Australian Academy of Science

| | | |
|---|---|---|
| John Kirkegaard: | 00:00:03 | This is Dr. John Kirkegaard, interviewing Dr. John Passioura for the Conversations with Australian Scientists program on the 13th of April 2022, for the Australian Academy of Science. John, let's start with your ancestry. Passioura is an interesting name. What is your heritage? |
| John Passioura: | 00:00:21 | Oh, my father was Greek. He was born in Smyrna, which was a multicultural city, on the western shore of what is now Turkey. But it was in a part of Greece called Anatolia at the time. He lived there until he completed his schooling. When that happened, his father became concerned about the start of the First World War. He sent my father and his brother to the Sudan, where my grandfather had a friend who sold cotton. |
| John Passioura: | 00:01:06 | They stayed there for four years during the war. After that, they moved to Alexandria, and stayed there for a bit and then to Athens. But in 1922, there was a war between the Greeks and the Turks. Smyrna was essentially burnt to the ground. My grandfather and his remaining family escaped, barely. They were quite wealthy in Smyrna, and they left with nothing. They went to live in Athens. |
| John Passioura: | 00:01:51 | Thereafter, there was a major exchange of populations between the Turks and the Greeks, because the Ottoman Empire was in its death throes, but it was still there. There were many Turks living in what is now Greece, and many Greeks living in what is now Turkey. My father, at that time, decided that he liked to go and live in Melbourne, which was a hotbed for Greeks. |
| John Passioura: | 00:02:25 | From about that time, he settled in Melbourne, and he had no problems speaking English for he spoke six languages fluently. At school, they went to a French school, which was common in the Ottomans. He spoke Greek at home and Turkish with the kids in the street. It was three. Then when they moved to Alexandria, he picked up on ... of course, in Khartoum, he picked up Arabic, and then English and Italian in Alexandria. |
| John Kirkegaard: | 00:03:00 | How old was your father when he arrived in Melbourne? What did he do when he arrived? |
| John Passioura: | 00:03:04 | Well, he was 29 when he arrived in Melbourne with very little cash in his pockets. He soon got a job with a green grocer in St Kilda. The job was to go to the Victoria Market, north of the CBD of Melbourne, which was the largest fruit and veg market in the |

| | | |
|---|---|---|
| | | country, well, in Melbourne. His transport was a horse and a cart. He had to get up at 4:30 in the morning to harness the horse to the cart. |
| John Passioura: | 00:03:50 | He got into the cart. He slapped the horse on the ramp. He then went to sleep because the horse had done this so many times that he knew where to go. They went there, he picked up the goods that the greengrocer wanted, and they came back. |
| John Kirkegaard: | 00:04:07 | How long did he stick at that job? |
| John Passioura: | 00:04:10 | Well, after about three years, he had enough saved to rent a café in Fitzroy. That was where he met my mother to be who was the waitress in the café. That was in 1928, a year before the descent of the Great Depression. They were doing well for a while. When the Great Depression struck, they were going broke very fast as were very large proportion of Australians. |
| John Kirkegaard: | 00:04:49 | What was your mother's ancestry? |
| John Passioura: | 00:04:51 | Well, her ancestry was essentially working-class Australia. She was the oldest of five children and she was essentially the breadwinner. Her mother was not at all well. As they were going broke, they decided that they would then go north, northwest to settle in Balranald, on the Murrumbidgee. My father opened another cafe there. But it didn't do very well. |
| John Passioura: | 00:05:30 | They stayed there until 1938 when I was born, as they said, on the kitchen table in a small house, which had 10 people living in it in those depression days. They became itinerant, wandered around the countryside a bit, then to Melbourne. Because my father was good at attracting customers, for things like cafes, he was offered the rental of a milk bar and attached house, on Elwood Beach. |
| John Passioura: | 00:06:08 | That got the family out of poverty. Because at the end of the Second World War, when people started to move, they were attracted to Elwood Beach. It was the most popular in Melbourne. There were tens of thousands of them on hot days clamoring for ice cream, and cold drinks. It was only two or three years before we could start feeling that we were financially alive. |
| John Kirkegaard: | 00:06:38 | You worked at the milk bar ... |

| | | |
|---|---|---|
| John Passioura: | 00:06:40 | Yes. I did. The main house and milk bar which was quite large and could take 30 or 40 clamoring people in it. There was a little kiosk about 500 meters away at the end of the car park along the beach, and I worked in there with a semi-half-sister for four years during the summer, feeding sometimes my schoolmates. |
| John Kirkegaard: | 00:07:17 | You say it really helps you decide running a milk bar wasn't for you? |
| John Passioura: | 00:07:21 | **Absolutely. Absolutely.** |
| John Kirkegaard: | 00:07:25 | Was it your parents to encourage you towards science? Or did you have other influences in that? |
| John Passioura: | 00:07:30 | Well, they didn't have much idea about science. But they were aware that I was really interested in the refrigeration engineers who were frequent members of our household because the refrigeration systems tended to break down very easily in those days. We in fact, had about a ton of ice cream in a large container at the back, and that would have been quite an expensive loss. I used to chat to them and talk to them and so on. That was good. |
| John Kirkegaard: | 00:08:13 | Well, you have not ended up a refrigeration engineer. But where did your specific interest in agriculture come from? |
| John Passioura: | 00:08:20 | Well, that came because of the several winter term breaks that I had at school that were on a sheep station, about 50 kilometres north of Balranald on the way to Lake Mungo. The wife there lived with us for a time and was a close friend of my mother. She took me up there each year. I became really enthralled by her husband, who was phenomenally able person to run a sheep station. He was very successful in that even during long droughts. |
| John Passioura: | 00:09:12 | He showed me all sorts of things that they were doing, like trapping rabbits, which were extremely busy at that time. |
| John Kirkegaard: | 00:09:25 | What about other things that were going on the farm in those days? |
| John Passioura: | 00:09:29 | Oh, the sheering shed, the rabbit trapping that I mentioned, the maintenance of the windmills, his ability to go to an enormous warren and put 30 or 40 traps in there and go back the next day |

and knew where the traps were out of 200 or 300. He just had that amazing ability.

| | | |
|---|---|---|
| John Kirkegaard: | 00:09:53 | Someone very adapted to their environment. |
| John Passioura: | 00:09:55 | Very adapted to his environment. |
| John Kirkegaard: | 00:09:59 | He had quite an influence on you and ultimately influenced your decision to enrol in agriculture at university? |
| John Passioura: | 00:10:07 | Yeah. His success as a farmer stayed with me for the rest of my life as an ag scientist and was reinforced by the many superb farmers that you and I have met in our professional lives. |
| John Kirkegaard: | 00:10:32 | **Early mentors such as that farmer can have really profound effects on us when we reflect on it. Were there other strong influences in your school days?** |
| John Passioura: | 00:10:42 | Well, my mother was very upset about not being able to do the final four years of high school because she had to leave school at 13. She was very interested in education and so was my father. By then we had enough money to go to one of the premier schools in Melbourne, which was Wesley College. I found a marvellous school. It was with Wesley you detect that it might be Wowser-ish, no alcohol, certainly, and no dancing, although they had come through that, no this, no that era by then. |
| John Passioura: | 00:11:30 | They were very socially conscious. By far, the most socially conscious of that class of school. They sent students out to help people, say in care homes and so on. The values that they left us with were, I think, staying with most of us and most of our lives as trying to be very caring people. |
| John Kirkegaard: | 00:11:59 | **The station owner and parents and that school clearly helped set your compass towards studies in agriculture in Melbourne. What was it like in those days?** |
| John Passioura: | 00:12:08 | Melbourne University? Well, it was small. There were only 4,000 students. We had the first year was science courses, that is physics, chemistry, biology, and geology. In the second year, we went to Dookie College in Shepparton, about 200 kilometres to the north of Melbourne, which was a full year stay from January to December. |

| | | |
|---|---|---|
| John Kirkegaard: | 00:12:45 | On farm? |
| John Passioura: | 00:12:46 | On farm at the college. We had two weeks of lectures and then two weeks of doing stuff on farms, with pigs, sheep, cows, horses. We learned to harness horses, which was not useful. We had a very wet year in 1956. The broken River was about 20 kilometres wide. So, we didn't have any knowledge about growing crops. |
| John Kirkegaard: | 00:13:24 | Sounds like quite a rounded curriculum. The final two years in particular were quite broad. |
| John Passioura: | 00:13:29 | Yes. The third year was mostly about scientific issues, advanced physiology, entomology, plant sciences. In the third year, we had a more general curriculum. We had sociology, economics, and agricultural engineering, which covered in fact both years. |
| John Kirkegaard: | 00:13:56 | **Did any particular subject stand out as influencing the direction you took?** |
| John Passioura: | 00:14:00 | Well, soil chemistry was the most difficult of the subjects and Geoffrey Leeper who ran it was the most difficult of the lectures. He used to get into strive for not passing so many of the people. He was an extraordinary character. He was very smart. He had very broad interests. He taught us not only soil chemistry, but also how to think, how to write, how to understand people like Karl Popper who was the leading scientific philosopher at that time. |
| John Passioura: | 00:14:45 | I thought I would like to be a student of his. After graduation, I, with some trepidation, went along to his office and asked if I could be his student. He peered at me for a few moments and said, "What were your marks in agricultural engineering?" I said, "I believed I was the top," which he knew. He said, "Well, let's see what you can do." |
| John Passioura: | 00:15:23 | We then started doing an aspect of the trace element, manganese, and its influence on plants. The way that changes in the environment in a given place can make it either toxic in excess or extremely deficient, which also killed plants. |
| John Kirkegaard: | 00:15:46 | **That was the central thrust of the PhD?** |

| | | |
|---|---|---|
| John Passioura: | 00:15:48 | It was central thrust of the PhD. We had discovered a group in South Australia near the Victorian border, where manganese was very deficient, that the farmers were perplexed that the wheel tracks grew quite a good crop, but not the ones that you'd sown. |
| John Kirkegaard: | 00:16:12 | Which you might think would be the opposite. |
| John Passioura: | 00:16:13 | Which we thought was the opposite. We thought that the wheel tracks had been sufficiently squashed, that oxygen in the soil might have been scarce. That would result in a very insoluble manganese oxide, releasing the manganese ions that the plants needed. But we measured the manganese ions and found that they hadn't changed. |
| John Passioura: | 00:16:42 | We started wondering about what the compaction was doing to the roots of the plants and were aware that the roots were having trouble growing through the smaller pores that the compaction caused. In so doing, forcing their way through, they had to make very close contact with the surfaces of the particles that was surrounding them. |
| John Passioura: | 00:17:15 | We then thought that close contact was enabling the roots to squeeze as it were the manganese ions off the solid surface. Inspired by the work that Hans Jenny had done, who was the most notable soil scientist of his time in looking at how clay particles could exchange the ions that were adhering to them only when they got very close together. |
| John Kirkegaard: | 00:17:51 | I understand that this, your first PhD paper was actually published in Nature? |
| John Passioura: | 00:17:55 | It was published in Nature. Yes. Nature published papers of slightly over a page at that time. I think they were attracted to the fact that compacted soils could be beneficial. I think they were attracted to the idea of the contact exchange. |
| John Kirkegaard: | 00:18:20 | **After your PhD studies, you moved on to postdoctoral studies in the UK and Europe. How did that come about?** |
| John Passioura: | 00:18:29 | Well, I was fortunate enough to get a CSIRO Scholarship, of which there were 10 or 20 a year at that time. I went to work in the Macaulay Institute in Aberdeen, because one of Leeper's ... In fact, Leeper's only previous PhD student had gone there, too, |

and liked it. Well, I went there and I didn't like it. It was a rather mundane group that was there.

John Passioura: 00:19:03 In the summer of the following year, I went there in September '63. the summer of the following year, I travelled around Western Europe, Scandinavia, Western Germany, Netherlands, and France. I became interested in what was going on at Wageningen University where there was a very good soil chemist and physicist called Jerry Bolt, who was trying to understand what happens to clay particles when they move around a bit and how they like Hans Jenny says, moved and exchanged particles and so on.

John Passioura: 00:19:50 For example, if you have calcium on the clay particles, they stick together. If you have sodium, they wander away because the sodium pushes them away.

John Kirkegaard: 00:20:00 You say that you found the mathematics here was daunting?

John Passioura: 00:20:03 Daunting. But just understandable in my mathematically uneducated state.

John Kirkegaard: 00:20:10 The theme of physics and chemistry at that stage was clear in your work. But there was a talent for mathematics also beginning to emerge?

John Passioura: 00:20:18 Yes. Because quite simple mathematics can enable you to do a lot more things than you might have otherwise thought. Instead of waving your hands about what might be happening in a field, you can start looking precisely at what might be going on. Going back to when I was a graduate student, I became interested in how the nutrients were moving towards the roots, and how they were carried by the water that was moving towards the roots.

John Passioura: 00:20:56 I wrote a not very mathematically accurate paper that was published in Plant and Soil about the same time as the paper in Nature. That was appended to my PhD thesis. I was fortunate enough in Wageningen to share a lab with a fellow called Maurice Frere from USDA, who liked to be called Mo Frere. The local Dutch people kept asking me where ... they didn't know that I had a brother, which is the French 'mon frere' of course, and almost.

| | | |
|---|---|---|
| John Passioura: | 00:21:41 | He knew how to do numerical analysis of difficult equations that you couldn't deal with analytically. We worked on those. We wrote a paper that the mathematics was good at. We published that just after I came back to Canberra a couple of years later. |
| John Kirkegaard: | 00:22:06 | Using some early Fortran, I understand. |
| John Passioura: | 00:22:08 | Using some early Fortran, yes, and a rather grumpy 1620 IBM computer, which involved a long night of calculation followed by spitting out about a meter of Hollerith cards, which then had to be carried to a printer. The printer would then turn those into print. |
| John Kirkegaard: | 00:22:32 | Hardly a supercomputer. |
| John Passioura: | 00:22:35 | No. No. But it was the first popular computer. |
| John Kirkegaard: | 00:22:39 | **After that CSIRO scholarship, the guarantee a subsequent job with CSIRO?** |
| John Passioura: | 00:22:48 | Well, CSIRO expected but did not demand that one could join a CSIRO division after the fellowship was over, which it had been over for two years. But then I heard from Ralph Slatyer, towards the end of my time in Wageningen, which was roundabout July, August of '66 that he would like to offer me a job, which I grabbed with some glee. |
| John Passioura: | 00:23:19 | We eventually turned up in Canberra with me, a pregnant wife and two-year-old child. We settled in Canberra quite close to CSIRO, which was easy to do at that time. |
| John Kirkegaard: | 00:23:36 | What was Ralph's background? |
| John Passioura: | 00:23:38 | Ralph was a very talented scientist who worked both as an ecologist and as a plant physiologist, and he became the first Chief Scientist of Australia. That was partly because he and Bob Hawke went school together. He moved to the ANU a couple of years later, after I turned up. What was wonderful about him and about being in CSIRO at that time was that we had no financial problems, because the federal government pretty well paid for everything. |
| John Passioura: | 00:24:20 | We had lots of scientific leisure, which we made very good use of. Ralph's group would meet at mid-morning, every day, those |

of us who were there and we would just chat. In the afternoons, we would meet with the division as a whole. The rest of the division which was 80% to 90% of the total was more interested in broad topics like hydrology, land use, and so on.

John Kirkegaard: 00:25:00 Ralph had been building this group in CSIRO?

John Passioura: 00:25:01 Yes.

John Kirkegaard: 00:25:03 A group of people who were interested in the behaviour of plants and crops and particularly water use. What specifically did he ask you to do when you arrived?

John Passioura: 00:25:15 Well, Ralph never asked anybody to do anything, because he was interested in trying to get people who were creative and who could become more creative and to get themselves going by talking to the rest of the group. It was spontaneous.

John Kirkegaard: 00:25:36 Early on, one of that group was Ian Cowan?

John Passioura: 00:25:39 Ian Cowan had come to Canberra just after me. He'd previously been working at Rothamsted, was the great micrometeorologist of the time, Howard Penman. They were looking at how water moves from the soil through the plant to the atmosphere. Kramer was the leading micrometeorologist of the world at that time. I was doing similar thinking, using numerical techniques, because I couldn't solve the equations, and neither could Ian.

John Passioura: 00:26:11 But when you cut the right corners, you get the right answers. Ian and I worked together for a while in which we compared the numerical with the mathematical that he was doing, and found that they were in pretty good agreement, which was a delight, because that meant that we could use the simple mathematics rather than worry about the numerical to solve the equation.

John Kirkegaard: 00:26:41 This was, in particular, regard to the cylindrical geometry of roots that you have found. [Fix sound here]

John Passioura: 00:26:45 Quite. Yeah. The cylindrical geometry requires quite a few tricks to do the mathematics on. Because when things are flowing towards them, they have to speed up as they get closer and closer into the ... They start out here. Then they have to get into there.

| | | |
|---|---|---|
| John Kirkegaard: | 00:27:04 | You've spent a lot of time over the next 20 years exploring how roots and soil interact to control uptake of water, and particularly when it becomes limiting. I understand your work in those early days also took you to the Ord River Project. |
| John Passioura: | 00:27:19 | Yes. Well, another colleague that I became friends within Ralph's group was working in Kununurra, at the top of Western Australia, almost on the border was the Northern Territory. There they had created a micro-version of a possible large dam. There was a group of people there who were trying to grow cotton, because they thought that would be the best plant to grow. |
| John Passioura: | 00:27:52 | But by the time we got there, one could smell the insecticide in the air. We were not so much interested in trying to grow the cotton as in trying to work out how one could most effectively use the very large amounts of nitrogen fertilizer that cotton required. That was Rob's project, which I helped with. He tried three ways of applying nitrogen. |
| John Passioura: | 00:28:23 | He would either spread it or put it in irrigation water, or most importantly, to drill it into the ground as a long band to the side of the ridge that the cotton was growing on and which extended alongside in parallel with the cotton. We found that the band was by far the most economical way of using the nitrogen because none of it escaped. |
| John Kirkegaard: | 00:28:54 | You were focusing in on the root-soil interactions again? |
| John Passioura: | 00:28:57 | We were. The reason that none of it escaped was that it was highly toxic, because there was so much of it there, so much of the fertilizer, that it was having an osmotic effect. The roots would approach it and they would then stop and start proliferating as the nitrogen moved from the band out to where the roots were, which was about five centimetres distant from the band. |
| John Passioura: | 00:29:30 | They could then get the nitrates that was coming towards them and they slowly eat their way in to the centre. None of the nitrogen escaped, all finished up in the cotton. |
| John Kirkegaard: | 00:29:47 | I believe the unlikely pairing of radio phosphorus and a chainsaw were put to good use. |

Australian Academy of Science

| | | |
|---|---|---|
| John Passioura: | 00:29:51 | Yes. Well, we wanted to show that this actually happened in the field. We took a larger lump of lead with holes in it, put radioactive phosphorus in it. Put it in the hold of the plane as we went to Kununurra. We used that radioactive phosphorus to inject into the stems of the cotton plants, because we knew that the phosphorus was being sent down to the roots, not only to the roots, but as the root tips. |
| John Passioura: | 00:30:27 | We borrowed a chainsaw... a long chainsaw, and we cut across the band... |
| John Kirkegaard: | 00:30:37 | In the soil. |
| John Passioura: | 00:30:38 | In the soil. Right across the ridge, and then put a chest x-ray, an unexposed chest x-ray in there, left it for a day or so, pulled it out, and then developed it. Sure enough, there was this ring of wonderful little black dots showing where the root tips were there. |
| John Kirkegaard: | 00:31:02 | Remarkable science John, but I won't be lending you my chainsaw anytime soon. What became of the Ord River project? |
| John Passioura: | 00:31:10 | Well, those of us who were working there at the time were very sceptical that it was worthwhile putting in the dam. The chief of the Division of Land Research was a great enthusiast for Northern Australia. He was raring to go. I think many of the politicians the time as we have many of the politicians these days were keen on developing Northern Australia. So, they went ahead. |
| John Passioura: | 00:31:40 | The subsequent history, which I briefly looked up said that the dam and the irrigation system had spent one and a half billion dollars and the return was 17 cents per dollar. So, things are still looking crook. |
| John Kirkegaard: | 00:31:56 | CSIRO's work on cotton subsequently moved south with some success. |
| John Passioura: | 00:32:00 | Yes. With a great deal of success, because they had a superb breeder and a superb agronomist, and they moved to Narrabri. |
| John Passioura: | 00:32:08 | I forgot to mention earlier that the cotton was being eaten rapidly by bollworms, which they could not control. But in the less humid environment of Narrabri, they could make a living |

there. They still needed to spray many times until BT came along which was a gene extracted from soil microbe that when put into a plant would kill any caterpillars when they ate the plant.

John Kirkegaard: 00:32:39 **Just going back to Ralph Slatyer, who clearly had a significant impact on the direction of your work. What observations would you make about his leadership style? How did it come to influence your leadership?**

John Passioura: 00:32:51 Well, he made sure when we had our morning and afternoon meetings nobody could sit down. People mingled and the discussions that went on were much richer than what happened when a group of mates sat by a table and talked about the weekend football scores. On top of that, he thought we would all enjoy playing croquet on the lawn in front of our building up there. Not the top of Black Mountain but the top of CSIRO — we used to play croquet there. We would discuss all manner of other things at the same time.

John Kirkegaard: 00:33:27 I've heard you describe this as scientific leisure. I think it's a great term. It's a dream for my generation of scientists.

John Passioura: 00:33:35 A lost dream?

John Kirkegaard: 00:33:35 I hope not! Can you expand on what you see as the benefits of scientific leisure?

John Passioura: 00:33:46 Well, we had an administration whose job was to support the scientists. Nowadays, we have an administration that creates impediments for the scientists. Perhaps they're following orders, because there's a huge amount of legislation that is required now, especially health and safety, which we never know what the records are on health and safety.

John Passioura: 00:34:17 The current administration had offloaded administrative chores like buying something onto us now as the scientists, and it takes us half an hour to order something which would have taken three or four minutes for one of the administrators in the old CSIRO.

John Kirkegaard: 00:34:40 John, these gatherings of people came to influence your thinking on other interactions in biology. Can you elaborate on that?

John Passioura: 00:34:49 Well, the form of social interaction intrigued me. I began to think about hierarchical structures and the interactions between different levels or scales in such structures. For example, laboratory research on gas exchange by plants could be studied for its own interest, or it could be thought of in the context of field-grown plants, and how modifying rates of gas exchange might help increase yields of crops.

John Passioura: 00:35:16 In relation to hierarchical structures, I chanced upon a book called Beyond Reductionism, which contained a set of papers given at a remarkable conference organized by Arthur Koestler in Alpbach, Switzerland in 1968. The first paper in that book, written by Paul Weiss dealt with the hierarchical structure of living organisms, and was in part based on the idea of general systems theory that was pioneered by Ludwig von Bertalanffy, who wrote the second paper in that book. Weiss emphasized the difference between machines and hierarchical systems in this way.

John Passioura: 00:35:55 I quote, "In a system, the structure of the whole determines the operation of the parts. In a machine, the operation of the parts determines the outcome. Both processes occur in living systems." Weiss's paper was revolutionary. It guided me at least subliminally for the rest of my career. I doubt that Ralph was overtly aware of general systems theory, but his leadership certainly did reflect it.

John Kirkegaard: 00:36:22 **In my world of crop agronomy, you're perhaps best known for your work on effective water use by crops. How did that work initially developed?**

John Passioura: 00:36:32 One afternoon, I was talking to Henry Nix at the general get together. He told me about the work that he had been doing in Biloela, which is the northern tip of the wheat belt in Australia. He told me that the yield of the wheat over several seasons that they were looking at it was proportional to the amount of water contained in the soil at about the time of flowering.

John Passioura: 00:37:03 That was a blinding flash of light, because it was a perfect example of Louis Pasteur's dictum, that chance favours the prepared mind.

John Kirkegaard: 00:37:17 It really changed the direction of your research?

John Passioura: 00:37:20 It changed the direction of my research, because I started to think, together with Henry, about how we could save water for use during the more important times of flowering and grain filling, and not use it up during the vegetative phase.

John Kirkegaard: 00:37:40 Seems obvious now. But how did you follow up on that eureka moment?

John Passioura: 00:37:45 Well, I started doing some experiments in which I tried to emulate the field experience of plants by growing them in one-meter-long cylinders of soil which had about the same amount of soil in that they would get in the field, and could hold about the same amount of summer rainfall, which is what the crops in Biloela require. Same amount of water, as they had in the field.

John Passioura: 00:38:19 The seed of wheat has got about five seminal roots, as they're called, which emerge during germination, sometimes more, but about five. They, in half of the pots that I was using, were allowed to grow freely into the soil. The other half, I prevented four of the five seminal roots from getting into the soil, and that left only one.

John Passioura: 00:38:52 The idea was that with reducing the size of the root system, we would somehow save water by reducing the growth rate of the plants for use during the later flowering and grain filling times.

John Kirkegaard: 00:39:11 Did your hypothesis on the badly tortured wheat plants win out?

John Passioura: 00:39:15 It did win out, but it caused us considerable troubles of thought, because the total root system of the tortured plants was greater than that of the un-tortured ones. How could that be? Well, we then started thinking about the geometry of what was going on and became aware that all of the water used by a large plant had to move through a vessel in the seminal root, in the center of the seminal root that was only 60 micrometers wide.

John Passioura: 00:39:58 That water was moving, as it moved in from the roots to the leaves, at one meter per second, which is very fast. Indeed, is a world record, I would say. That gave us the idea that we could, instead of worrying about the number of the roots, we would reduce the size of the vessels that were carrying the water, and such cylindrical vessels have to obey Poiseuilles law, which states that the conductance of water through those tubes depended on the fourth power of the diameter, that is, if you have the diameter, you would reduce the conductance by a factor of 16.

John Kirkegaard: 00:40:46 I believe that later led on to a breeding program to seek such plants with narrow vessels, which we may come back to later. But you're moving to plant physiology following this led to a sabbatical in Cambridge?

John Passioura: 00:41:00 Yes. It's quite stunning to look back on it. To be told by the Chief that given that you're moving into physiology, we think you should go to Cambridge to spend a year. I don't think anything like that happens these days, and went to Cambridge and to the botany school there and picked up a reasonably good understanding of what was going on in the crop plants that I was interested in.

John Passioura: 00:41:31 At that time, I became interested in not only the movement of the water from the soil and the things that carried to the leaves, but to the backwards flow of nutrients, including carbohydrates from the leaves to the roots, and then became interested in how fast the leaves would be growing.

John Passioura: 00:41:58 My contact was with Enid MacRobbie in the Botany School, who was a leader in studying the transport of water, and metabolites across membranes. My interest in the vascular system of wheat roots had extended to the phloem, which carried sucrose from the mature leaves to the growing areas. The rate of flow being determined by its transport across membranes.

John Passioura: 00:42:22 Thus five years after returning to Australia, we found ourselves back in Britain. During my 12 months there, I learned much about general plant physiology from my new colleagues. I also met and kept in touch with many plant physiologists from UK and Europe. That knowledge, which is all that I brought back with me, gave me many ideas to build on in relation to agriculture.

John Kirkegaard: 00:42:45 **Then, on your return to Australia in 1972, I believe you found a much-restructured CSIRO and that prompted another career shift.**

John Passioura: 00:42:55 Yes. When I came back, we were told that the Division of Land Use Research was no more, and it became a Division of Land

and Water working on the large scale. The few of us who were physiologists at that time, were attracted to the Division of Plant Industry by Lloyd Evans.

| | | |
|---|---|---|
| John Kirkegaard: | 00:43:22 | Back to the theme of more efficient water use by plants? |
| John Passioura: | 00:43:27 | Returning to the idea of breeding wheat plants had had narrow xylem vessels in their seminal roots. I asked Lloyd if it was possible to recruit an appropriate breeder? He said, "Well, yes, but we'll have to get some money from the Wheat Research Council to do that," which was being run by Max Day. Max didn't think much of that to start off with. |
| John Passioura: | 00:43:55 | But eventually, we got his permission. Well, I have an addendum in midstream, which was that Max had refused us for two years. Lloyd happened to be going up in the lift in the old headquarters of CSIRO with Max, fortuitously, and Max said, "You haven't put in an application this year." Lloyd said, "It's been on your desk for a fortnight." |
| John Kirkegaard: | 00:44:25 | It was clearly successful? |
| John Passioura: | 00:44:27 | It was clearly successful. I think it was good that we had to wait a bit longer because we were lucky to get Richard Richards as breeder who had just finished his PhD in Western Australia, working on canola, which was having a bad time with disease in that era. He came and we started exploring the possibility of reducing the size of the xylem vessels, the tubes that carry the water to the leaves in the upper part of the root system. |
| John Passioura: | 00:45:05 | We looked at thousands of plants, which we could do quite quickly, two or three a minute. We found varieties that had narrowed xylem vessels. Richard made use of those to cross into existing varieties to see if that would help them save water during the vegetative phase of the crop for use during later on. |
| John Passioura: | 00:45:31 | He showed that, although we weren't up in the tropics, at the time, that water was saved by the manipulated plants, and they did give larger yields during dry years. |
| John Kirkegaard: | 00:45:49 | After that you're interested in making better use of water when it is in limited supply continued to grow. I think you had been doing some pot experiments too. Investigating optimum use of water when it's in limited supply? |

| | | |
|---|---|---|
| John Passioura: | 00:46:03 | I'd been doing more pot experiments because I was interested in making an equation, which would explore the water use by crops in three components. That is the water supply for the plants, the ability of the plants during the vegetative stage to make effective use of that water in producing biomass. The third was the harvest index, which is the ratio of the grain yield to the biomass. |
| John Passioura: | 00:46:41 | There were three separate components of grain yield in water limited environments. I did experiments which convinced me that trade-offs between those various ... those three were quite weak, which means that instead of just thinking we need more water at flowering time, we could start looking at getting more water, making it more effective in producing biomass, which is the least important and also how much water, what proportion of the total water supply would be needed to give you the highest harvest index. |
| John Passioura: | 00:47:26 | I showed that that was 30% of the total water supply. |
| John Kirkegaard: | 00:47:33 | John, that equation is perhaps one of the most influential for breeders and agronomist alike, providing different but potentially additive targets for improvements in both genetics and in agronomic management. Were you aware at the time of the impact it was going to have? |
| John Passioura: | 00:47:49 | Not in the least. I wrote it as a short article in an Australian agricultural journal, Institute of Agricultural Science. I wrote it for my colleagues, many of whom were highly sceptical, thought I might convince them. But then, Champ Tanner, who was visiting us in 1981, took it back to the United States with him. I also gave a longish talk at a meeting in the Midwest in 1983, which became a paper that was fairly highly cited, I think, because of that equation. It occupied the world. |
| John Kirkegaard: | 00:48:37 | **It certainly has, and I guess I came to know you as the head of the Crop Adaptation Group in Plant Industry in Canberra. How did you come to lead the Crop Adaptation group at CSIRO?** |
| John Passioura: | 00:48:50 | Well, I came to lead it because Lloyd had resigned. Jim Peacock was his successor. Jim asked me to lead a program called Crop Adaptation. The various groups in Crop Adaptation were scattered all over the site. The first thing we had to do was to |

build a building, which could accommodate us all, or almost all. That we did, and it was built in 1984 and we all moved in.

| | | |
|---|---|---|
| John Passioura: | 00:49:28 | My role I saw then was that the subprogram leaders were all superb. I saw my role as ensuring that they talked to each other, and everybody talked to each other. I tried to replicate the technique that Ralph used of having morning meetings that many people came to, in which people could not sit down. |
| John Passioura: | 00:50:00 | We used to have a quite a large meeting in a dry chemistry laboratory at which we had a brief seminar by one of the people present. We would discuss things about that. That resulted in many new ideas being voiced and coming to fruition. |
| John Kirkegaard: | 00:50:22 | Scientific leisure living on? |
| John Passioura: | 00:50:26 | Yes. Yes, at that time there was because Jim understood scientific leisure. He understood that no program leader was worth his or her salt unless they were spending 50% of their time on their own research. |
| John Kirkegaard: | 00:50:45 | It was around this time that you met Rana Munns? |
| John Passioura: | 00:50:48 | Yes, I did. I met Rana Munns at a conference in Perth in 1980. She had just finished working with a Dutch mentor. She was a postdoc. She was looking for a job. I was intrigued by the work that she and Hank Greenway, who was her mentor they had been working on what happens? Why does the growth of plants reduce when you give them a shot of salt water? |
| John Passioura: | 00:51:28 | What was especially intriguing was that the most sensitive parts of the plants were the growing leaves. That was what stopped immediately. But there was no sodium chloride in the expanding cells. Why were they not expanding? |
| John Kirkegaard: | 00:51:44 | I believe you had developed an ingenious new apparatus that was central to unravelling the answers to some of these questions. |
| John Passioura: | 00:51:52 | I had. That was just coming to maturity, I would say, at about the time I was talking to Rana, the time we had Champ Tanner here and that was in 1981. That was the year that Australia had the National Botanical Congress. There were many visitors |

around the place at that time. This apparatus involved growing plants in pots that could be put inside a pressure chamber.

John Passioura: 00:52:27 The pots had a thick aluminium plate on the top with a small hole drilled through the centre to enable one to let the roots grow through there while the leaves were above it. Then it was locked into the pressure chamber. The pressure could be controlled by applying a mixture of oxygen and nitrogen to the roots. We had the wherewithal for precisely controlling the water status of the leaves. What was that doing in the salt-affected plants?

John Passioura: 00:53:03 One of the things we did was to show if we put a lot of salinity in the soil that was going to slow down the growth of plants, we could overcome the osmotic effect of that salinity by applying an equal pressure that cut it off. But the surprising thing was that that didn't affect the reduced rate of growth of the plants. They kept growing slowly.

John Kirkegaard: 00:53:38 In effect, even when the shoots were as happy as they could be from a point of view of water supply, they still slowed their growth?

John Passioura: 00:53:46 Not quite as happy as they could be, because at that stage, we were just getting rid of the osmotic effect of the salt. Nevertheless, the plants slowed their growth and that led us to discover, and several others were discovering at the same time that roots when they found themselves in an inhospitable space would send inhibitory signals to the leaves to stop them growing.

John Passioura: 00:54:13 We didn't know then and we don't know now what those signals are, but we can prove that they exist. The same is true for growing plants in drying soil. That is not using salinity. The same thing occurs. The plants slow their growth rate, even though the leaves are at their happiest, as you mentioned. The leaves were on the point of bleeding xylem sap out into the air.

John Kirkegaard: 00:54:42 This is some feed forward response, presumably?

John Passioura: 00:54:46 Well, yes, we thought of it as a feed forward response because it is a response that predicts rather than reacts to. It's telling the plant that even though there is still plenty of water and nutrients at your disposal, that you're taking measures to prepare for that condition worsening.

| | | |
|---|---|---|
| John Passioura: | 00:55:10 | We also showed that if you compacted the soil to make the soil a bit harder for the roots to go through, the effect of the drying soil became much earlier because then it was the hardness of the soil rather than the dryness of the soil that was sending the inhibitory signal. |
| John Kirkegaard: | 00:55:38 | John, at the time, you were working on the theory of water uptake by roots, and you were focused on the speed at which water would flow to the roots, as you said and the density. That theory would predict that most of the available water would be taken up in just a couple of weeks. That certainly wasn't the case from field observations. Why do you think the water uptake was so much slower? |
| John Passioura: | 00:56:03 | Well, there are guesses. One obvious reason is that the roots are not uniformly distributed in the soil. But we're often clumped into cracks or large soil pores, often termed biopores. If that was so, the flow of water through the roots, and its uptake was determined more by the distribution of the pores, and how well connected the roots were to the pore walls. |
| John Passioura: | 00:56:27 | The implication of these biopores on root growth, water uptake and crop production was at the centre of many subsequent collaborative studies with soil scientists and agronomists for more than a decade, particularly as it seemed to be responsible for the slow growth of crops and a no-till farming, which was being widely adapted by farmers at that time. |
| John Passioura: | 00:56:48 | No tillage meant more biopores and harder soil in between. Some inhibitory microorganisms could also colonize roots in these pores or in the hard soil between them which ushered in an increased interest in microscopy and targeted microbiology focused right around the surface of the roots. |
| John Kirkegaard: | 00:57:08 | **While you were managing the program, there were other sabbaticals?** |
| John Passioura: | 00:57:11 | Yes. I was invited to go and work with the Scottish Crop Research Institute in Dundee, Scotland for six months in 1991. I set out to explore the physiology underlying the growth rate of roots and leaves. I became especially interested in the |

expansion of the young cereal leaves, as I mentioned before in relation to salinity. That interest was stimulated by a remarkable meeting in Corfu Island off the west of Greece, a meeting that was entitled The Mechanics of Swelling.

| | | |
|---|---|---|
| John Passioura: | 00:57:51 | I met there an extraordinary collection of world leaders, including Nobel laureate Nobel-Laureate Pierre-Gilles de Gennes, who helped me develop a model for the rearrangement of hemicellulose polymers in the walls of growing cells. The growing cells in cereals have got rings of cellulose around them. Those rings are held together by these hemicellulose polymers, because the cellulose is straight and hemicellulose is crooked. |
| John Passioura: | 00:58:22 | The model thereby explained the initial surprising behaviour of the growing leaves whose elongation rate doubled when pressure was applied in the root chamber, thereby doubling the turgor in the growing soils, that is the pressure within the growing cells, but only transiently before returning to the previous elongation rate after about a quarter of an hour, despite having much higher pressures inside them. |
| John Passioura: | 00:58:48 | The reversal so applied, removing the pressure resulted in the leaves stopping their growth totally for a few minutes or so, but only transiently before the growth rate returned to what it had been at the start of the experiment. |
| John Kirkegaard: | 00:59:05 | That behaviour... |
| John Passioura: | 00:59:06 | That behaviour was described by the model that de Gennes helped me build on the role of the hemicellulose links between the cellulose rings in the cells. |
| John Kirkegaard: | 00:59:24 | Scaling back up from cell walls back up to field crops your interest in on farm translation of research became very first hand when you joined the GRDC panel, the Grains Research and Development Corporation. |
| John Passioura: | 00:59:37 | It certainly did. In 1995, I resigned from leading the crop adaptation program because I'd become frustrated by the reluctance of GRDC to support the excellent projects in CSIRO Plant Industry, especially at the time that Allan Green and Surinder Singh were starting on their work for improving the quality of the oils in Lenola, which subsequently resulted in the |

extraordinary achievement of getting canola with omega-3, the real omega-3 fatty acids, which are extremely valuable.

John Passioura: 01:00:18 I threw my hat into that ring. I was fortunately elected to the GRDC southern panel, which had 10 very able members in it, half of whom were farmers. It was influential in many ways, in getting closer to farmers and their advisors in crop genetics and in novel agronomy. John, you are part of all of that.

John Passioura: 01:00:42 Although the membership was supposed to occupy about one month a year, in fact, it required at least three months. It was very successful that six years that I was there.

John Kirkegaard: 01:00:53 **Yes. You remained on that panel right up until close to your retirement in 2002. Since then, you've clearly been a very active retiree and as an Honoury Research Fellow with CSIRO for over 20 years. You've had ongoing and significant impact both in CSIRO and in other organizations. Maybe which of those activities since retirement have meant the most to you and why?**

John Passioura: 01:01:20 Well, I wrote several critical reviews and brought together themes that had been of interest to me but weren't immediately obvious that they were connected. The most important theme, I believe, has been a widespread failure in the agricultural research community to recognize the hierarchical structure of agricultural plants, the layers in which the plants can be thought of operating.

John Passioura: 01:01:47 This has resulted in a slippage of understanding about how important it is to be aware of how high levels in the hierarchy, for example, a crop canopy compared with an individual plant can constrain the behaviour in the lower more detail levels, so that experiments at those lower levels become misguided because they are not aware of the constraints that the higher levels make on them. A leaf with a surface constrains everything that's with inside it, and if they try to do something else, they can't.

John Kirkegaard: 01:02:24 These misunderstandings, I guess, that can be avoided when gas exchange people are playing croquet ...

John Passioura: 01:02:30 Indeed.

| | | |
|---|---|---|
| John Kirkegaard: | 01:02:31 | ... with aspiring cotton agronomist from the Ord, for example. I believe you also, as well as reflecting on your own research programs and an interest, you also were involved in reviewing research programs at other Institutes during that time. |
| John Passioura: | 01:02:45 | Yes. Well, I was asked to take part in a review of one of the CGIAR Institutes of which there are about 15 or so International Agricultural Research Institutes scattered around the world. I was asked to take part in a group that was reviewing the International Center for Agricultural Research in the dry areas whose bailiwick ran from the western side of Morocco, across North Africa, through the Middle East, to Central Asia, in that semi-arid area. |
| John Passioura: | 01:03:25 | The most important point that we made at that time during that review, which involve a couple of weeks to start off with, and then we went home and came back and it broke up to look at various outposts. The most important thing was the very poor agronomy that was going on at the time. That poor agronomy had [major] consequences. |
| John Passioura: | 01:03:53 | Because in North Africa, at least, wheat is a staple food and they only grew half of the wheat that they needed. Two years after our review, the price of wheat doubled. There were riots in all the cities because of that. Tunisia started rebellion, and that started spreading eastwards to the other North African countries through to the Middle East. |
| John Passioura: | 01:04:26 | The consequences of that are still with us in Syria. We had ACIAR, the Australian Centre for International Agricultural Research, having a superb team working on improving the agronomy, and we're doing so by introducing direct tillage, which had the great opportunity of being flexible in sowing time, and that in itself, increased yield by 10%. |
| John Kirkegaard: | 01:04:59 | I guess your other big activity has been here at the Academy. |
| John Passioura: | 01:05:04 | True. But before moving on to that, I also worked as a consultant for CGIAR [Consultative Group for International Agricultural Research] about 10 years ago. I undertook high level reviews of several of their programs, whether they existed or were prospective. Those programs, the CGIAR was trying to get different institutes to interact with each other and the programs that are reviewed. I thought would not enable that. |

| | | |
|---|---|---|
| John Passioura: | 01:05:37 | So, involvement with ... I was elected to the Academy in '94. My first memory of being a Fellow was attending a meeting of the Dining Club. The Fellow who had been running the dining club resigned, and they were looking for somebody else and couldn't find anyone. I said that I would be delighted to do it, which I did for 9 or 10 years. We had initially wonderful meetings. |
| John Passioura: | 01:06:11 | We had very good speakers, and we had very good dinners that followed the talk. But as the years went by, our clientele slowly withered away, because the clientele were people considerably older than myself who came up in an era of scientific leisure, where they could be curious about things. |
| John Passioura: | 01:06:38 | From the mid-'90s, on the pressure on university staff was so great that they couldn't entertain any curiosity about anything except what they were working on, and what the next project proposal was. We never got any of those coming along. Eventually, I asked Suzanne Von Caemmerer, if she would like to take over from me and I would take over the role of essentially MC with those meetings, and we lasted another few years before we just couldn't afford the rising prices with the falling numbers of people who turned up. |
| John Passioura: | 01:07:21 | That was the dining club. Then in 1999, David Curtis, a former President, asked me if I would take over from him as the Chair of the Board of Historical Records of Australian Science, which I did, which he had been the Chair of. It was an interesting, though time consuming task to find authors to write scientific obituaries and to encourage them to do so in a timely fashion. |
| John Passioura: | 01:07:51 | I served on the board for nine years, until four years ago until Chris Dickman took over. Then, in 2015, I was asked to represent the Academy on the National Library of Australia's Fellowship Advisory Committee. They have about 10 fellowships a year for senior academics to come and look at various bits of the enormous supply of archives at the National Library holds to develop a theme that they had been interested in. |
| John Passioura: | 01:08:31 | The Fellowship Advisory Committee also dealt with summer students who would be PhD students and they would be there for only six weeks or so. It was a very gruelling exercise. I mean, they've got 150 applicants. They've got 10 who get in and getting unanimity or close to unanimity amongst the committee was pretty good at the beginning, but it became more difficult. |

John Passioura: 01:09:04 I retired from that a year early, because I felt that anything that I had to offer was pretty well random and wouldn't have any effect on who was selected. But those 10 people would be asked to give full lectures at the Library at the end of their time there. Then you get a couple of 100 people in the Library at that time. I was just amazed at what the National Library, what things they could do with archives, which you would never have imagined had you not been told.

John Kirkegaard: 01:09:43 **John, getting back to agriculture and the challenges of food production in the face of climate change seem to me to call on a whole new generation of John Passioura's to continue the search for physiological understanding of genetic and agronomic adaptations. What is your or advice to young people interested in a career in agricultural science focused on global food security?**

John Passioura: 01:10:07 Well, I hate to say it, but it's not very enthusiastic and why? Well, the pressure on young scientists to publish in high impact journals is much too great. It's frequently much too displaced. Many of these journals are high impact, because they allow scientists with trivial projects, to review each other's papers.

John Passioura: 01:10:36 They do so without any idea of the paper's agricultural significance. For example, there are about 5,000 or 6,000 papers — 5,000 when I wrote a review on translational research in agriculture, a couple of years ago. These molecular biologists put yet another gene into another batch of Arabidopsis looking for drought resistance or salinity resistance.

John Passioura: 01:11:07 Five thousand of them then achieved nothing, one did. That one required 20 more years work to go from what these papers were to getting into the field and getting into farmer's fields. None of the others can do that. While I was writing that review, I came across a paper written in a small news sheet, associated with the National Academy of Sciences in the US by a fellow called Mark Neff, who wrote a devastating criticism of the irrelevance of much of the work that is being done and being treated as high impact with the title of How Academic Science Gave Its Soul to the Publishing Industry.

John Passioura: 01:12:01 How you make dents in the armour of most of the publishing industry is almost beyond academic science, I say. It is beyond academic science. I think that the only hope is for funding agencies, like the NAS [?], or the ARC [Australian Research Council] of Australia not to be swayed by claims of utility in research proposals without such proposals being reviewed by other scientists who know what utility means.

John Passioura: 01:12:29 Then not only would you cut out the rubbish, you would enable those who had something of real utility to go to work on it and the people working on the rubbish to actually start looking at functional aspects of the systems that interest them rather than putting another gene in to no effect.

John Kirkegaard: 01:12:55 I guess which comes back to that connectedness to people working at different scales.

John Passioura: 01:12:59 Exactly.

John Kirkegaard: 01:13:01 **Just moving to life outside work?**

John Passioura: 01:13:07 55 years in Canberra accumulates many diverse friends and colleagues of great importance as one's family. For example, my wife, who's Kaye Johnston, was prominent in the women's electoral lobby in the early '70s, which I took an interest in and later when she became a guide at the National Gallery and the Classics Museum at the ANU [Australian National University] and she was also prominent in helping manage and make costumes for the Canberra Dance Theatre when that was active, at a time when Graham Farquhar was one of its members.

John Passioura: 01:13:39 I took interest in all of such activities, which greatly expanded the number of friendships. But going more widely than that, I've picked up many friends ranging from heavyweights in politics, for example, John Kerin, who was Minister for Agriculture in the Hawke years, and Michael Keating, who was the boss of Prime Minister and Cabinet during Paul Keating's premiership and being members of the Australian Garden History Society in Botanic Gardens and you pick up a lot of people of very diverse backgrounds in all of that.

John Passioura: 01:14:20 There is, I think, a now discredited number called the Dunbar number which says 150 people is the most that you can stay friends with. But it turns out that it's much more variable than that.

John Kirkegaard: 01:14:38 Looking back on your career, do you sense a unifying theme?

| | | |
|---|---|---|
| John Passioura: | [01:14:43]() | Well, I do. Let me try and convince you. In my scientific life, I have been a sole chemist, a sole physicist, a biophysical chemist studying the polymer chemistry of cell walls in leaves that controls how fast leaves grow. An agronomist, a pre-breeder, a substantial contributor to plant and soil water relations, a co-discoverer of inhibitory signals from roots that modulate the behaviour of the leaves, and an analytical philosophy. Does that sound bewildering? |
| John Passioura: | [01:15:19]() | Well, all of those areas of concerned improving agricultural productivity, the transitions have been almost seamless, largely because of serendipitously chancing upon related phenomena that I thought I could usefully explore, as in Pasteur's Chance Favours the Prepared Mind. Similar stories apply to most of my colleagues, including you, especially you. |
| John Passioura: | [01:15:45]() | That's not the random bouncing around that inspires these transitions. It's the curiosity about what other people are productively doing in one scientific or even administrative neighbourhood. Finally, I'd like to thank the many visitors that local colleagues and I have attracted over the years. These include many from the northern hemisphere, especially Champ Tanner, John Boyer, Joe Ritchie, Paul Jarvis, Mark Westgate, Missy Holbrook, Ken Shackel, Wendy Silk, Grant Cramer, Thomas Gollan, Ian Dodd, and the highly entertaining Ulrich Zimmerman. |
| John Passioura: | [01:16:31]() | One of those visitors came and stayed. That was Margaret McCully, a Canadian who is the very eminent microscopist, who was invited to come to the Division of Plant Industry by the GRDC because of her immense knowledge about roots and microorganisms in undisturbed field soil. That came out of a meeting of the Southern panel of the GRDC that I was on at that time. |
| John Passioura: | [01:17:02]() | I talked to the other members of that saying, "This woman is amazing, and it would be good to invite her because they were just becoming interested in microbial underground work." She decided when she arrived to retire from Carleton University in Ottawa. |
| John Kirkegaard: | [01:17:23]() | In the same way you retired? |

| | | |
|---|---|---|
| John Passioura: | 01:17:25 | Yes, thereafter stayed as an honorary Fellow with CSIRO for many years, during which time she organized annual one day meetings, including visitors from overseas, meetings on microscopy that attracted full houses. They were fantastic. |
| John Kirkegaard: | 01:17:43 | I can't imagine that you don't have a next move planned? |
| John Passioura: | 01:17:47 | My next move will be in the next few weeks. I hope to take my experimental equipment with me, which would otherwise be buried in the skip. COVID disrupted the experiments that I was doing with that equipment on your soil samples, which I couldn't finish. I can now resume those experiments to find out why it is that deep roots take up water so slowly, which is totally at odds with the simple physical chemistry of water movement in soils. |
| John Kirkegaard: | 01:18:21 | Well, I might join you, John, and good luck with that project. Thanks for sharing these insights in your career. As one of the many who has benefited tremendously from your friendship and mentorship, I can assure you that your focus on rigor and relevance in science lives on in all of us, as does your plea for us to find time for more scientific leisure from which creativity springs. Thanks a lot. |
| John Passioura: | 01:18:43 | Thank you, John. |