Project Order

Proforma 2011

1. Short Project Title (less than 15 words)

Project 3 – Gas-farm design

Long Project Title	Designing combined farming-gas enterprises to minimise costs and maximise benefits.
GISERA Project Number	A3 1215
Proposed Start Date	July 2012
Proposed End Date	Dec 2015
Project Leader	Neil Huth

2. GISERA Research Program

- ☐ Biodiversity Research
- ☐ Marine Research
- ☒ Land Research
- ☐ Water Research
- ☐ Social & Economic Research

3. Research Leader, Title and Organisation

Neil Huth
Senior Research Scientist
CSIRO Ecosystem Sciences

4. Summary (less than 300 words)

Some of the Darling Downs's farms will require change to provide layouts that enhance profit and sustainability as they transition from farming to mixed gas-farm enterprises. Modern farming has evolved layouts and practices designed to derive maximum long-term value from the soils and climate of the northern grains region. Techniques such as controlled traffic and conservation tillage, for example, have been developed to maintain soil

structure in heavy clay soils, increase storage of water from variable rainfall and, as a result, increase productivity. In many cases farm design, including the size and layout of paddocks, positioning of irrigate on infrastructure and farm roadways, and the purchase, adjustments to, and standardisation of farm machinery have all been designed to better facilitate modern farming best practice. The incorporation of gas infrastructure into such a farming landscape, and opportunities that may flow from this, will require efforts to design a farm that can best support a new mixed land use. Design rules will need to be developed to match the needs of a range of agricultural enterprises including dry land cropping, irrigated cropping, grazing or mixed farming.

5. Budget Summary (From Excel Budget Pack worksheet "Project Plan Summary")

Expenditure	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	2016/17 Year 5	Total
Labour	96,834	190,958	168,183	33,354		489,329
Operating	28,000	60,000	50,000	24,000		162,000
Total Costs	**124,834**	**250,958**	**218,183**	**57,354**		**651,329**
CSIRO	124,834	250,958	218,183	57,354		651,329
Total Expenditure	**124,834**	**250,958**	**218,183**	**57,354**		**651,329**

Expenditure per Task	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	2016/17 Year 5	Total
Task 1	124,834	250,958	218,183	57,354		651,329
Task 2						
Task 3						
Task 4						
Task 5						
Total Expenditure	**124,834**	**250,958**	**218,183**	**57,354**		**651,329**

Cash Funds to Project Partners	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	2016/17 Year 5	Total
CSIRO	79,880	166,880	145,160	43,000		434,920
Total Cash to Partners	**79,880**	**166,880**	**145,160**	**43,000**		**434,920**

Source of Cash Contributions	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	2016/17 Year 5	Total
Australia Pacific LNG	79,880	166,880	145,160	43,000		434,920
Total Cash Contributions	**79,880**	**166,880**	**145,160**	**43,000**		**434,920**

In-Kind Contribution from Partners	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	2016/17 Year 5	Total
CSIRO	44,954	84,078	73,023	14,354		216,409
Total In-Kind Contribution from Partners	**44,954**	**84,078**	**73,023**	**14,354**		**216,409**

	Total funding over all years	Percentage of Total Budget
Australia Pacific LNG Investment	434,920	66.7%
CSIRO Investment	216,409	33.3%
Total Other Investment		
TOTAL	**651,329**	**100%**

Task	Mile-stone Number	Milestone Description	Funded by	Participant Recipient	Start Date (mm-yy)	Delivery Date (mm-yy)	Fiscal Year	Fiscal Quarter	Payment $
Task 1	1.1	Initial Team Meeting	GISERA	CSIRO	Jul-12	Sep-12	12/13	Quarter 1	19,970
Task 1	1.2	Identify Case Study Sites	GISERA	CSIRO	Oct-12	Dec-12	12/13	Quarter 2	19,970
Task 1	1.3	Initial Literature Review	GISERA	CSIRO	Jan-13	Mar-13	12/13	Quarter 3	19,970
Task 1	1.4	Case Studies Benchmarked	GISERA	CSIRO	Apr-13	Jun-13	12/13	Quarter 4	19,970
Task 1	1.5	Case Study Site Monitoring Commenced	GISERA	CSIRO	Jul-13	Sep-13	13/14	Quarter 1	41,720
Task 1	1.6	Case Study Site Monitoring Complete	GISERA	CSIRO	Oct-13	Dec-13	13/14	Quarter 2	41,720
Task 1	1.7	Analysis of Monitoring Data	GISERA	CSIRO	Jan-14	Mar-14	13/14	Quarter 3	41,720
Task 1	1.8	First farmer discussions	GISERA	CSIRO	Apr-14	Jun-14	13/14	Quarter 4	41,720
Task 1	1.9	Analysis of issues arising from farmer discussions	GISERA	CSIRO	Jul-14	Sep-14	14/15	Quarter 1	36,290
Task 1	1.10	Second iteration of farmer discussions	GISERA	CSIRO	Oct-14	Dec-14	14/15	Quarter 2	36,290
Task 1	1.11	Synthesis of Results	GISERA	CSIRO	Jan-15	Mar-15	14/15	Quarter 3	36,290
Task 1	1.12	Draft Scientific Manuscript	GISERA	CSIRO	Apr-15	Jun-15	14/15	Quarter 4	36,290
Task 1	1.13	Thesis Production (PhD)	GISERA	CSIRO	Jul-15	Sep-15	14/15	Quarter 1	21,500
Task 1	1.14	Thesis Submitted (PhD)	GISERA	CSIRO	Oct-15	Dec-15	15/16	Quarter 2	21,500

6. Other Researchers (include organisations)

Researcher	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Neil Huth	0.6 FTE	Farming Systems Research, Modelling, Trade-off Analysis	>20	CSIRO
Perry Poulton	0.5 FTE	Farming Systems, Modelling, Farmer Engagement	>20	CSIRO
Brett Cocks	0.4 FTE	Field operations, soil characterisation, farmer engagement, agronomic technical support	>15	CSIRO
Justin Fainges	0.35 FTE	Mathematics, programming, data analysis	2	CSIRO

7. GISERA Objectives Addressed

Research that improves and extends knowledge of agricultural and environmental impacts and opportunities of CSG-LNG projects, enabling the CSG-LNG industry to better meet the expectations of relevant communities and the broader public.

Informing farm managers and gas industry professionals on improved methods for gas-farm design and operation.

GISERA performance indicators addressed in this work include:

- Publication of results
- Involvement of a university local to CSG and LNG activity participating in research projects
- PhD studentship
- Engagement with local gas and agricultural industries.

8. Program Outcomes Achieved

Details are provided in *Section 13. Project Objectives and Outputs.*

9. Program Outputs Achieved

Details are provided in *Section 13. Project Objectives and Outputs.*

10. What is the knowledge gap that these research outputs will address?

Currently there are no clear and publicly available principles to guide the re-design of farm enterprises and operations to include CSG production systems. Nor is there a method for a wide range of farmers and gas developers to pool their design and layout experiences. This impairs the ability to continually improve the capacity to minimise disturbance and to maximise the opportunities from gas development on farms through knowledge sharing and mutual learning as development unfolds. This project will address these knowledge gaps by:

- developing methods for evaluating farm designs and the operations that inform them and emanate from them
- applying these methods to the analysis of the impacts of gas infrastructure and operations on farm layout and operations
- developing design principles for mixed gas-farm enterprises that minimise disturbance and maximise the opportunities from gas development on farms
- applying these design principles to evaluate alternative gas-farm designs for dry land cropping, irrigated cropping, grazing and mixed farming enterprises
- making publicly available principles to guide the design, layout and operation of mixed gas-farm enterprises.

11. How will these Research outputs and outcomes be used by farmers or the CSG-LNG industry?

The design principles and lessons from this project will be documented and communicated to the farming and gas industries for use in negotiations and discussions between gas and farm managers before farms undergo redevelopment to include a gas production system. Some of the information may also help farmers to better manage their agricultural enterprise around existing gas production (and other) infrastructure such as roads, pipes and wells. The generic aspects of the work will also enable it to be used to inform farm design and management responses to the emergence of new technologies.

12. Project Development (1 page max.)

The project was developed in consultation between Australia Pacific LNG and CSIRO staff. The proposed activity was discussed with members of various farmer/stakeholder groups and was endorsed as an important research need.

Controlled traffic in combination with conservation tillage has been shown to increase plant available water holding capacity and decrease runoff leading to increased production on clay soils in the northern grains region (Li et al 2001, 2007; Thomas et al 2007). Furthermore, decreased compaction increases the efficiency of other farming operations. Tullberg (2000) demonstrated the reduction in tillage energy which occurs in controlled traffic systems because approximately 50% of a tractor's power output can be dissipated in the process of creating and disrupting its own wheel compaction. As a result, controlled traffic/conservation tillage has been widely adopted across the northern grain belt and farm design has changed to suit it. Similarly, irrigation systems have been carefully designed to minimise deep drainage losses which not only represent an inefficient use of water, but are also an environmental hazard (Moss et al 2001, Smith et al 2005). Similarly, agronomy has evolved to make better use of available irrigation water supply through better understanding of soils (Dalgliesh et al 2006), crops and crop management (Peake et al 2008). In these various ways, farming and farm designs have evolved to suit best practice in addressing important issues.

Gas-farms will need to be designed to address a wider range of needs. The need to design farms to suit different needs from mixed enterprises is not new. In particular, design principles have been pursued for farming systems when landholders have looked to incorporate forestry, carbon sequestration or conservation components into their farm enterprise. House et al (2008) investigated the costs and benefits of various farm designs in case studies looking at integrating natural resource management into farm configuration. House et al (2008) were able to identify threats and mitigating options, identify opportunities for enhancing farm configuration and explore options to offset financial losses. In a similar way, Huth (2010) explored costs and benefits of various configurations and placement of woodlots on farm and found options which reduced costs by a factor of eight, often without significant loss of other benefits of the trees. Much of the gains here were made by identifying better locations for the new enterprise within the existing farm. These same approaches could be employed to identify farm designs that minimise costs but maximise benefits of a mixed gas-farm enterprise.

The local farming community has also sought ways to increase efficiency in the use of scarce irrigation water supply. In some locations, new water supplies may be available for a period of time due to the development of the coal seam gas industry. The availability of this resource may influence farmers in changing from existing land use strategies but the exact long-term value of this water for various cropping scenarios is unknown. Farming systems models, such as APSIM (Keating et al 2003) can be used to explore these options. This knowledge will also prove invaluable in considering wider gas-farm design issues.

The work builds strongly on past and ongoing research activities of the project team in farming systems research based upon strong stakeholder engagement. Team members are currently involved on cross-disciplinary studies at the farm level in Australia, Asia and Africa. Such a farming "systems focus" will assist in the untangling of issues within a combined gas-farm enterprise.

References

Dalgliesh N, Wockner G, Peake A (2006) Delivering soil water information to growers and consultants. In proceedings of the 13th Australian Agronomy Conference, Perth WA.

House APN, MacLeod ND, Cullen B, Whitbread AM, Brown SD, McLvor JG (2008) Integrating production and natural resource management on mixed farms in eastern Australia: The cost of conservation in agricultural landscapes. *Agriculture Ecosystems & Environment* **127**, 153-165.

Huth, NI (2010) Measuring, modelling and managing tradeoffs in low rainfall agroforestry for Australia's subtropics.. PhD thesis, University of Queensland.

Keating BA, Carberry PS, *et al.* (2003) An overview of APSIM, a model designed for farming systems simulation. *European Journal of Agronomy* **18**, 267-288.

Li YX, Tullberg JN, Freebairn DM (2001) Traffic and residue cover effects on infiltration. *Australian Journal of Soil Research* **39**, 239-247.

Li YX, Tullberg JN, Freebairn DM (2007) Wheel traffic and tillage effects on runoff and crop yield. *Soil & Tillage Research* **97**, 282-292.
Moss, J., Gordon, I.J. and Zischke, R., 2001. Best management practices to minimise below root zone impacts of irrigated cotton. Final report to the Murray–Darling Basin Commission (Project I6064). Department of Natural Resources and Mines, Queensland.
Peake A, Robertson M, Bidstrup R (2008) Optimising maize plant population and irrigation strategies on the Darling Downs using the APSIM crop simulation model. *Australian Journal of Experimental Agriculture* **48**:313-325
Smith RJ, Raine SR, Minkevich J (2005) Irrigation application efficiency and deep drainage potential under surface irrigated cotton. *Agricultural Water Management* **71**, 117-130.
Thomas GA, Titmarsh GW, Freebairn DM, Radford BJ (2007) No-tillage and conservation farming practices in grain growing areas of Queensland - a review of 40 years of development. *Australian Journal of Experimental Agriculture* **47**, 887-898.
Tullberg JN (2000) Wheel traffic effects on tillage draught. *Journal of Agricultural Engineering Research* **75**, 375-382.

13. Project Objectives and Outputs

This project aims to provide a set of design principles for combined gas-farm enterprises as well as tools for evaluating a set of alternative farm designs. Design principles will allow for consideration of the differing issues of dry land and irrigated cropping, grazing or mixed farming systems.

Outputs include:

- A literature review into issues and approaches identified in previous research in gas-farm systems or other multiple enterprise farming systems
- A set of design principles that can be used by farm and gas professional to better design mixed gas-farm systems
- Demonstration of these principles, and methods for evaluating various designs, on a suite of diverse case study farms
- Publications documenting the findings of the surveys, including a list of existing knowledge gaps.

14. Project Plan

14.1 Project Schedule

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
1	Initial Team Meeting	Neil Huth	Jul-12	Sep-12	
2	Identify Case Study Sites	Neil Huth	Oct-12	Dec-12	Task 1
3	Initial Literature Review	Neil Huth	Jan-13	Mar-13	Task 2
4	Case Studies Benchmarked	Neil Huth	Apr-13	Jun-13	Tasks 2,3
5	Case Study Site Monitoring Commenced	Neil Huth	Jul-13	Sep-13	Task 4
6	Case Study Site Monitoring Complete	Neil Huth	Oct-13	Dec-13	Task 5
7	Analysis of Monitoring	Neil Huth	Jan-14	Mar-14	Task 6

	Data				
8	First farmer discussions	Neil Huth	Apr-14	Jun-14	Task 7
9	Analysis of issues arising from farmer discussions	Neil Huth	Jul-14	Sep-14	Task 8
10	Second iteration of farmer discussions	Neil Huth	Oct-14	Dec-14	Task 9
11	Synthesis of Results	Neil Huth	Jan-15	Mar-15	Task 10
12	Draft Scientific Manuscript	Neil Huth	Apr-15	Jun-15	Task 11
13	Thesis Production (PhD)	Neil Huth	Jul-15	Sep-15	
14	Thesis Submitted (PhD)	Neil Huth	Oct-15	Dec-15	Task 13

Task 1.

TASK NAME: Initial team meeting

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

TASK OBJECTIVES:

- Establish a project team
- Establish contact with GISERA collaborators
- Refine work plan according to Australia Pacific LNG-CSIRO discussions

SPECIFIC DELIVERABLE: Short report providing information about initial team meeting, established relationships, processes for choice of case study sites.

Task 2.

TASK NAME: Identify case study sites

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

BACKGROUND: Case studies on different farm enterprises will be undertaken to consider the various costs and benefits of various gas-farm designs.

TASK OBJECTIVE: A manageable number of case study farms will be chosen to support research and later discussions. These should include grazing, dry land cropping, and irrigated cropping. The exact number and locations will arise from team discussions, interaction with farming community and gas industry operatives.

SPECIFIC DELIVERABLE: A short report outlining the chosen case study sites and the rationale behind their choice.

Task 3.

TASK NAME: Initial literature review

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

BACKGROUND: An extensive search of the existing literature is always required to avoid duplication of previous work and to accelerate progress.

TASK OBJECTIVE: To collate as much relevant background information on farm, especially gas-farm, design for use in ongoing research. Information should be relevant to the case studies where possible. Information should include design principles, models for evaluating designs, data on gas production, and background information on the agricultural systems of the case study regions.

SPECIFIC DELIVERABLE: A document describing and analysing the relevant findings of the literature review.

Task 4.

TASK NAME: Case studies benchmarked

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

BACKGROUND: Case study sites need to be adequately benchmarked in terms of current or potential agricultural and gas production before alternative scenarios can be evaluated.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A document briefly describing the case study sites in terms of their location, area, history, production and opportunities. If possible this should include maps of enterprise design, soil types, production areas, and areas of environmental significance.

Task 5.

TASK NAME: Case study site monitoring commenced

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: Once benchmarked, further information regarding production, impacts of gas developments, soil types or other issues identified during benchmarking may need to be evaluated via on site measurement and monitoring.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A brief document describing the measurement and/or monitoring regimes implemented at each case study site.

Task 6.

TASK NAME: Case study site monitoring complete

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: Data from on-farm measurement and monitoring needs to be gathered to allow meaningful exploration of options for gas-farm design. Such monitoring should be almost complete at this time to allow collation of results and analysis for use in later farmer discussions.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A report briefly showing the raw results of the on-farm measurement and monitoring for each of the case study sites.

Task 7.

TASK NAME: Analysis of monitoring data

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: Data from the on-farm measurement and monitoring needs to be analysed and converted into knowledge or simple models/relationships which can be used in the evaluation of alternative gas-farm designs.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A report briefly describing the findings of the case study monitoring and how these data will be used to inform discussions on gas-farm design.

Task 8.

TASK NAME: First farmer discussions

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: The findings of the monitoring and literature review will be used in discussions with case study farmers to explore a preliminary set of gas-farm design principles and likely options for improved gas-farm designs on the chosen farms. Issues (lessons, information gaps, risk and opportunities) identified during these discussions will be documented and will become the basis of further refinement of models and design principles.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A brief report describing the outcomes of the preliminary discussions with the various case study farmers regarding farm design principles.

Task 9.

TASK NAME: Analysis of issues arising from farmer discussions

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: Preliminary discussions with farmers will have identified methods for improving or expanding the gas-farm design principles and models used. Work must be undertaken to account for these lessons.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A brief report demonstrating progress toward addressing the concerns or opportunities identified in the preliminary discussions with farmers.

Task 10.

TASK NAME: Second iteration of farmer discussions

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: Preliminary discussions with farmers will have identified methods for improving or expanding the gas-farm design principles and models used. Once these have been addressed, a second round of discussions will be undertaken to gauge the effect of further development aimed at these issues.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A brief report demonstrating progress toward addressing the concerns or opportunities identified in the secondary discussions with farmers.

Task 11.

TASK NAME: Synthesis of results

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: Case studies completed. The findings from all these efforts need to be synthesised into a coherent set of findings including data, design guidelines and calculated outcomes.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A report briefly outlining the results and lessons learned from the case study sites.

Task 12.

TASK NAME: Draft Scientific Manuscript

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: Communication of findings to the scientific community.

TASK OUTPUTS & SPECIFIC DELIVERABLES: Draft manuscript(s) prepared for journal(s) and/or conference proceedings.

Task 13.

TASK NAME: Thesis production (PhD)

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2015/16

BACKGROUND: Final preparation of thesis document will take some time. The exact form of the thesis will depend on arrangements between the student and the university.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A brief report on progress to final thesis production.

Task 14.

TASK NAME: Thesis submitted (PhD)

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2015/16

BACKGROUND: Finalising thesis of PhD student.

TASK OUTPUTS & SPECIFIC DELIVERABLES: PhD thesis and/or publication(s) related to PhD thesis.

15. Budget Justification

The budget for this project has been approved by GISERA's Research Advisory Committee and Management Committee.

16. Project Governance

Project management tasks and dissemination activities are specified in *Section 14 Project Plan*.

17. Communications Plan

General communication will be managed by GISERA.

18. Risks

At this stage no unmanageable risks particular to this project are foreseen.

Capacity to deliver: all project staff have sufficient experience to lead and supervise the various activities and ascertain the research outcomes. Therefore the impact of unplanned key staff departure is low and could be mitigated.

There are risks inherent with working closely with human research subjects. Though the risks in this project are considered to be low, the project will be managed in accordance with CSIRO Human Research Ethics policies.

19. Intellectual Property and Confidentiality

<table>
<tr><td>Background IP (clause 10.1, 10.2)</td><td>Party</td><td>Description of Background IP</td><td colspan="2">Restrictions on use (if any)</td><td>Value</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>Ownership of Non-Derivative IP (clause 11.3)</td><td colspan="5">CSIRO</td></tr>
<tr><td>Confidentiality of Project Results (clause 15.6)</td><td colspan="5">Project results are not confidential.</td></tr>
<tr><td>Additional Commercialisation requirements (clause 12.1)</td><td colspan="5">Not Applicable</td></tr>
<tr><td>Distribution of Commercialisation Income (clause 1.1)</td><td colspan="5">Not applicable</td></tr>
<tr><td rowspan="3">Commercialisation Interest (clause 1.1)</td><td colspan="3">Party</td><td colspan="2">Commercialisation Interest</td></tr>
<tr><td colspan="3">Australia Pacific LNG</td><td colspan="2"></td></tr>
<tr><td colspan="3">CSIRO</td><td colspan="2"></td></tr>
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