**PCRANCH: Cow-Calf Herd Simulation System**

J. W. Oltjen¹, A. Ahmadi¹, A.J. Romera², D.J. Drake¹, S.J.R. Woodward³

¹Animal Science Department, University of California, Davis, California, USA, jwoltjen@ucdavis.edu
²Whole Farm Modeling Team, DairyNZ, Hamilton, New Zealand
³Supply Chain Systems Group, Lincoln Ventures Limited, Hamilton, New Zealand

**Abstract**

PCRANCH is a computer program for simulating cow-calf herd dynamics over a long time horizon. It is written in the C++ programming language and runs under the Windows operating system. PCRANCH consists of three components. The first component is the input interface which consists of range (physical characteristics of the farm), herd (animal numbers and type), block (land allocation), weather (climate data), and parameters (management) dialog boxes. The user enters all input data in these dialog boxes. The second component is the run interface. It runs the simulation engine, CCFARM, which is written in the Java programming language as a separate program and gets its input as a series of text files from PCRANCH. The third component is the output interface which consists of a series of reports and graphs, generated from the output files of the CCFARM simulation engine. One difficulty for most research-oriented simulation systems is its user interface which is written to be used by the researcher and not by ranchers. The PCRANCH software package addresses this problem by decoupling CCFARM from its research-oriented user interface and coupling it with a friendlier rancher-oriented user interface without modifying the original user interface of the simulation program or reducing its capabilities. This approach allows the simulation program written in a different programming language to be used by researchers with its original user interface and at the same time to be used by ranchers with the new user interface written in another programming language by a separate team of programmers. This method has great potential for other research-oriented simulation programs to make them accessible by general users.

**Key words:** Cow/Calf Herds, Decision Support System, Simulation Model.

**Introduction**

Pastoral livestock farms are complex and dynamic systems, and are subject to many forms of external disturbance. Management strategies can be aimed to minimize system variations in order to control the system and to achieve specific goals. A research simulation model (CCFARM) was developed by Romera et al. (2004) to study the long term dynamics of complete cow-calf production systems. In the model, the operation of the farm is simulated by decision rules entered by the user. One major difficulty for this research-oriented simulation system is its user interface which is written to be used by the researcher and not by ranchers. The PCRANCH software package addresses this problem by decoupling CCFARM from its research-oriented user interface and coupling it with a friendlier rancher-oriented user interface without modifying the original user interface of the simulation program or reducing its capabilities.
PCRANCH is written in the C++ programming language and CCFARM is written in the JAVA programming language. They interact with each other by a set of input/output text files. PCRANCH consists of three components: Input, Run, and Output.

**Input Component**

The first component is the input interface which consists of range (physical characteristics of the farm), herd (animal numbers and type), block (land allocation), weather (climate data), and parameters (management) dialog boxes.

**Range Dialog Box:** A Range is land with herbaceous vegetation cover used for grazing of livestock. Range growth can consist of grasses, legumes, other forbs, shrubs or a mixture. Soil type, minimum annual temperature, and rainfall are important factors in range management. The program supports three kinds of ranges. For each range, the user enters the Productivity level (1=Low 2=Average 3=High), Altitude, Initial Soil Water, and Irrigation status. The soil system is composed of three major components: solid particles (minerals and organic matter), water with various dissolved chemicals, and air. The maximum amount of water that a given soil can retain is called field capacity, whereas a soil so dry that plants cannot liberate the remaining moisture from the soil particles is said to be at wilting point. Available water is that which the plants can utilize from the soil within the range of field capacity and wilting point.

**Herd Dialog Box:** A herd is a group of beef cattle. In this screen, the user enters the number of heifers and cows, after normal weaning and culling. The program supports four herds:

Replacement Heifers - Replacement Heifers are females kept in the herd for replacement their first year after weaning and then bred (about 7-18 months old).

Bred Replacement Heifers - Bred Replacement Heifers are pregnant heifers kept in the herd after pregnancy check through weaning their first calf (about 19-30 months old).

Second Calf Heifers - Second Calf Heifers are females kept in the herd after weaning time of their first calf and after pregnancy check through weaning their second calf (about 31-42 months old).

Cows - Cows are older females kept in the herd after weaning time and their pregnancy check (more than 42 months old).

**Block Dialog Box:** A block is a collection of paddocks. A Paddock is a unit of land enclosed in fences which is used to graze the cattle. Each herd is allocated a block of paddocks. Paddocks can belong to different range types. The user enters the following information for each block:

Area - Total area of block of paddocks in acre or hectare.
MinHerbageMass - Minimum herbage mass in lbDM/ac or kgDM/ha
MaxHerbageMass - Maximum herbage mass in lbDM/ac or kgDM/ha
MinGreenFraction - Minimum green fraction.
MaxGreenFraction – Maximum green fraction.
Range1_Paddocks - Number of Paddocks of Range Type 1
Weather Dialog Box: In this dialog box, the user selects a weather file from a list of 131 weather stations in California. Weather files have been downloaded from CIMIS web site. The California Irrigation Management Information System (CIMIS) is a program in the Office of Water Use Efficiency (OWUE), California Department of Water Resources (DWR) that manages a network of over 120 automated weather stations in the state of California. CIMIS was developed in 1982 by the California Department of Water Resource and the University of California at Davis to assist California’s irrigators manages their water resources efficiently. The solar radiation value has been converted from w/sq m to cal/cm2/d by multiplying it with 2.0592. The wind speed value has been converted from m/s to km/h by multiplying it with 3.6. The temperature is already in metric system. The relative humidity is in percentage and hence do not need to be converted.

The program supports three types of weather: Actual Weather, Average Weather, and Random Weather. The default is Random weather. Actual Weather uses the actual data over the time period specified. Average Weather uses the average daily weather over the time period specified. Random Weather uses weather by randomly choosing years from the actual data during the time period specified. PCRANCH uses the Microsoft Web browser program and Google Earth to display map of weather stations.

Run Component

The second component is the run interface. It runs the simulation engine, CCFARM, which is written in the Java programming language as a separate program and gets its input as a series of text files from PCRANCH. Before running the simulation, the user must initialize the simulation. Once the user clicks on the Initialize Simulation or Run Simulation buttons, two extra windows open up. These are CCFARM windows. The user is not supposed to do anything with these windows, except watch them. After the simulation is finished, the user must close these windows by clicking on the X button on the top right corner of the CCFARM window. Or the user can set the field “Quit Simulation Program after Running” to 1 in the Run dialog box. In this case the simulation windows will close automatically.

The Initialize Simulation button ignores the daily and monthly options and generates an empty yearly output, which must be ignored. The Run Simulation button considers daily, monthly and yearly options and generates real outputs.

The simulation engine, CCFARM, is written in the Java programming language and needs the Java engine to run. The user must install the Java engine before initializing or running the simulation program.

The user can specify the following fields:

NumberOfYears - Number of years to run simulation. Only the Random weather type uses this value. The Actual and Average weather types ignore this field and use Starting and Ending Dates to calculate number of years to run simulation.
KeepDailyRecords - Keep daily records (0=false 1=true)
KeepMonthlyRecords - Keep monthly records (0=false 1=true)
PcNumber - Number of PC processors. If you have more than one CPU in your computer, the simulation uses extra CPU to run faster.
Repeat - Number of times to repeat simulation
QuitAfterRunning - Quit CCFARM after running simulation (0=false 1=true). Note that quitting CCFARM does not terminate PCRANCH program.

**Output Component**

The third component is the output interface which consists of a series of reports and graphs, generated from the output files of the CCFARM simulation engine. The main report is the summary report with the following columns:

- First Day of Simulation
- Pregnancy Rate
- Weaning Rate
- Average Calf Weaning Weight (kg)
- Weaning Weight Per Exposed Female (kg)
- Total Heads
- Revenue Calves Ranch
- Revenue Cows Ranch
- Revenue Total Ranch
- Revenue Calves Per Cow
- Revenue Cows Per Cow
- Revenue Total Per Cow
- Cost Hay Ranch
- Cost ID Ranch
- Cost Total Ranch
- Cost Hay Per Cow
- Cost ID Per Cow
- Cost Total Per Cow
- Gross Margin Ranch
- Gross Margin Per Cow

**References**