A NEW SORGHUM PLANTING STRATEGY RESULTING FROM THE SYNERGY OF FARMER SYSTEMIC KNOWLEDGE AND SYSTEMATIC SIMULATION OF SORGHUM PRODUCTION SYSTEMS

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Abstract

Learning that is unique to the participatory approach of the FARMSCAPE project occurred outside the scope of the planned activities when one of the farmers (RS) expressed "a hunch". The farmer's hunch was that in El Ni?o years sorghum sown i n late December is likely to out-yield sorghum sown in early October. With the APSIM simulator, soil characterisation data for the farmer's paddock, and the past 25 years local weather data all on hand, the researchers were able to test and confirm thi s hypothesis at the meeting. What took place at this meeting was a mutual learning experience. The farmer's hunch was based on very limited experience. Without the availability of a reliable simulator (or many years of costly field experimentation) this hunch could not have been "validated". For the researchers the farmer's insight was a testable hypothesis. The product of this collaboration was a timely insight that can impact on a significant farm management decision.

Key words: Participatory learning, simulation, farm management, sorghum, Southern Oscillation Index.

As set out in another paper in these proceedings, the FARMSCAPE (Farmers', Advisers' and Researchers' Monitoring, Simulation, Communication And Performance Evaluation) approach is predicated on the question "... can farmers value cropping syste m simulation as a means of trialing their own management ideas and in their local context?" (1). This paper describes an activity that illustrates how farmers, advisers and researchers can learn together in using this approach.

Opportunities for farmers, advisers and researchers to learn together are illustrated with reference to a meeting of the Kupunn Graingrowers Group. The meeting was held in July 1997 after the group's consultant (GC) analysed deep soil core samples on tw o farmers' paddocks. The group invited APSRU researchers to use this information and, with the cropping systems simulator APSIM (2) to investigate crop choice options given the current Southern Oscillation Index (SOI) phase. APSIM had previously been i ntroduced into the group's activities in a benchmarking context and was shown to make realistic on farm predictions of sorghum and cotton yields (3).

Paddocks belonging to two farmer members of the group had been characterised (4) for wheat and cotton crop lower limits of water extraction and starting moisture and nitrogen data were determined by the group's consultant (GC) on 29 April 1997. In the c ase of Ken Watter's "Far West" paddock, soil moisture as measured to a depth of 90 cm was above the drained upper limit throughout the profile. Soil N analysis showed a total of 50 kg/ha nitrate N of which about one half was in the 30-90 cm layer. Prior to the meeting, the researchers were asked to use this information as the basis for simulations. They were asked to look at the prospects for the coming summer crops (sorghum and dryland cotton) given that the SOI appeared to be locked into a neg ative phase. They were also asked to do a simulation looking at going into the summer with 45cm of moisture, a likely scenario in the district for paddocks in which summer crops were harvested earlier in the year and minimal rain had fallen since that time.

Results of prepared simulations

Four simulations were run in preparation for the meeting:

• *Watter's Sorghum:* Simulating the growth of a sorghum crop using local meteorological data from 1972 to 1997 and resetting soil water and soil nitrogen data every year on 29 April to the data recorded for

Watter's paddock. Sowing was simulat ed each year when a cumulative rainfall of 30 mm was observed over any 3 day period between 7 October and 15 January.

• *Short Fallow Sorghum:* Simulating the growth of a sorghum as in 1 above, except that, soil water was reset on 1 September so that it was close to drained upper limit in the top 45 cm but at the crop lower limit below that depth.

• *Watter's Cotton:* Simulating the growth of a cotton crop using local meteorological data from 1972 to 1997 and resetting soil water and soil nitrogen data every year on 29 April to the data recorded for Watter's paddock. Sowing was simulated each year on 1 October.

• *Short Fallow Cotton:* Simulating the growth of a cotton crop as in 3 above, except that, soil water was reset on 1 September so that it was close to drained upper limit in the top 45 cm but at the crop lower limit below that depth

APSIM simulations calculate the potential yields of crops, based on daily meteorological data with emphasis on soil moisture and nitrogen, and assuming no limitations due to pests and diseases. The results of these simulations are summarised in Table 1. They show that given the climatic variability of the previous 25 years, mean potential yield expectation for a sorghum crop was 5.2 t/ha. This contrasted with a mean of 3.7 t/ha for a paddock representing the starting conditions on a short fallow padd ock on an identical soil. In addition to having a lower mean yield, the short fallow paddock also showed greater variability of yield as indicated by the ranges and standard deviations.

Similar result trends were observed for the simulated cotton crops, though the mean differences were less than in sorghum. This difference possibly reflects cotton's relative sensitivity to waterlogging and the incidence of waterlogging simulated in a n umber of seasons given the wet starting conditions measured for Watter's paddock.

Table 1: Mean, standard deviation and range of cotton and sorghum yields as influenced by prior stored moisture between 1992 and 1997.

Simulation	Mean Yield (t or bales/ha)	Standard Deviation (t or bales/ha)	Range (t or bales/ha)
Watter's Sorghum	5.2	1.2	2.1 – 6.9
Short Fallow Sorghum	3.7	1.4	0.7 – 5.7
Watter's Cotton	4.2	0.9	2.7 – 6.2
Short Fallow Cotton	3.9	1.5	0.8 – 6.0

SOI phase information adds to understanding of yield probabilities

As mentioned earlier, the group requested an analysis of how prospects for the coming summer season might be influenced by the SOI. Stone et al. (5) have shown how phases of the SOI are related to rainfall variability and may be used for rainfa ll forecasting in a range of locations in Australia and around the world. For large parts of Eastern Australia, they have shown that a consistently negative or rapidly falling SOI pattern is related to a high probability of below average rainfall at ce rtain times of the year. As the SOI pattern tends to be 'phase-locked' into an annual cycle (from autumn to autumn), the SOI phase analysis provides skill in assessing future rainfall probabilities for the season ahead. SOI phases are determined monthly by the pattern of mean SOI values of the current and previous months: these can be either consistently negative (1), consistently positive (2), rapidly falling (3), rapidly rising (4) or near zero (5).

In our analysis crop yields were allocated to the SOI phase in the month of September prior to sowing that crop. Table 2 differentiates between yields following phase 1 in September (1972, 1976, 1977, 1982, 1987, 1990, 1993,1994) and yields in all other years since 1992. The results show that yield expectations are significantly reduced in phase 1 years for all four simulations. For sorghum, the mean yields in phase

1 years were 1.1 t/ha lower with Watter's starting soil moisture and 0.9 t/ha lower f or the short fallow starting moisture. For Cotton, the mean yields in phase 1 years were 0.6 bales/ha lower with Watter's starting soil moisture and 1.2 bales/ha lower for the short fallow starting moisture. Yield variability was slightly higher in phas e 1 for all simulations as may be observed by comparison of standard deviations.

Table 2: Mean and standard deviation of cotton and sorghum yields in SOI phase 1 years compared with all other years between 1992 and 1997.

Simulation	Phase 1 Mean Yield (t or bales/ha)	Phase 1 Standard Deviation (t or bales/ha	Other Phases Mean Yield (t or ales/ha)	Other Phases Standard Deviation (t or bales/ha)
Watter's Sorghum	4.4	1.47	5.5	1.3
Short Fallow Sorghum	3.0	1.8	3.9	1.7
Watter's Cotton	3.8	0.9	4.4	0.8
Short Fallow Cotton	3.1	1.7	4.3	1.6

A farmer expresses a "hunch"

The Kupunn group appreciates the value of the soil moisture and nitrogen data and the added value of the simulation results presented for their planning for the coming summer crop. Some farmers indicated that the presentation of the yield analysis with SOI phases helped them appreciate for the first time the value of SOI information for farm management. Other farmers observed that with full soil moisture profiles, the prospects for profitable yields were still quite good and that this was in stark co ntrast with the "media hype" surrounding El Ni?o.

During the discussion session, one farmer (RS) recalled that in a previous El Ni?o season a farmer who was new to the area deviated from local convention by sowing sorghum just prior to Christmas and obtained a very good yield in comparison with his neighbours who sowed early in October. RS proposed that late sown sorghum crops are more likely to benefit from storms in late summer. This "hunch" was recognised as a hypothesis testable by the simulator.

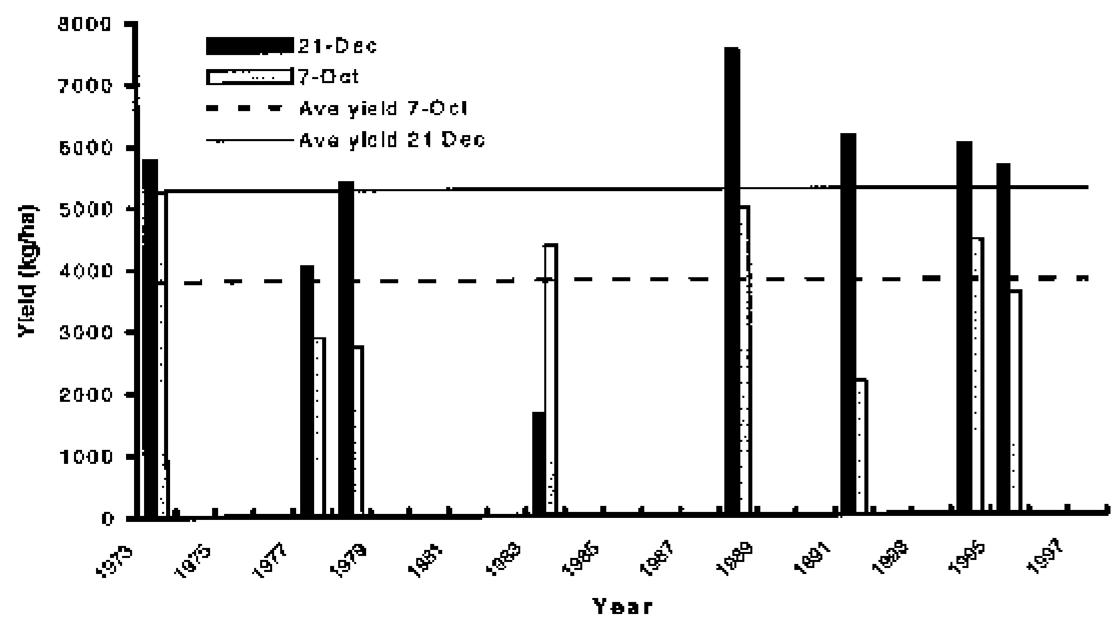

Figure 1: Results of a simulation of early and late sown sorghum yields for Watter's starting soil moisture conditions in years that had an SOI phase 1 in September.

Testing the hypothesis

While the rest of the group took a well earned tea break the researchers set up and ran two more simulations based on Watter's paddock. These simulations compared the yields of a sorghum crop sown each year on 7 October with that of one sown on the 21 D ecember.? The results (Fig. 1) were presented and discussed after the tea break. The simulation results gave strong support to the hypothesis. In seven of the eight years with SOI phase 1 in September calculated sorghum yields were higher for the later sowing date. Mean yields for the 7 October sowing were 3.80 t/ha (Standard Deviation = 1.12 t/ha) while mean yields for 21 December sowing were 5.27 t/ha (Standard Deviation = 1.75 t/ha). Thus with the knowledge of SOI phase in September, farmers can decide to delay sowing sorghum to December and thus offset the negative impact of a negative SOI on yield expectations. In taking such a decision other risks, such as those associated with pests and diseases, must also be considered.

Following the Kupunn meeting these outcomes were tested for a number of sites in the Darling Downs of Southern Queensland, using a range of starting soil moisture conditions and 100 year meteorological records. All simulations confirmed the hypothes is that later sowing results in higher yield expectations than early sowing. Further analysis showed that the risk of not having a sowing opportunity after the end of November was also found to be minimal (about 2 years in 100).

Extension to other farmers

Farmer members of the Kupunn group took the initiative of extending the message they gained from this interaction. They did this through presentations to other groups and through stories to the rural press and the national press (including the Bulletin) . The message was also extended through similar simulations tailored to fit the soils and local meteorological data of other FARM-SCAPE groups and IAMA groups benefiting from a close association with the FARMSCAPE project. Overall more than 150 farmers were present at such group activities. A press release prepared by APSRU researchers was given good exposure in the local media.

Conclusions

This is a case study of researchers taking tools such as simulation models and deep soil sampling technology into a participatory learning environment with farmers and advisers. The story of one such learning activity illustrates the potential for syner gy of farmers' systemic knowledge of farming and the systematic analysis that can be carried out with a simulation model that has been specified to a farmer's paddock. It is significant that previous analysis of SOI and time of sowing of various crops in this region, conducted in Operations Research mode, did not discover the potential benefit of sowing sorghum late in a negative September SOI phase. The opportunity for farmers to fine tune their management options while researchers gain new insights into farm management by systematically testing farmers' insights is unique to the FARMSCAPE approach.

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