 hectares and two flood-irrigated reuse areas of 13 and 18 hectares. Compost is spread on a 65 hectare paddock while two other properties of 316 and 143 hectares can also be used for spreading compost, giving approximately 490 hectares available for compost use. A leased property brings the total farmed area to 1250 hectares.

Canola-wheat-canola or canola-wheat rotations are routinely cropped on the property with the stubble cultivated into the soil prior to seeding.

## Farm Management Objectives

An integrated total farm management program has been developed incorporating waste management and treatment, extensive irrigation of treated liquid effluent, spreading of compost and a rotational cropping program. The components of the program include:

- Daily flushing of pig sheds to an anaerobic digester;
- Biogas capture and reuse for cogeneration on-site;
- Ponds for effluent storage, polishing and evaporation;
- Compost production incorporating mortalities and utilised for spreading on the property;
- Spray irrigation for eight to nine hours per day for five days over a 20 week cycle;
- Flood irrigation onto two reuse paddocks;
- Nutrient analysis of effluent and compost, measurement and recording of irrigation rates; and
- A rotation of canola and wheat crops.

## Issues Identified

Property records indicated that up to 100 ML of effluent is irrigated annually, which would apply 70.9 t N/ha, 4.5 t P/ha and 17.8 t K/ha annually, or using an application rate of 0.38 ML/ha over the whole irrigation area, would provide 162 kg N/ha, 17 kg P/ha and 38 kg K/ha. Compost spread over the existing 490 hectares at 2.55 t/ha would contribute 6 kg N/ha, 15 kg P/ha and 7 kg K/ha.

Surface soil sampling in the flood-irrigated reuse paddocks showed suitable levels of nutrients for crop production with adequate levels of N on most sites. However, the available P levels were above the threshold levels on all paddocks.

Crop yield data was used to calculate the potential for nutrient removal rates, based on growing wheat and canola. The amount of N and K applied is substantially more than is being removed by both crops, with wheat removing approximately 78 per cent and canola 56 per cent of the N applied respectively. At an application rate of 0.28 ML/ha, N application rates exceeded the crop demand by 26 kg for wheat and 52 kg for canola. The nutrient budget for compost spread at 2.55 t/ha indicated that this would not meet crop nutrient demands.

Overall, soil analysis showed there is a large bank of nutrients in the soil.

## Risk Assessment

A nutrient risk assessment was completed taking into account all the components of the integrated waste management processes. Soil available P levels in the two flood-irrigated reuse paddocks were substantially above environmental thresholds, indicating that there would be adequate P reserves for several years of intensive cropping without any further application of effluent or fertiliser. Also, across most paddocks there were high surface nitrite levels indicating a potential risk of nitrate leaching. Soil salt levels were also a limitation to the range of crops at some sites on the property.

The nutrient risk assessment identified the need for improved management of nutrient application and removal rates for both the liquid and compost applied on reuse areas.

## Action Plans and Recommendations

It has been recommended that no further by-products be applied to the two flood-irrigated reuse areas until soil P levels have been significantly reduced by growing hay or silage crops. A soil monitoring plan for these areas needs to be developed and implemented that includes sampling at deeper soil levels to check for any nutrient leaching.

A plan for the sustainable balance between the application of nutrients and removal by crops over the remainder of the property is recommended. This may involve irrigating a larger area of land, growing crops that will remove nutrients at a higher rate, or likely a combination of both. A soil monitoring plan for these areas also needs to be implemented so that paddock scale nutrient budgets can be calculated to match crop types.

## Implementation

The management of the piggery has responded to the Nutrient Management Plan (NMP) and recommendations by undertaking a two stage improvement program to irrigate the treated liquid effluent over a greater area of the properties.

Stage one entails the connection of the existing underground main effluent line directly to the holding ponds, rather than through the piggery pumping system, to enable the effluent to be pumped to increased areas of the property for irrigation. This stage has been completed.

The second stage is to install two further underground main lines to pump effluent to areas of the property that has previously not been irrigated.

Both of these initiatives will result in the effluent nutrients being applied over a greater area of the property and allow the flood-irrigated reuse paddocks to be rested for longer periods, in order to re-establish a nutrient balance.

Progress in developing and adopting an extensive monitoring plan to maintain and improve nutrient management over the site is well underway.

# Farm F

110 SOW FARROW TO FINISH UNIT, SOUTHERN AUSTRALIA

## Farm Description

This piggery is situated in Southern Australia on 99 hectares with soils ranging from sandy loams to medium clays. A 49 hectare leased block adjacent to the property is also available for the enterprise.

There are two sheds of conventional design with solid concrete floors that require hand cleaning by hosing out every second day; a time consuming task.

The effluent is collected in a small sump and irrigated daily after washout over a six hectare area using a single stationary sprinkler which is moved periodically. It is estimated that the total effluent spread is approximately 7 ML per year.

The property is cleared for pastures, pasture hay and sheep and cattle grazing.

## Farm Management Objectives

The owners would like to be able to spend less time hosing and cleaning manure from the sheds, reduce the amount of water used for this task, and therefore spend more time on husbandry tasks for the pigs. This will necessitate installation of flush tanks to the sheds. Also the sump-pump system has limited capacity and therefore irrigation needs to continue regardless of the season or weather conditions.

The current sprinkler system blocks periodically, so consideration is being given to installing an agitator and solids separator; the solids can continue to be spread on the reuse area.

Recognising these issues as well as the nutrient value of the effluent, the owners would also like to irrigate the effluent over a greater area and with more uniformity and consistency. This would also provide the potential to blend effluent with freshwater to further increase the effluent application area.

> "The pig industry produces a valuable source of fertiliser; we need to learn how to use it correctly."

## Issues Identified

*PigBal* was used to determine the theoretical nutrient mass balance for the piggery and the annual nutrient output of the herd is 4.2 t N, 1.6 t P and 1.4 t K. Application and soil surface losses of N would result in approximately 2.5 t N/yr being available for pasture and crop uptake.

Approximately six hectares of land are currently irrigated with effluent. Applying 7 ML to this area at a rate of 1.17 ML/ha will provide approximately 416 kg N/ha, 259 kg P/ha and 233 kg K/ha.

Soil samples were taken from the reuse area and from other sites that could potentially receive effluent in the future. These samples indicated that the current reuse area has high total soil N and P levels and should be spelled, then pastures or crops grown and harvested to reduce nutrient levels.

Soil samples from the other paddocks had variable nutrient analysis but in all cases acidity was of concern. These variable results would suggest that a more tailored nutrient application plan will be needed for each paddock.

By using pasture hay yields of approximately 7 t/ha (3.5 t DM/ha), the nutrient budget indicates that significantly more nutrients are added than removed by harvesting pasture hay, showing an excess of 363 kg N, 248 kg P and 252 kg K per hectare.

The excess N and P applied via the effluent and inorganic fertilisers may be lost to the environment through leaching and/or surface run-off.

## Risk Assessment

A nutrient risk assessment was completed taking into account all aspects of the effluent management and reuse system. Overall the assessment identified some high risk areas, including:

- Labour intensive shed cleaning methods;
- Existing pump is undersized and effluent needs to be irrigated regardless of soil conditions;
- Blockages are a recurrent problem;
- Existing sprinkler needs to be manually moved and likely to result in uneven application; and
- Effluent is not routinely analysed, the reuse rate not measured or recorded and therefore a sustainable reuse rate has not been determined.

## Action Plans And Recommendations

To improve effluent management and reuse, a number of actions have been suggested:

- Development of a monitoring program incorporating annual soil sampling and analysis to aid decisions about future effluent applications;
- Installation of flush tanks for more effective and efficient shed cleaning and to accommodate a longer term plan to irrigate effluent using a larger irrigator;
- Installation of a mechanical agitator-solids separation system at the sump;
- Installation of a larger effluent sump to provide back-up volume and allow more effective mixing;
- Improving the irrigation system to provide a more even distribution of effluent over a larger land area; and
- Development and implementation of a Nutrient Management Plan (NMP).

## Implementation

To date the owners have built and installed five automatic flush tanks with the resultant improvements to the volumes of water used to clean the sheds, as well as saving considerable labour time that is now being devoted to the pigs. A related observation is that there is less odour in the sheds.

There is also less reliance on regular irrigation from the sump and so better control over the rate of nutrient application to the reuse area. The remaining recommendations are under consideration by the owners.

> "The project has enabled us to significantly reduce the amount of water used to clean our shed on a daily basis, which in turn has meant that there is less pressure on our sump. We also have more time to look after our stock."

# Farm G

1300 SOW FARROW TO FINISH UNIT, NORTHERN AUSTRALIA

## Farm Description

This piggery, established in 1986, is situated in Northern Australia on 608 hectares of gently sloping soils derived from moderately weathered sedentary rock or old alluvia. The design is conventional sheds with fully slatted floors and a flushing effluent system. There are two units, both of similar design and construction.

The effluent from one unit flows into a series of four treatment ponds and then to an effluent irrigation holding pond. The effluent from the other unit flows to two treatment ponds before flowing to the irrigation holding pond.

## Farm Management Objectives

The farm management practices include flood irrigation of the treated effluent from the holding pond twice a year over a 32 hectare grazing paddock; approximately 18 ML per year of treated effluent being irrigated. The irrigated area has been established with non-improved and improved pasture species. There are no other major nutrient inputs to the paddocks.

The ponds are desludged as required, usually every five to 10 years. Mortalities are composted in straw bale constructed bays, although no compost is spread on the property.

Annual soil monitoring is undertaken after the end of a cropping cycle or at the end of the growing period for permanent pastures. The soil samples are taken at 0-10, 20-30 and 50-60 cm depths.


Photo: Initial soil samples show high levels of sodicity

## Issues Identified

The on-farm nutrient budget indicates that improvements could be made to increase nutrient recovery from both the piggery and the effluent reuse paddock. If the estimated 18 ML of treated effluent with a composition of 408 mg/L N, 19.4 mg/L P and 1210 mg/L K was evenly applied annually to the 32.4 hectare area, this would be equivalent to applying 145 kg N/ha, 11 kg P/ha and 672 kg K/ha. Grazing cattle at a stocking rate of 1 hd/ha will only remove a small proportion of these levels, indicating that the current reuse practices do not remove all nutrients, particularly N and K, that are applied in the effluent.

Relatively low levels of N and P at the test sites in the reuse paddock shows that the paddock is not irrigated very frequently or evenly. The contour channel has not been well maintained and the effluent appears only to have reached approximately one half of the irrigation area. The condition of the pasture in the paddock also supports this observation.

The site with less irrigated effluent has poor pasture growth and levels of N and P are both marginal for crop and pasture growth. The levels of N are more normal at the site receiving most of the effluent, though P and K levels are high. As the effluent is not diluted with clean water, soil testing results at both sites showed that the reuse area is highly sodic.

The environmental performance at the mortality composting site could also be improved by bunding the compost storage areas to reduce the potential for nutrient leaching and run-off.

## Risk Assessment

The risk assessment included the effluent collection and treatment systems, mortality management and the effluent reuse system. This identified several areas of high risk to the environment.

The current irrigation rates are based on the volume of the effluent that needs to be removed from the ponds and not on the plant removal rates or soil reserves of nutrients and salts. The soils in the irrigation areas are highly sodic and the effluent is not evenly distributed across the paddock by the flood irrigation system.

## Action Plans and Recommendations

The recommendations include activities to improve:

- The effectiveness of the flood irrigation system and the overall balance between nutrient application and removal;
- The initial handling and treatment of effluent; and
- The composting process.

The distribution of effluent across the irrigated reuse area can be improved by regrading the flood irrigation contour channel to ensure regular and effective application rates of nutrients. Nutrient removal can be increased through the use of improved pasture species and by cutting hay as well as grazing livestock, or through growing and harvesting hay, grain crops or a sorghum forage crop. For example, cattle would need to be stocked at 1 hd/ha together with the harvest of at least 8 t/ha of improved pastures or a forage crop to ensure adequate nutrient removal.

The high salt soils can be ameliorated with gypsum and by irrigating with fresh, non saline water.

By installing a solids separation screw-press, the nutrient content of the effluent would decrease, the requirement for pond desludging would reduce and the management of by-products would improve by easier handling, application to land, or incorporation into the compost process.

Co-composting the treated liquid effluent with separated solids and the stockpiled carcass compost would provide finished compost available for sale or to spread on other areas of the property. This would use excess liquid effluent to further reduce the overall application of nutrients to this area. The carcass composting and storage area needs to be bunded to reduce the potential for leaching and run-off.

The current soil monitoring program will also need to be adapted to monitor the overall nutrient management of the site.

## Implementation

An extensive program has been instigated at this property to improve nutrient recovery and by-product reuse through desludging the pond, drying the solids and selling the nutrient-rich product off-farm.

The piggery management group has also identified a three stage improvement program to adopt the recommendations from the Nutrient Management Plan (NMP) by:

1. Installation of a solids separator, including solids storage pads, to enable the piggery solids to be incorporated with chicken litter for use in the cropping operations and hence improve the nutrient removal from the site;
2. Investigation of the option to improve the current operation of the pond as an evaporative system to reduce the volume of effluent applied to the irrigation area; and
3. Redesign and realignment of the irrigation channel to ensure a more even application of the treated liquid effluent to the reuse paddock.

These actions will have a marked improvement on nutrient use and recovery at the site.

# Farm H

300 SOW FARROW TO FINISH UNIT, NORTHERN AUSTRALIA

## Farm Description

This piggery situated in Northern Australia on a 110 hectare property has been established for over 40 years. The soils are derived from moderately weathered sedimentary rock or old alluvia. The enterprise also operates a small cattle feedlot.

The piggery effluent removal design is a combination of static pits and full flush from conventional sheds. The effluent from the breeder sheds is collected in small ponds and piped to a 10 ML holding pond. Effluent from the grower sheds is collected in a sump, piped to a holding tank and then over a static run-down screen for the removal of solids. Leachate from the screens is piped to the holding pond. The solids are kept on a bunded concrete pad before being removed for storage or spreading.

Solids and effluent produced by both the pig and cattle facilities are spread on the property. The liquid effluent from the 10 ML holding pond is irrigated using two centre pivots onto several paddocks, and onto other paddocks using a hard hose travelling irrigation system.

The by-product reuse areas are used for growing highly productive perennial pastures, cut several times each year for hay, and for grazing cattle.

Photo: Highly productive perennial pastures are regularly cut for hay

## Farm Management Objectives

The owners of this enterprise recognised back in the 1980s the need to expand the irrigated reuse areas and since then have purchased two additional 80 hectare properties to improve the utilisation of effluent applications.

The cropping program has been markedly improved from irrigated tropical pastures used for grazing cattle to the utilisation of highly productive perennial pastures cut regularly for hay and for grazing cattle.

A regular soil monitoring program has been instigated to monitor nutrient inputs.

## Issues Identified

Effluent, feedlot manure and screened piggery solids are applied to the same paddocks. Effluent from the piggery is combined with the feedlot's effluent before being irrigated. Adjusting for application losses, the nutrient mass balance has shown that 86 kg N/ha/yr, 31 kg P/ha/yr and 152 kg K/ha/yr is available for plant growth; if the pond sludge is not included, and the material is spread evenly over the 40 hectare reuse site.

Soil testing indicated that the general nutrient status where piggery and feedlot by-products are spread is low. There were two exceptions where excessive levels of P were recorded. The paddocks with the lower P results had been double and triple cropped for many years and so the general low nutrient status of the soil is likely due to high plant removal rates.

The nutrient budget of paddock management practices (grazing and three cuts of pasture hay) has indicated that all the N and P applied in the by-products is being removed. This however assumes that nutrients are evenly spread across the whole reuse area, which is unlikely.

At the property level these results show that all the nutrients that the piggery and feedlot produce would be sustainably reused on the property, provided that application rates are matched to removal rates. Currently there are no accurate assessments of these rates across the reuse area.

## Risk Assessment

An environmental risk assessment matrix identified that surface water quality is at high risk. The breeder unit is sited close to a creek running through the property although there are effective filter strips in place.

The quantity of solids and effluent applied to the reuse area is not measured or estimated, nor matched to expected removal, losses and soil storage. However loss of nutrients from surface run-off or leaching is low and the soils are tested annually.

There is no designated storage area for the piggery sludge and screened solids which is stockpiled before spreading, and may be a potential risk to surface water and leaching.

## Action Plans and Recommendations

The quantification of the amounts of nutrients that are available for reuse from both the piggery and feedlot is required, together with a review of the current application practices, by completing a whole-of-farm nutrient balance. This will ensure long term sustainability of the irrigation and cropping practices.

Some options to improve hay production and to maximise the value from the manure products in the paddock irrigated with centre pivots include:

- Applying effluent at 1 ML/ha/yr with urea to achieve moderate production targets of 2 head cattle/ha and 20 t/ha pasture hay; or
- Applying effluent at 1.5 ML/ha/yr with urea to achieve high production targets of 2 head cattle/ha and 30 t/ha pasture hay.

Options for applying screened piggery solids and feedlot manure to the remaining paddocks to achieve a production target of 2 head cattle/ha and 20 t/ha pasture hay include:

- Application rates of 26 t/ha/yr of stockpiled piggery and feedlot solids; or
- Application rates of 14 t/ha/yr of feedlot manure with 12 t/ha/yr of piggery solids.

> "We are now able to match our by-product waste to areas of the farm where we know it will not cause a problem."


Photo: Screened piggery solids offer a valuable source of nutrients for cattle and hay production

A compacted and bunded pad is necessary for storing screened piggery solids prior to spreading and contour banks should be constructed in paddocks adjoining waterways to prevent nutrient run-off.

> "The project results, the monitoring of all relevant inputs combined with assessments and recommendations are presented extremely well in the piggery Nutrient Management Plan (NMP). (Future activities) will be ongoing, the recommendations in the NMP will be a strong source of reference."

## Implementation

The property owners have reacted positively to the NMP by installing two further primary anaerobic ponds, purchasing and installing two centre pivot irrigators with the appropriate trenching and pipe work, and re-routing farm roads and realigning farm fences to improve access, distribution and operation of the irrigated reuse areas.

The considerable expenditure for this program of works will ensure the continual viability and sustainability of the mixed farming enterprise.

> "The most important part is that the project has identified areas where we can enhance production with increased nitrogen and potassium in target paddocks. As a result we have purchased more advanced machinery to achieve this result more efficiently."
>
> "We have been urging them (other growers in the north) to look at sustaining their future by implementing these techniques."

Photo: Ponds from which effluent is irrigated using the new centre pivots

# Farm 1

550 SOW FARROW TO FINISH UNIT, SOUTHERN AUSTRALIA

## Farm Description

This 550 sow farrow to finish piggery in Southern Australia is situated on a 38 hectare block with soils derived from weathered sedimentary rocks. The unit has been in operation for over 10 years.

The breeder unit is of conventional design utilising flushing and pull-plug for effluent removal, while the weaner to finish accommodation is housed in eco-shelters using oaten hay as the bedding, which is grown on the property. The effluent is stored in ponds with a combined capacity of 3.6 ML.

The liquid sludge from the ponds is spread every three years on the reuse paddock for a hay crop, and the deep litter from the eco-shelters is stockpiled until spread on the same paddock at 20 t/ha every two years.

## Farm Management Objectives

The owners have been concerned that they have not been making better use of the treated effluent on the property and by doing this it will also reduce the incidence of pond overtopping events.

The suggestion was to be able to irrigate treated effluent onto a small area of the farm (approximately five hectares) adjacent to the effluent pond.

## Issues Identified

A summary of the nutrient balance and the estimated quantity of nutrients available for reuse from the effluent, pond sludge and spent eco-shelter litter was 18.24 t/yr N, 9.01 t/yr P and 14.8 t/yr K.

Although the levels on N and P are high in the effluent, this would not be of concern as long as any effluent application was matched to crop removal rates and soil nutrient reserves. Of greater concern is the high electrical conductivity (EC) and sodium absorption ratio (SAR) of the effluent. This combination of high EC and SAR values may inhibit plant growth.

Soil samples from the proposed irrigation sites were taken for nutrient analysis, ie. from paddocks that currently receive sludge and spent litter applications, and sites considered as an alternative area to receive effluent application.

The nutrient budget indicates that the current reuse paddocks have been overloaded with nutrients, as analysis showed high levels of N and K and medium to high levels of P. There are also high levels of N in the sub-horizon at 50-60 cm soil depth; samples at this depth also showed high EC, sodium and chloride levels. These sites are considered not suitable for long term effluent application.

The crop removal nutrient budget was based on the assumption that the sludge and spent litter was evenly spread over the 25 hectare reuse site and that the oaten hay yielded 2 t/ha. For this low yielding hay crop, the additions of N and P are significantly greater than the crop removal rates, which would lead to high nutrient accumulation in the soil.

Overall, the nutrient analysis and budgets are indicating that the piggery is producing more effluent by-products than it can sustainably use on the property.

## Risk Assessment

A nutrient risk assessment was completed based on the effluent collection system, treatment system, solids by-products storage, mortality carcass management and the by-product reuse area.

As the piggery is not located close to any surface water or groundwater, these natural resources were rated as not vulnerable, although some improvements could be made to further reduce any risk to the environment.

The by-product reuse design and management was the category that indicated a medium risk ratio for soils of this area. The main reason for this is that soil tests are not regularly conducted; by-product application rates are not measured and therefore not matched to expected crop removal rates, losses and soil storage.

## Action Plans And Recommendations

The suggestion of irrigating a five hectare site with treated effluent would not be considered sustainable as the effluent is high in salts and the SAR level may contribute to salinity and sodicity in the reuse area; soil analysis indicates that the proposed site already has high nutrient levels and moderate salt and sodium levels in the subsoil; and, irrigating a 5 t/ha oaten hay crop would only require 0.1 ML/ha of effluent which at these low rates would not be financially feasible.


Photo: The NMP identified that the proposed irrigation area was not sustainable

It is recommended to investigate the potential to use the excess pond effluent, sludge and spent litter without the need to install irrigation infrastructure, and to produce a by-product that is easier to manage. A number of recommendations to address this course of action are:

- Construct a composting pad to stockpile and co-compost spent litter with sludge and effluent;
- Construct a new effluent pond to hold excess effluent until the composting facility is built;
- Sell excess compost by-products off-site to reduce overloading paddocks with nutrients and salts;
- Cease spreading by-products on the reuse area until nutrient levels have declined;
- Investigate growing forage wheat and sorghum for hay to increase nutrient removal rates; or
- Install a drainage system around the piggery to prevent additional run-off water from the ponds.

If the piggery by-products are not composted, then the application rates should be reduced considerably, specifically:

- Applying 3 t/ha/yr of stockpiled spent litter and sell the remainder off-site; or
- Spread the piggery sludge off-site or spread the sludge rather than spent litter and sell any excess off-site.

> "Any excess compost will be sold to the already waiting farmers and vineyards."

## Implementation

The owners have responded immediately to the recommendations. A new effluent pond has been built, the composting site is being developed and machinery sought, the excess stockpiled spent litter has been sold off-site, forage wheat has been sown for silage and allowed to regrow and cut for hay (this will be followed by forage sorghum for silage and hay), and routine soil testing will determine when and how much compost is required for cropping with any excess sold to the now established markets.

> "After receiving the soil test, we have also sown wedgetail forage wheat over the whole property which we plan to cut for silage and then let regrow."

# Farm J

30 SOW FARROW TO FINISH UNIT, NORTHERN AUSTRALIA

## Farm Description

This 30 sow farrow to finish piggery is situated on a 27 700 hectare property in Northern Australia. The soils are deep greyish sandy loam overlying yellow-brown clay. There are plans to expand the piggery to 120 sows.

The three sheds have flush tanks installed which are flushed three times each week into a 4 ML pond.

Most of the property is used for extensive cattle grazing of dryland savannah. There is a 50 hectare arable cropping area and the crops grown include pumpkins, grass seed and soybeans.

## Farm Management Objectives

The owners have recognised that the most efficient use of the effluent from the expanded piggery is to irrigate high value crops on a small area of land.

A 6.5 hectare area for effluent irrigation is planned with the piggery effluent drained from the effluent pond to a 25 ML freshwater dam. This will be irrigated onto the reuse area.

A run-off dam will be constructed to collect any surface water from the irrigated reuse area.

## Issues Identified

The soils have little structure, are permeable and have low nutrient holding capacity. A water balance calculated on the expectation that the effluent will be mixed with freshwater at 5.3 per cent has indicated that the effluent pond will be emptied by the end of each dry season.

A nutrient balance calculated using the same assumption of effluent and freshwater mix ratio and based on two pumpkin crops each year, has indicated that the rate of nutrient accumulation will be negative for N, low for Ca, P and Mg and moderate for K.

These accumulation rates suggest that the reuse area will need to be rotated to at least an equivalent land area. Potassium levels are likely to accumulate faster than Ca and Mg which may result in a nutrient imbalance for crop or hay production.

## Action Plans and Recommendations

The annual effluent output from the piggery is estimated at 3.3 ML and the 6.5 hectare reuse area will require 36.4 ML of irrigation for each dry season cropping rotation.

The reuse area will require regular rotation to a different land area or alternatively to grow Rhodes grass for hay which is more effective in removing sodium from the soil. Applications of lime or dolomite on a regular basis will also assist in maintaining nutrient balances in the soil.

It is recommended that effluent and run-off dams be regularly monitored and that soil and crop nutrient analysis be undertaken biennially to assess changes in nutrient content.

## Implementation

A six hectare reuse area has been established with a solid set irrigation system. This system is also connected to a centre pivot system if required. An 80 ML run-off dam has been established below the piggery.

Effluent is now pumped from the effluent pond into the main line at approximately 5.5 L/sec and diluted with water from the run-off dam. This is pumped at 70 L/sec through the solid set irrigation system.

> "The system we have designed is very cost effective. This is due to the original layout which allowed us to implement this combined effluent and irrigation system efficiently."

The most suitable crops are pumpkins, sweet corn and watermelons, though seed crops and hay production will also be considered. It is possible for two crops a year to be grown.

Soil testing will be conducted annually and if nutrient levels start to increase, then forage sorghum will be grown for hay or silage.

The reuse irrigation area has been contoured to avoid run-off in heavy rain and any run-off will be captured in a dam.

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