SYSTEMS

agriculture

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DPI in SCHOOLS

NSW GOVERNMENT
Department of Primary Industries

Tocal COLLEGE
RTO 91166

Acknowledgements

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Systems Agriculture

An understanding of systems agriculture is integral to all stages in the NSW Agriculture syllabus. The following resource provides background and engaging authentic learning activities to develop and challenge student understanding of the concept.

This resource is produced to address NSW Agriculture Syllabus Stage 5 and 6 outcomes and cross curricular syllabus outcomes for NSW Technology mandatory Stage 4.

Outcomes:

Agriculture- Stage 6 HSC

H2.1 Describes the inputs, processes and interactions of plant production systems

H2.2 Describes the inputs, processes and interactions of animal production systems

H3.4 Evaluates the management of the processes in agricultural systems.

Agriculture- Stage 6 Prelim

P1.1 Describes the complex, dynamic and interactive nature of agricultural production systems

P1.2 Describes the factors that influence agricultural systems

P2.3 Describes the farm as a basic unit of production.

Agriculture- Stage 4/5

5.1.2 Explains the interactions within and between agricultural enterprises and systems

4.1.2 Outlines the interactions within and between agricultural enterprises and systems

The following resource requires students to utilise the Tocal College resources to aid in understanding and completion of activities.

- ESRI Story Maps
- Tocal Property and Farms

Glossary

Boundary: Limitations of the system. Includes amount of land, climate, soils, technology, managerial skill and funds available.

Enterprise: An individual management activity on a farm that produces an income.

Feedback: Product performance information received by the farmer. Includes quality and quantity data such as yield, protein %, weight gain for age, dressing %, micron, price etc. Feedback is used by the farmer to influence management decisions regarding inputs and processes within the system to alter sustainability and production.

Holistic: Characterised by the belief that the parts of something are intimately interconnected and understandable only through consideration of the whole.

Input: Anything that is added into or used in a production enterprise. Inputs can be divided into two groups, physical inputs such as seed, hay, raw materials; and cultural inputs such as money, labour and skills. Only use physical inputs.

Interaction: Situation when objects or organisms do something to one another causing change.

Output: Final and raw products, such as milk, eggs, meat, livestock.

Processes: Actions within the farm that alter a raw material into a desired product. Include shearing, drenching, harvesting, sowing, milking etc.

Subsystem: An element or system that itself forms part of a larger system. It may be an enterprise or a unit of the farm such as soils or management.

Stimulus: Objects or events which cause a reaction. Subsystems within a system interact with each other in response to stimuli. Examples include market information, pesticide residue and climate.

Systems Approach

Agriculture is a human activity. It is carried out to produce goods and services ('products'), through the management of animals and cultivation of crops. Pressures which challenge the business of farming include production and economic pressure, social pressures, changing technology, environmental pressures and sustainability goals. Sustainability goals include issues such as protecting water, soil and air resources, reducing agrochemical use, mitigating greenhouse gas emissions and conserving biodiversity.

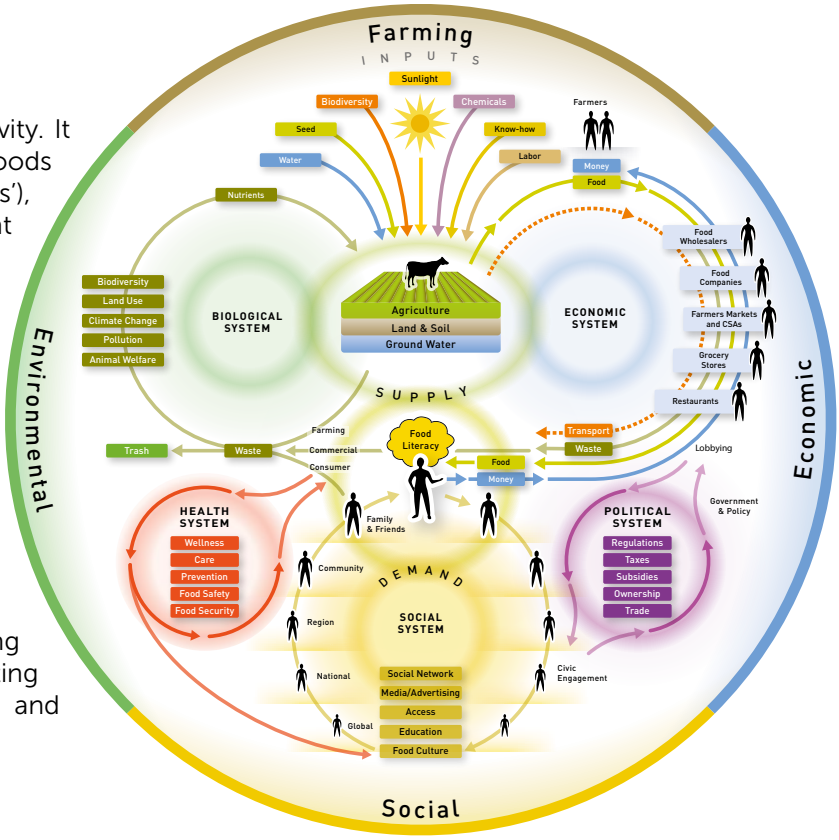

Figure 1: Worldlink Nourish Food System Map

The Nourish Food System Map (Worldlink, 2014) illustrates influences and interactions on agricultural production. It is a system showing many interacting components.

A farm may be regarded as a managed ecosystem. There are similarities between a farm ecosystem and natural ecosystem as both are open systems. Open systems are influenced by external stimuli. They consist of sub systems that are inter related and interdependent and are connected by feedback links to the environment.

Farm ecosystems are different to a natural ecosystem because they are manipulated and managed by humans. Outputs are removed from the system disrupting the natural cycling which occurs in unmanaged ecosystems. Thus, inputs are routinely introduced to sustain production to a desired level. Inputs include livestock, seed, fertiliser among others, and dependant on the production system. Even climatic factors can be managed to an extent.

Systems' thinking in agriculture is an approach which explores how humans manipulate and interact with controlled environments. Fundamental to systems thinking is the identification of agricultural production having the following interacting components.

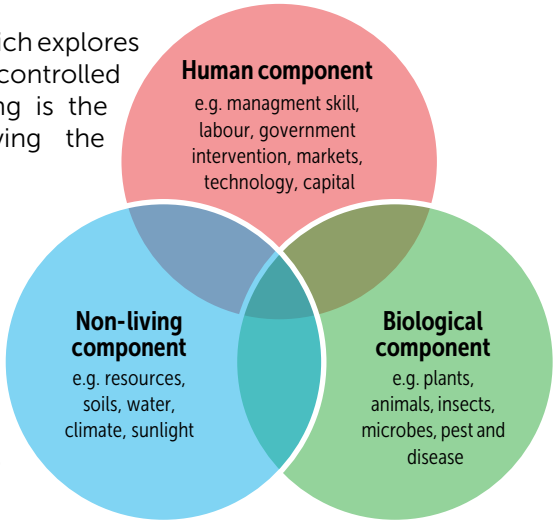

Figure 2: Components of agricultural systems

Interactions occur when objects or organisms do something to one another causing change. Changes are evidence that an interaction has occurred and are brought about by processes.

A group of interacting components which operate for a purpose is a system. The systems thinking approach recognises that objects or organisms do not function on their own but exist in relationship with other organisms or objects.

A systems approach allows management of complexity by allowing the identification of the level to which the study of the system will be taken to. It is achieved through identifying a boundary, for example, establishing a balanced crop rotation requires development of a whole farm model with the physical fence line as the system boundary. However effective investigation and treatment of a soil degradation issue would require a much broader view. The boundary could be a catchment management area, a state or a continent. Boundaries limit the system investigation. The larger the system; the greater the amount of subsystems and complex interactions studied.

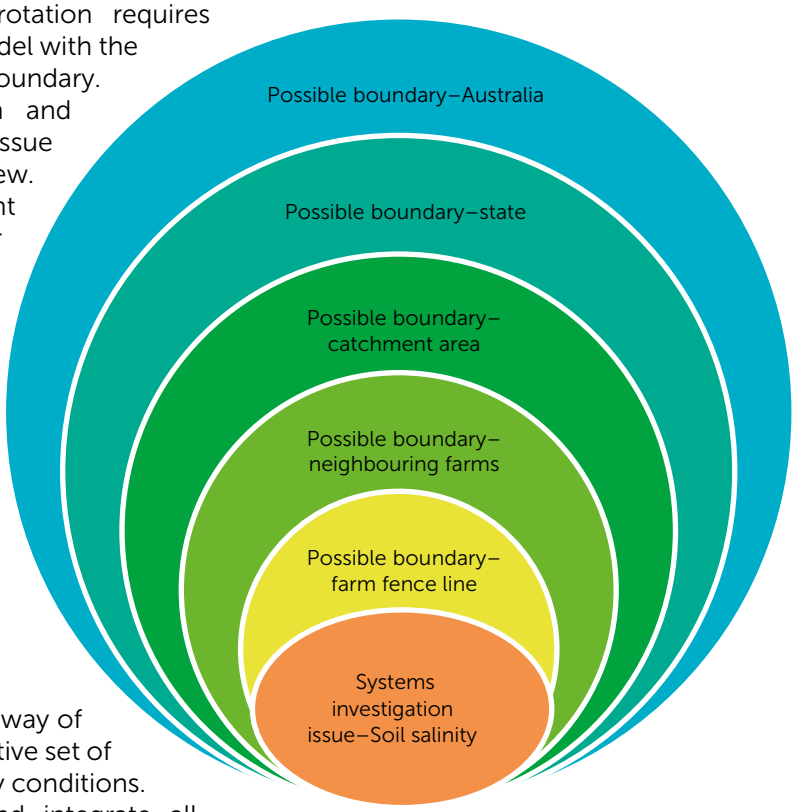

Figure 3: Systems boundaries impose limitations

The following definition encapsulates the systems approach.

"A systems approach is a holistic way of addressing a complex and interactive set of problems within a set of boundary conditions. It aims to identify, quantify, and integrate all factors and processes that shape and constrain farming systems. It helps identify researchable issues, clarify relations, and generate testable hypotheses for research and development. 'Systems thinking' examines every aspect of the climatic, biological, political and financial context in which farmers and pastoralists operate, identifying the most suitable solutions to sustainably enhance productivity and reduce risk." (DrylandSystems, 2013)

Systems models

Models are representations of real things. In agriculture systems, models are used to diagrammatically represent the content (subsystems), processes and interactions of a farm system.

Benefits of using models:

- Simplify complex structures and processes.
- Used for communication or clarification.
- Can be altered to communicate specific information.
- Allow analysis of systems from multiple perspectives.
- Identify cause and effects.
- Improve system understanding through visual analysis.
- Allow for identification of errors quickly.
- Allows for exploration of alternatives.
- Improve impact analysis and identification of potential consequences due to change.
- Different model types show different depth of data.

Limitations include:

- They can give limited detail.
- Oversimplification can lead to misunderstanding.
- Incomplete or inadequate problem analysis.
- Models are representations.

Model Types

Three model types are commonly used in agriculture to represent farm systems. Each type has varying level of detail.

Black box model-

- Black box systems model are the least detailed type of systems diagram.
- List inputs and outputs and identify the system boundary.
- Do not give detail on processes involved to convert inputs to outputs.
- Simple system.
- Identify enterprise type.

Figure 4 shows a Black box model of Tocal Colleges' layer enterprise "Numeralla". Follow these links for further reading Tocal Property and Farms and ESRI Story Maps.

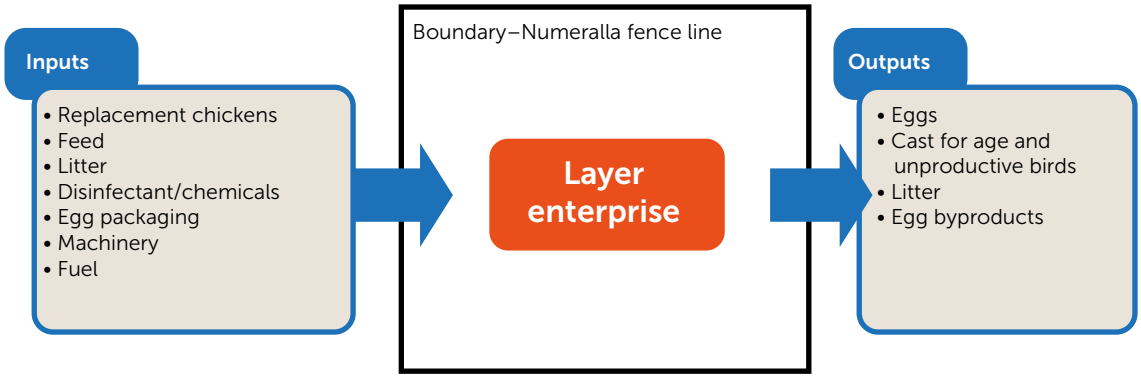

Figure 4: Black box model of Numeralla

Static display model

- Displays more information than the Black box model.
- Static display models show subsystems operating in a system. They do not show changes between subsystems and how they influence the whole system.
- Lines represent connections and arrows show directions.

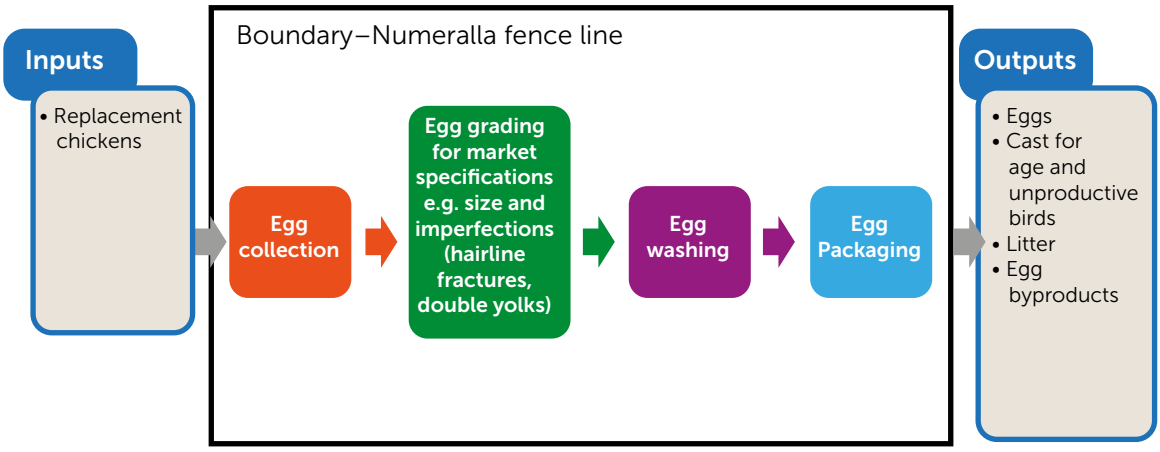

Figure 5: Static model of Numeralla

Figure 5 shows a Static model of "Numeralla". Follow these links for further reading Tocal Property and Farms and ESRI Story Maps.

Comprehensive model

- Also termed dynamic model.
- Provides greater description.
- Subsystems are identified and displayed in boxes.
- Transformations on farm considered.
- Processes and relationships between inputs, outputs and subsystems identified.

Figure 6 shows a Comprehensive model of Tocal Colleges' layer enterprise "Numeralla". Follow these links for further reading Tocal Property and Farms and ESRI Story Maps.

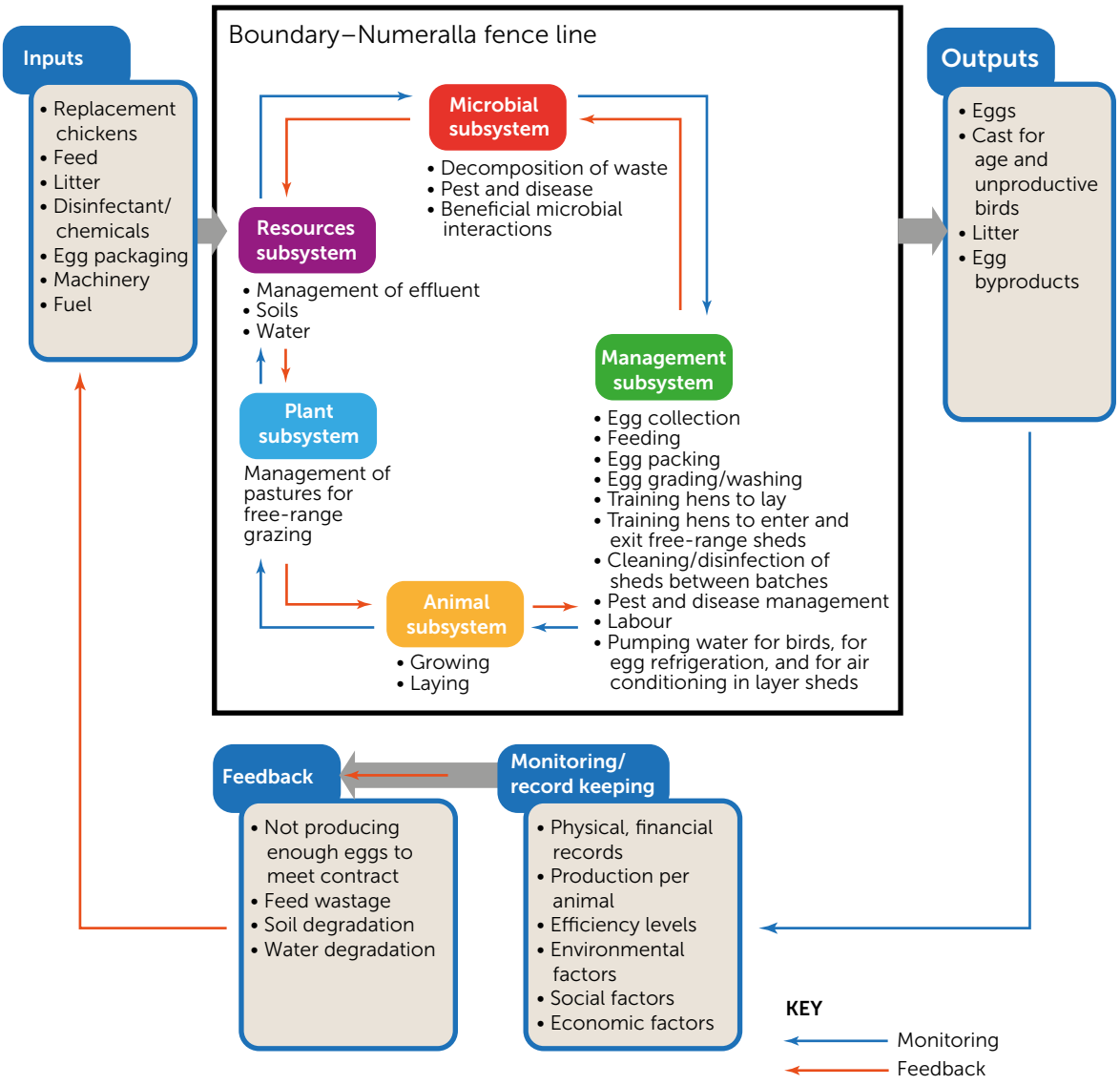

Figure 6: Comprehensive model of Numeralla

Summary

- A systems approach is a holistic way of addressing a complex and interactive set of problems within a set of boundary conditions. It aims to identify, quantify, and integrate all of the factors and processes that shape and constrain farming systems.
- Systems models are visual representations used to simply display the complex interactions, content and processes; that occur in a farming system. Three common types are the black box model, the static display model and more comprehensive types such as the dynamic model.
- Systems have inputs which they transform into outputs.
- What is inside the system boundary is identified as content (e.g. plants, animals, soils) and processes (e.g. growth, reproduction, management). Content and processes are managed by the farmer.
- Environment is outside the systems boundary. It influences what occurs within the farm systems, but cannot be controlled by the farmer.
- The boundary separates the system from the environment. The systems boundary is identified by the 'designer' of the system being investigated.
- Feedback is information about outputs from the system. Often this information is essential to the systems future operation. It influences the transformation process and is controlled by the manager.
- Performance of a system involves measuring internal features (e.g. content and processes) and external features (e.g. productivity, environmental, economic and social factors). No one performance measure should be measured in insolation.

Numeralla layers

Egg collection conveyor

Egg packing plant

Systems Worksheet

The following section requires students to utilise the Tocal College resources in addition to this worksheet, to complete the following activities.

- Tocal Property and Farms
- ESRI Story Maps

1. Define systems approach

_____

_____

_____

_____

2. List the main enterprises and subsystems on Tocal College.

_____

_____

3. How is it possible that farmer systems are subsystems of much larger systems?

_____

_____

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4. What advantages are there of making a model to represent a farm system?

_____

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Go to the Tocal Property and Farms and choose ONE enterprise, to complete the following systems activities. Do not choose egg production at Numeralla, it has been covered.

For your chosen Tocal College enterprise:

5. List the inputs.

_____

_____

_____

_____

6. List the outputs.

_____

_____

_____

_____

7. List the position of the systems boundary.

_____

_____

8. What stimuli, outside the boundary, are likely to influence the enterprise?

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_____

9. What sort of feedback information should the manager monitor for this enterprise?

_____

_____

_____

_____

10. In the space below create a black box model for your chosen enterprise.

11. In the space below create a dynamic model for your chosen enterprise.

References and Further Reading:

ESRI Story Maps

Hathway J, 2017, '*ESRI Story Maps',* NSW Department of Primary Industries, Tocal College , https://trade.maps.arcgis.com/apps/MapSeries/index.html?appid=54c8fa832fc445d8a8994e4731956e0a, viewed 8 February 2018

Nourish Food System Map

WorldLink, 2014, '*Nourish Food System Map'*, Wordlink, www.nourishlife.org, viewed 7 March 2018

Systems research for agriculture

Drinkwater L, Friedman D, Buck L, 2016, "Systems research for agriculture- Innovative Solutions to Complex Challenges", SARE Handbook Series 13, SARE and National Institute of Food and Agriculture, http://www.aceweb.org/resources/Documents/2017%20Gold%20Awards/Class%2022-Systems_Research_for_Agriculture.pdf, viewed 8 March 2018

Systems Thinking – Addressing the agricultural system as a whole

DrylandSystems, 2013, "Systems Thinking – Addressing the agricultural system as a whole", DrylandSystems, CGIAR, http://drylandsystems.cgiar.org/content/systems-thinking-%E2%80%93-addressing-agricultural-system-whole, viewed 8 March 2018

Tocal Property and Farms

Hathway J, 2017, '*Tocal Property and Farms'* NSW Department of Primary Industries, Tocal College , https://www.tocal.nsw.edu.au/tocal-farms, viewed 8 February 2018

Target Outcomes

Agriculture- Stage 6 HSC

H2.1 Describes the inputs, processes and interactions of plant production systems

H2.2 Describes the inputs, processes and interactions of animal production systems

H3.4 Evaluates the management of the processes in agricultural systems.

Agriculture- Stage 6 Prelim

Outcomes	Content
P1.1 Describes the complex, dynamic and interactive nature of agricultural production systems P1.2 Describes the factors that influence agricultural systems P2.3 Describes the farm as a basic unit of production.	• Describe agriculture as a system which is made up of inputs, outputs, boundaries, subsystems, processes, interactions, feedback and monitoring • Simulate, construct or represent an appropriate model showing inputs, outputs, boundaries, subsystems, processes and interactions between subsystems on a farm

Agriculture- Stage 4-5

Outcomes	Content
5.1.2 Explains the interactions within and between agricultural enterprises and systems 4.1.2 Outlines the interactions within and between agricultural enterprises and systems	• use drawings, diagrams and flow charts to show relationships between plants, animals, soils, climate and micro-organisms for specific enterprises studied

Cross curricular Outcomes

Technology Mandatory Stage 4 2019 syllabus- Agriculture and food technologies

Outcomes	Content
TE4-5AG Investigate how food and fibre are produced in managed environments	Students investigate how food and fibre production is managed in environments as a system and how sustainability can be improved, for example: (ACTDEK032) ST • boundaries, inputs, outputs, processes and feedback occurring in a managed environment • plants and/or animal species grown in managed environments